UNIVERSITY OF SOUTHAMPTON

MESOLITHIC AND NEOLITHIC CERAMICS IN THE CENTRAL SUDAN, 8TH-3RD MILLENNIUM B.C., WITH SPECIAL REFERENCE TO THE PHYSICO-SCIENTIFIC APPROACH

VOL.1

A thesis presented for the degree of Doctor of Philosophy

by

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November, 1995

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

FACULTY OF ARTS
ARCHAEOLOGY

Doctor of Philosophy

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This dissertation describes a course of research undertaken by the present writer at the Department of Archaeology, Faculty of Arts, Southampton University, the goal of which was to shed further lights on technological aspects of Mesolithic and Neolithic ceramics in the central Sudan.

Since Arkell's work in 1940's and early 1950's, the picture of the Mesolithic and Neolithic ceramics in the central Sudan (apart from small-scale attempts of T.R. Hays [1971], H. Nordstrom [1972], T.R. Hays and F. Hassan] [1974], D.F. Williams [1982] De Paepe [1986] and M. Chlodnicki [1989]) has remained inconspicuous.

The origin(s) of these ceramic assemblages as well as the cultural mechanisms articulating the various human groups inhabiting the central Sudan during the Mesolithic and Neolithic periods are not obvious. The technological aspects of ceramics have not been fully investigated and utilized. Nonetheless, some conclusions have been put forward and sometimes accepted as working hypotheses.

Releasing itself from the emphasis on the traditional artifactual comparative analyses, the present work attempts to bring the physico-scientific approach-in a wider scale-to the study of the Mesolithic and Neolithic ceramics in the central Sudan by applying a series of the most recent techniques of petrological, chemical (X-ray-fluorescence spectrometry), petrochemical (Goethite Norm calculations), X-ray diffraction, thermal (DLT) and computer analyses to the selected data (cf. chapters 3-8).

Ample samples have been chosen in the light of the beset objectives in an attempt to attain satisfactory conclusions.

Looking at the Mesolithic and Neolithic ceramics in the central Sudan from a broader perspective, in order to enhance our knowledge about the unexplored aspects of this field of research, to fill the gaps and eliminate the weak sides of the previous small-scale endeavours, the present programme, which is rather wider in scope, has been designed to clarify the situation.

As a result of the fabric analyses carried out in the present work, technological differences were observed and even some ceramic groups were distinguished in the chronological developments (see supra and chapters 3-11). Moreover, using a hypothetical model (cf. chapter 9) and utilizing the results of the physico-scientific analyses, the present research has shed new lights on the nature of the Mesolithic and Neolithic ceramic distribution in the central Sudan at both intraregional and interregional levels.

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Acknowledgments

The present research would not have seen the horizon without the stimulating influence of many. First of all, I would like to express my deep gratitude to my supervisor Professor David Peacock, and advisor Dr. D.F. Williams, for their expert advice, useful guidance and constructive criticisms in the course of the work.

I spent many stimulating and inspiring hours discussing various aspects of my research with Professor David Peacock. He has kindly provided with me with rare books from his private library and helped in putting the facilities of the Department of Archaeology, Southampton University at my disposal. His patient guidance and useful advice have strengthened my confidence that the research approach I have chosen had a promising potential.

I also benefited from Dr. David Williams encouragement, fruitful discussions of various issues pertaining to my dissertation, particularly petrological analyses which have substantially contributed to this research.

I appreciate the help given from Professors P.J. Ucko and B. Sparkes whose continuous correspondence during their headship of Archaeology Department, accelerated my enrollment in an M.Phil-Ph.D. programme at Southampton University.

I am very grateful to Professor Ahmed. M.A.Hakem, then the General Director of the Sudan Antiquities Service, for giving me permission to conduct three test-excavations at the Mesolithic site of Sarurab2 and the Neolithic ones of Islang2 and Nofalab2 in the vicinity of Khartoum district.

Many thanks are due to Professor L. Van Der Plas, Department of Soil Science and Geology, Wageningen Agricultural University, Holland and his associates (Mr. J. Van Doesburg and Mr. A.J. Kuyper) for allowing me to make full use of the facilities at their laboratories during my one-month stay in Wageningen commencing 9th March-5th April 1993. The fruitful discussions and valuable help received are highly appreciated.

Appreciation goes to the staff of Tcki De Steeg Ceramic Factory in Netherlands who helped in the DLT analyses of some pottery samples.

I am especially grateful to Dr. Abbas S. Mohamed-Ali, Department of Archaeology, King Saud University for his valuable comments on some portions of the work. Through his acquaintance and recommendation, I was able to collect sufficient samples from Shaqadud site, being presently stored at Southern Methodist University in Texas.

I owe a debt of gratitude to Dr. Yousif. M. Elamin of Archaeology Department, King Saud University, Riyadh whose fruitful discussions and valuable comments on some chapters are beyond evaluation.

Warm thanks are extended to Professor, Anthony Marks, Southern Methodist University, Texas who was generously put at my disposal adequate Mesolithic and Neolithic ceramic samples from Shaqadud Complex site and provided me with sections, maps of the sites and useful articles.

I am also grateful to my teacher Professor Randi Haaland of Historic Museum, University of Bergen, Norway who supplied me with pottery samples from her excavations at Rabak Neolithic site in the White Nile district and useful publications.

My sincere thanks are due to Professor Isabella Caneva, Department of Archaeology, Rome University who provided me with pottery samples from her excavations at Kabbashi Haitah, Kabbashi (Mesolithic) and Geili (Neolithic) sites and for supplying me with valuable publications.

I am extremely thankful to Professor J.D. Clark of Anthropology Department, University of California, Berkeley who provided me with pottery samples from his excavation at Shabona Mesolithic site in the White Nile district and for supplying me with valuable references.

I must record special thanks to my colleagues Mr. Hassan Hussein Idris, the Director of the Sudan Antiquities Service, Mr. Siddiq M. Gesm-al Seed, the Curator of the Sudan National Museum and Dr. Salah M. Ahmed, the Head of the Antiquities Inspection Division for giving me export permits to ship my material for England, Saudi Arabia and the facilities they rendered while I was conducting my field work.

I owe a special debt to Dr. Osman El-Hassan, associate Professor of statistics at King Saud University for his advice on some portions of the work.

Many thanks are extended to Dr. Angela Close, Department of Anthropology, Washington State University who provided me with valuable publications.

Appreciation goes to Professor Abdelgadir M. Abdulla for providing me with some valuable articles.

I am grateful to my friend and colleague Dr. Faisal El-Sheikh of Archaeology Department, Khartoum University for his role in granting me permission to use the facilities of Khartoum University and for allowing me to do some paper works in his office.

Thanks are due to Mr. Nick Bradford of Archaeology Department, Southampton University for his nice black/white photography of some artifacts.

Special thanks are due to my friends and colleagues Mr. Ali M.A. Koko who joined me in the field and Mr. Hassan El-Farrash who helped in drawing the figures.

I must record special thanks to my colleagues and friends Hussein Salim and Elamin H. Dai (Department of Geography, King Saud University, Riyadh) for the laboratory and photographic facilities they provided.

The hospitality and friendship of the inhabitants of Bauda village (Sarurab district) have made my stay in the area an enjoyable time.

My family deserves special thanks for encouragement and support.

My final and foremost thanks are extended to my wife, Nawal. It would never have been possible for me to accomplish the present work without her continuous help and moral support.

Declaration

The detailed research described in this dissertaion is the result of my own work, except where specific acknowledgement is made.

Chapter 1
1. Introduction

This introductory chapter aims to give the necessary background to the nature of the topic, problems of terminology, classifications as well as the scope and methodology of the present research. The importance of this chapter lies in the fact that the manner in which the writer viewed its contents influences the way in which he has tackled the research.

1.1.- Pottery and ceramics: a problem of terminology

At one time the name 'ceramics' was thought to refer only to the art of pottery making. The current etymology of the term shows that it has been derived from the Greek word 'Keramos' now commonly meaning 'a pottery', 'a potter's clay' or 'pottery', but the Greek word is related to an old Sanskrit root meaning 'to burn', and as used by the Greeks themselves, its primary meaning being 'burnt stuff' (Wilson 1927:1). Although in popular usage "ceramics" denotes materials made of clay, modern science applies the term more broadly to chemical compounds combining metallic elements (which give up electrons) with nonmetallic ones (which add or share electrons). Despite the fact that some ceramics are compositionally complex, they may also contain simple oxides of aluminum (A12 O3), magnesium (Mgo) or barium (Ba Ti O3)(Rice 1987:3-4). The word 'ceramics' has two sets of overlapping meaning, one set employed in material science and another used in archaeology. In material science, it is a broad term referring either to a wide range of compounds of metals and non-metals or, often slightly more restrictively, to materials made from silicates (usually clays) and hardened by applying heat. The term also embraces the research and applied fields developed around these products, that is, ceramic science, ceramic engineering and ceramic industries. Pottery is one of several specific industries within the overall ceramic field and includes low and high-fired tableware, utensils and tiles, and other ceramic industries which manufacture electrical, structural, glass or refractory products (Grimshow 1971:35).

In art and archaeology the term 'ceramics' usually excludes construction or industrial products (cements, bricks, abrasives, etc.) and denotes the plastic arts and clay. Within these domains, 'ceramics' refers to cooking and serving utensils, and objects manufactured of clay (Rice 1987:4). However, in the present research the

term 'ceramics' is used to mean only the art of pottery making. That is why it is frequently used as synonymous to the word 'pottery'.

1.2. Potential of ceramic studies

The objectives of ceramic studies are diverse though the ultimate aim is to achieve a better understanding of Man through the material remains that have been left for us to excavate. On this point Matson states:-

"Unless ceramic studies lead to a better understanding of the cultural context in which the objects were made and used they form a sterile record of limited worth" (Matson 1965: 202).

It is noteworthy that the traditional ceramics specialist sees his ceramic material as a means of dating, a sign of cultural diffusion and as an indication of ethnic and cultural identity (Renfrew 1977:3). Conversely, the current ceramic studies indicate changing emphasis from chronology and ethnic identification to subjects such as economics, social structure, psychology and artistic competence of producers. In response to this change in the goals and interests of ceramic research, new approaches have been introduced to the field of ceramics including ecological and technological approaches alongside the traditional approaches of typological analyses.

Ecological approach has recently been introduced to the field of ceramic archaeology with improved recovery methods for plant remains (by flotation) and faunal remains (by sieving) (Peacock 1977:3). The study of pottery in ecological terms is approached through the examination of the three elements of ceramic ecology-physical, biological and cultural (Matson 1965:213).

Changes in physical environment are relatively rare and in general there have been major climatic changes during the Holocene. Floods, deforestation of mountains as well as changes in river courses have only minor effects on pottery production, though they might result in a change in texture or even in the colour of ware (ibid).

Changes in biological environment such as diseases, drought and acts of man would have direct effects on ceramic products. For instance in Iran there was a

drought in early 1950's resulting in poor crops that were devastated by insects. Then the farmers changed to barley instead of wheat because there is a better chance for harvest. The only ceramic record of this reduction in food supply might be the fewer vessels that are made at a given period of time partly as a result of decrease in population (ibid.).

Changes in cultural environment as a result of outside contact, changes in social habits and customs and political conditions might have direct effects on the ceramic output of people (Shepard 1956:350). Foreign contact can lead to ceramic change as a result of introduction of new decorative concepts, vessel shapes or techniques of manufacture such as slipping, polishing or the use of superior temper without concomitant changes in stylistic designs. (ibid).

Change in social habits and customs of people may affect ceramic production. For instance at Isamu-Pati, an iron age site in Zambia, the upper most levels contained higher proportions of bones than the lower ones. At the same time, pottery changed dramatically from predominance of simple bag-shaped vessels to spherical shaped pots with out-turned lips which could only have contained liquid. This has been taken as a clue to change in dietary habits, perhaps an increase in milk consumption (Fagan 1972:210).

On the other hand, the technological approach has several advantages in ceramic studies, for it explains the main role played by the potter in terms of material exercised, methods of building and shaping and more important it affords possibility for determining the source of material utilized. Hence local or intrusive pottery production can be ascertained. The importance of this approach was advocated by Anna Shepard with the following statement:-

"In stating the role of ceramic technology, I am inclined therefore to stress not its accuracy and reliability, not the data it covers, not even the special advantage it offers for determining the sources and relationships of pottery, for these contributions are recognized in some measure at least, rather I would bring out the fact that ceramic technology places the human factor in proper perspective" (Shepard 1956:4-5).

1.3. History of ceramic research

Ceramics are one of the most common products of man's culture. They are relatively widespread in almost every archaeological context, their imperishable nature, being stable in a wide variety of contexts (Rye 1981:9), their resistance through time and their almost universal presence have made them a very important tool for the archaeologist in his study of the past (Arnold 1985:1).

Ceramics can be geared toward various studies. However, the main purpose of ceramic analysis is to reconstruct the general conditions of the potters, and to place in cultural context the various factors that guided their work (Nordstrom 1972:34). A series of ceramic researches have been conducted in different areas, applying differing approaches to achieve specific objectives. Some of these examples will be cited here to enhance our knowledge about the state of the present research in the field of ceramic archaeology.

The pioneering work of Shepard 'Ceramics for Archaeologist' (Shepard 1956) in which she has described not only the physico-chemical techniques in analyzing pottery but also methods of classifying shape and decoration. This work has remained the standard text-book for students of Archaeological Ceramics. Her ceramic data was derived from American Indian pottery. She has applied petrological analysis in 1930's to the study of glazed pottery from Rio Grande valley of New Mexico (Shepard 1965:62-87). Her aim was to study the development of ceramic technology and trade in that area.

Pottery has often been taken by some scholars as a decisive factor for determining the concept of 'culture' in archaeological context. In his 'Danube in prehistory', Childe defined 'archaeological culture' as 'certain types of remains-pots, implements, ornaments, burial rites, house forms-constantly recurring together' (Childe 1929: 417).

Matson has advocated the application of ecological approach in the study of ceramics. He has emphasized the study of the three elements of ceramic ecology i.e. physical, biological and cultural and applied this approach in the study of the

early cultures in the Near East recognized at Jericho, Jarmo and Catal Huyuk (Matson 1965: 202-17).

Ethnographic approach of ceramics has been widely applied by several workers in different parts of the world. Arnold has applied this approach in his study of contemporary south American ceramics in Mexico, Peru and Guatemala (Arnold 1981:31-44 & 1985). The work of Peacock on Roman pottery selected from different parts of the Roman World is another comprehensive example in this direction. His aim was to understand the processes operating in the Roman ceramic industry (Peacock 1982).

Balfet has made an ethnographic study on the processes of pottery making in North Africa. She was interested in relationship between the hand-made pottery which is produced by women and wheel-made pottery which is produced by men in workshops in villages and towns (Balfet 1965:161-77).

Van der Leeuw has studied three pottery groups, two of which were derived from Medieval potters' workshop of Haarlem and Neolithic beakers in Netherlands. The third group represents Medieval pottery from Tabaqa basin on Euphrates river in Syria. His aims have focused upon developing a theoretical framework in which the technological approach to pottery may be fitted, and upon the objectives for which one may achieve with technological analysis of pottery as a tool (Leeuw 1976).

Loughlin has conducted analyses on Dales wares of Roman period in England dated from c. 20 to A.D. 320. The study has attempted to elucidate something of the socio-economic environment within which Dales and other contemporary types of coarse Roman pottery were produced and marketed. (Loughlin 1977: 85-146).

Howard has stressed the importance of an integrated approach to ceramic studies and described the promising results obtained from an ecological-technological approach. She has applied this approach in her study of the British Neolithic site of Windmill Located on the Chalk Uplands of Wessex (Howard 1981:1-30).

Buko has studied the provenance of pottery of the medieval site of Sendamierz in Southern Poland. His approach combines the analysis of raw materials of the regions in question with detailed examination of ceramics to establish precise provenance of pottery (Buko 1984:348-65).

In the Nile valley the pioneering work of Petrie early this century on Egyptian predynastic cultures has introduced pottery seriation to establish Sequence Dating for the predynastic period (Petrie 1900; 1920). His periodization of Egyptian predynastic cultures in Upper Egypt begin with Amratian (Nagada I) which is characterized by red pottery with white infilled cross-lines followed by Gerzean (Nagada II) which is distinguished by wavy-handled wares decorated mainly with zoomorphic designs (ibid). This chronological scheme for predynastic Egypt has been further modified by Kaiser (1957). Based his work on analysis of pottery types, Kaiser shows that there are really four major phases from Badarian, Nagada I (Amratian), Naqada II (Gerzean) and Naqada II (Semainean)(ibid). These cultures have recently got a series of radiocarbon dates in the magnitude of early fourth millennium B.C., late fourth millennium B.C., the first half of the third millennium B.C. and late third millennium B.C. respectively (Hays 1984: 211-19; Hassan 1984b: 681-83; Hassan 1985: 100-2; 106-12).

1.3.2 Inside Sudan

In Sudan ceramic research began in response to the erection of the first Aswan dam 1902-1910. This work has brought to light archaeological "cultures" which are varied in both technological position and material finds. The discoveries have stimulated the non-rescue compaigns of British and American institutions namely Oxford, Pennsylavania and the Harvard-Boston Expeditions. The main emphasis of these expeditions was directed towards monuments, temples, cemeteries and Kings' inscriptions. Although pottery did not stimulate early researchers, they have been accustomed to identify sites as belonging to periods such as A-Group (c-3400-2000 B.C.) C-Group (c.2000-1500 B.C.) or Meroitic (c. 1000 B.C.-A.D. 325) on the basis of ceramic evidence (Adams 1962:245). The publications of A-Group and C-Group sites from Sudanese Nubia particularly those from Faras and from Gemai south of the Second Cataract, have brought to light brief ceramic reports (Bates and Dunham 1927). Randall MacIver and Woolley (1909-1911), Woolley (1911), Kirwan (1938) and Dunham (1957) have published interim reports on Meroitic pottery derived from cemeteries and habitation sites in lower Nubia.

Reisner has made a detailed study on the major part of pottery from Kerma site (c.2400-1500 B.C.) which lies on the eastern bank of the main Nile near the third cataract (cf.fig.1) (Reisner 1923:320-504). The excavator used five classificatory attributes for his analysis: form, technique, function, material and geographical origin. Then he divided all his ceramic material (mostly complete vessels derived from graves) into eighteen 'varieties of ware' which are further assembled into three large groups namely:Fine wares, Egyptianized wares and local coarse wares (ibid). Reading through Reisner's account it appears that his work suffers from several drawbacks resulting mainly from the selection of some unsatisfactory attributes and the inconsistency in his classificatory procedure. His attributes 'material' and 'geographical origin' mentioned above are not mutually exclusive to designate two separate groups. In addition to that, some of his attributes (e.g. technique) and labels (e.g. ware variety) are not rigorously defined through his work. It is clear that he doesn't use his 'technique' as an independent attribute to segregate specific phenomenon on his pottery corpus (e.g. technique of building and shaping) but instead he used it as a blanket term to encompass techniques of decoration (ibid: 447-53) and surface finish as well (ibid: 329-30). Moreover, he sometimes used multiple and loosely defined criteria to refer to his 'ware variety'. For example, one of his "ware varieties" is classed as 'ordinary red ware of varying quality' whereas others are labelled 'ordinary red ware with white slip or wash' or 'ordinary red ware with polished white slip'. (ibid. 325-26). It is noteworthy that the principal groups of his classificatory scheme are devoid of "decoration" as an essential attribute to be considered. (see Reinsner 1923:320). Nevertheless, Reisner often gives a cursory description to the decorations depicted on Kerma pottery with special emphasis on the techniques employed (Ibid:445-78, Pl. 70:1-5;Pl. 7:1; Pl. 72:2: Pl. 77:5).

Further south on the Blue Nile region, the work of Addison (1949) and Addison and Crawford (1951) has provided us with general pottery description mainly of Meroitic date.

Arkell's analyses and classifications of the Neolithic pottery from Early Khartoum and Shaheinab and from other sites in Khartoum Province (1949, 1953) as well as pottery finds from Libyan desert (1964), which remain the classic typology for Nilotic sequence, have been very important for interpretations of

similar pottery found in other archaeological contexts in the Sudan. Remarkably, the early pottery reports are of descriptive nature and no technological analyses were carried out. In Nubian Survey publications pottery assemblages are described mainly in terms of decorative features. Important features such as details of surface treatment were not considered. Despite the fact that the illustrations of the vessel shapes are abundant in most publications, it is difficult if not impossible to reconstruct an exact picture of all ceramic material that was found during the excavations before the international Nubian campaigns (Nordstrom 1972:33-34).

The work of Adams (1962, 1964, 1967, 1968, 1976 and 1986) marks the beginning of the formal ceramic research in Sudan. Adams analyses and classifications of the Meroitic, X-group and Christian pottery from Sudanese Nubia are pioneer examples of taxonomic classifications in Sudanese pottery. However, Adams has assembled all the progress reports of his previous classifications under one title named 'Ceramic Industries of Medieval Nubia' (Adams 1986). In that revised work, he has dealt with a large body of ceramic material unearthed from cemeteries and habitation sites in lower Nubia.

To deal with painted pottery, he has devised highly formal classification involving about a dozen major styles, two dozen minor styles and more than 2250 individual motifs. Vessel form was analyzed into 26 dozen classes and 640 individual forms. Other areas have been treated more informally; surface treatment (for example) was divided into a small number of basically alternative categories such as 'rough', 'matte', 'polished', 'burnished', 'glazed' and so on. Despite the wide range of hues, he found it reasonable to classify the decorative colours into five groups: White, yellow, orange, red and black. (Adams 1976: 81-83).

In applying taxonomic scheme, he has chosen seven attributes which could be arranged in ascending hierarchy of significance as follows:1 method of manufacture; 2 fabric; 3 form; 4 painted decoration; 5 relief decoration; 6 colours and 7 surface finish. From the recurring combinations of these attributes, four levels of taxonomic discriminations were recognized and designated: traditions (the most general level), families, ware groups and wares. Traditions are differentiated on the basis of method of manufacture alone. As a result two traditions are recognized:Wheel-made and hand-made. Families, within each tradition are distinguished from one another on the basis of fabric. Ware groups within each of

the major families are differentiated on the basis of two additional fields of variability: Vessel form and decoration (Adams 1976:63-70).

In his chronological chart Adams has proposed periodization of Nubian cultural history into successive developmental stages from one to three centuries (C. 200-1500 A.D.). Seven main chronological stages (index clusters) are included: Metroitic (C. 200-400 A.D.):- Dominant in this stage are Meroitic wheel-made wares in group NI and hand-made wares occur in Group D.I. X-Group (C.400-600 A.D.):- In this transional stage X-Group wares of Group NII have begun to appear but they are still outnumbered by Meroitic wares of Group N.I. Hand-made wares are represented by Group D.I and D.II .Imported wares as about as before. Early Christian (C. 600-850 A.D.):- Ceramics continue to be dominated by X-Group wares (Group N.II). Hand-made ware represented by Group D.II. Classic Christian (C. 850-1100 A.D.) displays wheel-made pottery of Group N. III and N. IV. Hand-made pottery of Group D.II, D.III are prevalent. Late Christian(C.1100-1400 A.D.):- Wheel-made pottery is represented by Group N.V and N. VI whereas hand-made pottery is as much as before and of the same groups. Terminal Christian (C.1400-1500 A.D.):- It is distinguished by increase in the quantity of hand-made pottery and glazed wares of Group G.IV significantly increased. Post-Christian (C. after 1500 A.D.) pottery is overwhelmingly hand-made (chiefly of Group A.II but with minor quantity of Group D.IV) and there is a gradual disappearance of wheel-made pottery. (Adams 1986: 10-11, 601-632).

Adams's classifactory scheme has solely been directed to the problem of dating and hence he has not thoroughly explored the potentialities of his tremendous ceramic material to reap the maximum beneficence of his data.

The work is devoid of physico-chemical analyses and other scientific techniques which have been developed in recent years. Adams was aware of this limitation and he expressed his desire that such type of analyses to be carried out in the foreseeable future by one or more expeditions (see Adams 1986:9).

Adams confessed that in his work he didn't furnish any place for the recognition of individual artistic creativity or creative diversity nor has he dealt, in any systematic way, with the dynamics, of change but he has given only passing

attention to the external influences-artistic and historical-that are manifested in the development of Nubian pottery (ibid: II).

In the writers' view, Adams's work depends almost entirely on unstratified collections, therefore his relative ages for the Nubian sites had been inferred indirectly and the task of correlation was complicated because of the lack of sites in lower Nubia of short occupation (e.g. see Adams 1962:17-18 and 1986:601) having just sufficient time overlap to relate them. Furthermore, the lack of stratigraphy in almost all the archaeological contexts dealt with (with the exception of Qasr Ibrim and Meinarti)(cf. ibid:601-603) has led him to devise conceptual designations whose cultural reality could not have been rigorously tested. Nevertheless, some workers are on the belief that his classificatory scheme of Nubian ceramics is the most satisfactory of Meroitic wares to date and it is based on material of wider and temporal distribution than was available for previous or later studies (Ahmed 1984: 121).

Nordstorm in his publication 'Neolithic and A-Group sites' has devised a taxonomic scheme for the study of Early and Middle Nubian pottery, the former includes the Neolithic ceramics in that area (Nordstrom 1972: 33-94) (see below).

Hays and Hassan qualitative analysis of the Neolithic ceramics of "Khartoum Horizon style" in Sudan and adjacent zones provides further example for the classifications which are based on more rigorous approaches (Hays and Hassan 1974:72-79)(see below). Despite their pitfalls, the preceeding three classifactory schemes have laid down the footing for future work on Sudanese pottery. It is hoped that the present work would attempt to carry this line of investigation a step forward.

1.4. Terminology of the "Mesolithic" and "Neolithic"

The pioneer work of Arkell (1949 and 1953) at the two late Prehistoric key-sites: Khartoum Hospital and Shaheinab led him to propose an evolutionary stage of culture development from a "Mesolithic" to a "Neolithic" stage with its origin in the Khartoum district. He introduced the terms "Mesolithic" and "Neolithic" for the first time in the literature of prehistoric studies of the central Nile valley.

The term "Mesolithic" in the name of "Khartoum Mesolithic" which was proposed by Arkell for the cultural assemblages recovered from Khartoum Hospital site "is intended to denote a food gathering culture younger than those of Palaeolithic age and earlier than the establishment of Neolithic culture in the Khartoum area" (Arkell 1953:102). He justified its applicability by the lack of direct evidence for either plants or animal domestication (ibid). Since that time the term has widely been used in the literature (e.g. Arkell and Ucko 1965:145-166; Clark 1965:158, 1967:601-627; Marks et al 1968:319-323, 1985:261-278; Marks and Mohamed Ali 1991; Shiner et al 1971; Hays 1971, 1974:27-32, 1975: 193-204; Caneva 1983, 1988; Mohamed Ali and Marks 1984:52-59; Elamin and Khabir 1987:175-185; Haaland 1987; Haaland and Magid 1991:36-43 and Hassan 1986: 83-102). However, "Mesolithic" is an entity originally used to define a particular archaeological material in Europe. Specifically, this term is referred to hunters'/fishers' groups in northern European plain territories most severely affected by the environmental changes at the close of the Pleistocene. The neothermal inhabitants of these regions had to adapt themselves to a landscape from tundra and open plain to closed forests. Even with the rest of the European continent it seems that no much change had taken place (Clark 1971:79-94). The climatic changes of Northern Europe would not seem to have profound effects on the remaining parts of the old world. In southwest Asia for instance, the weather was not quite violent as it was in Europe (Braidwood 1975:92). It is argued that the term "Mesolithic" is not properly applicable in southwest Asia because there is a little time lag and comparatively little difference between the Mesolithic hunters at the very end of the Pleistocene and the ones which accompany the initial traces of growing or at least the reaping of the cereals (Roe 1970:95). In African context, some scholars believe that its usage as a blanket term for similar archaeological finds in the continent is really confusing and should be discontinued because the situation of northern Europe has no clear equivalent in Africa (e.g. Balout 1965:156; Hassan 1986:83-102 and Mohamed-Ali 1973). The former states:-

"The definition of 'Mesolithic' is peculiar to Europe where it is applied to describe the intermediate period between the Palaeolithic with extinct and emigrant animals and the Neolithic with present fauna"

Nevertheless, this term has been used by some workers in the field of Nilotic prehistory (see supra). Hays, though believed that considerable confusion has

resulted from the use of the label "Khartoum" by Arkell (1949 and 1953), yet, he postulated that the term "Khartoum Mesolithic" be retained but the "Khartoum Neolithic" be replaced by "Shaheinab Neolithic". The latter term was occasionally used by Mohamed-Ali (1982) and it seems that most felt it merely adds a new nomenclature in a situation where there were already more than enough (Marks and Mohamed-Ali 1991:14).

It is noteworthy that the introduction of the term "Neolithic" in Arkells' publications (1949 and 1953) has led to another heated debate amongst the scholars working in Nile valley, Sahara and subsaharn Africa. However, the term was first used by John Lubbock in his "prehistoric Times" to denote later stone age "new stone age" in which stone implements became more skillfully made and more varied in form. According to Burkitt, the "Neolithic" is characterized by four diagnostic traits:the practice of agriculture, the domestication of animals, the manufacture of pottery, the domestication of plants, the manufacture of pottery and the polishing of stone-tools (Daniel 1963:58). There is no common accord between prehistorians as to the cultural traits that are necessary for any prehistoric communities to be termed "Neolithic". Most English-speaking prehistorians stress the economic tissue of the communities reserving the term for communities that depend partly or wholly on food production, i.e. agriculture and animal husbandry but not metal-users. For instance Smith pointed out that in European and Near Eastern prehistory, the term "Neolithic" be retained for communities that practised plant and animal domestication (Smith 1980:452). According to him the application of such definition to the Nile valley and Saharan Africa would not serve the purpose since ceramics predate the initial appearance of plants and animal domestication (ibid). Hays (1971 and 1975:75-201) suggested the use of the term "Subneolithic" for people who maintained "Mesolithic" economy but possessed certain technological aspects of Neolithic artifacts. Consequently, the term "Neolithic" according to him be reserved for those sites which contain evidence for domestication. On the other hand, Desmond Clark preferred that the use of the term "Neolithic" be retained for African industries within the zones of the Nile valley and Mediterranean littoral (Clark 1967:621).

In the central Nile valley most workers have favoured to use the term "Neolithic" despite the absence of an evidence for plant and animal domestication in this area before the fourth millennium B.C. (Arkell 1949 and 1953; Chittick

1955: 75-8; Arkell and Ucko 1965: 145-166; Clark 1967: 601-628, 1980:527-580; Shiner et al 1971; Hays 1971, 1974 and 1975; Nordstrom 1972: 1-94; Krzyzaniak 1974:30-32, 1977:144-146, 1984:309-315, 1989:34-35, 1990: 1-17; Geus 1976, 1977, 1979 and 1984:361-372; Caneva 1983, 1986: 42-44, 1987:53-54 and 1988; Wendorf and Schild 1984; Chlodnicki 1984:337-351; Elamin and Khabir 1987: 175-184; Haaland 1987:83-185-90, 1991:127-143, Haaland and Magid 1991:36-43 and Marks and Mohamed-Ali 1991).

In East African late prehistory the term "Neolithic" was rejected by Sutton (1966:38) as imprecise and biased, preferring the designation "late stone age" which bears fewer implicit assumptions. Though favoured by Sutton (ibid), the term "stone bowl culture" gained popularity for several years. The mid 1970's saw the return to the Neolithic in East African later prehistory (Collett and Robertshow 1983:57-74) and since 1977 the pastoral Neolithic has widely been accepted (e.g. Bower and Nelson 1979:554-554; 566; Collett and Robertshow 1983:57-74; Bower 1984:474-480 and Dianne et al 1984:457-471).

French-speaking prehistorians abandoned the term "Mesolithic". For them the term "Neolithic" can be used in a technical sense for the late stone age communities that have adopted advance cultural traits such as polishing, grinding stone and the making of pottery. However, they prefer terms such as "Khartoum Neolithic", "Neolithic of Sudanese tradition" or "Saharo-Sudanese Neolithic" (e.g. Hugot 1963, 1982: 585-661; Balout 1965: 156-157; Camps 1969, 1982: 548-657 and Soleilhavoup 1988:49-71). These terms are used to denote later stone age communities with pottery ornamented with wavy lines and dotted-wavy lines extending from Khartoum along the Nile to the Western Egyptian desert as far west into the Sahara as Meniet (Algeria)(fig.42) from eighth to the fifth millennium B.C. (see supra, the references in this paragraph and Close 1988:145-176).

Some workers in the later prehistory of the Nile valley and East Africa (e.g. Adamson et al 1974:120-123; Phillipson 1977, 1982:410-477 and 1982:770-829 and Magid 1982 and 1988). avoided the terms "Mesolithic" and "Neolithic". Instead, they preferred to use the term "Early Khartoum" whereas Mohamed - Ali (1982) and Haaland (1987) occasionally favoured this usage. Clark though frequently preferred the term "Mesolithic" (see supra), he often returned to use the term "Khartoum complex" to describe later stone age sites with "Wavy Line"

pottery, comparable to the well-known type discovered at Khartoum Hospital site (see Arkell 1949:81-92 and Clark 1984: 25-56).

On the evidence reviewed here, both terms are controversial and there is no common accord between prehistorians as to the cultural traits that are necessary to be termed "Mesolithic" or "Neolithic,." Nevertheless, their usage has persisted in the literature of prehistoric research of the Nile valley, Sahara and subsaharan Africa, irrespective of the apparent deficiencies (see supra). In the present work, both terms, "Mesolithic" and "Neolithic", have been used for the following reasons:-

a) Because they are well entrenched in the literature of later prehistoric research in the Nile valley, Sahara and subsaharan Africa.

b) The material culture recovered from the later prehistoric sites examined in the present work is comparable in many ways as to what usually described as "Mesolithic" and "Neolithic" (cf. chapter 2).

c) Despite the fact that the usage of these terms have created a dilemma hitherto far from settled, the addition of new terms would merely complicate the situation where there are already more than enough (see also Marks and Mohamed-Ali 1991:14).

1.5. Former Mesolithic and Neolithic pottery classifications in Sudan :an assessment

1.5.1. Arkell's analysis and clasification

1.5.1.1. Introduction

Arkell has done a pioneering study on Sudanese Mesolithic/Neolithic ceramics. To test the hypothesis, based on typological evidence, that Early Khartoum tradition(1) should pecede the Shaheinab one(2), he conducted a trial excavation at al-Qoz site in central Khartoum province (Arkell 1953:101-102) (cf. fig.1). The site of al-Qoz wasunfortunately disturbed by erosion, grave diggings and animal-burrows, but two undisturbed layers at square X-38 and P-40 were found (ibid:101). These two undisturbed layers have shown that Early Khartoum (Khartoum Mesolithic) preceded the Shaheinab one (Khartoum Neolithic). A higher percentage of typical Erly Khartoum ware was found below the layer containing the maximum of typical Shaheinab ware (ibid: 68). At the site of Khartoum Hospital, the dotted-vavy line ware was found in the top layers in a few undisturbed places of the site, while the same type of pottery was encountered at the lowest layers at Sheheinab sie (ibid: 68).

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(1) The main characteristics of he Early Khartoum pottery is the presence of wavy line and unburnished dotted wavy line decorations. The pottery is well fired, neither burnished nor polished but slightly smoothed on the inside and with simple rims(see Arkell 1949 81-92.).

(2) Shaheinab pottery is almost exclusively burnished and often red-polished. Triangular pattern was the most favourite decoration. Burnished dotted wavy line and zigzag patterns are frequent. The rims are simple and the pottery is well fired with hard fabric (See Arkell 1953:68-77) (Detailed discussion in chapters 2 and 3).

1.5. Former Mesolithic and Neolithic pottery classifications in Sudan :an assessment

1.5.1. Arkell's analysis and classification

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Despite the fact that Arkells' classification of al-Qoz ceramic material focused on establishing the stratigraphical relationship between Early Khartoum and Shaheinab traditions, it has formed the basic framework within which subsequent finds of Mesolithic and Neolithic pottery have been fitted in. He classified al-Qoz pottery with special reference to decoration and surface treatment (cf. Arkell 1953:97-101).

1.5.1.2. Arkell's analytical procedure

Obviously from Arkell's tables (X-38 and P40) at al-Qoz site, decorative motifs have been used as diagnostic attributes. He divided all his material into two main categories: 'Mesolithic' and 'Neolithic' ware according to the cultural division he had established. His 'Mesolithic' wares have been divided into four groups: 'wavy line' 'dotted-wavy line' 'probable dotted-wavy line' and 'doubtful' sherds. The "Neolithic' wares have been subdivided into 'Gouge culture' and 'probable Gouge' wares.

In general, the al-Qoz site was excavated in layers of an arbitrary thickness of 10cm. When that became difficult due to erosion or animal-burrowing, the depth of layers was extended to avoid such difficulties (ibid: 98-101).

In both squares (X-38 and P40) the number of sherds belonging to 'Gouge culture' often exceeds 'Mesolithic' ware in the lower layers specially in square X-38. This phenomenon was attributed to the fact that the 'Gouge culture' sherds are of finer material and small in size. They quickly penetrated throughout the lower layers and have to some extent confused the picture in this square (ibid: 101). It is, however, important to realize that Arkell achieved much from his statisitical analysis. Using the changing frequencies of the established layers from the surface downwards, he managed to work out an acceptable stratigraphical scheme. Yet, his pottery classification created a series of problems later on, when more Mesolithic and Neolithic pottery types came to light and attempts were made to assign them to the scheme. For instance, the decorations of Early Khartoum Related Group pottery of Old Dongola Reach (cf. fig. 1) (see below) were fitted into the general classification of Early Khartoum, including wavy-line and dotted-wavy line types. But from the preliminary analysis of these finds, it seems that a classification, more

rigorous than Arkell's, will be necessary as dotted-wavy line sherds include both true dotted-wavy line and mat-impressed wares both of which were classified by Arkell under the same type (Marks 1968: 174). In addition to that, the labels for the pottery types used by Arkell are not well-defined. A certain degree of confusion has resulted from these labels placed on the decorative motifs. For example, the 'wavy-line' refers to a number of designs, many of which could not be described by that name. (e.g. Arkell 1949 Pls. 64, 65 & 70) (Marks et al 1968: 86).

Reading through Arkells' work it is apparent that by 'wavy-line' he was referring to almost all the pottery of the early settlement, i.e. it does not include only 'wavy-line' combed motifs but all of other motifs believed to have been made with a comb. On the other hand, dotted-wavy line pottery only refers to potsherds, which had designs apparently made by a curved, denotate stamp alternately impressed to form dotted-wavy line (see Arkell 1949, Pl. 72).

1.5.1.3. Problems of Arkell's analysis and classification

It appears from the above that some of the terms used for defining pottery types are not explicitly defined. Moreover, Arkell's analysis is inconsistent in terms of attributes chosen. Though he used decorative motifs as diagnostic attributes, yet he sometimes adopted non-decorative attributes, e.g. "black fracture ware" and "micaceous ware" comprising pottery with different decorative motifs (ibid: 88-89).

Some of his classifactory attributes are unsatisfactory. He categorized some potsherds as "Probable wavy-line" pottery and' probable dotted-wavy-line. At the same time some of the sherds have been classified as"doubtful" ware (ibid: 98-100). In the writer's opinion it would have been appropriate to seek another alternative because the classes labelled "probable" and "doubtful" are not mutually exclusive by definition. Therefore, they should not be used to refer to two distinct classes. Furthermore, Arkell used the decorative motifs as diagnostic attributes. This has, however, provided us with incomplete records of Early Khartoum and Shaheinab ceramic complex. Pottery fabric is essential since it sheds more light on the question of originality and intrusion as well as the technological standard of workmanship. Summing up, one can say that Arkell's analysis is inconsistent in terms of fabric, stylistic patterns and technique of pottery making. It is also deficient in that it lacks several essential or detailed attributes such as analysis of

clays used. On the whole, Arkell has provided qualitative description of pottery based on selected attributes while elaborate quantification is lacking.

1.5.2. Nordstrom classification

Nordstrom classification of Early and Middle Nubian Nordstrom 1972:32-68). pottery includes Neolithic wares of Early Khartoum and Shaheinab styles from Khartoum Variant (Shiner-1968-90), Abkan and A-group cultures (Reisner 1910). Pottery of these cultural assemblages has been fitted in his chronological chart within the group classified as Early Nubian ware dated from the fifth millennium B.C. to third millennium B.C. The aim of this classification was to facilitate statistical derivation and archaeological interpretations of these heterogeneous material (Nordstrom 1972: 57).

The taxonomic system adopted consists of five pottery groups. A property group is defined as "a point of similarity and differences between objects." The five property groups are fabric, vessel shape, decoration, surface treatment and size. In addition to these main property groups, other features may be included such as wall thickness and permeability. As a first step of correlation between the different property groups, the data were divided according to the pottery making techniques employed, i.e. hand and wheel-made pottery. Secondly, different fabrics of hand-made pottery were correlated with different sets of surface properties. This led finally to a logical division into three taxonomic categories of hierarchical nature:ware, ware group and ware family, representing different levels of similarities as regard fabrics and surface properties (ibid: 34). Thus his classification includes all the possible combinations of fabrics, techniques and patterns of decoration. As a result, the large collections of sherds and vessels from habitation sites and cemeteries of Early and Middle Nubian date have been classified into five principal groups termed 'ware families' (ibid: 57). They may be summarized as follows:-

Family K

It is characterized by sandy or micaceous wares of Early Khartoum or Khartoum variant tradition. Fabric IA and IB. Ware Group KI. Dated to Neolithic period. (ibid).

Family M

It is distinguished by mud wares of sandy composition of Abkan tradition. Fabric IA and IB. ware Group KI. Dated to Neolithic period (ibid).

Family H

It exhibits hand-made wares of Nubian tradition, tempered with ashes or cattle-dung, normally displaying black fractures and a porous body. Fabric ID (occasional) and Fabric IIA and IIB (predominant). Ware Group HI-H4. It is dated to A-Group, C-Group and New Kingdom. Manifested also in Kerma pottery and in the bulk of Pangrave pottery (ibid).

Family N

It displays hand-made, fine textured and sandy wares, of Egyptian predynastic tradition. Designated "Nile ware" in the pottery analysis of Armant collection. Flinder's petrie's "Black-topped", "Polished-red", "Black-polished", "White-cross-line" and "White-incised" are included in this group. It is of predynastic date (ibid).

Family D

It includes hand-made pottery, usually tempered with limestone, of hard-fabric, represented by pink ware of Egyptian Predynastic tradition. "Decorated", "Wavy-handled" and most of the "Late" wares in Flinder Petrie's classification belong to this family. Fabrics IVA and IVB. Ware Group DI. Dated to late predynastic and Early Dynastic (ibid: 57).

Notably, Nordstrom has worked out an acceptable model, discovered new technological indices, devised a new method of shape analysis and makes a distinction between shape and form. Shape refers to vessel contour, horizontal section proportions,... etc., while form refers to size function,...etc. (ibid: 34). Nevertheless, his material did not carry him further so as to produce a comprehensive chronological index. It was composed of complete or almost complete vessels and a large number of sherds derived from cemeteries and

habitation sites in Sudanese Nubia which rarely yielded stratified data. This is why his pottery "wares" have remained primarily technological concepts (ibid: 35-94).

Though the Neolithic assemblages in lower Nubia (Abkan, Khartoum variant and A-Group) (see above) and those of the central Sudan (mostly of Early Khartoum and Shaheinab-type sites) (see chapter 3) are not located within a single geographical area but they belong, to, an essentially, one "culture area" characterized by similar pottery styles. This would perhaps justify the present writer's attempt to assess the validity of Nordstrom classification of Early and Middle Nubian pottery in Lower Nubia and to evaluate its applicability as regard the Neolithic ceramics in the central Sudan (see chapters 3, 4 and 5).

1.5.3. Hays and Hassan classification

Hays and Hassan have done a mineralogical analysis on Sudanese Neolithic ceramics (Hays and Hassan 1974:71-79). The material used was derived from cultural assemblages bearing Early Khartoum and Shaheinab styles from Sudan (Khashm el Girba, the Second Cataract area, the Donogola Reach and Khartoum Province) and neighbouring zones in central Sahara (Wanyanga and Amekni) (cf.fig.2). The aim was to shed further light on the cultural differentiation and patterns of interaction between human groups with similar pottery styles inhabiting the northern Sudan and adjacent zones during the Neolithic period. The physico-scientific approach which has several advantages over the traditional approach of form and decoration was employed. A microscopic study of twenty-two potsherds from the selected sites resulted in classification of ceramics in terms of mineralogical composition and texture of temper. They divided the pottery in question into three main groups with their subdivisions in accordance with mineralogical composition and texture of temper (ibid: 74).

GROUP I contains basaltic lithic fragments and augite grains. The source of these minerals is the Abyssinian basalts which are drained by the Atbara River in the eastern Sudan. The sites represent this group are all located at Khashm el Girba, near the Sudanese - Ethiopian border.

GROUP II is predominantly quartz, orthoclase, microcline, Na-plagioclase and sometimes biotite and muscovite grains. A sub-group of this group (II Cii) also contains chlorite schist and polymineralic fragments of biotite gneiss. These

minerals are exposures of the Precambrian Basement Complex, which consists mainly of granite, gneissess and schists. The sherds of this group are associated with sites in all the areas investigated except those from Khashm el Girba.

GROUP III comprises sherds predominantly tempered with quartz-rich sand. Haematic inclusions are also common. This suite denotes sedimentary provenance. The presence of garnet grains which are common in the Nubian sandstone is the source of temper of the ceramics of this group. The sites belong to this group are located on a sandstone jebel about 18 km. from the Nile River in the area of the Second Cataract. The presence of a few granophyre and orthoclose fragments in some of the sherds of this group raises the possibility that their tempering materials are a mixture of Nubian sandstone and the Basement Complex (ibid: 75-76).

It has been postulated that the three groups identified can be related to the lithological provinces present in these areas on the basis of their mineralogical composition. It has been concluded from this that the pottery of each of these areas was made locally (ibid: 75-76). However, these results are inconclusive as far as the nature of cultural interaction (migration or diffusion) between the Neolithic potters of 'Khartoum Horizon style'(1) of the localities investigated is concerned. It is apparent that their samples are rather minimal and hardly justify the conclusions they have reached. Only twenty-two potsherds were selected to represent fabrics of twenty two Neolithic assemblages covering vast areas in central and northern Sudan and central Sahara. It is unfortunate that Hays and Hassan mineralogical analysis of Sudanese Neolithic ceramics lacks the comparison between the pottery samples examined and the local clays which might have been used by the Neolithic potters in question. The importance of unfired clay or modern fired clay analysis lies in the fact that it widens the latitude of inference about the source of raw material and its provenance.

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(1) This term has been used to refer to fourteen decorative motifs including wavy-line and dotted-wavy line shared by Mesolithic/Neolithic assemblages in Sudan and some localities in central Sahara (see Hays and Hassan 1974: 78).

1.6. Concluding summary

It is clear from the above that the classifactory schemes proposed for the Neolithic ceramics in the Sudan are limited in their scope and the objectives they have set to achieve (see above). Nevertheless some advantages are perceptible:-

1. The earlier research has managed to establish a broad scheme of cultural sequencing, e.g. 'Khartoum Mesolithic' and 'Khartoum Neolithic' (Arkell 1949 and 1953). Despite the limitations of this scheme, it has contributed much toward understanding of similar pottery developments in different parts of Sudan and adjacent zones.

2. Later works in early 1970's have introduced new approaches for the study of the Mesolithic/Neolithic and/or post-Neolithic ceramics in the Sudan (Nordstrom 1972 and Hays and Hassan 1974). These new approaches advocate the application of physico-scientific and combined-units approaches (the combination of both physico-chemical analysis and the traditional ceramic attributes) to a achieve a better conception of the ceramic corpus.

3. The past ceramic classifications have led to the discovery of new technological indices and even some new methods of 'shape' analysis have been devised (cf. Nordstrom 1972:32-68).

However, there are several drawbacks inherent in the earlier works on the Neolithic ceramics in the Sudan (see supra) and they can be summarized as follows:-

1. The terminology adopted to define the pottery motifs is not invariably well defined.

2. The classifactory schemes are occasionally deficient in that they either lack appropriate attributes or the selected attributes are unsatisfactory.

3. Elaborate data quantification is devoid in several publications.

4. The sampling of some workers is inadequate to justify the conclusions they have reached.

5. In some instances the physico-scientific analyses are confined to the pottery alone. The comparison of the constituents of the pottery with local raw material deposits and/or fired clay (modern pottery) is skipped from the works. Though the present study benefited from the positive aspects of the previous works, yet it attempts to carry the methodology of the Mesolithic and Neolithic ceramics of the Sudan further aiming at a wider scope and objectives. Hence, rather more emphasis has been laid, in the present research, on the nature of ceramic production and the direction of ceramic change (if any) through time, not only typologically but mineralogically and texturally as well. This is because the role played by the potters and the limitations imposed upon them by natural resources and/or cultural traditions could be better conceived and assessed.

1.7. Aims of the present research

By means of ceramic analysis it is hoped to achieve the following:-

1. To enhance our knowledge of the ceramic technology, and endeavour to delineate the nature of cultural mechanisms articulating the human groups inhabiting the central Sudan during the Mesolithic and Neolithic periods.

2. To cast further light on the chronological index of the Mesolithic and Neolithic ceramic technologies in this area by means of radiometric dates.

3. To clarify the situation in regard to some working hypotheses drawn by some researchers pertinent to the Mesolithic and Neolithic ceramics in the central Sudan.

The ultimate target is to develop a better understanding for the Mesolithic and Neolithic ceramic technologies in the central Sudan with special reference to the localities investigated.

1.8. Samples and sampling area

The data analyzed in the present study was derived from a series of Mesolithic and Neolithic sites in the central Sudan. The sample area includes Khartoum Province (lat. 15° 16 41"N and long. 32° 34' 30"E), the Western Butana (lat 16 30'N and long. 34 54'E) and the White Nile province (Lat 13-14 50'N and 32 18E) (cf. fig.1). The selected sites of Khartoum Province include Sarurab2, Nofalab2 and Islang2 (on the western bank of the Main Nile), all of which were test-excavated by the present writer (chapters 2 and 3). This is supplemented by examination of pottery from al-Geili, Kabbashi and Kabbashi Haitah (on the eastern bank of the main Nile) (Caneva 1987). Pottery samples from Shaqadud complex site (Otto 1963:108-16, Marks et al 1980:30-4, 1982a:47-50, 19082b:30-40, 1985:261-78, 1986:26-27; Mohamed Ali and Marks 1984:52-59, Robertson and Marks 1988:515-34; Caneva and Marks 1990:11-35 and Mohamed Ali 1991:65-93) were investigated in the present work. The White Nile Province is represented by pottery samples from the sites of Shabona (Clark 1984:1-21 and 1989:387-410) and Rabak (Haaland, 1984a: 28-32, 1984b: 39-51) (cf. fig. 1).

The preceding areas have been selected for sampling because they exhibit a rich spectrum of early ceramic sites marking sequent stages in ceramic history since the initial beginning of the Mesolithic and Neolithic periods in Sudan and hence it would be easier to follow the direction of ceramic change (if any) during that passage of time. Secondly, the central Sudan embracing two distinct zones (the central Nile and the Butana) both of which have played important cultural role during the prehistoric era. While the central Nile produced the earliest evidence of pottery making so far known in Sudan (Caneva 1982:149-52 and Khabir 1981:72-123), recent work in the Butana has revealed a rich and in many aspects unique pottery sequence (Fattovich et al 1984:173-88 and Elamin and Khabir 1987:175-84). A comparative data was taken from all these localities and text-excavations were conducted on one of them (Sarurab2, Nofalab2 and Islang2) as was shown earlier (see also Chapters 2 and 3).

1.9. Methods of investigation

1.9.1. - Recording

All the sherds have been recorded as regard provenance, cultural sequence, sherd thickness, surface condition, colour (Munsell 1975) and tempering material. These recorded criteria are based on macroscopic observation. Further, vessel forming techniques, surface finish, shape and decoration are recorded.

1.9.2. Computer Analyses

Due to the large amount of data obtained from examining a series of attributes, rigorous statistical treatments which no doubt necessiate the use of computer programmes have been applied (cf. sections 3.3.5.5, 3.6-5.6, 7.3-7.5).

1.9.3. Methods of analyses

The test sherds will be examined concerning clay, tempering, vessel forming, technique, surface finish, decoration and firing index. Clays will be investigated for mineral composition. Petrological examination, chemical tests, X-ray and Goethite Norm analyses have been used for investigation.

1.10. Raw material studies

The clay material resources of the areas in question have already been examined by earlier work (Gunn 1982:81-1092; Buursink 1972; Whiteman 1971 and Khabir 1981:72-123). Therefore, the present writer has decided to test only the fired clays of modern pottery present in the locations investigated. This will integrate the picture of the utilized raw clay resources. Since pottery is a traditional craft, the potter's selection of clay suitable for potmaking will be governed by his experience with the local clays. Hence, the mineralogical study of the modern ceramics, rather than the raw clays of the region, would provide much more precise information about the type of clay utilized by the Mesolithic/Neolithic potters of the central Sudan.

Chapter 2

2. State of the Mesolithic and Neolithic Pottery Contexts in the Central Sudan.

This section sets forth a summary of the research results and excavations of the Mesolithic and Neolithic settlements in the central Sudan. This background is essential because the selection and test-excavations of some localities embodied in this work were made in the light of the present state of research carried out in this area.

2.1. Khartoum Province

The prehistoric research in this region has started with the pioneering work of Arkell and his excavations of the Mesolithic and Neolithic settlements:- Khartoum Hospital (Arkell 1949) and Shaheinab (Arkell 1953) respectively in the vicinity of Khartoum district. Ever since, the subsequent finds of Mesolithic and Neolithic assemblages from Sudan and adjacent zones are always matched with these two key sites. Therefore, more detailed description will be given here to these two important sites.

2.1.2. Khartoum Hospital site (lat.15° 36' N Long. 32° 32' E)

It is situated on the west bank of the Blue Nile at Khartoum city (fig.1). It covered an area of c.5600 m2. The site was excavated in 1947 and the results have been published in 1949 (Arkell 1949). This settlement yielded the earliest evidence of the oldest pottery types in the Sudan. Unfortunately, no radiocarbon date was obtained for the site itself. This poses a problem whenever the cultural interrelations between Khartoum Hospital (the key-site of the Early Khartoum tradition) and other type-sites are disputed. Nevertheless, Arkell claimed that he would not be surprised if a date as early as 7000 B.C. is obtained one day for the Early Khartoum tradition (Arkell 1972: 222).

The pottery of Khartoum Hospital site was well-fired brown ware encountered only in the form of sherds. Pottery was abundant and thousands of sherds were recovered. However, the exact figure of ceramic vessels was not provided by the excavator. The majority of vessels were decorated all over the body with

particular care near the rim. The rims are simple and slightly thinner than the rest of the pot. They are usually plain and sometimes decorated with various impressions. The most frequent motifs depicted on sherds include woven mat, wavyline and dotted wavyline. Triangular impressions are rare. The pottery is neither burnished nor polished but often smoothed on the inside. It was built by coiling and shaped through paddling. Sand was mainly utilized as tempering material. Vegetal temper was occasionally observed. Most of the potsherds were open-mouthed bowls of different sizes with round bottoms. The sherds are generally brown in colour. (Arkell 1949:81-92).

The general characteristic of the lithic industry is microlithic. Retouched pieces are overwhelmingly microlithic due to the predominant use of small nodules of quartz for their manufacture. Over 500 lunates are recorded, all of which measure below 30mm in length. Scrapers are of the most common types, 418 were found. End-scrapers, core-scrapers and a variety of side-scrapers including convex, concave and straight were found in considerable numbers. Denticulates are common and they were included by Arkell in his "utilized flakes" (Arkell 1949, pl. 22; fig.1). Backed blades, points and geometrics were reported. The perforators reported by A. Arkell do not include only borers but groovers as well (Arkell 1949, pl.14; fig.4-6). Burins are rare and always atypical. Notches ere included by Arkell in his "hollow scrapers" (Arkell 1949, pl.19, figs.3-4). Quartz was mainly utilized for microlithic tools, rhyolite was favoured for larger implements. Single and irregular cores are in evidence and they were made on quartz and rhyolite. Grinding implements were abundant. Several small disk grinders were found. Arkell argued that these must have been utilized for grinding wild grown seeds for food. Many sand stone disk grinders were found with traces of red ochre and were possibly used for grinding ochre for pigment (ibid: 41-73).

The site yielded bone artifacts comprising of decorated bone fragments and awls. Barbed bone harpoons which were once regarded as the diagnostic feature of Khartoum Mesolithic-type sites were encountered in appreciable numbers and they are exclusively of grooved-butts with flattened sections (ibid:75-78). The inhabitants of Khartoum Hospital site were heavily built Negroes (?) who lived on hunting and fishing for which they used harpoons or spears with rows of barbs (Arkell 1975:20). Dwellings were left in the form of traces of wattle and daub

wind-screens and they buried their dead carefully in the site which may have only a dry season camp.

The mammalian fauna includes an extinct reed-rat, of which the nearest relation comes from west Africa. Nile Lechwe and water Mongoose indicate a rainfall three to four times heavier (C.4.00-500mm.) than the present (C. 160 mm.) with swamps in the vicinity. Mollusca remains include (leopatra) bulimoicks, Lanistes carinatus, Ampullaria Wernei, and Limicolaria Flammata (ibid:15-30).

No evidence of domesticated grains were found. Yet, the excavator listed the presence of Celtis integrifolia and Elaeis guineensis in a limited number (ibid:3).

2.1.3 Shaheinab site (lat. 16° 03' N long. 32° 33'E)

It is situated on the west bank of the main Nile about 50 kilometers north of Khartoum (cf.fig.1). The site is located on an ancient river bank of the Nile extending c.200 meters along a ridge bordered to the east by a narrow alluvial plain (Arkell 1953).

Shaheinab is a type-site of Shaheinab Neolithic tradition frequently referred to in the literature as 'Khartoum Neolithic' (see chapter 1). The site got two radiocarbon dates in 1953, one on charcoal; 5445 ± 380 b.c. (C-754) and the other on shell; 5060 ± 450 b.c. (C-753). The two dates with high standard deviations were among the earliest radiocarbon dates processed by Libby at Chicago University. Arkell believed that the site was much older than what the radiocarbon dates indicated (Arkell 1953: 33), but in his latest publication the excavator accepted a date in the magnitude of 5300 B.P. for his site (Arkell 1975:28).

Unlike that of Khartoum Hospital site, the wavyline pottery which is the diagnostic feature of the Early Khartoum tradition (see chapter 1) is absent at Shaheinab site. Instead of the unburnished dotted wavy line pottery of Early Khartoum-type, Shaheinab site yielded hundreds of sherds of this decoration but with burnished surfaces (Arkell 1953:69). Triangular pattern was the favourite, occurring on thousands of sherds. Decorative patterns with vees or multiple lines of closely spaced dots are frequent. Zigzag patterns with dotted or incised lines are present in appreciable proportions. This pattern with its varieties was used

throughout this culture, on both the large bowls and also on much of the smaller cup-like bowls of finer ware, which were often decorated with red-slip. Combed patterns executed with horizontal direction occurs on a number of sherds from large bowls with diameter of mouth varying from 250 to 300 mm and with plain vertical rims. Rather infrequent motifs include incisions of closely spaced horizontal lines or semicircular panels depicted on bowls of varied sizes ranging from 150 to 300 mm. Rare decorative motifs comprising alternate hatched and plain chevrons, semicircular panels with various forms of dotted lines and black-topped fine red ware (ibid: 66-77).

Almost all the Shaheinab pottery is burnished on outer surface and sometimes red-polished. It was made by coiling and shaped through paddle and anvil technique. It was sand-tempered, well-fired and of hard-fabric (ibid: 69-77) (personal observation).

The Shaheinab assemblage is a microlithic-flake. The most frequent retouched tools are lunates which are exclusively struck on quartz nodules. Scrapers are numerous including end and side-scrapers. Convex, concave and thumbnail scrapers can be separated from Arkell's 'high backed' (Arkell 1953, pl 8, fig.1) and 'crescent' scrapers. Borers are made of rhyolite and are more numerous than in Khartoum Hospital site. Denticulates were included by Arkell in his 'utilized flakes' (Arkell 1953, pl. 9, fig.21). Gouges and adzes are the diagnostic lithic artifacts of this assemblage and the hallmark of all the Neolithic sites of Shaheinab-type in Khartoum district. Quartz and rhyolite were used for tool production. Grinding implements including grinders, hammers and pestles are numbered to hundreds. Different types of cores mainly single and cortex platforms are in evidence. (ibid:25-93).

2.2.- Later work in Khartoum province

Ever since Arkell's work in late 1940's and early 1950's the work in the Mesolithic and Neolithic culture-history of the central Nile valley has increased considerably, especially during the last two decades. Since then several archaeological missions have carried out excavations in Khartoum province (east and west bank of the Main Nile) and the results of their work have increased our

knowledge about the nature of the Mesolithic and Neolithic settlements and their chronological order. (cf. fig .4).

2.2.1- Mesolithic and Neolithic settlements : West bank of the Main Nile

The work on the west bank of the River Nile started with Arkell's pioneering excavation of Shaheinab Neolithic site in early 1950's (Arkell 1953) (see above). Recent research explorations in this area have been carried out by Khartoum University since 1972. The University of Khartoum concession lies 18 kilometers north of Omdurman and extends from Wadi Seyidna in the south to Khor Ed Desheinab just north of Jebel Umm Murrahi (cf. fig. 4). The archaeological work in this area was designed as training for Archaeology students in research since 1973. As a result, several sites come to light spanning the time from Palaeolithic, Neolithic right down to Meroitic period and post-Meroitic. Further works on the west bank of the Main Nile, undertaken by Mohamed-Ali (1982:36-45) and continued by Khabir (1981:124-72) and El-Anwar (1981:42-45) of the University of Khartoum, between Wadi Seyidna and Sarurab, revealed a rich cultural sequence covering a considerable period from the Mesolithic to the late Neolithic (see chapter 3). The Mesolithic spectrum of Khartoum University concession includes the unique site of Jebel Umm Marrahi, where a clear Mesolithic burial has been excavated with beads, ivory, amulets and large pottery bowls, in stratified deposits of two meters thick, below the beaten floor of a hut belonging to a much later date- Bauda culture- (C.200 B.C.-A.D. 200) (Hakem 1979:151-155), regarded as a southern variant of Meroitic culture (Abulgasim 1979).

2.2.2.- Mesolithic and Neolithic settlements: East bank of the Main Nile

Mesolithic and Neolithic research on the eastern bank of the Main Nile started with Chittick's work on the major Neolithic site of Kadero I. On the basis of surface collection, Chittick ascertained that its pottery shows remarkable similarities with the pottery of Shaheinab site (Chittick 1955:75-81). The systematic work on this site has started by the Polish Centre of Mediterranean Archaeology in Cairo. The excavation of the site has been directed by Krzyzaniak who published a series of reports about the progress of work on this site. (Krzyzaniak 1974, 1977, 1978, 1984, 1988, 1989 and 1990). The work of the polish mission has shown that the tool-kit of this site is similar to that of Shaheinab.

The pottery shows general resemblances with Shaheinab wares but it is devoid of wavy line patterns and it is more akin to that of Nubian A-Group (Krzyzaniak 1974:31). As at Shaheinab, stone grinders, gouges, polished celts and flaked stone implements were recorded (Nowakowski 1984:343-351). The total absence of wavyline and dotted-wavy line decorations, plus the considerable number of polished stone tools, point to a later age for the Kadero I than for Shaheinab. This assumption gets further support from the radiocarbon dates obtained for the site. Two radio carbon samples based on shell material gave dates of 3310 ± 90 B.C. (T-2188) and 3080 ± 70 B.G. (T-2189) (Krzyzaniak 1977:46)

Geili is another major site on the eastern bank of the main Nile excavated by the Italian Mission for Prehistoric Research in Egypt and the Sudan, supported by grants from Rome University. The site lies 46 kilometers north of Khartoum, located on the right bank of the Nile between 'al-Geili station and the asphalt road (cf.fig.4). Field activities continued for nine seasons. Pugilisi started his excavation of this site in 1970 and his work was the first systematic prehistoric research undertaken in this part of Khartoum Province since that time. (Pugilisi 1974).

The stratigraphy of the site is complex, testifying to the fact that the site was exploited for a long period of time, both as a settlement and as a cemetery. Some 124 graves have as yet been excavated. Graves of different periods (Meroitic, Christian and Islamic) often overlap, with frequent re-use of older pits and re-burial of previous skeletons. Some of these graves reach the dimension of 2.5.x2 meters and a depth of 1.2 meters disturbing the earlier settlement deposits (Caneva 1984:354-360). The surface of the site was seemingly modified by both human and atmospheric agents. The settlement yielded potsherds and implements sharing striking resemblances with the Shaheinab Neolithic assemblage. The lithic industry comprises of quartz microlithic tools (crescents, borers and end scrapers). A number of rhyolite tools are also presented, mostly scrapers, points and polished gouges. Grinding equipment is characterized by small grinding and pounding stones. The bone objects include a pottery comb, a few harpoons and perforators (Caneva 1987:115-144).

Saggai I is one of the most important Mesolithic sites of the Early Khartoum tradition in this region, excavated by the University or Rome Archaeological Mission. The site lies 30 kilometers north of Khartoum on the right bank of the

main Nile (cf.fig.1). The site appears as a low mound rising two meters above the surrounding plain, covering an area of 36000m and extending 200 meters north-south and 180 meters east-west. The cultural layers reaching virgin soil to a depth of 1.6 meters. The levels were rich in findings and occasionally disturbed by graves of much later dates (Meroitic period). Findings include lithic implements, pottery, bone artifacts and ground stone tools typical of Early Khartoum assemblage (Caneva 1982). Lithic implements consist almost exclusively of quartz microlithic crescents and chopping tools or hammer stones. Bone implements include combs for pottery decoration, grooved bones and some barbed points with barbs on one side only. Vessel shapes cannot be reconstructed but the sherds that suggest globular forms were predominant.Their surface is unburnished and decorated with comb impressions (Caneva1984:301-302). Wavyline decoration, the diagnostic feature of the Early Khartoum tradition was depicted on a considerable number of sherds (Caneva 1982, figs. 8,9,10,11,12). Further frequent motifs include interrupted arc motifs (ibid, figs. 11:2-6:18:5), interrupted straight motifs(ibid, figs.11:1-2), delimited structured motifs (ibid, figs. 12:1-2, 18:8-9) and straight lines (ibid, figs. 12:3-6). The presence of dotted wavy line motif is scarce (ibid, fig. 15:1-7).

The site of Saggai1 did not provide any charcoal remains for C-14 analysis. However, four radiocarbon dates based on mollusca shell (pila wernei) were obtained for the site, both from the northwestern and from southwestern area of the excavation, from soundings about 100 meters apart. Samples T-5025 (6260 ±100 B.C.) and T-5027 (6160 ± 110 B.C.) correspond to the first occupation of the site in the two areas just above the sterile bank. They were taken respectively at 145 and 100 cm below the present surfaces of the soundings; in both cases the elevation is 55 cm. above the surrounding plain. The other two samples: T-5024 (6080 ± 100 B.C.) and T-5027 (6160 ± 110 B.C.) were taken from the same areas, at the elevation of 135 cm. above the surrounding plain (respectively 65 and 30 cm. below the present surface). This elevation corresponds to the very beginning of the second phase of occupation recognized on the site. It is noteworthy that Saggi1 provided a single date of Nile oyster yielded an age of 8130 ± 100 B.C..(Caneva 1982:149).

The Italian Mission headed by Caneva conducted test-excavations on two Mesolithic settlements in the area namely Kabbashi and Kabbashi Haitah (cf.fig.4).

The two sites yielded cultural material almost exclusively identical to Shaheinab and Early Khartoum respectively (see section 3.3.2). In addition to that, a series of small Neolithic sites were discovered by the Italian Mission, on the right bank of the Nile, north of Khartoum. The surveyed area lies between the villages of Kabbashi and al-Geili and its total extent is 15x7 km. A brief reconnaissance was also undertaken a few kilometers south and east of this area, where no archaeological evidence was found except for scattered historical tumuli (Caneva 1987:321-343).

A number of Neolithic settlements in the eastern bank of the Nile were test-excavated by Haaland of Bergen University (Norway) during a period from 1975 to 1982. These sites include Zakiab, Kadero II, Hatab and Umm Direiwa I (cf. fig.4) (Haaland 1987)

Zakiab site was situated on an old bank of the River Nile, some 20 kilometers north of Khartoum (fig.4). It was a small one, (c.2000 square meters) compared with Kadero I which is c. 30 000 square meters. The lithic tools of Zakiab were of the same type as those found at Kadero I. There were, however, remarkable differences in the frequency distribution of grindstones, which are very scarce at Zakiab. The excavator argued that this low frequency of grindstones suggested that cultivation would not have taken place around the site (ibid:27). The pottery was similar to the material found at Kadero in terms of surface treatment (all potsherds being burnished) and decoration (vess/dots being dominant). The items related to pottery making, e.g. burnishers, equipment for decorating (shells with serrated edges and red ochre for colouring the pots) were absent at Zakiab; while there was clear evidence for these artifacts at Kaderol. The excavator hypothesized that the pottery was made at the base site Kadero I and brought to Zakiab site when needed during the dry season. To reinforce her claim that Kadero I being a base site, Haaland presented evidence as the fact that there were many burials around the site, whereas the Neolithic site of Zakiab did not contain any contemporary burials (ibid: 28).

Kadero II site was excavated by Haaland to test her hypothesis about seasonal activities at Kadero I in the same micro environment, 600 meters south east of the first site (cf. fig.1). The site was badly eroded and only one square was then excavated. There was no stratigraphy. Therefore, the site was excavated in

one layer only. The soil consisted of alluvial clays and silts. The cultural layers reached 40 cm in depth. The artifacts scattered around in an area of 10 000 square meters (ibid: 40-41). The site was similar to Kadero I in terms of dating (a shell sample taken from test pit gave a date of 4535±55 B.C. (T-3260) and the high frequency of artifacts especially grinders. The results of the small excavation at this site have been taken by the excavator as supportive evidence to her hypothesis that Kadero I was a seasonal site occupied only during dry season (ibid:30) (see the summary Khartoum province in this section - of the chapter).

Umm Direiwa, on the east bank of the Nile north of Khartoum, was excavated by Haaland to test her hypothesis that this settlement was a base site. The site was large, c. 9000 square meters, and was located 7 kilometers away from the present course of the Nile (cf. fig.1). It is difficult to estimate the exact size of the settlement since it is badly eroded and disturbed by tracks of vehicles passing on the eastern and Western portions of the site. Since there was no stratigraphy on the site, the habitation debris was excavated in one layer only. The material culture unearthed from this site is similar to that recovered from Zakiab site. (Haaland 1978:32-34; fig 32:164-167, tables 17:153, 19: 155 and section3.7 and 10.1.1.1.). The pottery production is markedly abundant suggesting to the excavator that even if some pottery production was maintained at a dry season camp, the bulk of the production was performed on the base site (ibid:33).

The lithic tools encountered were of the same types as found in Kadero I and Zakiab with high frequency of convex scrapers. Debris from lithic flaking, such as cores and flakes was infrequent. Thus the flaked tools seem to suggest to the excavator that the main bulk of activities took place in the dry season camp and not on the base site. (ibid). The grinding tools were ubiquitous (one square 2x2 meters contained more than 5000 fragments), showing the importance of ground grain in the economy of the dwellers. It is noteworthy that sickles or tools which could have been used for cutting grass/grains are absent in the site as well as other Neolithic sites in Khartoum Province. (ibid).

The osteological material showed that domestic animals were mainly cattle but also with some sheep/goats present.(ibid).

Two radiocarbon dates were obtained for the site yielded the following results:- 4165 ± 165B.C. (T-32161) (shell sample from test pit-unspecified by the excavator -), 4920 ± 130 B.C. (T-3297) (shell samples obtained from square 104 x 100y, C.15 cm below surface) (ibid:59).

Another Neolithic site named Umm Direiwa II, about 3 kilometers south-east of Umm Direiwal and 7 kilometers east of the Nile, was only surveyed because it is badly deflated. The site deflation is due to vehicles passing across the site and to erosion. It is difficult to estimate the extension of the site and probably it is more or less of the same extent as Umm Direiw and Kadero II. Pottery and lithic artifacts of this site are of Shaheinab Neolithic tradition. It was radiocarbon dated to 3800 ± 390 B.C. (T-3698) (shell sample obtained from test-pit C.5-10 cm. below surface) (ibid:44, 59).

Occupations of the latest Neolithic phase in Khartoum Province are scarce and are ephemeral camps sparsely scattered along the narrow strip of the Nile in a much wider area than that occupied by the early Neolithic folks (Caneva 1986:42-43). Four sites have, as yet, been discovered, two of them by an Italian Mission (Caneva 1986:42-43 and 1988d:338-339). The third was identified by the Sudan Antiquities Service- French Unit in a gravel quarry a few kilometers inland, east of Saggai village (fig.1), but a report on that site has, as yet not been forthcoming. Of these three sites, a rescue excavation was conducted on two of them (EL Kenger Middle and East). These two sites exhibit late Neolithic material comprising of burnished, impressed and incised wares together with polished axes and grinding stones. A few animal remains, consisting of only animal domesticates, were recognized at El-Kenger East. The cultural deposits of the tested soundings are very shallow, all below 30 cm. in thickness (ibid).

2.3:- Summary

The general characteristic feature of the Mesolithic and Neolithic occupations in Khartoum Province is that they are single component sites. In addition to that, most of them are located on gravel ridges or natural mounds at the edges of alluvial plain. Some of them are heavily deflated by natural (erosion) and cultural agencies (Mohamed-Ali 1982, Magid 1982, Haaland 1987 and Caneva 1987).

The Mesolithic and Neolithic occupations on the east bank of the Nile in Khartoum district are lacking stratified deposits. Kabbashi Haitah is the only site which seems to be stratified (cf. fig.1) but so far the excavator only made a test-excavation there. The extension of the trench is too limited to be taken as representative of the general stratigraphy of the entire site (Caneva, Pers., comm., 1992).

The Mesolithic and Neolithic settlements on the western bank of the river Nile are different from those of the eastern bank due to geological and to topographic differences. The western bank is composed of a narrow strip floodplain of Nubian sandstone formation and other lithological outcrops whereas the eastern bank of the Nile is a flat steppe which marks the western edge of the Butana plain. It is covered by Butana clays and Gezira alluvial deposits (Mohamed-Ali and El-Anwar 1988:66).

While the sites on the eastern bank are scattered in an area extending 7 kilometers inland from the river, those on the western bank are 1-2 kilometers near the river. The topographical variations between the two banks must have affected local adaptations. The flat alluvial clays of the east bank with their swampy nature and small water bodies would permit agriculture to be practised and would allow the presence of a rich pasture with thick cover vegetation and shrubs. On the other hand, the eroded sandstone and pebble conglomerates of the west bank would hinder agriculture. Moreover, the stony surfaces of this side of the river permit relatively little vegetation even after the rainy season (ibid).

This western part of the river bank revealed a rich Mesolithic and Neolithic spectrum with a more compact riverside distribution resulting in multicomponent sites. This possibly attributable to the narrow floodplain and the steeper bank on this side of the river, where evidence of agriculture was not found (Caneva and Marks 1990:35)

2.4. - White Nile Province

Archaeological works along the White Nile south of Khartoum revealed a series of early Holocene settlements of Early Khartoum and Shaheinab traditions. The first investigation in the White Nile province started during archaeological and

geomorphological fields between 13th February and 10th March 1973, by a mixed team of archaeologists, botanists, biologists and geomorphologists (Clark 1973: 57-64; Adamson et al 1974:120-123;). At three sites, namely Shabona (c.14 38'N 32 16 E)Tagra (c. 13 56' N 32 32' E) and Guli (c.13 34N 32 34E) (cf. figs.1,4), fragments of barbed bone points typical of those from the early Holocene settlements of "Early Khartoum" were found and dated at the three sites.

The first, Shabona Mesolithic settlement, received two radiocarbon dates of 5100 ± 120 B.C. (SUA- 298) on Pila shell and 5520 ± 240 B.C. (SUA -440) on human bone suggesting that Shabona was occupied in the 6th millennium B.C., though the excavator of this site considers it earlier (Clark 1989: 389-90). The site closely resembles Khartoum Hospital and other "Early Khartoum" type-sites in ceramics, lithics, bone industry and faunal material (Arkell 1949; Clark 1989; Khabir 1981; Mohamed-Ali 1982; Haaland and Magid 1990) (See also chapter 3). The usual decorative motifs and design forms found with the sites of the Early Khartoum tradition are represented in different proportions (see Clark 1989; fig 12:404). Wavy line and dotted wavy line, the diagnostic feature of the Early Khartoum tradition were present. Dotted straight lines are the most commonly encountered decorative motifs. Further frequent motifs include woven and linear mat impressions. Dotted - wolf and saw-tooth, dotted and linear triangle, herring-bone and fingernail impressions are scarce (ibid:402-5).

The lithic industry of this locality is a microlithic-flake but with heavy emphasis on microlithic-based technology. Retouched tools comprised more than 16% of the total stone artifacts. Microliths, which total 36.6% of the retouched tools and comprise various geometrics forms, are mostly made in quartz. The commonest are lunates but trapezium, triangles and rectangles are also present. These are the most characteristic forms of artifacts at the site (ibid, figs 8: 9-29).

The bone industry is characterized by uniserial barbed bone points of grooved butts, fragments of notched bone, awls and a lissoir all of which are in fragmented condition (ibid:401-402, fig.10:1-18).

At the second site, Tagra, Holocene clays yielded two fragments of a barbed bone point from a pit for which two radiocarbon dates were obtained. Mollusca from a depth of 1.6.-1.9 meters gave a date of 6420 + 350 B.C. (I-1485), and

another sample from a depth of 1.2-1.4 meters gave a date of 6180 ± 225 B.C. (SUA-68) (Adamson et al 1974:120), but these dates are of no help because they do not date an archaeological layer. Moreover, the barbed-bone point is not invariably associated with "Early Khartoum" sites. It has a long history in the Nile Basin and in the Sahel and is probably a spear for Nile perch and mudfish as well as for land mammals (ibid: 123).

At the third site, Guli midden, the discovery of barbed bone point of grooved butt midden is insufficient for assigning the site to "Early Khartoum" tradition since its pottery shows close affinities with the Shaheinab tradition.(see Arkell 1953:68-77). Nevertheless, burnished dotted wavyline and the opposed triangle impressed pottery-which is the diagnostic feature of Shaheinab tradition - are absent in the collection. The bulk of the sherds seem to come from well-fired, deepish spherical bowls with inturned rims. Rocker stamp decoration occurs on the interior of one sherds and the rim of a second. Another rim sherd shows a stamped chevron design such as occurs rarely also at Shaheinab site (ibid: 122-123). A radiocarbon date on shell from a depth of 30-35 cm in the midden gave an age of 3550 ± 100 B.C. (SUA -211) (Close 1988: 175), thus suggesting that Guli site is contemporaneous with the Shaheinab tradition. It is noteworthy that detailed report on the material culture of this site is, as yet, unavailable but only an interim report on its ceramic vessels has been provided (see Adamson et al 1974:120 - 123).

A later Neolithic fieldwork on the White Nile was carried out by a small team from Bergen and Khartoum Universities headed by Prof. R. Haaland. Archaeological surveys and test-excavations were conducted in January-February 1984 in the area between Jebel Tomat and Rabak on the White Nile, (150-320 kilometers south of Khartoum (cf. fig.1). The aim of this fieldwork was to enhance our knowledge about the nature and extent of settlement patterns of the Shaheinab tradition. Five sites were recorded but archaeological fieldwork was confined only to the Rabak site since the others were badly disturbed by agricultural activities and road building (El-Mahi and Haaland 1984:28).

The site is located 3 kilometers east of the present flow of the White Nile and just on the opposite bank lies the town of Kosti (cf.fig.2) (see chapter 3).

Analysis of the material remains shows that the lower levels of Rabak site had a pottery almost identical to that of the key-site of the Shaheinab tradition in Khartoum district (el-Mahi and Haaland 1987: 46, (fig.2). On the other hand, the lithic artifacts are rather different from that of the Shaheinab key site north of Khartoum. Typical tools of "Shaheinab tradition" were absent (gouges) and the lithic artifacts are very crude with very few retouched tools (lunates, groovers and scrapers) which are common cultural traits of this tradition. Grinders are rare, suggesting that exploitation of plant resources was of minor importance. Bone artifacts include harpoons and beads. Analysis of faunal remains shows that the dwellers of this settlement relied heavily on fishing and animal hunting. Bones of domestic cattle were encountered as it was the case in Khartoum area during late 5th millennium B.C. (El-Mahi and Haaland 1984:30 and Haaland 1987:35; 45-46).

The importance of Rabak Neolithic site stems from the fact that it is the most southerly Neolithic settlement excavated south of Khartoum and turned up with material culture-including pottery of the Shaheinab and Jebel Moya traditions (see sections 4.2.2, 4.3-4.9).

Radiocarbon dates obtained for the lower levels of this site cluster around 7th millennium B.P. (Shaheinab tradition) whereas the later occupation falls in the mid 5th millennium B.P. (labelled as Jebel Moya tradition)(see Addison 1949, plate XCI, plate XCIII, B.no.2,3;Haaland 1987, fig.14:i-k and section 10.1.1.2).

2.5. - Butana region

Archaeological work in the Mesolithic and Neolithic settlements of the Butana region started during the University of Humboldt (Berlin) surveys of Meroitic sites in the western part of this district. In early 1961 the site of Shaqadud Cave was discovered and a limited test-excavations were conducted the year after. It lies on the northwestern edge of the Butana, some 50 kilometers east of the Nile from the village of Wad Ban Nega (Cf. fig.1). The site was then described as the most important Neolithic occupation outside the Nile valley since it was large and appeared to have considerable in situ cultural deposits and burials (Otto 1963).

The eastern part of the Butana (the area lies in the vicinity of the town of Khashm-el Girba on the Atbara River, C.500 kilometers south east of Shaqadud)

was surveyed by a joint team of multi-national Universities headed by J. Shiner of Southern Methodist University (Texas) (Shiner 1971 a and b). However, since the eastern Butana lies outside the study area of the present research, I shall refrain from going too much into details of description of archaeological work in this district but rather keep to the general picture.

The work in the eastern Butana in the last decade was undertaken by two expeditions:the joint University of Khartoum/Southern Methodist University Butana archaeological Project and the Italian Archaeological Mission in Sudan (Kassala Province) (Fattovich et al 1984: 173-174). The latter mission focuses its efforts in connection with Ethiopia and particularly with Auxmite and pre-Auxmite developments (Fattovich 1980, 1982). Prior to these missions, some work had been carried out but on a small scale. In early 1917, Crowfoot travelled in Kassala Province in the eastern Sudan and recorded a major site named Mahal Teglinos which lies in a basin at the north-eastern end of Jebel Taka near the Gash Delta (Crowfoot 1928:112-116). (For further discussion on this site, see the forthcoming pages in this chapter). A one-month survey around the town of Khashm el Girba on the Atbara River was carried out by J. Shiner in 1971 (Shiner 1971). The previous work did not provide sufficient cultural material to indicate that the eastern Sudan had some archaeological potential, that is the reason behind the projects of Khartoum/Southern Methodist Universities and the Italian Mission in the Sudan to undertake more serious work during the subsequent years (1980-1983) in this region (Fattovich 1984:176).

Because of Shiners' pioneering survey in the eastern Butana (near the Atbara River), and since the main aim of the Butana Archaeological project (Khartoum/Southern Methodist Joint Mission) was to elucidate the cultural history of both eastern and western fringes of the Butana grasslands, the area around Khashm el Girba was chosen as a part of the eastern fringe to be investigated. (Marks et al 1987:140). On the other hand, the Italian Mission working in Kassala Province conducted a series of surveys but it concentrated its main efforts in the excavation of Mahal Teglinos site (see above). The site has a complete stratigraphic sequence from the early third to late second millennium B.C. The work on this site is still in progress (Fattovich, pers. comm.1990) (see below). As a result of the work of these missions a series of Palaeolithic and early ceramic-bearing sites were

located and some of them were test-excavated and radiometric dates were obtained (cf.section 10.1.4.1).

The earliest Holocene in the eastern Butana near the Atbara River and the Gash Delta in Kassala Province (eastern Sudan) witnessed the advent of pre-ceramic late Palaeolithic hunters who exploited large mammals such as hippo, giraffe and wild cattle but it is only during middle Holocene that such ceramic-bearing groups appeared and it seems that all the ceramic-bearing occupations of this area belong within a single cultural tradition named southern Atbai (Fattovich 1984:174-178; Marks and Sadr 1988: 69-69).

The ceramic sites in the southern Atbai tradition represents two different regional groups: a group of sites found along the Atbara River near Khashm elGirba with ceramics similar to those of the Early Khartoum and Shaheinab traditions in the Nile valley of the central Sudan. The other group is composed of a series of sites located in Kassala province around the Gash Delta in the eastern Sudan. The ceramic traits of this group2 is distinct from that of "Khartoum Horizon style" *1(ibid: 174).

The earliest recognized ceramic phase predating Atbai tradition of the eastern Butana is named pre-Saroba dated to the sixth millennium B.C. It is characterized by ceramics similar to those of the Early Khartoum tradition (Arkell 1949) in the central Nile valley of the central Sudan (see Marks and Fattovich 1989:455).

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*1.This term denotes the occurrence of a series of decorative motifs diagnostic of Khartoum Mesolithic and Khartoum Neolithic traditions in various sites in northeastern Africa extending from Khartoum province alo0ng the Nile to the West Egyptian Sahara and as far west as Meniet (Algeria) before 3400 B.C. (Hays 1971a, 1976 and 1974:28, fig.1).

The sites of pre-Saroba (2 sites) and Saroba (10 sites) are small in size (average area of c. 5000 sq.m.) located on the steppe east of the Atbara River and the Gash Delta. The depth of deposits (c.0.30 m) indicates that the sites were occupied, neither for long nor intensively, and their economies were based on riverine resources during pre-Saroba and on the hunting of savannah mammals during Saroba (Fattovich 1984:178-179) (Marks and Sdar 1988:72-73).

The Saroba ceramics continued in small proportions into the transitional Saroba/Kassala phase dated to the late 5th millennium B.C. Only one site during this transitional phase was recognized and it shows an increase in size from the pre-Saroba sites (c.15000 sq.m.). During this transitional phase the few ceramic traits that link Saroba with the Central Nile Valley (the presence of a few sherds with wavyline decoration) disappeared. At the same time, typical Saroba ware characterized by impressed motifs and scraped wares along with a hard, burnished, vertically rippled ware was predominating during this transitional period (Fattovich 1984: 178-179, fig. 3: 1-5).

The Kassala phase is most complex and most developed of the Atbai tradition. Some eight radiocarbon dates show that this phase extends from the middle of the fourth to the end of the second millennium B.C.. Within this phase two groups exist. This phase is represented by sites of Butana Group near the Atbara River and the sites of the Gash Group near Eriba and Kassala town (cf. fig.12). The difference between them lies in the proportional variation of the scraped wares (ibid: 180, fig. 4:5) and in the presence of some decorative motifs which are confined to one or the other (ibid, fig.4:1-3). However, a thick scraped ware is numerous and each site has certain number of well fired, decorated and burnished wares (ibid., fig. 4:4, 6; fig. 5:1-3, 5-6). The people of both the Butana and the Gash group were living in sizable villages covering between 40,000 - 120,000 m2 whose refusal was almost two meters deep (Marks et al 1986: 48).

The excavations conducted in the largest sites of Kassala phase (Mahal Teglinos of the Gash Group and KG23 of the Butana Group around the Atbara River) seem to indicate that these large villages attested on the steppe between the Atbara and the Gash Delta were in place before the introduction of domestic animals at the end of this phase (Marks and Fattovich 1989:455). Cereals possibly

entered the diet of these groups as early as fourth millennium B.C., though domesticated examples of both sorghum and millet have been reported from sites almost 2000 years after the earliest of the large villages around the middle of the fourth millennium B.C. (Marks et al 1986:48). During the middle and late Kassala phase there are some indications that extra-regional contact became more intense with eastern and northern districts of the Atbai tradition at Agordat (Ethiopia) and Erkowit (eastern coast of Sudan) (Arkell 1954:34-62; (Callow and Wahida 1981:34-36 and Fattovich et al 1984: 185).

The Butana and the Gash group appear to have disappeared suddenly from the area by about 2nd millennium B.C and were replaced by Jebel Mokram and Jebel Taka group of sites. These sites are small in area (C. 10,000-20000 sq.m.) and have thin cultural deposits (c.10-40 cm) (Mohamed Ali 1987:131) and they seem to represent ephemeral camps. Jebel Taka pottery is characterized by scraped ware and a few sherds suggest links with Meroitic and pre-Auxmite cultures to the west and east. On the other hand, Jebel Mokram group of pottery is overwhelmingly sand-tempered, undecorated brown ware (Fattovich 1984:183, fig. 6).

By the early first millennium B.C. the Meroitic Kingdom was flourishing in the Nile valley, while the region of Kassala was evidently left to be exploited by nomadic tribes who, as the level of information indicates, created small sites and settled only for short periods of time (Mohamed-Ali 1987:131).

2.6. - Western Butana

It was not until 1981, however, that serious work began in the western Butana region and a series of surveys and test-excavations were carried out over two field seasons in 1981/82 and 1982/83 by the Joint University of Khartoum/Southern Methodist University Butana Archaeological Project. The joint team was able to conduct work at two selected areas in the western and eastern fringes of the Butana leaving its central part untouched (Elamin and Khabir 1987:175).

The work in the western part of the Butana has shown that Shaqadud is a complex of sites covering an area of no less than 28000 sq.m. (cf. fig.5o). Based

upon the radiocarbon dates and ceramics for cross-dating, it now seems certain that the site extended over a long period of time from about 8000 B.P. to 3600 B.P.; thus providing the longest known cultural sequence for a Holocene occupation in Sudan. Therefore, the deep continuous stratification of the site is of an immense value not only in understanding the prehistoric sequence of the Butana vast plains of central Sudan but also might be useful for studying the prehistory of the Nile valley and neighboring areas (Marks et al 1985: 261-264).

The site is composed of four localities, two are the cave deposits (S1-A) and a large midden in front of it (S1-B) and the other two are large habitation sites (S1-C) and (S21) of in situ artifact distribution located on the flat surface just above the Cave (cf. fig.6). The oldest occupation is found at S21, along with at least the lower layers of the midden to be followed by the upper layers of the midden (S1-C)and then the Cave deposits (ibid:264-65).(For further information see chapter 5).

The analysis of data shows that the ceramics of the upper layers of the midden (Mohamed-Ali 1991 : 65-93, figs.5-(6-11); Mohamed-Ali and Marks 1984 1984; fig.4: middle row) are broadly comparable with those of the Shaheinab Neolithic tradition (Arkell 1953) whereas those of the lower midden (Mohamed-Ali 1991, figs.5-(1-5); Mohamed-Ali and Marks 1984, fig.4, bottom row) are generally comparable with those reported by Arkell (1949) for the Mesolithic wares of the Early Khartoum tradition. (Detailed discussion on Shaqadud pottery is presented in chapter 5).

2.6.1. Mesolithic settlements

2.6.1.1. Shaqadud midden (Lower levels)

During the course of excavations, a huge amount of lithic artifacts was recovered. The most common tools reported from the midden are geometrics, perforators and backed pieces (Marks et al 1985: 269, fig.9: a-f; Marks 1991:95-122, figs.6-(1-10) (fig.48). Grindstone comprises of hand stones, milling stones and stone rings are common. It is important to point out that these ground stone implements parallel their counterparts along the central Nile valley. Thus, for instance, stone rings are associated with "Early Khartoum" levels whereas pitted stones and keeled handstones are common in the levels of "Shaheinab tradition".

(ibid). The raw material utilized was dominantly pebble quartz, wadi chert, rhyolite, Nile pebble and agate pebble were also utilized for chipped stone tools. These raw materials were available either in the site area or in the surrounding vicinity (Marks 1991:69-101). Despite the fact that there is no significant change in stone tools of Shaqadud from the lowest to the uppermost parts of the midden, lithics at this site lack the diagnostic tools such as gouges, celts and large lunates typifying the Khartoum Neolithic tradition in the central Nile valley (Marks 1991: 120).

Faunal materials were recovered throughout the midden, but they tended to be relatively rare in all stratigraphic levels. The faunal remains suggest that hunting was important and it was pursued actively and intensively. A wide range of animals were hunted, from very small oribi to elephants, although antelopes seem to have been most regularly hunted (Peters 1991:197-235).

2.6.2. - Neolithic settlements

2.6.2.1. - Shaqadud midden (Upper levels)

The upper midden representing the Khartoum Neolithic tradition, produced a relatively bigger sample but contrary to the situation of the contemporary Holocene sites within the Nile valley, there is no evidence for any domestic animals in the upper unit of the Shaqadud midden. This poses a problem whether that was due to the lack of domestic animals on the site or the idea of utilizing them for food was unknown (Marks et al 1985: 271-272; Peters 1991: 197-235).

Mollusca remains such as fresh water snail Pila Wernei and Aspatharia sp. and the land snail limicolaria caillaidi and Zootecus insularis were reported from the lower midden. These species need at least 400 mm of annual rainfall to survive. The presence of a marsh cane rat reinforces the picture of seasonaly swamp habitat when the layers of the midden were exploited. Hence, there is ample evidence of wood savannah in the vicinity of Shaqadud with area of grass during the occupation of the midden. (Peters 1991: 198, 209, fig. 10-1:1-1).

2.6.2.2. - Shaqadud Cave

The Cave is set into the back of a box canyon and it covers an area of c.36M2 (cf. fig.49) When Otto first tested it, he found a large rock at a depth of c.65 cm which he thought was a bedrock. It appeared that the cave had a cultural material to a depth of 3.5.m., while similar material was also encountered along the north-eastern side of the basin in front of the Cave in test pit no.4, below 25 cm of pond sediments (cf. fig.50). Based upon radiocarbon dates (see chapter 5), it has been postulated that the sediments accumulated in the Cave was rapid, and the total span of occupation probably was somewhat less than 1000 years. The radiocarbon dates indicate that the oldest occupation of the basin was at C. 4200 B.P, whilst the top sediments of the Cave were deposited at C. 3600 B.P.. In spite of the relatively brief nature of the Cave, sufficient remains including artifacts, bones and seed were recovered. Unlike the stone artifacts, ceramics show significant change through time both in technology and decoration (Marks et al 1985:272). Perhaps most striking is the clear differences shared between ceramic assemblages of the basin and the lower levels of the cave with that of the upper midden. As the time passes, the ceramic traits of the middle and upper cave deposits show considerable change and the wares begin to give way to other forms and decorations which are different from those of the lower cave. The new ceramic forms and decorations of the middle and upper levels of the cave (Robertston and Marks 1984:515-34; Mohamed-Ali and Marks 1984; fig. 4, top row; Marks et al 1985; fig .12:a, e) (unknown in the contemporary Neolithic contexts of the Nile valley) are akin to the ones frequently present in the Atbai ceramic tradition from east of the Atbara River and Kassala district in the Gash Delta some 300 miles to the east (Fattovich et al 1984:180, 183, fig. 4:5; fig. 6: 3, 6-7).

The lithic material from the cave are relatively more omnipresent than those reported from the midden but typologically they are equally limited and the standard of workmanship is markedly poor. The chipped stone tools are overwhelmingly lunates, geometrics, retouched pieces, denticulates, perforators, end scrapers and backed pieces though present are fewer in number. (Marks 1991: 173-91, fig. 8-1). The most important raw material in terms of number was quartz. It always represents at least 82% of the total in all levels. Quartzite and Wadi chert are present in much lesser proportions and all of which were immediately available

at Shaqadud site. The analysis of lithic materials confirmed that they exhibited little variability and show almost no significant change through time (ibid).

Faunal and floral materials were recovered from the Cave in appreciable amounts. Cattle and small livestock are, however, reported in minor amounts. The animals remains indicate that wild game mostly herds of giraffe and gazelle in addition to large antelopes, porcupines, hare and aardvark were hunted. The faunal remains suggest a humid grass savannah with vegetation belt requiring an average annual rainfall of 350 mm. (Peters 1991 : 197-235).

Macrobotanical remains retrieved from the deposits of the Cave produced positive results. Seeds include grains of sorghum sp., Stapf (col. Ar. Adar), Panicum turgidum, Forsk (col. Ar. Toman), Grewia tenax, (Forsk) Fiori (col. Ar. Guddeim) as well as a number of fruits of Zizyphus spinachristi, Lam. (col. Ar. Sidir/Nabag). A number of Pennisteum sp. (col. Ar. Dukhn) probably of domestic millet have been identified and they are the earliest evidence so far known in Sudan. In addition, evidence of annuals and perennials were also recovered including seeds of Solanum dubium, L. (col. Ar. gubbein), Sida alba, L. (col. Ar. Umm Shadeida) and Steria sp. (col. Ar. Danab el Kalb) (Magid 1989: 27-28; 1991:193-96).

2.7.- Concluding remarks

In all the Mesolithic and Neolithic pottery contexts in the central Sudan no complete pots were recovered. Nonetheless, judging from the abundant fragments, the possibility that some production was performed on base-camp sites seems much more likely. Moreover, some lithic artifacts were probably used for crushing temper and lumps of red ochre as some disk-grinders and cores were stained with red ochre which was often used for colouring surfaces of the pots. Furthermore, the utilization of pottery and intensification of aquatic resource exploitation generated processes with wider implications, mainly population growth and sedentism (see supra, Haaland 1992:48 and sections 9.5-9.7).

The work in the Mesolithic and Neolithic archaeology of the central Sudan is, hitherto, confined to the narrow strip of the Nile whilst the hinterlands east and

west of the Nile valley (with the exception of Shaqadud site complex) have not been explored (see below).

The lack of long-term strategy in the past works of Mesolithic and Neolithic research in the central Sudan poses several problems as to the so-called "cultural gap" in history of the Khartoum Nile environment (see above) and the site-unilineal perspective rather than region-wide approach in interpretation.

It has observed that the Mesolithic-type sites (e.g. Khartoum Hospital, Sarurab2) on the central Nile are located near the river banks whereas the Neolithic-type sites (e.g. Shaheinab, Kadero I & II, Zakiab and Umm Direiwa) appeared to be short camps scattered in the Nile flood plain or along the Wadis (Caneva 1988:321-343). In the writer's opinion this diversity in adaptive patterns could be interpreted in terms of shift in subsistence economy from seasonal hunting, gathering and fishing (Sedentary or pastoral Neolithic) during the early Holocene (c.7000-5000 B.C.) into one based on domestication of animals (Pastoral Neolithic) during the middle Holocene (c. 4000-3000 B.C.) (see Arkell 1949: 107, 1953: 10-19; Haaland 1987: 185-197; Krzyzaniak 1974: 30-32; 1976:41).

Summing up, we will however, only be able to provide a more coherent picture about the Mesolithic and Neolithic periods in the central Sudan by a long-term programme of systematic surveys and excavations. This would necessitate joint efforts and collaborative works of varied institutions and departments.

Chapter 3

3. Ceramic Technology of Mesolithic and Neolithic Sites in Khartoum Province.

3.1 Introduction

The introductory section of this chapter embraces the necessary information concerning the geographical settings of the sampled Mesolithic and Neolithic sites in Khartoum Province. The remaining sections of the chapter provide detailed description and critical analyses of the technological features pertaining to the Mesolithic and Neolithic sampled pottery, with special reference to a series of physico-scientific analyses and in comparison with the typological characteristics of these ceramics.

3.1.1 Geographical location

3.1.1.1 West bank of the Main Nile

3.1.1.2 Mesolithic sites

3.1.1.2.1 Sarurab2 (15° 56'N, 32° 32' E)

The site of Sarurab2 is located some 45 km north of Khartoum on the west bank of the Main Nile. It is situated on a gravel ridge about 384m. above the sea level. The site measures 75m. from east to west and 35m. wide but it might have occupied much larger area in the past than at present. Surface indications suggest an estimated total area of 2800m (see section 3.2 and appendix 2). The site was excavated in two stages. A small portion of the site (c.300 m2) was excavated by Abbas S.M.Ali (1982:41-45). The larger part of the site was excavated by the present writer in January to April 1978 and labelled as Sarurab2 to distinguish it from Mohamed-Ali's (see Khabir 1981:124-172 and figs.4,5). Two radiocarbon dates based on charcoal were obtained for the site; the oldest being 7420 ± 80 B.C. (HAR-3475) and the youngest is 7380 ± 90 B.C. (HAR-3476) (see section 10.1.1.1 and appendix 2).

3.1.1.3 Neolithic Sites

3.1.1.3.1 Islang2 Site (15° 53' N, 32° 32' E).

The site is located some 26 km north of Omdurman on the west bank of the Main Nile. It is situated on a gravel ridge at c.394m. above the sea level and it lies two kilometers west of the Main Nile. The site is a small one and a total of 200m2 were excavated. It was previously partially excavated by EL-Sayed A. Anwar (c.496 m2) (Al-Anwar 1982:21). Surface indications suggest an estimated total area of 4000 m2 (figs.6,7). The cultural material recovered from the excavation carried out by the present author (see section 3.2 and appendix 3) labelled Islang2 to distinguish it from Al-Anwar's earlier work at the site. (see supra). The site has got a couple of radiocarbon dates; the oldest (based shell) being 4490±150 B.C.(SMU-2575) whereas the youngest (based on charcoal) is 4330±90 B.C.(SMU-2565) (see section 10.1.1.1 and appendix 3).

3.1.1.3.2 Nofalab2 site (15° 52'N , 32° 32'E)

The site is located some 28 km north of Omdurman on the west bank of the Main Nile. The larger portion of the site was previously excavated by EL-Sayed A. Anwar (Anwar 1982:18-20). The site is situated on a gravel ridge elevated two meters above the surrounding alluvial plain. The area of occupation measures 70m from east to west and 140m across from north to south. Surface finds suggest an estimated total occupation area of 1200m (figs.8,9). The cultural material recovered from the excavation labelled Nofalab2 to distinguish it from Al-Anwar's earlier work at the site. Two C-14 dates were obtained for the site, the oldest being 4380 ± 80 B.C.(SMU-2577) and the youngest is 2705 ± 295 B.C.(SMU-2561) (see section 10 .1.1.1 and appendix 4).

3.1.2. Geology

Khartoum province (lat.15° 16' 41" N and 32° 34' 30"E) is divided geologically and geographically by the White Nile and north of Khartoum by the United Niles, into western and eastern zones. The western zone is characterized by extensive Nubian sandstone Formation resting an a pre-Cambrian Basement Complex. This formation crops out north of Omdurman and Khartoum and in

scattered exposures further south (Vail 1982:57)(figs.3,4). It consists of the following three lithological units:

1) The Merkhiyat Jebels west of Omdurman, which is characterized by its high -silt content, abundance of white specks (kaolinized feldspar fragments), pebbly nature, well-developed cross stratification and abundant fossils.

2) The pebble congolomerates which are composed of vein quartz, quartzites and rocks of ferrous sand.

3) Mudstone composed mainly of clay minerals of the kaolinitic group together with quartz grains, some mica and sericite (Whiteman 1971:55-60).

Basement Complex occurs in the Sabaloka inlier some 50 miles north of Khartoum. Here, the Basement complex is exposed in a series of jebels and in the well-known gorge of the Nile in the Sixth Cataract area. This formation is composed of rhyolite, schists gneisses, quartzites and garnets (ibid: 22-23)(see figs.3-4).

Tertiary volcanic rocks are represented in this district by two small outcrops of olivine basalt which occur south and west of Omdurman near jebel et-Toriya and is presently quarried for road material. The other is a small outcrop of hexagonally jointed fine grained dark green basalt (Whiteman 1971:58) (see figs.3-4).

3.1.3. Topography

The topography of the sites area consist of three features; the Nile floodplain, raised of gravels and coarse red sand, and an extensive sandstone plateau of the Great Sahara. The Nile cuts its course through the sandstone layer, it had eroded a wide bay in the sandstone layer and built up a wide flood-plain and perhaps one thousand meter or so in width and several kilometers in length. At the end of this floodplain appears suddenly raised ridges of gravels, laying directly on the edge of the sandstone layer; their shapes had been continuously reshaped by numerous water channels and seasonal runoffs. Beyond this lies the extensive sandstone

plateau of the Sahara. Here and there are scattered small sandstone inselbergs/hills e.g. 'Markhiyat, kerrari, Jebel Mi'agil, Jebel al Qisi, ending up by Jebel Umm Murrahi right by the edge of the water of the Nile (fig.4). From these mountains there are several khors drain this plateau into the Nile. These cut through the sandstone surface carrying their load of quartz and other rocks towards floodplain. Their speed seem to slow down and they deposit their coarser load at the edge giving rise to the ridges mentioned above, which they in turn continuously cut through. It is this raised ridges which was exploited for human settlement that one finds sprawling villages and scattered ancient cemeteries (Hakem 1979:151).

3.1.1.1.1 East bank of the Main Nile

3.1.1.1.2 Geographical Location

3.1.1.1.3 Mesolithic sites

3.1.1.1.3.1 Kabbashi Haitah (15° 52 7' N, 32° 35' 1E)

The site is located on the northern border of Wadi el Kabbashi, about 1.5 km east of the railway. It lies some 26 km north of Khartoum about two kilometers east of the Main Nile (fig.4). It is extensive site containing about 100 (post-Meroitic) tumuli built up with prehistoric debris. The mounds are damaged to some extent by the local gravel seiving (Caneva 1988:342). Two radiocarbon dates (based on pila shell) of 6300±100 B.C. (T-6654) and 5530±90 B.C.) (Rom-259) were obtained for the site (Caneva et al 1993:23).

3.1.1.1.3.2 Kabbashi (15° 52' N, 32° 34' 20" E)

The site of Kabbashi is located some 34 km north of Khartoum, east of Kabbashi railway station (fig. 4). It is an extensive site containing 55 (post-Meroitic) tumuli built up with prehistoric (Early Khartoum) debris. Three mounds (each of which is c.30 m in diameter) were test-excavated. These were located some meters apart from each other to ensure exposure of any horizontal stratigraphy present in the cemetery. Test-excavations (32 1x1 m squares) were made at the periphery of tumuli fields to ascertain the correspondence between the surface and subsurface archaeological situation (Caneva 1987: 53 - 55, 1988: 342 and 1989: 37-39). This site has got two radiocarbon dates (based on pila shell) of 5325±85 (Rom-262) and 5120 ±120 B.C. (T-6645) were obtained for the site (see Caneva 1988a:28, Caneva et al 1993:23 and section 10.1.1.1).

3.1.1.1.4 Neolithic Sites

3.1.1.1.4.1 Geili (16° 1 24' N, 32° 33 20' E)

The site is located on the right bank of the Main Nile, at km 46 on the northern railway from Khartoum, between El-Geili station and the asphalt road (fig.4). It extends over an area of 150 x 80 m. in the form of huge mound (fig.11). The surface was probably modified by natural and human agencies. Prehistoric graves were found on the top of mound, not elsewhere, graves of later periods, though present on top, prevail in lower parts of the mound (Caneva 1988:19-22). It was radiocarbon dated 3520 ± 100 B.C. (T-5022) using a sample of Pila shell (ibid : 28).

3.1.2 Geology

The geology of the three sites mentioned above is basically Nubian Sandstone formation which spread over most parts of central and northern Sudan including Khartoum Province (figs.1 and 5) (Whiteman 1971:62-69). The Nubian Sandstone group consists of conglomerates, intraformational congolometrates, grits, sandstones, sandy mudstones and mudstones. Often the Nubian Formation is iron-rich and in a number of localities beds of iron occur. The formation is believed to be of Mesozoic age (ibid). This Nubian Sandstone Formation rests unconformably on a surface of a Basement Complex rocks. The latter formation is exposed into a series of hillocks and in the famous gorge of the Nile at Sabaloka in the sixth cataract area (fig. 5) some 50 km north of Khartoum. The Basement Complex rocks consist of quartzo-feldspathic gneisses with some garnetiferous gneiss, granitic gneiss, hornblende gneiss, amphibolite and quart dykes. This geological formation is believed to be of Pre-Cambrian age (Whiteman 1971:23-27).

3.1.3 Topography

The ancient alluvial plain of the Nile appears to be highly asymmetrical, much more extensive on the right bank of the river than on the left. This phenomenon can be explained by the geological and topographical conditions of the area: east of the Nile the Basement Complex outcrops prevail, highly weathered, in a typical pinplain morphology with isolated inselbergs emerging from

slightly undulating alluvial surface marked by broad wadis: west of the river the outcrops are exclusively Nubian Sandstone overlaying the Basement Complex; their bedding gently dipping westward coupled with their resistance to weathering, is a major cause limiting the expansion of the alluvidal plain on the left (Marcolongo and Palmieri 1988: 35-36).

The alluvial strip of the Nile includes all the successive movements of the river from the Mesolithic onwards. Inside this bands there are two continuous palaeochannels varying in width, often delimited by fluvial terraces and natural levees. They represent the low and medium water thawegs and during the flood water was likely to overflow into the whole alluvian plain. Floods were conspicuous during the Mesolithic period and became less pronounced during the Neolithic and later periods when the climate became more arid and the river bed became more incised. (ibid).

Most areas of the eastern bank are composed of silt and clayey deposits. Only the Sabaloka area is characterized by a prevalence of rock outcrops, with a reduced non-existent alluvial cover (Marcolongo 1983:40).

3.2. Archaeological Sites and Ceramic Material

3.2.1 West bank of the Main Nile

3.2.1.1 The site of Sarurab2

The settlement was located on an ancient Nile bank. A total of 51 squares of 2 x 2 m a depth of 0.6 m in most places and often exceeding that depth in very few instances up to 0.8m. A large amount of material have been recovered in the course of testing. These include pottery artifacts of Khartoum Mesolithic type (see below), lithic tools made mainly of quartz, c.70% (appendix 10), molusca shells (appendix 12) and bone remains (appendix 14).

A total of 4831 potsherds were collected from all test-pits, including bases, rims and body sherds. The pottery format and its decoration exhibit typical 'Khartoum Mesolithic' repertoire (Early Khartoum tradition as represented by Khartoum Hospital site and other related assemblages, see section 2.1.2), though much cruder and rougher examples are in evidence (Khabir 1981 : 124 - 146).

The pottery unearthed from the site was found only in the form of sherds. The majority of potsherds were decorated (c.87%). Dotted straight line is the most prominent motif in the collection amounting to 35%. Wavy line pottery which is the hallmark of Early Khartoum tradition (cf. chapter 10), being the second most frequent type of decoration at Sarurab2 site, present at c.5% of the total collection. Further frequent motifs include dotted wavyline, zigzag variety, impressed straight and plain pottery. Twine and triangular impressions are less common. Fingernail impression is exceptionally rare.

No specialized tools in association with pottery making nor kilns or wasters were found.

The techniques utilized for executing these decorations include rocker-stamp, single stamp and cord impressions. Shells and catfish spines and bone fragments have been found and could have been in use. It can be judged from the body and rim sherds that decoration is not confined to specific portion but covering the whole or almost the whole of the vessel.

The pottery of this site is mainly pale brown (10YR 6/3 Munsell soil colour chart). The fractures generally break with dark grey colours (2.5YRN4/0 7.5RN4/0 Munsell). Some potsherds (127 specimens) all of which belong to fine plain ware, have been coated with reddish brown (2.5YR 4/4 Munsell colour) which look deceptively like a slip (Discussed further in section 3.7.2.3).

Polished and burnished potsherds were not encountered in the total collection, however, the fine plain potsherds have been rubbed with a hard object such as water-worn pebble to get a smoothed surface, usually, inside (ibid.).

No complete pots were found. But judging from the rims and the few bases found, the bulk of the sherds seem to belong to hemispherical bowls.

Most vessels are of moderate thickness (c.5-10 mm), thin and thick examples (>10 mm and < 5 mm respectively) are infrequent.

Coiling-technique could have been practised as could be deduced from uneven thickness of the walls (for detailed quantitative analyses see section 3.7.2.3).

3.2.1.2 The site of Islang2

The site is located on a gravel ridge at 394 m. above the sea level and it lies 2 kilometers west of the main Nile Bank (Lat 15°53'N, Long. 32°32'E) (fig. 4). The site at present is a small one covering 10 x 20 m2 on E.W. line. It might have occupied much larger area in the past then it is now.

A metric-grid system was laid by the present writer to cover the entire site and the basic line was set in the east-west direction (fig. 6). The grid seemingly occupies the same extent of the site (10x20m2) with 10m. interval. The selected area was then divided into four rectangular grids of 50x10m2 and given the names; grid 1, grid 2, grid 3 and grid 4. Random sampling was used to select seven excavated-units within the grids for excavation. The test-excavated units of 2x2 m were distributed over the surface of the site with significant artifact concentration and/or diagnostic specimens. Then each excavated-unit has been marked with an alphabet from A to E in a clockwise order (fig. 7). As a result, the following squares were prepared for test-excavation: sq. 1-A, sq.2-B, sq.3-C, sq.4-D, sq. (3,4)E, sq. (1,4) F and sq. (2, 3)G. The excavated-units were excavated in 10 cm spits, yielding cultural material down to a depth of 50 cm. in most places and exceeding that depth in rare instances. The cultural deposits in one of these units (sq.1-A) extended to 60 cm. below the surface.

The site yielded considerable amount of archaeological remains. In all the excavated-units the greatest concentration of artifacts occurred between 10-30 cm below the surface.

Considerable materials including pottery (see below), lithic artifacts (cf. appendix 9) molluscan (appendix 12) and faunal remains (appendix 15) were found.

The pottery of Islang2 site was found exclusively in the form of sherds. Potsherds being 1312 in number and the majority were decorated (68% of the total collection). Undecorated sherds are frequent, (n=115) and the bulk of them are of fine-textured surfaces. They have been mainly coated with red slip which was prepared from nodules of red ochre. (iron oxides) (cf. section 3.7.2.3).

Zigzag is the most favourite decorative motif, being present at c.25% of the total pottery collection. "Vees" is the second most frequent decoration, occurs at c.14% of the total proportions. Further frequent motifs include triangles with dots, dotted lines, triangles, incised, combed (scraped), semicircular panels, impressed straight line and slanting serration (ibid).
Rocker stamping, combing, incision and impressions were used to execute these decorations.
No kilns, specialized tools or wasters were encountered.

No complete pots were encountered. It could be judged from the rim-sherds that the present ceramic collection represents a limited number of vessel forms. Most are hemispherical bowls, cups are present but apparently rare.
Wall thickness range from 2 to 11 mm with predomination of these from 4-9 mm thick(cf. section 3.7.2.1).

An appreciable amount of pottery was burnished by a hard-smoothed tool to get a compact lustrous surface, of which plain specimens are the most frequent. The sherds are sometimes smoothed on the inside only.
The surface colour of pottery is mostly brown (7.5YR 5/2 Munsell soil colour chart 1975). The sherds generally break with grey (5YR5/1 Munsell) or dark grey colour (5YR 4/1 Munsell)(see section 3.7.2.3).

The horizontal breakage and uneven thickness of walls raise the probability that Islang2 pottery was made by coil-technique. The pottery was sand tempered, well fired and has a hard fabric (ibid).

3.2.1.3 The site of Nofalab2

This settlement was previously partially excavated by El-Sayed A. Anwar (Al-Anwar 1982:18-21). The site is located on a gravel ridge elevated 2 metres above the surrounding alluvial plain. The area of occupation measures 70 m from east to west and 140m across from north to south. Surface indications suggest an estimated total area of 12000m (fig.8). The cultural material recovered from the excavation has been labelled Nofalab2 to distinguish it from Al-Anwar's include abundant pottery sherds (see below) lithic artifacts (appendix 10), faunal and

molluscan remains (cf. appendix 13) as well as radiocarbon samples in the form of charcoal and shell (cf. appendix 4).

Considerable parts of the site, particularly the eastern, southern and portions of the centre, were modified by natural and cultural agents. The present author has selected two areas for test-excavation on the basis of surface finds density and the nature of occupation debris. Therefore, excavations were conducted on the most preserved parts of the site. Random sampling was used to determine 10 squares for testing the already selected areas (fig.8).

The whole area of Nofalab2 site is divided into 15x15m. grids of dimensions 10x5m in the north-south direction and in the east-west direction respectively. Then two grids of equal-sized squares were chosen on the surface of northern and eastern portion of the site amid a rich surface scatter of artifacts. Each of these grids measures 59m and consists of five squares at 2m intervals with a bulk of 0.5m. between every two neighboring squares. The chosen grids have been designated as (4,3) and (4,6) with reference to the numeration of vertical and horizontal axis which was applied for the general division of the site grid. Then each square has been marked with a letter from A to E in anti-clockwise order. The following squares have been opened: (4,3) E whereas the squares of grid (4,6) include: (4,6) A, (4,6) B, (4,6) C, (4,6) D and (4,6) E (fig.8) The squares have been excavated in arbitrary 10cm. stratigraphic levels. This is because archaeological deposits are not complicated, besides I have aimed to keep as much control as possible over the context in which artifacts were found. The layers are numbered in ascending sequence. Consequently, the higher the number, the lower the layer. The test-pits were excavated down to a depth coincident with the disappearance of occupation remains. The artifacts found were located and plotted three-dimensionally with reference to the conventional layers established. All the deposits were seived using 1/4 inch mesh.

In all the excavated grids, the greatest concentration of material occurred between 20 and 40 cms below the surface. The cultural occupation often reached 70 cms in depth. The high concentration of finds between 30 and 40 cms is probably an indication that the period of occupation is unlikely to have been lengthy.

Considerable quantities of pottery (n=2981) were soley found in fragmented condition. The bulk of the potsherds is decorated (76%). Undecorated sherds are frequent (c.24%) (cf. section 3.7.2.2).

Unlike that of Islang2 (cf. section 3.2.1.2) "vees" decoration in this collection is the most popular motif, being present at c.22% of the total specimens found. Zigzag decoration is the second most prominent motif, occurs with nearly the same proportion as that of "vees" decoration. Further frequent motifs include incised, impressed, dotted lines, triangles, combed (scraped) and linear impressed. Black-topped red ware is scarce (cf. section 3.7.2.3).
Rocker-stamping, incision, impression and combing are the types of techniques applied.
Kilns, specialized equipments of potting or wasters were not found.

Considerable number of pottery is burnished, though surfaces are often smoothed on the inside only(cf. section 3.7.2.3).

The basic surface colour is mostly reddish brown (5YR 5/3 Munsell soil colour colour chart 1975). The fractures usually break with grey (5YR 5/1, 5YR 4/1, 10YR 6/1 Munsell) or dark grey colours of various shades (7.5YR N 4/0: 5YR N3/0 Munsell)(ibid.).
An appreciable number of pottery is slipped, particularly the fine plain sherds which are mainly coated with red or reddish brown slip. A red pigment of ochre was, in most cases, applied to the outer surfaces of the sherds, when the clay was in the leather-hard state and before firing (ibid).

Complete forms were not found in the collection. The vessels are, without exception, in the form of sherds the bulk of the sherds indicate direct rims probably belong to large or medium-sized bowls. Fewer thin-rims probably cups were in evidence and are exclusively of fine red ware. Vessel-bases not present in the collection(cf. section 3.7.2.1).
Wall thicknesses vary from 2 to 14 mm but the majority have thicknesses range from 5-10 mm.
Coiling-technique was used as could be inferred from uneven thickness of the walls. The horizontal breakage is imperceptible due, perhaps, to the exceptionally smaller sizes of most (c.92%) of the sherds (c.4-6 cm. maximum length) and the

completely obliterated surfaces of the relatively larger (c.8%) ones (c.6.5 - 16 cm. maximum length) as the surfaces most likely have been finished with smooth pebbles that concealed that scraping marks (ibid.).

3.2.2 East bank of the Main Nile

3.2.2.1. The site of Kabbashi Haitah

This site was test-excavated by the Italian Mission. It is an extensive site. located further east from the river than the more recent "dotted-wavy line" site of Kabbashi (cf. section 3.1.1.4 and fig.4). The latter possibly followed the westward shift of the Nile, have seen entirely occupied at about 5500 B.P. (Marcolongo and Palmieri 1988:35-47).

It yielded ceramic assemblage of Khartoum Mesolithic type. The prehistoric debris appeared to be very deep (down to 1.6 m) and rich in artifactual remains. Archaeological finds recovered from this site include abundant wavy line pottery, microlithic quartz implements, grinding stones, stone rings and shell in typical association noticed so far at Saggai1 (see Caneva 1983, 1987:53-55, 1988c:342 and 1989: 37-39) and Kabbashi (cf. section 3.1.1.5).

Some 1201 potsherds were uncovered from four soundings (KAH/Y/1-KAH/Y/3 and KAH/K/1) are mostly decorated (c.85.5%). Undecorated specimens amounting to c.24.4% of the total collection. (cf. section 3.6.2).

The most decorative motifs, being wavyline totalling 22% of the percentages. Undecorated sherds are the most prominent feature of this ceramic assemblage, occur at c.24% of the total ceramics. Zigzag decoration is similarly popular motif, being present at c.23.1% of the sherds proportions. Infrequent decorations include dotted wavy line being present at c.5.6% whereas alternate pivoting is rare being 1% of the total specimens. Considerable amounts of potshderds have been classes as "intrusive" (c.17.3%) and are atypical of Kabbashi Haitah and other related ceramics of Khartoum Mesolithic type. Scanty sherds (c.7%) were classified as "unclassifiable". These sherds are weathered and the precise nature of the surface finish on them could not be determined for certain. (cf. Garcea 1991:66 and section 3.7.2.3).

Incision, rocker stamp and alternate pivoting are the techniques employed for excuting the above mentioned decorations (section 3.7.2.2).

It can be inferred from the body and rim sherds that decoration is not restricted to specific part but covering the whole or almost the whole parts of the vessel (pers. obser.).

The surface colour of the pottery is mainly light reddish brown (5YR 6/4 Munsell soil colour chart), reddish brown (5YR 5/3 Munsell) and very pale brown (10YR 7/3, 10YR 7/4 Munsell) are also frequent. The fractures usually break with grey (10YR 5/1 Munsell) or dark grey (2.5 Y N4/0 Munsell) (section 3.7.2.3).

The pottery is exclusively unburnished, of coarse grained texture and grains of sand are occasionally visible on the outer surface. It has a crude appearance when it is compared with the polished pottery of the Geili site in the same vicinity (cf. fig. 4) and Caneva 1988:72).

The wall thickness of the majority of Kabbashi Haitah pottery varies between 3-10 mm whereas exceptionally coarse fragments display thicknesses in the range of 11-14mm. (cf. section 3.7.2.1).

It can be inferred from the uneven thickness of the walls that coiling might have been in use, though horizontal breakage (if any) is not clear due to the relatively small sizes of the most fragments. (ibid).

Complete pots were not found and the present ceramic material represents a limited number of vessel forms. The rims are almost exclusively direct and probably belong to medium and small-size bowls. Incurvate rims were possibly parts of hemispherical bowls. (ibid).

Kilns, specialized tools or wasters were not found and the source of the pottery has been investigated through a series of physico-scientific analyses (cf. sections 3.3, 3.4 and 3.5).

The macroscopic examination tends to show sand-tempered, hard and well fired pottery (for further discussion see section 3.5).

3.2.2.2 The site of Kabbashi

This site (fig.4) is composed of three mounds being excavated by an Italian Mission headed by I.Caneva (Caneva 1987:53-55). The archaeological deposits are 45 cm deep and rich in pottery, lithic implements, faunal and floral remains. Living surfaces were found, scattered with querns and grinding stones. (Caneva 1988c:342 and 1989 : 37-39).

The site belongs to the late Mesolithic period (cf. section 10.1.1.1) and the wavyline decoration which is the hallmark of the early Mesolithic period (Early Khartoum) tradition (cf. chapter 10), is relatively low in proportion. Instead dotted wavyline was encountered in relatively higher percentage (cf. section 3.6.2).

Some 2348 pottery specimens were unearthed from seven soundings (KAB/A/2, KAB/B/2, KAB/D/1, KAB/D/1b, KAB/Ea/1, KAB/Ea/Ib and KAH/K/1). (Garcea 1991:65 and Caneva et al 1993:39). The pottery was, solely, found in the form of fragments. The most decorative motif is zigzag variety, being present at 61% of the total sherds counted. Dotted wavy line was encountered at c.6% of the total sherds whereas wavy line occurs at c.4%. Decorations with alternate pivoting were absent and the "unclassifiable" group amounting to 17.3% of the total specimens at Kabbashi Haitah Pottery (cf. section 3.2.2.1). Non-decorated sherds account for c.11% of the total specimens.
Decorative techniques used on the vessel body include incision and rocker stamping (cf. section 3.6.2).
It could be deduced from the pottery collection that the decoration is confined only to the body and the remaining parts of the vessel (exclusively rims) are devoid of decoration (ibid).

The surface colour of the pottery is mainly pale brown (10YR 6/3 Munsell soil colour chart). Other surface colours include light brownish grey (10YR 6/2 Munsell), pink (7.5YR 7/4 Munsell), brown (7.5YR 5/2 Munsell). The sherds generally break with dark fractures of various shades (2.5YN 4/0, 5Y 5/1, 7/5YR N 4/0, 10YR 3/1 Munsell)(cf. section 3.7.2.3).

The pottery is devoid of burnishing or polishing, it is coarse -grained and grains of sand are occasionally visible on the outer surface. (ibid).

Complete vessels were not present in the collection. However, all the rims, almost exclusively undecorated, have direct shapes and probably they were parts of bowls of different sizes. (ibid)

Wall thicknesses range from 3 to 12mm but the majority of sherds have a thickness from 5 to 8 mm.
It can be judged from the irregularities of the sherds walls that coil technique might have been in use. (ibid).

No kilns, specialized tools or wasters were encountered. The source of the pottery has been investigated through a series of physico-scientific analyses (cf. sections 3.3 , 3.4 and 3.5).

3.2.2.3 The site of Geili

The Geili site is a low crescent-shaped mound rising about 4 meters above the surrounding plain, with an irregular elevation (cf. section 3.1.1.1.7 and fig.11). Graves of Meroitic and Post-Meroitic periods were found (Caneva 1988a:151 - 225). The surface is littered with potsherds and pebbles.

Five squares (F4, E4, D4, E3 (16), D3(16)) (fig.11) yielded cultural deposits down to a depth of 2.2m. The earliest deposits belong to late Neolithic phase comparable with that found at Kadada in the shendi Province dated to 5000 B.P. (Geus 1981:37-47), a few centuries after the Geili settlement was abandoned (around 5500 B.P., see section 3.1.1.1.7).

The site yielded considerable amount of archaeological remains (Caneva 1988) including large number of pottery (see below), lithic artifacts (ibid:115-147), human bone remains (Coppa and Palmieri 1988:275-302), animal bones (Gautier 1988:57-64), floral (Lentini 1988:49) and textiles remains (Caneva and Scala 1988:303-318).

Large collection of pottery (n=c.35000 sherds) was found only in fragmented condition. The majority of pottery is undecorated (c.84%), decorated sherds are present in much lower proportion (c.16%)(Caneva 1988:75).

The most prominent decoration is "dotted line" being present at c.23% of the total decorated sherds (n=5701). Triangles and dots forming the second most frequent decoration, occurs at c.31% of the total rims/body fragments depicted with decorations. Further frequent motifs include triangles, rippled, simple impressed and incised lines. Rare motifs include stippled and plain lines (ibid.).
It can be judged from the body and rim sherds that decoration is not confined to specific portion but covering the whole or almost the whole of the vessel (ibid.).

The decorative techniques employed include rocker stamp, alternately pivoting stamp, simple impression and incision. It is noteworthy that the most favourite decorative technique at the Geili pottery is rocker combing in all its versions. These account for more then 49% of the total decorated sherds (ibid:84-114).

The colour of pottery varies from buff (5YR 5/8, 5YR 5/6 Munsell soil colour chart), light red (2.5YR 6/6 Munsell) red (2.5YR 5/6, 10R 5/6, 10R 5/8 Munsell) and brown (5YR 5/2 Munsell), and from grey (2.5YN 5/0 Munsell), pinkish grey (7.5YR 6/6 Munsell), dark grey (2.5YN 4/0, 5YN 4/0, 10YR 3/1, 10YR 4/1 Munsell) and black (2.5Y N2/0).(ibid; cf.section 3.7.2.3 and the author pers. obser.)

The basic colour of the surface in the majority of potsherds is mainly brown (7.5YR5/2 Munsell). Fractures mostly break with dark grey or black colours (ibid:72 and the author pers. obser.).

Compared with the Mesolithic ceramic assemblages at Kabbashi Haitah and Kabbashi (cf. sections 3.2.2.1 and 3.2.2.2), new types of surface treatment (mainly slipping and polishing) appeared in the pottery collection of Geili. (ibid.).

The small size of the pottery fragments in the Geili collection does not permit reliable reconstruction of vessel shapes. Nonetheless, it could be inferred from the rim shapes that most vessels had more or less hemispherical body, lacking a distinct

neck, base and handles. A low proportion of rim sherds point to narrow mouth jars (ibid.:84-114 and the author pers. obser.).

Wall thickness varies in the pottery collection. The average thickness of the majority of the Geili pottery varies between 3 and 5-6 mm when exceptionally coarse sherds exhibit thickness in the range of 11-14 mm (ibid.).

No fragments of coils were encountered. Yet, the regularity in shape and size can be observed in the fragments, which would suggest a modular (coil) forming (ibid:74 and the author pers. obser.)

The pottery is sand-tempered and well fired could be judged from the macroscopical inspection (for microscopic description of the Geili pottery fabrics see section 3.3.6.2). These characteristics coupled with the surface polishing present in large amounts of fragments, permit pottery to withstand erosion and still has compact surface and a metallic sound (Caneva 1988:72) (for detailed description see section 3.7.2.3).

3.3 The Petrological Analysis

3.3.1 Introduction

3.3.1.1. Petrographic Analysis

This method is widely applicable and useful analytical tool in the study of prehistoric pottery. In recent years there has been an increasing interest in the study of ancient pottery by ceramic petrologists as a result of the pioneering works of such scholars as the late Anna Shepard in United States (1956), Tiziano Mannoni in Italy (1968) and David Peacock in Britain (1970), the petrological analysis of pottery is approaching the stage where it will be regarded as part and parcel of the post-excavation study of a pottery assemblage (Williams 1983:301).

Ancient ceramics are studied with the petrographic microscope either in thin-section or in powdered form (Shepard 1956:139-140). The thin section has several advantages over a powdered sample. It indicates the texture of the paste, the proportions of inclusions, the size and shape of grains, the relationship and proportion of different minerals, the texture and mineral components of rocks and the structure and texture of the clay. Moreover, thin section can be utilized for both

quantitative and qualitative studies. With the aid of micrometer eye-piece or recording micrometer stage, minerals can be measured and the texture of the paste can be compared. Finally, the thin section can be kept as a permenant record for reference and comparison (ibid.).

The preparation of a rock 'thin section' follow the practise which is standard in all Geology departments. First of all, a thin section is removed from the object by two parallel cuts of a diamond wheel. Inevitably, this makes a gap in the specimen which may be 4 mm wide and 15-20 mm deep. The injury can be filled with plaster and if painted thoroughly it may not be possible to discover that anything has been removed (Shotton 1963: 383).

The cut-out fragment is smoothed on one side which is then attached to a glass slide by a transparent cement such as Canada Balsam or "Lakeside". Then the rock is rubbed away with suitable abrasives till it reaches only 0.03 mm thick, when a cover glass is cemented upon it. At this standard thickness, most of the minerals detected in rocks are transparent, some coloureless, some with typical colours and only a few still remain opaque. Moreover, the thin section can be looked at in ordinary, plane polarized and cross-polarized light and the analyst can use varied accessories of the petrological microscope, identification of the minerals present, their shape and size, relative proportions and textural relations to each other, gives a rock a uniqueness which can be described and recognized when it is compared with another specimen (Shepard 1956:139-140 and Shotton 1963:483).

3.3.1.2 Objectives

The objectives of thin-section technique to pottery-analyst are as follows:-

a - to determine the way the paste was mixed (from the types and distribution of mineral inclusions)

b - to show whether the pot was wheel or hand-made (since wheel- turning will tend to orientate long inclusions parallel to the pot walls)

c - to estimate the firing temperature (by observing alterations in the thermal behaviour of certain key minerals (e.g. montmorillonite, kaolinite, chlorite and illite) (Peacock 1970:379).

Thin section technique is also of importance in characterization for pots made in a similar way from the same materials may appear alike under the microscope. In addition to that, when rock inclusions are present it is frequently possible to determine the origin of raw materials from the types of minerals present, if the geology of the area under study is well known. But, if the parent rock is, for instance, a limestone or sandstone which outcrops over a wide area, the lithological provenance of the pottery will be determined only within broad limits (ibid). The degree of precision in determining the likely provenance of pottery by petrological technique depends on the distinctiveness of the local geological formation and on the choice and methods of the clay preparation used in the manufacture (Williams 1979:75).

It is apparent that the petrography has some advantages over scientific techniques in that post-depositional changes in mineral composition are usually evident, therefore, it would be possible to predict sources on the basis of the internal evidence of a "single" sherd. No other technique, hitherto, can provide us with such precision (Peacock 1985:7).

In the present work, the petrographic analysis was conducted by the present writer using thin-sectioning technique to achieve the following objectives:-

a - to find criteria diagnostic of origin for the pottery in question.

b - to study methods and techniques of ceramic material preparation such as mixing, sorting and kneading which in turn provide information about the way the vessels were built.

3.3.2. Sampling and Laboratory Work

Preliminary analyses of 3620 selected potsherds representing 9 Mesolithic and Neolithic sites from three regions (Khartoum, White Nile and Western Butana) were conducted by the present writer using a hand-lens (10X) and a binocular

microscope (20X). The aim was to make a broad fabric classification and to reduce the number of the thin sections required. As a result some 248 specimens representing the fabric variables of each site were then selected for further analyses using a polarized microscope (80x). Thin sections were prepared of standard thickness (0.03 mm).

3.3.3 Practical Considerations

When the mineralogical and physical properties are selectively determined in the light of the archaeological questions that are raised, information can be obtained about the raw material selected and used by the potters, the manner of fashioning the vessels and of firing them (Matson 1963:489). It is with this notion in mind that a series of physico-scientific techniques (Petrological, X-ray diffraction, X-ray spectrometric technique and thermal [DLT] analyses) have been undertaken at the present study each of which was intended to achieve certain objective. As has been presented above (see section 1.7), one of the main goals of the present research is to enhance our knowledge about the main technological features of the Mesolithic and Neolithic ceramics in the central Sudan with references to the sites investigated. To attain this aim, analyses of farbrics representive of pottery samples from the study area have been proposed.

3.3.3.1 Pottery Fabric

It is defined as a group designation for all important physical and chemcial properties of clay and the non-plastic inclusions in a ceramic material, as well as all relevant technological features of the finished product (Adams 1962: 247). The fabric properties analyzed in the present context are as follow:-
ground mass, non-plastic mineral inclusions, organic inclusions, optical density and firing index. These attributes have been delibrately chosen as appropriate parameters in an attempt to find answers for specific questions being raised at the present research. Chemical components of the analyzed fabrics have also been determined.
The terminology used in defining these attributes are present below.

3.3.3.1.1 The Groundmass

It is defined as all the inclusions with particle size smaller than 60 microns (1 micron=0.001 mm) i.e. the fraction of clay and silt according to Udden/Wentworth scale (table 1). The differentiation between the groundmass and larger inclusions is set at 0.060 mm for practical reasons - particles of silt and clay size are examined only with difficulty using petrographic microscope with low power magnification (80X) (see Nordstrom 1972:40). It is worthmentioning that in particle size, the degree of angularity has also been used, as a criterion to differentiate between temper and the groundmass (matrix).

3.3.3.1.2 Non-Plastic Inclusions

These inclusions are comprised of mineral grains larger than 0.060 mm. In geological literature components up to 20 microns (0.02 mm) in diameter (Udden/Wentworth scale) are considered as forming the matrix (Shannon 1978:1185-1192). Nevertheless, in the petrographic analysis of pottery (e.g. Nordstrom 1972:33-64 and Bishop 1980:47-65) matrix is considered as all materials less then 0.060 mm (60 microns). The presence of fine or larger particles would be regarded as non-plastic inclusions while all the size gradations of silt would be considered as part of the matrix (ibid).

Some of the non-pastic inclusions form part of the clays and are normally rounded and generally smaller than 0.250 mm (table 1). Other grains may have been delibrately added to the clay to counteract shrinkage, improve workability and facilitate uniform drying, thus reducing plasticity and lessening the risk of cracking. This latter material can be differentiated from the natural of clay often by size, angularity and relative abundance. For instance, quartz as fine silt occurs in some clays, but coarse, water-worn sand does not become mixed with them in the process of nature (Shepard 1956:25).

A wide range of mineral inclusions presented in African pottery, and they differ considerably in texture, types of minerals and rocks, shapes, roundness and dispersion (e.g. Hays 1971a:55; Nordstrom 1972:33-64; Hays and Hassan 1974:71-79; Hulthen 1977; Banks 1980:299-315; Francaviglia and Palmieri 1983:191-205;

De Paepe 1986:113-140; Chlodnicki 1989:369-373 and Zedno and Wendorf 1993:1-27). A summary of these properties is given below:-

3.3.3.1.3. Texture

This term is used here in reference to the size of clay particles (table 3). The adoption of standard term description is essential. Otherwise, each person's usage is dependent on the range of pastes with which he is familiar, and one's man's fine may be another's coarse (Shepard 1956:118). However, a useful standard division of the sedimentary textures has been worked by Udden and modified by Wentworth (Pettijohn 1957:18, fig. 10 and table 12, this section). The names of the size fractions in this scale are used in the descriptions of African pottery. These non-plastic inclusions display a wide range of variety of texture, from fine sand to very coarse sand, although most are fine to medium size sand (Hays 1971a:55 and Nordstrom 1972:41)..

3.3.3.1.4 The Shape and Roundness of the Mineral Grains

The shape of the mineral grains is expressed in geometric terms. The shape of the mineral grains may be spherical, discoidal, bladed or rod-shaped. On the other hand, the degree of roundness is a term used by sedimentologists for a number of angles or sharp curves on the external contour of the grains. (Pettijohn 1957:13-55). A general division of different rounding classes is used: angular, subangular, subrounded, rounded and well rounded (see fig.12). In the present context only the degree of roundness is determined to show whether the inclusions are angular and hence likely to be crushed tempering material, or whether they are naturally rounded to a high or low degree.

3.3.3.1.5 The Dispersion

The dispersion of the mineral inclusions in the paste is generally even and homogenous. There is no evidence that the clay material utilized for shaping various types of vessels has been mixed with different amounts of temper to facilitate a uniform drying and shrinkage (Nordstrom 1972:41).

3.3.3.1.6 Organic Inclusions

Particles of organic matter encountered in ceramic material may be described in terms of the same variables as those used for the non-plastic mineral inclusions i.e. texture, shape,.....etc. (see supra, this section). The organic inclusions pesented in ceramics are particles of finely chopped straw or grass. These particles may be discoidal, spherical or rod-shaped in different sizes (Nordstrom 1972:41 and Rice 1987:76-78).

3.3.3.1.7 Optical Density

Inclusions more opaque than the matrix have high density (D +), those less opaque have low density (D -) and where there is little or no difference density is neutral (DN). The relative translucence of an inclusion (in plane polarized light) is associated with type, quantity, size and packing of its components and the thickness of the thin section (Whitebread 1986:81).

3.3.4. Introduction

The present writer has conducted petrographic analyses of 75 potsherds representing all the sampled sites and time periods (Mesolithic and Neolithic) of Khartoum Province (east and west bank of the Main Nile). The samples represent all the fabric variations and the range of the main decorative motifs (table 9) diagnostic of time periods, found at each sampled site. Quantitative estimate of fabric mineralogy was obtained by point counting technique. Counts were obtained for all different identifiable grains (monomineralic and polymineralic) forming the tempering inclusions present in the samples. Detailed descriptions of the fabric groups (designated A, B and C) and the subgroups follow(1).

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(1) All the groups of pottery specimens in this chapter will be referred to by the numbers assigned to them in the farbic descriptions above with the prefixes SRB2, ISG2, NOF2, KAH, KAB and GEI refering to Sarurab2, Islang2, Nofalab2, Kabbashi Haitah, Kabbashi and Geili sites respectively. All the fabric groups will be referred to by alphabetic letters (A,B,C). Subgroups of the fabric will be referred to by their appropriate subgroup number and prefix.

3.3.5 Fabric descriptions of the Mesolithic and Neolithic Pottery samples from the Western Bank of the Main Nile.

3.3.5.1 Mesolithic Period

3.3.5.1.1 Fabric descriptions of Sarurab2 Pottery

Some 25 specimens representing the fabric variations of Sarurab2 site pottery (table 4) were tested. As a result two main fabric groups have been identified on the basis of mineralogical compostion, proportions, temper origin, texture, shape and roundness, colour of the matrix and optical density. These fabrics have been designated as Group A and GroupB. The former has been subdivided into subgroups A1 and A2.

Group A

Subgroup A1

Specimens SRB2,2; SRB2,6; SRB2,8-SRB2,9, SRB2,11-SRB2,14; SRB2,19-SRB2, 20.

This fabric subgroup exhibits predominance of quartz inclusions. While quartz occurs in somewhat variable percentage amongst the different specimens in the group, it is the most dominant mineral occurs at c.30-40% of any visual field. It reaches c.81% of the total minerals proportions of this fabric. Iron oxides and other opaques account for 11 % of the total minerals, being present at c.5-7% of the specimen area. Feldspar is rare and it occurs in the form of orthoclase and plagioclases (c.5% of the total), being present at c.1-2% of the specimen area (see fig.13, pl.1).

Most grains above silt size (0.060 mm.) are subangular or angular (c.88%), Subrounded to rounded crystals though present are infrequent (c.12%) and of low to high sphericity.

The majority of grain sizes (c.80%) are in the dimension of 0.400-0.550 mm and only little percentage (15%) in the range of 0.600-800 mm has been identified. Quartz grains mostly fall within both size ranges whereas the remaining minerals exclusively fall within the former size dimension.

The material is generally ill-sorted and the non-plastic inclusions tend to show random orientations parallel to the pot walls.

In PPL the matrix colour ranges from light brown, yellowish brown and medium brown, while in XPOL the colour turns to brown, yellowish brown and dark brown respectively.

The occurrence of numerous quartz grains, frequent iron oxides and the scarcity of feldspar seem to suggest a sedimentary provenance and the Nubian Sandstone prevailing in the area of the site (see fig. 4) is the most likely source of derivation (see sections 3.8 and 3.8.1).

Subgroup A2

Specimens SRB2, 5; SRB2,3; SRB2,7; SRB2,14; SRB2,21-SBR2,23.

Quartz is, as in Subgroup A1, dominant in this Subgroup but with much lower percentage. It is present at c.15-25% of any visual field and comprising c.40% of the total minerals of this fabric Subgroup. Feldspar (mainly microcline and occasionally plagioclase) is present in similar proportion (c.37% of the total), being present at c.12-20% of any visual field and often outnumbering quartz inclusions in some parts of the sections. Mica (biotite and muscovite), though present in most of the specimens, but it tends to show much lower percentages than those of quartz and feldspar. It occurs in the range of c.5-10% of the specimen area and amounting to c.12% of the total minerals. Iron oxides are frequent, being present at c. 4-8% of any visual field and making up to c.9% of the total minerals percentages. Zircon, epidote, hornblende, opaque are rare, being present at c.1% or under at any visual field and exhibit very little percentages amounting to c.2% of the total minerals.(fig.13, pl.2).

The majority of non-plastic mineral grains are subangular or angular (c.80.2%). Subrounded to rounded crystals are present in much lower percentages (c.19.7%) and of low to high sphericity. The crystals of biotite mica are exclusively subangular and angular.

The grains of both quartz and feldspar exhibit wide range of sizes from 0.060-2 mm. These minerals mostly fall between 0.400-1mm and rarely exceeding that limit up to c.2 mm across.
Biotite and muscovite mica fall in the order of 0.120-1mm and most minerals are coarse grained in the range of 0.500-0.700 mm, however, rarely grains up to 2 mm across are conspicuous.
The accessory minerals (zircon, epidote, hornblende and opaque) are mostly present in the order of 0.170-0.250 mm across.

In the Plain Polarized Light (PPL) the groundmass colours range from light brown, brown to reddish brown, while under crossed polars (XPOL) it tends to show brown, medium brown and reddish brown colours respectively. In general, the matrices tend to show neutral optical density.

This suite seems to indicate a source of quartzo-feldspathic rocks. Such rocks are widely known in Sudan and the nearest better known source to the site is the Basement Complex at Sabaloka Gorge some 30 km. north of the site (see fig.4) which includes rich igneous, sedimentary and metamorphic rocks (Whiteman 1971:11-52) .

Group B

Specimens SRB2,1;SRB2,4; SRB2,10; SRB2,15-SRB2,16; SRB2,18 SRB2,24 and SRB2,25.

This second major group comprises of a number of specimens indicating variations in mineralogy from the first groups. Feldspar particuarly microcline is not only prevalent (C.54% of the total) being present at 25-40% of any visual field, but more numerous than quartz in the majority of the specimens examined. Quartz grains are also abundant (c.39% of the total) and distributed through the paste at c.15-20% of any visual field. Iron oxides are infrequent, occur at c.2% or less of the specimen area and totalling 3.3% of the overall minerals present. Mica (biotite and muscovite) is similarly infrequent, occurs at 1-2% of the specimen area and amounting to 2-3% of the total grains. Tourmaline, zircon and hornblende are extremely rare, each of which being present at less than 1% of the specimen area and forming c.1% of the total minerals (see fig.13, pl.3).

Organic inclusions were not observed.

Non-plastic minerals are mainly subangular or angular (c.78% of the total), subrounded and rounded crystals are present in markedly lower amounts (c.21.5%) and of low to high sphericity.

Quartz and feldspar exhibit grain sizes, mostly, in the range of 0.400-0.700 mm and rarely exceeding that limit up to 2mm. across. The remaining minerals are different from quratz and feldspar and they tend to show sizes in the range of c.0.62-0.400mm, indicative of fine to medium grained texture.

In PPL the specimens tend to show pale brown, light reddish brown, while in XPOL the colours range from brown to reddish brown. The groundmass tends to show neutral optical density.

This suite seems to suggest an igneous source and the prevalence of feldspars (mainly microcline) with relatively lower amounts of quartz and little proportion of iron inclusions favour this assumption.

3.3.5.1. 2. Intercomposition of Pottery Fabrics within Site.

Fabric subgroup A2 is basically different from fabric subgroup A1 with regard to the proportion of feldspar which is sparse or entirly absent in the latter (fig.29). With respect to matrix both fabrics display brown or light reddish brown colour in PPL, while in XPOL the colours become dark brown or reddish brown respectively. The only difference in colour is the occurrence of yellowish brown matrices in Fabric A1.

Fabric B tends to show rather different matrix composition and it differs from subgroup A1 and A2 in the presence of dominant feldspar grains (mainly microcline). On the other hand, both fabrics A2 and B varies from fabric A1 in the presence of relatively larger grains mostly exceeding 0.550mm across, the maximum grain size reached by mineral grains of the latter fabric. A part from these variations, the three fabrics are similar with respect to the degree of roundness (mostly subangular or angular) and the general colour of the matrices.

Fabrics of subgroup A1 and A2 could have similar origin. Both fabrics are dominantly composed of non-polycrystalline grains of quartz, though the proportion of quartz in the former is twice higher than in the latter, and frequent iron inclusions with nearly the same proportion (see supra, section 3.3.2.1) These minerals are suggestive of sedimentary suite and the Nubian Sandstone Formation prevailing in the area of the site (fig.4) is the most likely source. On the other hand, Fabric B which is overwhelmingly composed of feldspar, lesser proportion of quartz (mainly microcline) together with subordinate minerals (biotite, tourmaline and zircon) seems to postulate an igneous derivation. The nearest source immediately presents itself is the basement complex outcrop which lies in close proximity to the site area, a few kilometers to the north at sabaloka Gorge (see fig.4 and sections 3.8 and 3.8.1).

3.3.5.2 Neolithic Period

3.3.5.2.1 Fabrics descriptions of Islang2 pottery

Some 27 specimens representing the fabric variations of Islang2 site pottery(table 5) were tested. As a result two main fabric groups have been discerned on the basis of the same criteria used for the classification of the previons Fabrics (see section 3.3.2.1). These two main fabrics have been designated as Group A group B. The former has been subdivided into Subgroups A1 and A2.

Group A

Subgroup A1

Specimens 1SG2,1;1SG2,7;1SG2,12;1SG2,21-1SG2,25.

This fabric subgroup is represented by most of the potsherds (12 specimens). Non-plastic minerals are almost exclusively quartz amounting to c.81% at the average in the samples examined and ranging to up.20-40% of any visual field. The remaining non-plastic inclusions are either little in amounts or extremely rare these include iron inclusions (c.9% of the total), being present at c.3-8% of any visual field. Feldspars (microcline and plagioclase) are rare, occur at c.5% of the total inclusions and present at 2-5% of the specimen area. Mica (mainly biotite) presents at c.1-2% of the specimen area and totalling c.3% of the overall minerals. Zircon and hornblende are extremely rare, each is present at c.1% of the total minerals and at 1% or under of the specimen area (fig. 14, pl.4).

The non-plastic inclusions are generally subangular or angular (c. 78%), while subrounded to rounded minerals are occasionally observed (c.22%). Iron inclusions, in a few examples, are in the form of masses of interlocking character.

The particle size of the minerals is generally in the order of 0.300-0.800 mm across, most exhibit sizes in the range of 0.400-0.480 mm, while only c.3-5% of the specimen area occupies with inclusions in the range of 0.500-0.900 mm across. The maximum grains size within this Subgroup is c.2 mm and only quartz and feldspar fall within this size dimension. The material is generally rather well sorted.

In PPL the matrix is mostly very pale brown or light yellowish brown in colour, while in XPOL is still unistropic and tends to exhibit light brown and yellowish brown shades respectively. In general, the matrix exhibits a neutral degree of optical density under XPOL.

The predominance of quartz grains, the frequent occurrence of iron inclusions and the scarcity of feldspar are suggestive of sedimentary provenance. The Nubian Sandstone prevailing in the area of the site is a source worthy of consideration (see fig.4 and sections 3.8 and 3.8.1).

Subgroup A2

Specimens ISG2,2-ISG2,6; ISG2,8-ISG2,9; ISG2,17-ISG2,20

The fabric of this Subgroup is represented by rather small group of specimens (7 examples). Non-plastic minerals of quartz, being present at 20-35% of any visual field. It accounts for c.63% of the total minerals. The next common mineral is feldspar which is represented mainly by microcline, though other varieties including plagioclases and orthoclase are in evidence. This mineral is present at c.10-15% of the specimen area and amounting to c.26% of the total minerals. Iron oxides are present at 1-3% of the specimen area and reaching 1% of the total inclusions (pl.5). Mica (biotite) and rock fragments mainly igneous) are rare (each c.2% of the total), being present at 1-2% of any visual field. Zircon is extremely rare (c.0.5% of the total). It is present at c.1% of of the specimen area.

The grains are mostly (c.83%) subangular to angular. Subrounded to rounded grains through present, are infrequent (17%). Iron inclusions which are nearly all subrounded to rounded, being the only exception.

About 80% of the mineral grains are in the range of 0.300-0.900 mm across. Those in the middle size range (c.0.300-0.499 mm.) are mainly mica (muscovite and biotite), while the grains in the largest size range (c.0.500-2.100 mm) are predominantly quartz and feldspar. Rock fragments are exclusively above 0.700 mm across in size and in two instances reaching 1 mm. across. About 20% of grains exhibit smaller sizes in the order of 0.060-0.290 mm and are represented mainly by iron inclusions, hornblende and zircon.
The inclusions are generally ill-sorted.

The colours of the matrices in the sections of this fabric group is generally similar to that of Subgroup A1. The only difference is that this farbic rarely exhibits matrices with mid brown colour in PPL and slightly darker brown in XPOL.
In general, the matrix displays a neutral degree of optical activity under XPOL.

An igenous origin could be postulated for this fabric Subgroup and the prevalence of non-polycrystalline quartz, biotite as the only form of mica present, the occurrence of rock fragements mostly of igneous source are in favour of this assumption (see sections 3.8.1 for further discussion).

Group B

Specimens ISG2,10; ISG2,11 - ISG2,13 - ISG2,16; ISG2,26 - ISG2,27.

Microcline feldspars are the dominant non-plastic components of this fabric group, present at c.20-30% of any visual field and amounting to c.55% of the total minerals. Quartz grains are present with markedly lesser proportion (c.30%), occur at c.8-15% of the specimen area. Iron inclusions are frequent (c.11%), comprising c.5-10% of the specimen area. Mica (muscovite and biotite) are occasionally present (c.4%) at c.3-5% of any visual field. Rock fragments are absent in comparison with the fabric Subgroup A2 (pl.6).
Organic matter was not present.

Rounding of the minerals is generally subangular or angular (c.83%), subrounded to rounded crystals (c.17%) are often in evidence. Iron oxides are either subangular or subrounded and in a few examples tend to show rounded crystals. Grains of biotite mica occasionally exhibit needle-like or bladed shapes.

The particle length is generally in the order of 0.200 - 0.800 mm across. Those in middle size range (c.0.20-0.499 mm) consist of biotite and muscovite mica, while the grains in the largest size dimension (c.0.500 - 0.800 mm.) are mostly quartz and feldspar. Iron oxides mainly in the order of c.200 - 0.500 mm across and rarely exceeding that limit up to 2 mm across.
This fabric is generally ill-sorted and this is possibly due to imperfect mixing and/or insufficient kneading.

The groundmass colour is light/mid brown or pale yellowish brown in PPL and brown, dark brown and yellowish brown, respectively in XPOL. In general, the matrix shows a neutral degree of optical density under XPOL.

This suite seems to indicate a source of quartzo-feldspathic rocks. Such rocks are widely known in Sudan and the nearest source to the site area is the Basement Complex outcrop some 35 km. north (see fig.4 and Whiteman 1971:11-52).

3.3.5.2.2 Intercomposition of Pottery Fabrics within Site

Rock fragments which are present in fabric A2 are the sole minerals distinguishing it from farbic A1. Most of these rock fragments are of igneous origin and only two are of sedimentary source. Otherwise, the two groups are similar in regard to the remaining minerals present, their proportions and colour of the matrices. The only colour difference is that fabric A2 rarely exhibits matrices with medium brown colour in PPL and slightly darker brown in XPOL.

Fabric B differs from both fabrics (A1 and A2) in mineralogical composition. In this fabric microcline feldpar is the most dominant non-plastic inclusion whereas quartz grains are present in relatively lower percentages. Iron inclusions are frequent. Fabric B shows close match with fabric A2 as regard the grain size distribution, both of which (A2 and B) tend to show medium to coarse grained

texture in the range of 0.400-0.700 mm and 0.400-0.800 mm across respectively. On the other hand, Fabric A1 shows relatively smaller particle sizes mainly (c.65%) in the order of 0.400-0.480 mm across indicating medium grained texture. Rock fragments are also absent at fabric B.

The minerals of the three fabrics are very similar with respect to the degree of roundness. Most display subangular or angular grains whereas subrounded and rounded crystals are rare and of low to high sphericity.

Non-plastic inclusions in all the fabrics tend to show random orientation parallel to the wall surfaces.

Fabrics A1 and A2 that are predominantly tempered with quartz together with frequent iron inclusions and occasional mica seem to recall a sedimentary provenance, whereas fabric B is dominantly composed of microcline feldspar favours an igneous source. The Nubian Sandstone and the Basement Complex in the area, respectively, are sources petrologically worthy of consideration (Further discussion in sections 3.8 and 3.8.1).

3.3.5.2.3 Fabric descriptions of Nofalab2 Pottery.

Some 23 specimens representing the fabric variations of Nofalab2 site pottery (table 6) were tested. As a result one main fabric group has been identified on the basis of the same criteria used for the classification of the previous fabrics (e.g. see section 3.3.2.2). This fabric has further been subdivided into two subgroups designated A1 and A2. Detailed descriptions of the fabrics will be given below.

Group A1

Specimens NOF2,1- NOF2,8; NOF2,11; NOF2,13 - NOF2,17.

This Fabric Subgroup is characterized by abundant non-plastic components of quartz (c.80%), being present at c.30-40% of any visual field. Iron inclusions are present in the range of c.5-10% of the specimen area and amounting to c.10% of the total minerals. Feldspars (orthoclase, microcline and plagioclases) are rare (c.4%), sparsely distributed in the specimens in the range of c.2-3% of any visual field. Other rare minerals include biotite mica (c.2.4%), rock fragments (mainly

metamorphic) (c.1.5%), hornblende (c.1%), zircon and epidote (c.1.4%), being present at 1-2% or less at any visual field. (fig.15, pl.7).
Organic inclusions are not present.

The mineral grains are mostly (c.84%) subangular or angular. Subrounded to rounded inclusions, though present, are of much lower percentage (c.16%). It is worthnoting that nearly all the iron oxides display subrounded or rounded grains.

Quartz sizes fall in the range of 0.060 - 1 mm across and most minerals are in the order of 0.130-0.400 mm across. The remaining minerals of this fabric tend to show average size grains in the magnitude of 0.250-0.380 mm across.

Though the material is generally fine to medium grained, ill-sorted texture, having grain sizes in the range of 0.060 - 2 mm across, is occasionally in evidence.

In PPL the matrix ranges from light greyish brown, pale reddish brown, while in XPOL the colour alters to grey brown, reddish and dark brown respectively.
In general, the matrix tends to show neutral degree of optical density under XPOL.

The prevalence of quartz together with frequent iron inclusions in this fabric group favours an origin in or close to exposures of Nubian Sandstone Formation. Nubian Sandstone prevailing in the area of the site (fig.4) is quartz-rich and often highly ferruginous (see Whiteman 1971:62 and sections and 3.8.1).

Subgroup A2

Specimens NOF2,9 - NOF2,10; NOF2,12; NOF2,18 - NOF2,23.

Quartz inclusions are, as in Subgroup A1, predominant making up to c.25 - 40% of any visual field and amounting to c.81% of the total minerals present. Iron inclusions are the second prominent non-plastic minerals (c.10%), being present at c.3-8% of any visual field. Mica (mainly biotite) is frequent (c.6.3%) and present at c.3-5% of the specimen area. Rock fragments (mainly sedimentary) occur at c.1% or less at any visual field and amounting to c.2% of the total minerals (pl.8).
Organic inclusions are absent.

Most mineral grains (c.82%) are subangular or angular, subrounded to rounded grains are occasionally present (c.18%) and of low to high sphericity. Iron inclusions are nearly all subrounded or rounded.

The majority of quartz sizes (c.60%) are in the range of 0.060 - 0.380 mm across, grains ranging up to 0.700 mm across are fairly frequent. The largest grain sizes (c.0.950-2 mm across) are represented by rock fragments, some quartz grains and occasional mica. Iron inclusions tend to show sizes in the order of 0.065-0.500 mm across.

The non-plastic minerals are generally moderately-sorted, however, ill-sorted inclusions are occasinally observed in some specimens.
All the minerals tend to show random orientation relative to wall surfaces.

In PPL the matrix ranges from light or medium brown, pale yellowish brown to light orange brown, while in XPOL it appears as brown, dark brown, yellowish brown and medium orange brown respectively.

The fabric Subgroup could have a similar origin to subgroup A1. The prevalence of quartz inclusions and the frequent occurrence of iron oxides coupled with the absence of feldspar favour a sedimentary provenance and the Nubian Sandstone exposures prevailing in the area of the site is a source worthy of consideration (see section 3.8 and 3.8.1).

3.3.5.2.4 Intercomposition of Pottery Fabrics within Site

Both fabric subgroups (A1 and A2) are characterized by predominant grains of quartz and occasional iron inclusions and rock fragments. The main distinguishing feature is the absence of feldspar in fabric A2 and it shows sparse occurrence in fabric A1.

The non-plastic minerals in the two fabric subgroups are nearly the same in terms of degree of roundness. Most grains in the two fabric subgroups are subangular or angular, subrounded and rounded crystals are rare.
Non-plastic inclusions of all the samples tend to show random orientation relative to the pot walls.

The minerals of the two fabric subgroups are homogenous in terms of particle size distribution. Both fabric subgroups tend to show fine to medium grained texture and the minerals are generally in the order of 0.060-0.390mm across. Coarse grains are relatively rare (c.11-15%) in most of the specimens examined.

The matrix colour in the two fabrics is generally similar, both of them tend to show pale brown, light reddish brown colours in PPL, dark brown and reddish brown in XPOL. The non-plastic minerals in most instances are set in anistropic matrix of baked clay.

The predominance of quartz together with frequent iron oxides in the two fabric subgroups favours a sedimentary source. The Nubian Sandstone sediments in the area of the site which are mainly quartz-rich and often highly ferruginous (see Whiteman 1971:62) is a source worthy of consideration (see sections 3.8 and 3.8.1).

3.3.6. Fabric descriptions of the Mesolithic and Neolithic Pottery Samples from the Eastern bank of the Main Nile.

3.3.6.1 Mesolithic Period

3.3.6.1.1 Fabric descriptions of Kabbashi Haitah Pottery.

On the basis of 23 specimens (table 7) two main farbics have been identified and designated as Group A and Group B.

Group A

Specimens KAH 1-KAH 2; KAH 7-KAH 10;KAH 12;KAH 19-KAH 23.

This group is largely composed of quartz inlcusions (c.79% of the total), occur at c.20-40% of any visual field. Feldspars (microcline, orthoclase and plagioclases) occur in low amounts (c.9%), being present at c.5-8% of the specimen area. Iron inclusions are rather frequent (c.6%), occur in the range of c.3-5% of any visual field. Mica (biotite and muscovite) is scarce (c.2%) occurs at 2% of the specimen area. Rock fragments, hornblende, zircon, epidote and hyperthsene are similarly rare all of which are present at 2% or less at any visual field (see fig.16, pl.9).

No organic matter was found.

The mineral grains are generally subangular or angular (c.78%), subrounded to rounded crystals are frequent (c.19%) and of low to high sphericity. Iron inclusions often tend to exhibit grains in the form of irregular masses (c.3%). Mica (muscovite and biotite) occasionally presents in the form of bladed flakes.

The majority of mineral grains (c.75%) are in size range of 0.350 - 0.950 mm across, most of which are quartz. About 15% of the mineral grains exceeding 1 mm in length, most of which are rock fragments and quartz. Only 10% of the non-plastic minerals are of smaller sizes in the range of 0.060-0.200 mm across, of which the accessory minerals (hornblende, zircon and edpidote) and some iron inclusions are the commonest. The overall grain size distribution exhibits ill-sorted material and the texture is generally coarse grained.

In PPL the matrix tends to show light brown, reddish brown and medium brown colours, while in XPOL the colours shade from brown, reddish brown to dark brown respectively. It is worthnoting that reddish brown colour is dominant in most of the specimens examined.
In general, the matrix tends to show neutral optical density.

This suite which is predominantly composed of quartz grains, very little feldspars and scarce amount of mica, suggests a sedimentary provenance. The Nubian Sandstone prevailing in the area of the site (cf. fig.4) is the most likely source.

Group B

Specimens KAH 3 - KAH 6; KAH 11; KAH 13 - KAH 18

This group is characterized by abundant grains of quartz, most of which (c. 88%) are monocrystalline quartz (pl.10). It is present at c.15-30% of any visual field and amounting to c.61% of the total components. Feldspars (microcline, orthoclase and plagioclases) are the next common minerals (c.28%), occur at c.8-12% of the specimen area, most of which are plagioclases. Mica (biotite) is common (c.5%) being present at 2-3% of the specimen area. Iron inclusions are infrequent (c.4%), occur at 1-2% of the specimens area. Rock fragments mainly

metamorphic and hornblende are extremely rare (1%), being present at c.1% of the specimen area.

The majority of minerals (c.82%) are subangular or angular, subrounded and rounded crystals have a much lower proportion (c.17%) and of low to high sphericity. Iron oxides sometimes tend to show grains in the form of masses of interlocking character (c.1%). Crystals of mica and hornblende rarely present in bladed shapes.

The majority of grain sizes of the non-plastic minerals fall in the range of 0.300-0.900 mm across (c.86%), most of these are quartz having slightly larger sizes in the order of 0.480-0.900 across mm. The maximum grain size within this fabric is 2.150mm and the smallest is 0.060 mm. About 60% of the total minerals tend to show medium to coarse grained texture (0.400-0.600 mm across).

In PPL the matrix shades from pale, reddish brown to medium brown, while in XPOL it shows brown, reddish brown and dark brown respectively. In general, the matrix tends to show neutral optical density.

This suite seems to suggest an origin in or close to exposures of sedimentary, igneous and metamorphic rocks. Such rocks are widely spread in Sudan and the Basement Complex at Sabaloka Gorge (fig.4) is petrologically worthy of close consideration. Sabaloka Basement Complex lies c.50 km. north of Khartoum and in close proximity to Kabbashi Haitah site. It includes rich igneous, sedimentary and metamorphic rocks (see Whiteman 1971:11-52).

3.3.6.1. 2 Intercomposition of Pottery Fabrics within Site

In terms of individual minerals fabrics A and B are within similar range of percentages for quartz and rock fragments, whereas proportions of feldspar, mica and iron are markedly different. The presence of feldspar in Farbic B, in particular, is more pronounced and occurs in relatively high proportion than in fabric Group A. Hornblende is extremely rare in both fabrics with nearly the same percentage. Accessory minerals (zircon, hyperthsene and epidote) are rarely scattered within fabric A and was not noted in the composition of fabric B.

Both fabrics (A and B) are similar in regard to the degree of roundness and shapes of minerals. Most (78-83% respectively) are subangular and angular, subrounded to rounded crystals are of much lower proportions (c.18 and 22% respectively). In both fabrics iron inclusions are often observed in the form of irregular masses whereas mica scales (biotite and muscovite) occasionally present as bladed flakes.

In overall grain size distribution fabric Group B comes closely to Group A but still differs from it in having relatively lower concentrations of inclusions above silt size of low sphericity in the range of 0.062-0.200 mm.

In plane polarized light (PPL) and under crossed polars (XPOL), the specimens of the two fabrics tend to exhibit nearly the same shades. Both fabrics exhibit, pale, medium brown and light reddish brown colours in PPL, while in XPOL the colour shades from brown, dark brown and reddish brown respectively.

The presence of numerous quartz grains together with very little feldspar and frequent iron inclusions seems to suggest a sedimentary provenance. On other hand, the suite of Fabric B which is dominantly composed of monocrystalline quartz, appreciable feldspar, frequent mica and little iron content seems to suggest a source in or close to exposures of quartzo-feldspathic metamorphic rocks (mixed lithography) (see supra, section 3.3.6.1).

3.3.6.1.3 Fabric descriptions of Kabbashi Pottery

Some 23 specimens representing the fabric variations of Kabbashi site pottery (table 8) were examined. As a result two main fabric groups (A and B) have been identified on the basis of the same criteria used for the classification of the previous fabrics (e.g. see section 3.3.6.1). The former fabric group has further been divided into two subgroups designated as A1 and A2. Detailed descriptions of the fabrics will be given below.

Group A

Subgroup A1

Specimens KAB2; KAB5 - KAB7; KAB11 - KAB15; KAB23

In this fabric, inclusions above silt size are very frequent. Quartz is, as usual, the dominant mineral and it reaches 80% of the total grains, being present at c.20-35% of any visual field. Most of quartz grains are non-polycrystalline. Iron inclusions are relatively frequent (c.10%), being present at c.8-10% of the specimen area. Feldspar is very little in amount (c.5%), being present at c.2-3% of the specimen area, microcline is the commonest, orthoclase and plagioclases are rare. Mica mainly muscovite is scarce (c.2%), present at c.1-2% of the specimen area. Hornblende and rock fragments are similarly rare (each c.1%), being present at c.1% of the whole section. Zircon is rare being present at 1% of the total non-plastic minerals (fig.17, pl.11).

Rounding of the minerals is mostly subanguar or angular (c.85%). Subrounded to rounded crystals are of relatively low percentage (c.14%). Mica sizes rarely tend to show bladed shapes.

The majority of the mineral grains are in the range of c.500-0.800 mm across, grains within this size dimension are mainly quartz and microcline feldspar. The maximum grain size range within the Subgroup is c.1-2 mm across. Quartz, feldspar and rock fragments occasionally occur within this size dimension. The minimum size range is 0.060 - 0.300 mm across, mica and hornblende, in most instances, fall within this size range. The material is, generally, ill-sorted.

In PPL the matrix shades from very pale brown, light greyish brown to medium brown colour, while in XPOL, the matrix tend to show, respectively pale brown, greyish brown and dark brown colour. In general, the matrices tend to show neutral optical density.

The prevalence of non-polycrystalline grains of quartz together with frequent iron oxides and little amounts of feldspar and mica seem to suggest a sedimentary suite for this fabric Subgroup.

Subgroup A2

Specimens KAB3; KAB9 - KAB10; KAB16 - KAB17; KAB19.

This fabric subgroup is represented by slightly lesser number of specimens. It is characterized by numerous number of quartz grains (c.85%), being present at c.30-40% of any visual field. Iron inclusions (c.9%) are frequent, being present at c.5-10% of the specimen area. Mica (mainly biotite) is rather common (c.4%), occurs at c.3-5% of the specimen area). Feldspar is absent in the composition of the specimens of this fabric subgroup. Hornblende is rare (c.2%), being present at c.1% of the specimen area (fig.17, pl.12).

The mineral inclusions are mainly subangular or angular (c.81%), subrounded to rounded crystals occur in rather low percentage (c.18%). Some grains of mica (biotite and muscovite) tend to show bladed shapes.

About 84% of the non-plastic mineral grains are in the size range of 0.300 - 0.900 mm across, most of which are quartz grains. Those in middle size range (0.300-0.499 mm) are mostly muscovite mica and iron inclusions, while grains in larger sizes (0.500-0.900 mm) are predominantly quartz. The maximum grain size within this Subgroup is c.1-2 mm, about 4% (mostly quartz) of the total minerals attain this size range. About 15% of minerals tend to show smaller sizes in the range of 0.060 - 0.280 mm across and are represented mainly by muscovite mica and hornblende.

In PPL the matrix ranges in colour from light, medium brown to plae yellowish brown, while in XPOL the colour changes, respectively, to reddish brown, dark brown and yellowish one.
The matrices, in general, tend to show low optical density.

The occurrence of mumerous quartz grains and fairly frequent presence of iron oxides coupled with entire absence of feldspar seem to raise the probability that this fabric Subgroup is in favour of sedimentary provenance.

Group B

Specimens KAB1; KAB4; KAB8; KAB18; KAB20-KAB22

This group is predominantly tempered with feldspar-rich sand, mostly perthite. It is present at c.20-30% of any visual field and amounting to c.67% of the total inclusions. Microcline and palgioclases are present but in markedly lower proportions (c.13% of the total feldspars). Quartz is non-polycrystalline, generally present in much lesser amounts than feldspars (c.22%), making up to c.10-15% of the specimen area. Iron oxides are common (c.6%), being present at c.3-5% of the specimen area. Rare non-plastic minerals include biotite and muscovite mica (c.2.5%), occur at c.1-2% of the specimen area, hornblende and rock fragments (c.2%), being present at c.1-2% of the specimen area (fig.17, pl.13).
Organic inclusions were not observed.

Most non-plastic minerals either subangular or (c.81%), subrounded to rounded crystals comprising c.16% of the total grains. Some c.3% of the minerals are present in the form of irregular masses and are exclusively iron inclusions.

The majority of inclusions (c.86%) are in sizes in the dimension of c.0.400-0.800mm across. About 5-10% of the minerals in the specimens of this fabric are in the range of 0.900-1.5mm across and occasionally exceeding that limit up to 2.01 mm. Grains fall within the latter size range are nearly all quartz. Grains in smaller size range (c.0.060-0.250mm) occur rarely, being present at c.5% of the total minerals.
The material is generally rather well-sorted, showing medium to coarse grained texture.

In PPL the matrix exhibits light brown, brown and medium one, while in XPOL the colour, respectively, changes to brown, dark brown and blackish brown. Some minerals, occasionally, stained with iron spots and appear as opaques.
The matrices, in general, tend to show low optical density.

The lack of polycrystalline quartz and the predominance of perthitic and microcline feldspar favour an origin in or close to exposures of igneous deposits. In

this respect the Basement Complex of Sabaloka Gorge which lies only a few kilometers north of the site (fig.4) is the most likely source.

3.3.6.1.4 Intercomposition of pottery Fabrics within Site

There are basic differences between the two main fabrics of this site.(Fabrics A and B) as regard the type of mineralogy. While Subgroups Al and A2 contain minerals composed of high proportions of non-polycrystalline quartz (c.80 and 85% respectively), Fabric B contains markedly lower percentage (c.20%). Feldspar appears to be exceptionally higher at fabric B (c.65%) and extremely rare at fabric A1 (c.5%) and entirely absent in the composition of the specimens belong to fabric A2. Mica proportion is the same at fabrics A1 and B (2% each) and it is relatively higher at fabric A2 (c.4%), though it is still very low in quantity. Iron inclusions are frequent but with somewhat variable proportions (c.12%, 9% and 7% respectively) at fabric A1, A2 and B.

The two main fabrics display similar range of roundness and sphericity. Most of the non-plastic inclusions are subangular or angular with much lower proportions of subrounded to rounded minerals and of low to high sphericity.

The non-plastic components display similar general range of grain size distribution. Subgroup A1 tends to show relatively higher proportions of medium size minerals (c.0.200-0.350 mm) than that of either fabric A1 or fabric B (c.8% and 10% respectively).

In plane polarized light (PPL) the matrices of the fabrics (A1, A2, B) are generally pale or medium brown in colour, while under crossed polars (XPOL) the colours tend to show medium and dark brown respectively. Fabric A1 differs from fabrics A2 and B in having occasionally greyish brown matrices, while fabric A2 varies from fabrics A1 and B in having yellowish brown colour under XPOL.

A noteworthy feature is the cracking of considrable number of non-plastic minerals (mostly quartz) as can be seen in specimens KAB3 and KAB10. This phenomenon of mineral cracking is a strange and has not been observed in the microstructure of other specimens of this fabric (fig.27). The presence of such features is, perhaps, due to high firing or rapid firing or cooling. But since cracking

has been detected in only two specimens (see supra) and entirely absent in the remaining ones, the present writer is of opinion that such phenomenon is more likely due to high firing temperature that affected parts of the vessels microstructure during firing process.

With respect to fabric origin, fabrics A1 and A2 show close match as both of them tend to exhibit mineral suite (dominantly composed of quartz, Frequent iron oxides, little or absence of feldspar, respectively) favours a sedimentary source. On the other hand, the lack of polycrystalline quartz and the high content of perthite and microcline at fabric B suggest an igneous provenance (see section 6.4.1 for further discussion).

3.3.6.2 Neolithic Period

3.3.6.2.1 Fabric descriptions of Geili Pottery

Some 25 specimens representing the fabric variations of Geili site Neolithic Pottery (table 9) were examined by petrographic microscope. As a result two main Fabric groups designated as A and B have been identified on the basis of the same criteria used for the classification of the previous fabrics (e.g. see section 3.3.3.4). Fabric A has been further divided into Subgroups A1 and A2 (fig.18, pl.14). Detailed descriptions of the fabrics will be given below.

Group A

Subgroup A1

Specimens GE1,3; GE1,5; GE1,6; GE1,8; GE1,15; GE1,16; GE1,21 - GE1,22.

This group is characterized by predominant quartz inclusions (c.80%). Quartz is mostly non-polycrystalline (c.90% at the average), being present at c.30-40% of any visual field. Iron inclusions are frequent (c.10%), being present at c.3-5% of any visual field. Feldspar (plagioclase and microcline) is sparsely distributed in the paste of the specimens (c.6%), occurs at c.2-3% of the specimen area. Mica (muscovite) is rare (c.2%), being present at 1% of the specimen area. Rock fragments and hornblende (each c.1%) are extremely rare, being present at c.1% of the specimen area (fig.18).

Organic material was not observed

The detrital grains of the minerals are dominantly (83%) subangular or angular, subrounded to rounded crystals are present in much lower proportion (17%) and of low to high sphericity.

The average size of the grains is c.0.065 - 0.350 mm across, though small amounts of minerals up to 0.890 mm across are in evidence and in rare cases the size reaches 2 mm across. The minerals in medium size dimension form the bulk of the inclusions (90%), while grains in smaller sizes (c.0.060 - 0.095 mm across) are 7% and those with larger sizes (0.500-2mm) are only 3% of the total inclusions. The texture of the tempering material is generally fine grained, though occasionally medium grained texture is conspicuous. Non-plastic inclusions are haphazardly distributed through the paste.

In PPL, the matrix ranges from light, medium brown, pale reddish brown colour, while in XPOL the colour changes, respectively, to brown, dark brown and reddish brown. However, most specimens tend to show reddish brown colour under XPOL.
The matrix, in general, exhibits a neutral optical density.

The presence of numerous quartz grains with frequent iron inclusions and rare amount of feldspar (mainly plagioclases) seem to suggest a sedimentary provenance for this fabric Subgroup.

Subgroup A2

Specimens GE1, 4; GE1,7; GE1, 13 - GE1, 14, GE1, 17; GE1, 18; GE1, 24 - GE1, 25.

The non-plastic inclusions of this fabric Subgroup exhibits very similar mineralogy as fabric Subgroup A1 with slight variation in the absence of Feldspar and mica in the Subgroup A2. Quartz, is, as usual, the dominant mineral (c.82%), being present at c.20-35% of any visual field. Iron inclusions are frequent (c.14%) and amounting to c.5-10% of any visual field. Rock fragments (c.2%), zircon and hornblende (each c.1%), being present at 1% of the specimen area (fig.18, pl.15).

The aplastic inclusions are mostly subangular or angular (c.88%), subrounded to rounded crystals are low in proportion (c.11.5%) are present in the form of bladed shapes.

The average dimension of the detrital grains ranging from 0.060-0.365mm across. The maximum grain sizes ranging from 0.370-0.700mm. The minerals in the low to medium size dimension are the most prominent (c.90% of the total) and consist mainly of quartz, feldspar and all the subordinate minerals present (Rock fragments, hornblende and zircon), while the grains in the largest size range are nearly all quartz and iron inclusions.
The material is generally well-sorted indicative of perfect mixing and sufficient kneading.

In PPL the matrix displays light brown or light reddish brown colours, while in XPOL the colours alter to brown and reddish brown respectively. In general, the matrix tend to show neutral optical density.

This fabric Subgroup could have a similar origin as Subgroup A1. The predominance of quartz minerals, the frequent occurrence of iron oxides, coupled with the absence of feldspar seem to favour a sedimentary origin.

Group B

Specimens GEI, 1; GEI, 2; GEI, 9-GEI, 12; GEI, 20-GEI, 23

This fabric group is characterized by aboundant quartz (68%) with appreciable amounts of polycrystalline crystals (30-90%), being present at c.15-25% of any visual field. Mica, nearly all muscovite, is frequent (c.15%), being present at c.5-12% of the specimen area. Iron oxides are less frequent (c.10%), being present at c.3-% of the specimen area. Rare minerals include hornblende (c.3%), rock fragments (mainly metamorphic and rarely sedimentary) (c.3%), Feldspar (c.2%) and zircon (c.1%). The two former minerals are present 1-2% of any visual field, whereas the latter occurs at c.1% of the specimen area (fig.18, pl.16).
Organic inclusions are not present.

The bulk of the tempering inclusions are subangular or angular (89%), subrounded to rounded crystals, though present, are infrequent (10.5%). Mica occasionally exhibits inclusions of bladed shapes.

Inclusions above silt size are, as in fabrics A1 and A2, frequent in occurrence. Most (c.83%) (quartz and mica) are in the range of 0.200-0.385 mm across with only 6% in the range of 0.400-0.500 mm across, c.7% in the range of 0.060-0.200mm across, most of which are either quartz, rock fragments, muscovite mica and iron inclusions. The texture of the tempering inclusions is generally well-sorted suggestive of rather perfect mixing and sufficient kneading.

In PPL the colour of the matrix of the specimens is pale, light reddish brown or medium brown, while in XPOL the colour becomes brown, reddish brown and dark brown respectively. The commonest colour of the groundmass under XPOL is dark brown.
The matrix, in general, tends to show low optical activity.

The source of this fabric seems to lie within metamorphic deposits. The occurrence of appreciable amount of polycrystalline quartz, appreciable amounts of mica (mostly muscovite) and occasional presence of rock fragments of metamorphic origin provide clues that metamorphic gneiss exposure is the most likely source for this fabric group.

3.3.6.2.2 Intercomposition of Pottery Fabrics within Site

The types of temper inclusions of the three fabrics (A1, A2, and B) are the same. The only difference between fabrics A1 and B on one hand and fabric A2 on the other one, is the entire absence of feldspar and mica at the latter. However, fabric A2 is within the range or equal to the maximum percentages exhibited by fabric A1 for quartz and hornblende. Mica is relatively higher at fabric B and scarce in the composition of specimens from fabric A1. Iron inclusions are frequent in the three fabrics being relatively higher at fabric A2.

The three fabrics exhibit similar range of grain size and shared particle lengths mainly in the order of 0.060-0.385 mm across.

The non-plastic inclusions are overwelmingly subangular or angular, subrounded to rounded crystals are relatively rare and of low to high sphericity.

In plane polarized light (PPL) the matrices of the three fabrics are similar as all of them present pale or light reddish brown colours, however, fabric B seems to be slightly different than that of either fabric Subgroups A1 or A2 in having darker brown colour under crossed polars (XPOL)

A noteworthy feature of Geili pottery is the presence of quartz grains in cracked condition. This phenomenon of quartz cracking is indicative of a change in microstructure, being confined only to two specimens of fabric Subgroup A1 (specimens GE1, 20 and GE1, 21). The cracking could be due to high firing, or cooling. This phenomenon is not common, as previously indicated (see section 3.3.3.2.1) in the minerals of the remaining specimens. It could have resulted from thermal shocks affected parts of the microstructure of these specimens.

Fabrics of Subgroups A1 and A2 are very similar in having numerous quartz inclusions, frequent iron oxides, very little (Fabric A1) or absence (Fabric A2) of feldspar. Such suite suggests a sedimentary origin and the presence of Nubian Sandstone in the area of the site (fig.4) is a source worthy of consideration. On the other hand, the occurrence of abundant amount of polycrystalline quartz with appreciable number of mica (mainly muscovite) at Fabric B seems to favour a metamorphic source (see section 6.4-1 for further discussion).

3.3.7 Intercomposition of Pottery Fabrics between sites

Fabrics A and A1 of the selected Mesolithic sites (Sarurab2 on the west bank of the Main Nile, Kabbashi Haitah and Kabbashi from the east bank of the Main Nile) and Neolithic sites (Islang2, Nofalab2 on the west bank of the Main Nile) are characterized by quartz-rich sand which is the major non-plastic mineral constituent (79-82%), whereas feldspars (c.4-37%), mica (c.2-15%), rock fragment (c.1-3%), iron oxides (c.3-14), hornblende (c.1-3%) are present in much lower or in a few amounts in most fabrics. Other minerals which are scarce (mainly zircon-c.1-2%) and rarely tourmaline, eipdote and hypersthene (c.1% or less)) (cf. sections 3.3.5 and 3.3.6).

Feldspar is present in most pottery fabrics referred to as group A and A1 of the sampled Mesolithic and Neolithic sites in Khartoum Province. The only exceptions being fabric A2 of Nofalab2, late Neolithic site from the western bank of the Main Nile and fabric A2 of Kabbashi late Mesolithic and Geili Neolithic sites on the eastern bank of the Main Nile. Though this phenomenon could be due to a function of sampling but it is equally possible that it might have resulted from the sedimentary nature of raw material quarried by Kabbashi Mesolithic and Geili Neolithic potters where quartz is usually present in association with little or no veins of feldspars (cf. Whiteman 1971:5-60 and Vail 1982:57). Therefore, Nubian Sandstone prevailing in the area of the sites in question is the most likely source for this type of temper utilized by prehistoric potters in this district.

In fabrics B of the Mesolithic and Neolithic ceramics in this region, feldspar is present in lesser amounts than quartz and in relatively higher proportions than in fabrics A and A1 in nearly all the sampled Mesolithic and Neolithic ceramics. It is present in the range of 28-67% in almost all fabrics B of the Mesolithic and Neolithic ceramics in this region. It is, however, scarce in fabric A1 of Nofalab2 (west bank of the Main Nile) and fabric B of Geili site (east bank of the Main Nile) being present at 4% and 2% respectively. In nearly all these fabrics feldspar is mostly represented by microcline, often perthite, occasionally plagioclases and rarely orthoclase. Microcline is present in the range of 60-80% of the total feldspars in most fabrics B which are characterized by predominance of feldspars (cf. sections 3.3.5.1., 3.3.5.2, 3.3.6.1 and 3.3.6.2).

Plagioclases occur in markedly lesser proportions than microcline. It is present in the range of c.10-25% of the total feldspars in most fabrics of the Mesolithic and Neolithic sites in Khartoum Province. These include pottery fabrics of the Mesolithic (Sarurab2) and Neolithic (Islang2 and Nofalab2) sites on the western bank of the Main Nile as well as the Mesolithic (Kabbashi Haitah and Kabbashi) and Neolithic (Geili) sites on the eastern bank of the Main Nile. (ibid.).

Pottery fabric B of Kabbashi late Mesolithic site (on the east bank of the Main Nile) is predominantly tempered with perthitic-rich sand. It is present at 20-30% of any visual field and reaching c.67% of the total non-plastic components. Though microcline and plagioclases are present in fabric B of ceramics from this

site but in markedly lesser proportions, being 13% of the total feldspars (see section 3.3.6.1.3).

Most Mesolithic pottery fabrics in Khartoum Province (Sarurab2 on the west bank of the Main Nile) have relatively higher proportions of quartz exceeding c.80% of the total inclusions in most samples, whereas the Neolithic pottery fabrics (Fabric B) from the same area (Islang2 on the west bank; Kabbashi and Geili on the east bank of the Main Nile) tend to exhibit relatively lower proportions of quartz inclusions (c.39%, 30% and 22% respectively) than feldspar (see supra). The sole exception being fabric B of Kabbashi Haitah Mesolithic ceramics (on the east bank of Main Nile) where quartz is twice as much as feldspar (c.61%) (cf. sections 3.3.5 and 3.3.6).

The percentages of iron oxides in fabrics B tend to show steadily increase from the Mesolithic (3.3% at Sarurab2, 4% at Kabbashi Haitah and 6% at Kabbashi) to the Neolithic times (c.11% at Islang2 site) (ibid.).

Mica (mainly muscovite and occasionally biotite) is common in fabric B of both Mesolithic and Neolithic ceramics in Khartoum Province. In the Western bank of the Main Nile the occurrence of this non-plastic mineral inclusion tends to show low percentages in the range of 2-3% at the Sarurab2 Mesolithic and 4% at Islang2 Neolithic ceramics whereas the proportion of the mineral shows slight increase at ceramics of fabric A2 of the late Neolithic site of Nofalab2. In the eastern bank of the Main Nile, the early Mesolithic ceramics of Kabbashi Haitah site exhibit low proportion of mica flakes being 5% of the total non-plastic grains. The late Mesolithic ceramics of Kabbashi provides scarce amount of mica, being present at c.2.5% of the total tempering inclusions. At the Neolithic period mica was more pronounced in the composition of pottery fabrics as shown by fabric B which reaches c.15% of the total mineral percentages of this fabric (cf. sections 3.3.5.1, 3.3.5.2, 3.3.6.1 and 3.3.6.2).

Rock fragments are extremely rare in the pottery composition of fabrics group B during the Mesolithic and Neolithic periods in this Province. In the western bank of the Main Nile, rock fragments are absent in fabrics group B of Sarurab2 Mesolithic and Islang2 Neolithic ceramics. On the other hand, the proportions of rock fragments in the Mesolithic (Kabbashi Haitah and Kabbashi)

and late Neolithic (Geili) ceramics of the eastern bank of the Main Nile are scarce being c.1% 2% and 3% respectively (ibid.).

Hornblende is extremely scarce in the pottery composition of fabric group B during the Mesolithic and Neolithic periods in this area. In the eastern bank of the Main Nile, it is present at a magnitude of 1% at Sarurab2 Mesolithic pottery whereas the Neolithic pottery of Islang2 and Nofalab2 is devoid of this mineral. In the eastern bank of the Main Nile though it is still rare mineral, nonetheless, it shows marked increase from the Mesolithic (Kabbashi Haitah and Kabbashi) to the Neolithic(Geili) ceramics being present at 1%, 2% and 3% respectively (ibid).

Accessory minerals (zircon, tourmaline, epidote and hyperthene) are solely present at fabric group B of Sarurab2 site (Mesolithic period) and it is entirely absent among the components of the same fabric designation at Islang2 and fabric A2 of Nofalab2 ceramics (Neolithic period). In the eastern bank of the Main Nile, minor minerals are extremely rare in fabric group B, it is represented only by zircon, reaching 1% of the overall minerals at fabric B of Geili Neolithic ceramics (cf. section 3.3.6.2.1). The pottery of fabric B from the Mesolithic sites of Kabbashi Haitah, Kabbashi is devoid of accessory minerals (cf. sections 3.3.6.1.1 and 3.3.6.1.3).

The particle sizes of the non-plastic mineral inclusions from the sampled Mesolithic sites in Khartoum Province are mostly in the order of 0.500-0.900 mm, occasionally exceeding that range up to 1-2.150 mm across. Mineral grains below these ranges are infrequent or rare in the pottery fabrics of this period (cf. sections 3.3.5, 3.3.6, 7.6.1 and 7.6.2).

The pottery fabrics of Sarurab2 (on the west bank of the Main Nile) tend to show generally coarse grained texture. Fabric A1 of this site shows non-plastic minerals in the range of 0.500-550 mm, the mineral sizes of fabric A2 are generally in the order of 0.400-0.900 mm across whereas those of fabric B are mainly in the magnitude of 0.400-0.700 mm across (cf. sections 3.3.5.1.1 and 7.6.2).

The fabrics of Kabbashi Haitah Mesolithic ceramics (east bank of the Main Nile) exhibit similar ranges of grain sizes mostly in the magnitude of 0.450 - 0.900 mm across (cf. section 7.6.2.1.1). The late Mesolithic ceramics (Fabrics A1, A2 and

B) of Kabbashi from the same district tend to show average size range in the order of 0.500-0.950 mm across for the bulk of the tempering inclusions (cf. sections 3.3.6.1.3 and 7.6.2.1.2).

The average grain sizes of the tempering inclusions from the Mesolithic ceramics in Khartoum Province are comparable, mainly displaying coarse-grained texture (cf. section 7.6.1 and 7.6.2), medium grained (c.0.200 - 0.390 mm) and fine texture (c.0.060-0.190 mm) but are infrequent or rare in the bulk of non-plastic inclusions of pottery fabrics (cf. sections 3.3.5 and 3.3.6)

The average grain sizes of the Neolithic ceramics in Khartoum Province (Islang2, Nofalab2 on the west bank of the Main Nile and Geili on the east bank of the Main Nile) are mainly in the range of 0.100-0.390 mm, often below that dimension (0.060-0.1950 mm) and rarely exceeding maximum grain size of 0.390 mm (ibid.).

The grain sizes of all the Neolithic pottery fabrics are comparable. The pottery fabrics of Islang2 (A1, A2 and B) tend to show, in general, medium-grained texture. The aplastic minerals of fabric A1 are mainly (70%) in the order of 0.200-0.300 mm across occasionally exceeding that range up to 2 mm. In fabric A c. 78% of the non-plastic minerals are in the range of 0.250-0.385 mm across whereas fabric B provides 65% of tempering inclusions having sizes in the order of 0.150-0.380 mm across. It is noteworthy that the texture of the three fabrics is mainly fine to medium grained. The coarse grained textures of the three fabrics belong to specimens (samples:ISG2, ISG27,8 and ISG2,10) derived from the lowest layers of squares 1-A and (3,4) E at a depth of 60 cm and 50 cm respectively (cf. sections 3.2.1.2 and 7.6.2.1)

The fabrics of Nofalab2 Neolithic ceramics (on the west bank of the Main Nile) tend to show fine to medium grained textures. In fabric A1 the non-plastic components are almost exclusively in dimensions of 0.250-0380 mm across whereas those of fabric A2 are in the range of 0.060-0.380 mm across (cf.sections 3.3.5.2.3 and 7.6.1.2.2).

The pottery fabrics of Geili are similar as regard grains sizes. Most mineral grains (mostly quartz, feldspar and less frequent are iron oxides and mica) are in

the range of 0.060-0.380 mm across and the material is, generally, well sorted (cf. sections 3.3.6.2.1 and 7.6.2.2.1).

Most non-plastic inclusions of the sampled Mesolithic and Neolithic pottery fabrics in Khartoum province are subangular or angular (78-89%), subrounded and rounded crystals are present but in much lower proportions (10-22%). Iron inclusions which are present in the form of irregular masses of interlocking character are rare (c.1-3% of the total inclusions). All the fabrics tend to show comparable proportions of rounding classes. Angular and subangular minerals are exceeding 80% in almost all the Mesolithic and Neolithic pottery fabrics. The sole exception being the Mesolithic (Sarurab2) and Neolithic (Islang2) pottery fabrics from the west bank of the Main Nile and the Mesolithic fabrics (Kabbashi Haitah and Kabbashi) from the east bank of the Main Nile (cf. sections 3.3.5.1, 3.3.5.3, 3.3.6.1 and 3.3.6.2).

With respect to matrices, there is no clear grouping tendency as regard the colour in plane polarized light (PPL) and under crossed nicols (XPOL) of the Mesolithic and Neolithic ceramics in Khartoum Province. Colours of the matrices under PPL are very similar. Most fabrics tend to exhibit light reddish and pale brown colours. The sole exception being fabrics of Islang2 Neolithic ceramics (A1, A2 and B) which are exclusively characterized by matrices with medium brown colours in PPL and slightly darker brown in XPOL. Apart from Sarurab2 Mesolithic and Geili Neolithic ceramics, the remaining Mesolithic (Kabbashi Haitah and Kabbashi sites on the east bank of the Main Nile) and Neolithic ceramics (Islang2 and Nofalab2 on the west bank of the Main Nile) tend to show medium brown colour under PPL and darker brown shades in XPOL (cf. sections 3.3.5 and 3.3.6).

Most pottery-fabrics of both Mesolithic and Neolithic sites are characterized by matrices showing neutral optical density. The only exception being fabric A2 of Kabbashi Mesolithic and fabric B of Geili Neolithic ceramics from the eastern bank of the Main Nile (ibid.).

3.4. X-ray diffraction analyses

3.4.1. Introduction

In order to further compare the tempering inclusions with that of the paste, X-ray diffraction method has been used. This technique is utilized to obtain qualitative information on clay mineralogy and rarely used to obtain quantitative data (Weymouth 1973:33).

The thin section has a drawback that it does not permit the study of clay mineralogy of pottery. Clay is a heterogeneous material which is composed of submicroscopic grains of various clay minerals of which common examples are montmorillonite, kaolinite, illite and chlorite. Since clay mineralogy varies in different clay deposits, this can, theoretically, be used to characterize pottery (Peacock 1970:380).

X-ray diffraction technique is used to identify the mineral phases and chemical compounds in the archaeological artifacts. With regard to pottery, this method has widely been used to identify clay minerals, high temperature phases resulted during firing and mineral inclusions incorporated into the clay matrix. Moreover, it has also been used for the identification of pigments, for the study of the mechanical and thermal treatments to which metals were subjected and in the examination of some artifacts (Shepard 1956:146-147; Tite 1972:285-287 and Rice 1987:282-286).

In this technique a very small sample (5-10 grams) of crystalline structure is required. The sample is bombarded with monochromatic X-rays (i.e. X-ray with sharply-defined wavelengths) and the rays that penetrate are partially scattered from many successive planes within the crystal. Since no two minerals have the same interatomic distance in three dimensions, the angle at which the maximum diffraction occurs will be distinctive for a particular mineral (Whittig 1965:672-698 and Peacock 1970:380). However, in practice most clay minerals are destroyed by heating above 500°C and hence it is applicable successfully to low fired wares. This method has also proven to be valuable in the study of wares fired at very high temperature where new artificial minerals have developed in the fabric (Peacock 1970:380).

Two methods of X-ray diffraction are the most frequently used: diffractometer method and the powder photography (camera) method. These differ in the kind of apparatus used as well as in sample preparation, but both required fine-grained or powdered sample.

In the diffractometer method, some 20 mg. powdered material is placed on a glass slide inserted into diffractometer apparatus. The X-ray source remains static whereas the sample rotates through an angle 0 and the detector (counter) revolves about the counter of the sample through an angle. The diffraction pattern is recorded on a paper chart by a recording device (Rice 1987: 284). On the other hand, in the powdered photography method a sample of 2-5 mg. is finely ground (to less than 240 mesh) and formed into a thin (less than 0.3 mm) rod either by mixing the powder with a gum, inserting the powder into a capillary tube or covering a fiber with a Vaseline and rolling it in the powder. This sample is then placed in the center of a special cylindrical camera that has an X-ray sensitive film. The X-ray beam is then strikes the sample from different angles. Because the mineral grains randomly placed in the sample rod, the X-rays are diffracted in the form of concentric cones of scattered waves (ibid).

3.4.2. Sample Preparation

The preparations of the samples were carried out by the present writer in 4 steps: -

1. Several pieces from different portions of the sample (Potsherd) were combined and homogenized by grinding using a porcelain pestle and a mortar. The aim was to get a representive sample of the entire pot.

2. The mixture was then ground using an electric ball-mill.

3. Then a small amount of the very fine powdered sample (c. 0.5 gram each) was mixed with glycerol (only one drop or so) and rubbed to make an even and fine mixture.

4. In the final step, each sample (clay paste) was smeared with spatula onto a sample holder (a volume of about 1cm x 3cm x 1mm), being ready for processing by the X-ray diffraction machine.

3.4.3. Analytical Method

The X-ray diffraction photographs have been made with cok radiation and an Enraf Nominus Guinier Camera FR552 with a Johanson monochromator.

Guinier cameras with curved crystals monochromator are sometimes preferred because of low background, scattering, sharp lines and greater resolutions (Brown and Brindley 1980:316). Of the utmost advantages of Guinier camera is the production of 4 (Nonius Guinier de Wolf camera) or 3 (Nonius Alfa 1 camera) complete X-ray powder patterns at the same time, i.e., in about 60 minutes. A diffractometer produces one pattern at a time and those patterns are recorded on a rather long strip paper. With the Guinier camera the three or four patterns are recorded petrographically on a strip of film of only 17 cm. being rather easy to measure, to compare and to handle (Van Der Plas, pers. comm. 1993).

3.4.4. The Analyses

Some 37 analyses were conducted by the X-ray diffraction method (camera method) at the department of Soil Science and Geology, Wageningen University in the Netherlands (tables 10-11, 25,33). The present writer has, initially, determined to analyze some 54 samples representive of fabric variations within the Mesolithic and Neolithic sampled specimens from the central Sudan. However, the number of the samples has been reduced to 37 potsherds for it has proven futile to continue analyzing the rest of the samples because the main clay minerals (e.g. montmorillonite, kaolinite, chlorite and illite) were no longer present in the samples. The absence of the key minerals in the samples tested is due to the high firing temperature which destroyed all the crystalline structures of these minerals. Heating and its effects on the crystalline structure of clay minerals is one of the major problems in the analysis of archaeological ceramics (see Shepard 1956:19-24, Carrol 1970: table 9 and Rice 1987:86, 90).

3.4.5. Results of Analyses and General Commentary

The relative abundance of the minerals present has been estimated from the blackening of the X-ray diffraction lines.

++++ strong
+++ medium
++ weak
+ very weak
+ present not clear
- not visible

As can be seen in tables 10-11, 25, 33, the following minerals have been identified:-

1. Quartz

Quartz and other forms of silica are among the commonest impurities present in clays (Shepard 1956: 18 and Brown 1980:378). Structurally, quartz is composed of silica tetrahedrons (Si04), the same unit that form the silica layers of clays (Rice 1987:94-95).

The X-ray diffraction photographs have shown that all the samples of the Mesolithic, Neolithic and modern pottery hold apreciable amounts of quartz inclusions, (see section 3.4., 4.4 and 5.4.). The results show that quartz gave a diffraction pattern with a series of reflection lines (4.26Å, 3.34 Å, 2.46 Å, 2.28Å, 2.23Å, 2.13Å, 1.97Å, 1.82Å, 1.80Å, 1.67Å, 1.66Å, 1.60 Å and 1.54Å). All these diffraction lines have been used for the identification of quartz in the samples understudy. This is not surprising because when a mineral is present in high amount (as for quartz in the present analyses), the whole diffraction pattern can be used for identification of that particular mineral (Doesburg, pers. comm. 1993).

2- Clay

The X-ray diffraction photographs have indicated a weak or very weak presence of very fine grained particles of clay minerals (020) (cf. tables 10- 11, 25, 33). These are, seemingly, detrital grains of the stable minerals of the present rock or a mixture of various constituents derived from different sources.

3. Feldspars

Feldspars often form a minor components of clays and usually occur in the coarser, 1-2 um and larger fractions. Feldspars may be a major component of the clay fractions in some samples such as rock flour. These minerals are framework silicates formed by tetrahedral groups, usually Si04 and Al04. However, in the X-ray diffraction analysis two, three or four sharp strong reflections in the order of 3.30-3.18 A usually indicate the presence of feldspars (Brown 1980:381-384).

It can be seen in tables 10-11,25,33, that X-ray diffraction shows a weak or very weak presence of plagioclase feldspar in all the analyzed samples. Plagioclases have been identified on the basis of five diffraction lines being 4.03 Å, 3.22 Å, 3.20 Å, 3.17 Å and 3.15 Å. For K-feldspars, the presence is not clear or invisible in almost all the tested samples. The X-ray diffraction patterns of the latter has been determined from only three diffraction lines (4.22 Å, 3.29 Å and 3.24 Å).

4. Iron oxides

Iron oxides, which are the chief colourant of fired clay (Shepard 1956:22 and Rice 1987:335-336) have been recognized in the present samples of the Mesolithic, Neolithic and local modern samples only in the form of ferric oxide (hematite-Fe 203).

Hematite, the anhydrous ferric oxide, is a common alteration product and in turn alters to magnetite, limonite, siderite and other iron minerals, depending on conditions (Shepard 1956:37). This oxide is one of the most widely distributed minerals, it is abundant in some sedimentary rocks, occurs as a product of

metamorphism in crystalline schists, colours many minerals and rocks, and present in large crystals over volcanoes and is common frequent in ore veins (ibid. and Rice 1987:336).

In the present analyses (cf.tables 10-11, 25, 33) the X-ray diffraction photographs after firing the sherds in an electric oven to 750° C (heating period 1 hour) show the development of ferric oxide (hematite - Fe 203). The potsherds of all samples did not contain detectable amounts of hematite before firing in the laboratory.

The identification of hematite in the present analysis was based on a series of diffraction lines (3.68 Å, 2.70 Å, 2.52 Å, 2.21 Å, 1.84 Å and 1.69 Å).

5. Mica

Micas are similar in their in their general structure to the illite minerals. The basic structural unit of the former is composed of dioctahedral or trioctahedral and there is no sharp variation in the population of octahedral positions and also possible variation in the way of stacking of silicate layers above each other. Thus, muscovite mica is dioctahedral whereas biotite micas are trioctahedral with octahedral positions populated mainly by iron and magnesium (Grim 1962:20 and Brown 1980:333).

The presence of mica minerals (biotite and muscovite) in the samples analyzed is evident on the basis of a single diffraction line (10 Å)(cf. tables 10-11,25,33). The presence of this diffraction line of mica may also be present due to heating of smectite and vermiculite (Van Doesburg, pers. comm. 1993). However, this diffraction line is usually taken by mineralogists as a characteristic for most mica minerals (Grim 1968:144 and Brown 1980:333)

6- Calcite

It is one form of calcium family. Calcium carbonate is present in nature (Cac03) in a very fine form (crytocrystalline) as gypsum (CaS04)(Shepard 1956:19 and Rice 1987:97). As a clean crystal, it occurs as white veins and pockets in limestones (Frank and Hammer 1986:45).

The diffraction data of all the analyzed samples (tables 10-11,25,33) shows that the presence of calcite is not always conspicuous. Even if it is present, it was identified on the basis of one diffraction line only (3.03Å)

7- Anatase

It commonly occurs as a minor constituent of clays. When anatase occurs in kaoline-rich clays its strongest diffraction, d=3.52Å. Heating at 440°C for a few hours destroys the kaolinitic structure and the anatase reflection is clearly seen (Brown 1980:400).

In the present analyses (cf.tables 10-11,25,33) anatase has been indentified on the basis of a single diffraction line. This mineral is present in very low quantity and hence, only the strongest diffraction line has been used for identification.

8- Kaolinite

Kaolinite is a chief member of kaolinitic group and also a chief constituent of most high grade clays (Shepard 1956:8). Its structure is composed of a single silica tetrahedral sheet and a single alumina octahedral sheet combined together to form a common layer roughly hexagonal in outline (Grim 1962:10-11 and 1968:57).

In general, the determination of kaolinite group by X-ray diffraction is simple, but the indentification of the particular members of the group may be more difficult. The prominent basal reflections at 7.16Å and 3.57Å are adequate for identifying the members of kaolinitic group. (Grim 1968:130)

The present analyses (cf.tables 10-11,25,33) show a weak presence of kaolinite and therefore, it has been identified on the basis of a single diffraction line (7.2Å)(see section 3.4.6).

3.4.6. Results

The X-ray diffraction photographs of the tested Mesolithic, Neolithic and modern ceramics in khartoum province (tables 10-11) show that quartz is the dominant mineral inclusion and it is present in all the samples with similar amounts. The rest of the minerals were reported in minor quantities.

3.4.6.1. West Bank of the Main Nile

As indicated above, quartz is the most prominent mineral in all the Mesolithic, Neolithic and modern ceramics from khartoum province.

Samples of the fine earth fractions (020) show a very weak presence in all the samples examined.

The pottery samples from the Mesolithic and Neolithic sites on the West Bank of the Main Nile (Sarurab2, Islang2 and Nofalab2) reveal a very weak presence of plagioclase feldspar. The modern pottery samples from the same area (sample: G93-10b, table 10) show slightly higher percentage of plagioclases than in the remaining samples, though the presence is weak.

Apart from the Mesolithic pottery of Sarurab2 site which shows a very low amount of k-feldspar, the presence of this mineral is inconspicuous in the sampled pottery of the Neolithic sites (Islang2 and Nofalab2).

Hematite is imperceptible before firing. However, after firing in an electric oven (Ihr period) the samples showed the development of hematite.

Mica is inconspicuous in the pottery samples from sarurab2 (sample: G93-06) and Islang2 and entirely invisible in the samples from Nofalab2. After firing to 900°c, this mineral is absent in most of the samples. The only exception are the samples of Islang2 which hold the same proportion of mica after firing.

The occurrence of anatase is extremely weak in all the Mesolithic and Neolithic tested pottery of the this area.

Calcite shows a weak presence, being identified on Sarurab2 (sample:93-07) and the modern local pottery from the same area (sample: 93-10b).

With the exception of the Neolithic pottery of Islang2 site, the pottery samples from Sarurab2 Mesolithic and Nofalab2 Neolithic sites are devoid of kaolinite. The presence of this clay mineral is apparently weak, being identified on the basis of a single diffraction line (7.2Å).

Calcite, anatase and kaolinite are not present in the analyzed pottery samples after firing to 900°c for a period of one hour.

3.4.6.2 East bank of the Main Nile

Quartz is the dominant mineral in all the pottery samples of the Mesolithic (kabbashi Haitah and Kabbashi) Neolithic (Geili) sites and the local modern pottery.

The presence of fine clay fractions (020) in all the samples is weak or very weak whereas the indentification of one sample from Kabbashi Haitah (G93-09c) is conspicuous.

Almost all the pottery samples from the three tested sites on this area (Kabbashi Haitah, Kabbashi and Geili) exhibit a weak presence of plagioclase feldspar and only one sample from Kabbashi site (G93-08c) is devoid of this mineral.

K-Feldspar shows moderate abundance at Kabbashi Haitah (G93-09c) and Geili (G93-08c). The pottery samples of kabbashi (G93-09a) and Geili (G 93-08a) reveal, respectively, a weak and very weak occurrence of this mineral.

It is noteworthy that feldspar content of Kabbashi (sample:G93-08C) and Geili (sample:G93-08b) samples does not agree with those of the fired (900° C) sherds (G93-13c and G93-13b respectively). For that reason samples of Kabbashi and Geili (G93-21b and G93-20b respectively) were analyzed again. These results (cf. table 11) are correct.

Hematite was unobservable prior to heating. However, after heating (table 12) to 900°C (1hr. period) the samples promoted hematite.

Calcite content is scarce in the samples of Kabbashi Haitah (G93-09b), Kabbashi (G93-08c) and Geili (G93-08b) sites and unclear in samples (G93-09c), (G93-09a) and (G93-08a) from the same sites, respectively.

Anatase has not been identified with certainty, being represented by two samples (G93-08a and G93-21b).

After heating to 900° C calcite and anatase are absent in almost all the samples. The sole exception being a sample from Geili pottery (G93-13b) which indicates a very weak presence of anatase (see table 11).

3.5 Chemical analysis

3.5.1 Introduction

Chemical analysis has found considerable application in ceramic studies, particularly the problem of characterization, for different clays can be distinguished by their chemical content (peacock 1970: 377). Chemical analyses of elemental concentrations may serve several purposes:-

(a) identify the composition classes that can be discriminated for the pottery of known or assumed provenance.

(b) to allocate the source of pottery of unknown provenance to one of these classes or determine that allocation is unjustified.

(c) to check the petrographic data (Wilson 1978: 224, 226 and Buko 1984:358).

3.5.2 Methods of analyses

Determination the chemical composition of pottery material, ancient or modern, is an important analytic goal (Rice 1987:389). Chemical analyses may reveal similarities and differences which may not be evident from microscopic

examination alone. However, methods of chemical analyses can be divided into two main groups: classical methods and physical ones.

3.5.2.1 Classical methods

Classical or wet methods measure the products of chemical reactions by their weight (gravimetric method) or volume (volumetric methods). Classical (wet) chemistry is of value for quantitative analysis of major and minor elements in an unknown compound and for identification of non-metallic elements (carbon, sulfur, nitrogen, phosphorous and their oxides) (Rice 1987:391). The main advantage of this method is that it is inexpensive. Yet, it is a time consuming, destructive and elements present in trace amounts could not be determined (ibid). Moreover, it is not very accurate, and error up to 10-30% is often expected (Peacock 1970:377 and Rice 1978:391). The microchemical technique described by Anna Shepard to determine iron, manganese, copper and mercury which are important constituents of pigments applied to pottery (Shepard 1956:141-142) and the microchemical tests carried out on a series of pottery samples from Early and Middle Nubian pottery (northern Sudan) (Nordstrom 1972: 40) can be taken as examples for the classical methods.

3.5.2.2. Physical methods

These methods do not require chemical reactions between known and unknown constituents but based on detectable changes in the elements when energy is introduced into them, for instance by heating or by bombarding them with X-rays, electrons or neutrons. The majority of the physical methods used in analyzing artifacts, especially pottery, include X-ray fluorescence, optical emission spectroscopy, atomic absorption, Mossbauer spectroscopy, Infra red spectroscopy, electron microscope, neutron activation analysis and X-ray photoelectron spectroscopy. These methods are devoid of the disadvantages of the classical methods (see e.g., Peacock 1969b:41-61; Perlman and Asaro 1969:21-52; Tite 1972:315-323; Poole and Finch 1972:79-92; Hall et al 1973:53-78; Rye 1981:47-49 and Rice 1987:389 - 404).

3.5.3. Goal of the work

In order to further differentiate pottery from the sites investigated and to trace the possible source of material utilized in its manufacture, the chemical composition of the pottery has been determined. The present chemical analysis has been conducted using X-ray fluorescence spectrometric technique at Department of Soil science, Wageningen Agricultural University in the Netherlands under the present writer guidance and participation at all stages of analyses. However, these analyses are not broad and the ultimate goal is to enhance our knowledge about the chemical composition of the potsherds understudy and to check the results of the major analysis (petrographic examination) employed in the present research.

3.5.4 X-ray fluorescence methods

This method is of particular value in distinguishing between wares that appear identical under the microscope. It gives no indication of the minerals in the body, though the proportion of the chemical elements can be determined (Hodges 1965:25). By analyzing samples using X-ray fluorescence technique both quantitative and qualitative elements present can be determined. (ibid).

The sample analyzed by this method is ground to a very small particle size to ensure an even mixture of various component minerals. The sample is bombarded with primary X-rays which expel electrons from inner orbits of the atoms of the constituent. The electrons of the outer orbits immediately fill the vacant inner electron levels and the energy obtained by this process appears as secondary or fluorescent X-rays with varying wavelengths (characteristics of the atoms in the struck material). Elements present in specimen can be identified determining the wavelengths of the secondary X-rays. On the other hand, the intensity of X-rays at a particular wavelength indicates approximate concentration of the associated element (Tite 1972:267; Tertain and Claisse 1982 and Rice 1987:393-395).

X-ray fluorescence is useful for detecting about eighty elements present in major, minor and trace elements (Rice 1987:394, see also section 3.5.5.3.). This method of analysis is inexpensive and may be non-destructive for small artifacts (for others it requires slight damage for sample removal). Moreover, the technique is of relatively high percision (usually better than ± 5%). For all these reasons it has

found a considerable application in ceramic studies (e.g. see, Young and Whitemore 1957:1-27; Peacock 1969b:41-61; Francavigilia and Palmieri 1983:191-205; Buko 1984:348-364; Palmieri 1987:221-229; Smith 1990 and Stein et al 1991:261-277).

3.5.5. Experimental considerations

3.5.5.1 Sampling

Some 32 chemical analyses (tables 4-5,26-27,36-37) were performed on a series of Mesolithic, Neolithic and modern ceramics from the central Sudan (Khartoum Province, White Nile and Western Butana regions) using XRFS method at the Department of Soil Science and Geology, Wageningen University in the Netherlands (see section 3.5.3.). The samples tested were selected by the present writer in the light of sampling requirements for X-ray spectrometry (Matson 1963:496). They were not washed, ground or pretreated and show no sign of corrosion. However, X-ray spectrometric technique suffers from a drawback that it only analyzes the surface of the sample to a depth of 0.01-0.1 mm. Hence, weathered or corroded surface seriously affects the measurements. If the surface of the pot has been treated in any way, or if surface enrichment in chemical elements has occurred during burial, the analysis may not be representive of the sample as a whole. This problem can be overcome by analyzing about 2 to 5 grams of pot to a fine powder after removal of the outer layer (Peacock 1970:378).

3.5.5.2. Selection of chemical elements

The selection of which chemical elements to be analyzed is arbitrary and there is no common consent about the optimum elements to study. In the British Isles, aluminum, magnesium, iron, titanium, manganese, chromium, calcium, sodium and nickel are the most commonly studied (Peacock 1970:377). In North America, sodium, potassium, calcium, barium, manganese, titanium and iron are the most frequently investigated (e.g. Rands and Bishop 1980:19-49; Bishop 1980:47-65 and Deutchman 1980:119-131). In north Africa archaeologists have laid emphasis on elements including silicon, aluminum, titanium, sodium, potassium, calcium and manganese (e.g., see Palmierie 1983:191-205, 1987:221-229 and Smith 1990). The number of elements to be chosen is, similarly, arbitrary

one. However, in elemental analysis of pottery between 8 and 38 elements have commonly been measured (Wilson 1978:221).

In the present work eleven major and minor elements were analyzed: SiO , NaO, MgO, AlO, PO, KO, CaO, TiO, MnO, Fe O and BaO. The author has chosen these elements in the light of the following reasons:-

(a) Major and minor compounds provide information on tempering material, therefore on lithological provenance, as well as technology (Palmieri 1987:225-226) whereas trace elements are sensitive indicators as to the geochemical environment (Reeves and Brooks 1978:2) and hence reflecting very specific local sources.

(b) Trace element composition appears to be unsuitable for the classification of prehistoric ceramics containing appreciable amounts of coarse minerals (Buko 1984 : 348-365; Van Der Plas 1988:92 and Stein et al 1991:261-277).

3.5.5.3. Laboratory Pre-treatment

Sample materials to be analyzed were ground (<0.02 mm) and dried (105 C). For preparation of glass-disks (see section 3.5.5.4.) the material was heated to 1000 C to determine loss on ignition. By this technique such effects as interelement interferences and macroscale heterogeneity can be avoided (Buursink 1971:161). Ignition removes volatile materials (e.g., organic substances) that are often present (Wilson 1978:224). At the same time it does not alter the relative concentrations of involatile elements, and certain materials used for temper either does not affect the elemental concentrations (e.g., when crushed pottery is used) or may not be properly corrected by the use of concentration ratio (ibid: 228).

3.5.5.4. Sample preparation

Basically there are two methods for the preparation of samples to be analyzed by XRFS (see e.g., Peacock 1970:378; Rice 1987:393-395; Potts 1987:271-272; and Robert et al 1993:44-53):-

3.5.5.4.1. Pressed tablet

In this method 1.0. gram of sample-material is mixed with 1.0. gram of wax and pressed in a press-machine. The tablets are 3 to 4 mm thick and have a diameter of 3.5 cm.

This method is used for qualitative analysis, analysis of volatile components, in future for quantitative analysis of plant-tissue, and for general demonstration purposes.

3.5.5.4.2 Glass disks

A mixture of 600 mgr. ignited sample-material and 240 mgr. melting agent is fused in a high-frequency fusion equipment (lithiumteraborate glass) of about 1200 C. The disks are 3 mm thick and have a diameter of 3.5 cm.

This method is the routine procedure for the analysis of major and minor compounds and trace elements. Therefore, it has been applied in the present chemical analysis. The molten glass resulting from samples solutions (see section 3.5.5.3.) was powered in platinum crucibles (disks) and quickly cooled. The glass crucibles prepared in this way were used for measuring the chemical composition.

3.3.5.5 XRF - Spectrometer and Data analysis

The samples were processed with a highly automized Philips X-ray fluorescence apparatus model PW104 which is computer-controlled. The major compounds were measured with a scandium-anode X-ray tube. The measured intensities were corrected for matrix effects by so-called ' alpha-coefficients', based on 'average' sample composition. Total time for analysis per sample was about five minutes. Results have been given in weight percentage (see tables 4 and 5). The relative standard deviation varies between 1-2% while the detection limit is between 0.01-0.05% depending on the element being analyzed.

All the necessary element parameters, system setting, data managements, the drawing of the groups presented as well as statistical operation were done with

Symphony Software. The types of triangular diagrams used in the present work were developed by E.L. Mijer (1987) using the options in Symphony.

3.5.6. Results

The analyses (tables 12-13 and figs. 54-62) show that the chemical composition of all the samples (Mesolithic, Neolithic and modern) from Khartoum Province (east and west bank of the Main Nile) is silicon-rich. When silicon (Si) is high it is probable that free quartz content will be high and this is the most common impurity of clays (Wilson 1927:44). The average of 16 analyses is 63.5 wght % silicon. Silicon oxide (Si02) concentration in the Mesolithic, Neolithic and modern ceramics analyzed is exclusively above 50 % suggesting high quartz index.

Aluminium (Al) is a rough index of feldspar (Spock 1961:97). It occurs mainly in feldspar, feldspathoids and micas and to a lesser extent may be of amphiboles and pyroxenes (Jeffery 1975:94). The percentages of aluminum oxide (Al203) are comparable in all the Mesolithic, Neolithic and modern samples. The highest amount is seen, in most cases, on samples from the east bank of the Main Nile (Kabbashi Haitah, Kabbashi and Geili (sample:Geili(3)). The concentration of Al203 at these samples being present in the range of 19-19.8% by weight. It is worthnoting that only one sample from the Neolithic site of Islang2 site, on the western bank of the Main Nile holds similar amount of aluminium oxide, being 19.5 wght%. The lowest amounts were reported from the Mesolithic site of Sarurab2 (sample:Sarurab2(5)) and the Neolithic site of Nofalab2, (sample:Nofalab2(3)) all of which are located on the west bank of the Main Nile (cf.fig.1).

Iron is one of the commonest elements, occurring to an extent of 5% by weight of the earth's crust, and fourth in the list of the most abundant elements after oxygen, silicon and aluminium (Jeffery 1975:273). In the analysis of silicate rocks, both ferrous and ferric oxides are reported, usually expressed as oxides (Shepard 1956:18 and Jeffery 1975:275). Iron oxide is the chief colourant of fired clay (Shepard 1956:18).

In the present analysis, ferrous oxide (Fe203) is rather common, being present at 6.9% by weight at the average in almost all the samples. It occurs in, exceptionally, lower amounts at two samples (Kabbashi Haitah (3) and Geili (3))

from the eastern bank of the Main Nile, being present at 2.9 wght% and 3.5 wght% respectively.

Titanium (Ti) is less frequent impurity in clay (Shepard 1956:19). In geological context, it is more frequent in basic rocks than in acidic ones. Titanium content is, therefore, of similar order to that of igneous rocks, 0.2-1% Ti. This mineral could have been produced from the minerals rutile, titaniferous iron ore or illuminite (Rhodes 1973:211-212; Hammer and Hammer 1986:320-321).

The proportions of Ti02 in the present analyses are homogenous and most values are little above 1% by weight. It is noteworthy that all the samples from Kabbashi Haitah (Early Mesolithic), Kabbashi (late Mesolithic) in addition to a single sample from Islang2 (sample:Islang2 (9)) and another one from the Neolithic site of Geili (sample:Geili(3)) exhibit values less than 1 wght%.

Manganese (Mn) is present in the igneous rocks in the divalent state, associated with ferromagnesian and accessory iron minerals (Jeffery 1975: 326). Clay and shales contain similar amounts of manganese to those encountered in igneous rocks, whilst sandstone and residual sediments, in general, contain rather less (ibid).

All the Mesolithic, Neolithic and the comparative modern pottery samples from Khartoum Province contain rare amounts of manganese oxide (Mn0), all of which below 1% by weight. The samples are comparable, displaying very homogenous range of values.

Magnesium (Mg) is usually reported as the oxide Mg0, and as such can constitute as much as 51% of certain silicate rocks-varieties of dunite for example have 30 to 40%. Mg0 is fairly frequent, being encountered in certain ultrabasic rocks such as picrites and periodotites (Jeffery 1975:306) though it is less frequent as clay impurity, it occasionally influences the colour of clay (Shepard 1956:19).

In the present chemical analysis the concentration of magnesium in nearly all the Mesolithic and Neolithic samples from Khartoum Province is exclusively below 1% by weight. The proportion of this oxide in the modern pottery from the same

same area is nearly three times higher than as that reported from the ancient pottery (Mesolithic and Neolithic).

Calcium (Ca) is the third important mineral in pottery after quartz and feldspar. It occurs in varied forms of calcium carbonate (CaCO3), such as limestone, calcite, and shell or calcium sulphate, such as gypsum (CaCO4) or in the form of animal bone ash (Rice 1978:97).

The present analyses (cf tables 4-5) show that calcium content of the Mesolithic and Neolithic pottery is very small in amount mainly present below 2% by weight, whilst the modern pottery samples from the same vicinity exhibit relatively higher concentrations (c.3-8% by weight). Calcium percentage is markedly different between ancient pottery (Mesolithic and Neolithic) and the comparative modern specimens from the vicinity of Khartoum Province.

Calcium is one of the constituents of feldspar and responsible for the division of this mineral into soda-lime feldspar (containing relative amounts of sodium and calcium) and alkali-feldspar (containing potassium; e.g. orthoclase and microcline) (Rice 1987:35). It is inherent in clays with varying ratios (Pettijohn 1948:381-390 and Folk 1968:91).

The amounts of sodium in all the Mesolithic, Neolithic and modern samples from the eastern and western bank of the Main Nile occur below 1wght%. In two cases only (samples of Khartoum Prov. W.B.M.).(2) and Khartoum Prov. E.W.M.P.(4)) modern local pottery contains sodium that is twice higher than the remaining samples from other localities, but it is still rare.

It is an index of feldspar, being one of the three elements (Potassium, sodium and calcium) present in feldspar in different ratios (Rice 1987:35). It also occurs in clays as impurity with varied proportions (Shepard 1956:19 and Folk 1968:90-91).

The concentrations of potassium oxide (K20) in most of the samples is markedly very low, being present under 2 wght% A noteworthy feature is that almost all the Mesolithic and Neolithic pottery samples from the eastern bank of the Main Nile (Kabbashi Haitah, Kabbashi and Geili sample (4)) hold relatively higher amounts in the order of C.5-7% by weight. K20 was detected in similar

proportion at a single sample from Islang2 Neolithic site on the western bank of the Main Nile.

Phosphorous (P) is recognized as abundant constituent of silicate rocks. Its occurrence decreases in the plutonic and volcanic series (Jeffery 1975:375).

Phosphorous oxide (P2O5) is comparable in all the Mesolithic, Neolithic and modern pottery from Khartoum Province, being present at less than 1% by weight.

Barium (Ba) has been reported from igneous rocks but particularly from acidic and alkaline silicates. Marine limestones and evaporite sediments contain only very small amounts of barium, 10 ppm in most specimens. It occurs in silicate rocks as the sulphate mineral (baryte or bartyes) and as the barium feldspar, celsian (ibid:130).

Proportions of Barium oxide (Ba0) in the tested samples of the Mesolithic, Neolithic and contemporary pottery are very similar, all of which present in the range of less than 1% by weight.

3.5.7 Discussion and Conclusions

The chemical composition of Khartoum Province Mesolithic, Neolithic and modern ceramics is rather comparable (cf. tables 12-13). Silicon is the most prevalent chemical compound. The silicon oxide (Si02) exceeding 60% in most of the samples.

Since silicon is linked to quartzitic sand component, the low level of this element in the most ancient contexts would suggest the use of natural clay without any additional temper (palmieri 1988:228). Such level of silicon (sand deposits) around c.40% or more above in some cases appears to be the characteristic of the clay layers interbeded with sandstone in the central Sudan (see Whiteman 1971: 140-141; El-Boushi and Abdelsalam 1982:65 and Gunn 1982:81-109).

It can be seen (table 12) that silica concentration decreases from ancient periods (Mesolithic and Neolithic) (60-71 wght%) to the recent time (52-58 wght%), with a tendency, in the recent period, toward a greather similarity. The

increased silicon oxide (Si02) rate in the ancient contexts seems to mark a tendency of the Mesolithic and Neolithic potters in Khartoum Province to use additives (sand) to the natural clay, whereas the decreased concentration of silicon oxide is, perhaps, an indicative of the use of natural clay without any deliberate addition of sand temper. It is worthnoting here that a common practise among the present day local potters in Khartoum Province is the usage of animal manure as a temper (Personal observation, see also section 3.3).

Aluminium is a rough index of feldspar (see supra, section 3.5.6, this chapter). Apart from the two samples tested by XRD analysis, derived from the Mesolithic site of Sarurab2, on the west bank of the Main Nile (fig. 4)(cf. table 10, sample G 93-12) and modern pottery samples from the same vicinity (cf. table 10, sample G 93-10b), the linear relationship between the amounts of aluminium of the total composition of potsherd (temper plus matrix) (Tables 12-13) and the K-feldspar still remained in the pottery after refiring to 900 C (1h) (table 16) raises the probability that it is an indicative of feldspar content of these samples.

One of the major characteristic of Khartoum Province ceramics during the Mesolithic, Neolithic and modern times, is its relatively high iron content (up to c.9%), to which the red or reddish brown colours seems to be related (see sections 7.7 and 8.8)

It is noteworthy that the amounts of iron oxide in the modern pottery samples from Khartoum Province (both east and west bank of the Main Nile) are relatively higher than in the remaining samples, the only exception being Kabbashi late Mesolithic pottery which hold similar amounts.

It is worthnoting that iron-rich surface is important marker in the Khartoum Province. Iron is present either as oxides coating the Nubian Sandstones prevailing in the area or in the form of iron-ore deposits. Iron concretions are common in the Nubian Sandstone of Khartoum Province (Merkhiyat Jebels and eastern Sabaloka Gorge). They vary in size from spherical to tube-like. Some concretions are as much as 3ft in diameter (Whiteman 1971:55-57 and figs. 3-4).

Titanium (Ti) content of soils and clays found on one location is rather constant due to the weathering resistance of TiO2 phases (Scheffer et al 1979:32).

Therefore, the TiO2 content as a property of a specific clay can help to select the clay used for making pottery out of a collection of clays available in the area (Stein et al 1991: 269-270).

Titanium is scarce in the clays of central Sudan (see El-Bedri 1972: 97; Khabir 1981:238, table 4 and Gorashi, pers. comm., 1993). It has been reported in appreciable amounts as titanium oxide in gabbros and association rocks only at the Red Sea Hills in the eastern Sudan (19 54 N, 36 35 E), being present in the range of 16-38% titanium oxide (Whiteman 1971:248). Therefore, its occurrence in very small amounts (0.46-1.83 wght%) in the clays used for Mesolithic, Neolithic and modern pottery from Khartoum Province (tables 12-13) is consistent with its rarity in the soils of the central Sudan.

The analysis shows that manganese oxide (MnO) is rare in all the samples from this district, being present exclusively below 1 wght%. At this level of concentration, it is much more likely that it is a minor element rather than an index of major mineral.

The results show that magnesium oxide (MgO) is present in very small amounts in all the samples (below 2 wght%) from this Province. Therefore, it is more likely that it is an index of minor mineral (impurity) present with the main minerals.

The low concentrations of calcium oxide (CaO) recorded from the Mesolithic, Neolithic and modern tested samples of Khartoum Province (mostly below 2%) suggest that they may not have resulted from a deliberate addition of calcareous clays or marly raw material.

Sodium (Na20), phosphorous (P2O5) and Barium (BaO) oxides may represent a contribution to one or more of the minerals present if they have been found in considerable amounts. But since these mineral oxides are scarce, almost exclusively under 1% by weight, it is possible that they are indices to minor minerals present with the main detected minerals (see section 3.3, this chapter).

The mineralogical composition of the Mesolithic and Neolithic pottery samples from the tested sites (Kabbashi Haitah, Kabbashi and Geili) on the eastern

bank of the Main Nile which is rather moderate in alkali feldspars (see table 14), explains the relatively higher K20 content in the pottery of this area, though it is still rather low.

The ubiquitous quartz grains detected in the composition of the Mesolithic, Neolithic and modern ceramics from Khartoum Province, is the reason responsible for a relatively high Si02 and rather low K20 concentrations (see tables 12-13; and sections 3.5.6 - 3.5.7).

3.6 Goethite Norm Analyses

3.6.1 - Aim and principles of the method.

Pottery can be regarded as a metamorphosed sedimentary rock, hence it can be argued that ceramics are best approached in a manner similar to that in the geological study of the parent raw materials. (Peacock 1977:26). This technique provides the petrologist with a set of hypothetical mineral assemblages that were petrographically comparable and similar to certain mineral assemblages found in rock specimens. It can also lead us to know the mineral assemblage of a specific parent rock if it has been changed without the removal or addition of material into "stable" mineral assemblage of the various soil horizons (Van der Plas and Schuylenborgh 1970: 365).

In the present work the X-ray diffraction results (cf. sections 3.4, 4.4 and 5.4) have shown that quartz is the most important mineral constituent of the samples. Relics of mica-type minerals were found only as traces. This points to firing temperature over 550° C (vanishing of kaolinite) and over 600° C (vanishing of poorly crystallized illite) and over 800° C (vanishing of well crystallized illite). Thus the results of pottery samples from the selected sites in Khartoum, Western Butana and the White Nile Provinces indicate a relatively high temperature which causes destruction of crystalline structure of almost all the clay minerals present. Therefore, I have decided to use Standard Goethite Norm Calculations in an attempt to determine the original fine earth fractions which might have been present in the pottery samples.

3.6.2. Methodology

Petrographers and ceramists developed methods for the conversion of chemical analyses of rocks, clays and raw materials into a set of minerals or crystalline phases assumed to be present in the rocks, the clays, the raw materials or the ceramic products. In general two different calculating procedures were followed. The first method assumes the presence of a set of minerals and tries to fit these into the chemical analysis following a method developed by Buuri and Niggli (Buuri 1959). The method has been applied to soils and clays by Van der Plas, 1986.

Another approach applies the laws of equilibrium thermodynamics and calculates a set of minerals or crystalline phases that are stable at a chosen temperature and pressure. This approach advocates a computer programm developed by Brown and Skinner (1974), and Meyer (1980) modified it for the use on soils, clays and ceramic products. The programm could be used with one of the available Symphony or lotus 1,2,3 operating systems under the name EQUI (Van der Plas, pers. comm., 1993). The later programm will be used in the present work for the reconstruction of the mineralogical composition of the clays used for making the pots under study because it yielded fair results as seen in the analyses of Neolithic pottery from the Netherlands (see Van der Plas, 1986:26-40 and below).

The present norm calculations were carried out using the chemical composition of the matrices of the Mesolithic, Neolithic and pottery samples from the central Sudan (cf. tables 14-15). As mentioned above (cf. section 3.6.2), the programme EQUI which was already developed in the department of soil science and geology, Wageningen University, Netherlands (see supra, this section) has been used in the present work. The programme consists of a spread sheet with MACRO'S that runs in lotus 1,2,3 called CALC.3.WRI and CALC4.WRI. With the direction of that programme and the practical steps given by Van Der Plas and Schulenborgh (1970:357-385), the present writer has been able to calculate the norm mineral phases of the fine earth fractions of 32 samples from the study area (see table 17 and below).

3.6.3 Results

Goethite norm calculations (cf. section 3.6.3 and table 17) indicate that kaolinite and illite are the dominant minerals in the composition of the Mesolithic, Neolithic and modern pottery samples from Khartoum Province (see sections 6.3.4, 6.5.5).

With the exception of a single sample from Islang2 (sample = Islang2 (9)), Mesolithic (37.5%), Neolithic (37.5%) and modern pottery (25%) samples hold appreciable proportions of kaolinite, being mainly in the magnitude of c.18-46 wght% (see table 17).

Illite occurred in appreciable amounts in most of the samples (69%) analyzed. However, it is partially higher in the composition of the Mesolithic, Neolithic and modern pottery samples of the east bank of the Main Nile in comparison with their counterparts in the western bank. In the bulk of the samples (75%) from the east bank of the Main Nile, it ranges in proportion from c.42-52 wght% and often exceeding that range up to 80.137% (sample: Geili(3)) (ibid.).

It is noteworthy that both kaolinite and illite have advantages in ceramic practise. As previously indicated (cf. section 3.4), kaolinite is prized for its ceramic value because of its non-swelling nature and it does not require high firing temperature to become hard and solid. Similarly, illite is non-expandable on wetting (see Shepard 1956:8-10). Therefore, it is less amendable to shrinkage.

Quartz is present in almost all the Mesolithic, Neolithic and modern pottery samples from the West bank of the Main Nile, being in the majority of cases (87.5%) in the range of c.21-37 wght%. Conversely, their counterparts of the eastern bank of the Main Nile are, in most instances (62.5%) devoid of quartz inclusions. Exceptions are the Mesolithic pottery samples of Kabbashi Haitah and only one Neolithic pottery sample from Geili site (sample: Geili (1)) (table 17).

Montmorillonite is relatively sparse in the composition of the Mesolithic specimens, being present in low amounts (Sarurab2 samples: c.9.6-9.8 wght%) or scarce (Kabbashi Haitah:c.0.178-0.194 wght% and Kabbashi: 0.194 wght%).

Similarly, the Neolithic pottery samples from this district hold low or very low amounts (Islang2: c.7-8 wght%, Nofalab2: c.7.4 wght% and Geili:c.3-9 wght%). On the other hand, the modern pottery samples from this area tend to display montmorillonite in comparable proportions (samples of the west bank of the Main Nile: c.8 wght%) or relatively high amounts (samples of the eastern bank: c.10-13 wght%) than those of the Mesolithic and Neolithic periods (ibid. and section 6.3.4).

Chlorite is almost absent in all the samples examined (cf. table 17). The sole exceptions, being a single sample from the modern comparative pottery of the western bank of the Main Nile (sample: Kh.Prov. W.B.M.P. (2) - c.14 wght%) and the modern pottery samples from the eastern bank of the Main Nile, being c.3 wght% (sample: Kh.Prov.E.B.M.P (3)) and less than 1 wght% (sample: Kh. Prov. E.M.B.P (4)), (ibid and section 6.3.4).

Hematite is rather frequent in all the samples, being present in comparable proportions in the range of c.9-14 wght% (cf. table 17).

The remaining mineral phases including talc, paragonite, diaspore, clinchlor, Mg-Fe-Chlor and Fe-Chlor are, in general, tend to show haphazard distribution with rather low (c.9-14 wght%), very low (c.4-6 wght%) or scarce (c.0.749-2.70 wght%) amounts (ibid.).

Conclusions.

The results indicate that the original fine earth fractions of the Mesolithic, Neolithic as well as the comparative modern pottery samples might have held appreciable kaolinitic, illite and quartz-rich minerals.

Patterning in the composition of the samples analyzed during the passage of time was not perceptible.

3.7 Pottery Typology

3.7.1 Introduction

The analysis of the present ceramic material poses a problem resulting not only from the aims of the present research (cf.section 1.7) but also by the nature of the sample as well (cf.section 1.8). Classification of pottery in fragmented condition is apparently different matter from that of the complete pots, i.e. some

attributes which can be used in the classification of the whole pots such as vessel shape and size will be rather hypothetical if applied to potsherds. However, two main steps are involved in sherd classification: first of all the classifier has to recognize the features that can establish hypothetical relationship for a group of sherds. This is by no means an easy thing bearing in mind that we are dealing with small pieces of different parts and varied vessel shapes, besides the surface features do not show only the differences resulting from individual variations in craftsmanship and accidents of production but also the effects of weathering and usage. After the selection of groups distinguished by common characteristics that are supposed to represent basic rather than chance distinctions, the second step is to create coherent picture for each group by determining the norms in variable features and by collecting and interpreting the fragments of both shape and design (Shepard 1956:307).

3.7.2. Attribute analysis

In the present pottery classification, attribute analysis has been used because it is more informative than the subjective evaluation of style which depends almost entirely upon personal experience and bias. The attributes employed in the present analysis are similar to those used by Nordstrom in his classification of the Early and Middle Nubian pottery (cf. section 1.5.2). Nevertheless, some modifications and additions have been made to suite both the nature of the material understudy and the objectives of the present work. (1) However, the principal attributes groups may be defined as follows:-

3.7.2.1 Vessel form.

The morphological details dealt with here include rim and base shapes. In addition to that, other features such as wall thickness and building method have been included.

3.7.2.2 Decoration

Includes location, technique and type of motif.

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(1) The present typological analyses conducted by the present writer were based on pottery samples unearthed from his own excavations (Sarurab2, Islang2 and Nofalab2) or made available to him from a series of excavated Mesolithic and Neolithic sites (Kabbashi Haitah, Kabbashi, Geili in Khartoum Province and Shaqadud in the Western Butana region) in the Central Sudan (cf. sections 3.7, 4.7, 5.7 and 5.8).

3.7.2.3 Surface properties

Include basic surface colour, surface coating, smudging, polishing, burnishing, decoration is excluded.

3.7.2.1.1 Rims

Rim is defined as a margin of the vessel orifice. The value of rim sherds in classification stems from the fact that the vessel edge can be shaped, reinforced and elaborated in many ways taking a variety of forms. The rim may be a means of strengthening the orifice, or modifying form for functional purposes-pouring, lifting and retaining liquid-or of affording decorative effect (Shepard 1956:245-247).

The rim shape refers to the rim profile and the transitional between the rim and the uppermost of the vessel. The rim profile gives more clear cut picture of the rim than does the perspective view and the variations that may not be appreciated from an exterior view only (ibid.:247).

3.7.2.1.2 Comparative analysis

In the direct rims the vessel wall is carried out to the lip without break in the smoothness of contour or change in thickness (ibid.:245). Direct rims are the most commonly encountered types of rim shapes at the Mesolithic (Sarurab2) and Neolithic (Islang2 and Nofalab2) sites in the Western bank of the Main Nile, Khartoum Province. Some 492 specimens were recorded from Sarurab2, 128 from Islang2 and 392 from Nofalab2 sites.

Direct rims with flattened tops are of low incidence at the ceramic collection of Sarurab2 (c.15% of the total number), relatively higher at Islang2 ceramics (c.30%) and of much lower proportion at Nofalab2 ceramics (c.10%). Rims-type A4 of Sarurab2, A1-A4 of Islang2 and A6 of Nofalab2 are comparable (cf. figs.19-21). However, types A3 which is slightly thickened and type A4 which is smoothly tapered at the exterior tends to differentiate the rims of Islang2 ceramics from those of Sarurab2 and Nofalab2 (ibid.).

Direct rim-type A5 of Islang2 which is slightly thickened to the exterior is distinct in shape and have no counterparts in the ceramics of Sarurab2 and Nofalab2 site (cf. fig. 20).

Rim shapes with rounded or semi-rounded tops is the commonest type amongst the 'direct' variety, reaching 75% of the total direct rims at Sarurab2, 60% at Islang2 and 78% at Nofalab2. rims from Sarurab2 (Type A3), Islang2 (Type A7) and Nofalab2 (Type A2) are comparable, displaying rounded or semi-rounded tops (figs. 19-21).

Direct rims with pointed tops are of markedly low incidence, being c.10% at Sarurab2, Islang2 and reaching 12% at Nofalab2 ceramics. Comparable examples of direct rims with pointed tops from Sarurab2 (Type A1), Islang2 (Type A6) and Nofalab2 (Type A5) have been recorded (ibid.).

With regard to reverted rims, the vessel wall direction is curved inward with varying degrees. This type of rim shapes is frequent and only 7.6% of rim sherds from Sarurab2 (total no=720), 13% from Islang2 (total no.=305) and 10.4% from Nofalab2 (total no.=530) are in evidence.

Reverted rims with flattened or angularly flattened tops are scarce in the Sarurab2 pottery (Type C3), being only 5% of the total rims identified (cf. fig. 19), relatively higher (20% and 10% respectively) at Islang2 [Types B1-B2, B5, fig.20] and Nofalab2 [Type B2, fig.21]. Percentages of pointed tops are identical (c.20% each) in the reverted rims of Sarurab2 (Type C1, fig.19) and Islang2 (Type B4, fig.20) whereas their proportion (c.10%) at Nofalab2 pottery (Type B3, fig.21) is markedly low. Rounded tops are the most commonly encountered types of reverted rims, being 75%,60% and 65% at the ceramics of Sarurab2 Type C2, (fig.1), Islang2 Type B4, (fig.20) and Nofalab2 Types B1, B4-B5 (fig.21) respectively.

Everted rims are common and some 21% of rims-sherds from Sarurab2, 24.3% from Islang2 and 15% from Nofalab2 were recorded.

Everted rims with flattened tops are absent in the ceramic repertoire of the Mesolithic and Neolithic sampled sites (Sarurab2, Islang2 and Nofalab2) from the Western bank of the Main Nile in Khartoum Province. However, angularly

flattened rims at the edge of the vessels exteriors have, solely, been observed in Islang2 ceramics (Type C3, fig.20), being only 5% of the total rims recorded (see supra, this paragraph). Proportions of pointed tops are comparable in the collection of rim-sherds at Sarurab2 (Type B1, fig.19) and Islang2 (Types C2, C5, fig.20), being 20% and 25% respectively, whereas those of Nofalab2 (Types C2, C4, fig.21) are relatively higher amounting to 35% of the total rims encountered (see supra). However, rims with rounded tops are the most prevalent types, being 80% at Sarurab2 (Types B2, fig.19) and 65% at Nofalab2 (Types C1, C3, fig.21). It is remarkable that some everted rims with rounded or semi-rounded tops tend to show evertion with clear corner points. Types C1, C4 from Islang2 (fig.20) and Nofalab2 (fig.21) are examples illustrating this tendency.

Complete pots were not found in the Mesolithic (Sarurab2) and Neolithic (Islang2 and Nofalab2) sites and the present ceramic repertoire represents a limited number of vessel forms. Most of the direct rims from Sarurab2 and Rabak ceramics indicate possible rim diameters, respectively, of 14-24 cm, 17-22 cm and 16-22 cm and probably belong to medium-sized and large bowls. The incurvate rims of these sites, respectively, exhibit diameters of 7-14 cm, 10-15, 9-15 cm and possibly they were parts of hemispherical bowls. A few rims probably of cups from these three sites, respectively, provide rim diameters of c.7-11 cm, 7-9 cm and 8-11 cm and almost all of them (c.85%, 80%, 91% respectively) below 2.5 mm in thickness, are exclusively of fine plain ware.

Wall thicknesses range from 5-30 mm at Sarurab2, 5-14 mm at Islang2 and 2-14 mm at Nofalab2 with predomination of these from 5-10 mm at Sarurab2 and Islang2 and 4-9 mm at Nofalab2 ceramics.

Unlike Islang2 and Nofalab2, vessel bases were present at Sarurab2 ceramics. Base shapes amounting to 10 specimens were encountered at the latter site. They are very few in comparison with the considerable number of sherds found which exceed four thousand (see supra this section). Remarkably, the base sherds are exceptionally thicker if compared with the body sherds. They are mainly above 10mm in thickness and sometimes display walls exceeding 20mm. All the base sherds have blunt conical bases (Pl.15). The base sherds exclusively belong to plain coarse ware. The rest of the pottery sherds were probably bowls of different sizes in which the base has the same thickness as the rest of the pot. It could be inferred

from the absence of bases in the ceramic collections of Islang2 and Nofalab2 that the pottery sherds were probably bowls of different sizes in which the base has almost the same thickness as the rest of the pot.

In the eastern bank of the Main Nile some 30 rim-sherds (total sherds=1201) were recorded from the early Mesolithic site of Kabbashi Haitah, only 3 specimens from the late Mesolithic site of Kabbashi (total no=2348) (see Caneva 1993:39-56) and some 680 specimens from the Neolithic site of Geili (see Caneva 1988:75) are in evidence. These rims exhibit varied types of shapes and they can be comparatively discussed as shown below.

Direct rims are the most frequent types, being 85% at the ceramics of Kabbashi Haitah, 66.6% at Kabbashi (Caneva 1995, pers. comm.) and C.50% at Geili (see Caneva 1988:74, 76, 111, fig.4 and Caneva pers. comm. 1994).

Rims with rounded tops are dominant amongst the 'direct' examples of Kabbashi Haitah (c. 69.5%), Kabbashi 9c.80%) (see Caneva 1993:51, 53). Rims-types A1-A3 from Kabbashi Haitah (fig.22), type A1 from Kabbashi (fig.23), types A3 and A5 (fig.24) and types 3-4,6 from Geili (see Caneva 1988:77, fig.4) are comparable.

Direct rims with flattened tops are common in the ceramics of Kabbashi Haitah (c.20%), Kabbashi (c.20%) and accounting for 10% of the total direct rims from Geili ceramics (total no.=340). Rims types A5 from Kabbashi Haitah (fig.22), type A2 from Kabbashi (fig.23), types A6 (fig.24) and no.4 from Geili (see Caneva 1988:77, fig.4) are counterparts.

Direct rims with pointed tops are rare at Kabbashi Haitah ceramics (c. 10.5%), absent at Kabbashi and prevalent in the ceramics of Geili (c.4%). Pointed tops from Kabbashi Haitah (fig.22) and Geili [Types A1-A2, A4, fig.24 and no.8-fig.4] are comparable (Pers. obser., see Caneva 1988:77).

Reverted rims are rare (c.5%) at the ceramics of Kabbashi Haitah (Caneva 1993:53), frequent (c.53%) at Kabbashi (ibid:51) and Geili (c.25%) ceramics (Caneva, pers. comm.1994).

Reverted rims with flattened, semi-flattened tops are rare (c.5%) at Kabbashi Haitah (see Caneva 1993:51 and pers. comm. 1995), Geili (c.5.3%) and absent at Kabbashi (ibid.). Angularly flattened rims types B3, B4 from Kabbashi Haitah (fig.22), type B4 (fig.24) and nos. 7 (see Caneva 1988:7, fig.4) from Geili sites are comparable.

Rounded tops are the commonest (c.26%) types amongst the reverted rims of Kabbashi Haitah accounting for 26% of the total specimens recorded [Types B1-B2, fig.22]. Kabbashi reverted rims [Type B] are exclusively rounded-topped (fig.23) (see Garcea 1991:65) whereas Geili reverted ones [Types B2, B4-B5] are mostly (c.76.5%) rounded-topped (see fig.24 and Caneva 1988:74-79).

Reverted rims with pointed tops which are represented by types B5 (fig.22) from Kabbashi Haitah (c.20%), B1 (fig.24) and No.1 from Geili (18.2%) are counterparts (see Caneva 1988:77 and Caneva et al 1993:51).

Everted rims with angularly flattened tops to the exterior from Kabbashi Haitah (c.10%) are represented by types C2 (fig.22) and C3 (fig.24) respectively (see Caneva 1988:77-79, 1993:51-56 and Personal comm. 1995). It is noteworthy that the everted rim;type C2 from Geili (fig.24) has no counterpart in Kabbashi Haitah ceramics (cf. Caneva 1993:51-53) whereas rim sherds of Kabbashi are devoid of everted shapes (ibid.:50-51).

Everted rims with rounded tops are dominant, amounting to c.77%, 79% at Kabbashi Haitah and Geili respectively. Types C1 from Kabbashi Haitah (fig.22), C1, C4-C6 from Geili (fig.24) are counterparts.

Complete pots were not encountered in the ceramic collections of the Mesolithic and Neolithic sites in the eastern bank of the Main Nile. The present ceramic repertoire represents a limited number of vessel forms. Most of the direct rims Kabbashi Haitah, Kabbashi and Geili ceramic indicate possible rim diameters, respectively, of 16-25, 17-23 and 12-32 cm and probably belong to bowls of varied sizes. The incurvate rims of these sites, respectively, display diameters of 8-15, 10-16 and 8-15 cm and possibly they were parts of hemispherical bowls and cups. Everted rims are generally infrequent and during the Neolithic period rare types (cf.

fig.24 and Caneva 1988: 77, fig.4:12) had seen the horizon. The latter types probably belong to rare plates (for further details see section 3.7.2.1.2).

When the vessel forms of the Mesolithic and Neolithic ceramics in Khartoum Province (east and west bank of the Main Nile) are compared, it was found that they are fairly similar in most characteristics. Most of the rim-profiles are direct continuation to vessel walls. These rims occurred with different proportions and were probably parts of hemispherical bowls displaying vaired sizes. However, the rim-shapes with rounded tops are the commonest in all the examined collections. (see supra, this section).

Reverted rims are generally scarce in most fo the sampled Mesolithic (Sarurab2 Kabbashi Haitah) and Neolithic (Islang2 and Nofalab2) sites. Exceptions are the late Mesolithic site of Kabbashi and the Neolithic one of Geili where the proportions of reverted rims are frequent (ibid.).

Rounded-tops are prevalent in the Mesolithic and Neolithic ceramic-groups examined whereas flattened and pointed-tops are exceptionally rare. The everted rims, in general, were probably parts of hemispherical bowls and in a few instances rim-profiels probably of cups were found (ibid.).

Everted rims are generally infrequent in all the Mesolithic and Neolithic sampled pottery from Khartoum province. Rounded tops are prevalent whereas angularly flattened and pointed-tops are markely rare. (ibid.).

Bases are not, solely, rare as in the Sarurab Mesolithic ceramics (West bank of the Main Nile) (cf. Pls. 17-18) but they are absent in the Mesolithic ceramics (Kabbashi Haitah and Kabbashi) and almost all the Neolithic potsherds (Islang2 and Nofalab2) recovered from the eastern and western bank of the Nile, respectively. With respect to Geili Neolithic site, except for rims, no other "architectural elements" for the pot is recognizable (ibid. and Caneva 1988:74). It could be inferred from this phenomenon that the curvature and thickness bases and bodies of the pots (mostly bowls) are homogenous.

Patterning on rim-profiles (form) through time was not found (see supra, this section).

3.7.2.2 Vessel decoration

Includes location, technique and type of motifs present on bodies, rims and bands of vessels.

3.7.2.2.1 Body decoration

3.7.2.2.1.1 West bank of the Main Nile

On the west bank of the Main Nile wavy line decoration which is the diagnostic feature of the 'Khartoum Mesolithic' has been recorded from the site of Sarurab2 (cf. sections 3.1.1.2 and 3.2.1.1), it is devoid in the ceramics collections of Islang2 (cf. section 3.2.1.2) and Nofalab2 Neolithic sites (cf. section 3.2.1.3). The proportion of this distinct decorative motif in the ceramics of the former site reaches 7% of the total sherds encountered (cf. table 18). Two types of wavy line motifs occur; ones with waves tend to be arched in shape (fig.25:a, Pl.19) or, more commonly, ones with broad and continuous waves (Pl.20). This decoration was probably executed by some kind of comb. It is noteworthy that the present writer has not found tools in association with pottery making at this site (cf. section 3.2.1.1). The wavy line decorations (cf. table 18) are, in most cases, fairly distributed through the stratigraphy of the site with comparable proportions.

Dotted wavy line (Pl.21) is present in low frequency at the ceramic repertoire of Sarurab2, being 5.7% of the total specimens (ibid.). It is absent in the ceramic collections of Islang2 and Nofalab2 (tables 19-20). This type of decoration was probably executed by making ordinary wavy line and then impressing dots by rocker stamp technique along the grooved lines. It shows a steady increase towards the upper levels (cf table 18)

Dotted straight line decoration (fig.27:a Pl.22) is common in Sarurab2 ceramics, being 22.4% of the total sherds. It is also recorded from the ceramics of Islang2 (5.8%) (Pl.23) and Nofalab2 (c.8%) (fig.30:a, Pl.24) but with markedly low frequencies (tables 19-20). This decoration was produced by impressing the surface of the vessel with a pointed object. The sherds bearing this motifs show an increasing tendency towards the upper levels (ibid.).

Zigzag impressed line (fig. 25:b, Pl.25) has, solely, been reported from Sarurab2, being c.9.7% of the total sherds. On the other hand, zigzag dotted lines (fig.25c) are, remarkably, low (c.11.3%) at the ceramics of Sarurab2, apparently frequent at Islang2 (c.22.5%) (fig.27:b,c,Pl.26) and Nofalab2 (c.20.6%) (fig.30:b, Pl.27). All these zigzags were probably made with a tool moving rockerwise over the clay surface forming different zigzag motifs. Both types of zigzag tend to show a steady increase towards the upper levels (cf. table 18).

Fingernail impression (fig.25:d, Pl.28) made by a single stamp technique has, rarely, been recorded from Sarurab2, amounting to 1.3% of the total sherds. This type of decoration has not been reported from Islang2 and Nofalab2 ceramics. The very few sherds (n=55) recorded are haphazardly distributed throughout the levels of Sarurab2 site (cf. table 18).

Linear impressed potsherds (fig.25:e, Pl.29) have been noticed with sparse frequencies at Sarurab2 (c.6.5% of the total sherds) and Nofalab2 (c.4% of the total, fig.30:c); this type of decoration has not been found at Islang2 ceramics. It can be made with a string or straight comb which produces longitudinal lines of short intervals. The frequency distribution shows an increase in popularity towards the upper levels(ibid.).

Triangular motif has been noted in the ceramic collection of Sarurab2 (fig.25:f, Pl.30), Islang2 (fig.27:c, Pl.31) and Nofalab2 sites (cf. tables 18-20) with very low frequencies, being 3.8%, 5.8% and 3.9% respectively. Varieties of this decoration include triangles with dots at Islang2 and Nofalab2 (Pl.32) whereas this variety was not found in the ceramic collection of Sarurab2. This type of decoration was probably executed with a piece of sherd or the edge of a shell. This motif and its varieties, generally, show a decreasing in popularity towards the lower levels(ibid.).

Decorative motif of horizontal incised lines is, notably, rare in the ceramic collection of Islang2 (c.31%) (Pl.33) and Nofalab2 (c.5.3%) (Pl.34). It is absent in the collection of Sarurab2 (tables 18-20). This decoration was apparently made with a sharp tool probably a forked stick or a shell fragment. The frequency distribution is haphazard through the levels of Islang2 and generally show a decrease in popularity towards the lower levels(ibid.).

Twine impressed decoration has, solely, been encountered at Sarurab2 (Pl.35) and it is entirely absent in the collection of Islang2 and Nofalab2. It was probably made to immitate basket-work and can be executed by a rocker technique using a cord or twisted twine. It is absent in the top (L1-L2) and lowest (L7-L8) layers and concentrated in the middle layers (L3-L6) with a decrease in popularity towards the bottom(ibid.).

Impressed straight line is present in very low frequencies at Sarurab2 [c.7.5%] (Pl.36), Nofalab2 [c.5.6%] (Pl.37) and scarce at Islang2 [c.1.3%] (Pl.38) ceramics. This motif was possibly made with a string moved gently over the clay surface while it was still in the leather-hard state. The frequency distribution of this motif is generally homogenous through the stratigraphic levels of Sarurab2 and Nofalab2 (tables 18,20) and apparently heterogeneous through the levels of Islang2 site (table 19).

Undecorated sherds are frequent at Sarurab2 ceramics, being c.15% of the total sherds, relatively higher at Islang 2(c.31%) and Nofalab2 (c.24%) specimens. In general, these plain sherds tend to show a steady increase towards the upper layers of these sites (cf. tables 18-20).

Unlike Sarurab2, Islang2 and Nofalab2 ceramics provided specimens ornamented with vees and dots. Vees decoration (Pl.39) occurred in very low proportion at the ceramics of Islang2 (c.4.1%) and Nofalab2 (c.7.1%), vees/dots (Pl.40) decoration is relatively higher at Nofalab2 amounting to c.15.3% of the total sherds whereas its occurrence is relatively low at Islang2, being 8.8% of the total specimens (ibid.). These decorations were, seemingly, executed with catfish spine or shell fragments of serrated edges. It is noteworthy that appreciable numbers of shells were recorded from these sites (cf. appendices 12-13).

Decoration of semicircular panels (Pls. 41-42 respectively) is comparatively higher at Nofalab2 (c.20.6%) than in Islang 2 (c.1.9%) ceramics (tables 19-20. It is noteworthy that this type of decoration is associated with sherds classified as bowls of different sizes (cf. section 3.2.1.2). The decoration consists of 2-3 and often 4 lines forming a band of 10 mm below the rim. Then we get a series of concentric

lines centered on the band, seemingly, covering the whole surface of the pot and dividing it into a series of semicircular panels of incised or dotted lines.

Brushed decoration is restricted to Islang2 (Pl.43), it is scarce and depicted on only two specimens (cf. table 19).

Scraped motif is rare (Pl.44), confined to Nofalab2 site, reaching c.2.7% of the total sherds encountered (cf. table 20). It was done in roughly horizontal direction with an implement, seemingly, of closely spaced teeth used to remove paste rather than to incise it deeply. It is distributed liberally throughout the layers of this site (ibid.).

Zoned impressed decoration (Pl.45) is represented by a single sherd from Nofalab2 site (ibid.).

Black-topped red ware is scarce, being, solely, reported from Nofalab2 (Pl.46). Of the total ceramic collection from this site, only 6 specimens (0.2%) from the lowest level (L7) were recorded. In this type of decoration the rim is ornamented with a row of inverted black triangles (ibid.).

A group of pottery from the Mesolithic (Sarurab2) and Neolithic (Islang2 and Nofalab2) sites has been classed as "others" (ibid.). They are present in low frequencies but relatively higher at Sarurab2 (c.5.6%) and with comparable percentage at Islang2 (c.2.8%) and Nofalab2 (c.2.9%). The potsherds of this group are weathered and the precise nature of the surface finish on them could not be determined. Therefore, it is not possible to assign them to any of the categories mentioned above. In general, the sherds of this class tend to show a decrease in popularity towards the lower layers (ibid.).

3.7.2.2.2 Rim top decoration

In the ceramic collections of the three sites, the bulk of rim sherds are devoid of decoration. Decorated rims of Sarurab2 ceramics amounting to 449% of the total rims (n=716) recorded, the percentage reaches 43.2% of the total rims (n=305) reported from Islang2 whereas Nofalab2 gives 80.5% of the total rims (n=530) found at this site.

Unlike Islang2, Sarurab2 and Nofalab2 ceramics yielded four impressed sherds bearing rim decoration composed of small deep circular impressions about 2-3 mm each other and c.3 mm below the rim on the outside (fig. 26:a).

The rim tops of the three sites exhibit several comparable decorations. Parallel slanting lines of dots which is the commonest motif in the ceramic collection of Sarurab2 (fig.26.b), being c. 21.6% of the total rims. Conversely, it is extremely rare in the collections of Islang2 (fig. 28.9) and Nofalab2 (fig.30:9), accounting for 3.1% and 2.2% respectively. This type of decoration was probably produced with syndontis spine.

Herring bone motif (c. 7.9%) and zigzag impressed straight lines (c.53%) are, solely, present in the ceramic repertoire of Sarurab2 (figs.26:d,e,f) in comparison with Islang2 and Nofalab2 collections. The first motif was probably produced with a comb held in slanting position. One of the slanting bands slopes downward from right to left, the second slopes from left to right. The combination of the two bands giving a herring-bone effect. The second motif was probably produced with a curved edge of a shell, fish bone or potsherd which has been moved rockerwise to produce zigzag straight lines.

Dotted straight line is the most predominant decoration (fig. 28:b) in the collection of Islang2 (c.27.1%), extremely rare (fig.30:c) at Nofalab2 (c.2.6.%) and entirely missing in Sarurab2 ceramics. This motif can be executed with a pointed object.

Parallel slanting linear impressed (fig.26:e) is a rare decoration at Sarurab2 (c.5% of the total rims) and Islang2 (fig.28:e-f), being c.3.5% of the total rims. This type of decoration (fig.30:e) is most prevalent in the rims of Nofalab2 (c.30.4%), a variety of this decoration in the form of incised rather than impressed lines (fig. 30:f).

Parallel slanting impressed line is present in the ceramic collection of Nofalab2 (fig.30:b), being 7.2% of the total rims. It is, however, absent in the ceramics of Sarurab2 and Nofalab2. It was produced using the same technique of

parallel slanting linear impression (see supra) except that the slanting is of straight lines, being relatively longer than the linear ones (fig.30:e).

Parallel slanting serrated line is infrequent in the ceramic group of Sarurab2 (fig.26:f), being 9.9% of the total rims, it is rare in the ceramic collection of Islang2 (fig.28:d) and extremely rare (c.2.2%) in Nofalab2 (fig.30:b, Pl.47). This decoration was probably executed with a catfish spine of serrated edge.

Zigzag impressed straight line, though very low in amount, occurs in almost the same proportions at Sarurab2 (c.4.6%), Islang2 (c.4.5%) and is entirely absent in the ceramics of Nofalab2. This type of decoration was executed with rocker stamp technique (see supra, this section).

Vertical impressed lines are only present in the ceramics of Islang2 (fig.28:a) and Nofalab2 (fig.30:0), being present in almost the same proportion (c.11.5 and 11% respectively). This motif was probably made with a string gently moved over the clay surface while it was still in the leather-hard state.

3.7.2.2.2.3 Rim-bands

Rim-bands are restricted to Nofalab2 ceramics (fig.30:a, Pl.48) and represented by a motif composed of slanting lines and triangles (cf. sections 5.8.4.1 and 5.8.4.2).

3.7.2.2.2.2 Body Decoration

3.7.2.2.2.1.1 East bank of the Main Nile

Wavy line decoration which is the diagnostic feature of the Early Khartoum tradition (cf. sections 2.2.1 and 3.7.2.2.1.1) is present at Kabbashi Haitah (fig.31a) and Kabbashi (fig.33:a) sites with varied frequencies (cf. table 21). While this decoration is frequent at Kabbashi Haitah, being c.23% of the total potsherds encountered, its proportion is only 2.1% of the total sherds from Kabbashi (ibid.). It is absent in the ceramic repertoire of the Neolithic ceramics from Geili (see table 22 and Caneva 1988:65-111). Remarkably, there is a clear difference between the wavy line decorations of Kabbashi Haitah and Kabbashi. While the format of the wavy lines of the former site (fig.31a, Pl.49) tends to be arched and somewhat

disconnected, those of the latter exhibit angular shapes (fig.21, Pl.50). All these wavy line varieties were, seemingly, executed using the same techniques as those applied for their counterparts from the Western bank of the Main Nile (cf. section 3.7.2.2.1.1). This decoration usually occurs on potsherds, seemingly, belonging to bowls of different sizes and with vertical or everted rims (cf. section 3.7.2.1).

Dotted wavy line motif is present in low frequencies at Kabbashi Haitah (fig.31:b Pl.51), being 8.1% of the total sherds encountered, while this proportion decreases at Kabbashi (fig.33b,Pl.52) to only c.3% of the total specimens (cf. table 21). This decoration is devoid in the ceramic collection of Geili site (cf. Caneva 1988:65-114 and Table 22). It was, seemingly, executed applying the same technique, being used for Sarurab2 specimens (see section 3.7.2.2.1.1). This decoration is associated with sherds having different rim-profiles (direct, everted and reverted) and exclusively bowls(see section 3.7.2.1.2).

Zigzags (fig.33:C) are frequent at Kabbashi (c.61.4%), less common at Kabbashi Haitah (c.22.2%) (fig.31:d, table 21) and Geili (c.23.6%) (fig. 35a-d, Pl.53 table 22). These decorations, as previously noted (cf. section 3.7.2.2.1.1), were executed using rocker stamp techniques.

Undecorated pottery is present in the collections of the three sites (Kabbashi Haitah, Kabbashi and Geili) with varied proportions. It is apparently frequent at the ceramics of Kabbashi Haitah, being c.24.5% of the total specimens (see table 21), it decreases to 10.2% amongst the total potsherds of Kabbashi (ibid.), whereas the proportion, notably, increases at the Neolithic ceramics of Geili, accounting for 23.5% of the total sherds recorded (cf. table 22). This plain pottery occurs on sherds, seemingly, belonging to bowls of different sizes(see section 3.7.2.1.2).

Vees impression (c.3.4%) is, remarkably, rare at Geili (Pl.54, table 22) and absent at Kabbashi Haitah and Kabbashi collections (table 21). A variety of this motif composed of triangles/dots shows a noticeable popularity and examples amounting to c.22% of the total sherds were recorded from this site(ibid.). These decorations were, seemingly, executed applying the same technique used in the production of their counterparts from the west bank of the Main Nile(see section 3.7.2.2.1).

Dotted straight line (fig. 35b, Pl.55) is common in the ceramic collection of Geili site (c.14.5%) (table 22), entirely absent at Kabbashi Haitah and Kabbashi (table 21). The decoration was probably executed with a double pronged tool (spatula or stick) providing various horizontal lines of dots. This decoration occurs on bowls of varied sizes (cf. Caneva 1988:95, fig.11).

Rippled decoration (fig.35:c, Pl. 57) is rare, being 4% of the total sherds recorded from Geili site (cf. table 22). It was most probably executed with a comb moving vertically in a regular position over the clay surface. This decoration was not reported from Kabbashi Haitah and Kabbashi (cf. table 21). It is usually belonging to rim profiles, strikingly, everted, characteristic of hole-mouth ovoid vessels(cf. fig.24 and Caneva 1988:106, fig.17,1,5).

Stippled line motif (fig.35d, Pl.97) is extremely rare (c.1.3%) at Geili collection (cf. table 22) and it is devoid in either Kabbashi Haitah or Kabbashi ceramics (cf. table 21). It was, seemingly, produced with simple impression technique where a comb is lifted completely after each application resulting in continuous parallel lines around the pot. This decoration was associated with various potsherds belonging to open bowls of different rim-profiles (see fig.24 and Caneva 1988:10, fig. 15).

Brushed decoration is extremely rare (c.2.1%) at Geili collection (Pl.58, table 22) and it is devoid in either Kabbashi Haitah and Kabbashi (cf. table 21).

It is worthnoting that all the above mentioned decorations are not confined to specific position of the vessel and they have been recorded from the rims, upper and lower parts of the body sherds (cf. fig.31,33,35; Caneva 1988:65-114 and the present writer, pers. obser.).

3.7.2.2.2.3 Rim-top decoration

In the east bank of the Main Nile, rim-tops, though frequent, are distributed differently in the early Mesolithic ceramics of Kabbashi Haitah (c. 2.4% of the total sherds), late Mesolithic ceramics of Kabbashi (c.0.2% of the overall collection) (table 21) and Geili Neolithic ceramics (table 22).

The three sites exhibit rim-tops with frequent slanting impressed decoration, being 22.4% at Kabbashi Haitah (fig.31:b), 2.5% at Kabbashi (fig.34:b) and 16.7% at Geili ceramics (fig. 36:b) (ibid.).

Serrated decorations probably executed with catfish spine have been noticed on rim-tops of the three sites but with different frequencies. This type of decoration is the most prominent in the ceramics of Geili, reaching 25.8% for the serration with curved impression (fig.36:e) and 27% for the serration with sharp edges probably executed using catfish spine (see also Caneva 1988:75, fig.5). Similarly, both Kabbashi Haitah (fig.31:a) and Kabbashi (fig.34:b) display comparable proportions of serrated decorations on rim tops, being 20.3% and 25% of the total rims respectively(see Caneva et al 1993:50-53).

Cross-hatched decoration was depicted on rim-tops from Kabbashi (fig.34:C), Geili (fig.36:C) with almost the same proportions (c.25% and c.25.8% respectively) and it shows a drop in the ceramic-collection of Kabbashi Haitah (ibid. and the present writer, pers. obser.).

Vertical impressed lines are prevalent decorations on Kabbashi Haitah (c. 35.6%), Kabbashi (c.25%) rim-tops (figs.31:a, 34:a) and are absent in the collection of Geili (ibid.).

Dotted impressed decoration was depicted on rim-tops of Kabbashi Haitah (fig.31:e) and Geili (fig.36:a) with comparable proportions, being c.9% and c.10% respectively. However, the format of this decoration is incompatible in the collections of the two sites. While the dotted impression of Kabbashi Haitah rims are arranged in the form of rows, those of Geili are distributed liberally throughout the top of the rim (ibid.).

Rim-tops embellished with zigzag impressed straight line at Kabbashi Haitah (fig.31:C) and lozenges of dotted lines (fig.36:d) at Geili ceramics occur in comparable proportions, being c.10.6% and 9.6% respectively (ibid., Caneva, pers.comm 1993 and the present author, pers. obser.).

3.7.2.2.4 Rim bands

Rim bands are restricted to Geili Neolithic ceramics (see supra) and are not reported from Kabbashi Haitah and Kabbashi ceramics (cf. Caneva 1993:50-53). With respect to the former site, rim bands are decorated with zigzag impressed straight lines executed with rocker stamp technique (fig.36:a1) (ibid.).

3.7.2.3 Surface properties

3.7.2.3.1 Basic Surface Colour

It is defined as a colour that is characteristic of the uncoated surface of a vessel, or the colour which may be visible beneath a wash, slip or a painted design (Nordstrom 1972:44). The primary courses of colour are the composition, temperature and duration of firing. Secondary modifications which result from post-firing conditions such as absorption of stains during use, deposition of carbon in cooking over the fire, wear, deposition of substance from the soil after discard, leaching by soil waters and accidental reheating (Shepard 1956:103). These effects were noticed in the analyses of the present pottery. Therefore, in Khartoum Province, some 51 sherds from Sarurab2 106 from Islang2, 95 from Nofalab2 (West bank of the Main Nile); some 45 sherds from Kabbashi Haitah, 34 from Kabbashi and 305 from Geili which show secondary change of surface colour have been discounted.

In the White Nile Province, some 78 sherds from Shabona, 45 sherds from Rabak were excluded because they show secondary colour change (see supra, this section).

In the Western Butana region, some 134 potsherds from the Mesolithic levels and 171 specimens from the Neolithic levels of the midden were discounted. Some 195 sherds from the Cave ceramics were, similarly, excluded from secondary changes seen on surface colour (see infra).

In the western bank of the Main Nile, the surface colours for the Mesolithic (Sarurab2) and Neolithic (Islang2 and Nofalab2) ceramics are rather comparable (see Pls.17-48 and below).

The pottery of Sarurab2 (n=4831) is mostly (c.95%) pale brown (10YR 6/3 Munsell), the bulk of Islang2 (c.82.5%) pottery is brown (7.5YR 5/2 Munsell) whereas that of Nofalab2 is mostly (c.93.4%) reddish brown (5YR 5/3 Munsell) (see also section 3.2.1).

The remaining pottery sherds from Sarurab2 tend to show very little proportions (c.2.6%) of reddish brown colour (c.2.5 YR 4/4 Munsell) exclusively belong to fine plain wares which look deceptively like a slip or greyish brown (10YR 5/2 Munsell) with nearly the same proportion (c.2.4%) (ibid.).

The pottery of Islang2 (n-132) often exhibits reddish brown surfaces (5YR5/2 Munssell) amounting to c.10.4% of the total sherds, while rather comparable (c.7%) proportion shows pottery with light reddish brown colour (2.5YR 6/4 Munsell) (ibid.).

The surfaces of Nofalab2 ceramics (n=2981) in a few examples (c.4%) exhibit reddish brown (5YR 5/4 Munsell) and rarely (c.2.5%) brown (7.5 YR 5/4 Munsell) colours (ibid.).

Though the pottery fractures of the three sites mostly break with dark grey colours, however, Islang2 and Nofalab2, in most instances, tend to provide compatible range of colours (see infra).

The pottery fractures of Sarurab2 break with dark shades of grey colour (2.5YR N4/0; 7.5YR N4/0) (Pl.59).

In the situation of Islang2 and Nofalab2 ceramics, fractures (c.83.5% and c.80.2% respectively) are mainly grey in colour (5YR 5/1 Munsell) and occassionally (c.16.4% and c.8.7% respectively) dark grey (5YR 4/1 Munsell). Nofalab2 ceramics in some instances (c.11%) tend to show grey (Pl.61) shade (10 YR 6/1 Munsell) which is different from that of Islang2 (Pl.60).

In the eastern bank of the Main Nile, it appears that the surface colours for the Mesolithic (Kabbashi Haitah and Kabbashi) and Neolithic (Geili) ceramics are different (cf. Pls.49-58). The pottery of Kabbashi Haitah (n=1201) is mainly

(72.5%) light reddish brown (5YR 6/4 Munsell Soil Colour Chart 1975), the bulk of pottery sherds from Kabbashi (75.3%) are pale brown (10YR 6/3 Munsell) whereas those of Geili are mainly (62.5%) brown (7.5YR 5/2 Munsell). (cf. section 3.2.2, Caneva et al 1993:50-53 and Caneva 1988:72 and the present author, pers. obser.).

The remaining potsherds which exhibit infrequent or scarce amounts (see below) are, similarly, unrelated pertinent to surface colour. The pottery of Kabbashi Haitah occasionally (c.20%) display reddish brown colour (5YR 5/3 Munsell) and rarely very pale brown one (10YR 7/3 [3.4%] and 10 YR 7/4 ([3%] Munsell) (cf.section 3.2.2, Pls.49-58, Caneva et al 1993:50-51 and the present writer, pers. obser.).

The pottery of Kabbashi occasionally exhibits surface colours, being brown (7.5YR 5/2 Munsell) amounting to c.10.4% of the total sherds (n=2348), light brownish grey (10YR 6/2 Munsell) reaching 10.2% or pink (7.5YR 7/4) which is only c.4% of the total sherds (cf. section 3.2.2, Pls.49-58, Caneva et al 1953:51-53 and the present writer, pers. obser.).

The surfaces of Geili ceramics (n=3500) sometimes display pinkish grey (7.5YR 6/6 Munsell), brown (5YR 5/2 Munsell), buff (5YR 5/6, 5YR 5/8 Munsell), light red (2.5YR 6/6 Munsell) or red colours (2.5YR 5/6 Munsell), being c.11.1%, c.10.3%, c.5%, c.3.2% and c.2.3% respectively (see Caneva 1988:72; pers., comm. 1993 and the present writer, pers. obser.).

Unlike Kabbashi Haitah fractures which mainly (c.60.4%) break with grey (10YR 5/1 Munsell) and frequently (c.33.5%) dark grey (2.5Y N4/0 Munsell) colours (Pl.62), the pottery sherds of Kabbashi generally (c.67.5%) break with dark grey (2.5Y N4/0; 7.5YR N4/0 Munsell chart), occasionally (c.25%) very dark grey (10YR 3/1 Munsell, Pl.63) and rarely (c.7%) grey (5Y 5/1 Munsell). The Geili ceramic fractures resembling the major portion of Kabbashi specimens (see supra, this paragraph), being dark grey (2.5Y N 4/0 Munsell).

Since the geological formations of the Mesolithic (Sarurab2, Kabbashi Haitah, Kabbashi) and Neolithic sites (Islang2, Nofalab2 and Geili) in Khartoum Province (see supra and sections 3.1.2, 3.3-3.6) are similar and the firing conditions

are comparable (cf. section 8.5), it is more likely that the variations seen on the surface colours of the Mesolithic and Neolithic ceramics (see supra, this section) in this region is due to variations in the amounts of iron oxides and other impurities embeded in the original clays used for pottery making (cf. sections 3.3-3.6).

3.7.2.3.2 Surface Coating

The term "surface coating" refers to the material which is many cases was applied on the vessel as a thin layer, usually before firing (Nordstrom 1972:46).

In the western (Sarurab2, Islang2 and Nofalab2) and eastern bank (Kabbashi Haitah, Kabbashi and Geili) of the Main Nile in Khartoum Province, some potsherds from the Mesolithic and Neolithic ceramic sites all of which belong to plain fine ware have been coated with reddish brown or red colours (see section 5.8.2.3.1 for detailed information).

Microchemical tests using hydrochloric acid were carried out by the present writer on ten representive samples from each of these ceramic groups. The ferric oxide (Fe203) or red ochre dissolved in hydrochloric acid leaving a residue of siliceous material. As a result, it appeared that the thin layer on these potsherds is not a real slip but a slip-like colour. This colour or wash which looks deceptively like a slip is due to the presence of red pigment (iron oxide). It is noteworthy that in ceramic literature the term slip usually refers to a white burning, sometimes grey burning, clay mixed with water and applied, before firing, on a vessel which is usually made of a red-burning clay (ibid.). There are several technical requirements of a slip. First, it should adhere well to they body, neither crazing nor peeling. Second, it should harden within the same temperature range as the body. Finally, the slip should have sufficient covering power to conceal the body. These requirements are not fulfilled on the Mesolithic and Neolithic ceramics from Khartoum province examined in the present work (Shepard 1956:88).

3.7.2.3.3 Smudging

It is a mean of blackening pottery by causing carbon and tarry products of combustion to be deposited on it (ibid.).

With respect to the Western bank of the Main Nile, the Mesolithic site of Sarurab2 provided three specimens with black colour. They are exclusively belonging to plain ware. Islang2 (Neolithic) ceramics are devoid of black-coloured pottery whereas Nofalab2 (Neolithic) yielded only six red-sherds with black-topped colour (cf. section 3.7.22 and P.46).

In the eastern bank of the Main Nile, the Mesolithic ceramics of Kabbashi Haitah and Kabbashi are devoid of examples indicative of smudging. In the Neolithic ceramic collection of Geili site black burnished vessels were recorded, being only 5% of the total sherds (cf. section 3.7.2.2.1.2 and Caneva 1988:75, 110, fig.17, 3).

In the Mesolithic (Sarurab2) and Neolithic (Geili) examples shown above, vessels with black colours are rare. This phenomenon raises the probability that the black colour depicted on them was not, perhaps, invariably applied to produce intentional smudging. It may have resulted from accidental deposition of soot or burnt organic matter on the vessel due to the direct contact with the fuel used. The sole exception, being the specimens recorded from Nofalab2 site (see supra, this section) where backening of rims was, seemingly, used to produce decorative effect. The sherds were decorated with a series of black inverted triangles that extend onto the rim. The blackening of triangles might have resulted from deposition of soot or organic substance due to direct contact with the fuel used (see supra).

3.7.2.3.4 Burnishing

It is a mean of rubbing down the surface of a green-hard shape with a smooth, hard tool (Hodges 1976:81). It has also been defined as a low degree of polish obtained by rubbing the almost dry clay of the still unfired pot with a hard object such as water-worn pebble, large smooth seed or an animal's tooth (Arkell 1953:69). It is also suggested that this low degree of polish could be due to the conditions in which the sherds were found (ibid.).

During the Mesolithic period the sampled ceramics (Sarurab2, Kabbashi Haitah and Kabbashi) from this region are exclusively unburnished but smoothed

on the inside surface only prior to decoration and firing (cf. section 3.2; Caneva et al 1993:50-53 and the present writer, pers. obser.).

During the Neolithic period the bulk of pottery from the sampled sites (Islang2, Nofalab2 and Geili) was burnished (see infra).

Burnishing accounts for 78% of the total sherds (n=1314) recovered from islang2 site, the percentage reaches 85% at Nofalab2 (n=2980) whereas Geili ceramics (n=3500) are almost always burnished even in different degrees and probably during different stages of manufacture (see Caneva 1988:72 and the present author, pers. obser.).

3.7.2.3.5 Polishing

It is a way of rubbing the vessel surface to give it a high lustre (surface that reflects a high degree of glass). It is an important mean of obtaining surface finish, being distinguished by other lustrous classes by the fact that pits, grooves and all the depressions not reached by a tool are matte or dull (Shepard 1956:122-123).

With respect to the Neolithic period all the ceramics of Sarurab2, Kabbashi Haitah and Kabbashi are unpolished (cf. Caneva et al 1993:50-53 and the present author, pers. obser.).

During the Neolithic period, the ceramics of Islang2 and Nofalab2 are apparently devoid of polishing. Though the Geili ceramics are occasionally polished (see e.g, Pls.55, 57-58 and Caneva 1988, fig.17, 1, 3, 5), yet Caneva always invariably used the word "polishing" as synonmous to "burnishing" and referred to almost all the ceramic collection of this site as having polished surfaces (see Caneva 1988:72, figs. 6-16; 17:2,4; 18-20).

3.7.3 Conclusions

The physical and chemical analyses of the Mesolithic and Neolithic ceramics in Khartoum Province (see supra, this chapter) show that the pottery fabrics have mineral assemblages consistent with that present in the locally available clays and geological formations.

The petrological analyses shows that there is no significant variability amongst the Mesolithic and Neolithic ceramic fabrics in the relative frequencies of different minerals, which could postulate the use of common tempering (Nubian Sandstone and Basement Complex) and clay (Nile silt) source (cf. sections 3.3 and 3.3.7).

Inspite of variability in mineralogical composition of some minerals within the fabrics examined, the minerals, in general, particularly quartz, feldspar, micas and iron oxides which are the most commonly encountered, are similar in certain characteristics (see below).

All the fabrics of the sampled Mesolithic and Neolithic pottery tend to show comparable proportions of mineral rounding-classes (cf. section3.3.7). The aplastic mineral grains are mostly subangular or angular and hence, most likely crushed as tempering material. Subrounded and rounded crystals are present in very small amounts and this raises the probability that they are parts of the plastic inclusions.

The average grain sizes of the tempering inclusions, though they exhibit some variations at intra-and inter-site levels, but they tend to show a steady change towards fineness from the Mesolithic (Sarurab2, Kabbashi Haitah and Kabbashi) to the Neolithic (Islang2, Nofalab2 and Geili) periods (see sections 3.3.6.2.2 and 3.3.7).

The X-ray diffraction analysis of clay mineralogy shows that the Mesolithic and Neolithic pottery samples are comparable. They are all characterized by the absence of the key minerals (e.g. montmorillonite, illite, chlorite and kaolinite in almost all the ceramic assemblages). The sole exception, being a sample from Islang2 which shows a weak presence of kaolinite (7.2 Å) (see section 3.4.5).

The results of chemical analyses as seen from the ternary diagrams (cf. section 5.5.4) show, in general, high silicon-rich sand (Si02) for the tested samples. Aluminium (Al203) is relatively high in all the Mesolithic and Neolithic pottery samples. The remaining oxides, (Fe03, Ti02, Mn0, Mg0, Na20, Ca0, K20, P205 and Ba0) are present in very small or rare amounts.

Complete pots were absent in the ceramic collections of all the Mesolithic and Neolithic sampled sites. Though the vessel forms at the intra-and inter-site levels indicate some variations, nevertheless, most of rim-profiles seem to indicate open bowls of varied sizes, a few inverted rims probably belong to cups and markedly flaring rims possibly parts of plates. The absence of bases in most sites seems to strengthen the probability that most of the pottery sherds encountered were probably bowls of varied sizes in which the base has almost the same thickness as the rest of the pot (cf. section 3.7.2.1).

Wavy line decorations which are the diagnostic features of the Early Khartoum potting-tradition as well as dotted wavyline ones are exclusively found in the Mesolithic ceramic assemblages. On the other hand, zigzag decorations are present in both Mesolithic (Sarurab2, Kabbashi Haitah and Kabbashi) and Neolithic (Islang2, Nofalab2 and Geili) assemblages. The remaining decorations on body surfaces, rim-tops and bands (mainly impressed straight, dotted straight, incised, slanting serration, herring-bone, linear impressed and cross-hatched) often overlap in the Mesolithic and Neolithic ceramic assemblages suggestive of cultural continuity between the human groups inhabited this district.(cf. section 3.7.2.2).

The microchemical tests carried out in the present work show that all the surfaces of the Mesolithic and Neolithic ceramics have not been coated with real-slip. The red-coated surfaces occasionally seen on some vessels have been executed using a pigment (red ochre) which looks deceptively like a slip (cf. section 3.7.2.3.2).

Burnishing was absent during the Mesolithic period and it was evident on the majority of vessels during the Neolithic one (ibid.).

Polishing was not noticed on the sampled ceramics of the Mesolithic (Sarurab2, Kabbashi Haitah and Kabbashi) and Neolithic (Islang2, Nofalab2 and Geili) periods (ibid.).

It has been noticed in all the sampled Mesolithic and Neolithic ceramic assemblages that the sherds from which the samples had been taken for fabric analysis, exhibit comparable range of decoration and surface finish. Nonetheless,

there is no grouping tendency as regard certain type of decoration and/or surface finish versus fabric group per se (cf. section 3.7.2.3).

3.7.2.4 Typological features and Fabric groups

It is interesting to note that the fabrics of the Khartoum Mesolithic and Khartoum Neolithic ceramics identified by the present writer exhibit varied decorative motifs and surface treatment (see below and sections 3.3-3.7, 4.3-4.7, 5.3-.5.7). There is no grouping tendency as regard certain type of decoration/surface finish versus fabric group per se (see below).

With respect to Sarurab2 ceramics, fabric subgroup A1 (SRB2, 2; SRB2, 6; SRB2, 8-SRB2, 9; SRB2,11-SRB2, 14; SRB2, 19- SRB2, 20) which is represented by specimens ornamented with wavy line, dotted wavy line, zigzag, fingernail impression (each c.8%); fabric subgroup A2 (SRB2, 5; SRB2, 3; SRB2,7; SRB2, 14; SRB2, 21-SRB2, 23) which embraces decorations of wavy line, dotted wavy line, zigzag, fingernail, coarse plain (each c.4%), triangular impression (c.8%) and fabric group B which encompasses dotted straight line, impressed straight line, mat impression, coarse and fine plain are, in most instances, exhibit (cf. section 3.3.5.1.1) comparable range of decorations and exclusively unburnished.

Decorative motifs of fabric subgroup A1 from Islang2 ceramics (ISG2, 1; ISG2, 7; ISG2, 12; ISG2, 21- ISG2, 25) which include semicircular panels (c.37%); incised straight line, dotted straight line (c. 7.4%), brushed, coarse plain (c.3.7%); fabric subgroup A2 which includes vees (c.11%), zigzag dotted curved line (c.7.4%), semicircular panels, incised straight line, triangles/dots, zigzag dotted straight line, zigzag impressed straight line, plain (c.3.7%) and fabric group B which is represented by decorative motifs namely dotted straight line (c.11%), triangles/dots (c.7.4%), semicircular panels, zigzag dotted straight line and vees (each is c.3.7%) mainly exhibit homogenous range of decoration (see supra, this section) and surface finish despite their quantitative and qualitative mineralogical variations (cf. sections 3.3 and 3.7.2.3).

Fabric group of Nofalab2 ceramics (NOF2,1-NOF2,8; NOF2,11; NOF2,13-NOF2, 17) which embraces decorative motifs namely zigzag dotted straight line (c.13%), impressed straight line (c.8.6%), zigzag dotted curved line, dotted straight

line, linear impression, incised line, coarse and fine plain, black-topped red ware and Subgroup A2 which includes dotted straight line, dotted curved line, triangles, impressed straight line, scraped (each is c.4.3%), plain and black-topped red ware (each is c.8.6%) tend to display homogenous range of decoration (see supra, this paragraph) and surface finish (cf. section 3.7.2.3).

In the eastern bank of the Main Nile, it appears that the ten analyzed samples (cf. sections 3.7.2.2-3.7.2.3) of the early Mesolithic ceramics of Kabbashi Haitah (KAH1-KAH2, KAH7, KAH10, KAH19-23) classified as belonging to fabric group A (cf. section 3.3.6.1.1), display varied decorative motifs including wavy line, rectilinear bands, coarse plain (each is c.9%) and zigzag (c.21.7%). On the other hand, fabric group B (KAH3 - KAH6; KAH11, KAH13-KAH18) include the same motifs of fabric group A but with rather different proportions, being c.4.3%, c.13%, c./17.3% and 4.3% for the above mentioned motifs respectively(ibid.).

With respect to the late Mesolithic ceramics of Kabbashi, the same phenomenon (see supra, this section) could be seen in its ceramics where fabric groups, encompass, in most instances, comparable percentages of decorative motifs. Fabric subgroup A1 (KAB2; KAB5-KAB7; KAB11-KAB15; KAB23) has been represented by wavy line, dotted straight line (each is c.8.6%), rectilinear band (c.17.2%) and zigzags (c.23%); fabric subgroup A2 (KAB3; KAB9-KAB10; KAB16-KAB17; KAB19) (cf. section 3.3.6.1.3) which has been represented by the same motifs but with different proportions, being c.4.3%, c.8.6%, c.17.2% and c.4.3% respectively and fabric group B (KAB1; KAB4, KAB8, KAB18; KAB20-KAB22) which embraces rectilinear bands (c.12.9%), dotted straight and zigzags (each is c.8.6%) are, in the majority of cases, rather comparable. It is noteworthy that the samples of all Kabbashi Haitah and Kabbashi ceramics are characterized by unburnished surfaces (cf. section 3.7.2.3).

In regard to the Neolithic ceramics of Geili, it appears that the analyzed samples for fabric composition exhibit homogenous distribution of pottery decorative motifs and surface finish. Fabric subgroup A1 (GE1, 3; GE1, 5; GE1, 6; GE1, 8; GE1, 15; GE1, 16, GE1, 21-GE1, 22) which is represented by specimens ornamented with punctation, stippled lines, zigzag (each is c.8%), rippling and dotted straight lines (each is c.4%); fabric subgroup A2 (GEI, 4; GEI, 7; GEI, 13-GEI, 14;GEI, 17-GEI, 18;GEI, 24-GEI, 25) which includes punctation, dotted

straight lines, stippled lines (each is c.8%), zigzag, fine plain (c.4%) and fabric B (GEI, 1; GEI, 2; GEI, 9-GEI, 12;GEI, 20-GEI, 23) (cf. section 3.3.6.2.1) which is represented by dotted straight lines (c.16%), zigzags (c.8%), ripples, punctation, fine plain and stippled lines (each is c.4%) decorations are, in most instances, comparable. It is noteworthy that all the analyzed samples from this site are characterized by burnished surfaces (see section 3.7.2.3).

Chapter 4

4. Ceramic Technology of Mesolithic and Neolithic Sites in the White Nile Province.

4.1 Introduction

For the proper understanding of the Mesolithic and Neolithic ceramics in the White Nile Province, knowledge of geographical and geological features of the sampled sites is essential, as it influenced the existence and daily life activities of the prehistoric man in this area to a large extent. Hence, it is deemed necessary to give in the introductory part of this chapter a brief outline of the geography and geology of the area. The remaining portion of the chapter embraces detailed information pertaining to technological traits of the Mesolithic and Neolithic sampled pottery in this area.

4.1.1 Geographical location

4.1.1.1 Mesolithic sites

4.1.1.2 Shabona (c.14° 38' N, 32° 16' E)

The site is located some 8 km east of the White Nile and 110 km south of Khartoum (figs.2,37). It is, to date, the most southerly site at which Khartoum Mesolithic tradition (see Arkell 1949) has been found. The occupation covered an extensive area totalling 52, 000 m2. It is comprised of two middens each of which is about 26,000 m2 in area though that to the southeast was more deflated (fig.37). Two radiocarbon dates were obtained for the site; the oldest (based on Pila shell) being 5520 ± 240 B.C. (SUA-440) and the youngest (based on Pila shell) is 5000 ± 120 B.C.(SUA-298) (see section 10.1.1.2).

4.1.1.3 Rabak (13° 09' N, 32° 46' E).

The site of Rabak is situated on an old bank of the White Nile about 270 km south of Khartoum. It is now 3 km east of the present course of the White Nile (fig. 37). The extent of the site is 200 x 80 m (16,000 m) and the excavated area is 18 m (cf. fig.38). The deepest levels (levels 14-4) are almost identical in material culture to Khartoum Neolithic tradition. The oldest level from a downcutting (level 15) is

dated to 4890 ± 120 B.C. (T-5134) The upper levels is dated to 3270 ± 100 B.C. (T-5132) which is almost 2000 years later (cf. section 10.1.1.2 and appendix 5). The latest levels are similar to Jebel Moya site, located c.40 km east of Rabak site (Haaland 1984: 39-51, 1987:45 - 47 and el Mahi and Haaland 1984:28-32).

4.1.1.4 Geology

The surfaces of the immediate vicinity of Shabona and Rabak site are devoid of Nubian Sandstone Formation. The nearest Nubian Sandstone sheets lie some 40 km. north of Shabona and c.6 km east of Rabak site (fig. 39). The Nubian Sandstone Formation is generally reported in scattered areas from the eastern and western parts of the White Nile Province. The Nubian Sandstone rocks have been used locally as building stone and were quarried extensively at this area and other parts of the central and northern Sudan (Vail 1982:60). This is not surprising for the river alluvium and Gezira plain clays prevailing in the areas of these sites were usually devoid of stone. Instead small pebble of quartz, chert and chalcedony occur in the swales between the dunes and on deflated surfaces of sand (ibid:57-58 and Clark 1989:390). The Nubian Sandstone Formation, as usual case in the regions of central Sudan (see e.g. section 3.1.2) rests unconformably on the Basement complex rocks which are mainly characterized by ancient crystalline group of gneisses and schists, metavolcanic rocks and granites (see Vail 1982: 53).

The White Nile sediments contain metamorphic assemblage of sillimanite, kyanite, garnet, epidote, hornblende and staurolite (Whiteman 1971: 125).

4.1.1.5 Topography

The palaeogeography of Shabona/Rabak area is strongly linked with the history of the White Nile (Adamson 1982: 165) and it is the main physical feature delimiting to the west. Unlike the Blue Nile, the sediments deposited by the White Nile into the main Nile is small; some two millions during its annual flood (Williams 1982:119).

The clays of Shabona/Rabak area are characterized by their dark colour and alkaline cracking nature. Due to the cracking nature of these clays, no clear

sedimentary structures are evident within these early Holocene deposits (Adamson et al 1982:165 - 219).

White Nile is a highly seasonal river cut off from its water supply from lake Victoria. During 1800-12000 years ago sands in the bed were redeposited by wind action resulting in the formation of an extensive area of old sand dunes from Shabona area northward to near Khartoum (ibid : 165-190).

During that time (see the above paragraph) palaeo-channels draining from the Blue Nile deposited fine sands and carbonate gravels across the plain and along the eastern side of the White Nile. At the same time the general flatness of topographic ensured existence of extensive areas of permanent water and seasonal swamps between the two rivers (ibid).

The present landscape (see section 4.1.1.4) is almost plain clays, usually devoid of stone but scattered quartz pebbles, chert and chalcedony covering wide areas.

4.2. Archaeological Sites and Ceramic Materials

4.2.1 Mesolithic sites

4.2.1.1 The site of Shabona

The contour map of the site (fig. 37) shows the occupied area to have been the top of the tongue-shaped, old lateral dune, elevated some 2 m-above the surrounding clays of the embayment. The material culture is scattered in two areas: one at the northwest end of the occupation and another to the southeast. Each of the two middens is about 26, 000 m2 in area, yet the southeast was relatively more deflated (Clark 1989:390-391).

Four areas were chosen for excavation on the basis of surface finds-two in what has been referred to as the main occupation (SH/G1 and SH/92), and two in the southeast part of the site (SH/South/G1 and Sh/South/G2) (ibid. and fig.37).

Considerable amounts of archaeological finds were discovered at this site. These include abundant pottery (see below), bone artifacts, faunal and floral remains (ibid: 388-410).

Some 2094 potsherds were recovered from this Mesolithic settlement and the majority (n=1482) were decorated. Decorated sherds totalling 71% of the specimens found whereas undecorated pieces are only 29%. Dotted straight line is the most popular motif, being present at 33% of the total sample. Linear mat impression is the second most popular, occurs at 27% of the whole collection. Wavyline is present in very low amount, being present at c.4% of the total specimens. Dotted wavy line is relatively frequent, occurs at 14% of the total samples. Woven mat impression is similarly common (c.12%). Other decorations are rare mainly at 2% or below. These include wolf-tooth, dotted and triangles, linear and triangles and fingernail impressions (ibid:402-405).
Decorations usually consist of one design that would have covered the whole pot (ibid:403). Incision, impression, combing, rocker stamping and pivoting techniques were used for executing these decorations (ibid).

The surface colour of the pottery is mostly light reddish brown (7.5YR 6/4 Munsell soil colour chart 1975). The fracture is mainly coloured in shades of dark grey (2.5 YR - N3/0, 7.5YR 3/1 and 10YR 3/1 Munsell) (Clark, pers., comm. 1992 and the present author examination of some 60 samples, some of which have been utilized for fabric anlayses presented in sections 4.3 - 4.5.).

The vessels forms appear to have been large open mouthed-bowls or globular pots though no complete vessels were found. The mean wall thickness reaches 10.5 mm and the majority have a thickness from 8 to 11.5 mm (cf. Clark 1984:14 and section 4.7).

It has been argued that evidence of pottery manufacturing by coiling technique was shown by two sherds that have broken along the coil-lines (Clark 1989 : 403). However, the present author was not able to get these sherds for assessment as the excavator informed him that these two sherds were not present in his collection since long and might have been removed somewhere (Clark, pers. comm., 1991). Pottery samples from Shabona examined by the present author showed no horizontal breakage indicative of coiling technique and the irregularities of the sherds walls seem to suggest the use of paddle and anvil technique as a finishing method (cf. section 4.7).

Kilns, specialized tools or wasters were not found and the source of this pottery has been pursued through a series of physico-scientific analyses (cf. sections 4.3- 4.5, 4.8 - 4.9 and 6.5.2).

4.2.2 Neolithic Sites

4.2.2.1 The site of Rabak

The extent of this site, as previously mentioned, is 220 x 80 m (cf. section 4.1.1.3) and the excavated area is 18m2 (cf. fig. 38). It has been excavated by arbitrary levels of 10 cm. each because stratigraphy was lacking. The cultural debris generally varies in depth from 0.5 - 0.8m and one square (107X/100Y) has provided the deepest levels of 1.5 m. (interpreted as kitchen midden but all these deposits are unstratified). The lower levels (14-4) of square (107X/100Y)(1) yielded pottery and standardized lithic tools (lunates, groovers and scrapers) and ground stone which are common traits in the Khartoum Neolithic tradition. The Gouges which are the hallmark of this tradition (cf. Arkell 1953 : 68 - 101) are absent. Plant, faunal remains and bone artifacts (harpoons and beads) were also found (Haaland 1987:45-47 and 1989:259-367).

The upper levels (3-1) yielded pottery closely related to Jebel Moya tradition (cf. Addison 1949: Pls. XC1 and XC11:Haaland 1989:363-365 and Caneva 1991:262 -268, fig. 3). On the other hand, the pottery from the lower levels (14-4) is identical with the Khartoum Neolithic tradition, except for pattern no.7 (see section 4.7).

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(1) It is the only dated square (cf. sections 4.1.1.3 and 10.1.1.2) and yielded the deepest cultural debris (see supra). Therefore, the material culture recovered from this square is much more reliable, this particularly so when one takes into account that the remaining squares are distrurbed by the later Meroitic and Muslim grave digging whereas square 107x/100y seemed undisturbed (cf. Haaland 1987: 45-47, 1989:259-367) which is classified as ceramics of the non-Khartoum type (Haaland 1984:28-32; 1987:45-47 and 1989:359-367).

The pottery of this site (n-572), as can be seen from square 107X/100Y is mostly undecorated (60%), whereas decorated specimens account for 40% of the total. (Haaland 1989:362-365).

The potsherds encountered at this site are all burnished (Haaland 1987 : 46 and the present author pers. obser.)

The decorations are represented by relatively higher percentage of "vees" motif (c.16%), zigzag dotted curved line (dotted saw-tooth) is the second common motif, being present at c.6% of the total sample. Jebel Moya type of decoration is similarly common, occurs at the same proportion as zigzag dotted curved lines. The rest of decorative motifs which include catfish spine, vees/dots, saw-tooth, fingernail and 'non-Khartoum type' are rare, all of which occur at 3% or below (ibid:362).

Decoration was made with rocker stamp, single stamp, alternately pivoting stamp, combing simple impression and incision techniques (ibid).

The surface colour of the pottery is mostly grey (5YR 5/1 Munsell soil colour chart) Fractures generally break with dark shades (2.5YR N3/0, 5YR 4/1, 7.5YR N4/0, 7.5YR 4/2 Munsell). (cf. section 3.7.2.3). The potsherds encountered at this site are all burnished (Haaland 1987:46 and the present author pers. obser.)

Complete pots were not found. The vessels are of simple globular pots (ibid.2:6), as in the Neolithic of Khartoum area (ibid:364; see also Arkell 1953:69-71 and Caneva 1988:74). Hemispherical bowls of different sizes seem to be present as could be deduced from the direct rims of appreciable number of pottery sherds examined by the present writer (cf. section 3.7.2.3). Wall thicknesses vary from 0.2 - 1.2 mm with predomination of these from 0.5 - 0.8 mm. (ibid).

No kilns, specialized tools or wasters encountered at this site. The origin of the pottery from this locality has been investigated solely through a series of physico-scientific analyses (cf. sections 4.3 - 4.5, 4.8 - 4.9 and 6.5.2.).

4.3 The Petrological Analysis

4.3.1 Introduction

Examination of 54 potsherds representing all the sampled sites and time period (Mesolithic and Neolithic) of the White Nile Province was conducted. The samples represent all the fabric variations (see section 3.3.2) and the range of the main decorations (see tables 23,24) diagnostic of time periods, ecnountered at each sampled site. Quantitative estimate of fabric mineralogy was obtained, as previously indicated (see sections 3.3.1 and 7.7), by point-counting technique. Counts were obtained for all different identifiable grains (monomineralic and polymineralic) forming the non-plastic mineral inclusions present in the samples. Detailed description of the fabric groups (designated A,B,C) and the subgroups follows.(1)

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(1) All the groups of pottery specimens in this chapter will be referred to by the numbers assigned to them in the fabric descriptions above with the prefixes SHB; RAK (K.N.) and RAK (J.M.) referring to Shabona, Rabak (Khartoum Neolithic Levels) and Rabak (Jebel Moya Levels) respectively. Subgroups of the fabrics will be referred to by their appropriate subgroup number and prefix.

4.3.2 Fabric descriptions of Shabona Pottery

Some 26 specimens representing the fabric variations of Shabona pottery (table 23) were examined. As a result two main fabric groups have been discerned on the basis of mineralogical composition, proportions, temper origin, texture, shape and roundness, colour of the matrix and optical density. These fabrics have been designated as Group A and Group B. The former fabric has been divided into Subgroup A1 and Subgroup A2 as follows:

Group A

Subgroup A1

Specimens SHB 4- SHB 7, SHB 11, SHB 16- SHB17, SHB21 and SHB 24.

This fabric group is characterized by high content of non-polycrystalline quartz grains amounting to 85% at the average in the specimens examined and present at c.35-40% of any visual field. The next frequent inclusions are iron oxides being present at c.5-15% of any visual field and ranging in proportions from c.9-21% over the whole sections. Quartzite is rare represented by only two subangular crystals. Hypersthene is extremely rare and only a single crystal is present. Organic inclusions were not present (fig.40, pl.65)

The particle length is mainly (c.78%) in the order of 0.500-0.800 mm, a few crystals (c.2% reaching 1-1.5 mm in length and minerals up to 2.15 mm across are occasionally observed. Aplastic minerals of fine and medium-grained texture (c.060-0.490 mm across) being c.20% of the total inclusions.

The mineral particles are mostly subangular or angular (c.85%). Subrounded or rounded crystals (c.15%) are sparsely distributed through the matrix. It is remarakble that most iron inclusions are subrounded or rounded and often oval in shapes. Some rounded crystals of iron are exceptionally large (c.1 mm) and might have been natural inclusions. The material is ill-sorted and generally coarse-grained in texture.

In PPL the matrix shades from light, medium brown to light reddish brown, while in the XPOL the colour alters, respectively, to brown, dark brown and

reddish brown. Some black spots probably of iron inclusions were noted in the form of stains on the minerals, however, most thin-sections tend to show anistropic matrix. The matrix has a neutral degree of optical density.

The predominance of non-plastic grains of quartz and the appreciable iron inclusions seemsto suggest a sedimentary provenance and the prevalance of Nubian Sandstone Formation in the area (fig.4) confirms this.

Subgroup A2

Specimens SHB2, SHB3, SHB8-SHB10, SHB12 and SHB15

This group is similar to the previous one (Subgroup A1) as being predominantly tempered with quartz grains, mostly non-polycrystalline (95%). Quartz rich-sand reaches c.62% in proportion (fig. 40) and present at 20-35% of any visual field. Iron inclusions are frequent (c.12%), being present in the order of c.5-12% of any visual field. Other minerals occur in small or rare amounts.These include feldspar (orthoclase, microcline and plagioclases) (c.11% of the total) being present at 10% of the specimen area (pl.66). Mica (biotite and muscovite) is similarly rather frequent (c.8%), occurs at 5-7% of the specimen area. Rock fragments (metamorphic) are small in amount (c.5%), being present at 1-2% of the specimen area. Hornblende, zircon and rutile are extremely rare (all of which below 1%), occur under 1% of the specimen area.

The mineral grains are mostly subangular to angular (87%). Subrounded to rounded crystals are present in markedly low proportion (C.13%) almost all of which are confined to iron oxides.

Inclusions above 0.060 mm are, as in Subgroup A1, frequent in occurrence, making up to c.45% of any visual field. Most (c.85%) are in the range of 0.400 - 0.900 mm across with 20-30% in the range of 0.600 - 0.750 mm. About 70-80% of the non-plastic grains in all the sections are in the range of 0.500 - 0.600 mm across, most of which are quartz. Only c.15% of the aplastic inclusions are in the order of 0.060-0.390 mm across.

In PPL the matrix appears as pale brown, light reddish brown and rarely as medium brown, while in the XPOL, the matrix, respectively, shows brown, reddish

brown and dark brown colours. The groundmass has a neutral degree of optical density.

The presence of metamorphic rock fragments and hornblende is a diagnostic feature of metamorphic source if they appear in appreciable amounts. But since these minerals are present in low proportions they cannot be taken as an indication to metamorphic origin for this fabric Subgroup.

Despite the occurrence of the various accessory minerals outlined above, this suite closely matches the previous one (Subgroup A1) as regard the provenance of the main minerals, their proportions and overall grain size distribution. Therefore, a similar origin could be postulated for this fabric.

Group B

Specimens SHB1; SHB13-SHB14; SHB18; SHB20; SHB22-SHB23; SHB25-SHB26.

This suite mainly consists of feldspar rich sand (c.48% of the total). The feldspars are dominantly microcline and perthite being present at c.25% and 35%, respectively, of any visual field. Plagioclases are present at 3-5% of any visual field. The average proportion of feldspars reaches 48% of the total mineral inclusions of this fabric. Quartz grains are present in appreciable amounts (c.28% of the total minerals) about 15% of any visual field but in markedly lesser proportions then quartz. Mica (mainly biotite) grains are frequent, being present at 10% of any visual field and amounting to c.13% of the total inclusions. Hornblende occurs at c.4-9% of any visual field and amounting to c.6% of the total minerals Iron oxides occur at c.5-8% of any visual field and making up to c.5% of the total minerals. Quartzite is extremely rare in occurrence and only a single grain has been identified. Organic inclusions were not observed. (fig.40, pl.67).

The mineral grains are mainly subangular to angular (c.78%), subrounded to rounded ones (21%) are occasionally conspicuous. Iron inclusions are almost exclusively subrounded or rounded and in rare instances (c.1%) tend to show irregular masses of interlocking character.

The majority of grains (c.80%) (mainly quartz and feldspar) are in the range of 0.500-0.850 mm across. The maximum grains sizes (c.5%) ranging from 0.900-2 mm across. The minerals in low to medium size (c.0.060-0.490 mm) range are present at much lower percentages (c.15%). These include in addition to very small amounts of quartz and feldspars, mica and iron inclusions. The material is, generally, not well sorted and this indicative, perhaps, to imperfect mixing and/or insufficient kneading.

In PPL the matrix shades from light, pale brown to pale reddish brown, while in the XPOL the colours tend to show medium, dark brown and reddish brown. The matrix exhibits neutral optical density.

The occurrence of dominant perthite and microcline inclusions is in favour of igneous provenance for this fabric group. The nearest source of igneous rocks to the site lies c.200 km. to the north at Sabaloka Gorge area north of Khartoum (see fig.4). This seems to suggest either a high degree of mobility by at least segment of the dwellers of Shabona site or the presence of some sort of exchange mechanism via some mobile groups (hunters and gatherers) who might have played the role of middle men between the folks inhabiting the areas along the strip of the Nile in Khartoum and White Nile regions during prehistoric era (see section 9:11).

4.3.2.1 Intercomposition of Pottery Fabrics within site

The main distinguishing feature between fabrics A1 and A2 is the absence of some minerals of fabric A2 including feldspars and rock fragments (metamorphic) and some accessory minerals (Zircon, rutile and hornblende) in the composition of specimens of fabric A1. Otherwise, the two fabrics are similar with respect to the main minerals present (Quartz and iron oxides) but with varying proportions. Quartz is the most abundant non-plastic inclusion in both fabrics and iron oxides are more prominent in fabric A1 than in fabric A2 (fig. 40).

Fabric B is basically different from the Subgroups A1 and A2 with regard to the mineralogy. All the specimens of this fabric exhibit feldspar-rich sand exclusively microcline and perthite with lesser amounts of quartz, relatively lower amounts of mica and iron inclusions.

The mineral grains of all the fabrics identified are very similar in terms of grain size distribution and the majority of the particle sizes tend to show lengths in the range of 0.400 - 0.800 mm across indicative of medium to coarse grained texture.

The three fabrics are homogenous with respect to the degree of roundness of mineral inclusions, the predominance of subangular to angular grains whereas subrounded to rounded crystals are relatively low.

Most of the martrices colours are light or pale brown in plane polarized light, while in the crossed nicols, the matrices tend to show various shades mainly reddish brown or dark brown.

4.3.3 Fabric descriptions of Rabak Pottery

Some 28 specimens (table 24) representing the variants of Rabak pottery farbics (Khartoum Neolithic and Jebel Moya cultural levels) were classed into three main groups on the basis of mineralogical composition, proportions, temper origin, texture, shape and roundness, colour of the matrix and optical density. These fabrics have been designated as Group A, Group B and Group C with subdivisions where necessary as will be shown below.

4.3.3.1 Fabric descriptions of Rabak site Pottery (Khartoum Neolithic Levels)

Three main fabrics designated as groups A, B and C have been identified on 18 samples from Khartoum Neolithic cultural levels of this site. Detailed description of these fabrics will be given as follows:

Group A

Specimens RAK (K.N.)1 and RAK (K.N.)21

This fabric is represented by only two specimens. Under the microscope, the field of view is dominated by microcline and perthite feldspar. These minerals are present at 20-35% of any visual field and amounting to 54% of the total mineral inclusions. Plagioclase feldspar is rare amounting to only 2% of the specimen area. Quartz is less prominent, being present at c.28% of the total amounts and at c.10 -

15% of any visual field. Mica is common (c.10% of the total), biotite is more pronounced than muscovite, both minerals are present at 5% and 1%, respectively, of the specimen area. Iron oxides are present at c.3% of the specimen area and amounting to 6% of the total inclusions. Hornblende, rock fragments and zircon are extremely rare (c.0.3%, 0.4% and 1% respectively) all of which are present at 1% or less at any visual field. Organic inclusions do not appear to be present in any part of the sections (fig.41, pl.68).

Grains are dominantly subangular or angular (83%), subrounded to rounded crystals are present in relatively low proportions (c.16%). A few grains of quartz, plagioclase and all muscovite mica (c.1%) are present in the form of bladed flakes.

The majority of mineral inclusions(c.76%) are in the range of c.100-0.380mm across. Minerals fall within this size range are mainly feldspar (perthite, microcline and plagioclase) and quartz. Minerals in low size range are frequent (c.21%) and consists mainly of zircon, hornblende and muscovite mica, being present in the order of 0.060-0.100mm across. Grains in the largest size (1-2mm) are extremely rare, occur at c.3% of the total minerals and restricted to quartz, feldspar (perthite and microcline) and rock fragments. All these mineral inclusions, with the exception of muscovite mica flakes, tend to display random orientation parallel to wall surfaces.

In the PPL the matrix colour shades from light brown to pale reddish brown, while in the XPOL the colour ranges from brown to reddish brown respectively. The matrices tend to show neutral optical density.

This fabric recalls igneous origion as could be deduced from the prominent occurrence of microcline and perthite feldspar, the presence of biotite as a dominant mica and the lack of calcitic minerals and polycrystalline quartz (see sections 4.8 - 4.9).

Group B

Specimens

RAK(K.N.)3;RAK(K.N.)4;RAK(K.N)7;RAK(K.N.)9;RAK(K.N.)11;RAK(K.N.)13 ;RAK(K.N.)22-RAK (K.N.)28.

The fabric group occurs in most of the specimens tested. The most distinguishing feature of this fabric is the predominance of quratz (c.97% are non-poly crystalline), being present at 20-30% of any visual field (c.60% of the total inclussions). Iron oxides are the next prominent minerals being present at c.8-18% of the specimen area and amounting to c.22% of the total amount. Feldspar (microcline and plagioclase) is present at relatively lower percentages (c.12% of the total) and at c.3-5% of any visual field (fig.41, pl.69). Subordinate minerals comprise of mica (biotite and muscovite),(c.3% of the total) whereas zircon and tourmaline occur under c.2% of the specimen area and amounting to 3% of the total inclusions. Organic material is absent in the sections examined.

Mineral inclusions are mainly subangular or angular (87%), subrounded to rounded crystals are of relatively low proportion, being present at c.13% of the total minerals above silt size. A few grains of quartz present in bladed shapes are occasionally observed.

Most of the grain sizes c.85% fall in the range of 0.200-0.390 mm across, rarely non-plastic inclusions (c.13%) ranging up to 0.700 mm are observed. Mineral sizes in the dimension of 1-1.2 mm are extremely rare (c.2%),only a very few crstals fall within this size range. It is notewortly that fine or very fine grained inclusions, predominantly quartz and all of which are below silt size (under 0.060mm). This raises the probability that these minerals could have been part of the clay matrix.

All the temper inclusions, except mica flakes, appear to be oriented randomly to wall surfaces.

In PPL the matrix of the specimens examined ranges from pale brown, light reddish brown to pale yellowish-reddish brown colour, while in XPOL the colour changes from brown, reddish brown, yellowish brown to yellowish reddish brown. The matrix has a neutral optical density.

A sedimentary origin for this suite is most likely, the presence of predominant quartz grains and very little feldspar in addition to a considerable amount of iron oxides (hematite) tend to support this conclusion (see sections 4.8 - 4.9).

Group C

Specimens RAK (K.N.) 15 and RAK (K.N.) 18

This group is distinguished by the occurrence of high amount of quartz. The quartz inclusions are mainly (85%) polycrystalline, being present at 30-40% of the specimen area and c.57% of the total percentage. The next prominent mineral is hornblende, being present at c.10-20% of any visual field and totalling c.20% of the overall proportions. Feldspars (orthoclase and plagioclase) are in evidence and often abundant. They are present at c.8-12% of the specimen area and reaching c.12% of the total inclusions. Iron oxides are also rather common (c.7% of the total) and occur at c.5-10 of the specimen area. Other inclusions are rare including zircon and tourmaline, being present at 1% of the total proportion (see fig. 41, pl.70).
Organic inclusions were not recognized.

The non-plastic minerals are mainly subangular or angular (c.81%), subrounded to rounded inclusions are often observed (c.18%) and are of low to high sphericity. A few grains of muscovite mica tend to show bladed shapes. Iron oxides in rare instances appeared in the form of subrounded masses of interlocking character.

Grain sizes are mostly (85%) in the order of 0.125-0.390 mm across. Grains in the largest size (1-2 mm) are only quartz, rock fragments and hornblende (1%), while grains in the low to medium size range (0.200-0.300mm.) consist mainly of quartz, biotite mica and plagioclase feldspars (c.14%). The overall grain size distribution indicates fine to medium grained texture. All the non-plastic inclusions, except for some muscovite mica, are liberally distributed throughout the paste.

In PPL the matrix colour shades from light, medium brown to light reddish brown, while in the XPOL matrix colour changes to brown, dark brown and reddish brown.

Most specimens tend to show neutral optical density and rarely indicate low optical activity.

The predominance of polycrystalline quartz inclusions in all the samples together with appreciable amount of hornblende and little feldspar favour an origin in or close to an outcrop of metamorphic source (see sections 4.8 - 4.9).

4.3.3.2 Intercomposition of Pottery Farbics within Site.

When the fabrics of Rabak site (Khartoum Neolithic) pottery were compared in terms of their general characteristics, it was found that the three fabrics are basically different from each other in regard to temper origin and constitutent mineralogical content. Mineralogically, fabric group A is predominantly composed of perthite and microcline feldspar (igneous source) in comparison with farbic group B which is mainly composed of quartz-rich sand and little feldspar (sedimentary source) and fabric group C that is distinguished by higher proportions of polycrystalline grains of quartz and appreciable amounts of hornblende crystals (metamorphic source).

In terms of individual minerals, fabric A is within the range of the maximum percentages exhibited by fabric B for the minerals quartz and feldspar only. It differs from the values of fabric B and C particularly in mica rock fragements, iron oxides and accessory minerals (Zircon and tourmaline). Both fabrics A and C tend to show proportions of feldspar relatively higher than that reported from fabric B (see fig. 41).

The grain size distribution is generally comparable in the three fabrics each of which display somewhat variable percentage of grain sizes in the range of 0.100 - 0.380 mm across.

The three fabrics are similar in regard to the degree of roundness of grains, most of them are subangular or angular, subrounded to rounded grains are notably little in amount. Preferred orientation of mineral inclusions was not observed.

General resemblances in the colour of the paste is conspicuous in all these fabrics. Most of the matrix colour is light, reddish or light reddish brown in the PPL, while in the XPOL, these colours tend to be a bit or very dark brown.

Fabric A is distinct from fabric B in having a few grains of microcline showing evidence of sericitization (alteration at the edge of the crystals). In geological context, alteration as a result of sericitization is attributable to weathering, humidity and thermal conditions that minerals have witnessed in the source rock or in the soil of the source area in post-depositional conditions (Folk 1968:84). In the writer's opinion, it is highly unlikely that this phenomenon has resulted from post-depositional or burial conditions of the pottery in antiquity. This is due to the very little number of grains having evidence of alteration. Hence, sericitization is restricted to a small portion of pottery and does not constitute a general phenomenon.

Fabric B differs from the other fabrics (A and C) in the presence of cracked grains of quartz in appreciable amount (see plate 6). This phenomenon is strange and it is confined to only three specimens, viz, samples RAK (K.N.) 7, RAK (K.N.) 8 and RAK (K.N.) 24. Cracking could be due to high firing, rapid firing or cooling.

4.3.4. Fabric description of Rabak Pottery (Jebel Moya Levels)

Four farbics have been designated as Subgroups A1, A2 and Group B and C have been identified on 10 specimens derived from Jebel Moya cultural levels of Rabak site.

Group A

Subgroup A1

Specimens RAK (J.M.)6; RAK (J.M.)12; RAK (J.M.)14; RAK (J.M.)16-RAK (J.M.)17 and RAK (J.M.)21.

This group is characterized by abundant quartz grains being present at c.20-30% of any visual field and amounting to c.59% of the total grains of this fabric. The quartz grains are predominantly non-polycrystalline. Iron inclusions are the next prominent, being present at c.9-15% of the specimen area and making up 18% of the total minerals present. The remaining minerals occur in much lower amounts or absent. These include feldspar (c.10.2%), mica (c.4.5%), rock fragments (2.1%) and hornblende (c.0.5%). Accessory minerals which are present in low amount (c.1% of the specimen area) are solely represented by zircon (see fig.42, pl.71).

Non-plastic inclusions are mostly subanguar or angular (c.83%), subrounded to rounded minerals occur in relatively lower percentage (c.16%) and of low to high sphericity. Grains in the form of irregular masses of interlocking character are extremely rare, being present at 1% of the total minerals.

Inclusions above 0.060 mm present wide range of grain sizes up to about 1.5 mm across. The majority of grain sizes (c.82%) occur between 0.125-300mm across, most inclusions fall within this size range are quartz, feldspar (microcline and perthite) and iron oxides. Non-plastic inclusions are in general, rather well sorted. Minerals of fine and medium-grained (0.310-0.490 mm across) texture amounting to c.17% of the total inclusions. Coarse grains are extremely rare (0.1%), being 0.500-0.0800 mm across, only some quartz, mica and lithic fragments fall within this size range. The overall distrubution of the particles above silt size tends to show fine to medium grained texture. All non-plastic inclusions, exception the mica fragments, display random orientation relative to wall surfaces.

In PPL the matrix colour ranges from very pale or pale brown, medium brown and light reddish brown, while in the XPOL the colour changes from pale brown, brown, dark brown to reddish brown respectively. The matrix is generally anistropic and reddish brown colour is the most prominent and in rare instances black spot of iron oxides stain the aplastic inclusions.
The matrix tends to show low optical density in most specimens.

The predominance of quartz grains, frequent iron oxides and the very little feldspar content seem to suggest a sedimentary provenance for this group of pottery. The prevalence of Nubian Sandstone Formation in the area (fig.39) is a source worthy of consideration (see sections 4.8 and 4.9).

Subgroup A2

Specimen RAK (J.M.)2

This fabric subgroup represented by only one specimen. It is characterized by considerable amount of non-polycrystalline grains of quartz (c.69% of the total), being present at 20-30% any visual field. Mica (mainly muscovite) occupies 5-12% of the specimen area (c.16% of the total) Iron inclusions are frequent, being present

at c.3-8% of any visual field. They are present at c.8% of the total minerals. Rock fragments in the form of limestone nodules are present in low amount (c.6% of the total), occur at 4-7% of any visual field. Plagioclases and rutile are extremely rare, occur below 1% of the specimen area (see fig.42, pl.72).

The non-plastic minerals are mainly subangular or angular (c.91%), subrounded to rounded minerals are rare (c.9%) and of low to high sphericity. Rounded crystals are mostly restricted to iron oxides and rutile. Quartz and rock fragments occasionally tend to show rounded crystals.

The majority of grain sizes (c.85%) above silt size (>0.060mm) fall in the order of 0.200-400 mm, most quartz and rock fragments fall within this size dimension. Grain sizes in the order of 0.400 - 0.700 mm across amounting to 13% of the total minerals. Coarse grained minerals (c.1-2 mm across) are only c.1% of the overall inclusions. Rare grains, all of which are quartz or rock fragments, fall within this size range. A part from a sparse grains of quartz and rock fragments with sizes exceeding 1mm, the overall distribution of particles indicates a medium grained texture.
All non-plastic inclusions are oriented randomly in relation to vessel walls.

In PPL the matrix colour is pale reddish brown, while in XPOL the colour turns to reddish brown.
The thin section tends to show neutral optical density.

The occurrence of abundant non-polysrystalline quartz and appreciable amount of limestone fragments of calcitic nature seem to suggest a sedimentary source for this fabric Subgroup. The nearest limestone source to Rabak site is an outcrop of calcitic rock lies c.45 km. further east (see fig.39). This temper material (limestone fragments) was not reported from the other fabrics of this site (Further discussion in sections 4.8-4.9).

Group B

Specimens RAK (J.M.)5, RAK (J.M.)19 and RAK (J.M.)20.

This fabric group is characterized by appreciable amount of quartz, being present at 20-35% of any visual field and totalling c.63% of the minerals present.

Hornblende is the second prominent non-plastic mineral in all the sections, occurs at c.10-15% of any visual field and reaching c.15% of the total minerals: Iron inclusions are, similary, frequent, being present at c.8-15% of the specimen area and c. 10% of the total. Plagioclase feldspar is generally sparse (c.6%), being present at c. 3-5% of any visual field. However some plagioclases show evidence of seriticization at the edges of the crystals. Biotite and muscovite mica are, similary rare, being present at c.2-3% of any visual field and amounting to 5% of the total number counted. Minor minerals are extremely rare (c.1%) all of which are present at 1% of the specimen area. Organic inclusions do not appear to be present in any parts of the sections. (fig.42, pl.73).

The non-plastic grains are dominantly (c.80%) subangular or angular, subrounded to rounded crystals occur in much lower percentage (c.20%) and of low to high sphericity.

Most of grain sizes (c.89%) occur in the range of 0.100-0.350 mm. The largest grains (c.2%) are 1.5-2 mm across, only quartz and orthoclase feldspar being of this size. A small proportion of the non-pastic mineral inclusions (c.8.9%) fall in the range of c.400-0.700 mm, minerals occur within this size dimension are mostly feldspar (microcline and plagioclases). A part from some mica fragments, the remaining tempering minerals are randomly oriented relative to wall surfaces.

In PPL the matrix colour ranges from light brown, brown and pale reddish brown, while in XPOL the colour of the matrix shades from brown, dark brown to dusky brown respectively. All the samples tend to show neutral optical activity.

The minerals of this fabric favour on origin in or close to exposures of metamorphic rocks. This is suggestive by the occurrence of abundant polycrystalline grains of quartz, the presence of appreciable numbers of hornblende crystals, the scarcity of feldspar and lack of calcitic minerals.

Group C

Specimen RAK (J.M.)10

This group is characterized by high amount of non-polycrystalline grains of quartz, (c.61%), being present at c.15-25% of any visual field. Microcline and

perthitic feldspars are the next abundant non-plastic minerals (c.30%), being present at 12-15% of the specimen area. Iron oxides are rather common (c.8.8%), occur at c.4-5% of any visual feld. Rock fragments are extremely rare (c.0.1%), only one grain of igneous origin was recognized. (fig. 42, pl.74).
Organic inclusions are not present.

The aplastic minerals are mostly subangular or angular (c.88%), subrounded to rounded grains are of much lower proportion (c.11.5%) and of low to high sphericity. Iron oxides (c.0.5%) seldom display grains in the form of masses of interlocking character.

Most of the minerals above silt-size (c.75%) fall in the size of c.200-0.300mm across. The maximum grain size is c.2mm., quartz and microcline feldspar rarely occur within this size dimension.

A part from a few grains of quartz and a single crystal of rock fragment, the overall size distribution shows a fine to medium-grained texture.
All the non-plastic inclusions display random orientation in relation to the vessel walls.
In PPL the matrix colour is light reddish brown, while in the XPOL the colour becomes reddish brown (anistropic).
The martix tends to exhibit neutral optical density.

The igneous origin of this fabric group is suggestive by the prevalence of non-polycrystalline grains of quartz and the occurrence of appreciable quantity of microcline and microperthite (see section 4.8 and 4.9).

4.3.4.1 Intercomposition of Pottery Fabrics withtin Site.

The mineralogical composition of the four fabrics tend to show remarkable variations between them. While fabric Subgroup A1 distinguished by its predominance of quartz grains, fabric A2 is characterized by high proportion of quartz inclusions and appreciable limestone fragments, fabric B presents high percentages of quartz and hornblende in all the sections and fabric C is largely

composed of non-polycrystalline quartz and feldspar, exclusively microcline and microperthite.

The main characteristic distinguishing Subgroup A2 from subgroup A1 is the presence of rock fragments, the latter, exclusively of limestone nature. Otherwise, the two subgroups are similar in regard to the main mineral types but with varying proportions.

The mineral inclusions of all fabrics are more or less the same in terms of degree of roundness. The majority exhibit subangular or angular and relatively lower percentages of subrounded to rounded grains of low to high sphericity. Non-plastic inclusions in all fabrics display random orientation relative to wall surfaces.

The minerals of all the fabric groups are rather homogenous in terms of grain size distibution. Fabric subgroup A1 closely matches fabric B, both of them display similar range of sizes in the order of 0.100-.350mm. On the other hand, fabric A2 and C are comparable for both of them tend to show minimum grain sizes of 0.100-.200mm across, however, the maximum grain sizes are varied, being 0.400m and 0.300mm respectively.

Thin section specimens of fabric subgroups A1 and B are generally comparable. The colours are mostly pale brown or brown in PPL and appear dark or dusky brown in XPOL.

Matrices in specimens RAK(J.M.)7. of fabric subgroup A1, RAK (J.M.)2 of fabric subgroup A2 and RAK(J.M.)10 of fabric C tend to show the same colour (reddish brown) under crossed polars.

4.3.5 Intercomposition of Pottery Fabrics between Sites

Though the mineralogical composition of the Mesolithic ceramic fabrics (Shabona) in the White Nile region, mainly, overlaps with that of the Neolithic ones (Rabak: Khartoum Neolithic and Jebel Moyal Levels) of the same regions, nonetheless, mineralogical compositions in both ceramic assemblages are rather different with respect to the proportions and/or occurrence of certain minerals (see

section 4.3 and figs 40,41 and 42 for further information pertaining to the discussion of fabric mineralogy which will be presented below).

In fabric A1 and A2 of the Mesolithic ceramics (Shabona) the proportions of quartz though somewhat differ from each other (c.85% and c.64% respectively), they are comparable to the late Neolithic ceramics of Rabak site (J.M. levels) (cf. section 4.3.4.2). The percentage of this mineral tends to be lower in fabric A1 of Rabak ceramics (Khartoum Neolithic levels)

Iron oxides of the Mesolithic ceramics (Fabrics A1 and A2) are fairly similar in proportions (c.1% and 12% respectively) to those of fabrics A of Rabak (Khartoum Neolithic levels) (c.6%) and fabric A2 (c.8%) of Jebel Moya ceramics from the same locality. The amount of iron oxide is relatively higher at fabric A1 of the latter ceramics, though the proportion of this mineral is generally rather low.

Mica is absent in the mineralogy of Shabona Mesolithic ceramics as shown in fabric A1. It increases from the Shabona Mesolithic (Fabric A2), Rabak Neolithic (Kh. Neo.L.) (Fabric A) to Rabak late Neolithic (J.M.L.) (Fabric A2), being present at c.8%, c.10% and c.16% of overall non-plastic minerals (ibid.).

Rock fragments are present in low percentages in fabric A2 (c.5%) of Shabona Mesolithic and are extremely rare in fabric A of Rabak Neolithic ceramics (c.0.3%). The proportion increases in fabric A1 (c.2%) and A2 (c.6%) of Rabak late Neolithic ceramics, though it is still sparse.

Pottery fabrics A1 and A2 of Shabona Mesolithic, groups A and A2 of Rabak Neolithic ceramics (Kh. Neo. and J.M. levels) are devoid of hornblende. Exceptions are fabric group A of Rabak Neolithic (Kh. Neo. L.) and group A1 of Rabak late Neolithic ceramics (J.M.L.) where this mineral is extremely rare, being c.0.4% and 1%, respectively, of the overall non-plastic components.

Accessory minerals (zircon, tourmaline and epidote) are extremely rare in most pottery specimens of fabric groups A, A1 and A2 during the Mesolithic and Neolithic times in this region. The proportions of these minerals being 1% at fabric A1 of Shabona Mesolithic, fabric A of Rabak Neolithic (Kh. Neo.L.) and group A2 of Rabak Late Neolithic (J.M.L.) ceramics.

The mineralogy of Shabona fabric B is different, in most instances, from Rabak site particularly in the occurrence of relatively low proportion of quartz, being only c.28% of the total aplastic minerals.

The proportion of feldspar is exceptionally higher at fabric B of Shabona Mesolithic ceramics, being c.48% of the overall non-plastic components. This mineral occurs in relatively low amounts in the fabric composition of Rabak Neolithic ceramics (Khartoum Neolithic and Jebel Moya levels), being present at 12% and 6% respectively.

Iron oxides in fabrics B of the Mesolithic ceramics (Shabona) (c.5% of the total) and the late Neolithic ceramics (J.M.L.) of Rabak (c.10% of the total) are apparently low , both being different from fabric B (c.22%) of Rabak Neolithic (Kh.Neo.L.) pottery which is relatively high.

Mica percentages of Khartoum Neolithic and Jebel Moya-type of pottery are comparable, being c.3% and c.5% of the overall non-plastic inclusions at fabrics group B. These proportions are relatively lower than that of fabric B of Shabona Mesolithic ceramics.

Rock fragments are rather rare in the composition of the Mesolithic (Shabona) and Neolithic (Rabak:kh.Neo.L.) ceramics in the region.

Hornblende is infrequent in the fabric composition (Group B) of Shabona Mesolithic ceramics, it increases up to c.20% at Rabak fabric (Group B) of Khartoum Neolithic levels, while its percentage reaches c.15% at fabric B of Rabak late Neolithic (J.M.L.) ceramics.

Minerals of fabrics B from the Neolithic ceramics of Rabak site (Khartoum Neolithic and Jebel Moya levels) in the white Nile region are comparable, occurring at c.2% and c.3% of the overall aplastic inclusions.

Fabric C is distinct for it shows fairly clear variations between the ceramics of Khartoum Neolithic and Jebel Moya levels at Rabak site. In both ceramic assemblages only quartz (c.58% and c.61% in the respective fabric groups) and

feldspar (c.12% and 9% respectively) are comparable. The remaining minerals (mica, rock fragments, hornblende, epidote, zircon and tourmaline) are absent at late Neolithic fabrics of Jebel Moya levels and , in most instances, exhibiting varying proportions at the ceramics of Khartoum Neolithic from the same site.

As regard fabric mineralogy, no patterning was recognized during the passage of time spanning the Mesolithic and Neolithic periods in the white Nile region (see supra). The fabrics, in most cases, exhibit similar mineral assemblages. The sole exception is hornblende which shows noticeable increase from the Mesolithic (c.6% of the overall aplastic inclusions) to the Neolithic periods (c.15% at Rabak (J.M.) and c.20% at Rabak (kh.Neo. levels).

The percentages of grain sizes of Shabona Mesolithic ceramics are markedly different from the values exhibited by the Neolithic ceramics of Rabak site. While the fabric (A1-B) of the Mesolithic ceramics (Shabona) in the White Nile province tends, in most cases, (80-85%) to indicate coarse grained texture (o.500-0.900 mm across), the fabrics of the Neolithic ceramics of Rabak (Kh. Neo.L. and J.M.L.) have considerably higher proportions of fine (0.125-0.250 mm across) and medium (0.251-0.490 mm across) grain sizes (cf. sections 7.7.1 and 7.7.2).

When the fabrics of the Mesolithic and Neolithic ceramics in the White Nile region are compared, it was found that they are more or less similar as regard the degree of roundness of the tempering inclusions. In almost all those fabrics (Shabona Mesolithic and Rabak Neolithic ceramics) the non-plastic inclusions are exceeding 80% of the overall minerals present. Exceptions are fabric group B of Shabona Mesolithic ceramics and fabric A2 of Rabak Neolithic (J.M.L.) which show 78% and 91%, respectively, of the non-plastic minerals being subangular or angular. Subrounded and rounded crystals though are frequent but they tend to occur in much lower proportions ranging between 13-21% in all the fabrics. It is noteworthy that fabric B of the Mesolithic ceramics of Shabona provided the highest percentage totaling 21% of the overall aplastic minerals. Iron oxides occasionally occur in the form of irregular masses of interlocking character as shown in ceramic fabrics B of Shabona Mesolithic and fabrics A1 and C of Rabak (J.M.L.) which represent the late Neolithic ceramics. Mica in the form of bladed flakes is, rarely, seen in fabric A of Rabak Neolithic ceramics (cf. sections 4.3.2, 4.3.3 and 4.3.4).

With respect to the groundmass colours, the fabrics of the Mesolithic and Neolithic ceramics in this region are generally homogenous. Almost all the Mesolithic and Neolithic ceramics (Shabona and Rabak respectively) are comparable. Their matrices are generally characterized by the presence of light, medium brown to pale reddish brown colours in plane polarized light (PPL), which under crossed nicols (XPOL) the shades alter to brown, dark brown and reddish brown respectively. Exceptions are a few specimens from fabric B of Rabak (kh. Neo.L.) ceramics which tend to exhibit pale yellowish and reddish brown colour in PPL and yellowish brown to yellowish reddish brown in XPOL (ibid.).

Most Mesolithic and Neolithic pottery fabrics in this region tend to display neutral optical density and rarely low optical activity as in fabric A1 from Jebel Moya levels of the same locality which provide low optical activity (ibid.).

4.4. X-ray diffraction

4.4.1. Introduction

Some X-ray diffraction analyses were conducted on a series of Mesolithic, Neolithic and modern ceramics from the White Nile region. The analyses were carried out at the Department of soil Science and Geology of Wageningen Agricultural University in the Netherlands. (see sections 3.4.1. and 3.4.2). The results of these analyses are summarized in table 25 and will be described in detail below.

4.4.2. Results

As can be seen from table 25, the mineralogical composition of all the samples show that quartz is the most abundant mineral, being present in high proportions before and after firing to 900°C in an electric oven for a period of one hour.

Clay fractions (020) are scarce showing weak appearance in the majority of the samples. In two instances, from Rabak (Kh.Neo.(7)) and the local modern pottery (samples: G93-120C and G93-10C respectively), the amount of the fine earth fractions (020) are absent or very weak in the respective samples.

Plagioclase feldspar gave very weak appearance in nearly all the samples. The only exception being one sample (G93-12C) from the Khartoum Neolithic Levels of Rabak which point to unclear presence of this mineral.

The presence of K-feldspar is weak in most of the samples, very weak or unclear in nearly all the remaining ones. It is invisible in only one sample (G93-12C) from Rabak site (Khartoum Neolithic Levels).

Prior to heating all the Mesolithic, Neolithic and modern pottery samples of this area are devoid of hematite. However, as a result of heating to 900°C (1hr), the samples from all localities showed a development of hematite.

Mica has been distinguished on the basis of only one diffraction line at 10A. The presence of this mineral is very weak or inconspicuous in two samples from Shabona Mesolithic (G93-17b and G93-17C) and only one sample from Rabak site (Kh.Neo.L.) (sample:G93-06C).

Anatase has solely been identified at the pottery samples (G93-06C and G93-07C) from Rabak site (Kh.Neo.L.). However, its occurrence is either weak or inconspicuous.

Calcite shows a very weak or unclear occurrence at the analyzed specimens from Shabona Mesolithic and Rabak Neolithic (Kh.Neo.L.) site respectively. The most noteworthy feature is the presence of moderate amount of calcite minerals in the composition of pottery from Rabak site (J.M. Levels) (sample:G93-18a, see also section 5.4.2.).

With regard to the mineralogy of the modern local pottery, the analyses (samples: G93-10C and G93-14C) seem to exhibit fairly homogenous range of occurrence on the basis of most minerals identified. When the modern pottery is compared with the Mesolithic and Neolithic samples, it can be seen that it possesses nearly all the characteristics of the latter.

A prominent feature, after refiring the potsherds, is that most minerals have retained their relative abundance, hematite being the sole exception.

4.5. The chemical analysis

4.5.1 Introduction

Some 8 XRFS analyses were conducted on a series of pottery samples derived from Shabona Mesolithic, Rabak Neolithic settlements in the White Nile region, in addition to modern pottery samples from the same area. The results are shown in tables 26 and 27 and will be described in detail below.

4.5.2 Results

All the samples of the tested localities are composed of silicon oxide (Si02) in high proportion amounting to 63 wght% at the average. It is noteworthy that a sample from Rabak site (sample: Rabak J.M. (7)) derived from Jebel Moya material (upper levels) tends to show slightly lesser proportion of silicon oxide amounting to 52.2% by weight. The samples of all periods (Mesolithic, Neolithic and modern) are comparable, displaying homogenous values.

Aluminum oxide (Al203) is the second prominent chemical component amounting to c.16 wght% at the average. Nearly all the samples are comparable. The sole exception being a sample from the Khartoum Neolithic cultural layers of Rabak site (sample: Rabak Kh. Neo.(6)) where aluminum oxide is relatively high (c.2.2 wght%) in comparison with the remaining samples. The samples exhibit more or less homogeneous values.

Ferrous oxide (Fe203) is present at c.7 wght% at the average. Nearly all the analyses are comparable. The exception being a single sample from Jebel Moya cultural layers of Rabak site (sample: Rabak J.M.(a)), that reflects a slightly higher proportion being c.11% by weight.

Titanium oxide (Ti02) did not amount more than 2.1% by weight in all the analyses. In most examples the percentages are below 2 wght%. Two analyses from Shabona and Rabak settlements (samples: Shabona (8) and Rabak Kh.Neo.(6)) tend to show much lower amounts all of which are below 1% by weight. The samples are comparable and no change is seen between the Mesolithic

samples (Shabona) and the Neolithic ones (Rabak:Khartoum Neolithic and Jebel Moya layers).

Manganese oxide (Mn0) is markedly very low in amount being present at c.0.1% by weight and even less in some examples. The samples of all periods (Mesolithic, Neolithic and modern) tend to show homogenous values.

Magnesium oxide (Mg0) is present in most analyses in low concentrations little above 1% by weight. The average value is c.1.4 wght%, Three analyses (samples of Shabona and Rabak Kh.Neo(6)) show slightly lesser amounts all of which below 1wght%. The only exception is a sample from Jebel Moya levels of Rabak site (specimen:Rabak J.M.(9)) which shows relatively higher concentrations amounting to C.4% by weight (table 26).

Calcium oxide (Ca0) concentration is apparently low in all the samples being c.2.2 wght% at the average. The results tend to reflect a range of variation through periods of time. The Mesolithic and Neolithic samples of Shabona and Rabak (Khartoum Neolithic levels) show similar proportions in the range of c.1.4 wght% - c.1.7 wght%. In one example from Shabona pottery (sample:Shabona (8)), the percentage of calcium is below 1% by weight. On the other hand, the samples of the late Neolithic ceramics from Rabak site (Jebel Moya Levels) and the modern local pottery contain relatively higher concentrations in the range of 2-2.5 wght% but still low. Only one analysis from Rabak, Jebel Moya Levels (sample: Rabak J.M.(a)) shows a concentration of calcium amounting to 5.3% by weight. The latter concentration is markedly high, being three or four times higher than the remaining samples, though the amount is still low.

Sodium content of the samples is very low being present at 0.9 wght% at the average. The concentration of the oxide (Na20) in the samples is mostly below 1wght%. However, three analyses of Rabak site pottery (sample:Rabak, Jebel Moya (6)) and the modern pottery samples from the same area, show slightly higher percentages little above 2 wght% and 1.2 wght% respectively.

Potassium content of the samples shows varied proportions and the average concentration is 2.7 wght%. With the exception of only sample from the Mesolithic site of Shabona (sample:Shabona (7)), the remaining examples from this

settlement and Rabak one (Rabak Khartoum Neolithic Levels) tend to show relatively higher proportions of potassium, being present at 6.1 wght% and C.3.6 wght% at the average, respectively. The samples of the late Neolithic ceramics (Rabak Jebel Moya Levels) and the modern pottery from the area contain relatively low concentrations mostly below 2 wght%.

Phosphorous oxide (P205) in all the samples is present in rare concentrations being 0.3 wght% at the average. The samples are generally comparable and no marked variation was noted.

Barium oxide (Ba0) is present in scarce amounts being c.0.1% by weight at the average and most of the samples are exclusively below that range.

4.5.3 General Discussion

The results of the chemical data (tables 26 and 27) indicate that chemical composition of the Mesolithic, Neolithic and modern pottery from White Nile region is characterized by a high Si02 content. The concentrations are comparable. Si02 varies between c.52-70% wght% and it reaches an average value of c.63 wght%. This mineralogical particularity explains the higher Si02 contents from Shabona, Rabak sites and the modern tested ceramics from the area. The sites exhibit pottery containing grains of quartz as dominant non-plastic constituents (see section 4.4).

All the samples are rather rich in aluminum oxide (Al203), being present in the range of c.12-18 wght% as already indicated (see section 4.5.2). This confirms the results of the microscopic analysis which suggests that the pottery from this district is rather rich in alkali feldspars (see section 4.4).

All the pottery samples tend to show moderate amounts of Fe203 being present at c.5-11% or little above (see section 4.5.2). Iron oxides are common in Nubian Sandstone Formation in the White Nile Province (see fig.39) occurring in scattered places including the Mesolithic and Neolithic sites of Shabona and Rabak respectively. In a number of localities beds of iron ore are present (see Vail 1982:58 and Clark 1989:390).

Nearly all the samples display percentages little below 2 wght%. In only two cases from Shabona Mesolithic and Rabak Neolithic, concentrations of Ti02 are less than 1% by weight (see section 4.5.2). Such low Ti02 concentrations are consistent with the rarity of this mineral in the central Sudan clays (see section 3.5.7).

The elemental analysis shows that the concentrations of magnesium oxide (Mn0) in all the samples are markedly very low (below 0.1 wght%). This very low Mn0 raises the probability that it is an impurity or an index of a minor mineral.

The tested samples are poorer in Mg0 content, almost all of which are little above 1 wght%. Patterning in oxide concentrations through time was not observed.

Calcium oxide (Ca0) concentrations vary from low to moderate, being present at c.6 wght% in nearly all the samples. Calcium content seems to increase steadily from ancient sites (Mesolithic and Neolithic periods) to recent ones (pottery samples from the late Neolithic levels of Jebel Moya at Rabak site and modern local pottery). This result is in accord with the microscopic and X-ray results (see sections 3.4.3 and 4.3.3.2) which indicate a moderate occurrence of calcite (limestone) at the pottery samples from Rabak site (Jebel Moya cultural levels) (see table 25 and section 3.4.4).

The proportions of sodium oxide (Na0) are very small in most of the samples from this area (under 1 wght%). The values of all periods are generally comparable. The sole exception being the samples of modern pottery and one sample belongs to the late Neolithic phase of Rabak site (Jebel Moya Levels) which shows relatively high Na0 content exceeding 2% (tables 26 and 27).

Potassium oxide (K20) occurs in varying amounts ranging between c.1-6% or little above (see section 4.5.2). The Mesolithic (Shabona) and Neolithic (Rabak) pottery in the area, in most instances, tends to exhibit relatively higher proportions (c.3-6) than the modern pottery which is mostly below 2 wght% (ibid). The moderate concentration of potassium oxide (K20) is consistent with the mineralogical composition of Shabona Mesolithic and Rabak Neolithic pottery which points to abundant temper containing K-Feldspar rich sand (see section 4.3).

Phosphorous oxide (P205) is one of the rare elements, occurring in proportions exclusively below 1 wght% (see section 4.5.2). The values are homogenous and the oxide is, seemingly, an accessory element (impurity) brought in with other oxides.

Barium oxide (Ba) is similarly, rare being present in proportions all of which below 1% by weight (see section 4.5.2). Therefore, the probability that it is an accessory element (impurity) present with other oxides becomes more likely.

4.6 Goethite norm analyses

4.6.1 Introduction

Some 8 analyses were carried out by the present writer to determine the mineral phases and then the norm clay minerals of the fine earth fractions of the Mesolithic, Neolithic and modern pottery samples from the White Nile region. The practical steps used in the analyses are the same as those previously described (cf. section 3.6.4). The results are given in table 29 and will be discussed in detail below (see also section 6.3.4 for comparative analyses).

4.6.2. Results

A part from three samples derived from Rabak (Kh.Neol.L. - samples nos 7,8) and Jebel Moya levels of the same locality (sample: Rabak J.M.L.no.9), the remaining Mesolithic and Neolithic pottery samples hold considerable proportions of quartz inclusions, mainly (62.5%) > 20 wght% (cf. table 29).

Kaolinite norm minerals are pronounced, being present above 30wght% in the bulk of the samples (75%) analyzed. The proportions of this norm mineral are relatively lower in the composition of the modern pottery samples from the White Nile province, being in the range of c.15-18 wght% (ibid. and section 6.3.2).

Illite (the sum of paragonite, muscovite and biotite) occurred in appreciable amounts in most of the samples (75%) analyzed, being in the order of c.17-33 wght%. Exceptions are the samples of Rabak (J.M.L) which indicate low (8.928 wght%) (sample:Rabak J.M.L.7) rare amount (2.25 wght%) (sample: Rabak J.M.L.9) (table 29).

Montmorillonite (the sum of talc and addition of Mg-Fe-Chlore) is present in most tested samples (62.5%) in low proportions, mainly (80%) in the range of c.5-12 wght%. Exceptions are the samples of Rabak (Kh.Neo.L) which are devoid of this mineral and a single sample from the Jebel Moya levels of the same locality (sample: Rabak J.M.L (9)) (ibid.).

Chlorite is absent in most (75%) of the samples examined. The sole exception, being the two samples of Rabak (Kh.Neo.L) which contain very small amounts in the magnitude of c.3 wght% each (ibid. and section 6.3.4).

Hematite is rather frequent in most (62.5%) of the samples analyzed, being almost exclusively present in the order of c.8-17 wght% (see table 29).

The remaining mineral phases including calcite, diaspore, clinochlor and Fe-chlor tend to exhibit low (c.6-9 wght%) or rare (c.3-5 wght%) amounts in most (75%) of the samples analyzed (ibid.).

4.6.3 Conclusions

The results presented above indicate that the fine earth fractions of all the Mesolithic and Neolithic pottery samples are rather comparable and might have held appreciable amounts of kaolinite, illite and quartz minerals

Patterning in the composition of the Mesolithic, Neolithic and modern pottery samples was not observed.

4.7. Pottery Typology

4.7.1 Introduction

A detailed analysis of pottery typological features from the sampled Mesolithic and Neolithic ceramics in the White Nile Province will be discussed below and further compared with the technological features (see supra) pertinent to the same ceramics.

4.7.2 Attribute analysis

The attributes used in the analysis of the Mesolithic and Neolithic sampled ceramics from the White Nile Province are the same as those selected for the analysis of the Khartoum (section 3.7) and Western Butana (section 5.8) Mesolithic and Neolithic ceramics to permit consistent comparative analyses between these ceramic assemblages.

4.7.2.1 Vessel form

As previously indicated (cf. section 3.7) vessel form includes rim and base shapes in addition to wall thickness and building method employed.

Three different types of rims were identified in the ceramics of Shabona Mesolithic (n=335) and Rabak Neolithic (n=65) [Kh.Neo.L, 36% and Jebel Moya, c.64%] sites (see below).

Direct rims of Shabona ceramics are rare, accounting for c.4% of the total rim sherds. Direct rims with pointed tops are the most commonly encountered types (c.60%, 40%, 33.3%) than those with flattened (c.20%, 20%, 16.6%) or rounded tops (c.20%, 40%, 50%) in the ceramic collections of Shabona Mesolithic, Rabak (Kh. Neo. L.) and Rabak (J.M.L.) respectively. Direct rims types A1, A2 and A3 from Shabona ceramics (cf. fig.43) are similar to types A2 of Khartoum Neolithic levels (fig.44) and A1, A3 of Jebel Moya levels from Rabak site (cf. fig.45).

The direct rims with flattened tops (Type A4) from Shabona, Khartoum Neolithic levels (Types A1, A5) and Jebel Moya levels (Type A5) of Rabak site (figs. 44,45) are similar but with varied wall thicknesses.

The direct rims with rounded tops and internally and externally thickening from Shabona ceramics (fig.43) are different when compared with those recorded from Rabak (cf. figs. 44,45 and Haaland 1987:45-47) Moreover, the direct rims types A3 and A4 from the Khartoum Neolithic levels of Rabak site (fig.44) have no counterparts in Shabona (fig.43) and Jebel Moya-like ceramics of the former site (see fig.45 and the author pers. obser.).

Most of Shabona rims (c.49%) are reverted (see Clark 1989:402-403).The reverted rims (fig.43) exhibit different types of lips and thicknesses. Of the total inverted rims, some 65% are thickened at the interior part with varying degrees. The rims are, in most instances, (%), slightly thickened to the interior with rounded tops (cf. fig. 43,132), often terminating in a relatively thin edge of semi-rounded top (ibid., fig. B6), in some cases being strongly reverted (ibid, fig.B7) with rounded top or slightly reverted with pointed top showing smooth transition between the rim stance and the uppermost of the vessel (ibid., fig.61).

The reverted rims from the lower levels of Rabak site (Khartoum Neolithic levels) tend to bear more resemblances with the ones reported from Shabona than those recorded from the upper levels (Jebel Moya levels) of the former site (cf. figs. 44:B1-B4, 45:B1-B5). The reverted rims of Rabak (Kh. Neo. L.) (fig. 44, Type B2, 10% of the total) that are similar to ones (fig. 43, B1, B3, B5) reported from Shabona site (20%, 31%, 16% respectively), all of which display flattened tops with different thicknesses. With the exception of only two reverted-rims with flattened tops from Jebel Moya levels of Rabak site (fig.44,B1, B4) which bear resemblances to types B2 and B4 of Shabona and type B3 from Khartoum Neolithic levels of Rabak, the remaining reverted rims from Rabak (J.M.L) are basically different from these groups. It is noteworthy that the reverted rims which display resemblances are slightly thickened at the interior part (Type B1, B3 and B2 of Rabak [J.M.L], Rabak [Kh,Neo.L.] and Shabona respectively), angularly flattened to the interior with distinct transion between the rim top and the uppermost of the vessel (Type B4 of Shabona and Rabak [J.M.L.]) or distinctly curved inward and terminating in a relatively thin edge of semi-rounded top (Types B6 of Shabona and B2 of Rabak [J.M.L]).

Everted rims are rare in Shabona ceramics (2%). The moderately everted rims of this ceramics (Types C1, C2, fig. 43) are comparable to ones recorded from Khartoum Neolithic levels (Type C1) and Jebel Moya levels (cf. fig.44 and 45 respectively) of Rabak site. All these types of rims exhibit rounded or semi-rounded tops at the uppermost of the vessels. Moderately and slightly everted rims (Types C2 and C3 respectively) with, respectively, pointed and rounded tops, recorded from Rabak site (J.M.L.) have no counterparts in Shabona and Khartoum Neolithic ceramics of the former site (figs. 43-44). On the other hand, Shabona and Jebel

Moya-like ceramics of Rabak site are devoid of everted rims paralleling type C2 of Khartoum Neolithic ceramics from the latter site. This type of rims is moderately everted with smooth transition between the rim stance and the uppermost of the vessel terminating in rounded top (cf. fig.44). It is worthnoting that strongly everted (flaring) rims have been identified. Types C3 of Shabona (fig. 43), C3 and 4 of Rabak [Kh. Neo.L.] (fig.44) and C5 of Rabak [J.M.L.] (fig.45) illustrate this tendency. All the flaring rims tend to show angular transion between the rim stance and the uppermost of the vessel. Most of the everted rims (c.75%) are observed with rounded tops, the sole exception being type C4 of Rabak (Kh.Neo.L.) which has flattened top (cf. fig.44).

The rims shapes of the Mesolithic (Shabona) and Neolithic (Rabak-Kh. Neo.L and J.M.L.) ceramics in the White Nile region (see supra, this section) are similar and the majority (c.80% and 85% respectively), are direct continuations of the vessel walls. Rims, in most cases (see section 3.7.2), belong to plain vessels.

Complete pots were not found and the present ceramic repertoire represents a limited number of vessel forms. The vessel forms of Shabona Mesolithic ceramics appear to have been medium and large open-mouthed bowls, though no complete or semi-complete vessels were encountered. Most direct rims (80%) indicate possible rim diameters of 14-32 cm. which probably belong to somewhat medium and large bowls. The incurvate rims have diameters of 13-17 cm, possibly belong to medium hemispherical bowls. Wall thicknesses of the vessels range from 4-15 mm, while the majority (c.65%) exhibits mean thickness of 10.5mm. On the other hand, wall thicknesses of the rims range from 0.2 to 1.5 cm.. It is noteworthy that vessel bases are not present in the assemblage which might suggest that the pottery mainly consisted of bowls in which bases have nearly the same thickness as the rest of the body. It seems that coiling technique was used for building vessels as some of the sherds were found to have broken along the coil lines (see pl. 75). Irregularities of sherds walls also suggest the use of paddle and anvil technique for thinning and smoothing (see Clark 1989: 420-404, pers. comm. 1993 and the present author pers. obser.).

During the Neolithic period in the White Nile region, it seems that vessel forms of the early Neolithic period which are represented by Rabak (Kh.Neol.L.) do not reflect noticeable change and the Mesolithic forms (Shabona) persisted

through this period. The direct rims of Rabak (Kh.Neo. L.), in the majority of cases (c.85%), indicate possible rim diameters of c.13-18 cm. which probably belong to small or medium-sized bowls. The incurvate rims have diameters of 10-16 cm, and possibly belong to cups or small hemispherical bowls. Open-mouthed globular vessels with rounded bottoms are present in ceramic groups of Khartoum Neolithic levels and Jebel Moya levels of Rabak site (see Haaland 1987:46-47 and pers. comm. 1993). Shapes of the pots from Jebel Moya-like pottery at Rabak site are different from the Khartoum Neolithic-like pottery of the same locality, the former being narrow or long-necked with thin or very thick everted rims (see Pls. 45-46, figs. 45-46).

Wall thicknesses of ceramic groups from the Khartoum Neolithic and Jebel Moya levels of Rabak site are comparable. The mean wall thickness of vessels from Khartoum Neolithic levels is 9.6 cm and for Jebel Moya levels is 8.4 cm., where those of the rims are 0.2-1.9 cm and 0.2-1.8 cm respectively.

It seems that coiling technique was used in building as could be inferred only from uneven thickness of the vessels walls. The horizontal breakage is imperceptible, perhaps, due to the exceptionally smaller sizes of most (c.85%) of the potsherds (c.5-8 cm. maximum length) and the complete obliterated surfaces of the relatively larger (c.15%) ones (c.9-18 cm. maximum length) as the surface most likely has been finished with smooth-tool (pebble) that concealed the scraping markings.

4.7.2.2 Vessel decoration

4.7.2.2 Body decoration

When the pottery of Shabona Mesolithic site is compared with Rabak Neolithic one, it appears that they bear little in common. Both sites yielded a few ceramics with compatible decorations but showing differential proportional occurrences. These include zigzag dotted curved lines (Dotted sawtooth) amounting to c.1.6% of the total sherds at Shabona (Pl.76) and though still low in quantity, these decorations are relatively higher at Rabak (Kh. Neo. L.), being c.6.1% of the total sherds (cf. tables 28,30). These decorations are associated with sherds lacking rims and hence, could not be attributed to specific vessel forms with certainty (cf. section 4.7.2.1) (fig.45:1, Pls.77-78).

Zigzag impressed straight line (sawtooth) is absent at Shabona and scarce at Rabak (Kh.Neo.L.) ceramics, being only 0.6% of the total sherds. This decoration was associated with hemispherical bowls, often with perforated rims (fig.45:2).

Zigzag impressed curved lines (wolftooth) are extremely rare at Shabona (1.6%). They are present in very low frequency at Rabak-Kh.Neo.L.site (6.1%) (fig.45:a) and it is seemingly, associated with bowls at the latter site (pers.obser.).

Wavy line (Pl.79) and dotted wavy line (Pl.80) at Shabona site are present in the order of c.4% and c.14% respectively. The former decoration occurs with slight wave probably executed by form of a comb. Both motifs were often depicted on potsherds with direct rim-profiles which probably belong to somewhat medium and large bowls (cf. section 4.7.2.1).

Wavy line and dotted wavy line are devoid in the ceramic groups (Khartoum Neolithic and Jebel Moya levels) of Rabak site. However, dotted rectilinear bands atypical to that found in the Nile valley (e.g. see sections 3.7.2.2.1, 5.8.2.2.1, 10.1 and 10.2) has been encountered at the Jebel Moya levels of Rabak site. (Haaland, pers. comm. 1993). This type of decorative motif (Pl.81) has been included in "non-Khartoum type of decoration", accounting for only 0.2% of that class. It was also recorded from Jebel Moya site (fig.2) in the Blue Nile Province, south-eastern Sudan (cf. Addison 1949:199 and Caneva 1991:265-266, fig.3). This type of decoration was noticed on the surface of sherds, seemingly, belonging to hemispherical bowls (ibid. and the present author, pers. obser.).

Linear impressed lines are present at Shabona (Pl.82) and Rabak (Pl.83) sites with varied frequencies, being c.28% at the ceramics of the former site (table 30) whereas its occurrence at the latter amounting to only c.8.3% (table 31). At the latter site it has been included in the "non-Khartoum type of decoration" reaching 1.7% of the total sherds belonging to this class (The author pers. obser.). This type of decoration was not found in association with rim-sherds and, therefore, the vessel form(s) bearing this decoration could not be determined for certain.

Mat-impressions are commonly present at Shabona ceramics (Pl.84), being c.11.5% of the total specimens (table 30). This type of decoration is associated with

somewhat medium bowls of direct rim-profiles (cf. section 4.7.2.1). Inversely, in the situation of Rabak (Kh.Neo.L) the proportion of this decoration is markedly low, being only c.4% of the total sherds classed as "Decoration non-Khartoum type" (fig.45:b). This type of decoration was confined to rim-sherds, seemingly, belonging to bowls of different sizes and with reverted rims (Pl.85, see section 4.7.2.1).

Fingernail impression decoration is extremely scarce at Shabona (c.0.1%) and Rabak (J.M.L) and only five specimens were recorded (c.0.8%). (table 31) At the former site, the decoration was exclusively depicted on body sherds and, hence, the associated form(s) could not be determined for certain. On the other hand, the latter site exhibits examples where this decoration was depicted on rim tops (Pl.86).

Dotted/triangles class is rare at Shabona (Pl.87), occurring at c.1.3% of the total sherds (table 30). Rim sherds to strengthen the probability of ascertaining the vessel form(s) of this decoration motifs are lacking in the collection of this site (Clark, pers. comm. 1992).

Wiped pottery is the commonest group at Rabak site, amounting to c.60.1% of the total specimens recorded (cf. table 31). This type of motifs is invariably associated with large open bowls and direct rims (Pl.88). Inversely, in the situation of Shabona, the undecorated sherds accounting for only 3.3% of the total sherds (cf. table 30). These plain pottery sherds are associated with direct rim profiles (fig.43), seemingly, parts of bowls of medium or large open bowls (cf. section 4.7.2.1).

Unlike Shabona, Rabak (Kh.Neo.L.) pottery is often ornamented with dots arranged in horizontal lines (Pl.89), slanting linear lines (Pl.90) and catfish impressions (Pl.91), being 16.4%, 0.3% and 0.1% respectively (table 31). All these decorations were solely depicted on body-sherds. Therefore, the associated vessel form(s) could not be determined for certain.

It is noteworthy that the upper and lower levels of Rabak site exhibit two different groups of pots, the oldest is reminiscent of 'Khartoum Neolithic' (see Pls.77, 92) as represented by Shaheinab (see supra; Arkell 1953:68-77, Pls. 29-39) and related sites (e.g. see sections 2.2.2, 2.2. 5.2, 2.6.2.1.2). The youngest is

recalling Jebel Moya types of decoration (see supra; Addison 1949, Pls. XCI, XCIII, B.no. 2,3 and Haaland 1987:45-47, fig.14:i, j, k). The latter type of pottery examined by the present writer presents examples of hachured parallel grooving (Pl.93), zoned impressed (Pl.94), herring-bone (Pl.90), rectilinear and dotted wavy bands with angular curves (Pl.81). All these decorations including wiped surface (see supra, this section) have been classed as "Jebel Moya type of pottery" (cf. table 31).

4.7.2.2.2 Rim-top decoration

Rim-top decorations of Shabona Mesolithic (fig.44) and Rabak Neolithic ceramics (fig.47) are dissimilar. Shabona decorations (n=120) are composed of dotted straight lines (c.15%-fig. 44:a), short vertical impressed lines (c.65% - fig.47:b), short impressed curved lines (c.10%) and herring-bone impression (c.5%-fig.47:d) (cf. Clark 1989:387-410 and pers.comm.1992).

At Rabak (Kh.Neo.L.) rim-top decorations are limited in comparison with Rabak (J.M.L.). Only two motifs namely slanting impressed (fig.47:a) and cross-hatched (fig.47:6) were identified, being c.10% and 14% of the total rims found (n=83). On the other hand, rim top decorations of Rabak (J.M.L.) frequently consist of slanting impressed (c.35%-fig.47:a), cross- hatched (c.18%-fig.47:b), impressed curved (c.13% - fig.47), occasionally fingernail (c.7.5% - figs. 46:e, 47:d) and rarely a combination of slanting lines and dots (c.2.5% - fig.47:e) (The present author pers. obser. and Haaland, pers. comm.1993).

4.7.2.2.3 Rim-band decoration

Rim-band decorations (n=24) are confined to Rabak ceramics of Jebel Moya levels (fig.48). The most commonly encountered types of rim bands include incised vertical lines (c.30% - fig.49:a), slanting impressed lines (c.26% - fig.48:b), slanting incised lines (c.20% - fig.48:c), whilst crescent shapes (c.11.4%- fig.48:c), and herring-bone (c.12.4%-fig:48:e, Pl.90) motifs are markedly low in proportions(ibid.).

4.7.2.3 Surface properties

4.7.2.3.1 Basic Surface Colour

The pottery surfaces of the Mesolithic (Shabona) and Neolithic (Rabak) periods in this region are dissimilar (see below and sections 4.2.1 - 4.2.2).

While the bulk of Shabona pottery (c.90%) tends to show that surfaces are reddish brown (7.5YR 6/4 Munsell), most of Rabak pottery (c.72.5%) is grey in colour (5YR 5/1 Munsell), (see Clark 1989:402-405, pers. comm. 1992, Haaland 1989:362-365, pers. comm. 1993 and the author pers. obser.).

With respect to the remaining potsherds, it appears that Rabak pottery exhibits relatively small proportion (c.15%) of red coloured specimens (2.5 YR 5/6 Munsell). Some 10% of the sherds show weak red colour (10R 5/4 Munsell). On the other hand, the remaining sherds of Shabona (c.10%) show pale brown colour (10YR 6/3 Munsell) (ibid.).

The fractures of Shabona (Pl.95) and Rabak-Kh.Neo.L.and J.M.L.-ceramics (Pls.96-97 respectively) are rather comparable. Most of them break with dark or very grey colours (see below). The sole colour which is present at the two collections is very dark grey shade (2.5YR N3/0 Munsell), occurring at c.60% and c.55% of the total specimens respectively (ibid.).

The rest of the potsherds are very dark grey (7.5YR N3/0 and 10YR 3/1 Munsell-c.25% and c.15% of the total respectively) at Shabona whereas those of Rabak (Kh.Neo.L. and J.M.L.) are dark grey (5YR N4/1 Munsell-c.38.4% of the total) or dark brown (7.5YR 4/2 - c.6%) (ibid.).

Since the geological formations of the sites areas are similar (cf. section 4.1, 4.3-4.6) and the firing conditions (cf. section 8.6) are comparable, it is more likely that the variations noticed on the surface colours of the Mesolithic (Shabona) and Neolithic (Rabak) ceramics in this region is due to variations in the amounts of iron oxides and other impurities these quarried clays-used for potting-contained in nature (cf. sections 4.3-4.6).

4.7.2.3.2 Surface Coating

In the White Nile region the reddish surfaces are devoid in the ceramic collection of Shabona Mesolithic site, whereas appreciable number of red coloured specimens in different shades (c.25% of the total sherds) have been encountered in the ceramic collection of Rabak (cf. section 4.7.2.3.1).

A representative sample of 30 red - coloured sherds was examined by the present writer using hydrochloric acid. As a result, the ferric oxide (Fe203) or red ochre dissolved in hydrochloric acid leaving a residue of siliceous material. Therefore, it has become clear that the thin layer on these potsherds is not a real slip but a slip-like colour. It occurred as a result of the presence of red ochre (iron oxide) (cf. section 3.7.2.3.2).

4.7.2.3.3 Smudging

In this region, the Mesolithic pottery of Shabona is devoid of smudging (Clark 1989:387-410; Clark, pers. comm. 1993 and the present author, pers. obser.).

With respect to Rabak ceramics, only two potsherds derived from Jebel Moya levels of this site (L2-20 cm below the surface of sq. 107Y100) were identified by the present writer; one with black colour on rim-top (Pl.85) and the other with black shade covering both the top and band of the rim (Pl.86). The excavator of the site (cf. Haaland 1984:39-51 and 1989:374-379) did not refer to this phenomenon, probably because his reports on ceramics were only preliminary. However, these black coloured surfaces are apparently rare and therefore, the possibility that they resulted from an absence of oxygen on these parts of the vessels during firing process (may have come to rest on the surface of a pot) becomes much more likely.

4.7.2.3.4 Burnishing

All the Mesolithic ceramics of Shabona are unburnished but smoothed on both surfaces prior to decoration and firing (cf. Clark 1989:403; section 4.2.1 and the present author, pers. obser.).

During the Neolithic period in this region (cf. section 10.1.1.2), Rabak ceramics were all burnished through the 'Khartoum Neolithic' levels of the site (cf. Haaland 1987:46; section 4.2.2 and the present author, pers. obser.). The pottery recovered from 'Jebel Moya' levels of this site was seldom burnished (ibid.).

4.7.2.3.5 Polishing

A common feature for both Mesolithic (Shabona) and Neolithic (Rabak) sites in this region is the absence of polished surface-pottery (ibid.).

4.7.4 Conclusions

The physical and chemical analyses (see supra, this chapter) show that the mineralogical compositions of the Mesolithic ceramic fabrics (Shabona) overlaps with that of the Neolithic ones (Rabak: Khartoum Neolithic and Jebel Moya levels). Nevertheless, the mineralogical composition in both ceramic assemblages are rather different with respect to the proportions and/or occurrence of certain minerals (quartz, feldspars and rock fragments) (see section 4.3.5).

Despite the variability in proportional occurrencies of some minerals (ibid.) within and between the fabrics identified, the minerals, in general, are similar with respect to rounding classes, grain sizes, clay mineralogy and chemical composition (see infra).

All the fabrics of the sampled Mesolithic and Neolithic ceramics display homogenous proportions of rounding classes (cf. section 4.3). The aplastic mineral grains are, in most cases, subangular and angular suggestive that they have been crushed deliberately and added by the potters as temper. Subrounded to rounded crystals are present in low proportions. Therefore, they are most likely inherent in the paste in their natural state.

The average sizes of the tempering minerals though display some variability at the intra-and inter-site levels, but they tend to exhibit an increasing tendency of fine-grained textures from the Mesolithic (Shabona) to the Neolithic (Rabak) period (cf. sections 4.2.1-4.2.2, 4.3.3.2).

The X-ray diffraction analysis indicates that the clay mineralogy of the Mesolithic (Shabona), Neolithic (Rabak) and modern local pottery samples exhibit fairly homogenous range of occurrence on the basis of most minerals identified. The main clay minerals (e.g. montmorillonite, kaolinite, illite....etc.) are devoid in the composition of the tested samples (cf. sections 4.4. and 7.7.).

The chemical analysis shows that all the Mesolithic (Shabona), Neolithic (Rabak) and local clays samples from the White Nile Province are rather homogenous. All the samples are distinguished by their markedly high concents of silicon-rich sand (Si02). Aluminum is relatively high in all the Mesolithic, Neolithic and modern pottery samples examined in the present work. The rest of oxides (Fe 203, Ti03, Mn0, Mg0, Na20, K20, P205 and Ba0) are present in very small or rare amounts (cf. section 4.5).

Complete pots were not found in the collections of the tested Mesolithic and Neolithic ceramics in this region. (see infra).

The rim shapes of the Mesolithic (Shabona) and Neolithic (Rabak) ceramics in the White Nile region are similar and the majority are direct continuations of the vessel walls. During the Mesolithic and Neolithic periods, in this area, it seems that vessel forms did not witness marked changes and the majority, seemingly, belong to hemispherical bowls. At the later Neolithic phase of Rabak site (J.M.L.) narrow and long-necked vessel with thin or very thick everted rims supersede the open mouthed-globular jars of the earlier Neolithic phase from the same site (cf. section 4.7.2.1).

Decorations depicted on body surfaces and rim-tops of Shabona Mesolithic and Rabak Neolithic sites bear very little in common (see below).

Wavy line and dotted wavy line which are the diagnostic decorations are devoid in the collection of Rabak. However, dotted rectilinear bands atypical to the found in the Nile Valley (cf. sections 3.7.2.2.1, 5.8.2.2.1 and 10.1.-10.2) have been encountered at the latter site. In addition to that, pottery sherds embellished with vees/dots and catfish spine impressions from Rabak site were not found at Shabona.

Nevertheless, a few ceramics from both sites were observed with the same decoration (dotted saw-tooth) (cf. section 4.7.2.2).

Rim-top decorations of Shabona and Rabak sites are dissimilar. While Shabona decorations are mainly represented by short vertical impressed lines, occasionally short impressed curved or dotted straight lines, those of Rabak (Kh.Neo.L.) are composed of slanting impressed, cross-hatched lines, whereas Rabak (J.M.L.) examples are mostly ornamented with impressed and cross-hatched decorations (cf. section 4.7.2.2.2).

Rim-band decorations are exclusively found at Rabak (J.M.L.) site, mainly comprised of incised vertical lines, slanting impressed and incised lines (cf. section 4.7.2.2.3).

The pottery surfaces of the Mesolithic (Shabona) and Neolithic (Rabak) periods in this region are different. While the bulk of the Mesolithic ceramics are reddish brown in colour (7.5YR 6/4 Munsell), most of the Neolithic specimens are grey in shade (5YR 5/1 Munsell). On the other hand, the colour of the fractures during the Mesolithic (Shabona) and Neolithic (Rabak) periods break with grey (5YR N4/0 Munsell) or dark grey colour (2.5YR N3/0 Munsell) (cf. section 4.7.2.3.1).

Real slip was not noticed on the red-coated surfaces. The microchemical tests carried out in the present work show that the red-coated surfaces are slip-like colour occurred as a result of the presence of red ochre pigment (cf. section 4.7.2.3.2).

Smudging did not appear during the Mesolithic (Shabona) whereas Neolithic (Rabak) witnessed rare occurrence of smudged pottery. This phenomenon raised the probability that the black-coated surfaces might have been resulted from the presence of insufficient oxygen on the vessel-surfaces during firing process (cf. section 4.7.2.3.3).

Burnishing was absent during the Mesolithic (Shabona) period and it is the hallmark of 'Khartoum Neolithic' ceramics from Rabak and apparently scarce during "Jebel Moya levels" of the same site (cf. section 4.7.2.3.4). It is noteworthy

that polishing was absent during the Mesolithic and Neolithic periods in this region (cf. section 4.7.2.3.5).

The Mesolithic and Neolithic specimens analyzed for fabric comparisons are, respectively, homogenous pertinent to decoration and surface finish. There is no grouping tendency as regard certain type of decoration and/or surface finish versus fabric group per se (cf. section 4.7.2.4).

4.7.2.4 Typological features and Fabric groups

Specimens of subgroup A1 derived from Shabona ceramics (SHB4 -SHB7; SHB11, SHB16-SHB17; SHB21 and SHB24) which are embellished with motifs of wavy line, dotted wavy line, zigzag straight line, zigzag curved line, coarse plain (each is c.7.1% of the total sherds examined), straight line and fingernail (each is c.3.5% of the total); fabric subgroup A2 (SHB2-SHB3; SHB8-SHB10; SHB12-SHB15) which are ornamented with wavy line (c.7.1%), dotted wavy line, woven mat, dotted straight line, (each is 3.5.%), often undecorated (c.7.1%) and fabric group B (SHB1; SHB13-SHB14; SHB18; SHB20; SHB22-SHB23; SHB25-SHB26) (cf.section 4.3.2) which embraces wavy line, woven mat, zigzag straight line, zigzag curved line (each is c.3.5% of the total sherds analyzed), dotted wavy line (c.7.1%) and coarse plain (c.10.7%) exhibit, in most instances, the same range of decorations (see supra, this paragraph) and surface finish (cf. section 4.7.2.3).

Pottery samples of fabric group A from Rabak site (RAK [K.N.]1 and RAK [K.N.]21) which include decorations of wiped surfaces, dotted straight line (each is 3.5%); fabric B (RAK [K.N.]3-RAK [K.N.]4; RAK [K.N.]9; RAK [K.N.]11; RAK [K.N.]13; RAK [K.N.]22-RAK [K.N.]28 which encompass dotted straight line, zigzag dotted curved line, linear impression (each is c.3.5%), wiped surfaces, catfish impression, coarse plain (each is 7.1%), dotted straight line (c.10.7%) and fabric group C(RAK [K.N.] 15 and RAK [K.N.]18) (cf. section 4.3.3) which includes wiped motif (c.7.1% of the total analyzed sherds) tend to show comparable range of decorations (see this paragraph) and almost all of which are burnished, the only exception being the coarse plain sherds which bear different surface finish (cf. section 4.7.2.3).

Specimens of fabric subgroup A1 (RAK [J.M.]5; RAK [J.M.]12; RAK [J.M.]14; RAK [J.M.]16-RAK [J.M.]17 and RAK [J.M.]21) which are decorated with wiped, zigzag impressed straight line, zigzag impressed curved line, zoned impressed (each is c.3.5%), cord impressed (c.7.1%); fabric subgroup A2 (RAK [J.M.]2) which includes fine plain, dotted straight decoration (each is c.3.5%); fabric B (RAK [J.M.]5; RAK [J.M.]19 and RAK [J.M.] 20) (cf. section 4.3.4) comprises cord impressed (c.3.5%), zones motif (c.7.1%) and fabric C (RAK [J.M.]10) which is characterized by wiped decoration (c.3.5%) are comparable pertinent to decoration (see supra) and surface finish (burnishing). The sole exception, being the sherds bearing wiped surfaces which are exclusively unburnished (cf. section 4.7.2.3).

Chapter 5

5. Ceramic Technology of Mesolithic and Neolithic Sites in the Western Butana Region

5.1. Introduction

This chapter encompasses an introductory section concerning the necessary geographical and geological information of the Western Butana region. The larger part of the chapter is devoted to detailed descriptions and analytical study of the technological features of the Mesolithic and Neolithic sampled pottery from this region.

5.1.1 Geographical location

5.1.1.1 Mesolithic sites

5.1.1.2 Shaqadud Complex site

Shaqadud is a complex of archaeological sites. It is located in a tiny box canyon at the southern end of irregular, elongate sandstone outcrop that is some 50 km east of the Nile valley at Wad Ben Naqa (fig.1) (Marks 1980:30-33, 1982 :47-50). The box canyon and its immediate surroundings hold four different sites (fig.48). These include sites S1-A (cave), S-1B (midden), S-1C (a small site at the lower portion of Shaqadud inset) (Marks 1991:33 - 63 and fig.48). The present writer has selected pottery samples from the first two sites, viz, Shaqadud cave (S1-A) and Shaqadud midden (S1-B). This is due to the fact that site S-21 had no features and its material culture, mainly groundstone, faunal remains and tiny undiagnostic sherds, is generally poor. Site S -1C is similarly poor, it yielded late Khartoum Mesolithic and Khartoum Neolithic pottery sherds. But since densities were low and the depth of deposits unimpressionistic, work by the joint team of Southern Methodist and Khartoum Universities in site S-1C was terminated. (Marks 1991 : 57 - 60).

5.1.1.3 Shaqadud midden (S-1B)

It is a large site, c.15000 sq. m. and extends across the whole of the box canyon, as well as 240 m out along it. As the midden extends northwards, the occupation debris decreases from over 3 m to less than 20 cm. at the mouth of the canyon because of erosion and deflation factors (Marks et al 1985 : 265) (fig.47). The midden contains both Khartoum Mesolithic and Khartoum Neolithic cultural deposits. A series of radiocarbon dates were obtained for the midden cultural levels (Khartoum Mesolithic levels), the oldest being 6625 ± 445 B.C. (SMU-1736) and the youngest is 4630 ± 130 B.C. (SMU-1287). The Khartoum Neolithic levels of the midden got two radiocarbon dates in the magnitude of 4880 ± 330 B.C.(SMU-1735) and 4430 ± 80 B.C. (SMU-1134) (cf. section 10.1.1.3 and appendix 6).

5.1.1.4 Shaqadud Cave (S -1A)

It is set at back of the box canyon (fig.49). The site was first excavated by Otto (1963) who made a test pit at a depth of c.60 cm below surface (fig. 18). The site covers an area of c. 36 m but due to the very low roof of the cave only c.9 m were excavated by a joint team from Southern Methodist/Khartoum Universities in 1981/82 field season (Mohamed - Ali and Marks 1984:52-59; Robertson and Marks 1985:515-534 and Marks 1991:53 - 60).

The Cave site yielded cultural material down to a depth of c.3.5 m before hitting bedrock. The ceramic assemblage of this locality is of post-Khartoum Neolithic age, dated to the third millennium B.C. (cf. section 5.2). Five radiocarbon dates were obtained for different levels of the cave. The oldest being 2700 ± 170 B.C. (ETH 045-0447), whereas the youngest is 1990 ± 130 B.C. (SMU-1133) (Marks 1991 : 61 and appendix 6).

5.1.2. Geology

Shaqadud area is part of the vast Butana plain (fig. 50). The geology of the study area (Western Butana region) is comprised of four distinctive units. These units include 1) gravels and superficial deposits 2) Butana clays 3) Nubian

Sandstone Formation and 4) Basement Complex. (Whiteman 1971:127 and Vail 1982 : 60).

Gravels and superficial deposits:- These are the youngest cover of the area which are still being formed today or which are of relatively recent origin. Wind-blown sands cover almost all the Butana region. These sands are usually of rounded quartz grains which are stained red by surface oxidation. East of the Nile, particularly around the north side of the Butana, a remarkable deposit occur (ibid).

In east of the Gezira plain thin, black soils and silt which are the characteristic of the Butana plains have been called Butana clays. These clay beds were transported as evident from their layered nature, and argillaceous character regardless of whether they overlie Nubian Formation sandstones and grits, Basement gneisses and granites, green schists or igneous ring-complexes (ibid).

The alluvial clays in the form of clay and silt terraces are well-developed on the town of Wad Ben Naga. These terraces border on the Nubian Sandstone Formation, while on the right bank, where rocks of the Basement Complex predominate, these terraces are poorly developed and in some areas almost non-existent (ibid).

Nubian Sandstone covers almost all the Butana plain. This formation composed of conglomerates, intraformational conglomerates, grits, sandstones, sandy mudstones and mudstone. Colours vary considerably at outcrop dependent on the nature of weathering as well as the original chemical composition. The cement in the Nubian Sandstone is commonly iron oxide or iron carbonate. Calcium carbonate or silica cement also occur. In general the formation is poorly cemented and of medium hardness (Whiteman 1971:62). No evidence of fossil wood has been recorded from this area so far, although small pieces of it do occur among the debitage at the site complex of Shaqadud (Magid 1991:23).

Basement Complex consists largely of undifferentiated metamorphic and sedimentary rocks and is believed to be pre-Cambrian age (Whiteman 1971:5). This geological formation crops out east of the Blue Nile in parts of the Butana plain. The main outcrop of the Basement Complex in the area is at the sixth cataract on

the Nile some 50 miles north of Khartoum. Another outcrop is at Jebel Qeili about 85 miles north of Khartoum. East of the sixth cataract there is a broad ridge of smaller outcrops that extends to Jebel Qeili and corresponds approximately to the drainage trend north and south of it (Whiteman 1971:112).

The main rock types of this lithological unit include:-

a) a band of granite which occurs at Jebel Fau in the Western Butana plain east of the River Rahad.
b) Mica schists and green schists occur in some parts of western and eastern Butana.
c) limestone rocks are also present in scattered localities in the Butana near Jebel Qeili (Vail 1982 : 57).

5.1.3 Topography

The plains of Butana, in general, are undulating. Five sheets of sand and silt covered elevated ground, along the banks of watercourses and streams, in areas of hillocks and in the depressions between Nubian Sandstone outcrops. Soils of this region can be defined as in nature because they are not completely developed as a result of several factors, among which climate effects such as high temperature, erratic precipitation, high evaporation rates and surface winds (i.e. sandstone) seem to play a major factor (Magid 1991:23-24). It has, therefore, been assumed that the upper layers of the recent Butana deposits are natural product of the present climatic conditions but this does not necessarily to have been the case for older strata (Andrew 1948:117).

The drainage system consists of water-courses and occasional streams (khors and Wadis) which are characterized by remarkable variability in size, depth, length and width. Since the rain is seasonal (between July and September) and remarkably low (150mm), none of water-courses and streams hold water all the year, except in rare examples when there is a year with heavy rain storm. Some of these several streams occasionally flowed as far as the Nile, some 50 km to the west (Magid 1991:23-24).

5.2 Archaeological Sites and Ceramic Material

5.2.1 The site of Shaqadud midden

The excavation on the midden (fig. 48) was concentrated on the southern end as it was the deepest and rich part of it and there was a decrease in the midden thickness towards the northward direction. The main part of the western edge of the midden has been excavated by Otto (1963 : 108 - 115). An undisturbed area on the eastern half of the midden covering about 300 sqm. were chosen for excavation. Six excavation units of 1 sqm. were tested. These squares (H,I, H7, 17, J17 and J18) were excavated to a depth of 3-10 m below midden datum or 3 m below the surface (Marks 1991:42 - 43).

About 2.0m. below the surface there is an abrupt change in the nature of pottery. The thick simple, hard potsherds were superceded, with a 15 cm depth, by sherds that are similarly thick with unslipped and unburnished surfaces. About 1.5 m. below the midden surface Khartoum Mesolithic type of pottery gave way to Khartoum Neolithic type. It is noteworthy that this change was not accompanied by change in lithic technology or other material culture which remained essentially the same. The only major change in design elements correlated with this technological break is the disappearance of wavy-line motifs made with dragged comb and its replacement by a dotted-wavy line motif seemingly executed by rocker stamping with a toothed comb. To what extent can this ceramic break be correlated with a change or constancy in fabric composition?; is a question that will be addressed in the forthcoming sections (cf sections 3.8 and 3.8.1).

a) Mesolithic Levels (3.10 - 1.25 m in depth)

The bulk of of the potsherds are decorated (c.75%), undecorated specimens amounting to c.25% of the total. Banded decoration is the most favourite motif, being present at c. 24% of the total sherds. Dotted zigzag has been recorded in similar proportion, being present at 21% of the total specimens. Mat impression is frequent, occurs at c.16% of the total number. Wavy-line which is the diagnostic decoration of the Khartoum Mesolithic (cf. Arkell 1949) present in small amount about c.6% of the total collection. The rest of the motifs are apparently rare all of which present below 1% of the total specimens recorded. These include fishnet,

triangles and vees. (Marks et al 1985 : 265 - 270 and Mohamed-Ali 1991 : 65 - 93.).

b) Neolithic Levels (1.25 - 0. m in depth).

In these levels of the midden, the undecorated sherds are the most popular class (c. 36% of the total). Zigzag dotted lines is a prominent motif (c.26%), Mat impression is frequent, being present at c.15% of the total specimens. Banded motif which is the most popular decoration in the Mesolithic levels of the midden (see supra) is present here in rare proportion (c.2%). Wavy-line, the hallmark of Khartoum Mesolithic is absent (see supra) and dotted-wavy line is present in very low proportion (c.3%). The remaining motifs are either very low in proportion (lined zigzag) or rare (dotted straight, continuous straight and fishnet) (ibid).

Decoration techniques used for executing these decorations include: incision, impression rocker stamping and alternately pivoting (cf. section 5.7).

In both the Mesolithic and Neolithic levels of the midden, the surface colour of the fine pottery is mainly light reddish brown (5YR 6/4 Munsell soil colour chart 1975) and very pale brown (10YR 7/3 Munsell), whereas the coarse pottery exhibit pinkish grey (7.5 YR 6/2 Munsell), light brownish grey (10YR 6/2 Munsell) or greyish brown (10YR 5/2 Munsell). (cf. section 5.7).

There was a complete absence of pots or sherds that can be reconstructed to form complete or semi-complete vessles. It was, rarely, possibe to infer from the very few bases and rims the shapes and forms of vessels. Pots seem to have direct rims and conical bases.(ibid).
Wall thickness of coarse ware ranges from 5-10 mm, while the fine wares irrespective of colours, have walls which range from 3 m and 5 mm (Marks et al 1985 : 272; Mohamed-Ali 1991:83 and section 5.7).

No kilns, wasters or specialized tools were found. Therefore, the source of the midden pottery has been investigated on the basis of a series of physico-scientific analyses (cf. sections 5.5, 5.6 and 5.7).

5.2.2 The site of Shaqadud Cave

The site was first test-excavated by Otto of Humboldt University, Berlin, who dug a test-pit (fig.49) in the form of roughly rectangular shape (Otto 1963:108-115), covering about 12 sq. m. and reaching 65 cm below surface. Some of this depth has been refilled by washed-in silts and gravels (Marks 1991:49). A joint team from Khartoum-Southern Methodist Universities continued work at this site through two field work seasons: 1981/82 and 1982/83 during which four units were excavated. These include B5-6, C5-6, D6 and E6 (cf. fig. 49). These new units were adjacent to Otto's trench so that they can be tied directly to the other trench units. During 1982 field season the work was expanded to include units B8 through 18, and then expanded again 50cm eastward in four units, B9 through E9 (cf. fig.49). Excavation was undertaken using arbitrary stratigraphy of 5 cm spits because natural stratigraphy was not visible. The excavation was made to increase the artifact samples by excavating below the floor of Otto's spit in 1 sqm. area where it was possible to remove part of the rockfall. Since the northern and eastern edges of Otto's excavations stopped at a sizable rockfall on the north and the edges of the Cave on the east, it was decided to extend his excavations to the south and west, with more emphasis on the western side, since the back of the Cave was only a few meters from the southern edge of his old sounding (cf. fig. 49 and Marks 1991:49 - 57).

The cultural material recovered from the Cave consists mainly of ceramics, chipped and grinding stones, plant and animal remains (Marks et al 1985:261-287; Robertson and Marks 1985:515-534 and Marks 1991:49 - 57).

The ceramic finds of the Cave (n=3634) exhibit two different groups:- one group recovered from the lower levels of the Cave and the other one from the upper and middle levels (Marks et al 1985: 261 - 278 and Robertson 1991 : 123 - 172).

a) Lower Cave (3.70 - 2.05 m in depth)

The lower layers of the Cave displayed new decorations atypical to those found in the Neolithic/Mesolithic midden (see supra), they are extremely rare and are present in the form of "chard" marks over the body of the vessel or a band of

triangular stamped impressions just below the rim of what mostly appeared to be thin, thin, black-slipped open bowls (Marks et al 1985 : 272 and section 5.7)

Upper and middle Cave (2-0m in depth)

The ceramic assemblage of these parts of the Cave is characterized by wiped and burnished, unslipped ware with striations reminiscent of brush strokes and rims of grooved incised lines forming chevron, diamond or hachured zones and fingernail impressed ware (ibid).

Decorative techniques used for executing these decorations include incised, impressed, combing, rocker stamping, single stamping and alternately pivoting (Robertson 1991:123 - 172).

The surface colour of the pottery is mainly reddish brown (2.5YR 5/4 Munsell soil colour chart 1975) light brown (5YR 6/4 Munsell) and grey (10YR 5/1 Munsell). The slip colour varies in the total collection but basically brown (7.5YR 5/2 Munsell) or buff (7.5YR 7/8 Munsell). Fractures generally break with shades of different colours (2.5Y N4/0, 7.5 YR N3/0, 7.5YR N4/0, 10YR 5/1, 10YR 6/2 Munsell) (cf. section 5.7).

No complete pots were found but judging from rim shapes and diameters, most ceramics seem to exhibit small, thin, black slipped open bowls, the remaining potsherds with flaring necks seem to belong to jars. Wall thicknesses range from 2-19 mm with predomination of these from 4-7 mm (ibid).

No kilns, wasters or specialized tools were found. Hence, the lithological provenance of the pottery has been pursued through a series of physico-scientific analyses (cf. sections 5.5, 5.6 and 5.7).

5.3. Petrological analysis

5.3.1 Introduction

The present author has conducted a petrographic examination of 48 potsherds representing all sampled sites and time periods (Mesolithic and Neolithic) of the Western Butana region. The samples represent all the fabric variations and the range of the main decorative motifs (tables 31,32) diagnostic of time periods, found at each sampled site. Quantitative estimate of fabric mineralogy was obtained, as noted above (see e.g. section 4.3), by point-counting technique (figs.13,14). Counts were obtained for all different identifiable grains comprising the aplastic mineral inclusions occur in the samples. Detailed descriptions of the fabric groups (designated A,B,C) and the subgroups follow (1)

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(1) All the groups of pottery specimens in this chapter will be referred to by the numbers assigned to them in the fabric descriptions above with the prefixes SHAG (M,M), SHAG (M,N) and SHAG (C), referring to Shaqadud midden (Mesolithic Levels), Shaqadud midden (Neolithic Levels) and Shaqadud Cave sites respectively. All the fabric groups will be referred to by alphabetic letters (A,B,C). Subgroups of the fabrics will be referred to by their appropriate number and prefix.

5.3.2 Fabric descriptions of Shaqadud midden Pottery:Mesolithic Levels

Some 13 specimens representing the fabric variables of Shaqadud midden site pottery (Mesolithic Levels) were examined. As a result two main fabric groups (designated A and B) have been identified on the basis of the same criteria used for the classification of the former fabrics (e.g. see section 4.3). Detailed descriptions of the fabrics will be given below.

Group A

Specimens SHAG (M,M) 1; SHAG (M,M) 10; SHAG (M,M) 12; SHAG (M,M) 19 - SHAG (M,M) 20.

This group is characterized by a high amount of quartz (c.72%), being present at 15-25% of any visual field. Most quartz inclusions (c.90%) are monocrystalline. Feldspars (microcline, orthoclase and plagioclases) are relatively rare (c.13%), occur at c. 2-3% of the specimen area. Iron oxides are common (c.8%), being present at 1-2% of the specimen area. Mica is occasionally present (c.5%), occurs at less than 2% of the specimen area. Hornblende and rock fragments (each c.1%) and zircon (c.0.5%) are extremely rare, being present at c.1% of the specimen area. (fig.53, pl.98).
Organic inclusions are not present.

Mineral grains are mostly subangular and angular (c.83%), subrounded to rounded crystals are present in relatively low proportion (c.17%) and of low to high sphericity. A few grains of quartz (c.5%) and iron oxides (c.3%) are exceptionally larger, exceeding 1 mm in length, exclusively rounded and well rounded.

Grain sizes of the minerals are, in most examples (82%), in the range of 0.400 - 0.500 mm across, minerals within this size dimension are mainly quartz and iron inclusions (c.78% and 62% respectively). The maximum size ranges from 1-2 mm across, only some quartz and rock fragments fall within this size grade. Particles of sizes in the range of 0.060 - 0.300 mm across are frequent and all the minerals listed above display this size range but with varying proportions.

All the non-plastic minerals of this fabric, except some bladed flakes of mica, tend to exhibit random orientation relative to wall surfaces.

In PPL the matrix ranges from light brown, brown and light reddish brown, while in XPOL the colour shades from brown to dark brown and reddish brown respectively.
The groundmass, in general, tends to show neutral optical density.

The suite favours a sedimentary origin as indicated by the presence of high amount of quartz grains, scarcity of feldspars and frequent occurrence of iron inclusions. The Nubian Sandstone Formation which is quartz-rich and often highly ferruginous (see Whiteman 1971:62), prevailing in the area of the site, is a most likely source (see section 6.6.1 for further discussion).

Group B

Specimens SHAG (M,M) 5; SHAG (M,M) 8; SHAG (M,M) 9; SHAG (M,M) 21 - SHAG (M,M) 25

This fabric is distinguished by the presence of high amounts of K-feldspar (microcline and perthite) (c.59%). Feldspar inclusions occur at c. 15-35% of any visual field. Quartz is the next frequent non-plastic mineral (c.15%), making up to c.8 - 15% of the specimen area. Mica (biotite and muscovite) is common within this fabric (c.11%), being present at c.5-21% of the specimen area. Rock fragments are occasionally conspicuous, metamorphic and igneous rocks are in evidence, though the latter is more frequent. They account for c.8% of the specimen area. Iron inclusions are rather frequent (c.6%), being present at c.3 - 5% of the specimen area. Hornblende and zircon are extremely rare (c.1% each), being present at c.1% or less at the specimen area. (fig. 51, pl.99).
Organic inclusions are not present.

The aplastic mineral grains are mostly subangular or angular (c.79%), subrounded and rounded crystals are much less common (c.18%). Iron oxides (c.3%), often present in the form of irregular masses whereas bladed shapes are restricted only to mica scales (biotite and muscovite).

Inclusions above present wide range of sizes from 0.060 mm up to about 2 mm. The majority of grains sizes occur between 0.400 - 0.800 mm across (c.83%), most inclusions fall within this size range are feldspar (microcline and plagioclases) and quartz. The maximum size ranges from 1 -2 mm, only quartz and rock fragments, frequently, occur at this size dimension.
Non-plastic inclusions are generally unevenly distributed through the paste and they tend to show random orientation relative to wall surfaces.
The overall distribution of the grain sizes above silt size tends to show a fabric of coarse grained texture.

In PPL the matrix colour ranges from pale, medium brown to light reddish brown, while in XPOL the colour changes to brown, dark brown and reddish brown respectively. Some mineral particles are occasionally stained with black spots of iron oxides.
In general, the matrix tends to show low optical density.

The predominance of non-plastic inclusions which are composed of perthite and microcline feldspar coupled with the extreme rarity of polycrystalline quartz seem to suggest that this suite is in favour of igneous source. Two main sources of igneous rocks in the study area immediately present themselves. These are the Basement Complex outcrops that are located at Sabaloka Gorge, some c. 80 km. west of Shaqadud site and near Jebel Ǫeili south east of Shaqadud (for further discussion see section 6.6.1).

5.3.2.1. Intercomposition of Pottery Fabrics within Site.

In terms of individual minerals, the two fabrics (A and B) of the Mesolithic levels at Shaqadud site are similar with respect to the types of minerals present but with varied proportions. Quartz is numerous in fabric A and it is present in, notably low proportion in fabric B, feldspar (mostly perthite and microcline which shows relative high proportion at fabric B is rare at fabric A. Minerals such as hornblende and rock fragments are rare in fabric A, being absent at fabric B and when occurs in the former, they are scattered liberally through the paste. Zircon is similarly scarce in both fabrics.
Organic matter was not observed in all the sections examined.

Both fabrics are comparable with respect to the degree of roundness and shapes. Most are subangular or angular as indicated above (see supra, this section). Iron oxides occasionally present in the form of irregular masses, whereas bladed shapes are restricted only to mica flakes (biotite and muscovite) that occur at the two fabrics.

In overall grain size distribution the two fabrics exhibit, in the majority of instances, nearly the same range of sizes (c.0.400 - 0.600 mm across), though the concentration of larger sizes (above 0.600 mm) at fabric B is higher than as that of fabric A. The maximum grain size in both fabrics ranges from 1-2 mm across and only quartz and rock fragments, frequently, occur at this size dimension. All the non-plastic minerals are scattered liberally through the paste. The overall particle distribution above 0.060mm shows a coarse grained texture.

In plane polarized light (PPL), both fabrics tend to show the same range of colours including pale, medium brown and light reddish brown, while under crossed polars (XPOL) the fabrics alter to brown, dark brown and reddish brown respectively.

The geological sources of both fabrics are, seemingly, different. Fabric A recalls a sedimentary provenance, the high amount of quartz, scarcity of feldspar and fair frequent occurrence of iron oxides favour this assumption. Fabric B is more likely an igneous in origin and the predominance of K-feldspar of polycrystalline quartz and lower proportion of iron oxides are suggestive.

5.3.3. Fabric descriptions of Shaqadud midden Pottery:Neolithic Levels.

Some 12 specimens representing the fabric variables of the Neolithic cultural levels of Shaqadud midden were examined. As a result two main fabric groups (designated A and B) have been identified on the basis of the same criteria used for the classification of the previous fabrics (e.g. see section 5.3.2). Detailed descriptions of the fabrics will be given below.

Group A

Specimens SHAG (M,N)2-SHAG (M,N)4; SHAG (M,N)13 - SHAG (M,N)18.

This fabric group is distinguished by predominance of non-polycrystalline quartz (c.84%), being present at c.20-40% of any visual field. Iron inclusions are the next prominent minerals but with markedly lower proportions (c.12%) than quartz, being present at c.3-8% of the specimen area. Feldspar (only plagioclases) and hornblende are extremely rare (c.1% each), being present at less than 1% of the specimen area. Accessory minerals comprising rutile, zircon and epidote are similarly scarce (c.2% of the total minerals), being present at 1% of any visual field. (fig. 52, pl.100)
Organic material is absent.

The aplastic mineral grains are mostly subangular or angular (c.79%). Subrounded to rounded crystals are present in much lower proportion (c.20%), being present at c.3-10% of the specimen area. Only 1% of iron inclusions occurs in the form of masses of interlocking character.

The majority of mineral grains above 0.06mm are in the range of c. 0.300-0.500 mm across (95%), minerals fall within this size are exclusively quartz. Iron oxides are mostly present in the size range of 0.300 - 0.485 mm across but often tend to show sizes up to 0.600 mm. Rare non-plastic minerals (zircon, rutile, hornblende and epidote) exhibit particle dimensions in the order of 0.100 - 0.380 mm across and in exceptional instances exceeding that limit up to 0.550 mm. With the exception of iron oxides and the accessory minerals (zircon, rutile, hornblende and epidote), the aplastic components are generally medium to coarse grained in texture. The overall grain size distribution indicates rather ill-sorted material. All the non-plastic inclusions display random orientation in relation to the wall surfaces.

In PPL the matrix colour ranges from pale brown, while in XPOL the colour shades from medium brown, yellowish brown to reddish brown respectively.
In general, the matrix tends to show neutral optical density.

The minerals of this fabric group favours an origin in or close to exposures of sedimentary source. This is indicated by the occurrence of numerous quartz inclusions, frequent occurrence of iron oxides coupled with almost complete absence of feldspar (see section 6.6.2 for further discussion).

Group B

Specimens SHAG (M,N)3; SHAG (M,N)6; SHAG (M,N)7; SHAG (M,N)11.

This group is predominantly composed of feldspar (c.66%), being present at c.20-40% of any visual field. Perthite is the most prominent (c.46%), microcline is the next pronounced mineral (c.15%) and plagioclase is relatively rare (c.5%). Quartz grains are less prominent than feldspar (c.22%), being present at c.5-15% of the specimen area. Iron oxides are rather frequent (c.6%), being present at c.2-3% of the specimen area. Mica (biotite and muscovite) is rare (c.3%), occurs at c.1% of the specimen area. Rare minerals also include accessories of hornblende, zircon and epidote (c.1% each), were identified at only two specimens: SHAG (M,N)7 and SHAG (M,N)9 each of which present at 1% of the specimen area. (fig.52, pl.101).

Mineral grains are, in most instances, subangular or angular (c.81%), subrounded or rounded crystals, though present, are relatively low in proportion (c.19%) and they range from low to high sphericity.

Most of grain sizes (c.80%) fall in the order of 0.300 - 0.580 mm across, minerals with this size range are mainly feldspar and quartz. The bulk of these aplastic inclusions are in a dimention below 0.400 mm across. The maximum grain size dimension being 1-2 mm across. Grains within this size range are mainly feldspar and quartz. Minerals in the range of 0.065 - 0.200 mm across are generally less prominent in amounts, of which hornblende, zircon and epidote are the most conspicuous.
All the non-plastic particles are found in random orientation in relation to the wall surfaces.

In PPL the matrix colour ranges from pale or medium brown to light reddish brown, while in XPOL the colour shades from brown, dark brown to reddish brown

respectively. Most of specimens belong to this fabric group tend to exhibit anistropic matrix under XPOL.
In general, the matrix tends to show neutral optical density.

The predominance of perthitic and microcline feldspar coupled with frequent occurrence of iron oxides and relatively lesser amount of non-polycrystalline quartz seem to suggest an igneous origin for this fabric group (cf. section 6.6.2).

5.3.3.1 Intercomposition of pottery fabrics within site

Mineralogically, fabric A differs from fabric B particularly in quartz, of which it has higher content and feldspar, of which it has rare proportion. Perthite is the most prevalent type of feldspar in the composition of fabric B. Iron inclusions are twice higher in fabric A than in fabric B. Iron inclusions are twice higher at fabric A than in fabric B. Mica (mainly muscovite) is scarce at fabric B and absent at the specimens of fabric A. Zircon, hornblende and epidote are extremely rare in both fabrics (see fig. 52).

Both fabrics are similar in roundness and shapes of mineral grains. The majority are subangular or angular, subrounded to rounded minerals are present in lower percentages. Iron oxides, in rare instances, tend to occur in the form of irregular masses.

In overall grain size distribution, the two fabrics are more or less the same, displaying grains sizes, in the majority of cases, in the dimension of c.0.300 - 0.500 mm across. In exceptional examples, grains of quartz in both fabrics ranging up to 2 mm across. Subordinate minerals (hornblende, zircon, rutile and epidote) in the two fabrics tend to show particles dimensions in the order of 0.150 - 0.350 mm indicative of medium grained texture.

The overall grain size distribution tends to indicate, in general, medium to coarse grained texture and rather ill-sorted material indicative, perhaps, to imperfect mixing and or insufficient kneading.

The two fabrics (A and B) are rather homogenous as regard colour of the groundmass in plane polarized light (PPL) and under crossed polars (XPOL). In PPL both fabrics tend to show light brown, brown and pale reddish brown colours, while in XPOL these colours alter to brown, medium brown and reddish brown respectively. Fabric A often differs from fabric B in having light yellowish brown matrices in PPL which turns to yellowish brown in XPOL.

It seems that the source of both fabrics is not the same. The predominance of non-polycrystalline grains of quartz, frequent iron oxides and the absence of feldspar suggestive of sedimentary origin for fabric A. On the other hand, the prevalence of perthitic feldspar in fabric B favours an igneous source (see section 6.7 for further discussion)

5.3.4. Fabric descriptions of Shaqadud Cave Pottery: late Neolithic period.

Some 23 specimens representing the fabric variations of Shaqadud cave pottery were examined. As a result three main fabrics have been identified on the basis of the same criteria used for the classification of the former fabrics (e.g. see section 5.3.3). These fabrics have been identified as groups A, B and C. The former fabric group has been divided into Subgroup A1 and Subgroup A2 as follows:

Group A

Subgroup A1

Specimens SHAG(c)1; SHAG(c)4; SHAG(c)6; SHAG(c)9; SHAG(c)12; SHAG(c)21; SHAG(c)23.

This group is characterized by abundant non-polycrystalline inclusions of quartz (c.61%), being present at c.15-30% of any visual field.
Feldspar is frequent (c.27%), being present at c.10-15% of the specimen area, both microcline and plagioclases are in evidence though the former is more frequent. Iron inclusions are the next minerals (c.6.1%), being present at c.2-3% of the specimen area. Rock fragments are rare (c.3%), three varieties of rocks (igneous metamorphic and sedimentary) are in evidence, though the former (igneous) is more frequent. The rock fragments are present at c.1-2% of the specimen area.

Mica (biotite and muscovite), hornblende, zircon and epidote (c.1% each) are extremely rare, being present at c.1% of the specimen area (see fig. 53, pl.102)
Organic matter is not present.

The majority of mineral grains at 0.06 mm and above are subangular or angular (c.80%), while subrounded, rounded and well rounded crystals are relatively low in frequency (c.19%) in the whole section. Biotite mica (c.1%) occasionally presents in the form of bladed flakes.

The majority of mineral grains (c.85%) are in the range of 0.350-0.900 mm across, inclusions fall within this range are mainly quartz and feldspar. The maximum grain size range is c.1-1.08 mm across, quartz and rock fragments frequently fall within this limit, while feldspar (microcline) rarely presents within this size. The minimum size range is 0.060-0.125 mm across, mica, hornblende and iron oxides, in most cases, fall within this size dimension.
The material is generally rather well-sorted.
All non-plastic inclusions, except some bladed mica flakes, appear to be randomly oriented to wall surfaces.

In PPL the matrix colour ranges from pale brown, light yellowish and light reddish brown, while in XPOL it ranges from brown, yellowish brown and reddish brown respectively.
The matrix, in general, tends to show neutral optical density.

The abundant quartz grains, the appreciable amounts of feldspars coupled with frequent occurrence of iron inclusions and occasional presence of rock fragments (mainly igneous and occasionally metamorphic and sedimentary) raises the probability that the most likely source for this suite is quartzo-feldspathic gneisses. Such rocks are widely spread in Sudan (Whiteman 1971). The nearest better known source to the site is at Sabaloka, some 50 km to the south west (fig.4) (for further discussion see section 6.6.2.2).

Subgroup A2

Specimens SHAG (c)3; SHAG(c)7; SHAG(c)8; SHAG(c)10; SHAG(c)13-SHAG(c)14; SHAG(c)16

This fabric subgroup is characterized by abundant inclusions of non-polycrystalline quartz (c.50%), being present at c.20-30% of any visual field. Calcitic inclusions in the form of lithic fragments are the next most frequent minerals (c.40%), being present at c.15-25% of the specimen area in most of the sections (specimens:SHAG(c)3; SHAG(c)7; SHAG(c)8; SHAG(c)13 and SHAG(c)16). The rock fragments are embedded in calcite (limestone) matrix. Iron oxides (c.5%) are present at c.2% of the specimen area. Minerals which are extremely rare include feldspar (c.2%), mica, hornblende (c.1% each), zircon and rutile (c.0.5% each). All these minerals are present at 1% or less of the specimen area (see fig. 53, pl.103).

Most non-plastic components are subangular or angular (80%), subrounded and rounded crystals are present in relatively lower proportion (20%).

The majority of the aplastic minerals (82%) are in size range of 0.100 - 0.300 mm across, of which quartz is the commonest. About 12% of non-plastic mineral grains are in the range of c.0.300-0.400 mm across, of which quartz, feldspar and rock fragments are the most frequent. A small proportion of the aplastic minerals (c.4%) is in size range of 0.060-0.098 mm across. Grains fall within this latter size class are largely some quartz, mica and iron inclusions. The largest dimensions of grain sizes ranging between 0.800 - 2mm across, only rock fragments and quartz are often present within this size range.
The non-plastic inclusions tend to show ill-sorted texture.

In PPL the matrix shades from pale grey, reddish brown to medium brown, while in XPOL the colours range from whitish grey, dark reddish brown and dark brown respectively.
In general, the matrices tend to show low optical density.

The occurrence of abundant inclusions of limestone fragments and the calcitic nature of the matrices of most of the specimens of this fabric favour an origin in or near deposits of sedimentary source (see section 6.6.2.2 for further discussion).

Group B

Specimens SHAG(c)2; SHAG(c)5; SHAG(c)11; SHAG(c)14 -SHAG(c)15, SHAG(c) 18-SHAG(c)20.

This group is distinguished by considerable amount of quartz grains (c.36%), being present at c.15-25% of any visual field. Feldspar (mostly perthite and microcline) occurs in fairly frequent amount (c.20.4%), being present at c.15-20% of the specimen area. Mica (biotite and muscovite) is similarly frequent (c.21%), being present at c.12-15% of any visual field. Muscovite is the commonest scale of mica (c.63% of the total mica). Hornblende is rather common (c.8%), being present at c.3-5% of the specimen area. Iron inclusions are relatively less common (c.6%), being present at c.2-3% of the specimen area. Rock fragments (igneous type) and zircon are extremely rare (c.1% each), being present under 1% of the specimen area. (fig. 53, pl.104).
Organic matter is not present

The bulk of the non-plastic mineral constituents are subangular or angular (c.79%), subrounded or rounded minerals are present in relatively lower proportion (c.20%). Biotite mica rarely tends to show bladed shapes. Iron oxides, in a few instances (c.1%) appear as irregular masses.

Inclusions in the size of 0.06 mm and above are frequent within this fabric group, being mostly (c.80%) present in the size range of 0.200 - 0.400 mm across, quartz, feldspar (perthite and microcline) and mica (muscovite) fall within this size dimension. About 17% of overall mineral grains are in the range of 0.350 - 0.440 mm across, of which quartz inclusions are the most prominent. A small percentage (c.3%) is about 0.450-0.585 mm across in size, of which microcline feldspar and muscovite mica are the most pronounced. Grains in this latter size range are largely quartz, rock fragments and iron oxides.
The non-plastic minerals, in general, tend to show well-sorted material.

In PPL the matrix colour changes from pale brown, light reddish brown and medium brown, while in XPOL the colour shades into brown, reddish brown and dark brown respectively.
In general, the matrices tend to show neutral optical density.

This fabric group is composed of abundant non-polycrystalline quartz and K-feldspar (igneous source) and appreciable amount of hornblende (metamorphic source) suggestive of a mixture of tempering materials from igneous and metamorphic sources (mixed lithography) (cf. section 6.6.2.2).

Group C

Specimen SHAG(c)17

This group is characterized by predominance of hornblende (c.40%), being present at c.15 - 30% of any visual field. Quartz is the second prominent mineral inclusion (c.27%), being present at c.10-18% of any visual field. Feldspar is present in a slightly lesser proportion (c.24%), occurs at c.10 - 15% of the specimen area. Plagioclase is the dominant type of feldspar present (c.22% of the total feldspar). Microcline is present in a much lower percentage (c.3%). Iron oxides are rather common (c.7%), being present at 2% of the specimen area. Mica (muscovite) and zircon are extremely rare (each 1% of the total), being present under 1% of the specimen area. (fig.53, pl.104).

Non-plastic minerals are mostly subangular or angular (80%), subrounded or rounded crystals are relatively lesser in proportion and of low to high sphericity (20%).

The majority of aplastic minerals (c.86%) exhibit sizes in the range 0.100-0.298mm across, grains fall within this size range are mainly quartz and plagioclase feldspar, while hornblende crystals are mostly in the size range of c.1-1.2mm across, only a few crystals of quartz and plagioclase feldspar fall within this size. The minimum size range is c.0.060-0.090mm across, only a small proportion of quartz (c.10%) falls within this size dimension. A part from a few grains of quartz,

feldspar, iron oxides and zircon, most of the aplastic minerals tend to show fine to medium grained texture.

In PPL the matrix tends to show medium brown colour, while in XPOL it exhibits dark brown shade. Some portions of the thin section are isotropic as a result of some iron precipitate occurs as opaque.
In general, the matrix tends to exhibit low optical density.

The metamorphic origin of this fabric is suggestive by the occurrence of a high proportion of hornblende grains outnumbering all the aplastic inclusions present in the section. However, the local geology of Shaqadud site is mainly composed of Nubian Sandstone Formation overlain Basement Complex deposits (fig.4). The nearest source of metamorphic rocks to the site is the Basement Complex outcrops at Sabaloka Gorge some 50 km to the south-west, near Khartoum (see fig.4) where metamorphic rocks (including geneises and migmatites) are present. Therefore, it can, however, be said that the origin of this fabric is highly unlikely to be at Shaqadud site area in the western Butana and it is less likely to have been in the eastern Butana (khashm el Girba) which is composed of Nubian Sandstone Formation overlain Tertiary volcanic rocks (Shiner 1971:294-295). However, in the south-eastern Butana plain metamorphic rock exposures of rich-hornblende deposits prevail at Jebel Qeili some 133 miles distance from Shaqadud site (see fig.39) (Whiteman 1971:28-29 and Vail 1982:56-57). Due to the fact that Shaqadud site is much more nearer to Sabaloka Gorge, only 80 km north east of this geological outcrop, while the distance separating this site from jebel Qeili is nearly 212 km to the south-east, an origin of this fabric in Sabaloka Gorge area, near Khartoum seems more conceivable. (See section 6.6.2.2 for further discussion).

5.3.4.1. Intercomposition of Pottery Fabrics within Site

In regard to individual minerals the four fabrics (A1, A2, B and C) are within similar range of percentages for quartz, B and Subgroup A1 have the same proportion of quartz, whereas fabric Subgroup A2 holds slightly lesser proportion of this mineral and fabric C somewhat variable from the rest.

Feldspar which is almost absent at fabric Subgroup A2, being present at relatively higher proportions at fabrics A1, B and C. Rock fragments are absent at fabrics A1, and C, being present at high proportion at fabrics Subgroup A2.
Hornblende is extremely rare at fabrics Subgroups A1 and A2, rather frequent at fabric B and predominates at fabric C.
Organic inclusions appearing not to be present in the sections examined.

The grain size distributions in most fabrics, are generally comparable (fabrics A2, B and C) displaying particle lengths in the order of 0.100-0.300mm across. Fabric Subgroup A1 is the sole exception and it exhibits grain sizes in the range of 0.400-0.800mm across showing medium to coarse grained texture.

The four fabrics are similar with regard to the degree of grain roundness and shapes (mostly subgroup or angular). Subrounded to rounded crystals are occasionally observed and with low to high shericity.

The matrix of fabric Subgroup A2 which contains calcite inclusions (limestone) tends to be quite distinct and whitish grey colour prevails in all the sections having calcitic inclusions. In the rest of the sections of fabrics Subgroup A1, B and C the colours of the matrices are generally light brown or reddish brown in PPL and brown or dark brown in XPOL.

Fabrics Subgroups A1 and A2 are of sedimentary origin, however, the basic composition of the two fabrics is not the same. While fabric Subgroup A1 is distinguished mainly by abundant quartz grains and frequent iron oxides, fabric Subgroup A2 is distinguished by its calcitic nature and the predominance of limestone fragments. On the other hand, fabric B seems to be derived from a mixed lithography. It is mainly composed of abundant non-polycrystalline grains of quartz, k-feldspar and appreciable amount of hornblende (see section 6.7. for further discussion).

5.3.5. Intercomposition of Pottery Fabrics between sites

Fabrics A of the Mesolithic and Neolithic ceramics of Shaqadud midden and fabric A1 of Shaqadud Cave ceramics (late Neolithic period) hold appreciable amounts of quartz inclusions in the range of 84%, 72% and 61%, respectively, of the total mineral inclusions. The only exception being fabric A2 which is characterized by relatively lower quantity of quartz reaching c.50% of the total aplastic inclusions (cf. sections 5.3.2, 5.3.3 and figs.51,52 and 53 for further information pertaining to the fabric mineralogy which will be discussed below).

Feldspar is present in markedly lower proportions and often scarce in the fabric groups designated A, A1 and A2 of the Mesolithic and/or Neolithic ceramics. Fabric A of the midden Mesolithic and group A1 of the Cave late Neolithic ceramics exhibit relatively higher proportions of feldspars (c.13 and c.27% respectively) than in the remaining two fabrics (Group A of Shaqadud Neolithic and subgroup A2 of the Cave, late Neolithic ceramics) which are extremely rare, being c.1% and 2% respectively.

Iron oxides are rather frequent, being present, respectively, at c.13% c.12% and 6% at fabric groups of the midden Mesolithic, midden Neolithic and the Cave ceramics.

Mica inclusions occur in much lower percentages (c.5%) at fabrics A of the midden Mesolithic ceramics and are extremely rare at fabric subgroups A1 and A2 (each 1% of the total aplastic minerals) of Shaqadud Cave ceramics. It is absent in the composition of Shaqadud Neolithic ceramics.

Rock fragments are extremely scarce in fabric A of the midden Mesolithic (c.1%) and fabric subgroup A1 (c.3%) of Shaqadud cave late Neolithic ceramics. fabric A of Shaqadud midden Mesolithic ceramics is devoid of these minerals. Calcitic inclusions in the form of rock fragments are abundant in fabric A2 of Shaqadud Cave ceramics.

Hornblende is extremely rare at fabric A of Shaqadud midden ceramics (Mesolithic and Neolithic levels) and at Fabric A1 of Shaqadud Cave specimens. At all these fabrics it is present at c.1% of the overall non-plastic inclusions.

Minor minerals (Zircon, rutile and epidote) are extremely scarce in the composition of fabrics A of Shaqadud midden ceramics during the Mesolithic and Neolithic periods and fabric subgroups A1 and A2 of Shaqadud Cave ceramics during the late Neolithic period.

In fabrics B quartz (mostly non-polycrystalline) is present in much lower proportions than in fabric A of the Mesolithic and Neolithic ceramics in the Western Butana region. It is, however, present in markedly lower proportion (c.15%) at Shaqadud midden Mesolithic ceramics, relatively higher at the Neolithic ceramics of Shaqadud midden and more pronounced at the late Neolithic ceramics of Shaqadud Cave.

Feldspar distribution in the composition of fabrics B is different from that of quartz in fabrics, A, A1 and A2 of the Mesolithic and Neolithic ceramics of the Western Butana region. Fabrics B differ from fabrics A (see supra) in having relatively higher percentages of feldspars (mostly perthite) being c.20% at the late Neolithic ceramics of Shaqadud Cave and exceeding that limit up to c.46% and c.59% at the midden Neolithic and Mesolithic ceramics respectively.

All fabrics B of the Mesolithic and Neolithic ceramics from the Western Butana region show the same proportion of iron oxides, being c.6% each of the total mineral inclusions. In the meantime, these fabrics are similar to fabrics A as regard the percentage of iron oxides.

Contrary to the homogenous mica distribution at fabrics A of the Western Butana Mesolithic and Neolithic ceramics, fabrics B of the same ceramics tend to show varied proportions. While the midden Mesolithic fabric groups provide c.11% mica inclusions, the Neolithic fabric (Group B) of the same locality gives only c.3% of the total minerals identified. At the late Neolithic period (Shaqadud Cave) the percentage of mica (mainly muscovite) shows steadily increase, being c.21% of the overall non-plastic inclusions.

Rock fragments, as in fabric A, (see supra) are, in general, relatively frequent or extremely rare in fabrics B of the midden Mesolithic (c.8% of the total) and the Cave-late Neolithic-ceramics. Shaqadud midden Neolithic ceramics are devoid of these types of aplastic inclusions.

Hornblende of Shaqadud midden ceramics is extremely rare, being c.1% of the total inclusions at each of the Mesolithic and Neolithic ceramics. It shows relatively higher proportion at the late Neolithic ceramics of Shaqadud Cave.

Minor non-plastic inclusions (zircon, epidote and rutile) are extremely rare, being present at c.1% at each fabric of the Mesolithic and Neolithic ceramics.

Fabric C of Shaqadud Cave ceramics tends to share much more mineralogical affinities with fabric group B of Shaqadud midden Neolithic ceramics than with the remaining fabrics. The sole difference being the presence of relatively higher proportions of hornblende (c.41% of the total minerals) at fabric C, while this mineral is extremely rare in the rest of the Mesolithic and Neolithic ceramics.

Fabrics A and B of Shaqadud midden Mesolithic ceramics are distinct from those of Shaqadud midden Neolithic ceramics and Shaqadud Cave as regard the degree of grain size distribution. Though most non-plastic minerals (mainly quartz, feldspar, iron oxides and occasionally mica and rock fragments) of fabrics A(c.82% and B (c.85%) of Shaqadud midden Mesolithic ceramics are in the range of 0.400-0.800 mm across, the coarse grained minerals ($\geq$ 500 mm across) are exceeding 80% of the overall aplastic grains (cf. sections 5.3.2, 5.3.3 and 5.3.4). Therefore, the particle size distribution of fabrics A and B of Shaqadud midden Mesolithic ceramics is, mostly, coarse grained in texture. Medium and fine grained aplastic inclusions of fabric A (c.15% and 5% respectively) and group B (c.16% and 4% respectively) are, respectively, infrequent and rare. On the other hand, the pottery fabrics (Groups A and B) during Shaqadud midden Neolithic period tend to display non-plastic inclusions, mostly, (c.88% of the total), in size dimension of 0.300 - 0.490 mm across indicative of medium grained texture. Coarse grained aplastic minerals ($\geq$ 500 mm across) are present (c.8% of the total) but are markedly rare. Fine-grained mineral inclusions are extremely scarce, being only c.4% of the

overall inclusions. With regard to Shaqadud Cave pottery, it is remarkable that the bulk of its tempering inclusions are in the range of 0.200 - 0.400 mm across indicative of fine-grained texture. Medium (c. 12% each of Fabrics A1 and A2, c.17% at Fabric A and c.9% at Fabric C) and coarse-grained (≥ 500 mm across) textures (c.3% each at Fabrics A1, B,C and c.2% at Fabric A2) (cf. sections 5.3.4 and 7.8.2.2) are, respectively, infrequent and scarce.

All the Mesolithic and Neolithic ceramics of the Western Butana region (Shaqadud Complex) are very similar as regard the degree of roundness of the tempering inclusions. In all fabrics of the sampled Mesolithic and Neolithic ceramics (Shaqadud midden, Mesolithic and Neolithic levels and Shaqadud cave) non-plastic minerals are mostly subangular or angular. Fabric A of Shaqadud midden Mesolithic ceramics tend to show c.83% of the aplastic minerals being subangular or angular, whereas fabric B indicates that 79% of the tempering minerals are subangular or angular. The pottery of Shaqadud midden Neolithic levels provides similar percentages. Fabric A has 79% of subangular and angular minerals, while this degree of angularity reaches 81%at fabric B from the same locality. It is noticeable that fabrics A1 and A2 of the late Mesolithic ceramics at Shaqadud Cave are similar to the midden fabrics with respect to the degree of mineral roundness and shapes. Fabrics A1 and A2 of the Cave ceramics are mostly (each 80% of the total aplastic minerals) subangular or angular (see sections 5.3.2, 5.3.3 and 5.3.4).

In fabric B from the same locality, subrounded to rounded crystals are present in relatively low proportion, being c.20% of the total aplastic minerals. Fabric C is identical to fabric A2 and very similar to the remaining ceramic fabrics of Shaqadud complex,(see supra). subangular to angular minerals of this fabric (Group C) reaching c.80% whereas subrounded to rounded crystals amounting to only c.20% of the total minerals (ibid.).

In plane polarized light (PPL) some fabrics of the Mesolithic and Neolithic ceramics tend to display the same range of colours. Remarkably, fabrics A and B of Shaqadud midden Mesolithic ceramics, fabric B of Shaqadud midden Neolithic ceramics as well as fabric A1, A2 and B of Shaqadud Cave ceramics are almost identical. The sole exception is fabric A which sometimes tends to exhibit light

yellowish brown colour. Fabric C of the Cave ceramics is distinct for its shows brown and medium brown colour (cf. sections 5.3.2.1, 5.3.3.1 and 5.3.4.1).

Under crossed polars (XPOL) the fabrics, in general, are similar and they alter to relatively darker shades (ibid.).

Most of the fabrics of the Mesolithic and Neolithic ceramics from the Western Butana tend to show neutral optical density. Exceptions are matrices of fabrics A and B of Shaqadud midden Mesolithic ceramics and fabric group C of Shaqadud Cave late Neolithic ceramics, all of which display low optical activity (ibid.).

5.4. X-ray diffraction

5.4.1. Introduction

Some 12 diffraction analyses were performed on a series of Mesolithic, Neolithic and local modern pottery form Shaqadud complex site, viz midden (M-Meso. L and M-Neo.) and Cave (L. Neo.) in the Western Butana region. The results of the analyses are presented in table 34 and will be described as follows:-

5.4.2. Results

The X-ray diffraction analyses show that the composition of all the Mesolithic, Neolithic and modern samples is quartz-rich before and after firing to 700-900 °c.

Nearly all the samples from Shaqadud (midden and cave) site and the modern local pottery from the same vicinity indicate a weak presence of fine clay fractions (020).

Plagioclase feldspar shows very weak presence in almost all the Mesolithic and Neolithic samples of Shaqadud midden and cave. The modern pottery from the Western Butana presents an amount of plagioclase slightly higher than that in the ancient samples (Mesolithic and Neolithic), though its presence is still weak.

K-feldspar content of Shaqadud midden samples (Mesolithic and Neolithic Levels) is scarce and it is imperceptible in Shaqadud Cave specimens and the modern local pottery.

Hematite is invisible in all the samples of Shaqadud complex site. Its occurrence is, however, more pronounced after firing the sherds to temperatures in the range of 700-900°c in an electric oven for a period of one hour.

The presence of mica is not clear (sample:G93-07 and G93-18b) or very weak (sample:G93-066) in the midden samples and it is not observed on Shaqadud Cave pottery (samples:G93-18c) and the modern local pottery samples (G93-10a and G93-14a).

Anatase is generally inconspicuous in the samples from the midden (G93-07b and G93-18b) and often shows a very weak presence (G93-06b). The Cave analyzed pottery is devoid of this mineral.

A part from two specimens from Shaqadud midden (G93-07b) and Butana modern pottery (G93-10a), which indicate very weak occurrence of calcite, the amount of this mineral is exceptionally higher at Shaqadud cave (G93-18a). The pottery of the latter site presents moderate amount, being anomalous in comparison with this mineral concentrations in the remaining samples.

Mica and nearly all anatase minerals are absent after refiring the sherds at temperatures in the range of 700-900°c. The only exception being a single specimen belongs to the Neolithic levels of Shaqadud midden (sample: G93-11b) which indicates a very weak presence of anatase.

5.5. Chemical analysis

5.5.1 Introduction

Some 8 analyses by XRFS method were conducted on a series of Mesolithic, Neolithic and modern pottery samples from the Western Butana regions. The Meolithic and Neolithic pottery samples represent the three cultural phases of

Shaqadud complex site. These are Shaqadud midden: Mesolithic and Neolithic Levels and Shaqadud Cave deposits (see sections 5.2.1, 5.2.2 and tables 36-37).

5.5.2 Results

All the samples of the Mesolithic and Neolithic pottery from the midden and Cave deposits and modern comparative ceramics from the vicinity of the Western Butana region, show high index of silicon oxide mostly above 60 wght%. It is remarkable that the Mesolithic pottery sherds from the early midden (Mesolithic Levels) exhibit slightly higher percentages of Si02 than that reported from the lower midden (Neolithic levels) and the Cave (late Neolithic).

It is the second relatively higher element after silicon oxide (Al203), being present at an average of C.16% by weight. Its amount is comparatively higher at the samples of Shaqadud Cave being present at c.21 wght% at the average.

Iron oxide (Fe203) is a common element in all the samples, occurs in the order of c.6.3 wght% at the average. The distribution seems to be homogenous in almost all the samples during all periods (Mesolithic, Neolithic and modern). A sample of modern pottery from the Western Butana (sample:Butana M.P.(2)) being the only exception. It holds an amount of ferrous oxide (hematite) twice higher than at the remaining samples (C.11 wght%).

The proportions of Ti0 are very small in all the samples, little above 1% by weight at the average. The samples of Shaqadud are notably different, all of which are less than 1% by weight. A single sample representing the modern pottery of the Western Butana region has a value of c.1.1% by weight at the average.

Manganese oxide (Mn0) is present in all the samples with very similar proportions. The samples of all periods (Mesolithic, Neolithic and modern) hold rare amounts of Manganese which occur at less than c.0.1% by weight in most cases.

The percentages of Magnesium oxide (Mg0) is notably very little, being present at 1.1 wght% at the average. A sample of Butana modern pottery (sample: Butana M.P.(2)) is the only exception. It is present in amount of 4% by weight.

Calcium oxide (Ca0) occurs in nearly all the samples through all periods with similar amounts being c.2% by weight at the average. The sole exception is a modern pottery sample from the same area (sample: Butana M.P.(2). This sample contains calcium oxide at c.5% by weight.

Sodium oxide (Na20) was detected in almost all the samples with similar proportions, being c.0.5 wght% at the average. Again the other sample of modern pottery (sample: Butana M.P.(2)) shows relatively higher percentages of sodium being c.3 wght%, though it is still very small in amount.

All the samples hold very small amounts of potassium oxide (K20) generally in the range of 1-2 wght% or little above. In one example from Shaqadud midden (sample:Shaqadud (M) Neo.(2a)) and Shaqaud Cave samples (table 6 and 7), the potassium content is relatively high being in the range of c.2 wght% and c.3-6 wght% respectively.

Phosphorous oxide (P205) is present in all the samples in the range of 0.1-0.4 wght% or little above. The samples have homogenous values and are chemically comparable.

Barium oxide (Ba0) is present in very low concentrations at c.0.1 wght% in most examples and even less in other analyses.

5.5.3. Discussion and Conclusions

From the above description (see section 5.5.2), it is clear that the pottery samples of the Mesolithic, Neolithic periods as well as the comparative modern examples have high amounts of Si02. The percentages of silicon concentrations exceeding 60% in most of the samples (table 28). As previously noted (see section 3.5), high silicon content is a rough index of quartz. The predominance of quartz both in the local geology (mainly Nubian Sandstone Series) (Whiteman 1971:52:-

53 and fig.50) and the clays of the area (ibid:140 and Vail 1982: 59-60) seem to explain the high silicon content in the pottery of this region.

Aluminum oxide (Al203) is present in relatively appreciable amounts exclusively above 13 wght% (see section 5.5.2). It is worthnoting that the tested samples of Shaqadud Cave site (samples: Shaq. C.(5) and Shaq. C. (6)) have high concentrations (c. 20-21 wght%). This element is a rough index of feldspar (see section 3.5.6) and the chemical result is in accord with abundance of feldspar in the mineralogical composition of the tested samples (see table 14).

The very low content of Titanium oxide (Ti02), little above 1 wght% in all the tested samples is consistent with the rarity of this element in the chemistry of the central Sudan clays (see sections 3.5 and 4.5.).

Iron oxide (Fe203) is present in relatively high proportion (c.5-12 wght%). It is exceptionally higher at the modern pottery examples (c. 12 wght %) in comparison with the Mesolithic and Neolithic pottery from the area (c.5-7 wght%). Iron is common in the Nubian Sandstone Formations, covering all the Butana plain (Whiteman 1971:62). In the Western Butana Nubian Sandstone Formation is occasionally capped with dark or black colour from ferruginous crusts (see section 5.1.2.).

Manganese (Mn)) and Magnesium (Mg0) oxides exhibit very low amounts almost all of which below 1% by weight. A single example from the modern Butana pottery (sample:Butana M.P.(2)) being the only exception. It shows Mg0 content a little above 4% by weight (see section 5.5.2). The very low Mn0 and Mg0 content of the Mesolithic, Neolithic and modern samples tested in the present work seems to suggest that these two elements are indices to minor or accessory minerals.

The relatively low concentration of calcium oxide (Ca0), at the pottery samples of Shaqadud complex site, being present mostly below 2 wght%, is not in entire agreement with the petrographic (see section 5.3) and X-ray diffraction analyses (see section 5.4 and table 34), which point, respectively, to moderate and rather rich occurrence of this element (in the form of calcite minerals) in the

composition of fewer pottery samples belonging to the late Neolithic period at Shaqadud (the cave site). The only exception being a sample from the modern pottery of the Butana (sample:Butana M.P.(2)) which shows calcium content reaching c.5% by weight (see section 5.5.2). This phenomenon might not solely be attributable to a function of sampling but equally possible could be due to a rather rare occurrence of the pottery from the Western Butana containing calcium material. If that was the case, then the possibility that the pottery with moderate or rather-rich calcium content (section 5.3) was 'imported' from elsewhere to Shaqadud site does not seem unlikely (see section 5.5.4).

Given the relatively low quantity of the calcite inclusion pottery in the Neolithic site of Rabak site (Jebel Moya levels) (Discussed in detail in section 5.7 and 5.8), the probability that the latter site received its calcitic inclusion pottery from the former, does not seem unlikely. In the absence of a common originating centre, hitherto, for the calcitic pottery of both sites and taking into consideration the relatively higher concentration of calcitic inclusions in the composition of Shaqadud Cave pottery than at Rabak site (Jebel Moya Levels) pottery and the stylistic conformity of the calcitic inclusion pottery in both sites and the prominent presence of this pottery at Shaqadud Cave site than at Rabak (Discussed in detail in sections 5.7 and 5.8), the possibility of a pottery movement from the Western Butana (Shaqadud Cave) towards the White Nile (Rabak site:Jebel Moya Levels) becomes much more likely (cf. section 6.3.3). However, this is particularly more conceivable, when one considers the relatively wider mobility (unrestricted to home base) of the later Neolithic people in the central Sudan in comparison with the Mesolithic folks inhabited the same area (cf. section 9.6).

Potassium oxide (K20) content of the samples is generally low, being mostly present below 2% by weight (see section 5.5.2). It is worthnoting that only one sample from the Neolithic levels of Shaqadud midden (sample:Shaq. (M) Neo.(2)) and the samples of Shaqadud Cave (sample: Shaq. C. (5) and Shaq. C.(16)) show relatively high proportions of potassium at values of 2.3 wght%; 3.5 wght% and 6.3 wght% respectively. This high quartz content of Mesolithic, Neolithic and modern ceramics is the reason for the high Si02 content and, at the mean time, responsible for the low concentrations of K20 proportions.

Oxides of sodium (Na20), phosphorous (P205) and barium (Ba0) are rare in all the tested samples of the Mesolithic, Neolithic and modern ceramics. In all these samples they are present almost exclusively below 1% by weight (see section 5.5.2). Therefore, they are most likely minor elements (impurities) brought in with other oxides rather than indices to specific main minerals inherent in the composition of the pottery in question.

5.6 Goethite Norm analyses

5.6.1 Introduction

Some 8 analyses were carried out by the present writer to determine the mineral phases and then the norm clay minerals of the fine earth fractions of the Mesolithic, Neolithic and modern pottery samples from the Western Butana region. The practical steps adopted in the present analyses are the same as those previously described (cf. sections 3.6.4, 4.6.1).

5.6.2 Results

With the exception of the two samples representing the modern pottery of the Western Butana (samples:Butana M.P.(1) and Butana M.P.(2), the remaining Mesolithic and Neolithic pottery samples present, in general, norm clay minerals each with comparable proportions (see table 39 and section 6.3.4).

Kaolinite is the most prominent norm clay mineral in the majority (75%) of the samples examined, being present in a magnitude of c.30-45 wght%. It is, however, absent in the composition of the modern comparative pottery from this area (cf. table 39).

Quartz is a prominent norm mineral in all the samples analyzed, being present in the bulk of the samples (75%) in the range of c.30-37 wght% (ibid.). The appreciable amounts of quartz are consistent with the X-ray diffraction results which point to strong presence of this mineral in all the Mesolithic, Neolithic and the modern pottery samples from the central Sudan (cf. sections 3.4-5.4).

It is noteworthy that the proportions of this clay norm mineral are comparable in all the Mesolithic and Neolithic pottery samples derived from Khartoum, White Nile and Western Butana regions, being present in the order of c.30-45 wght% and rarely exceeding that range up to c.52 wght% (cf. sections 3.6-5.6).

Illite norm minerals occurred in all the samples with varied proportions, being mostly in the range of 1-10 wght%. However, the specimens of the modern clay samples from the Western Butana provided relatively high proportions of this mineral, in the order of c.39-44 wght%. yet, the general picture which points to relatively low amounts of this minerals is in accord with its minor occurrence in the recent sediments of Khartoum and White Nile regions, being present in the order of 9-12 wght% (cf. sections 3.6.2 and 6.3.2 for further discussion).

Montmorillonite is present in low proportions (c.8-12 wght%) in the Mesolithic and Neolithic samples of the Western Butana and it is absent in the composition of the modern pottery samples from the same area (cf. table 17).

Chlorite is absent in all the Mesolithic and Neolithic samples analyzed. It is, however, restricted to the modern pottery samples (Butana M.P. (1) and (2), being present at c.13 wght% and 15 wght% respectively (see table 39). This result is consistent with the range of this mineral (3-37 wght%) in the recent clays of the Nile River sediments (see El-Attar and Jackson 1973-196).

Hematite, in general, is rather common in the samples analyzed, being present, in most cases (87.5%), in the order of c.7-17 wght% (cf. table 39).

The remaining mineral phases including talc, paragonite, diaspore, biotite, clinochlore, Mg-Fe-Chlor, Fe-Chlor, in most cases, display very low (c.6-9) wght%), low (c.10-14 wght%) or scarce (c.1.46-5 wght%) and often absent in the composition of the samples analyzed (ibid.).

5.6.3 Conclusions

The goethite norm analyses show that the clay matrices of the Mesolithic and Neolithic sampled pottery might have held considerable proportions of the

kaolinite, illite and quartz-rich minerals. Exceptions are the modern clays from the same area which are devoid of kaolinite, quartz and montmorillonite minerals (see section 6.3.2 for further discussion).

Montmorillonite which is the most prominent mineral in the present clays of the central Sudan (cf. sections 3.4-5.4, 6.3.2) has been detected in relatively low amounts in the Mesolithic and Neolithic pottery samples.

5.7 Pottery Typology

5.7.1 Introduction

Rim-sherds of Shaqadud midden-Mesolithic levels are devoid in the 'Hard Coarse' ceramics (see table 40) and restricted to dotted wavy line motif which falls within the category classed as "Friable large Ware" and accounting for c.20% of this group (see Marks et al 1985: 265-275; Mohamed-Ali 1991:88-93, Marks, pers. comm. 1993 and the author pers. obser.).

Rims are generally infrequent in the ceramics of Shaqadud midden Neolithic levels, varying from c.2% at the 'Hard Coarse' ceramics (total=484) to just under 5% at the 'Friable Coarse' ceramics (total no=1825) and the proportion ranges from 5.7% at the brown fine ware to c.11% at the black-slipped ware (see Mohamed-Ali 1991:83-84; Marks, pers. comm. 1993 and tables 40-41).

Rim-sherds from Shaqadud Cave are scarce, being only c.7% of the total potsherds (n=6771) recorded and they display different shapes and sizes (see below).

5.7.2 Attribute analysis

The attributes used in the analysis of the Western Butana Mesolithic (Shaqadud midden-lower levels) and Neolithic (Shaqadud midden-upper levels and Shaqadud Cave) ceramics are the same as those used for the analysis of the ceramics from Khartoum (cf. section 3.7) and the White Nile (cf. section 4.7) regions to allow consistent comparative analyses between these ceramic assemblages.

5.7.2.1 Vessel forms

Rim-sherds from Shaqadud midden-Mesolithic levels are scarce (n=32), relatively higher at Shaqadud midden-Neolithic levels (n=101) and apparently frequent at Shaqadud Cave (n=447) (see below).

Most of the direct rims from Shaqadud midden-Mesolithic (c. 60% of the total rims), Shaqadud midden-Neolithic (c.55% of the total rims) and Shaqadud Cave (c.60% of the total rims) exhibit pointed tops. These types of rims from the Mesolithic levels (Types A1, A2), Neolithic levels (Types A1, A2) of Shaqadud midden and Shaqadud Cave (Types A1, A2) are counterparts. Direct rims with semi-rounded tops from the midden-Mesolithic levels [L55-56, Type A3] and Neolithic levels [L19-30, Type A3 are coeval, all of which with rounded tops (see Mohamed-Ali 1991:65-93 and the author pers. obser), whereas the Cave pottery does not provide such types of rims (cf. Robertson and Marks 1985:515-534, 1991:123-172 and the present writer pers. obser).

Direct rims types A4 from Shaqadud midden that are characterized by angular shape, pointed top and types A5 and A6 which are thickened with rounded tops (cf. fig.63) are not comparable with those reported from the Neolithic levels [L9-10, 27-30] of Shaqadud midden and type A3 of Shaqadud Cave are rather identical in shape. All these types of rims have flattened tops, the sole exception being type A5 which is slightly pointed at the edge to the exterior (cf. figs.63-65; Mohamed-Ali 1991:65-93; Robertson 1991:123, 127; Marks pers. comm. 1993 and the present author pers. obser.).

Reverted rims are less frequent in the ceramic groups of Shaqadud midden-Mesolithic and Neolithic levels [c.30% and 31% respectively] and Shaqadud Cave [c.25% of the total rims] (cf. Mohamed-Ali 1991:65-93 and the present author pers. obser). Most reverted rims of Shaqadud midden-Mesolithic and Neolithic levels [c.67% and 59% of the total respectively] and Shaqadud Cave [c.60%] have pointed lips whereas those of rounded tops are less prevalent [c.30%, 31% respectively]. With respect to reverted rims with rounded tops, relatively larger part

of the rim is folded obliquely inward as can be observed on type B3 of Shaqadud midden-Mesolithic levels (fig.63) and Shaqadud Cave (fig.65).

The reverted rims with flattened tops and slightly pointed interiors [Types B5 of the Mesolithic levels:L31-40 and Type B3 of the Neolithic levels: L 19-24] have been recorded from Shaqadud midden (cf. figs. 63- 64).

Everted rims are less common in comparison with direct and reverted rims (see supra). They account for c.10% of the total rim-sherds from the Mesolithic levels, c.14% from the Neolithic levels of Shaqadud midden, whereas its occurrence shows a relatively low incidence (c.5%) at Shaqadud Cave ceramics (The present author pers. obser. and Marks pers. comm. 1993).

Everted rims with rounded tops (Types C1, C2) from the midden-Mesolithic levels [31 through 66], the midden-Neolithic levels [L5 through 30] (Type C1) and Shaqadud Cave (Type C1) are coeval (cf. figs. 63,64 and 65 respectively).

Everted rims of types C2, C4 from the Mesolithic levels, types C2 from the Neolithic levels of Shaqadud midden and type C5 from Shaqadud Cave are comparable (ibid.). All of them tend to show that the border part of the rim is folded obliquely outward and the transion between the rim and the vessel exterior is angular. But while those reported from Shaqadud midden (Neolithic levels) and Shaqadud Cave [Type C2 and C5 respectively] have rounded tops, the comparable rim-type [Type C4] from Shaqadud midden (Mesolithic levels) tends to show pointed-top (ibid.).

Strongly everted (flaring) rims are rare at the ceramics of these sites (c.8%, 10%, 11% respectively). Rim types C3 of the Mesolithic levels [L31 to 59] and C4 of the Neolithic levels [L5 to 30] from Shaqadud midden (see Mohamed-Ali 1991:65-93 and Marks pers. comm. 1993) and C4 from Shaqadud Cave (Robertson 1985:551-534, 1991:123-172 and the present author pers. obser.) are comparable. However, rim tops of Shaqadud midden samples are rounded or semi-rounded, whereas those from Shaqadud Cave are pointed. Angular transion between the basal part of the lip and the vessel exterior is observed on rim sherds from Shaqadud midden (cf. figs. 63-65).

Complete pots were not encountered in the ceramic collections of Shaqadud midden and Cave. The ceramic repertoire represents varied numbers of vessel forms(see infra).

Direct rims of Shaqadud midden (Mesolithic and Neolithic levels) indicate similar rim diameters, being c.10-32 cm, c.8-30 cm respectively and probably they were parts of hemispherical bowls of varied sizes. The sole exceptions are c.5% and c.8% of rims from the Mesolithic and Neolithic levels, respectively, having diameters exceeding 25 cm and possibly they were parts of subglobular jars (see supra, this sub-section; Mohamed-Ali 1991:88-93 and the author pers. obser.). On the other hand, the rims of Shaqadud Cave (c.190-265 cm), seemingly, belong to small vertical necked vessels. In the upper (100-90 cm) and lower (265-370) levels vessels with vertical walls (c.6-18 cm, c.8-20 cm respectively) are scarce (Robertson 1991:161-162 and the author pers. obser.).

The incurvate rims of Shaqadud midden-Mesolithic and Neolithic levels tend to show more or less comparable rim diameters in the magnitude of c.11-24 cm and c.10-22 cm respectively (Marks pers. comm. 1993 and the author pers. obser.) and most likely belong to open bowls of varied sizes. On the other hand, the Cave ceramics show that the incurvate walled-vessels with restricted orifices indicate possible rim diameters of c.12-30 cm and most likely belong to hemispherical bowls of varied sizes with walls average c.0.6 cm in thickness (cf. Robertson 1985:551-534, 1991:123-172 and the author pers. obser.).

The everted rims (figs. 63-64) of the Mesolithic (c.12-26 cm in diameter at the average) and Neolithic (c. 10-22 cm in diameter at the average) ceramics from the midden are comparable, probably forming parts of globular or sub-globular vessels as could be inferred from the degree of curvature of these rim-sherds (see supra, this paragraph; Marks et al 1985; Marks, pers. comm. 1994 and the author pers. obser.). Unlike the Mesolithic and Neolithic ceramics the midden (see supra) and the Cave ceramics tend to exhibit rims with flaring walls (Type 5, fig.65), in most cases (c.60%), belong to miniature vessels (c.9-10 cm in diameter), probably parts of dishes. However, rims belonging to flaring necked vessels (cf. Types C1-

C3, fig.65) are also frequent, amounting to c.40% of the total everted rims (see Robertson 1991:123-172, Marks, pers. comm. 1993 and the author pers. obser.).

Wall thicknesses of Shaqadud midden Mesolithic and Neolithic ceramics are more or less homogenous, being, respectively, 0.3-2 cm, 0.3-1.8 cm (see supra) whereas all thicknesses of the rims are, respectively, at the average of 0.2-1.7 and 0.2-1.9 cm (see supra; Marks pers. comm. 1993 and the author pers. obser.). Though Shaqadud Cave ceramics exhibit similar range of diameters in the magnitude of 0.3-1.7 cm but these are, noticeably, less frequently (c.35% of the total sherds) than those of Shaqadud midden-Mesolithic (c.65% of the total sherds) (c.65% of the total sherds) and Shaqadud midden-Neolithic (c.74% of the total). A remarkable difference between the wall thicknesses of Shaqadud midden (Mesolithic and Neolithic levels) and the Cave ceramics, is the occurrence of an exceptionally higher proportion of rims (c.65%) in the latter in comparison with Shaqadud midden-Mesolithic (c.35%) and Shaqadud midden-Neolithic (c.20%) ceramics. Most probably these rims were parts of miniature vessels (see supra, Mohamed Ali 1991:65-93; Robertson 1991:123-127; Marks pers. com. 1993 and the present author pers.obser.). Similarly, wall thicknesses of rims reported from the Cave tend to display a range of 0.2-1.8 cm (ibid.), comparable to the midden rim-sherds (see supra, this paragraph).

There is almost complete absence of basal sherds at the Mesolithic levels of Shaqadud midden, only less than 1% of the total potsherds have been observed to have conical bases (Mohamed-Ali 1991:65-93 and the author pers. obser.). During the Neolithic sequence of Shaqadud midden, there was a relative increase in the proportion and type of bases. Some 124 bases were found at the latter sequence accounting for c.5.3% of the total potsherds recorded (cf. table 41; Mohamed-Ali 1991:65-93 and the present author pers. obser.). At the end of the Neolithic period the bases of the Cave ceramics were still extremely rare (under 1% of the total specimens) analogous to the situation in the Mesolithic period (see supra, this paragraph). Rounded bases were predominating (c.90%) whereas conical ones (c.10%) are, notably, rare at the end of the Neolithic sequence at Shaqadud Cave (Robertson 1991:123-172 and the present author pers. obser.).

Though traces of coil lines on ceramics from the Mesolithic and Neolithic occupations of Shaqadud sites are imperceptible (see Mohamed-Ali 1991:65-93 and the present author pers. obser.), yet the uneven thickness of vessel walls raises the probability that coil-technique might have been in use for building. There is an inverse situation during the late Neolithic period for the Cave ceramics where traces of coil marks are occasionally present on the body sherds (cf. Robertson 1985:515-534, 1991:132-172). However, the samples examined by the present writer (n=245) did not reveal traces of coiling-technique.

5.7.2.2 Decoration

When the Shaqadud midden ceramics: Mesolithic and Neolithic levels are compared, it is apparent that their similarities outnumber the differences. In both cultural levels the decorative motifs, in most instances, are the same in format but there is a steady increase in percentages from the lower levels (Mesolithic) to the upper ones (Neolithic) throughout the midden (see below).

The wavy line decoration which is the diagnostic criteria for the Early Khartoum tradition (e.g. see sections 2.2.1, 2.5.1, 2.6.1.1) is present in almost all the levels of the lower midden (levels 39-40 to 63-64). It is clear that the distribution is decreasing steadily from the lower (L. 55-56 to L63-64) (average 8.9%) to upper (L39-40 to L40-41) (average 0.4%) levels and it is absent in a few top levels (cf. table 41). It is worthnoting that this type of decoration is entirely absent throughout the Neolithic levels of Shaqadud midden (cf. table 42). Two types of wavy line decoration occur; ones, more commonly, with continuous waves (fig.68:a, Pl.106) or ones with angular waves (fig.68:b, Pl.107).

Banded motif (fig.68:6:c, Pl.108) which is the most prevalent in the Mesolithic ceramics of the midden (c.50.9% of the total) is extremely rare throughout the Neolithic levels (Pl.109), being c.0.8% of the total sherds recorded (cf. table 42).

Dotted straight line decoration is rare, showing comparable proportion in the Mesolithic (c.55%) (Pl.110) and Neolithic levels (c. 6.9%) (fig.69a, Pl.111) of the midden. This motif tends to display two different types of distribution; whilst the

coarse sherds decreasing in proportions from the lower to upper levels, the fine ones exhibit reverse situation (cf. tables 41-42).

Triangles/Vees class is restricted to the Khartoum Neolithic levels of the midden (Pl.112) and it is devoid throughout the Mesolithic levels. In the former levels this class is frequent, being solely c.5.8% of the total sherds. The frequency distribution is heterogeneous throughout the levels (ibid.).

Lined zigzag or zigzag straight line is absent at the Mesolithic levels of the midden. This type of decoration (fig.69:b-c, Pls.113-114) is unpopular in the Neolithic levels, accounting for 6.3% of the total sherds recorded. The mode of distribution tends to show, in most cases, an increasing tendency towards the upper levels (ibid.).

Continuous straight line is extremely rare in the Mesolithic ceramics (fig.70:a), being only 0.3% of the total sherds and restricted to fine ware. Similarly, this motif is scarce in the Neolithic levels reaching c.0.9% of the total sherds (fig.70:c) and tend to display homogenous distribution throughout the levels (ibid.).

Most impressed sherds are, remarkably, infrequent, amounting, to c.8.5% (fig.71:a) and c.9.6% (fig.71:b) of the total Mesolithic and Neolithic sherds respectively. In the Khartoum Mesolithic and Khartoum Neolithic sequences, this motif, in most cases, tends to show an increase in popularity towards the lower levels (ibid.).

Unlike the Mesolithic and Neolithic pottery of the midden (see supra, this section), the Cave pottery decorations (table 43) fall outside the norm of the Khartoum Mesolithic and Khartoum Neolithic potting traditions (e.g. see sections 2.2-2.5, 10.1.1 and 10.1.2).

Thick black-slipped ware (table 43) includes c.18% potsherds ornamented with zoned impressions (fig.72:a, Pl.115) and the remaining specimens of this class are undecorated (Pl.116) (Robertson and Mark 1988:515-534, fig.13, Robertson 1991:184, table 7-1).

Thin black ware (table 43) includes c.25% of the total sherds ornamented with impressed decorations executed with a comb and zoned impressed (fig.72:a, Pl.117) amounting to c.7.3% of the total sherds from this group (ibid.).

Impressed pottery is mainly composed of sherds having wiped surfaces (fig.72:b, Pl.118), being c.28% of the total specimens from this category, whereas the remaining sherds are comb-impressed (ibid.).

Wiped pottery (fig.72:b) is common, being c.11.3% of the total sherds recorded (cf. table 43).

Unslipped (criss-cross and fingernail, figs.72:c-e,Pls.119-120 respectively) and hachured grooved sherds are the commonest (fig.72f, Pl.121), amounting to c.27% of the total sherds recorded (ibid.).

5.7.2.2.2 Rim-top decoration

Rim-top decorations of Shaqadud midden are restricted to three types namely vertical impressed (fig.70:a), vertical incised (fig.70:b)and slanting impressed (fig.70:c), being 18.3%, 21.4% and 60.2% respectively (see Mohammed-Ali 1991:65-93: Marks, pers. comm. 1994 and the author pers. obser.).

Rim-tops of Shaqadud midden ceramics (fig.70:a-c) are almost exclusively different from those of the Cave (see below). The sole exception, being the slanting impressed decoration which occurs at Shaqadud midden (see supra, this section) and Cave at nearly the same proportion (c. 18.5% and 18.3% respectively) (ibid. and Robertson 1991: 123-172).

The Cave top-decorations (fig.73:a-f) are characterized by the prevalence of motifs bearing vertical dots (fig.72:a) and parallel incised lines (fig.72:g), being, respectively, 23.2% and 21.5% of the total rims. (ibid.).

Decorations occur noticeably rare than the above mentioned examples include slanting dotted lines (fig.72:b) and rows of dots (fig.72:e), respectively, amounting to 4.7% and 4.3% of the overall with sherds (ibid.).

5.7.2.2.3 Rim-band decoration

Rim bands of Shaqadud midden are almost entirely different from those of the Cave. The sole affinity can be seen on the occurrence of dotted lines in the form of rows, being pairs of rows mostly triple dots at rim bands of the midden (fig.70:d) and pairs of multiple dots at the Cave bands (fig.74:d) (cf. Mohammed-Ali 1991:65-93, Robertson 1991:123-172 and the author pers. obser.).

Rim bands of Shaqadud midden Mesolithic (n=240) and Neolithic (n=285) levels exhibit the same decorations, yet with different proportional occurrences. While the vertical impressed decorations at the Mesolithic ceramics (fig.71:a) reaches 50% of the total bands, those of the Neolithic levels provide 30.1% of the overall rim bands (see Mohammed-Ali 1991:65-93; Robertson 1991:123-172 and the author pers. obser.).

Vertical incised motif (fig.71:b) is present on the Mesolithic bands in the magnitude of 20% whereas its proportion is relatively lesser at the Neolithic examples, reaching 12.5% of the total rim bands (ibid.).

Zigzag impressed curved line which shows low frequency (c.10.4%) at the Mesolithic bands (fig.71:c), is the most pronounced features on the Neolithic examples of the midden (fig.71:c), reaching 40.3% of the total (ibid.).

Serrated impressed bands of the midden-Mesolithic (c.8.3%) (fig.71:e) and Neolithic ceramics (c.3.6%) are markedly present in very low frequencies (ibid.).

Compared with Shaqadud midden (see supra, this section), the Cave ceramics provide a richer array of decorative motifs as will be described below:-

Slanting incised motifs are the most prominent on the rim-bands of the Cave (fig.74:a), reaching c.30.5% whereas slanting lines with dots (fig.74:b) are, comparatively, lower in proportion (c.10.2%) (ibid.).

Cross-hatching (fig.74:c) is the second most frequent decorative-motif depicted on rim, being c.23.4% of the total specimens (ibid.).

Herring-bone (fig.74:e), hachured grooved (74:f), fingernail (fig.74:g) and punctuations (fig.74:h) are very low in frequencies, being 6.7% 8.6%, 5.6% and 6.4% respectively (ibid.).

5.7.2.3 Surface properties

5.7.2.3.1 Basic Surface colour

Unlike the Cave ceramics, the surface colours of Shaqadud midden (Mesolithic and Neolithic levels) ceramics are the same but with different proportional occurrences (see infra and sections 5.2.1 and 5.2.2).

While the bulk of the sherds from the Mesolithic (c.70.5%) and Neolithic (c.80.5%) levels are light reddish brown in colour (5YR 6/4 Munsell), the majority of the Cave specimens (c.73.5%) are reddish brown (2.5YR 5/4 Munsell) (ibid.).

Further,frequent sherds from the midden tend to show very pale brown colour (10YR 7/3 Munsell) at the Mesolithic (c.18%) and Neolithic levels of the midden whereas the Cave ceramics (c.17%) exhibit light brown shade (5YR 6/4 Munsell) (ibid.).

The surface colours present in rare examples include pinkish grey (7.5%YR 6/2), being c.5% and c.4% at the Mesolithic and Neolithic levels respectively.

Dark grey colours from the ceramics of the Mesolithic (5YR3/1 Munsell) and Neolithic (10YR3/1 Munsell) levels of the midden (c.2.4% and 2.5% respectively) and the Cave (3%) show much lower percentages. Light brownish grey (10YR 6/2 Munsell) and greyish brown (10YR 5/2 Munsell) colours are, similarly, scarce at the Mesolithic and Neolithic ceramics of the midden (each is c.2%). On the other hand, the Cave ceramics exhibit rather rare (c.6.4%) examples of grey colour (10YR 5/1 Munsell) (ibid.).

The fractures of all the specimens from the Mesolithic (Pl.122) and the Neolithic (Pl.123) levels of the midden and most of these from the Cave (60.5%) are dark grey (2.5Y N4/0 Munsell). The remaining ceramics of the Cave display grey (10YR5/1 Munsell-13.4%), light brownish grey (10YR 6/2 Munsell-8.2%), dark grey (7.5R N4/0 Munsell-8.5%) or very dark grey (7.5YR N3/0 Munsell-3.3%) colours (Pl.124).

Since the geological formations of the sites area are similar (cf. sections 5.1.2, 5.3-5.6) and the firing conditions (cf. section 8.7) are comparable, it is more likely that the variations noticed on the surface colours of the Mesolithic (midden) and Neolithic (Cave) ceramics in this region is due to variation in quantities of iron and other impurities inherent in the original clays used for pottery making (cf. sections 5.3-5.6).

5.7.2.3.2 Surface Coating

In the Western Butana region, red-coated surfaces were noticed on considerable number of ceramics from Shaqadud midden and the bulk of the Cave ceramics (cf. section 5.8.2.3.1 for further details).

Representative red-coated potsherds from the Mesolithic levels (n=20), Neolithic levels (n=16) and the Cave (n=20) were subjected to chemical tests by the present writer using hydrochloric acid (HCL). As a result, ferric oxide (Fe203) or red pigment dissolved in hydrochloric acid leaving a residue of siliceous material. Hence, it has appeared that the thin layer on these potsherds is not a real slip but a slip-like colour. It resulted from the presence of red ochre (iron oxide) pigment (cf. sections 3.7.2.3.2 and 4.7.2.3.2).

5.7.2.3.3 Smudging

It has been mentioned that black-slipped ceramics were recorded from the Mesolithic (n=49) and Neolithic (n=330) levels of the midden, being, respectively, c.1.5% and 4% of the total sherds recovered (cf. Mohamed-Ali 1991:92-93 and tables 41-42). Similarly, a group of pottery (n=944) classed as "black-slipped"

(c.14% of the total) has been reported from the Cave (cf. section 5.8.2.3.1; Robertson 1991:126-127 and table 43).

It is noteworthy that the Shaqadud ceramics are categorized as black, solely, on the basis of visual inspection whereas colour description of Munsell soil colour chart is lacking (see supra, this section). However, on the basis of the midden and Cave ceramics examined by the present writer (cf. section 5.8.2.3.1), black-coloured ceramics were absent but only dark and very dark grey colours depicted on a series of specimens. Therefore, judging from the steady increase of the dark grey or "black-slipped" pottery (see supra, this section) spanning the time from the Mesolithic/Neolithic (midden) to the late Neolithic (Cave), it seems much more likely that it was deliberately obtained during the firing process (cf. section 3.7.3.3) to constitute a diagnostic group.

5.7.2.3.4 Burnishing

During the Mesolithic sequences (see appendix 6) of Shaqadud site all the ceramics of midden (lower levels) were unburnished (Mohamed-Ali 1991:65-93 and the present author, pers. obser.). The transition from the Mesolithic to the Neolithic period (see section 10.1.1.3) witnessed a change in surface treatment of the midden ceramics. During the later period c.55% of the total ceramics recorded from the upper midden, which have been classed as "Fine Ware", have been noted with low to high lustrous burnish (e.g. see Pls. 113-114).

5.7.2.3.5 Polishing

Polishing was not found on the Mesolithic and Neolithic ceramics of the Shaqadud midden (cf. Mohamed-Ali 65-93 and the present author, pers. obser.).

5.7.3 Conclusions

The physical and chemical analyses of the Mesolithic and Neolithic ceramics in the Western Butana region (see supra, this chapter) show that the pottery fabrics have mineral assemblages consistent with that of local clayey and geological deposits.

The petrological analysis shows that the fabrics of the Mesolithic and Neolithic ceramics (Shaqadud midden , lower and upper levels) and late Neolithic ones (Shaqadud Cave) are characterized by proportional differences rather than mineral inclusions (cf. sections 5.3 and 5.3.5). This phenomenon could suggest the use of more than one material source for pottery making (ibid.).

Despite the proportional variability in the mineralogical composition of the fabrics identified, the minerals, in general, are rather similar with respect to rounding classes, grain sizes, clay mineralogy and chemical content (see infra).

The fabrics of both Mesolithic and Neolithic ceramics (see supra, this section) tend to show comparable rounding classes for the aplastic minerals identified. The aplastic mineral grains are, in most cases, subangular or angular which could postulate the deliberate crushing of tempering material. The remaining non-plastic minerals which are naturally subrounded and rounded, are present in relatively low proportions.

The average grain sizes of the non-plastic mineral inclusions are markedly different through the passage of time. While the Mesolithic ceramics (Shaqadud midden-lower levels) are generally coarse in texture, the Neolithic specimens (Shaqadud midden-upper levels) are mainly medium to fine-grained in texture, those of the late Neolithic (Shaqadud Cave) are virtually fine-grained (cf. sections 5.3 and 5.3.5).

X-ray diffraction analysis reveals rather anomalous mineral concentrations in the composition of the Mesolithic and Neolithic (midden), late Neolithic (Cave) ceramics as well the modern pottery samples from the vicinity of these sites. All the samples are characterized by their quartz-rich sand whereas the main clay minerals (e.g. montmorillonite, kaolinite, illite, chlorite,....etc.) are absent. (cf. section 5.4).

The X-ray spectrometric analysis shows that the pottery samples of the Mesolithic, Neolithic periods as well as the comparative modern examples have high amounts of Si02 which is an index of quartz content. Aluminum content (rough index of feldspar) is present in relatively appreciable amounts in all the

samples. The remaining oxides (Fe203, Ti03, Mn0, Mg0, Na20, K20, P205 and Ba0) are present in very small or rare concentrations (cf. section 5.5.).

No complete pots were recorded. However, direct rims of the Mesolithic (lower midden) and Neolithic (Upper midden and Cave) ceramics are characterized by relatively larger diameters exceeding c.25 cm and probably they were parts of globular vessels, whereas those of the Cave, seemingly, belong to vertical necked vessels. The incurvate rims of Shaqadud midden and Cave are rather comparable mostly belong to open bowls of varied sizes. Unlike the midden Mesolithic and Neolithic ceramics of the midden whose everted rims probably forming parts of globular and subglobular vessels, those of the Cave, in most instances, belong to miniatures vessels (cf. section 5.8.2.1).

With the exception of wavy line decoration which is confined to the Mesolithic levels (lower midden), there is a striking overlap between the decorative motifs depicted on ceramics of the Mesolithic (lower midden) and the Neolithic (upper midden and Cave) sequences. The motifs occurred on body sherds on both periods (see supra) mainly zigzag, banded motif, brushed(wiped) and impressed straight lines. Motifs recorded on rim tops include vertical or slanting impressed lines and slanting impressions (cf. section 5.8.2.2.).

Unlike the midden ceramics, the decorations of the Cave ceramics fall outside the norm of Khartoum Mesolithic and Khartoum Neolithic decorations (cf. sections 3.7.2.2 and 4.7.2.2). The commonest decorations depicted on bodies including hachured grooved, wiped and vertical dots; parallel incised lines on rim-tops and mainly slanting incisions and cross-hatching motifs on rim bands (cf. section 5.8.2.2).

The surface colours of the Mesolithic/Neolithic (Shaqadud midden) and late Neolithic (Shaqadud Cave) ceramics from the Western Butana region are basically similar, being reddish with varied shades. Similarly, the bulk of the fractures of the Mesolithic and Neolithic ceramics from these sites are dark grey (2.5YR N4/0 Munsell) (cf. section 5.8.2.3.1).

The microchemical tests carried out in the present work show that red-coated surfaces noticed on appreciable number of pottery from the Mesolithic and Neolithic ceramics in the Western Butana are not real-slips. These slip-like colours resulted from the presence of red pigment (iron oxide) which was applied to vessels before firing and during leather-hard state (cf. section 5.8.2.3.2).

Burnishing is a distinguishing criteria between the surface finish of the Mesolithic (lower midden) and Neolithic (Upper midden and Cave) ceramics, whereas polishing is absent in these collections (cf. sections 5.8.2.3.4-5.8.2.3.5).

It has been observed in all the sampled Mesolithic and Neolithic ceramics in the Western Butana that sherds from which the samples had been taken for fabric analysis, display analogous decorations and surface finish. Nevertheless, there is no patterning as regard certain type of decoration and/or surface finish versus fabric group per se (cf. section 5.8.2.4).

5.8 Typological features and Fabric groups

Pottery samples of fabric group A from the Mesolithic levels of Shaqadud midden (SHAG(M,M)1; SHAG (M,M)10, SHAG (M,M)12; SHAG (M,M)19 - SHAG (M,M) 20. which are represented by potsherds (n-113) ornamented with incised wavy line (c.23%), zigzag dotted straight lines (c.7.6%) or left undecorated (c.7%) and fabric B which displays the same decorative motifs, being c.23, c.15.3% and 23% respectively of the total sherds examined, are comparable. All the specimens of these fabrics are unburnished (cf. section 5.8.2.3).

Pottery specimens of fabric group A derived from the Neolithic levels of Shaqadud midden (SHAG (M,N)2-SHAG (M,N)4; SHAG (M,N)13-SHAG (M,N)18 embellished with the same range of decorations, namely zigzags, banded motifs, triangles, dotted, vees and mat impression, each of which is c.8.3% of the total sherds examined by petrographic analysis. With respect to fabric B, it represents samples decorated with zigzag dotted lines, single-banded motif, mat impressed, occur in equal proportions (each c.8.3% of the total potsherds examined from the Neolithic levels of the midden). The only exception, being fine plain specimens which occur in relatively higher proportion accounting for c.33.3% of

the total sherds. All these specimens are burnished and rather comparable (cf. section 5.8.2.3).

Examples of fabric subgroup A1 from Shaqadud Cave (SHAG(c)1; SHAG (c)4; SHAG(c)6; SHAG (c)9; SHAG (c)12; SHAG(c)21 and SHAG(c)23) which include cord impressed decoration (c. 8.6%), wiped, fingernail, fine and coarse plain (each is 4.3% of the total sherds examined from this site); specimens representing fabric subgroup A2 (SHAG(c)3; SHAG(c)7; SHAG(c)8; SHAG(c)10; SHAG(c)13;-SHAG(c)14 and SHAG(c)16) that comprises hachured grooves, wiped, coarse plain (each c.8.6%) and undecorated fine surfaces (c.4.3%); examples of group B (SHAG(c)2; SHAG(c)5; SHAG(c)11, SHAG(c)14-SHAG(c)15; SHAG(c)18-SHAG(c)20) which embrace hachured grooves, coarse plain. (each c.8.6%), red slipped and triangular impression (each c.4.3%) and the sole example of fabric C (SHAG(c)1) are comparable with respect to decoration (see supra) and surface finish (cf. section 5.8.2.3).

5.8 General Assessment: Interregional level

Comparative analyses between ceramic attributes of the selected Mesolithic and Neolithic sites in the central Sudan (form, decoration, surface properties) in relation to the fabrics examined in the present work (cf. sections 3.7, 4.7, 5.8.1-5.8.3) will be presented below.

5.8.1 Khartoum and White Nile Province

5.8.1.1 Decoration

The decorative motifs which are exclusively found in the Mesolithic ceramic assemblages from Khartoum and White Nile Provinces (cf. tables 18,21, 30) include wavy line, dotted wavy line and twine impressions. Yet, there is a remarkable overlap between the decorative motifs encountered on the body from the Mesolithic and Neolithic periods (see supra and table 4). Nonetheless, these decorative motifs occur with different frequency distribution throughout their cultural layers. The most frequent motifs present in both periods include zigzags, dotted straight lines, wiped surfaces, dotted wavy and the undecorated sherds in most sites except Islang2 (Khartoum Province) whereas plain sherds are

exceptionally rare (cf. tables 18-22,30,40). Further frequent motifs include wavy line, linear impressions, triangles, triangles/dots, vees, dots, incised triangles and impressed lines. Rare decorations are generally twine and fingernail impressions (Sarurab2), scraped (brushed) and semicircular panels (Islang2 and Nofalab2), occasionally dotted wavy line, zigzag (Khabbashi Haitah) or wavy line (Kabbashi) (ibid.).

Rim-top decorations show that dotted straight line and vertical impressions are the most frequent motifs depicted on rim-tops of Khartoum and White Nile ceramics. The sole exceptions are rim-tops of Rabak and Sarurab2 which are devoid of these decorations (cf. sections 3.7.2.2.2 and 4.7.2.2.2).

Rim-tops decorated with linear impressions, serration, zigzag incised curved lines (Wolf-tooth) and slanting dotted lines which have been identified in varied frequencies (cf. 3.7.2.2.2) from Mesolithic (Sarurab2, Kabbashi Haitah and Kabbashi) and Neolithic (Islang2, Nofalab2 and Geili) sites in Khartoum Province showing a drop in the collections of the Mesolithic (Shabona) and Neolithic (Rabak) sites from the White Nile Province (cf. section 4.7.2.2.2). On the other hand, fingernail impressions, crescent-like shapes and slanting/dots which rarely occur in the collection of Rabak Neolithic site from the White Nile Province (ibid.) are entirely absent in Khartoum Province ceramics (see section 3.7.2.2.2).

Herring-bone decoration is depicted on rims tops of the Mesolithic sites of Khartoum (Sarurab2) and White Nile Provinces and absent in the remaining tested collections from both areas (see supra, this section).

Rim-bands are absent in the tested collections of the Mesolithic and Neolithic ceramics from the White Nile Province. conversely, Nofalab2 and Geili Neolithic sites from Khartoum, respectively, present seldom rim-band motifs namely wolf-tooth and parallel lines/triangles (see section 3.7.2.2.3).

5.8.2 Khartoum and Western Butana Provinces

5.8.2.1 Decoration

The decorative motifs which are exclusively encountered in the Mesolithic ceramic assemblages from Khartoum and Western Butana Provinces (table 18-22, 41-42) encompass wavy line whereas twine impressions are confined to the Mesolithic site of Khartoum Province (ibid.). However, there is a striking overlap between the decorative motifs found on ceramics from the Mesolithic and Neolithic sequences in Khartoum Province and Western Butana regions. The motifs reported from both periods, with varied proportional occurrences mostly represented by zigzag, banded decoration, brushed (wiped), impressed straight lines. Further frequent motifs encompass wavy line, dotted straight, mat impressions, vees, vees/dots, incised, fingernail, cord impressed and triangles/dots. Decorative motifs which show rare occurrence include scraped, triangles, semicircular panels, fishnet, dotted wavy line and continuous impressed straight lines (ibid.).

It can be judged from the frequency distribution of decorative motifs depicted on rim-tops from Khartoum Province and Western Butana region (cf. sections 3.7.2.2.2 and 3.7.2.2.3, 4.7.2.2.2 and 4.7.2.2.3) that the Mesolithic and Neolithic ceramics of the former region share more affinities with each other than with their latter counterparts (Shaqadud midden and Cave).

The slanting serrated decoration is shared by all the Mesolithic (Sarurab2, Kabbashi Haitah and Kabbashi) and Neolithic sites (Islang2, Nofalab2 and Geili) in Khartoum Province (cf. tables 18-22). This decoration is absent in the ceramic-collection of Shaqadud Mesolithic-layers (cf. table 41).

Vertical and slanting impressions are shared by most Mesolithic (Kabbashi Haitah, Kabbashi and Shaqadud midden-lower levels) and Neolithic (Nofalab2, Geili, Shaqadud midden-upper levels and Shaqadud cave) ceramics in Khartoum Province and Western Butana region. The sole exceptions, being the ceramics of Sarurab2 and Islang2 from Khartoum Province which are devoid of these motifs (cf. sections 3.7.2.2.3 and 5.8.2.2.2).

Rim-bands of the Mesolithic and Neolithic ceramics from the selected sites of Khartoum Province are entirely different from their counterparts of the Western Butana region (ibid.). At the same time variations are also present at the intra-site levels within each of these two regions. For instance, in Khartoum province, though rim-bands are scarce, they are recorded from only two Neolithic sites namely Nofalab2 and Geili. yet, the decorations depicted on rim-bands are dissimilar, being parallel lines/dots at the pottery of the former site, whereas the latter is embellished with zigzag impressed straight line (cf. sections 5.8.4.1 and 5.8.4.2). On the other hand, the rim bands of Shaqadud midden and Shaqadud Cave ceramics from the Western Butana are almost exclusively different. The sole affinity between them manifested in the occurrence of dotted lines in the form of rows depicted on a number of rim- bands (cf. section 5.8.2.2.3).

The decorations which are occasionally depicted on rim-tops from the Mesolithic and Neolithic ceramics of Khartoum Province include dotted straight lines (Islang2, Nofalab2 and Geili), slanting rows of dots (Kabbashi Haitah), herring-bone (Sarurab2 and Islang2), zigzag incised straight line-sawtooth (Sarurab2), zigzag incised curved line (Sarurab2, Kabbashi and Islang2), linear impression (Sarurab2, Islang2 and Nofalab2), cross-hatched (Kabbashi and Geili) and lozenges (Geili) (ibid.).

5.8.3. White Nile and Western Butana regions

5.8.3.1 Decoration

Wavy line is the sole decoration that is exclusively attested in the Mesolithic contexts of the White Nile and Western Butana regions (Shabona and the Mesolithic levels of Shaqadud midden) (tables 30, 41). Yet, there is a noticeable overlap between a series of decorative motifs of the Mesolithic and Neolithic periods, being more clearer, in most cases, at the intra-regional rather than inter-regional level. For instance, in the White Nile region, dotted sawtooth, fingernail, dotted lines seem to link the Mesolithic site of Shabona with the Khartoum Neolithic levels of the Rabak site (cf. tables 28,30). On the other hand, in Western Butana situation, almost all the motifs at the Mesolithic and Neolithic levels of Shaqadud midden are identical. The only exception, being the absence of triangles/vees, lined zigzag and fishnet at the Mesolithic levels of the midden and

the exclusive presence of wavy line at the Neolithic levels (cf. tables 41-42). At the end of the Neolithic period the pottery of the White Nile and the Western Butana regions underwent similar changes pertinent to decorations. At both areas the upper levels of Rabak site and Shaqadud Cave yielded comparable decorations (wiped surface, unslipped hachured grooves and zoned impressions) marking a clear disjointed continuity from the Mesolithic to the early Neolithic decorations in these areas (see sections 4.7.2.2.1, 5.8.2.2.1, 9.10.3 and tables 30, 41-42).

Of the 12 rim-top decorations (cf. sections 4.7.2.2.2 and 5.8.2.2.2) present on the Mesolithic and Neolithic ceramics of the White Nile and Western Butana regions, only four decorations form a typological link between them. Three of these (slanting lines/dots, slanting impressions and cross-hatched) were found in the ceramic collections of the late Neolithic sites of Rabak (Jebel Moya levels) and Shaqadud Cave. The fourth decoration forming that link is composed of multiple lines of dots, present on a series of rim-tops from the White Nile (Shabona) and Western Butana (Shaqadud Cave) ceramics (4.7.2.2.2 and 5.8.2.2.2).

At the interregional level, multiple lines of dots, zigzag impressed curved lines and herring-bones are present on rim-tops of Shabona with varied frequencies. The former is the most pronounced decoration. These decorations are entirely lacking in the collection of Rabak site and only multiple lines of dots and herring-bone motifs are reported from Shaqadud Cave in the Western Butana (ibid.).

Vertical lines (impressed and incised) are frequently present on rim-tops of Shabona and Shaqadud-Mesolithic levels. These decorations are absent in the ceramic collections of Rabak (Khartoum Neolithic and Jebel Moya levels) as well as the Neolithic levels of the midden (ibid.).

Rim-tops with slanting impressed lines and dots are seldom in ceramic-collection of Rabak site and are exclusively absent in the collections of Shabona (White Nile) and Shaqadud midden and Cave ceramics (ibid.).

Fingernail, slanting impressions and cross-hatched motifs link the late Neolithic phase of Rabak site (J.M.L.) with Shaqadud Cave which represents the latest Neolithic sequence in the Western Butana region. It is noteworthy that these

decorations were absent in the ceramic collections of Shabona and Rabak (kh.Neo. L.) from the White Nile Province and Shaqadud-midden from the Western Butana region (ibid.).

Hachured grooved, punctation and slanting linear impressions are exclusively found on a series of rim-tops from Shaqadud Cave. These decorations are devoid in the collections of the White Nile and Western Butana (Shaqadud midden) Mesolithic and Neolithic ceramics. (ibid.). These motifs, perhaps, indicating cultural links with ceramics described from the eastern part of the Butana in Khashm el Girba and the Gash Delta called the Atbai ceramic tradition (cf. Fattovich et al 1984: 180-1983; fig.4:5 and fig.6:3,6,7).

The Mesolithic ceramics of Shabona (White Nile) and the Mesolithic/Neolithic ceramics of Shaqadud midden are devoid of rim-bands (cf. sections 4.7.2.2.3 and 5.8.2.2.3 respectively). Rim-bands are frequently present in the ceramic collections of Rabak and Shaqadud Cave. With the exceptions of slanting impressed lines and herring-bone motifs in the collections of the latter sites, the remaining bands display dissimilar decorations (cf. sections 4.7.2.2.3).

Chapter 6

6. Lithological Provenance of the Mesolithic and Neolithic Ceramics in the Central Sudan

6.1 Introduction

Provenance studies are commonly used in many studies, besides pottery including obsidian and stone artifacts (e.g. Bradley and Suthern 1990:117-122). These are very important in ancient pottery studies and the critical first step in studying pottery production, is to determine where the artifacts were produced. In historic period this does not pose a great difficulty, since the presence of documents and known kiln-sites indicate the location of pottery source (Shepard 1956:165-168, 336-341 and Rice 1987:413). In prehistoric periods information of the location of production-sites, the types of pottery fabricated and the organization of production are of great importance (Rice 1987:413).

Provenance studies more commonly use the composition of the unknown artifacts with that of more precisely known source, using the same analytical techniques and physico-chemical properties (ibid.). These known materials may be of two types. One data set may be obtained by analyzing samples of clays and tempers derived from the geological zone where the pottery under study occurs (Bishop and Rands 1982:283-314; Buko 1984:348-365 and Perlman 1985:203-217).

A second type, prevailing in Europe, is to use 'reference groups' consists of pottery taken from a specific locality or from particular workshops. These identified finished products, kilns wasters and unknown specimens are compared against these (rather than against the geological sources) to determine the lithological provenance. This approach has been used by several European workers (e.g. Poole and Finch 1972:79-91; Widemann et al 1975:45-59 and Keay and Jones 1982:45-61).

The present writer has used the second approach in the analyses of Mesolithic and Neolithic ceramics in the central Sudan (see section 6.3) for two reasons: firstly, the clay sources of the study areas have already been examined by earlier workers (Whiteman 1971:109-127; Buursink 1972; Gunn 1982:81-192 and Vail 1982:51-65), secondly, since pottery is a traditional craft, the

selection of clay appropriate for pottery making will be determined by the potters experience. Therefore, the test of the fired clay of modern local pottery rather than the raw clay has been carried out in the present work (cf. section 1.10).

6.2. The origin of material used for studying lithology

Within the approximate bounds of the central Sudan Lat. 13° 14' 50° - 16° 30'N, 32° 18' - 34° 54' E, cf. fig. 2) discussed above (c. sections 3.1.1, 4.1.1 and 5.1.1) ceramic samples (n=248) for the present study of lighological provenance have been drawn from nine sites located in three major areas (Khartoum, White Nile and Western Butana regions). Among these sites, local modern pottery samples (see below) have been used for comparative studies. A series of physico-chemical analyses were conducted to determine the provenance of the selected samples (cf. chapters 3 - 5).

6.3 Lithological Provenance of Pottery Studies

Scientific characterization of pottery involves the examination of the mineralogical composition of pottery with the purpose of isolating materials of different origin and, hence, establishing their source where possible. To do this effectively, the application of suitable scientific method is essential (Peacock 1970:370). However, in studies of ceramics from excavations, special emphasis has been made for many years to the determination of the provenance of pottery. The last decades have witnessed a great increase in the number of studies of this kind (e.g. Hays 1971a:55; Nordstrom 1972:33-94; Hays and Hassan 1974:71-79 Hulthen 1977; Banks 1980:299-315, Francaviglia and Palmieri 1983:191-205;De Paepe 1986:113-140, Chlodnicki 1989:369-373 and Zedeno and Wendorf 1993:1-27) linked primarily with methodological tools in other disciplines, especially physical chemistry.

Pottery provenance studies can be conducted using three basic approaches: firstly, there are studies whose primary aim is to evaluate the usefulness of various research techniques, making use of several tests upon the empirical material. Research intended to establish the variability of chemical elements as a consequence of firing, usage or long-term burial may also be included in this group though such studies may not provide direct contribution to the problem of identification, they are of considerable methodological

importance (Buko 1984:349). The work of Van Der Leeuw is an example of this type of research which lays more emphasis on the methodological problems. He attempted to design a model for various problems which must have played a part in the construction of vessels (raw materials, tools, economic aspect, customer and the pottery). His sample was derived from Neolithic pottery in Netherlands and medieval pottery (dated c. 600 - 1200 A.D.) on the Euphrates in northern Syria (Van Der Leeuw 1976: 191 - 315, 319 - 387).

The second approach which is the most wide spread, concerns with various types of analysis petrological, chemical, mineralogical, thermic .....etc. A model of composition is established for local production. Some archaeologists believe that it is possible by this way to establish precise standards of raw material composition with geological data and to isolate samples of unidentified provenance. The work of Hulthen on the Neolithic and iron age pottery in Denmark and Germany can be taken as an example to represent this line of investigation. A series of physico-chemical analyses have been carried out on 350 pottery samples. One of the main goals of her research is to determine the resources of raw material being exploited by prehistoric potters. A hypothetical model illustrating the possible ways of penetration of ceramic craft into different northern European Mesolithic areas has been devised and tested by the physico-chemical analyses outlined above (see Hulthen 1977).

There is yet another line of research which is applied more widely; parallel detailed studies of both ceramics and raw material of a region. The work of Nordstrom on the Early and Middle Nubian pottery dated from the fifth to the third millennium B.C. in Sudanese Nubia - Upper Nubia - (fig.2) (see Nordstrom 1972:33-93 and cf. section 1.5.2) illustrating the application of pysico-scientific analyses on both ceramics and raw materials of a region alongside the traditional classification. A sample of 15 sherds representing each of the different fabric variants was selected for thin-sectioning and examined with petrographic microscope. Two samples of Nubian sediments have been tested from ceramic point of view. These analyses were accompanied by a series of micro-chemical tests of the paste and the mineral grains (ibid.).

Another example of this approach was applied by Buko in his study of pottery from the early medieval site (dated in the mid-10th to mid-13th centuries) of Sandomierz region in southern Poland (Buko 1984 : 348 - 365).

From among 12000 potsherds which formed the data base, 130 specimens were selected for chemical analyses and 80 sherds were analyzed by petrographic analysis. Supplementary tests were carried out on the raw materials and vessels from contemporary folk pottery working-shops in the region. The results of analyses show that the petrographic composition of the pottery sherds and samples of local raw materials was similar, while the chemical composition different. In the light of the above results, and considering that it is products made from raw materials of this type that occur most widely in the Sandomierz region and which were, therefore, most likely produced locally, it would seem that these vessels were produced from local clayey deposits (the petrographic evidence), with an admixture of other clays rich in aluminosilicate (the chemical evidence) (ibid: 353 - 359)

In the present study physical methods rather than chemical ones have virtually been used to determine the lithological provenance of Mesolithic and Neolithic ceramics from the central Sudan. (see sections 3.1-3.6; 4.1-4.6 and 5.1-5.6). This is due to the nature of the pottery samples in the present work which are mainly coarse grained (cf. chapters 3, 4 and 5). Chemical analysis is most successfully applied to fine-textured and even fine-textured pottery can often benefit from petrographic analysis (Rice 1987:415). Petrographic analysis is most analytical procedure for differentiating local from 'intrusive' pastes in the following cases: when there has been extensive exchange of stylistically similar pottery over vast areas; when pottery was imported in sufficient quantities to give the impression of local manufacture, petrographic analysis can show that the materials are foreign, whereas the stylistic data do not because styles can be imitated, poor preservation of sherds, preventing identification of surface finish or decoration; and recognition of unusual inclusions as probable intrusive by a distinctive temper (Shepard 1956 : 165).

6.3.1 Discussion of the Petrological Analyses Results: Interregional level.

6.3.1.1 Fabrics

Two main fabric groups have been distinguished in the sampled Mesolithic and Neolithic ceramics of the central Sudan (cf. sections 3.3.-5.3) and these include sandy and mixed lithography fabrics (see below).

6.3.1.1.1 Sandy fabrics

In the present discussion the term 'sandy fabric' will be defined as all the aplastic inclusions of the non-mixed lithography but not as a particle-size.

Three main sub-types of sandy fabrics have been identified in the sampled Mesolithic and Neolithic ceramics and they are as follows:-

a-Sedimentary Group

This is the most common fabric group, being 51.5% of the total fabrics. On the basis of mineralogical composition, proportion and temper origin two main fabric groups can be identified:-

Group 1

It is characterized by high quartz content, reaching 80% in the bulk of the samples. Feldspar is generally little amounting to 5-13% in most samples (53% of the total) of fabrics group A from the Mesolithic sites of Shaqadud midden-lower levels-(Western Butana), Shabona (White Nile), Kabbashi Haitah (Khartoum Province) fabric subgroup A1 of Sarurab2; fabrics subgroup A1 of the Neolithic sites of Islang2, Nofalab2 (Khartoum province) and group B of Rabak (Kh. Neo.L.) (White Nile). It is absent in the remaining samples (47%) of fabrics subgroup A2 from Kabbashi, Geili, Nofalab2 Neolithic sites in Khartoum Province and the late Neolithic site of Shaqadud Cave in the Western Butana region. Iron inclusions are present in comparable amounts ranging between 8-10% in most of the Mesolithic and Neolithic samples presented above. Exceptions are fabrics group A (c.18% of the total minerals) and group B (c.22%) of Rabak Jebel Moya and Khartoum Neolithic levels respectively (cf. sections 3.3.-5.3, e.g. plates 1-4,6,13-14, 66,68,72-73, 98-99).

Accessory minerals which include zircon, tourmaline, epidote, hypersthene are present in haphazard distribution in all the thin sections examined, being in the range of 1% or less (ibid.).

b. Metamorphic Group

This includes fabrics (9% of the total) which are characterized by the presence of appreciable non-plastic minerals of metamorphic source such as hornblende, muscovite mica and some rock fragments (see below). Two types of fabrics of metamorphic source have been discerned:-

Subgroup1: This is the most frequent type of metamorphic fabrics amounting to 67% of the samples of this group. It is distinguished by the presence of relatively high or frequent occurrence of hornblende with little or scarcity of feldspar and lack of calcitic minerals. This accounts for c.40% of the total inclusions of the specimens of fabric group C of Shaqadud Cave (Western Butana region), c. 15%, c.20% of the total inclusions of fabrics groups B and C specimens derived from Rabak, Jebel Moya and Khartoum Neolithic levels respectively (White Nile Province) (cf. section 4.3.3, 4.3.4, 5.3.4 and 6.3.1.1 and plates 15-16).

Subgroup2: This accounts for 33% of the total samples classified as belonging to metamorphic fabrics. All the samples of this group belong to fabric group B of Geili Neolithic site (Khartoum Province). It is characterized by appreciable grains of quartz (c.68%) with frequent muscovite mica (c.15% of the total) and occasional rock fragments of metamorphic source (c.3%) (cf. sections 3.3.6, 6.6.3.1.1 and plates 67,74,100,105).

C. Mixed lithography

This type (12% of the total fabrics) has been identified in the composition of the Mesolithic fabrics which include ceramics of Sarurab2 (Fabric A1 - 40% of the total fabrics of this site), Kabbashi Haitah (Fabric B - 60% of the total) and the late Neolithic ceramics of Shaqadud Cave (Fabric B- 34%). In all these fabrics the non-plastic inclusions are mainly composed of abundant non-polycrystalline quartz and K-feldspar (igneous source) coupled with varying amounts of hornblende, muscovite mica and/or rock fragments (metamorphic origin) suggestive of mixture of tempering inclusions from igneous and metamorphic sources (cf. sections 3.3.5.1, 3.3.6.1, 5.3.4 and fig.XV11)

Group2

It is characterized by frequent inclusions of calcitic nature ranging between 6% to 40% at fabrics Subgroup A2 at Rabak-Jebel Moya levels-(White Nile) and Shaqadud Cave (Western Butana) respectively (cf. sections 3.3.4, 5.3.4).

d. Igneous Group

This group of fabrics is less frequent (27.3% of the total fabrics) than the previous one. It is distinguished by high content of microcline and perthite (c.18% - 67%) with relatively low amounts of non-plastic quartz (c.15-37%).

The Mesolithic fabrics of Sarurab2 (Groups A2, B), Shaqadud midden-Mesolithic levels (Fabric B), Shabona (Fabric B) and the Neolithic fabrics of Islang2 (Fabric B), Rabak-Khartoum Neolithic levels (Fabric A) and Shaqadud midden-Neolithic levels - (Fabric B) from Khartoum, White Nile and Western Butana regions, respectively, represent this tendency. However, apart from the above mentioned non-plastic minerals, the remaining mineral grains are present in little or low amounts. These include mica (biotite and muscovite) and iron inclusions which are little in amounts in most of the thin section slides of igneous fabrics group A of Sarurab2 (Khartoum Province), Rabak - Khartoum Neolithic levels-and fabrics group B of Shabona (White Nile Province) and Shaqadud-Neolithic level - (Western Butana) (cf. sections 3.3.-.5.3 and 6.3.1 and plates 6,12-13,65,71,99,100,104).

Subordinate non-plastic minerals which are extremely scarce (c.1-2% or less) in most of the igneous fabrics (Fabric groups A2, B of Sarurab2 [Khartoum Province], group A of Rabak - Khartoum Neolithic levels - , groups B of Shabona [White Nile] and Shaqadud midden [Western Butana]) include zircon, tourmaline, epidote or hypersthene (ibid.).

Grouping tendency through time was not observed within the fabrics of this group which tend to show marked resemblances (see supra and section 6.5).

6.3.1.2 Provenance

6.3.1.2.1 Sedimentary source

The origin of fabrics group 1 (cf. section 6.3.1.1) which is mainly characterized by quartz grains, little or absence of feldspar (mainly microcline and plagioclases) and mica is Nubian Sandstone Formation prevailing in most parts of central and northern Sudan including the Mesolithic and Neolithic sites investigated. This formation is composed of Cretaceous rocks mainly comprised of quartz-pebbles, conglomerates, arksoses and lesser shales, mudstones, abundant fossil wood and often high ferruginous (cf. sections 3.1.2, 4.1.2, 5.1.2, appendix 1 and figs. 3-4, 39 and 52).

The provenance of fabrics groups2 which is prominently composed of limestone fragments is likely in or near deposits of sedimentary source as indicated earlier (cf. section 6.3.1.1.1). This includes fabrics subgroup A2 of Rabak (J.M.L) from the White Nile Province (fig.39) and Shaqadud Cave from the Western Butana region (figs.1, 52). However, local limestone sources in the areas where the sites are situated are not available (figs.39, 52). The nearest limestone source for Rabak Neolithic site lies 45 km further east (fig.39) whereas the nearest source of calcitic rocks for the Neolithic site of Shaqadud Cave is Jebel Geili which lies 133 km to the south east (figs. 39, 52). As calcitic pottery in both sites is associated with pottery ornamented with parallel grooving, being more abundant at the later site, the possibility of exchanges seems to have been from Shaqadud Cave to Rabak site rather than vice versa becomes much more likely (cf. sections 4.3.4, 5.3.4, 6.3.1-6.3.3, 9.10.3, 9.11).

6.3.1.2.2 Igneous source

The nearest likely source for igneous fabrics from Khartoum Province (Fabrics group A of Islang2 Neolithic site, group B of Sarurab2 and Kabbashi Haitah Mesolithic sites) which are dominantly feldspar-rich (microcline and perthite), is Sabaloka Basement Complex. An outcrop of this formation lies a few kilometers north of the sites; being 35 km north of Kabbashi Haitah, 22 and 27 km north of Sarurab2 and Islang2 respectively (cf. fig.4).

With respect to the fabrics from the White Nile Province (Fabrics groups B of Shabona Mesolithic and Rabak-Khartoum Neolithic-levels-sites

respectively), the nearest possible source is the Basement outcrop of Sabaloka Gorge which lies c.200 and c.297 km north of the two sites respectively.

Rocks of igneous origin that could furnish an accessible source to the Mesolithic and Neolithic potters of Shaqadud are not available in the immediate area of the site. Therefore, the nearest workshops that might have been the source of igneous rocks for Shaqadud midden-Mesolithic and Neolithic potters lie in Sabaloka Gorge near the Sixth Cataract c.80 km to the south east (figs.52).

6.3.1.2.4 Metamorphic source

Most of the fabric groups of metamorphic sources (cf. sections 6.3.1.1) seem to have originated locally. With respect to group 1 (Fabrics B of Rabak - Khartoum Neolithic levels - in the White Nile Province and group C of Shaqadud Cave in the Western Butana), though metamorphic rocks are not available in or near the area of Rabak site (White Nile), yet the local clayey deposits which are rich in minerals of metamorphic origin (hornblende, mica, kyanite,.....etc.) strengthens the probability that the metamorphic minerals of Rabak may have been procured from clay pockets or clay beds bearing such minerals (cf. sections 4.3.3, 4.3.4, appendix1 and fig.39). On the other hand, the most likely provenance for the metamorphic fabric of Shaqadud Cave is located c.80 km to the north east at Sabaloka Gorge area which is rich in rocks of metamorphic origin (cf. sections 5.1.2, 5.3.4.1, appendix 1 and fig.52).

With respect to group 2 (Fabric B of Geili Neolithic site-Khartoum Province), the source of its fabrics seems to lie within the metamorphic rocks at Sabaloka Gorge in close proximity to the site of find (Geili), only c.12 km. to the north (cf. sections 3.1.2, 3.3.6,2, appendix1 and fig.4).

6.3.1.2.5 Mixed lithography

The ceramic fabrics of mixed lithography (Fabrics group B of Kabbashi Haitah Mesolithic [Khartoum] and Shaqadud Cave Neolithic [Western Butana] sites) have their sources outside their area of find. With regard to Kabbashi Haitah Mesolithic site (Khartoum Province), the non-plastic mineral inclusions deriving from metamorphic and igneous origin have sources in the Sabaloka Gorge c.35 km to the north (cf. sections 3.3.51, 3.3.6.1 and fig.4). Similarly, the

temper of mixed lithography (igneous and metamorphic) (Pl.155) from Shaqadud Cave (fig.1) raises the probability of derivation from workshops c.80 km. to the east at Sabaloka Gorge where ancient orogenic igneous and metamorphic rocks prevail (cf. section 5.3.4, appendix 1 and fig.52).

6.3.2. General Discussion of X-ray diffraction Results:Interregional Level.

Synthesizing this data, mineralogically the Mesolithic and Neolithic ceramics in the Central Sudan, as seen from the sampled areas (Khartoum, White Nile and Western Butana regions), are basically comparable (cf. sections 3.4, 4.4 and 5.4). The quartz grains are the most dominant in all the samples. A part from a single sample of the Neolithic site of Islang2 (sample:G93-17a) (table 10) which shows a weak presence of kaolinite (7.2 A), the remaining tested specimens of the Mesolithic, Neolithic and modern ceramics indicate a complete absence of the main clay minerals (e.g. Montmorillonite, illite, chlorite)(see tables 10-11,25-33). Therefore, on the basis of this X-ray diffraction data it is hardly possible to pinpoint any characteristic groupings. The results show that these clays have undergone some changes in their mineral structures due to heating. Heating clays above approximately 500C causes major chemical and mineral structural changes (Peacock 1970:380 and Rice 1987:90). The exclusive occurrance of montmorillonite in all the analyzed samples indicates a temperature exceeding 300°C because at this temperature the structure of this mineral undergoes changes (Grim 1968:314). The absence of kaolinite shows that the samples were fired above 550°C. At temperatures in the ranges of 500°-600°, kaolinite becomes amorphous (table 35). The structure of chlorite (Mg variety) collapses below 800°C. Vanishing of poorly crystallized illite points to firing temperatures over 600°C (Grim 1968:334) and vanishing of well crystallized illite and clay-size muscovite points to firing temperatures over 800° C (Grim 1962:103).

The weak or very weak diffraction patterns of the minerals identified (fine clay fractions (020), plagioclase, K-feldspar, hematite, mica, kaolinite, anatase and calcite) can represent their relative abundance in the samples. It is equally possible that such diffraction patterns can result from (1) amorphous ferruginous oxides, (2) the presence of exchangeable cations which produce poor reflections, and (3) degraded structure resulting from diagenesis from Khartoum Province. Such poor diffraction patterns are similarly present in a

series of tested samples derived from Pleistocene modern Nile sediment in Upper Egypt (ibid).

When the X-ray diffraction results of the Mesolithic and Neolithic ceramics examined in the present study (cf. tables 10-11,25,33) are compared with the Neolithic ceramics from the central and northern Sudan investigated by Hays and Hassan (Hays and Hassan 1974:71-79 and table 34), it can be seen that they differ from them in showing almost exclusively the absence of the key clay minerals (e.g. montmorillonite, illite, chlorite). The X-ray diffraction results have shown that the tested Neolithic potsherds from Khartoum, Second Cataract, Dongola reach and Khashm el Girba areas (see table 34) are composed of montmorillonite and montmorillonite-chlorite mixed structure with or without illite.

Montmorillonite-Chlorite mixed structure is present in all the tested pottery samples of northern Sudan (Second Cataract, Dongola reach and Khashm el Girba) and Khartoum area (see table 34).

The predominance of montomrillonite in the composition of the Mesolithic and Neolithic ceramics in the northern and central Sudan (see supra) is consistent with the availability of this clay in these regions. Montmorillonite is the most abundant mineral in the soils of central Sudan (Khartoum, White Nile and Gezira plains). Clay mineral analyses in respect of five soil samples from Khartoum (Sarurab, Shaheinab and Nofalab) and White Nile (Shabona and Rabak) indicate that montmorillonite is the most prominent mineral being present in proportions ranging betwen 60-81%. Montmorillonite is, similarly, a dominant clay type in the Gezira plains and all sediments derived from the Abyssinian Plateau (Finck 1961:265 Butzer and Hassan 1968:487; Hays and Hassan 1974:77-78; Khabir 1981:73,80 and Gunn 1982:90-92).

While the Mesolithic and Neolithic ceramics tested in the present work (Khartoum, White Nile and the Western Butana regions) (tables 10-11,25,33-34) are apparently varied in their clay mineralogy in comparison with those of Khartoum area (samples K-2, K-11, K-23) analyzed by Hays and Hassan (1974:77), the absence of montmorillonite in the two sets of samples indicates a close match between them. On the other hand, montmorillonite is a prominent feature of the Mesolithic and Neolithic tested sherds in the northern Sudan

(Second Cataract, Dongola reach and Khashm el Girba, where the three samples from Khartoum area, as indicated above, are devoid of this mineral (see table 34) (Hassan and Attia 1976: 340).

Kaolinite, as noted above, is absent in all the Mesolithic and Neolithic potsherds from central and northern Sudan examined by Hays and Hassan (1974:77-78). Since most primitive pottery is fired at a temperature of nearly 700 C, kaolinite is a mineral which would be most affected by the firing process (ibid.:77).

The clay mineralogy of Islang2 pottery (sample:G93-17a) differs from the remaining samples in having a very small amount of kaolinite (table 11). This feature is lacking in the remaining Mesolithic and Neolithic samples of central and northern Sudan (cf. tables 10-11,25,33-34). The extreme rarity of kaolinite in the composition of the Mesolithic and Neolithic ceramics of the central Sudan (tables 10-11,25,33) and its absence in the ceramics of the northern Sudan (see table 34) is in accordance with the low abundances of this mineral group in the recent sediments of both central and northern Sudan soils. Clays in the central sudan are characterized by predominant or large amounts of minerals of montmorillonite group with small amounts of kaolinite, the traces of quartz and mica are detectable (see Buursink 1971:192 and Vail 1982:92). Nonetheless, kaolinite seems to be one of the important soil constituents in the White Nile drainage to-day particularly in Kosti area, Bahr el-Ghazal and Bahr el-Arab (Gorashi, pers. com., 1993) in the southern Sudan (see fig.2). Analyses of two soil samples from the White Nile region (Shabona and Rabak areas) (see fig.1) indicate a small or moderate amount of kaolinite (Khabir 1981:73,80) being in the order of 11% and 23% respectively. These results are consistent with the pedological history of the White Nile region which indicates the occurrence of appreciable amounts of kaolinitic clays between 5000-10000 years ago due to the humid weather prevailed which caused weathering of granite and sandstone. The clays presented during that time resemble the clays of the present day Equatoria and the Bahr el Ghazal districts (fig. 2) which are kaolinitic in nature (Gorashi, pers. comm. 1993).

Taking into consideration the occurrence of appreciable amounts of kaolinitic clays in the White Nile sediments in the past (10000-5000 years ago) (see supra), and its abundance in the White Nile sediments today (see supra, this section), the question which immediately presents itself: why is the composition

of the Mesolithic and/or Neolithic ceramics in the Central Sudan (particularly from the White Nile Province) tested in the present research, apart from the sole sample of Islang2 (see supra, this section) exclusively devoid of kaolinitic clays?. This question stems from the fact that kaolinitic clays have advantages over montmorillonite and other types of clay - as far as ceramic practise is concerned - because of their non-swelling nature and good plasticity (Grim 1962:131). The most likely explanation, in the light of the level of information reviewed above, is that if kaolinitic clays had already been presented in the composition of the Mesolithic and/or Neolithic ceramics of the central Sudan examined in the present work, their crystalline structure must have been destroyed by heating. At temperatures above 550 °C, as previously noted (see supra, this section), the crystalline structure of this clay mineral becomes amorphous.

Illite is not a major soil constituent in recent sediments of the central Sudan and it forms only minor proportions in the mineralogical analyses of these sediments (Buursink 1971:192 and Gunn 1982:93). Analyses of five modern clay samples from Khartoum (Sarurab, Sheheinab and Nofalab areas) and White Nile (Shabona and Rabak) regions showed that mica/illite clays are present in the order of c.9-12% (Khabir 1981:73,80). Therefore, its inconspicuous indication in the samples from the Second Cataract, Khashm el Girba and complete absence in the tested samples of Khashm el Girba (see fig. 34) does seem conceivable. The sole exception, being the samples of Khartoum Province (ibid.)

6.3.2.1 Conclusions

The results outlined above indicate the absence of the key clay minerals namely montmorillonite, kaolinite, illite and chlorite. If these clay minerals already present in the composition of the Mesolithic and Neolithic ceramics examined, they must have undergone structural changes due to heating.

The results tend to show further that there is no grouping tendency at the intra-regional or interregional levels. The Mesolithic/Neolithic as well as the local pottery from the same locality present homogenous groups.

6.3.3 General Discussion and Conclusions for Chemical Analyses: Interregional level.

6.3.3.1 Results of Ternary diagrams

It is common practise in petrography to use ternary (triangular) diagram to demonstrate the relation between rocks on the basis of three components. Such components may be aspects of granulometric composition in the case of soils or sediments (viz, the classification using triangles of the current soil classification schemes), or aspects of the mineralogical composition in the case of igneous or metamorphic rocks (e.g. Folk 1968:25-31; Nordstrom 1972: 38-39, fig.2 and Lindholm 1987:184-229, figs. 8.3, 8.6-8.7 and 8.9-8.11). The same type of diagram may be used for ceramics in archaeology (see e.g. Hays and Hassan 1974:71-79, fig. 3; Ronald and Bishop:47-65, figs. 4-8 and Caneva 1990:36-37, figs.2-3). Any set of three unrelated quantitative data can be used, whether grain sizes, mineralogical composition versus matrix or oxides in the chemical analyses (Van Der Plas, pers. comm., 1993).

In order to show possible clusters within the set of samples that are rather obvious, set of ternary diagrams using these methods and the computer programm TRIANG developed by Mijer (1987) have been constructed.

In the present chemical analyses, the sampled Mesolithic and Neolithic ceramics in the central Sudan as well as local modern pottery samples have been defined in ternary diagrams (cf. figs. 56-64) based on the following sets of chemical components:-

Si02, Al203 and Fe203; Si03, Al203 and Mg0; Al203, Fe203 and Ca0; Al203, Ti0 and MgO; MgO, Na20 and CaO; Na 20, K20 and CaO.

The relationship between Si02, Al203 and Fe203 shows a cluster of samples (1-1;2,3-3; 9-9;9-9; 0;X; Z-Z) being slightly separated from the remaining potsherds (see tables 16,28). All the samples of this cluster (see plate 56) have high Si02 contents, relatively rich in potassium with rather moderate amounts of iron oxides. The specimens showing the highest concentrations representing all the pottery samples from Shaqadud complex site (midden and cave) in the Western Butana region together with a single modern pottery sample from the same area (sample:Butana M.P.(1)). The largest concentrations

are also represented by all the pottery samples of Sarurab2, Nofalab2 and a single example from Islang2 site, all of which are located on the western bank of the Main Nile in Khartoum Province. The eastern bank of the Main Nile in Khartoum Province is represented by only one sample from Geili site (sample: Geili(1)). (tables 16,28). The slightly separated group tends to show relatively lesser proportions than the cluster described above (viz, samples 2;4-4; 5-5, 6-6; 7; 8-8; X-X and n-n).

The diagrams of figs. 57 and 58 show a general cluster of figures indicative of relatively high Al203 and rather homogenous distribution of Fe 203 and Ca0 for pottery of the different periods (Mesolithic, Neolithic and modern). The only exception being four modern pottery samples (designated 4 and 8) from Khartoum Province, a single sample from Jebel Moya cultural levels of Rabak site (sample: Rabak J.M. (9), tables 16,28) and Butana modern pottery (sample: Butana M.P.(2) designated 'n' and 'O' respectively. All the latter samples tend to show rather dispersed figures, isolated from the remaining samples in the diagram. This pattern suggests close relations between these samples with regard to the proportion of each element present.

The diagram of figure 59 listing the relationship between Al203, and Ti02 and Mg0. Three clusters stand out clearly and can be described as follows:-

The first cluster (coded as 2, 5, 6 and 7, tables 16, 28) at the apex of the upper triangle (figs.59, 61), is represented by Mesolithic and Neolithic ceramics from Khartoum (samples:Nofalab2, Islang2 (9), Kabbashi Haitah, Kabbashi and Geili (3)) and White Nile (Shabona and Rabak (Kh. Neo(6) Provinces. All the samples of this cluster provide Al203 content little above 20% wght%, while all the proportions of Ti02 and Mg0 concentrations are lower than 1%.

The second cluster (coded as 1,2,7,9, n,z and 0, tables 16,28), at the middle of the upper triangle, includes Mesolithic, Neolithic and modern pottery from Khartoum Province (Sarurab2, Islang2(2) and Geili (1)), Western Butana (Shaq. (M) Meso.; shaq. (M) Neo. and Butana M.P.(2)). This cluster shows that a group of samples from these sites is composed of relatively higher Al203 content mostly little above 15% wght%, whereas Ti0 and Mg0 proportions are exclusively below 2%.

The third cluster (coded as 4,8 and 0, tables 16,28), scatters through the lower triangle (fig.59) and consists of modern pottery samples from Khartoum Province (Khartoum Prov. W.B.M.P. and Khartoum Prov. E.B.M.P.) and only one sample from the modern pottery of the Western Butana region (samples:Butana M.P.(2)). The values of Al203, Ti02 and Mg0 cluster around 13-18%, 1-2.3% and C.3-4% by weight respectively.

Three elements, SiO2, AL203 and Mg0 (fig.60) indicate a good clustering of the pottery samples from the Mesolithic,Neolithic and modern periods, make it clear that almost all the samples are rather similar if chemical composition is only taken into consideration.

It is remarkable that only two samples from the Jebel Moya levels of Rabak Neolithic site (sample: Rabak J.M.(9)) and the modern pottery from the Western Butana region (sample:Butana M.P.(2)) exhibit very similar concentrations of SiO2,AL2O3 and MgO, rather different from the remaining samples.

The relationship between MgO, Na20 and CaO (fig.63 and tables 16,28) shows a cluster of the bulk of the potsherds analyzed, make it clear that the samples are rather similar if chemical composition is solely taken into consideration. In most instances, CaO is relatively higher in proportion compared with MgO and Na20 which exhibit markedly low concentrations. However, a few specimens (viz, samples 4,6,8,n and O) tend to show exceptionally higher proportion of CaO (< 60% of the total of the three chemical components compared) in comparison with MgO and Na20 which are exclusively lower than that percentage. These specimens are represented by Mesolithic potsherds of Kabbashi site (samples: Kabbashi(2) and Kabbashi(4), a single Mesolithic potsherd from the Jebel Moya levels of Rabak Neolithic site (sample: Rabak (J.M.)9), modern pottery samples from the east bank of the Main Nile in Khartoum province (sample: Khartoum Prov. E.B.M.P.(4)) and western bank of the Main Nile in the same area (sample: Khartoum Prov. W.B.M.P.(1)) and only one modern pottery sample from the western Butana region (sample: Butana M.P.(2)). Samples 'n' and 'X" tend to show rather similar proportions with respect to the three chemical components (MgO, Na20 and CaO) compared (cf. fig. 63 and tables 16, 28). These samples represent pottery of the Mesolithic site of Shabona in the White Nile Province (sample: Shabona (8) and the Neolithic site of Rabak (sample: Rabak (Kh.Neo.)7).

The relationship between Na20, K20 and CaO (fig.64) shows a cluster of potsherds (O, 1-1, 2, 3-3, 4, 8, 9 and z-z) being slightly separated from the rest of the tested samples (cf. tables 16, 28). Most samples of this cluster exhibit relatively higher concentrations of CaO (40-60% of the total proportions of the three chemical components) and markedly lower percentage of Na20 and K20 (< 40%). The specimens showing relatively high concentrations of CaO representing the Mesolithic pottery samples of Sarurab2 site and Neolithic specimens from Islang2 and Nofalab2 (samples 1-1, 2 and 3 respectively) on the west bank of the Main Nile north of Khartoum and a sample of modern pottery from the same area (sample: Khartoum prov. W.B.M.P.(2)). The eastern bank of the Main Nile in Khartoum Province provided a single sample (sample: Khartoum Prov. E.B.M.P.(3)). Western Butana pottery is represented by a single specimen derived from the Mesolithic levels of Shaqadud midden (sample: Shaq. (M)Meso.(7)). The White Nile Province provided two modern pottery samples. The remaining samples (2,5,7,9-9,n and X) are liberally scattered through the lower part of the triangular diagram (calcium section) (fig.64) indicative of low proportions of calcium and much lower amounts of both Na20 and K20. However, only three samples provided contractions of CaO >60 of the three components compared. These are modern pottery samples from Khartoum province on the east bank of the Main Nile (sample: Khartoum prov. E.B.M.P.(4)) and west bank of the Main Nile in the same area (sample: Khartoum prov. W.B.M.P.(a)) and a single Neolithic potsherd derived from Jebel Moya levels of Rabak site (sample: Rabak (J.M.)9).

6.3.3.2 General Discussion

The chemical content of all the samples (Mesolithic, Neolithic and modern ceramics) from Khartoum, White Nile and the Western Butana regions, is characterized by silicon-rich sand. Si02 concentration reaches C.70% at the average. This high Si02 concentration is suggestive that the composition of the analyzed pottery samples (temper and matrix) is characterized by large amounts of incorporated quartz grains resulting from the prevalence of Nubian Sandstone Formation (see figs. 3-4, 50) in the three regions that form the case study of this research. (cf.sections 3.1.2; 4.1.2 and 5.1.2).

Aluminium oxide (Al203) is relatively high in all the Mesolithic, Neolithic and modern pottery samples from the three regions investigated Al203

occurs in similar proportions in most of the samples, being present in concentrations of c.16% at the average. However, it is relatively higher (c.20.2% at the average) at the pottery from the early Mesolithic, Late Mesolithic sites of Kabbashi Haitah and Kabbashi respectively and a single sample from the Neolithic site of Geili, all of which are located on the east bank of the Main Nile north of Khartoum. The proportion of this oxide is relatively higher (20.3%) at the Neolithic site of Islang2 on the west bank of the Main Nile. In the Western Butana region, the relatively higher percentages of Al203 (c.22% at the average) are confined to the Late Neolithic site of shaqadud Cave. In the White Nile region, three samples from Shabona Mesolithic; Rabak (Khartoum Neolithic Levels) and Rabak-J.M.L sites, respectively, present values amounting to c.20% at the average. Such pottery with rather rich Al203 content, is consistent with the abundance of K-feldspar in the mineralogical composition of these samples (see sections 3.3, 3.4 and 5.3).

Ferrous oxide (Fe203) is present in most samples with similar values reaching c.7.2% at the average. The analyses show F203 to be present in concentrations of c.6-9%; c.6-11% and c.11% by weight at the Mesolithic, Neolithic and modern local ceramics of Khartoum, While Nile and the Western Butana regions, respectively (see sections 3.5, 4.5 and 5.5).

Three samples representing the pottery of Jebel Moya Levels (late Neolithic) at Rabak site (Sample: Rabak J.M.(9)) in the White Nile province, modern pottery of Khartoum Province (sample:Khartoum Prov.E.B.M.P (3)) and the Western Butana (sample:Butana M.P.(2)) provide relatively high values amounting to c. 9 wght%, 12 wght% and c.11 wght% respectively (ibid).

Iron in the form of iron oxide (Fe203) or iron-ore deposits is common in the Nubian Sandstone Formations prevailing in Khartoum, White Nile and the Western Butana (central Sudan) and most regions of the northern Sudan as well (see sections 3.1.2, 4.1.2 and 5.1.2).

About 1% iron will give a noticeable tint light of tan (brown) colour (Rhodes 1973:207). The amounts of iron in the composition of the Mesolithic and Neolithic ceramics in the central Sudan, as seen from the present study, appear to be generally moderate or rather rich in iron oxides.(see sections 3.5, 4.5 and 5.5). Therefore, it seems possible that iron has an effect on the appearance of the pottery examined in the present work. The development of

surface colour during the Neolithic period particularly its later phase and the increasing tendency in refining ceramics with red slips, usually burnished, might have been favoured by the occurrence of iron associated with special firing conditions in oxidizing atmosphere (cf. sections 3.7; 4.7; 5.7 and chapter 8).

The proportions of Titanium oxide (Ti02) are very small in all the Mesolithic, Neolithic and modern samples from Khartoum, White Nile and the Western Butana regions. The percentages are less than 2 wght% in almost all the samples examined. Fewer samples from Khartoum (sample: Khartoum Prov. W.B.M.P.(2)), White Nile (Rabak J.M.L.(9)) and Western Butana (sample:Butana M.P.(2)) provide titanium concentrations little above 2% by weight.

Mn0, Mg0, Na20, P205 and Ba0 tend to be rare (mostly under 1wght%) in most of the Mesolithic, Neolithic and modern pottery samples from the central Sudan (Khartoum, White Nile and Western Butana regions). However, Mg0 concentrations have slightly higher values, though in most cases, provide values lower than 1% by weight. This raises the probability that these oxides are, perhaps, indices to minor minerals (impurities) brought in with other oxides.

Calcium oxide (Ca0) concentrations are rather low, being present, in most cases, little above c.2 wght%. It is noteworthy that the modern local pottery from this area tends to show rather moderate amounts in the order of c.3-8% by weight.

The pottery samples from the White Nile (Mesolithic, Neolithic and modern local ceramics) exhibit rather low amount of Ca0. Nearly all the samples are little above c.2 wght% and only one anomalous sample from the Jebel Moya Levels of Rabak Neolithic site (sample: Rabak J.M. (9)) has a moderate value being slightly higher than 5 wght% (tables 26 and 27).

The rather moderate amounts of calcium in the composition of the modern ceramics of Khartoum and White Nile regions are consistent with with results of chemical analyses of modern clays from various localities in these areas (see El-Attar and Jackson 1973:194; Mahgoub 1979:19-57 and Khabir 1981:238, table 4).

Two chemical analyses on soil samples from the White Nile region, near Kosti show that the clays in this area are generally calcareous and the tested samples have 2-8% of calcium carbonate (El-Attar and Jackson 1973-194). It is noteworthy that chemical analyses were conducted on a series of clay samples from the eastern bank of the Main Nile in Khartoum area shows that calcium in the form of calcium carbonate (CaC03) is present in proportions of 6-10% in the soil (Maghoub 1979:56).

The proportion of Ca0 is low in the Mesolithic and Neolithic pottery samples from the Western Butana, being mostly present below 2 wght%.

The low concentrations of Ca0 are not in accord with moderate or rather-rich calcitic inclusions detected in the composition of pottery from this area by petrographic (section 5.3) and X-ray analyses (section 5.4.). The only exception being a sample from the modern pottery from this area (sample:Butana M.P.(2)) which shows rather moderate amount little above 4% by weight.

As noted above (cf. section 5.5.3), although this phenomenon could merely be due to a function of sampling, it may also be the result of rather rare occurrence of the later Neolithic pottery from the Western Butana (Shaqadud Cave) containing calcium material. If that was the case, then the probability that the late Neolithic pottery of Shaqadud Cave with moderate and often rather rich-calcium content (see section 5.3) was produced of minerals taken from a source different from that used for the other samples and analyzed material of the Western Butana region, becomes much more likely (see section 6.7.).

The proportions of K20 are generally low in the majority of the samples, being present, in most examples, at less than 2 wght%.

The samples containing K20 in Khartoum Province (tables 12-13) are mainly below 2 wght% indicative of low concentrations. Nonetheless, a considerable number of samples (40%) containing moderate amounts of K20 content being in the range of c.5-7% by weight. These moderate concentrations are represented by the Mesolithic and Neolithic sites of the eastern bank of the Main Nile (Kabbashi Haitah, Kabbashi and Geili:sample Geili(3)). Notably, only one example from Islang2 Neolithic site (sample:Islang2 (9)) on the west bank of the Main Nile shows relatively higher concentrations reaching c.7% by weight.

The amounts of K20 are rather moderate in most of the Mesolithic, Neolithic and modern pottery samples from the white Nile region. The samples, in most instances, are in the range of c.3-7% by weight. The relativley higher proportions recorded from Shabona Mesolithic and the Neolithic levels of Rabak site (see tables 26 and 27 and section 4.5.2).

In the western Butana region, the Mesolithic, Neolithic and modern pottery samples exhibit low concentrations of K20 mostly below 2 wght%. A few examples tend to show relatively moderate amounts in the range of c.4-6% by weight (tables 26-27 and section 5.5.2).These samples were reported from the late Neolithic site of Shaqadud Cave. (ibid).

6.3.3.3 Conclusions

Despite the differences in the proportion of some oxides (tables 12-13,26-28,36-37) and sections 3.5, 4.5, 5.5 and 5.5.4), these Mesolithic and Neolithic pottery samples from the central Sudan do seem similar in general characteristics. The chemical analyses of the Mesolithic and Neolithic samples (dominantly silicon, aluminium and iron oxides) tend to support the results gained from the petrological (see sections 3.3, 4.3 and 5.3) and X-ray (see sections 3.4, 4.4, 5.4 and tables 10-11, 25, 33) analyses that quartz, feldspar and iron are the most prominent minerals in the composition of pottery from Khartoum, White Nile and the Western Butana regions.

On the basis of pottery chemistry, it is remarkable that there is, virtually, no clear grouping tendency in the Mesolithic and Neolithic pottery samples of Khartoum, White Nile and the Western Butana regions in intra-or interregional Levels. The sole exception being the results of simple clustering shown by triangular diagrams (figs.57-58) representing the relationship between Al203, Ti0 and Mg0. It is worthnoting that two clustering tend to show, in most instances, that Mesolithic and Neolithic ceramics along the central Nile (Khartoum and White Nile regions) are distinct from those of the Western Butana region in having relatively high concentrations of Al203 and low proportions of Ti02 and Mg0. Whether that grouping tendency is apparent or has a cultural reality, it is hard to judge from the scale of the chemical data set in the present study.

Temporal differences in ceramic paste composition, if any, is similarly inadequately perceptible from the chemical data set examined in the present study. The only exception is the experimentation with clays that are rather rich or moderately-rich in calcitic material during the late Neolithic period (3rd millen. B.C.), being present in the White Nile (the site of Rabak-Jebel Moya Levels) and the Western Butana (Shaqadud Cave) ceramics respectively.

It can be seen (tables 12-13, 26-27, 36-37) that there is, in most instances, a fair degree of chemical homogeneity between specimens from the same location or from different locations within the same area. In the writer's opinion the chemical results which show that the oxide elements, generally, display rather homogenous range of values is, perhaps, due to the chemical similarity in the source of potting material (the Nile silt and alluvial clays) and the potters methods of clay manipulation in the central Sudan particularly along the Nile (Khartoum and White Nile Provinces) (cf. El-Bedri 1972:97-100; El-Attar and Jackson 1973:194; Mahgoub 1979:19-57; Khabir 1981:73-80, 238, table 4; sections 3.3, 4.3 and 5.3). The considerable degree of similarity among the Mesolithic and Neolithic pottery fabrics and the modern pottery in the same location or from different locations within the same region (see sections 3.3, 4.3 and 5.3) could postulate the utilization of similar clayey source within and/or between each of these areas investigated.

As indicated above, the pottery of all periods (Mesolithic, Neolithic and modern) from the study regions (Khartoum, White Nile and Western Butana) tends to show distinct homogeneity with only little variations in intra-or interregional levels (ibid). However, this minor chemical variations, seem to reflect the amount of temper present (e.g. the Mesolithic and Neolithic pottery samples) and the particularity of ceramic phase (e.g. the modern pottery samples).

6.3.4 Goethite Norm analyses

The results of goethite norm calculations indicate that the original fine earth fractions of the Mesolithic, Neolithic and modern pottery samples from the central Sudan might have held kaolinitic-illite quartz-rich clays, small amounts of montmorillonite and rare amounts of chlorite (cf. sections 3.6-5.6).

The proportions of kaolinite norm minerals are relatively high (mainly-62-75%, c.27-52% wght%) in all the samples during the Mesolithic and Neolithic periods (ibid.). Exceptions are the modern pottery samples from the central Sudan which are either devoid of this mineral (Butana samples) (table 39) in most cases or contain relatively low amounts (Khartoum and White Nile samples) (table 17, 29).

Illite norm minerals are present in the composition of the Mesolithic, Neolithic and modern pottery samples from Khartoum, White Nile and Western Butana regions with varying proportions. The pottery samples of Khartoum Province tend to display rather high proportions mostly (c.62%) in the range of c.20-49 wght% and in one case (sample: Geili (3)) the percentage reaches 80 wght%. (cf.sections 3.6-5.6). However, the differences in frequencies could be due to the pretreatment of material used. Pretreatment may either increase or decrease the proportion of certain mineral depending on whether the pretreatment material contains or does not contain the mineral in question.

Quartz norm minerals are, in general, present in rather comparable proportions in the composition of the Mesoithic, Neolithic and modern pottery samples from Khartoum, White Nile (each c.63 wght%) and Western Butana (75 wght%) regions (cf. tables 17, 29, 39). This is not surprising because all the sites from which the tested samples derived are situated on Nubian Sandstone formations which cover most of the total surface area of the central and northern Sudan (cf. fig.3, sections 3.3-5.3, 6.3.1 and appendix 1).

Montmorillonite which is the most prominent clay mineral in the present sediments of the central sudan (cf. sections 3.4-5.4, 6.3.2) occurs in low proportions in almost all the samples from Khartoum (93%), White Nile (75%) and Western Butana (75%), being in the order of c.0.178- 10 wght%, c.5-12 wght% and c.7-15 wght% respectively.

Chlorite is rare or little in amount in Khartoum province Mesolithic, Neolithic and modern pottery samples (c.19% of the total samples), sparse (25% of the total) in the Western Butana and scarce in the White Nile region samples (25% of the total), being present in the range of 0.74% - 13.8 wght%, c.13-15 wght% and 3.14-3.15 wght% respectively.

6.3.4.1 Conclusion

The results of the goethite norm calculations (see supra and sections 3.6-5.6) differ from the X-ray diffraction ones (cf. sections 3.4 - 5.4, 6.3.2) which are devoid of the key minerals (montmorillonite, kaolinite, illite and chlorite) in the pottery samples analyzed. The sole exception, being only one sample from the Neolithic site of Islang2 (sample: G93-17a) in Khartoum Province which contains very small amount (cf. sections 3.4, 6.3.2).

The presence of appreciable kaolinitic minerals as shown by the geothite norm analyses, is consistent with the availability of this clay (c.12-19%) in the central Sudan during the Mesolithic and Neolithic periods. (see supra and sections 3.4-5.4, 6.3.3). On the other hand, the considerable proportions of this clay norm mineral in the composition of the modern samples from the areas investigated could be due to a cultural preference of the potters. The presence of small or rather moderate amounts of this clay mineral together with high proportions of montmorillonite seems to strengthen the probability that the modern potters in question use this type of clay because of its ceramic value (cf. section 6.3.2 for further discussion).

Illite is relatively high in proportions in most of the Mesolithic, Neolithic and modern pottery samples of the central Sudan due, perhaps, to the pretreatment of raw material used by the potters in question as this mineral is present in minor proportions (c.9-12%) in the recent clays of the central sudan (ibid. and section 6.3.4).

Chlorite is devoid in the composition of most of the samples analyzed (cf. section 6.3.4). This result (0.74-13.8 wght%) is consitent with that present in the clays of the Nile River sediments which range from 3 to 37 wght% (see section 5.4.2).

6.4. General Comparisons: Interregional level

6.4.1 Limitations

The present comparative study suffers from the following limitations:-

a- The first limitation is inherited from the previous physico-scientific analyses carried out by earlier workers on Mesolithic and/or Neolithic ceramics in the Sudan (see Hays 1971; Nordstrom 1972:33-68, 1981:80; Francaviglia and Palmierie 1973:191-205; Hays and Hassan 1974:71-79; Williams 1982:174-176; De Paepe 1986; Chlodnicki 1989:369-373 and sections 1.5-1.6). Quantification of the physico-scientific data in these analyses is lacking or inadequately presented to allow for unitary quantitative comparisons needed in making full use of the overall data available. Because of the differences in the manipulation of the results thus obtained rather than in the physico-scientific methods applied in pottery analyses (see supra, this paragraph), it is not possible to make quantitative comparisons between the petrographic, X-ray diffraction and chemical analyses of the tested Mesolithic and Neolithic pottery in the present research and those of the previous works (see supra, this paragraph and chapters 3-5).

b- The second limitation lies in that some of the earlier analyses (see infra) are, unfortunately, solely presented in the form of interim reports and thus not suitable for detailed comparative purposes especially so, when one considers the parameters used in the present analyses (cf. chapters 3-5). Some of the scientific reports, however, have mentioned that chemical tests such as major, minor or trace elements were conducted to check the petrographic and X-ray results (see Nordstrom 1972:33-68 and Hays and Hassan 1974:71-79). Regrettably, no information quantitative or qualitative pertinent to the types of chemical components characterizing the tested samples was given. Therefore, consultation of such very brief chemical information remains futile.

6.4.2 Comparisons

6.4.2.1 Introduction

The fabrics which characterize the tested Mesolithic and Neolithic ceramics in the central Sudan (cf. sections 3.3-6.3) are often comparable to

those derived from a series of Mesolithic and /or Neolithic sites from central, northern Sudan and adjacent zones (see below).

6.4.2.2 Sudan

6.4.2.2.1 Sandy fabrics

Fabrics group A of all the Mesolithic and Neolithic tested ceramics from the central Sudan are comparable to fabric groups (1A and 1C) of Khartoum variant from Upper Nubia (cf. Nordstrom 1972:48-49), fig.1), Group III of Neolithic ceramics from Khartoum (K11 and K25), the Second Cataract area (626-10) (cf. Hays and Hassan 1974:71-79 and table 40) and the Mesolithic/ early Neolithic ceramics of Wadi Howar region in the western Sudan (cf. Richter 1989:431-442 and fig.2).

The sandy fabrics of the present research (cf. section 6.3.1.1) are, similarly, analogous to Um Direiwa fabrics (see Nordstrom 1981:48-50); the Mesolithic fabrics of Sarurab1 ceramics (see Williams 1982: 174-176); a series of Mesolithic (Sarurab1, Jebel Um Murrahi and Saggai1) and Mesolithic/Neolithic (Qoz) ceramics in Khartoum Province (Francaviglia and Palmieri 1983:191-205) and the Neolithic pottery of El Kadada site in northern Sudan (De Paepe 1986:113-140).

The petrological work on Neolithic ceramics (n=15 sherds) from the Second Cataract (Abkan and Khartoum variant) provides evidence showing that fabrics 1A and 1C which are composed of sandy pastes and tempered with appreciable detrital grains of quartz, feldspar and often mica aggregates seem to suggest the exploitation of local raw material (clayey deposits and geological formations). The local geology of the area favours this possibility (cf. Nordstrom 1972:48-50, section 6.4.2 and fig.3).

The petrological analysis of Neolithic ceramics (n=13 sherds) from Um Direiwa site (fig.4) shows that quartz and feldspars are the main prominent non-plastic inclusions in all the samples analyzed, usually forming between 20 to 40% of the paste (see Nordstrom 1981:242).

The petrological and X-ray diffraction analyses of Hays and Hassan on a series of Neolithic sherds (n=22 sherds) resembling Khartoum Mesolithic and Khartoum Neolithic ceramics, covering the central and northern Sudan

distinguished two main fabric groups; one is "Sandy" being characterized by igneous (mainly feldspar and augite) or sedimentary (mainly quartz and iron inclusions) minerals; the other by mixed lithography (see section 4.6.2.2.2).

The sandy fabrics of Khartoum (K-2, K-11, K-23), Second Cataract (1045, D1W-5, D1W-50), Dongola reach (N13-4-17, N 13-4-22, N 40-2), Khashm el Girba (N 110, N114-6, N128) are in accord with the three lithological provenances (Nubian Sandstone, Basement Complex and Ethiopian suite) present locally in the sites of pottery find. Moreover, the clays of pottery sherds examined which are mainly montmorillonitic are in agreement with the predominance of this mineral in the central and northern Sudan soils (cf. section 6.3.2). These results tend to show that the mineral make-up of these tempers and clay matrices was a derivation from the local lithological provenances (cf. Hays and Hassan 1974:71-79; sections 6.3.1-6.3.2, 6.4.2 and figs.3-4).

The petrological analysis of the Mesolithic ceramics of Sarurab1 (n=22 sherds) in Khartoum Province (fig.1) provides evidence indicating the presence of two main fabrics; one (Fabric 1A) is characterized by numerous quartz inclusions which are probably derived from Nubian Sandstone deposits, on which this site is situated (see fig.4) and hence a local provenance for the pottery seems possible; the other (Fabric 2A) is distinguished by grains of plagioclase and microcline feldspar together with quartz inclusions and little muscovite. The source of this suite is most likely the Pre-Cambrian Basement Complex which outcrops in close proximity to the site, only c.22 km to the north (fig.4). Therefore, a fairly local provenance for the pottery seems likely (see Williams 1982: 174-176).

The petrochemical analyses conducted on potsherds (n=36) representing the Mesolithic ceramics of Sarurab1, Jebel Um Murrahi, Saggai1 and the Mesolithic/Neolithic sherds of Qoz in Khartoum Province indicate that the fabrics of these ceramic groups are characterized by the presence of normative quartz, feldspar correspond to the constant presence of modal quartz, feldspar detectable by X-ray diffraction and the pottery sherds are always saturated with sillimanite i.e. Al203 due to the low rate of CaO. The results which suggest a local derivation for the pottery and the Nubian Sandstone deposits, on which the sites are situated, favours this possibility (cf. Francaviglia and Palmieri 1983:191-205 and fig.4).

The petrological analysis on the Neolithic pottery of El Kadada (Shendi reach) in northern Sudan indicates that it is mainly characterized by alkaline feldspar and detrital grains of quartz with unequal frequency (De Paepe 1986:113-140). The source of quartz and feldspars, respectively, are the clastic sediments of Nubian Sandstone and the Pre-Cambrian Basement Complex that are distributed over most parts of Sudan including the site area (fig.3). The site is situated on Nubian Sandstone deposits and the nearest Basement Complex outcrop lies c.70 km to the south at the Sixth Cataract area (fig.52). Hence, a fairly local source for the ceramics seems possible.

6.4.2.2.2 Mixed lithography

Fabrics (Group B) of mixed lithography have been identified in the Mesolithic ceramic collections of Kabbashi Haitah (Khartoum Province) and Shaqadud Cave (Western Butana region) examined in the present work (cf. sections 3.3.1.1 and 5.3.5) and the Neolithic ceramics (Fabric 11Ci) from Khartoum Province (K-11, K-25) and the Second Cataract (626-1, 626-10) area (Fabric 111ai) (see supra, this section ; Hays and Hassan 1974:71-79 and table 40).

Fabrics B of Kabbashi Haitah (Khartoum Province) and shaqadud Cave (Western Butana region) are mainly composed of monocrystalline quartz, a fair amount of feldspar, a frequent amount of mica and little iron inclusions (cf. sections 3.3.6.1.1 and 5.3.4).

These fabrics are distinct in composition from fabric 111ai of the Neolithic potsherds from the Second Cataract (see supra, this section) which contain quartz, hematite inclusions together with a few orthoclase and granophyre fragments (see Hays and Hassan 1974:76 and table 40) probably indicative of mixing tempering materials from the Nubian Sandstone and Basement Complex. The exposures of Nubian Sandstone and Basement Complex prevail in the Second Cataract area and cross the Nile north of this area into Egyptian border (cf. Issawi and El-Hinnawi 1984:3; Hays and Hassan 1974, fig.2).

6.4.2.2.3 Discussion

Except for fabrics of sandy and mixed lithography types reviewed above (see supra, this section), the remaining major mineralogical groupings characterizing the Neolithic ceramics tested by Hays and Hassan (1974:71-79) in Khashm el Girba (N 110-N 114-6, N 128), Dongola reach (N 13-4-17, 13-4-2, N 40-2) and the Second Cataract (1045, D1W-5, D1W50) as well as those examined by Nordstrom (1972:48-64) in the latter area (Second Cataract) which embrace the Neolithic ceramics of Khartoum Variant (18A and 428), Abkan (365, 369-371, 414) and A-Group (277) at Wadi Halfa district (see fig.1) clearly represent different mineralogical groupings that are neither related to the Mesolithic and Neolithic of the central Sudan examined in the present work (see supra and chapters 3-5) nor to each other (see Hays and Hassan 1974:71-79 and fig.40).

Pottery-sherds from Khashm el Girba (fig.2) contain basalt lithic fragments and augite indicative of igneous source. This mineral suite is derived from Ethiopian Plateau drained by the Atbara River in the eastern Sudan (cf. figs. 1-2).

This mineralogical suite characterizing Khashm el Girba Neolithic pottery in the eastern Sudan (see supra, the above paragraph) has no counterpart in the northern sudan (Dongola reach and the Second Cataract area) (cf. supra, this section and the foregoing discussion). Conversely, in the Dongola reach (N 13-4-17, N13-4-22, N 40-2) and the Second Cataract area (1045, D1W-5, D1W 50), the mineralogical suite consists mainly of quartz, orthoclase, Na-plagiocalse and mica (biotite and muscovite). A subgroup of this suite (IIcii) also contains polymineralic fragments of biotite gneiss and chlorite schists. The origin of these minerals and the rock fragments is the Pre-Cambrian Basement Complex which consists mainly of gneisses and schists (cf. Hays and Hassan: 72-76 and table 40). All the tested Neolithic sites of Dongola reach and the Second Cataract (see supra) are located near exposures of Basement Complex (see figs. 1,3).

Unlike the Mesolithic and Neolithic ceramics of the central Sudan (Khartoum White Nile and Western Butana regions) examined in the present work (cf. sections 3.3, 4.3, 5.3 and 6.3) and the Second Cataract area (626, 626-

10, 1045, D1W 5, D1W 50) whose composition is devoid of organic inclusions, the Mesolithic and Neolithic sherds from Dongola reach (N 13-4-17, N 13-4-22, No 40-42) and the Neolithic ones from Khartoum district (K-23) hold appreciable amount of vegetal fibre (cf. table 40).

Though the predominant inclusions in Khartoum (K-23) and Dongola reach (N 13-4-17, N 13-4-22, N 40-2) are quartz, microcline and Na-plagioclase, yet the fine to very fine grained texture (0.0.60 - 0.250 mm) raises the probability that the mineral inclusions may be part of the paste rather than tempering material delibrately added by the potter (cf. Hays and Hassan 1974:74 and table 40).

It is noteworthy that ash-tempered and dung-tempered pastes (Fabric 11A and 11B) which have been identified in the composition of a series of A-Group ceramics - Classic A-Group - (cf. Nordstrom 1972: 51-53 and section 10.1.2.4) from the Second Cataract are absent in the Mesolithic and Neolithic ceramics from the central (cf. sections 3.3-6.3) and northern Sudan (see Nordstrom 1972:48 and Hays 1974:71-79).

6.4.3 Adjacent Zones

6.4.3.1 Egypt

By adjacent zones the present writer refers to Egyptian (cf. section 10.2.1) and central (cf. section 10.2.2) Sahara where Mesolithic and Neolithic ceramics comparable to that found in central (cf. sections 3.3 - 6.3, 10.1.1 and fig.43) and northern Sudan have been encountered (cf. Nordstrom 1972:48-68 and Hays and Hassan 1974:71-79).

In the eastern Sahara (cf. section 10.2.1) fabric analyses have been conducted on a series of Neolithic ceramics derived from the western (see Banks 1980:299-315) and southern (see Zedeno and Wendorf 1993: 1-46) parts of Egypt (cf. section 10.2.2 and fig.43).

The Neolithic pottery of Nabta Playa (fig. 43) which shows general resemblances in decoration (woven mat and occasional fern branch) to that of Abkan and Khartoum Variant from the northern Sudan (cf. Myers 1960:174-18; Shiner 1968:768-790; Nordstrom 1972:8-12, 74-77 and section 10.1.2.4), Shaheinab and related sites in the central Sudan (cf. Arkell 1952: Pls. 29,31:25-

29, Caneva et al 1993:39, fig.8 and sections 10.1.1 and 10.2.2) including some Neolithic ceramics (Geili, Rabak [Kh. Neo. L.] and Shaqadud Cave) examined in the present work (see sections 4.3.3.1, 3.3.6.21, 5.3 and below), is tempered with metamorphic gneissic with or without intrusive acidic igneous, containing microcline, polycrystalline quartz, quartz Na-plagioclase, biotite, opaque, granular calcite and hornblende (see Banks 1980:300, 303).

This mineral suite characterizing the Neolithic pottery of Nabta Playa is similar to fabric B of Geili (Khartoum Province) and fabric groups C of Rabak [Kh.Neo.L.] (White Nile Province) and shaqadud Cave (Western Butana region) (cf. sections 3.3.6.2.1, 4.3.3.1 and 5.3.4 respectively).

The local availability of metamorphic sources for both Nabta Playa (cf. Wendorf and Schild 1980: figs. 3-5; Zedeno and Wendorf 1993:11-12) and the comparable Mesolithic and Neolithic ceramics from the central and northern Sudan (cf. Nordstrom 1972:48-64 and sections 3.3.6.6.2.1, 4.3.3.1 and 5.3.4) strengthens the probability that these general typological and mineralogical parallels do not constitute a percetible ceramic movement from either direction (cf. sections 9.11-9.12 for further discussion).

The pottery temper of Bir Kiseiba Neolithic site (fig.1) is characterized by calcareous metamorphic inclusions consisting of granular calcite and epidote, indicating a metamorphosed impure carbonate sediments probably limestone. It is comparable in composition to pottery fabric of Nabta playa (see supra, this section) and showing general resemblances in decoration (woven mat) and the metamorphic fabrics with a series of Neolithic ceramics from the central sudan examined in the present work (Geili, Rabak and shaqadud Cave) (see supra, this section). However, in the later area, with the exception of Rabak and Shaqadud Cave, the calcitic inclusions which are predominant in the pottery of the Eastern Egyptian Sahara (Nabta and Bir Kiseiba) are devoid in the pottery composition (cf. sections 3.3.6.2.1, 4.3.31 and 5.3.4).

The Neolithic pottery from Wadi Bakht indicates general decorative resemblances (linear and chevron impressions) with Nabta "Middle Neolithic phase" and a series of Neolithic ceramics from the central Nile namely Shaheinab and Kadero (cf. section 10.2.2). It is characterized by two types of temper; one is acidic igneous with subangular to angular grains, and its origin is indicated by the microperthite, biotite as the dominant mica and the lack of

polycrystalline quartz; the other type is recycled sandstone dominated by quartz and very little feldspar. Fresh and weathered gabbro, either titanguite or geothite and hematite, is occasionally present (cf. Banks 1980:300, 308).

The igneous tempering minerals of Wadi Bakht ceramics seem to be a local derivation from the Basement Complex outcrops in the vicinity of the site whereas the sedimentary ones are most likely procured from the Nubian Sandstone Formation on which the site is situated (see Issawi and El-Hinnawi 1984:41-43).

The minerals of igneous origin (microperthite, biotite) characterizing some of the Wadi Bakht ceramics (see supra, this section) are very similar in composition to some pottery samples from Kadero (sample 9) which indicates the presence of large amount of perthite, a mineral that does not appear in the remaining samples from this site (cf. Chlodnicki 1989:386-373). However, this mineral is prevalent in the composition of some Neolithic ceramics in the central Sudan (Rabak-Kh.Neo.L. and Shaqadud midden Neo. L. (fig.1) which are, partially contemporary with Kadero (cf. sections 10.1.1, 6.3.1 and 6.4). Fabrics group A of Rabak -Kh. Neo.L. (White Nile Province) and group B of Shaqadud midden- Neo.L. (Western Butana region) are analogous to the fabric of sample no.9 from Kadero, all of which are characterized by appreciable perthite and microline (cf. sections 4.3, 5.3, 6.3.1 and supra, this section).

On the basis of the above evidence and taking into account that Kadero site lies in close proximity to a Basement Complex inlier at Sabaloka Gorge, only c.40 km to the north (fig.4), a local source for the igneous minerals (microperthite) is fairly possible.

Unlike the situation of Wadi Bakht and Kadero (see supra, this section) tempering inclusions of igneous origin " perthite" are absent. (see Nordstrom 1972:80). However, the common feature for the three sites is the presence of tempering material of sandstone origin, being characterized by quartz with little and/or absence of feldspar. The source of this type of temper is the Nubian Sandstone Formation prevailing in the areas of Nabta Plays, Bir Kiseiba, Wadi Bakht (Banks 1980:300, 308; Wendorf and Schild 1980:84-85), Shaheinab (see Nordstrom 1972:80) and Kadero (see Chlodnicki 1989:368-373) sites (fig.4).

Both in respect of technolgical (see infra) and typological (cf. sections 3.7 - 5.7 and 10.2.1) aspects, the Neolithic ceramics of the central Sudan (cf. chapters 3-5 and this section) differ from those of Fayum in an essential way. With regard to technological aspect, while the petrological results indicate that the Neolithic ceramics of the central Sudan (cf. sections 3.7-5.7, 6.3.1 and the foregoing discussion) are mainly sand-tempered, Fayum ceramics are characterized by organic inclusions (chaff and shell) and sand as well (cf. section 10.2.1). Therefore, on the basis of these basic technological differences concomitant with the typological ones (cf. sections 3.7 - 5.7, 10.2.1), sourcing ceramics from either direction (lower Egypt to central Sudan or vice versa) seems highly unlikely.

6.4.3.2 Central Sahara

Petrological analysis of Mesolithic pottery from Amekni (Algeria) and Neolithic ones from Wanyanga (Chad) in the central Sahara (see Hays and Hassan 1974:78, section 10.2.2, fig. 41) shows clear fabric differences betwen them. While the Wanyanga (Wan-K) pottery (Fabric 11 bii) is characterized by quartz, microcline, Na-plagiocalses and considerable amount of vegetal fibre, Amekni (AM-1-S-1 and Am-1-S-1) pottery (Fabric IIcii) displays mineralogical composition comprises of quartz, microcline, Na-plagioclase and small amounts of schists, gneiss rock fragments, hornblende and iron oxides (cf. table 40). The latter mineralogical suite shows affinities with fabrics groups 11bi and 1biii of Khartoum and Dongola reach respectively.

Chemical analyses using XRF technique show that the Mesolithic pottery of Wadi Ti-n-Torha (n=12) and the Neolithic examples from Fozzigaren (n-12) of Libyan Sahara is characterized by high silicon (Si02-48-75%) and aluminum (Al203-mainly 13-24%) where other major oxide (Mg0, Ca0, Na20, Fe203, K20) are present in minor amounts (mostly between 1-2% or even below) (cf. Palmierie 1987:221-230. The results are consistent with the clays suitable for pottery making in each of these sites (ibid.).

It is noteworthy that the Mesolithic and Neolithic sites of the central Sahara (Amekni and Meniet respectively) are situated in Nubian Sandstone deposits and often in close proximity to exposures of igneous rocks (Amekni) (see Hays 1974:76, fig.2). Hence, in the present writer's opinion, a fairly local source for the pottery is likely.

When the central Sahara Mesolithic and Neolithic ceramics (see supra, this section" are compared with their counterparts in the central Sudan (cf. sections 3.3.-5.3, 3.7-5.7, 6.3.1), it is clear that common affinities and often differences are remarkable. In both areas, quartz, microcline and Na-plagioclase are identified in the composition of the Neolithic ceramics of Wanyanga (Wan-K), Second Cataract (1045, D1W-5-83, D1W-50) and Dongola reach (N 13-4-22, N 40-2, N 41-1). Yet, the vegetal fibre which is the main feature of Wanyanga ceramic content, is devoid in the ceramics of the central Sudan (cf. sections 3.7-5.7, 6.3 and table 40). The vegetal fibre temper is present in appreicable amount in some Neolithic ceramics (N13-4-17) of Dongola reach (Fabric 11biii) but the non-plastic mineral inclusions of the latter are more finer in texture than those of Wanganga and may be part of the paste (see table 40).

Little can be saidabout the source of certain minerals, notably quartz and feldspars (microcline and Na-Plagiocalse) which are the common feature of both central Sahara and central Sudan Mesolithic or Neolithic ceramics (see supra, this section) because they are commonplace material. However, the presence of some schists and gneiss rock fragments along with occasional iron oxides indicates igneous deposits are the source of this suite. Precambrian Basement Complex which consists mainly of gneisses schists, and granites (cf. Whiteman 1971:11, 26) and lies in close proximity to the Neolithic site of Amekni (see Hays and Hassan 1974:76, fig.2) is a notworthy source.

6.5 The Scale of Resolution: Implications for the study

6.5.1 Limitations

Determination of the lithological provenance of the Mesolithic and Neolithic ceramcis in the central Sudan suffers from the following limitations:-

Firstly, the bulk of the pottery fabrics is composed of aplastic inclusions mostly quartz, feldspar, mica and iron inclusions which are commonplace material.

Secondly, as far as pottery and clay supply is concerned, the geomorphological structure of the central Sudan does not present marked lithological provenances. The central Sudan geology is generally homogenous. All the area (figs 3-4, 39,52) including the sampled sites are characterized by Nubian Sandstone deposits rest unconformably on a surface of Precambrian

Basement Complex (see appendix 1). Therefore, the lack of exotic rock fragments in the majority, if not all the analyzed samples is not surprising.

6.5.2 Petrological Results

Sandy fabric of sedimentary origin is either quartz-rich or limestone-rich. Quartz is the present in relatively high proportions (c.50-84% of the total) in almost all the fabrics of sedimentary origin (cf. section 6.3.1.1). The sole exceptions are fabrics subgroup A2 (c.40% of the total) and group B (c.3%) from Sarurab2 Mesolithic and Islang2 Neolithic sites in Khartoum Province (ibid). Feldspar (mainly microcline and plagioclases) is present in little amount (5-13%) and often absent. However, a clear cut source can not be given for these quartz-rich fabrics because quartz is a commonplace mineral. But since the sites with quartz-rich fabrics are, without exception, situated on Nubian Sandstone deposits (figs. 1,34,39,52), a fairly local source is worthy of close consideration (see sections 3.7 - 5.7, 6.3.1).

The other type of sedimentary fabrics is characterized by fair amounts of limestone fragments as represented by the Neolithic fabrics subgroup A2 of Rabak (J.M.L) in the White Nile Province and Shaqadud Cave in the Western Butana (fig.1). Sources for limestones in the vicinity of these sites are not available. The nearest source for Rabak site lies 45 km to the east (fig.39) whereas the nearest one for Shaqadud Cave lies 133 km to the south east (fig.52 and section 6.3.2.1).

Fabrics of igneous origin are present in almost all the Mesolithic and Neolithic ceramic groups examined in the present work (see sections 3.7-5.7, 6.3.1). Exceptions are fabrics A1, A2 and B of Geili Neolithic which are either sedimentary (Groups A1-A2) or metamorphic (Group B) in origin. The tempering material of the igneous fabrics (section 6.3.1) which is rich in microcline and perthitic feldspar (c.28-59% of the total) with little or no quartz are present in almost all the areas examined (Khartoum, White Nile and Western Butana). However, this phenomenon is probably not especially significant since, as just remarked (cf.supra, this section and appendix 1) feldspar-rich rocks and sediments derived from them are wide spread in the central Sudan (the study area). Nonetheless, the possibility of procuring sediments rich in igneous minerals from certain pockets of Precambrian Basement Complex underlying the Nubian Sandstone deposits, on which the sampled sites are located, does not

seem unlikely. An alternative option, being the Basement Complex outcrop of Sabaloka Gorge which lies c.50 km north of Khartoum and within easy reach to some Mesolithic and Neolithic sites of the study area especially those from Khartoum (fig.4) and possibly their counterparts from the Western Butana (figs.1-2, 52).

The metamorphic temper indicated earlier (see section 6.3.1.1) is composed of appreciable amounts of hornblende with or without polycrystalline quartz. With the exception of the Neolithic fabrics; subgroup A of Geili (Khartoum Province), group B of Rabak (White Nile region) and group C of Shaqadud Cave (Western Butana region) (cf. sections 3.3.-5.3, 6.3.1), this type of temper does not feature among the remaining Mesolithic and Neolithic ceramic fabrics in the central Sudan (ibid.).

Metamorphic source is accessible to the Neolithic potters of Geili, at Sabaloka Gorge c.12 km north of the site (fig.4). It is, similarly, the nearest possible source to the Shaqadud Cave Neolithic potters though at a distance of c.80 km to the east (figs.1, 52). On the other hand, the nearest metamorphic source for Rabak Neolithic site lies 133 km. to the south between Kosti and Sennar (figs. 2,4, 39). Taking into account that the White Nile sediments are rich in minerals of metamorphic origin including hornblende, kyanite, epidote, staurolite and sillimanite (see Whiteman 1971:125), such a local source within easy reach to Rabak potters seems fairly possible.

Fabrics of mixed lithography (metamorphic and igneous) are confined to Kabbashi Haitah Mesolithic (cf. sections 3.3.6.1.1, 6.3.1.1) and Shaqadud Cave - (cf. sections 5.3.3, 6.3.1.1). Both sites are situated on Nubian Sandstone deposits (figs. 4,39). Rocks or deposits of mixed lithography are not available in the immediate area of the sites. The nearest likely source for both sites is the Precambrian Basement Complex at Sabaloka Gorge which is composed of quartzo-feldspathic metamorphic and igneous rocks (cf. appendix 1). It lies c.35 km north of Kabbashi Haitah (fig.4) and c.80 km west of Shaqadud (figs. 1,52).

6.5.3 X-ray diffraction Results

On the basis of the X-ray diffraction results (cf. section 6.3.2) it is not possible to pinpoint any characteristic groupings. The results indicate the

absence of the key clay minerals (e.g. montmorillonite, kaolinite, illite, chlorite,....etc.). All the Mesolithic and Neolithic pottery sherds and modern local pottery samples consist of high quartz-rich inclusions with varying fine earth fractions (020), plagioclases, K-feldspar, mica, anatase and calcite. Hematite inclusions are not present before and after firing to c.700-900° C, the samples promoted hematite. However, the sole exceptions, being the weak presence of kaolinite clay in one sample (G 93-17a-table 10) from Islang2 site in Khartoum Province and the steady increase of calcite from the early Neolithic (Shaqadud midden-upper levels) to the late Neolithic phase (Shaqadud Cave) in the Western Butana region (see table 34).

The X-ray diffraction results of the sampled ceramics versus the local pottery samples are highly homogenous, suggestive of similar sources for pottery making during the Mesolithic and Neolithic periods in the central Sudan (see below for further discussion).

6.5.4 Chemical analyses Results

The results of chemical analyses, as discussed above (cf. section 6.3.3), show that the Mesolithic and Neolithic as well as the modern pottery samples of the central Sudan (Khartoum, White Nile and Western Butana regions) are generally homogenous in composition. The high SiO2 concentration is suggestive that all the samples are characterized by high amounts of incorporated quartz grains derived from Nubian Sandstone Formation. Aluminium (Al203) which is a rough index of feldspar is relatively high in all the Mesolithic, Neolithic and modern pottery samples from the three regions investigated. It occurs in comparable proportions in most of the samples, being present at c.16% at the average. Such pottery with a relatively high Al203 content is consistent with the abundance of K-feldspar as shown by X-ray diffraction analyses (cf. tables 10-11, 25,34). Ferrous oxide (Fe203) is present in most samples with similar values reaching c.7.2% at the average. Calcium (Ca0) concentrations are rather low, being present in most samples, little above 2 wght%. Titanium (Ti02,), manganese (Mn0), magnesium (Mg0), sodium (Na20), phosphorous (P205) and barium (Ba)) tend to be rare (mostly under 1wght%) in most Mesolithic, Neolithic and modern pottery samples from the central Sudan (cf. sections 3.5-5.5, 6.3.3).

The chemical data set (see supra, this section) does not indicate, in most cases, temporal differences in ceramic paste composition. The sole exception, being the experimentation of clays that are rather rich or moderately-rich in calcite material from the White Nile (Rabak [J.M.L]) and western Butana (Shaqadud Cave) ceramics respectively.

6.5.5 Goethite norm analyses

The results of the goethite norm analyses, as reviewed earlier (cf. section 6.3.4) indicate that the Mesolithic, Neolithic and the modern pottery samples of the central Sudan (Khartoum, Whilte Nile and Western Butana regions) are generally rather homogenous in composition (cf. section 6.3.4).

The clays in most of the samples analyzed might have held clays characterized by appreciable amounts of kaolinite, illite and quartz. On the other hand, montmorillonite which is the most prominent clay mineral in the recent sediments of the central Sudan tends to exhibit markedly low proportions in the composition of the Mesolithic, Neolithic and modern pottery samples from the areas investigated (cf. sections 3.6-5.6, 6.3.4).

With the exception of kaolinite, the relatively high proportions of the remaining clay minerals (montmorillonite, illite and quartz) are consistent with the availability of these clays in the recent sediments of the central Sudan (cf. section 6.3.4). On the other level, the presence of considerable amounts of kaolinite norm minerals is in accord with the appreciable occurrence of this clay mineral in the sediments of the central Sudan during the Mesolithic and Neolithic periods (ibid.).

The results of the goethite norm analyses presented earlier (see sections 3.6-5.6), 6.3.4) are not in accord with those of the the X-ray diffraction analyses (cf. sections 3.4-5.4, 6.3.2,6.5.3) which indicate the absence of the key clays minerals (e.g. montmorillonite, kaolinite, illite, chlorite,.....etc.) in the composition of the Mesolithic, Neolithic and modern pottery samples from the central Sudan (cf. sections 3.4-5.4, 6.3.2). Moreover, quartz which is the most prevalent mineral in the fine earth fractions of all the samples analyzed by X-ray diffraction (ibid.), is present in relatively lesser proportions in the norm minerals of the samples in comparison with kaolinite and illite clays (ibid. and tables 17, 29, 39).

Patterning in the clay composition of the Mesolithic and Neolithic samples analyzed was not observed.

6.5.6 Discussion

In the light of the physico-chemical data reviewed above, there is a high degree of similarity in non-plastic inclusions (the petrographic argument) and clay matrix composition (arguments of X-ray diffraction and chemical resutls) of the analyzed Mesolithic, Neolithic and modern pottery samples from the central Sudan (cf. chapters 3-5 and sections 6.3.1 - 6.3.3). Such results usually occurs in the case of clays and tempers which are chemically and mineralogically homogenous and which are not greatly modified during the course of production process or which are used in production in their original state (see Buko 1984:359 and section 6.3).

The present data set shows that X-ray diffraction (cf. sections 3.4-5.4, 6.3.2) and chemcial analyses (cf. sections 3.5-5.5, 6.3.3) tend to support the results gained from the petrological analyses (cf. sections 3.3-5.3, 6.3.1) that quartz, feldspars and iron inclusions are the most common non-plastic minerals in almost all the fabrics of the Mesolithic and Neolithic ceramics from Khartoum, White Nile and Western Butana regions (the argument of mineralogical and chemical homogeneity). On the other hand, the goethite norm anlyses (cf. section 6.3.4) provide information suggestive that the fine earth fractions of all the analyzed samples hold appreciable proportions of quartz-rich illite kaolinitic clays. This seems to add a credibility to the results obtained by petrological, X-ray and chemical analyses, all of which are advocating the mineralogical and/or chemical homogeneity of the samples examined.

The grain size analyses of the Mesolithic and Neolithic pottery samples from the three areas investigated (Khartoum, White Nile and Western Butana regions) tend to exhibit wide range of textural classes from the very fine-grained minerals (0.060 mm) to the very coarse ones (> 2mm) at the interregional rather than the intraregional levels (cf. sectons 3.3-5.3, 7.6-7.9). At the interregional levels, patterning in textural classes during the course of time from the Mesolithic to the Neolithic periods was noted (ibid.). This is suggestive of modification in processes of temper preparation during that passage of time (cf. chapter 7).

With respect to degree of rounding classes, natural minerals are rounded or subrounded to a high or low degree (cf. sections 3.3-5.3). According to the literature (see e.g. Shepard 1956:25-27 and Rice 1987:373-74) rounded surfaces do not develop strong interlocking frameworks of clay particles and therefore may lead to a weak body. Thus clay forms a poorer bond with smooth than with sharp irregular surfaces. Moreover, ample platy flat inclusions such as micas and chlorites, may make the clay body laminated or fissile through preferred orientation. Therefore, to be a good clay, then a natural deposit should include inclusions that are angular and occur in wide range of sizes (ibid.).

In the present petrological results of the Mesolithic and Neolithic sampled ceramics in the central Sudan (see supra, this chapter), the bulk of the minerals rounding classes are angular or subangular and hence most likely to be crushed tempering material. Subrounded and rounded crystals, though present, are infrequent in most of the analyzed samples (ibid.) (the argument of minerals modification and their state of usage).

The clays from which the Mesolithic and Neolithic ceramics in the central Sudan manufactured are most likely to be derived from different sources (cf. chapters 3-5). While the Nile silts (Nile flood clays) are, seemingly, the source of clays for the Mesolithic and Neolithic ceamics from Khartoum White Nile regions (cf. sections 3-13, 4.1.4, 4.1.1.5 and figs. 4,39), the alluvial Butana deposits in the form of clay and silt are source for the Mesolithic and Neolithic ceramics of the Western Butana region (cf. section 5.1.3 and fig.52).

In all these regions as indicated earlier (see supra, this section), the Nubian Sandstone Formation caps the area of the sampled Mesolithic and Neolithic sites in Khartoum Province (fig.4). This formation is not available at the immediate areas of Shabona and Rabak sites. Instead the areas of the two sites are characterized by dark colour, alkaline clay of alluvial nature, devoid of rocks but scattered quartz pebbles, chert and chalcedony covering wide area (cf. sections 4.1.1.4, 4.1.1.5 and figs. 39). On the other hand, the whole area of Shaqadud site is covered by Nubian Sandstone Formation and the nearest clays to the site are scattered pockets of alluvial clays c.5 km to the eastern and northern direction (fig.52).

In such situation, one would expect that in Khartoum Province rather than in the White Nile and Western Butana regions, the degree of variation in fabric between the tested Mesolithic and Neolithic pottery and the geographical separation of their sites of find is imperceptible (see infra).

Contrary to what has been postulated above (see supra), the degree of difference in fabric between all the Mesolithic and Neolithic pottery and the geographical separation of their sites of find (Khartoum, White Nile and Western Butana regions) is hardly conspicuous. In most instances, the petrological, X-ray diffraction and chemical results tend to show that the pottery samples of the Mesolithic and Neolithic periods are more similar to each other at the intraregional and interregional levels. An explanation to this may be that the sources of raw clay (Nile silt and alluvial clays) and temper (Nubian Sandstone and Basement Complex) are rather homogenous for the Mesolithic and Neolithic potters. The general uniformity of the local geology favours this suggestion (figs 3-4, 39-52 and appendix 1). Besides, the mobility of the Mesolithic and Neolithic folks in the areas of the central Sudan (Khartoum, White Nile and Western Butana) does not seem unlikely particularly at the end of the Neolithic period when it becames rather conspicuous (see below).

Unlike the situation in Khartoum Province (cf. chapters 3-5 and sections 6.3.1 - 6.3.3), fabrics group A of Rabak Neolithic site (Jebel Moya levels) in the White Nile Province and the Neolithic site of Shaqadud Cave in the Western Butana yielded calcite-inclusions pottery which seems to have been exchanged between the potters of these two contemporary sites as previously argued (cf. sections 4.4, 5.4, 6.3.1-6.3.3).

The degree of difference in fabrics between the analyzed samples and the geographical separtation of pottery-site of find is rather conspicuous in Dongola reach (fig.1) where fabric 11biii. of Mesolithic pottery (site N 13-4-17) contains > 80% organic (fibre) temper in comparison with fabric 11a (N 40-4) and 11Cii (sites N 13-4-22, N 40-2, N 41-1) from the same vicinity (the sites of these fabrics are only c.150-250 m. apart) which is mainly tempered with quartz, Na-plagioclase, muscovite, small hornblende, schists and gneiss rock fragments (cf. Hays 1971:89, 142, figs. 3-4 and Hays and Hassan 1974:72, 74-75 and table 40).

In this situation (see supra) the fabric differences between the Mesolithic pottery of Dongola reach are not governed by the availability of specific temper because the sites of pottery finds are situated in close proximity only c.150-250 m apart as indicated above. Therefore, the cultural preference of the potters rather than the availability of appropriate raw materials seems a conceivable explanation to the qualitative differences seen on the Mesolithic ceramic fabrics of Dongola reach which are mainly ornamented with wavy line and dotted wavy line, the diagnostic feature of Early Khartoum potting tradition (cf. sections 4.6.2.2, 10.1.2.3).

Evidence of exotic minerals was not discernable in the comparative mineralogical data of the Mesolithic and Neolithic ceramics from northern Sudan, central and eastern (Egyptian) Sahara as to clearly identify ceramic movements from these regions towards the central Sudan or vice versa (cf. sections 6.3-6.5).

6.6. Conclusions

The physico-chemical analyses presented here have indicated that most of the analyzed Mesolithic, Neolithic and the local modern pottery from the central Sudan are mineralogically and chemcially similar. It seems that this result has occured because of the considerable homogeneity in temper and clay matrices (cf. chapters 3-5 and sections 6.3-6.5). The probability that such homogeneity could have resulted from the great modification of raw material during the course of preparation processes or which have, perhaps, been used in their original state has proven invalid (see supra, section 6.5).

Despite this marked homogeneity, the analyzed Mesolithic, Neolithic and the local modern pottery samples are, relatively, less differentiated in terms of their clay mineralogy (X-ray diffraction and chemical) than they are on the basis of their tempering material (Petrography) (cf. chapters 3-5, sections 6.3-6.5).

Physical (petrographic and X-ray diffraction), chemical (X-ray spectrometric technique) and petrochemical (goethite norm calculations) analyses have demonstrated similarities between the Mesolithic, Neolithic and local modern pottery samples at the interregional levels. Nevertheles, they have not produced a satisfactoy clarification to differences occasionally seen in fabric between the Neolithic ceramics and the geographical separation of their sites of

finds. The occurrence of calcitic inclusion pottery at the late Neolithic sites of Rabak (J.M.L) and Shaqadud Cave site and its absence in the remaining Neolithic sites in the central Sudan can be taken as an example to illustrate this tendency (ibid.).

The results of the overall data set indicate that the analyzed pottery fabrics have a mineral assemblage consistent with that present in locally available clays. Consideration of the geology and clays in the immediate areas of the investigated sites that are generally uniform, has enabled a suggestion to be made about the origin(s) of the Mesolithic and Neolithic ceramics in the central Sudan, which are likely to be manufactured within each site of find.

The balance of evidence seems to suggest some points of contact either through individuals or small scale movements of people (indirect contact trade) between the people of the central Nile valley (central and northern Sudan) and central/eastern Sahara accounted for the distribution of the comparable Mesolithic and Neolithic ceramics of these regions. This, however, has not been confirmed by physico-scientific analyses which favour local utilization of raw materials for pottery manufacturing in each of the areas investigated (cf. sections 6.4.2, 9.11-.9.12).

Chapter 7
7. Textural Analysis

7.1. Introduction

The petrographic microscope has been the most widely applicable and useful analytical tool in the study of prehistoric pottery (Shepard 1956:136 and Plog 1980:54-76). It has been used to obtain quantitative and qualitative data on the constituents of pottery temper (e.g. Shepard 1965:62-87, Peacock 1969:145-149; Hulthen 1977; Van Der Leeuw 1976; Smith 1990 and Stoltman 1991:103-120). The technique was applied in the study of the Mesolithic and Neolithic ceramics in the Sudan (e.g. Nordstrom 1972: 33-79; Hays and Hassan 1974: 71-97; Khabir 1981:49-123, Williams 1982:174-176 and Chlodnicki 1984:337-342. However, the later works were virtually focused on the determination of provenance of pottery. The present section sets forth results of grain size analysis of temper and statistical tests based on SPSS-X package and subprogramm lotus 1 -2 - 3 carried out by the present writer on a series of Mesolithic and Neolithic ceramics from selected sites in the central Sudan (cf. sections 3.1.1; 4.1.1 and 5.1.1)

7.2. Temper and Matrix

Pottery is a multicomponent system, similar to sedimentary rocks in composition. It is usually thought of as being of clay minerals (those less than 0.002 mm) and non-plastic inclusions (temper) (Bishop 1980:49). The amount, shape, size and sorting of the non-plastic inclusions determine the texture of the ceramic paste (Shepard 1956:117). However, it is well known in geological literature that components up to 0.020mm (20 microns) in diameter (Udden/Wentworth scale) are considered as forming matrix (e.g. Shannon 1978:1185-1192 and Bishop 1980:47-65). Nonetheless, in the petrographic analysis of pottery from Africa (e.g. Sudanese Nubia) (Nordstrom 1972:33-79) and American Southwest-plenque sites-(Bishop 1980:47-65) matrix is considered as all materials less than 0.060 mm (60 microns). The presence of fine and/or larger particles would, therefore, regarded as non-plastic inclusions while all the size gradations of silt would be considered as part of the matrix (groundmass) is set, in the present work, at 0.60 mm (60 microns). This has been done for practical reasons - particles of silt and clay-size are examined with difficulty using petrographic microscope with rather low power magnification (80X). It is worth mentioning that in addition to the size particle,

the degree of angularity has also been used by the present writer as a criterion to differentiate between temper and matrix. Moreover, I would like to point out that in the present counting calculations, the term "temper" refers to the non-plastic inclusions larger than silt irrespective of how they came to form part of the ceramic paste. This is because tempered/non-tempered distribution is not always clear and the pottery may be described as having a texture similar to tempered or non-tempered wares (see Shepard 1968:25 and Bishop 1980:49). To avoid such confusion, I have used the definition of temper as mentioned above.

7.3.1. Textural analysis: Historical perspective, goals and methodology

7.3.1. Historical perspective

The technique of pottery texture analysis has been adopted from sedimentary petrography (e.g. Pettijohn 1949 and Peacock 1971). Since, geologically, a pot is a metamorphosed sedimentary rock, it can be argued that it can be approached in a manner similar to that used in the geological study of the parent raw material (Peacock 1977:26). It was first introduced to ceramic archaeology by Peacock in 1971 as an approach for studying "the coarse sandy wares" of Roman Period from excavation at Fishbourne in south England between 1961 and 1969 (Peacock 1971:255-259). Peacock used three textural parameters (ibid.):-

1. Percentage of inclusions.
2. Roundness and sphericity.
3. Size analysis

Of these parameters, size analysis has found the most popular application in archaeological studies (e.g. ibid.; Wandibba 1982:71-75; Streeton 1982: 123-134; Darvill and Timby 1982:73-87 and Middleton et al 1985:64-75).

7.3.2. Goals

How grain size data from a single sample or from a series of samples are manipulated depends upon the purpose of the project. Generally speaking, grain size analyses are made for one or more of the following objectives (McBridge 1971: 109-110).

1. To describe samples in terms of statistical measure.
2. To correlate samples from similar stratigraphic units or depositional environments.
3. To determine the agent (wind, river, turbidity, current, etc.) of transportation and deposition.
4. To determine the process (suspension, traction, saltation, etc.) of final deposition.
5. To determine the environment of deposition (channel, flood plain, beach, dune, etc.).

In archaeological discipline often the determination of the pottery provenance is not possible because the non-plastic mineral inclusions present in pottery are frequently common-place material. What appears in the thin sections is only quartz-sand which occurs either naturally in the clay or present as a deliberate additive to form a filler. When examining such large quantities of minerals in thin section, it is difficult to determine sources with percision. However, useful data can be obtained from textural analysis of the section, that is the examination of features such as shape, size and frequency of the sand grains (Williams 1983: 307).

Information pertaining to the geological source of the temper or clay is often deduced from the types of minerals present, their size, their association and the degree of mechanical and chemical weathering the individual grains have faced. The distribution of grain sizes in pottery is a possible marker of some procurement location, reflecting natural agencies such as lithological provenance, climate and depositional processes. With regard to quartz sand, surface features, viewed under high magnification, may allow one to infer the kind of environment from which the grains were derived, such as aeolian, glacial or shallow marine. However, assessments of this nature are normally too general for routine archaeological purposes (Bishop et al 1982:283).

7.3.3 Methodology

The quantitative analysis of ceramic thin section through petrography is a version of point counting that estimate with considerable accuracy the amount of human additives (temper) and natural inclusions (silts and sand) in ceramic paste. This technique provides objective basis for ceramic paste comparison which would be of immense value in dealing with a variety of problems

concerning classification, technological-functional interpretation, modes of production and the nature and extent of cultural interaction (Stoltman 1989:147).

Ever since Shepard pioneering studies of Rio Grande ceramics in New Mexico in the 1930's (Shepard 1965:62-87), it has been evident that the petrographic analysis of ceramic thin sections can be much more than merely a descriptive technique. Despite the great potential of the technique demonstrated by her early work, it is noteworthy that petrographic thin section analysis of ceramics has been only a limited application in North American Archaeology (ibid). Even her thin section analyses of Rio Grade ceramics were not quantitative, for she identified individual thin sections in terms of the presence or absence of specific type of temper (Stoltman 1989:148).

There are two main approaches to the quantitative analysis of thin sections that appear in the archaeological literature: visual comparison and point counting. The first concerns with estimation of the density of inclusions by visual comparison with human or prepared standards (Shepard 1965:119 and Matson 1963:595). A variant of this approach has been used effectively in defining 12 different paste types for vessels from Bottom region in American Southwest (Stoltman 1989:148). However, this approach has a virtue of efficiency; nevertheless, it is impressionistic and lacks the precision of point counting. The latter involves superimposing a grid over a thin section and counting all mineral inclusions beneath the grid intersection points (ibid).

Point counting is virtually a systematic sampling procedure by which thin section constituents are estimated from a series of observations made at fixed intervals, for instance 0.5 mm or every 1 mm. across the estimate area of the thin-section. This requires a polarizing microscope that is equipped with (1) measuring eye piece with crosshair (2) a stage with can attachment that allows the thin section to be moved in fixed increments beneath the crosshair. At each step of the stage, the analyst identifies the mineral directly beneath the crosshair, while features such as shape and size also can be recorded. The number of points counted depends upon the area of the thin section and the point counting interval selected (Middleton 1985:64-74 and Stoltman 1989:148-149).

Point counting technique has been advocated in ceramic studies because, as Peacock remarks, the texture of sandy pottery is extremely a complex matter

(Peacock 1970:385). If each of these factors such as proportion of sand to clay, roundness of grains, their sphericity and the properties of the size distribution, were isolated and measured in terms of mathematical parameters, it would form objective basis for the study of pottery fabrics (Stoltman 1989:158-159).

In order to obtain grain size distribution, between 50 and 300 grains in a thin section are measured, to achieve a satisfactorily valid assessment of the character of the grain size distribution (e.g. Peacock 1971:257 ; Streeton 1982: 128; Darvill and Timby 1982:74; Middleton et al 1985:64 and Stoltman 1989:150). However, the assessment of mean is precisely achieved with small samples than the assessment of standard deviations. This could be deduced from a series of experiments with ceramics from Roman sites (Fishbourne, Sussex, Orare, Wiltshire, Ower, Colchester Essex, Winchester, Canterbury, Droitwich, Chister, Winall and Clausentum) (Darvill and Timby 1982:82-83).

The number of points counted depends upon the area of the thin section and the counting interval selected. In the present work some 248 thin section slides were examined for textural analysis. In all the thin sections, the number of points counted exceeding 150 and therefore, furnishing adequate constituents of samples being ready for manipulation by statistical treatment (see infra, this chapter).

In the present work, the author, following the basic considerations of choice of the counting intervals including, the texture of the samples, awareness of sampling theory (sampling units or point counts in the present case), the level of precision sought and time available for analysis (Stoltman 1989:147-160 and 1991:103-120), has chosen I mm fixed interval across the estimated area of the thin section.

Each thin section was subjected to two-step analysis. The first, or qualitative, step, involved close inspection of the thin-section to get acquainted with the overall mineral inclusions. The second, or quantitative, step concerned point-count analysis using I mm counting intervals over the entire area of the thin-section. The I mm interval has proved to be satisfactory for point counting. It yielded total counts exceeding 100 points for most thin sections examined and in the mean time resulting in few sufficient multicount grains, even in coarse-grained thin sections to permit reliable tabulations (see below, this chapter). An example of textural analysis of ceramics from the Upper-Mississippi valley in

United States-dated from A.D. 200/300 to A.D. 600) could also be taken to illustrate the reliability of this sampling interval (see Stoltman 1991:109).

7.4 The Sample and Objective of the work

During the course of petrographic analyses of 248 thin section slides, the present writer has observed marked differences in mineral grain sizes of the pottery samples from the selected Mesolithic and Neolithic sites in the central Sudan (Khartoum Province, White Nile and Western Butana regions) (cf. sections 3-5).

The variability of grain size depends on the nature of tempering material and on the potter methods of preparation (Shepard 1956:117). Some materials are used in their original condition, others are ground, crushed or pulverized. Certain materials such as disintegrated sandstone may have uniform size in their natural state. Some solid materials break into particles of relatively uniform size when they are ground, as for example weathered equigranular igneous rock that parts on crystal boundaries. Other materials like potsherd or massive limestone have no natural plane of cleavage nor regular pattern of structural weakness to determine the size of particles that will be formed. When these materials are used as temper, grain size depends on the potter methods of preparation. Various means of sorting were used in some cases, just as they are being used by prewheel potters (Shepard 1956:117). One of the preceding reasons may account for the grain size variations observed in the tempering inclusions of the pottery examined. Therefore, a quantitative analysis based on estimates of the proportions of non-plastic minerals inclusions was conducted to see intra-and interregional variations in the quality of tempering inclusions (if any) during the Mesolithic and Neolithic periods in the central Sudan. Though point-counting is somewhat time-consuming, nonetheless, a full grain size analysis of 248 thin section slides (see supra) in addition to point counting were carried out by the present writer to test the beset objectives. The data has been arranged in Ascii files to be readable using SPSS-X package and subprogram lotus, 1,2 and 3.

7.5 Test of significance

The purpose of hypothesis testing in statistics is to draw conclusions about the population parameters based on results in a random sample (Norusis 1985:125).

This statistical procedure enables us to accept or to reject hypothesis or to determine whether the observed samples differ significantly from expected value (Spiegel 1972:167).

7.5.1 The T-test of significance

In each area investigated in the present work (Khartoum, White Nile and Western Butana), the two samples T-test were carried out by the present writer to determine the mean, standard deviation, standard error, F-value, T-value, degree of freedom and 2-tail probability for the non-plastic mineral groups (e.g. quartz, feldspar, mica,....etc.) representing all types of fabrics at each site (cf. Table 56-59).

To test the hypothesis whether the two populations means of the non-plastic mineral inclusions representing the fabrics of the sampled pottery are equal, the following equation was used:-

$$t = \frac{\bar{X}1 - \bar{X}2}{\sqrt{\frac{S1^2}{N1} + \frac{S2^2}{N2}}}$$

X1 stands for the mean of the first sample, X2 for the second, S1, S2 for the variances of the two samples respectively and N for the sample size.

The main purpose of the analyses, as previously indicated (cf. section 7.4), is to see whether the differences observed in the grain sizes of the Mesolithic and Neolithic pottery samples from the central Sudan are statistically significant or not. Then to address the wider issue of the phenomenon.

7.5.2 Level of significance

In literature, the level of significance of the test is the maximum probability with which we would be willing to reject a hypothesis when it should be accepted (e.g. see Spiegel 1972:167-168).

The level of significance is an arbitrary one but in practise a level of .05 or .01 is customary, although other values may be used (ibid:168).

In the present work, a level of significance is set at .05 not merely because this figure is frequently used as it is convenient is testing hypothesis of normal distribution (see Cohen 1965: 105 and Spiegel 1972:168) but also to minimize errors of decision by enlarging the level of confidence. Therefore, in the present work the results are probably significant at the .05 level or below, while results larger than this level are not significant (see below).

The observed significance levels for the F values of non-plastic mineral inclusions of all the groups are high (cf. tables 56-62). Therefore, the population variances are unequal and hence the pooled variance (a two-tailed test) rather than the separate one has been used for testing level of significance of the compared samples (see below).

It is noteworthy that minerals (zircon, tourmaline, hyperthene, epidote, hornblende) whose distribution is haphazard in almost all the fabrics examined (n = <5 in most instances) have not been included in the T-tests (cf. sections 3.3-5.3) because they are not representatives of the populations and hence conclusions of sampling and statistical inferences will be invalid (cf. Spiegel 1972:141-166).

SPSSX statistical package, release 4.1 for IBM/VM/CMS has been used in the present work. Memory in which commands are stored during parsing and in which results are stored during procedure processing is 1,234,736 bytes. The T-tests carried out in the present work required 504 bytes of workspace for execution.

7.6 Khartoum Province

7.6.1 West bank of the Main Nile

7.6.1.1 Sarurab2 Mesolithic and Nofalab2 Neolithic samples

While the majority of aplastic inclusions of Nofalab2 (c.63%) are coarse (cf. table 44:5 and section 7.6.1.1.1), those of Nofalab2 are either medium (c.44%) or fine-grained (34%) in texture (cf. table 45 and section 7.6.1.1.2).

Unlike Sarurab2 mineral inclusions (see supra), Nofalab2 ones are represented by extremely sparse examples of coarse and very coarse-grained texture being ≤1% of the total (cf. table 44:G5-G6).

While silt-size inclusions of Sarurab2 and Nofalab2 are extremely rare (each <1%), fine and very fine-grained textures of group1 (Sarurab2) and group2 (Nofalab2) are rare (<1% and c.4%) and frequent (c.18 and 34%) respectively (cf. tables 44-45:G1-G3).

a. Mean, standard deviation and standard error

1. Quartz

Values of group1 (M=726.32 um, ST.D=368.60mm, ST.E=8.17) (cf. tables 44:G5-G6,57) and group2 (M=253.88um, ST.D=113.79 um, ST.E=2.30 um) cf. tables 45:G4,57) indicate coarse and medium-grained textures respectively.

2. Rock fragments

Aplastic mineral inclusions of group1 (M=869.0 um, ST.D=345.87 um, ST.E=154.68 um) are coarse-grained in texture whereas those of group2 (M-368.33 um, ST.D=103.56 um, ST.E=34.53 um) are of medium-grained particles (ibid.).

3. Orthoclase

Values of group1 (M=647.10um, ST.D-311.25 um, ST.E=41.22 um) (cf. tables 44:G5-G6, 57) and group2 (M=174.90 um, ST.D=92.79 um, ST.E=6.07 um) (cf. tables 45:G3, 57) point to coarse and fine-grained particles respectively.

M=Mean value, ST.D=standard deviation, ST.E=standard error of the mean

4. Microcline

Group1 (M=674.39 um, ST.D=386.11 um, ST.E=12.10 um) and group2 (M=167.33 um, ST.D=73.32 um, ST.E=42.33) indicate coarse and fine-grained particles respectively (ibid.).

5. Plagioclase

Values of group 1 (M=631.48 um, ST.D=218.24 um, ST.E=24.24 um) and group2 (M=189.83 um, ST.D=80.89 um, ST.E=8.04 um) display coarse and fine-grained textures respectively (ibid.).

6. Mica-Biotite

Values of group1 (M=722.36 um, ST.D=376.91 um, ST.E=49.49 um) and group 2 (M=218.75 um, ST.D=62.50 um, ST.E=31.25 um) indicate coarse and fine-grained textures respectively (ibid.).

7. Iron

Values of group1 (M=506.81 um, ST.D=143.62 um, ST.E=9.23 um) and group2 (M=178.27 um, ST.D=171.41 um, ST.E=8.89 um), respectively, display coarse and fine-grained particles (ibid.).

8. Mica-Muscovite

Aplastic mineral grains of group1 (M=319.70 um, ST.D=280.07 cm, ST.E= 48.03 um) (cf. tables 44:G4,57) and those of group2 (M=195.16 um, ST.D=67.37 um, ST.E=19.45 um) (cf. tables 45:63, 57) point to medium and coarse-grained textures respectively.

b. T-tests

The T-tests of the pooled variances show that the differences in grain sizes of almost all the aplastic mineral inclusions between the groups combinations are statistically significant at .000 level of significance. The sole

exception, being mica-muscovite inclusions which are statistically insignificant at .05 level of confidence (see supra, this section and table 57).

7.6.1.1.2 Sarurab2 Mesolithic and Islang2 Neolithic samples

a. Frequency

Though most of the aplastic mineral inclusions from Saruarb2 and Islang2 ceramics are coarse, yet those of the former (c.81%) are relatively higher than their counterparts of the latter (c.63%) (cf. tables 44-45:G4).

Silt-size and very fine-grained minerals -some of which may be part of the paste-are present in comparable amounts in the two ceramic groups and are exclusively below 1% of the total inclusions (ibid.:G1-G2).

While the fine and medium grained-inclusions of the two ceramic groups are low or rather frequent, the proportions of Sarurab2 inclusions are relatively higher than those of Islang2 (ibid.:G3-G4).

a- Mean, standard deviation and standard error

1. Quartz

Values of group1-Sarurab2-(M=726 um, ST.D=368.60 um, ST.E.=8.17 um) and group 2 - Islang2-(M=706.88 um, ST.D=267.37 um, ST.E=5.35 um) (cf. tables 44-45:G5-G6, 56) point to coarse-grained textures.

2. Orthoclase

Aplastic mineral inclusions of group 1 (M=647.10 um, ST.D=311.25 um, ST.E=41.22 um) and group 2 (M=596.85 um, ST.D=217.71 um, ST.E=25.30 um) provide values indicative of coarse-grained textures (ibid.).

3. Microcline

Values of group 1 (M=674.39 um, ST.D=386.11 um, ST.E=12.10 um) and group 2 (M=635.87 um, ST.D=222.15 um, ST.E=9.20 um) point to coarse-grained textures (ibid.).

4. Plagioclase

Values of group 1 (M=631.48 um, ST.D=218.24 um, ST.E=24.24 um) (ibid.) and group 2 (M=290.20 um, ST.D=213.6 um, ST.E=18.42 um) (cf. tables 45:G4,56) indicate coarse and medium grained-textures respectively.

5. Rock fragment

Values of group1 (M=869.0 um, ST.D=345.87 um, ST.E=154.68 um) and group 2 (M=740.0 um, ST.D=246.25 um, ST.E= 100.53 um) indicate coarse-grained particles. (cf. tables 44-45:G5-G6, 56).

6. Mica-Biotite

Values of group 1 (M=722.36 um, ST.D=376.91 um, ST.E=49.49 um) and group 2 (M=527.62 um, ST.D=171.70 um, ST.E=15.67 um) display coarse-grained textures (ibid.).

7. Iron

Values of group 1 (M=506.81 um, ST.D=143.62 um, ST.E=9.23 um) and group 2 (M=618.83 um, ST.D=232.86 um, ST.E=13.94 um) show coarse-grained particles (ibid.).

8. Mica-Muscovite

Aplastic minerals of group1 (M=319.70 um, ST.D=28.07 um, ST.E=48.03 um) (cf. tables 44.G4,56) and group 2 (M=595.77 um, ST.D=161.69 um, ST.E=14.94 um) (cf. tables 45:G5-G6,56) show medium and coarse-grained particles respectively.

C. T-tests

The T-tests of the pooled variances show that the differences in grain sizes of almost all the non-plastic inclusions between the groups' combinations (see supra, this section) are statistically significant at .000 level of significance.

Exceptions are orthoclase and rock fragments which exhibit insignificant differences at .05 level of significance (cf. table 56).

7.6.1.1.3 Islang2 and Nofalab2 Neolithic samples

The size classes of Islang2 ceramics differs from those of Nofalab2 ones. While the majority of mineral inclusions of the former (c.81%) are coarse, the bulk of the latter are medium (44%) or fine-grained (34%) in texture (cf. tables 45-46).

About 1.4% of mineral inclusions in the ceramics of Islang2 are fine-grained in texture (cf. Table 45:G3), while about c.34% over the whole inclusions of Nofalab2 are medium-grained (cf. table 46.G4).

Inclusions of silt-size are extremely rare in both ceramic groups, being < 1% at Islang2 and c.2% at Nofalab2 ceramics (cf. tables 45-46:G1).

D. Standard deviation and standard error

1. Quartz

Values of aplastic minerals (M=706.88um, SR.D=267.37 um, ST.E=5.35 um are coarse-grained (cf. tables 45:G5-G6, 57) whereas those of group2 (M=253.88 um, ST.D=113.79 um, ST.E=2.30 um) are medium- grained in texture (cf. tables 46:G4, 58).

2. Rock fragments

While values of group1 (M=740.0 um, ST.D=246.25 um, ST.E=100.53 um) point to coarse-grained textures (M=368.33 um, ST.D=103.56 um, ST.E=34.52 um) indicate a medium-grained ones (ibid.).

3. Orthoclase

Values of group1 (M=596.85 um, ST.D=217.71 um, ST.E=25.30 um) point to coarse-grained textures (cf. tables 45:G5-G6,58) whereas those of group2 (M=174.90 um, ST.D=92.79 um, ST.E=6.07 um) indicate fine-grained ones (cf. tables 46:G3, 58).

4. Microcline

Values of group1 (M=635.87 um ST.D=222.15 um, ST.E=9.20 um) show coarse-grained particles, whereas those of group 2 (M=167.33 um, ST.D=73.32 um, ST.E=42.33 um) display fine-grained ones (ibid.).

5. Plagioclase

Values of group1 (M=940.20 um, ST.D=213.60 um, ST.E=18.42 um) indicate coarse-grained particles, whereas those of group2 (M=189.83 um, ST.D=80.89 um, ST.E=804 um) provide fine-grained texture (ibid.).

6.7 Mica-Muscovite and Biotite

Values of group1 (M=595.77, 527.62 um; ST.D=161.69, 171.70 um; ST.E=14.94, 15.67 um respectively) point to coarse-grained textures, while those of group2 (M=195.16, 218.75 um; ST.D=67.37, 62.50 um; ST.E=19.45, 31.25 um) show fine-grained particles (ibid.).

8. Iron

While values of group1 (M=618.83 um, ST.D=232.86, ST.E=13.94 um) display coarse-grained sizes, those of group2 (M=178.27 um, ST.D=171.41 um, ST.E=8.89 um) exhibit fine-grained textures (ibid.).

b. T-tests

The T-tests of the pooled variances indicate that the differences in grain sizes of all the non-plastic mineral inclusions between the groups' combinations (see supra, this section) are statistically significant at .000 level of significance (cf. table 58).

7.6.2 East bank of the Main Nile

7.6.2.1 Frequency and T-tests for independent samples: groups' combinations.

7.6.2.1.1 Kabbashi Haitah Mesolithic and Geili Neolithic samples

a. Frequency

The grain sizes of Kabbashi Haitah and Kabbashi Mesolithic ceramics are generally comparable. Both groups display high proportions of coarse-grained inclusions, reaching 84% and 83% of the total respectively (cf. tables 47-48:G5-G6).

Medium-grained textured inclusions are low (10%) in the samples of Kabbashi Haitah and very low (c.5%) in the examples of Kabbashi (ibid.:G4).

Fine and very fine-grained mineral sizes are extremely rare in both groups, being exclusively 1% whereas silt-size class is almost non-existent (ibid.:G1-G3).

b- Mean, standard deviations and standard error

1. Quartz

Values of group1 (M=860.34 um, ST.D=464.47 um, ST.E=11.94 um) (cf. tables 47: G5-G6, 59) and group2 (M=240.86 um, ST.D=115.24 um, ST.E=2.74 um) (cf. tables 49:G3,59) indicate coarse and fine-grained textures respectively.

2. Orthoclase

While values of group1 (M=10.10.55 um, ST.D=504.35 um, ST.E=57.47 um) point coarse-grained particles, those of group2 (M=244.57 um, ST.D=200.53 um, ST.E=53.59 um) indicate fine-grained textures (ibid.).

3. Microcline

Values of group1 (M=966.10 um, ST.D=460.24 um, ST.E=37.93 um) and group2 (M=177.74 um, ST.D=90.99 um, ST.E=9.53), respectively, indicate coarse and fine-grained textures (ibid.).

4. Plagioclase

Values of group1 (M=589.85 um ST.D=293.81 um, ST.E=22.73 um) and group2 (M=174.63 um, ST.D=110.26 um, ST.E=11.82 um) point to coarse and fine-grained textures respectively (ibid.).

5. Mica-Biotite

Group1 provides values (M=699.70 um, ST.D=43.53 um, ST.E=52.69 um) show coarse-grained particles. On the other hand, group2 values (M=185.26 um, ST.D=92.37 um, ST.E=12.23 um) indicate fine-grained textures (ibid.).

6. Iron

Values of group1 (M=636.72 um, ST.D=418.82 um, ST.E=30.62 um) indicate coarse-grained textures, whereas those of groups2 (M=195.64 um, ST.D=102.69 um, ST.E=6.63 um) exhibit fine-grained ones (ibid.).

7. Rock fragment

While values of group1 (M=774.47 um, ST.D=390.81 um, ST.E=58.91 um) point to coarse-grained textures (cf. tables 47:G5-G6, 59), those of group2 (M=270.09 um, ST.D=249.06 um, ST.E=31 um) show medium-grained sizes (cf. tables 49:G4,59).

8. Mica-Muscovite

Values of group1 (M=608.44 um, ST.D=260.0 um, ST.E=19.54 um) and group2 (M=278.34 um, ST.D=92.42 um, ST.D=6.81), respectively, point to coarse and medium-grained textures (ibid.).

C. T-tests

The T-tests of the pooled variances show that the differences in grain sizes of all the non-plastic mineral inclusions between the groups' combinations

are statistically significant at .000 level of significance (see supra, this section and table 59).

7.6.2.1.2 Kabbashi Haitah and Kabbashi Mesolithic ceramics

The particle-size dimensions of Kabbashi Haitah and Kabbashi are comparable. Both groups, in most cases (c.84% each), tend to exhibit coarse-grained textures (cf. tables:47-48, G5-G6).

Medium-grained textures are observed in very low (c.10.4%) and rare (c.5%) proportions at Kabbashi Haitah and Kabbashi respectively (ibid.:G4).

Fine and very fine-grained particles are extremely rare (<1%) in both ceramic groups (ibid.G1-G3).

a. Mean, standard deviation and standard error

1. Quartz

Aplastic mineral inclusions of group1 (M=860.34 um, ST.D=464.47 um, ST.E=11.94 um) and group2 (M=743.07 um, ST.D=283.46 um, ST.E=6.19 um) indicate coarse-grained textures (cf. tables 47,48:G5-G6, 60).

2. Ortholcase

Values of group1 (M=1010.558 um, ST.D=504.35 um, ST.E=57.47 um) and group2 (M=505.31 um, ST.D=69.45 um, ST.E=15.93 um) show coarse-grained textures (ibid.).

3. Perthite

Values of group1 (M=1014.94 um, ST.D=435.57 um, ST.E-43.77 um) and group2 (M=643.22, ST.D=196.48 um, ST.E=11.25 um) display coarse-grained textures (ibid.).

4. Microcline

Group1 (M=966.10 um, ST.D=460.24 um, ST.E=37.83 um) and group2 (M=700.01 um, ST.D=210.46 um, ST.E=21.70 um) provide values indicative of coarse-grained particles (ibid.).

5. Plagioclase

Values of group1 (M=589.85 um, ST.D=293.81 um, ST.E=22.73 um) and group2 (M=562.38 um, ST.D=197.12 um, ST.E=35.40 um) point to coarse-grained textures (ibid.).

6. Rock fragment

Values of group1 (M=774.47 um, ST.D=390.81 um, ST.E=58.91 um) and group2 (M=692.81 um, ST.D=524.31 um, ST.E=158.08 um) show coarse-grained textures (ibid.).

7-8. Mica-Muscovite and Biotite

Values of groups1 (M=608.44, 699.70; ST.D=260.00, 434.52 um; ST.E=19.54, 52.69 um) and groups2 (M=570.25, 638.00 um; ST.D=195.61, 264.01 um; ST.E=17.02, 49.89 um) indicate coarse-grained textures (ibid.).

9. Iron

While values of group1 (M=636.72 um, ST.D=418.82 um, ST.E=30.62 um) show coarse-grained particles (ibid.), those of group2 (M=489.69 um, ST.D=87.68, ST.E=10.12 um) point to medium-grained textures (cf. tables 49:G4, 60).

b. T-tests

The T-tests of the pooled variances indicate that the differences in grain sizes of the majority of aplastic mineral grains between the groups' combination are statistically significant at .000 level of confidence. Exceptions are the groups' combinations of plagioclase, rock fragment, mica (biotite and

muscovite) inclusions which are statistically insignificant at 0.05 level of confidence (see supra, this section and table 60).

7.6.2.1.3 Kabbashi Mesolithic and Geili Neolithic ceramics

The grain sizes of Kabbashi and Geili ceramics are different. While the majority of aplastic inclusions of the former ceramic group are coarse (c.75%) or very coarse (9%) (cf. table:48, G5-G6), the latter, in most cases, displays either medium (c.47%) or fine-grained (c.29%) texture (cf. table 49:G3-G4).

Aplastic inclusions <0.062 mm (silt size) are absent in the ceramic group of Kabbashi, whereas its presence is scarce (c.5%) in the ceramics of Geili (ibid:G1).

Very fine grained inclusions are frequent at Geili samples (c.18%) and extremely rare at Kabbashi (<1%) (ibid:G2).

a. Means, standard deviation and standard error

1. Quartz

Aplastic mineral inclusions of group1-Geili-(M=240.86 um, ST.D=115.243 um, ST.E=2.74 um) (cf. tables 49.G3, 61) and group2-Kabbashi-Kabbashi-(M=743.07 um, ST.D=283.46 um, ST.E=6.19 um) (cf. tables 48:G5-G6,61) indicate fine and coarse-grained textures respectively.

2. Orthoclase

Values of group1 (M=224.57 um, ST.D=200.53 um, ST.E=53.59 um) and group2 (M=505.31 um, ST.D=69.45 um, ST.E=15.93 um) point to fine and coarse-grained particles respectively (ibid.).

3. Microcline

Group1 (M=177.74 um, ST.D=90.99 um, ST.E=9.53 um) and group2 (M=700.01 um, ST.D=210.46 um, ST.E=21.70 um) provide values, respectively, indicative of fine and coarse-grained textures (ibid.).

4. Plagioclase

Values of group1 (M=177.74 um, ST.D=90.99 um, ST.E=9.53 um) and group2 (M=700.01 um, ST.D=210.46 um, ST.E=21.70 um) indicate fine and coarse-grained textures respectively (ibid.).

5. Mica-Biotite

While values of group1 (M=185.26 um, ST.D=92.37 um, ST.E=12.23 um) point to fine-grained sizes, those of group2 (M=638.00 um, ST.D=264.01 um, ST.E=49.89 um) show coarse-grained textures (ibid.).

6. Perthite

Perthite minerals are devoid in the composition of group1, whereas those of group2 (M=643.22 um, ST.D=196.48 um, ST.E.11.25 um) indicate coarse-grained textures (ibid.).

7. Rock fragment

Values of group1 (M=270.09 um, ST.D=249.06 um, ST.E.31.63 um) (cf. tables 49:G3, 61) and group2 (M=692.81 um, ST.D.524.31 um, ST.E=158.08 um) (cf. tables 47:G5-G6, 61) indicate fine and coarse-grained textures respectively.

8. Mica-Muscovite

Values of group1 (M=278.34 um, ST.D=92.42 um, ST.E=6.81 um) and group2 (M=570.25 um, ST.D=195.61 um, ST.E=17.02 um) display fine and coarse-grained textures respectively (ibid.).

9. Iron

While values of group1 (M=195.84 um, ST.D=102.69, ST.E=6.83 um) indicate fine-grained textures (cf. tables 47:G3, 61), those of group2 (M=489.69 um, ST.D=87.68 um, ST.E=10.12 um) show medium-grained ones (cf. tables 49:G4, 61).

b. T-tests

The T-test of the pooled variances show that the differences in grain sizes of all the aplastic mineral inclusions between the groups' combinations are statistically signficant at .000 level of confidence (see supra, this section and table 61).

7.7 White Nile Province

7.7.1 Frequency and T-tests for independent samples: non-plastic mineral inclusions of groups' combinations

7.7.1.1 Shabona Mesolithic and Rabak (Khartoum Neolithic levels) samples

a. Frequency

Compared with Shabona aplastic minerals which mainly (c.75%) fall in particle-size range of coarse-grained texture (cf. table 50:G5), the tempering inclusions of Rabak (Kh.Neo.L) are mostly (c.52%) medium-grained (cf. table 51:G4).

Proportions of silt-size are comparable in both ceramic groups. Yet, Rabak (Kh.Neo.L.) aplastic inclusions tend to exhibit relatively higher percentages of fine (c.24%) and very fine-grained (c.11%) textures in comparison with those of Shabona which are exclusively below 1% (cf. tables 50-51:G1-G3).

b. Mean value, standard deviation and standard error

1. Quartz

Values of group1-Shabona (M=728.6 um, ST.D=313.8 um, ST.E=6.99 um) point to coarse-grained textures (cf. tables 50:G5-G6). They are distinct from those of group2-Rabak, Neo.L.-(M=279.25 um, ST.D=123.9 um, ST.E=3.14 um) which indicate medium-grained particles (cf. table 52:G4).

2. Orthoclase

Values (M=522.4 um, ST.D-187.1 um, ST.E=24.1 um) of orthoclase for group1 (table 63) differ from those of group2 (M=297.2 um, ST.D=142.6 um,

ST.E=31.8 um) (ibid.). While the first group points to coarse-grained textures (cf. table 50:G5), the second indicates medium-grained ones (cf. 52:G4).

3. Perthite

Perthite is devoid in the aplastic minerals of group1 (Shabona). It is present in group2 (Rabak-Kharotum Neolithic) having a mean value of 285.18 um, standard deviation of 148.6 um and standard error of 12.2 um. The result indicates medium-grained texture (cf. table:62).

4. Microcline

Values (M=659.4 um, ST.D=248.5 um, ST.E=20.8 um) of group1 point to coarse-grained-textures whereas those of group2 (M=288.21 um, ST.D=144.45 um, ST.E:10.18 um) indicate medium-grained ones (cf. tables 50:G5-G6, 52:G4, 62).

5. Plagioclase

Values (M=484.4 um, ST.D=297.1 um, ST.E=53.56 um) of group1 are varied in comparison with those of group2 (M=165.5 um, ST.D=77.38 um, ST.E=6.38 um). While the first group shows medium-grained textures, the second indicates fine-grained ones (cf. tables 50:G4, 52:G3, 62).

6. Rock fragment

Values (M=671.7 um, ST.D=255.4 um, ST.E=77.0 um) of rock fragments for group1 (cf. tables 50:G5-G6,63) are different from those of group2 (M=270.09 um, ST.D=249.06 um, ST.E=31.63 um). While the first group points to coarse-grained textures, the second shows medium-grained particles (cf. tables 50:G5-G6, G52:G4, 62).

7. Mica-Muscovite

Values (M=702.11 um, ST.D=59.84 um, ST.E=147.9 um) of muscovite mica for group1 which point to coarse-grained textures (cf. tables 50:G4-G5, 63) differ from those of group2 (M=170.86 um, ST.D=119.65 um, ST.E=11.06 um) which indicate fine-grained ones (cf. tables 52:G3, 62).

8. Mica-Biotite

Values of group1(M=355.5 um, ST.D.= 241.3 um, ST.E= 76.31 um) (cf. Tables 50:G4,63) which point to medium-grained textures are distinct from those of group2 (M=163.80 um, ST.D=86.09 um, ST.E=88.09 um) which show fine-grained -ones (ibid.).

9- Iron

Values of group1 (M=614.44 um, ST.D=194.20 um, ST.E=10.04 um) which point to coarse-grained particles (if. tables 50:G5,63) differ from those of group2 (M=181.17 um, ST.D=95.46 um, ST.E=7.45 um) which indicate fine-grained textures (cf. tables 50:G5,62).

C. T-Tests

The T-tests of the pooled variances show that the differences in grain sizes of almost all the non-plastic mineral inclusions between the groups' combinations (see supra, this section) are statistically significant at .000 level of significance (cf.table 63). The sole expception, being perthite inclusion which is devoid in one of the two samples (Group1) compared (see supra, sample no.3). Hence, T-test is note possible between the two-sample means.

7.7.1.2 Rabak-Khartoum Neolithic and Jebel Moya-samples

a. Frequency

The bulk of the grain sizes from the 'Khartoum Neolithic and Jebel Moya samples display medium grained-textures but with varied frequencies. While the samples of the former is relatively high, being 59% of the total inclusions, the latter forms c.37% of the total (tables 51-52:G4)

With respect to the fine-grained aplastic inclusions, the samples of Jebel Moya levels provide a relatively higher proportion (c.36%) than those of Khartoum Neolithic ones (24%) (ibid.:G3).

Proportions of minerals of silt-size , coarse and very coarse-grained textures are rather comparable in the samples of both ceramic groups (ibid:G1, G5-G6).

b. Mean value , standard deviation and standard error

1. Quartz

Values of group 1 (M=234.78 um, ST.D=125.99 um, ST.E=3.09 um) (cf. tables 51:G4,63) are comparable with those of group2-Rabak-J.M.L.- (M=279.27 um, ST.D=123.09 um, ST.E=3.14 um, tables 52:G4, 63), both of which indicate medium-grained textures.

2. Orthoclase

Values of group1 (M=297.15 um, ST.D=84.66 um, ST.E. 13.73 um) are distinct from those of group2 (M=297.15 um, ST.D=142.62 um, ST.E=31.89 um) (cf. table 52:G4, 63). While the first group indicates fine-grained textures, the second points to medium-grained ones.

3. Perthite

Values of group1 (M=236.54 um, ST.D=114.13 um, ST.E=15.53um) (tables 51:G4,53) are rather comparable with those of group2 (M=285.18 um, ST.D=148.62 um, ST.E=12.25 um) (cf. tables 52:G4, 63). Both groups show medium-grained textures.

4. Microcline

Values of group1 (M=199.72 um, ST.D=123.13 um, ST.E=9.23 um) (tables 51:G3, 63) differ from those of group2 (M=288.21 um, ST.D.144.45 um, ST.E=10.18 um) (cf. tables 52:G4,63). The first group points to fine-particle dimensions and the second indicates medium-grained textures.

5. Rock fragment

Values of group1 (M=231.4 um, ST.D=217.89 um, ST.E=33.66 um) (cf. tables 51:G3,63) point to fine-grained textures, while those of group2

(M=465.80 um ST.D=539.24 um, ST.E=120.57 um) (cf. tables 52:G4, 63) show medium-grained ones.

6. Mica-Muscovite

Values of group1 (M=170-86 um, ST.D=119.65 um, ST.E=11.06 um) and group2 (M=244.27 um, ST.D=133.77 um, St.E=23.28 um) point to fine-grained textures (cf. tables 51-52:G3,63).

7. Mica-Biotite

Values of group1 (M=163.80 um, ST.D=86.09 um, ST.E=8.88 um) (cf. tables 51:G3,63) differ from those of group2 (M=251.97 um, ST.D=119.93 um, ST.E=20.56 um) (cf. tables 52:G4,63). While the first group indicates fine-grained textures, the second shows medium-grained ones.

8. Iron

Values of group1 (M=181.17 um, ST.D=95.46 um, ST.E=7.45 um) are distinct from those of group2 (M=278.88 um, ST.D=111.81 um, ST.E=6.65 um). While the first group provides fine-grained-textures, the second displays medium-grained ones (ibid.).

C. T-tests

The T-tests of the pooled variances indicate that the differences in grain sizes of all the non-plastic mineral inclusions between the groups' combinations (see supra, this section) are statistically significant at .000 level of significance (cf. table 63).

7.7.1.3 Shabona Mesolithic and Rabak-Jebel Moya levels-samples

a. Frequency

The particle dimensions of the aplastic minerals from Shabona Mesolithic ceramics (cf. table 50 and section 7.7.1.1) are different from those of Rabak-Jebel Moya levels (see table:52 and section 7.7.2.1. and below). While the bulk of group1-Shabona(c.83%)-is coarse-grained in texture, those of group2-(cf. table 50:G50,63) Rabak-J.M.L, in most cases, are either medium (1c.37%) or

fine-grained (cf. table 52:G3-G4) and rarely (<2%) coarse-grained (cf. tables 52:G3, 63).

The proportion of very fine particles of Rabak-J.M.L.-ceramics is exceptionally high (22%) in comparison with Shabona ones which are extremely rare, being below 1% of the total (ibid.).

Mineral grains of silt dimension are rare in both ceramic groups, being < 1% at Shabona and nearly 4% at Rabak-J.M.L. (cf. tables 50, 52:G1).

b. Mean, standard deviation and standard error.

1. Quartz

Values of group1-Shabona (M=728.61 um, ST.D=313.85 um, ST.E=6.92 um) (cf. tables 50:G5-G6, 64) which are coarse-grained differ from those of group2, - Rabak. J.M.L (M=234.78 um, ST.D=125.99 um, ST.E=3.09 um) which are fine-grained in texture (cf. tables 52:G3, 64).

2. Orthoclase

Values of group1 (M=522.40 um, ST.D=187.12 um, ST.E=24.15 um) which indicate coarse-grained textures are varied from those of group2 (M=166.0 um, ST.D=84.66 um, ST.E=13.7 um) which show fine-grained ones (ibid.).

3. Perthite

It is absent in group1 whereas values of group2 (M=236.53 um, ST.D=114.13 um, ST.E=15.53 um) point to fine-grained textures (cf. table 52:G3, 63).

4. Plagioclase

Values of group1 (M=484.45 um, ST.D=297.09 um, ST.E=53.35 um) (cf. tables 50:G5-G6, 63) are distinct from those of group2 (M=165.51 um, ST.D=77.37 um, ST.E=6.38 um) (cf. tables 52:G3,63). The first group points to coarse-grained textures and the second shows fine-grained ones (ibid.).

5. Microcline

Values of microcline inclusions for group1 (M=659.42um, ST.E=248.59 um, ST.E=20.86 um) which indicate coarse-grained textures are unlike those of group2 (M=165.51 um, ST.E=77.37 um, ST.E=6.38) which point to fine-grained ones (ibid.).

6. Rock fragment

Values of rock fragments for group1 (m=671.73 um, ST.D=255.43 um, ST.E=77.01 um) are distinct from those of group2 (M=231.4 um, ST.D=212.89 um, ST.E=33.66 um). The first group shows coarse-grained textures whereas the second indicates fine-grained ones (ibid.).

7. Mica-Muscovite

Values of mica-muscovite (M=702.37 um, ST.D=591.84 um, ST.E=147.96 um) for group1 differ from those of group2 (M=170.86 um, ST.D=119.650, ST.E-11.06 um). Unlike the first group which displays coarse-grained particles, the second shows fine-grained ones (ibid.).

8. Mica-Biotite

Values of group1 (M=355.50 um, ST.D=241.31 um, ST.E=76.30 um) (cf. tables 50:G4, 64) are varied from those of group2 (M=163.80 um, ST.D=86.09 um, ST.E=8.88 um) (cf. tables 52:G3, 63). The first group indicates medium-grained textures and the second points to fine-grained ones (ibid.).

9. Iron

Values of group1 (M=614.44 um, ST.D=194.20 um, ST.E=10.04 um) which show coarse-grained textures (cf. tables 50:G5-G6,, 64) are distinct from those of group2 (M=181.17 um, ST.D=95.45 um, ST.E=7.45) which point to fine-grained ones (cf. tables 52:G3, 64).

C. T-tests

Most of the T-tests of the pooled variances show that the differences in grain sizes of the aplastic inclusions between the groups' combinations (see supra, this section) are statistically significant at .000 level of significance. Exceptions are perthite inclusions which are devoid in one of the two groups compared (Group2). Therefore, in this case, T-test is not possible. In addition to that, rock fragments and mica (biotite) show insignificant differences at 0.05 level of confidence (cf. table 64).

7.8 Western Butana

7.8.1 Frequency and T-tests for independent samples: non-plastic mineral-inclusions of groups' combination.

7.8.1.1 Shaqadud midden-Mesolithic and Neolithic levels-samples

a. Frequency

Compared with the Mesolithic ceramics which are are predominantly (c.74%) coarse-grained in texture (table 53:G5), the Neolithic examples of the midden are, in most cases (c.54%), of medium-grained class (cf. table 54:G4).

While the fine (<1%) and very fine (c.1.1%) aplastic minerals of the Mesolithic ceramics are extremely rare, the fine examples of the Neolithic ones are rather frequent (c.13.3%) (ibid.: G1-G2).

b. Mean, standard deviation and standard error

1. Quartz

While the values of group1 (midden-Mesoltihic levels) (M=727.35 um, ST.D=393.32 um, ST.E=10.85 um) (cf. tables 53:G5,65) (midden-Neolithic levels) point to coarse-grained textures, those of group2 (M=255.48 um, ST.D=107.41, ST.E=2.88 um), show medium-grained examples (cf. tables 54:4,65).

2. Microcline

Values of group1 (M=744.25 um, ST.D=286.40 um, ST.E=24.12 um) differ from those of group2 (M=257.42 um, ST.D=348.93,ST.E=35.07 um).

Coarse and medium-grained textures are the results of the first and the second values respectively (ibid.).

3. Plagiocalse

Values of group1 (M=734.25 um, ST.D=234.21, ST.E=18.51) and group2 (M=257.42 um, ST.D=122.87 um, ST.E=9.62 um) point to coarse and medium-grained textures respectively (ibid.).

4. Rock fragment

Values of group1 (M=764.12 um, ST.D=348.93 um, ST.E=35.07 um) and group2 (M=275.5 um, ST.D=90.42 um, ST.E=20.22 um), respectively, indicate coarse and medium-grained textures (ibid.).

5-6. Mica-Muscovite and Biotite

Values of groups1 (M-804.43, 733.05 um, ST.D=240.7, 400.33 um, ST.E=8.97, 10.079 um) and groups2 (M=257.35, 254.37 um, ST.D=84.32, 71.89 um, ST.E=10.079, 14.67 um) respectively point to coarse and medium-grained textures (ibid.).

7. Orthoclase

Values of group1 (M=547.5 um, ST.D=201.52 um, ST.E=142.50 um) and group2 (M=227.70 um, ST.D=116.94 um, ST.E=36.98 um) point to coarse and fine-grained textures respectively (cf. tables 53:G5, 54:G3, 65).

8. Perthite

Values of group1 (M-790.27, ST.D.307.68, ST.E=17.58 um) and group2 (M=237.26 um, ST.D=108.64, ST.E=4.63 um) indicate coarse and fine-grained particles respectively (ibid.).

9. Iron

Values of group1 (M=743.05 um, ST.D=272.32 um, ST.E=26.08 um) and group2 (M=240.73 um, ST.D=89.70 um, ST.E=8.97 um) display coarse and fine-grained dimensions respectively (ibid.).

C. T-tests

The T-tests of the pooled variances indicate that the differences in grain sizes of almost all the aplastic minerals between the groups' combinations are statistically significant at .000 level of signficance. The sole, being orthoclase of group1 (Shaqadud-midden, Mesolithic levels). Because of its exceptionally smaller sample size (n=2) (see Spiegel 1972:141-142), the two sample T-test between group1 (Shaqadud-midden, Mesolithic levels) and group2 (Shaqadud-midden, Neolithic levels) was not carried out.

7.8.1.2 Shaqadud midden-Neolithic levels-and Cave samples.

a. Frequency

In most instances the aplastic mineral grains of the midden Neolithic (c.54%) and Cave (c.51%) ceramics fall in size-dimension of medium-grained texture (cf. tables 54-55:G4).

Silt-size, fine and very fine-grained minerals are comparable in both groups (midden-Neolithic levels and Cave), being present at c.2.4%, 13%, 29% and c.3.4%, 14.6%, c.29% respectively (ibid.:G2-G3).

Coarse and very coarse-grained minerals in both groups are scarce, all of which are below 1% of the total aplastic inclusions (ibid.:G4-G5).

b. Mean, standard deviation and standard error

1. Quartz

Values of group1 (M=255.48 um, ST.D=107.41 um, ST.E=2.88 um) differ from those of group2 (M=271.38 um, ST.D=76.28, ST.E=1.95 um) (cf. tables 54-55:G4, 66). Both groups indicate medium-grained textures.

2. Rock fragment

Values of group1 (M=275.55 um, ST.D=71.89 um, ST.E=14.67 um) and group2 (M=195.25 um, ST.D=74.31 um, ST.E=6.56 um) provide medium-grained textures (ibid.).

3. Orthoclase

Values of group1 (M=275.55 um, ST.D=71.89 um, ST.E=14.67 um) and group2 (M=195.25 um, ST.D=74.31 um, ST.E=6.56 um) provide medium-grained textures (ibid.).

3. Orthoclase

Values of group1 (M=277, ST.D=116.94 um, ST.E=36.98 um) and group2 (M=192.95 um, ST.D=95.95 um, ST.E=9.14 um) point to fine-grained textures (cf. tables 54-55:G3, 66).

4. Perthite

Values of group1 (M=237.26 um, ST.D=108.64, ST.E=4.63 um) and group2 (M=164.65 um, ST.D=90.05 um, ST.E=8.11) display fine-grained textures (ibid.).

5. Microcline

Values of group1 (M=250.43 um) ST.D=109.59 um, ST.E=10.96 um) and group2 (M=199.19 um, ST.D=162.89 um, ST.E=9.84 um) indicate fine-grained textures (ibid.).

6. Plagioclase

Values of group1 (M=257.42 um, ST.D=122.87, ST.E=9.62 um) and group2 (M=211.38 um, ST.D=108.62 um, ST.E=7.06 um) show fine-grained textures (ibid.).

7-8 Mica-Muscovite and Biotite

Values of group1 (M=257.35, 254.37 um, ST.D=84.32, 71.89 um, ST.E=10.07, 14.67 um) and group2 (M=181.04, 195.25 um, ST.D=209.68, 74.31 um, ST.E=19.81, 6.56 um) indicate fine-grained textures (ibid.).

9. Iron

Values of group1 (M=240.73 um, ST.D=89.70 um, ST.E=8.97 um) and group2 (M=160.04 um, ST.D=91.88 um, ST.E=7.82 um) show fine-grained particle-dimensions (ibid.).

C. T-tests

The T-tests of the pooled variances show that the grain sizes of the majority of the non-plastic mineral inclusions between the groups' combinations are statistically significant at .000 and .004 levels of significance. The only exceptions, being rock fragments and orthoclase. While rock fragments tend to show insignificant differences between the samples of group1 (Shaqadud Cave), orthoclase displays exceptionally smaller sample size (n=2) (see Spiegel 1972:141-142) and hence the two sample T-test between the two groups could not be possible.

7.8.1.3 Shaqadud midden-Mesolithic levels-and Cave samples

a. Frequency

Compared with the grain sizes of the Mesolithic levels of the midden which are mainly coarse (c.74%) in texture (cf. table 53 and section 7.7.1.1 for detailed information), the Cave aplastic inclusions are mostly (c.51%) medium-grained (see below).

Minerals of silt-size dimension, fine and very fine-grained in texture are present in both ceramic groups (cf. tables 53.55), but are relatively higher in the samples of the Cave (ibid.).

b. Mean, standard deviation, standard error

1. Quartz

Values of group1 (M=727.35 um, ST.D=393.23 um, ST.E=10.36 um) (cf. table 53:G5,67) and group2 (M=271.38 um, ST.D=76.28 um, ST.E=1.95 um) (ibid.: G4,65) point to coarse and medium-grained textures respectively.

2. Microcline

Values of group1 (M=744.50 um, ST.D=268.40 um, ST.E=24.12 um) and group2 (M=250.43 um, ST.D=109.59 um, ST.E=10.96 um) indicate coarse and medium-grained particles respectively (ibid.).

3. Plagioclase

Values of group1 (M=734.25 um, ST.D=234.21 um, ST.E=18.51) and group2 (M=257.42 um, ST.D=122.87 um, ST.E=9.62 um) exhibit coarse and medium-grained textures respectively (ibid.).

4. Rock fragment

Values of group1 (M=764.12 um, ST.D=348.93 um, ST.E=35.07 um) and group2 (M=275.55 um, ST.D=90.42 um, ST.E=20.22 um) display coarse and medium-grained textures respectively (ibid.).

5-6. Mica-Muscovite and Biotite

Values of groups1 (M=804.43, 733.18 um, ST.D=400.33, 409.49 um, ST.E=32.15, 38.86 um) and groups2 (M=181.04, 195.25 um, ST.D.=209.68, 74.31 um, ST.E=19.81, 6.56 um) indicate coarse and medium-textures respectively (ibid.).

7. Orthoclase

Values of group1 (M=547.50 um, ST.D=201.52 um, ST.E=14.50 um) (cf. tables 53:G5-G6, G65) and group2 (M=277.70 um, ST.D=116.94 um,

ST.E=36.98 um) (cf. tables 54:G3,65) point to coarse and fine-grained textures respectively.

8. Perthite

Values of group1 (M=790.27 um, ST.D=307.68 um, ST.E=17.58 um) and group2 (M=237.26 um, ST.D=108.64, ST.E=4.63 um) indicate coarse and fine-grained particles respectively (ibid.).

9. Iron

Values of group1 (M=748.05 um, ST.D=272.32 um, ST.E=26.08 um) and group2 (M=240.73 um, ST.D=89.70 um, ST.E=8.97 um) show coarse and fine-grained particles respectively (ibid.).

C. T-tests

The T-tests of the pooled variances show that the variations in grain sizes of almost all the non-plastic mineral inclusions between the groups' combinations are statistically significant at .000 level of confidence. The only exception, being orthoclase of group1 (Shaqadud-midden, Mesolithic levels). Because of its exceptionally smaller sample-size (n=2) (see Spiegel 1972: 141-142), the two sample T-test between group1 (Shaqadud midden-Mesolithic levels) and group2 (Shaqadud-Cave) could not be possible.

7.9 Grain sizes of the non-plastic minerals per area

7.9.1 Khartoum-east and west bank of the Main Nile

In almost all the samples derived from area1 (west bank of the Main Nile) and area2 (east bank of the Main Nile), the T-tests of the pooled variances between the groups'-combinations-through the Mesolithic and Neolithic periods-indicate that the differences among the non-plastic minerals are either statistically significant at .000 level of significance (quartz, orthoclase, plagioclase and mica-biotite) or insignificant at .05 level of confidence (microcline, rock fragment, mica and iron) (cf. table 68).

While the majority of aplastic minerals between the groups' combinations of area1 (west bank of the Main Nile) are, coarse-grained, those of area2 (east

bank of the Main Nile) are mainly medium-grained and occasionally coarse-grained in texture (ibid.).

7.9.2 Khartoum-west bank of the Main Nile and Western Butana

T-tests of the pooled variance between the groups' combinations show that the differences in the variables (50%) of the aplastic mineral components (quartz, orthoclase, microcline and mica-biotite) of area1 (Khartoum-west bank of the Main Nile) and their counterparts of area3 (Western Butana) are statistically significant at .000 level of confidence whereas the remaining variables (plagioclase, rock-fragment, mica-muscovite and iron) tend to show insignificant differences at .05 level of confidence (cf. table 69).

Perthite occurs only in the composition of the ceramic-groups from area2 (Western Butana). Therefore, T-test is not possible between the two areas (ibid.).

7.9.3 Khartoum-west bank of the Main Nile and White Nile

T-tests of the pooled variance between the groups' combinations of area1 (Khartoum-west bank of the Main Nile) and their counterparts of area4 (White Nile)tend to show that, in most cases, the aplastic minerals exhibit significant differences at .000 level of confidence. Exceptions are orthoclase and iron inclusions which show insignificant differences at .05 level of significance. Moreover, the absence of perthite, mica (biotite) in the composition of ceramics from area1 (Khartoum-western bank of the Main Nile) and mica (biotite) from area2 (White Nile) makes it impossible to determine the T-test between the groups' combinations (see table 70).

7.9.4 Khartoum-east bank of the Main Nile and Western Butana

T-tests of the pooled variances between the groups' combinations of area2 (Khartoum-east bank of the Main Nile) and area3 (Western Butana) show that the differences in most of the aplastic minerals are statistically significant at .000 level of confidence. While the aplastic mineral grains between the groups of area2, in most cases (quartz, orthoclase, perthite, microcline and plagioclase), display coarse-grained particles, those of group3 (quartz, perthite, plagioclase,

rock fragment, mica (biotite and muscovite and iron) almost exclusively medium-grained in texture (cf. table 71).

7.9.5 Khartoum-east bank of the Main Nile and the White Nile

T-tests of the pooled variances between the group' combinations of the Mesolithic and Neolithic ceramics from area2 (Khartoum-east bank of the Main Nile) and their counterparts from area4 (White Nile) tend to display, in the majority of instances, that the aplastic mineral inclusions indicate significant differences at .000 level of confidence. Exceptions are iron inclusions which tend to exhibit more or less the same mean between the groups' combinations. Therefore, no significant differences are seen at .05 level of confidence. Moreover, mica which is absent in the composition of ceramics from areas2 and 4 does not allow determination of the T-tests between the groups compared (cf. table 72).

While group1 (Khartoum-east bank of the Main Nile) aplastic mineral grains, in most cases, display medium-grained textures, those of group2 (White Nile) mainly provide fine-grained examples (ibid.).

7.9.6 Western Butana and White Nile

In the bulk of the samples derived from area 3 (Western Butana) and area 4 (White Nile), T-tests of the pooled variances between the groups' combination-through the Mesolithic and Neolithic periods-show that most of the aplastic mineral grains are statistically significant at .000 level of confidence. The sole exceptions, being perthite which indicates insignificant differences at .05 level of confidence. Moreover, the absence of mica (muscovite and biotite) in the composition of the ceramic groups from areas3 and 4, respectively, does not help to determine the level of confidence between the groups compared (cf. table 73).

While the samples of the Western Butana indicate, in general, medium-grained textures, those of the White Nile, in most examples, point to fine and medium-grained ones (ibid.).

7.10 Discussion and Conclusions

The analyzed samples, in most cases, have shown marked differences in the mineral grain-sizes of ceramics from Khartoum (Sarurab2 Mesolithic, Islang2 and Nofalab2 Neolithic sites), White Nile (Shabona Mesolithic and Rabak-Neolithic sites) and Western Butana (Shaqadud midden-Mesolithic and Neolithic levels and Cave). A few exceptions are represented by mineral components that are devoid in one or the paired-groups compared (cf. tables 55-67).

T-tests of the pooled variances for the grain sizes of the bulk of the aplastic mineral inclusions between the groups' combinations of the sampled ceramics (Khartoum, White Nile and Western Butana regions) are statistically significant at .05 level of confidence. Examples of the T-tests results between the groups' combinations of Islang2/Nofalab2 (table 58) and Rabak-Khartoum Neolithic and Jebel Moya levels (table 63) illustrate this tendency.

Some non-plastic mineral inclusions are often absent in the paired-groups compared. Hence, in this case, T-test of the pooled variances could not be possible. Examples to represent this situation can be taken from the compared samples of Kabbashi Haitah/Geili (cf. table 59), Kabbashi/Geili (cf. table 61) and Shabona/Rabak-J.M.L. (cf. table 64).

From what has been presented above, the results do not only show marked change(s) in the grain sizes of the ceramic-groups examined but also point, in most instances, to significant differences between them (see supra, this chapter). On the basis of this evidence, it seems highly unlikely that the variations in grain-sizes measurements between the ceramic-groups in each of the areas investigated are due to sampling errors (cf. tables 56-57). If that is the case, then one would ask what do these variations mean?. Are they due to the nature of the material itself or to the techniques employed?. In the present writer's view it seems highly unlikely that these variations are due to the nature of the material used in its original state. In support of this, the analysis of rounding classes of non-plastic components of the ceramic groups from Khartoum, White Nile and Western Butana regions (cf. sections 3.3-5.3) provides evidence that these mineral grains might have resulted from intentional crushing of sandstone rocks.

The aplastic grains of these ceramic groups are dominantly angular, often subangular. Subrounded to rounded mineral grains are rare. (ibid.).

The results of the rounding classes (see supra and sections 3.3.-5.3) and the T-tests of the grain size-variations between the groups' combinations at the intraregional (see supra, sections 7.6-7.8 and tables 56-57) and interregional levels (cf. section 7.9 and tables 68-71), in most cases, indicate significant differences at .000 and .05 level of confidence. Therefore, it appears plausible that these variations are neither due to sampling errors nor to the nature of the material used. But since the tested ceramic-groups follow each other chronologically, beginning with the Mesolithic period (Khartoum-Sarurab2, Kabbashi Haitah; White Nile-Shabona and Western Butana-Shaqadud midden-lower levels) and followed by the Neolithic (Khartoum-Islang2, Nofalab2, Geili, White Nile - Rabak, Khartoum Neolithic and Jebel Moya levels-Western Butana, Shaqadud-midden-upper levels and Cave) one (cf.section 10.1.1), it does not seem unreasonable to assume that these marked variations in the grain sizes of the ceramic groups examined are indicative of an intentional change in methods of temper preparation during that passage of time. If that is the case, then this would mark the tendency of the Mesolithic and Neolithic potters in the central Sudan to produce more fine-grained and refined ceramic output through time as visualized from the ceramic groups studied. On the other hand, the similarities in grain-sizes between the ceramics from the eastern bank (the Mesolithic sites of Kabbashi Haitah and Kabbashi) and western bank (Sarurab2 Mesolithic and Islang2 Neolithic sites) of the Main Nile in Khartoum province may point to the adoption of similar techniques in temper preparation (cf. tables 56, 60).

The results of the present study (see supra) could be of help for ordering chronologically the Mesolithic and Neolithic sites in the central Sudan depending upon the texture of temper of ceramics.

Chapter 8

Firing Index of the Pottery

8.1 Aims

Determination of firing temperatures seems to be the target of several studies of ancient technology (e.g. Roberts 1963:21-25; Van der Leeuw 1976: 335-337; Hulthen 1977:191-192 and 202; Payne 1982:189-193 and Smith 1990:15, 157).

The purpose of firing is to subject pottery to adequate heat for a sufficient period to ensure complete destruction of the clay mineral crystals (Rye 1981:96).

The firing conditions of ancient pottery are important because they provide information on the types of kilns used, clues to kinds of fuel utilized and consequently reveal something about the technological capabilities of the potters with respect to their ability to achieve certain temperature degrees and their understanding of the refractory properties of the clays exercised (Tite 1972:323). With these views in mind, a series of physico-scientific analyses (see below) have been employed in the present work to determine the firing conditions of the Mesolithic and Neolithic ceramics in the central Sudan.

8.2 Theoretical considerations

8.2.1. Firing conditions

The final appearance and serviceability of clay vessels depend on a number of different conditions during firing. These include the firing temperature, duration of firing and atmospheric conditions prevailing during firing. They can be combined into one set of factors termed the "Firing Index" by Nordstrom (Nordstrom 1972:43). The firing index is divisable into three grades: low, medium and high, each of which has certain characteristics and they are as follows:-

8.2.1.1 A High-grade Firing Index

The pottery fabric is fired at relatively high temperature (ranging between 700 to 1100°C) during relatively long period. The atmosphere is usually oxidizing during the final stage of firing, the duration of this stage being sufficient to burn out any organic matter and to complete the oxidation of the lower iron oxides (ibid.).

8.2.1.2 A Medium-grade Firing Index

It is a designation for firing conditions characterized by moderate (c.700° c) and moderately long firing. The oxidation phase is rather brief (ibid.).

8.2.1.3 A low-grade Firing Index

It is a characteristic of fabrics fired at relatively low temperature (c.600-650° C) during a short period of time, terminating by a brief oxidation phase(ibid).

8.2.2 Firing Temperature

The rate of heating is important because chemical reactions are not instantaneous and sufficient time must be allowed for the completion of desirable reactions. Reactions take place at certain temperatures; for instance the critical temperature must be exceeded to ensure destruction of clay minerals (Rye 1981:25).

The maximum temperature that can be gained is governed by several factors, including the type of fuel used, the amount of heat produced, and the insulation surrounded the vessel being heated. Excessive loss of heat by radiation and lack of forced draft kiln limit the temperature that can be obtained in firing without a kiln (Shepard 1956:83). Ethnographic evidences indicate that in open-firing without kiln construction the maximum temperature that can be attained does not exceed 1000° C (Rye 1981:25 and Shepard 1956:83).

The judgement of firing temperature is complicated by the availability of clays in their requirements for oxidation. In addition to that, wide variations in

maturing points of clay render unreliable estimates based on direct observations of firing properties. The density and the hardness of pottery may indicate the quality of firing but they do not show how high it was fired. It is possible to compare the pottery types with respect to quality by direct observations, but their firing temperature cannot be determined without knowing their firing behaviour (Shepard 1956:222).

Estimation of firing temperature attained by ancient potters required laboratory analyses. In this respect three types of data may be used: changes in the optical properties of the clay, thermal changes in mineral inclusions and changes in the physical properties of the body. These data shows approximate temperature range within which pottery was fired, but they do not provide us with the exact firing temperature (ibid.). They can be described as follows:-

8.2.2.1 Optical Properties of Clay

They can be used successfully for relatively low fired wares. If the crystalline structure of the clay minerals has not been lost, the temperature at which it was fired can be determined (ibid.). In this respect petrological examination by thin sections as well as X-ray diffraction method can be used to study the clay minerals which are altered during firing.

8.2.2.1.1 Petrological analysis

The study of thin section can provide information on the maximum temperature attained as well as the atmospheric conditions prevailing during firing. As far as maximum temperature is concerned, the clay material acts as a guide only if a temperature of 850°C or more has been reached. At this temperature some of the clay minerals break down to form spinel and glasses in the temperature range of 700-850°C. As a result the material appears istropic under crossed nicols (Hodges 1963:107). At even much higher temperature (1100-1600° C) partial fusion between the clay and the mineral inclusions occurs. However, partial fusion in pottery rarely provides information on the firing temperature since the temperature at which it occurs depends on the 'fluxing' impurities embeded in the clay (Tite 1972: 229).

The quantity and distribution of carbon in thin section provides information of the atmospheric conditions prevailing in a kiln during firing. In

practise precise statement about the atmospheric conditions prevailing during firing are not possible since the distribution of carbon also depends on the porosity of fabric, the maximum temperature reached and duration of firing (ibid.).

8.2.2.1.2 X-ray diffraction analysis

It can be used successfully for relatively low fired wares. If the crystalline structure of of clay minerals has not been lost, the temperature at which it was fired can be determined (see section 3.4). X-ray diffraction does not give direct information after the crystalline structure has been destroyed. Effects seen in polarized light show that the clay of low fired ware is still crystalline, and it is possible that the characteristic X-ray diffraction patterns could be obtained (Shepard 1956:153). This method is also of particular value in the study of wares fired at higher temperatures where new artificial minerals have formed in the fabric (Peacock 1970:380).

8.2.2.2 Thermal analyses

Thermal analyses include the different observable and chemical analyses that occur when the specimen is heated from room temperature to approximately 1000° c. Thermal changes are used to determine the firing tempeatures employed in the manufacture of pottery. However, there are three methods employed: Differential thermal analysis, Thermal expansion measurements (diatometer method) and Thermogravimetrical technique (see below).

8.2.2.2.1 Differential themal analysis

This method provides information on the endothermic (i.e. absorption of heat) and exothermic (i.e. evolution of heat) reactions that occur when pottery is heated. These reactions indicate that presence of specific minerals (e.g. clays minerals, calcite) which in turn provide an estimate of the original temperature of the pottery (Tite 1972:295). This technique involves simultaneously heating a powdered sample of the pottery, typically 100 mg in weight, and an equal volume of an inert material such as aluminum oxide (Al203). Then the two samples are placed symmetrically in separate compartments of an alumina block and are heated to approximately 1000c in an electric furnace in controlled condition. The difference in temperature between the two samples is measured

using a diffrential thermocouple which consists of two linked junctions, one in the pottery and the other in the inert material. A plot of the temperature difference versus the actual temperature range of the pottery sample can be obtained automatically using a suitable recorder. Positive peaks indicate higher temperatures in the pottery than in the standard and registered exothermic (heat-producing) reactions, examples are the combustion of organic matter and the formation of high-temperature minerals. Lower peaks indicate lower temperature in the pottery than in the standard and shows endothermic (heat-absorbing) reactions such as loss of mechanically and chemically combined water (Rice 1987:432-433).

8.2.2.2.2 Thermal Expansion Measurement

This method is used to determine the original firing tempreature of pottery on the assumption that, when clays are fired, shrinkage occurs as a result of various sintering processes, such as vitrification. Therefore, if pottery sample is heated up steadily-using a simple silica glass rod in-tube dilatometer- from room temperature it exhibits normal reversible thermal expansion, untill temperatures comparable with the original firing temperature are attained. As the temperature increases, the pottery begins to contract, superimposed on the reversible expansion, there is an irreversible shrinkage associated with the resumption of sintering: that is, the firing of pottery is being continued beyond the point reached during the original firing in antiquity. The temperature at which a net shrinkage is first noted showed, therefore, an indication of the original firing temperature of the pottery (Roberts 1963: 21-25 and Tite 1969:131-143 and 1972:298)

8.2.2.2.3 Thermogravimetrical analysis

This method determines the weight loss as the sample is heated under controlled conditions from room temperature to approximately 1000 C, a specially designed thermobalance being used. In the case of pottery loss in weight can occur in the 100-200 C range due to loss of absorbed water and in the 500-700 C due to loss of chemically combined water. The occurrence of significant loss in weight during the later temperature range, is indicative that hydrated clay minerals remain in the pottery and that the original firing temperature was below between 500 and 700 C. As in the case of differential

thermal analysis, this method is mainly appropriate to the study of pottery fired at low temperatures (Tite 1972:277 and Rice 1987:433).

8.2.2.3 Physical Properties of Pottery

Since the physical properties of pottery are liable to progressive changes with rise in temperature, these properties provide information of estimating the firing temperature. These physical properties include colour, shrinkage and porosity. However, there are some errors in interpreting the firing temperature from the thermal effects (Shepard 1958:223 and see also below).

The colour of ceramic specimen is a result of several variables, of which two are the most important. One is the size, amount and distribution of impurities, mainly iron and organic material, present in paste; the second concerns time, temperature and atmosphere of the original firing (Rice 1987:332).

Two factors should be taken into consideration when estimating firing temperature from change in paste colour: the original state of oxidation of the paste and rate of colour change in heating. For instance grey or black colours may be oxidized at or below its original firing temperature or at temperature higher than that of the original may be required. (Shepard 1956:233). White clays undergo no colour change on firing. Therefore, all white, grey and black pottery is unsuitable for judgement of firing temperature by colour change on refiring. Caution should also be made in drawing deductions from clays in brown and tan range because they may be incompletely oxidized. The second factor which limits the usefulness of colour is the fact that when oxidation is incomplete there may be no further observable change for several hundred degrees. (Ibid).

Porosity increases during firing due mainly to the burning out of carboneous matter which is affected by time, atmosphere and temperature. If pottery is not completely oxidized it increases in porosity on refiring but this does not mean that the original temperature had been exceeded. Carboneous matter might actually be burnt out at lower temperature than the original if atmosphere originally was not oxidizing. This is clearly seen in coarse pottery because of the more unrestricted pore space within which oxidation and movement of the particles can occur (Rice 1987:333-335).

Firing shrinkage is concomitant with decrease in porosity and becomes more pronounced as the ware matures and begins to vitrify. In certain stage, however, expansion rather than contraction may occur, it may be caused by minerals when they pass an inversion point (Shepard 1956:223).

In the present study X-ray diffraction (XRD) and dilatometer (DLT) analyses have been used to determine the firing temperatures of the Mesolithic and Neolithic ceramics from the selected samples in the central Sudan.

8.2.3. The Firing Atmosphere

The atmosphere of firing refers to the presence of gases, particularly oxygen, while the clay is heated and cooled (Rice 1987:81). The atmosphere or gas surrounding the vessel influences all types of ware, whether fired at low or high temperature, by reacting with constituents of the body (ibid.).

The three principal atmospheres - oxidizing, reducing and neutral - are distinguished by the dominance of oxygen (oxidizing), carbon monoxide (reducing), or carbon dioxide (neutral) (Rye 1981:25). The atmosphere is controlled by the amount of air available to burn the amount of fuel supplied. If adequate air is provided, reducing conditions occur. In such atmospheric conditions the fuel will not be fully burnt. It results in grey or black colours. Soot and carbon monoxide are carried into the kiln forming grey or black-surface pottery. A complete reducing conditions during firing is difficult to attain except under well-controlled conditions such as complete smothering of the firing load (Rice. 1987:81). Oxidizing conditions occur in the presence of sufficient air to allow complete combustion. It results in surface with light browns to red colours because all the carbon in the fuel will be converted into carbon dioxide and hence burnt out of the pottery.

The neutral conditions occur in pottery firing when there is a fluctuation in atmosphere or when it is not sustained. The result is a patchy pottery because vessels are either touched each other or due to heating (Rye 1981:25, 74, 104).

In kilns the atmosphere may be controlled by the selection of fuel and by regulating air-circulation within the kiln. In open-firing or bon-firings, the

atmosphere is more difficult to control because of wind and irregularities in fuel combustion. (Rice 1987:156, 158).

The atmosphere in which pottery is fired by primitive methods is never constant. It varies during the firing process. In the early stages an oxidizing atmosphere is usually present, becoming a reducing atmosphere as the fire increases. The final atmosphere is usually oxidizing but protecting the pots can be kept reducing to the end of firing (Colton 1953:23).

Many clays, especially those derived from a soil in which organic matter (humus, rootlets, fibers) has penetrated, contain considerable amount of carbon. In reducing atmosphere the carbon remains and if organic matter is present it is carbonized to charcoal. The carbon in the clay makes it black, grey or dark brown, depending on the amount present. In an oxidizing atmosphere the carbon burns out. It is important to note that in open firing the firing atmosphere is generally highly variable and is rarely completely oxidizing because of the proximity of the fuel and the prevalence of combustion products in the air (Hodges 1981:40 and Rice 1987:335). Therefore, in one vessel the iron and carbon may be oxidized on one side, with another side still in reduced state (Colton 1953:25).

8.2.4 Firing Time

The length of firing depends on the types of fuel used. The modern ceramists compare fuels with respect to their heat value and the length of time they burn. However, ancient potters have no way of comparing the heat value of differnt fuels, they can realize whether or not particular fuel has a clean or sooty flame, burns quietly or snaps, falls to pieces or holds its forms and keeps heat after the flame has burnt out (Shepard 1956:77).

The rate of combustion is governed by the ratio of the surface area to the weight of fuel, because this detemines the availability of oxygen. The firing time a fuel will burn depends on the proportion of volatile material it contains, the density of carbon, and the type of ash it forms. Slow firing occurs with large pieces of fuel, such as logs. This is because this type of wood acts as insulating blanket over the charcoal and thus serves to slow the rate of combustion and increase the firing time. Therefore, slow-burning fuel is usually placed under the stack of vessels; quick-burning fuel such as grass, placed around the sides

will burn rapidly due to the abundant surface area available to oxygen and it makes an insulating layer of ash over the vessels that allows retard heat loss (Hodges 1981:40 and Rice 1987:157).

The most important feature of open firings is the extremely rapid rise in temperature. Temperature of 900° C or higher are common and can be attained within twenty minutes in the American Southwest (Shepard 1956, fig.5 and table 3, see also Rice 1987:156 - 157).

Much pottery, while having a generally red surface, will be found to have a dark core in the fracture, and this is normally a sign of a fairly short firing in which insufficient time has been given to burn out all the carbon derived from the organic matter in the body (Hodges 1981:40).

8.3 Firing Methods

Pottery is fired by two principal techniques: with and without a kiln. Kilns possibly were an early response to the needs of the potters: they permit more control over products, higher firing temperatures and more exploitation of fuel (see below).

8.3.1. Non-kiln firing

Firing without a kiln is called open firing,bonfire or clamp method. Despite the fact that open firing needs little or no buildings and maintenance of structure, it requires high degree of skill and observation (Rye 1981:25). Although the techniques of open firing vary, they share certain general characteristics. A bed of fuel (often fairly slow burning) is prepared on the ground, the pottery to be fired is placed over the fuel and more fuels are stacked around and on top of the pottery. The fuel is kindled, usually starting with the lower layer (fig. 43), extra fuel is added and after a short time, the fuel burns itself out and the firing is over. Pots may be removed almost instantly or allowed to cool before firing taken from the ashes (Rice 1987:153).

To reduce loss of heat, potters often use some sort of insulation, such as placing large pieces of sherds over the top of the setting. Some control over rate of firing can be achieved through the selection of fuel. Animal dung, for example burns slowly and uniformly, raising the temperature gradually, whereas

chaff, straw and twigs burn very rapidly causing a quick rise. Potters using fast-burning fuels usually preheat the vessel to eliminate all free moisture and minimize the risk of cracking during heating. Some control over atmosphere can be gained by the placing of fuel and vessels so as to regulate the flow of air through the setting (Rye 1981:25 and Hodges 1981:39-40).

The basic technique of open firing varies from one place to another, depending on the nature of the potting, craft and the local resources. In some places large chunks of fuel, broken or discarded vessels, metal and other protective means such as basins or grates may be arranged around the vessels to make some sort of a rudimentary-kiln. Another type of protective device - a kind of cross between a kiln and a sagger-is the mapu etie, a bottomless vessel used by Shipibo-Conibo potters of the eastern Peru to fire small utensils (Rice 1987:153-154).

Different kinds of fuels are used to fire pots including wood, animal dung, straw, chaft or grass, charcoal, palm fronds, coal, bamboo, coconut husks .....etc. (ibid.).

With all forms of open firings, the atmosphere is, virtually, uncontrollable after the fire has begun (Rye 1981:25). The time of firing is highly variable. Some types of open firings last only a few hours, others take up to eight hours as among the Pamunkey tribes of Virginia in United States (Rice 1987:154). In some areas they may last only 15 to 20 minutes as in some regions of Nigeria (Nicklin 1981a:348), Southwestern United States (Shepard 1956: table 3) and the Philippines (Longacre 1981:60).

The drawbacks of this firing technique are many. The main one is that the vessels are incompletely protected either from contact with the fuel or from atmosphere. Therefore, open firings are almost never used for glazed ware. The fired-vessels are normally marked by fire clouds and the fluctuation of temperature ranges (as well as shifts in the placement of the fuel as it burns) can easily crack, dent or over-or underfire the pots. Moreover, the maximum firing temperatures are often markedly high, the heat is uneven and much heat is lost through radiation and convection (Rice 1987:155-156). However, open firing has some remarkable advantages. It is an economic solution to many traditional potters and for thousands of years it has provided a satisfactory mean of producing useful unglazed pottery for cooking and storage. The short firing is

possible using this technique because clays are sometimes of rather coarse-texture and thus less liable to thermal shock. Moreover, preheating the pots is essential so that the vessel could withstand the thermal shocks as a result of a rapid temperature rise. This method is apparently cheap and it does not require much money for construction, maintenance and repair (Shepard 1956:216-217 and Rice 1987:155-156).

Wind conditions adversely affect firing pottery by open firing, and potters must schedule their firing during seasons when the weather is calm and dry (Arnold 1985:71).

Humidity and rainfalls provide a negative feedback for firing pottery using open-firing method. Many of the potters are aware of firing losses during humid and rainy weather for rainfall and moisutre may cause breakage, blackening and uneven heating resulting in a defective and low quality product (ibid.). In northwest part of Pakistan, for example among Kharmothu, Bamu, Zakhal Bala and Hala tribes rain and high degree of cloudiness usually cause up to 50% loss during firing of unglazed pottery (Rye and Evans 1976:36, 161). The papuan tribe of Mailu island in New Guinea (Rye 1981:97, 103), the Yoruba of Nigeria (Arnold 1985:72), the Luo of east Africa(ibid.), the people of Kabiliya village in Morocco (Balfet 1965:164, 166), the dwellers of the Central Andes in South America (Arnold 1985:80) are among the many examples of potters who practise the method of open firing scheduled during favourable dry climate to avoid the damages caused by humid weather, rainfall and wind conditions.

Temperatures achieved by open firings usually range between 600-840°C but there is a considerable variation. The maximum temperatures that have been recorded in open firings are exclusively below 1000°C (e.g. Colton 1953:81; Shepard 1956:83 and figs.5; Hulthen 1977:26,56-194; Rye 1981:25 and Rice 1987:156-157). Maximum temperatures are normally achieved at or just after the fuel covering the vessels has been burnt out, following this the temperature decreases rapidly and then declines more slowly. Measuring temperatures of open firing may vary with measurement techniques used, and only a few ethnographic pyrometric studies have been done so far (Rice 1987:156-157).

It is generally known in ceramic practice that pottery is allowed to cool slowly before it is drawn from the kiln, to avoid the strain of excessive shrinkage.Some potters who use open firings are not aware of this caution. For

example, the Rio Grande Pueblo potters of the American Southwest draw their vessels soon after the temperature has passed its peak. In three examples from American Southwest the temperatures at which the first vessels were removed ranged between 700 and 800°C (see Shepard 1956:90 - 91, table 3). Unlike the Rio Grande potters, the Hopi Indian tribes do not remove pottery until it has ample time for cooling and the same practice was observed among the Yuma and Navajo tribes of the American Southwest (ibid:91).

One of the results of open firing is smudging, where the vessel is blackended, usually at the completion of firing, by covering the fuel with material such as very fine, loose manure or sawdust. This material prevents the supply of oxygen to the ware so that carbon is deposited on the surfaces and in the pores, making an attractive black pottery (Shepard 1956:88 and Rice 1987:157-158).

This practise is wide spread in several regions and among various potters such as the Pueblo Indians of the Rio Grande valley (Shepard 1956:88) particularly at San Iidefonso and at Santa Clara in the American Southwest (Colton 1953:34-35 and Shepard 1956:88). Such intentional smudging is not confined to the New World for similar pottery was made in the Old World, for instance, by Shaheinab Neolithic potters of the central Sudan (Arkell 1953:75) and the Badarians of predynastic Egypt over 4000 years (Lucas and Harris 1961:327; Arkell and Ucko 1965:151).

8.3.2 Kilns

Kilns may be regarded as enclosed chambers supplied with flames by one or more fire places out of which a chimney draws heat and smoke and it is used for firing ceramic materials. Ancient and traditional kilns can be classified into three main types: pit kilns, updraft and downdraft kilns (see Rye 1981:24-28; Hodges 1981:35-41 and Rice 1987:158-163).

8.3.2.1 Pit kilns

In the absence of permanent kilns, the potter either fired in a pit (fig.75) or surrounded his pottery with fuel above the ground (Shepard 1956:75). Pit kilns are regarded as intermediate types between open firings and updraft kilns in what they consist of enclosures though the fuel is stacked around and between

pots rather than being piled in a separate area (Rice 1987:158) (fig.76). Because heat is partially controlled, pit kilns may maintain higher temperatures and for a relatively long period than do completely bonfires (Shepard 1956: fig.4 and Rice 1987:158). Pit kilns bear most of the advantages and drawbacks of open firings (Rice 1987:158).

8.3.2.2 Updraft kilns

These are simple enclosed structures in which the fuel is set in a fire below the pottery which is itself enclosed in dome or similar structure (Hodges 1981:36); provided with a vent or blow-hole to allow heat and gases move upward from underneath the pots and then are escaped outward (Rice 1987:159) (fig.77-1). Such types of kilns are usually cylindrical or oval in shape for pottery firing but square or rectangular for firing bricks and may be provided with one or more stoke-holes. The fuel is placed in the firebox through a stoke hole or below and forward of the firing chamber or through an opening in the side of the kiln (ibid.) (fig.77-1). Updraft kilns have advantages over open firing because they retain heat for longer period. Their disadvantages include emission of heat through the top of the kiln, production of mishapen pottery as a result of over-firing and under-firing and the possibility of thermal shock to the vessels at the bottom of the kiln (Hodges 1981:38 and Rice 1987:159). They normaly vary considerably in their sizes, designs and are known with several names. The tall kilns with a chimney-shaped vent are sometimes called bottle-kilns, whereas those built on slopes and hillside are generally known as bank-kilns (Hodges 1981:38).

8.3.2.3 Down-draft kilns

In this type of kilns the fire, instead of being placed below the pottery as in the updraft kiln, is deflected from the direct contact with the vessels by a bag-wall. Then the flues force the hot gases to move upward in the kiln, where they are deflected downwards from the top of the kiln through the pottery to exit flues near the bottom of the chamber and into a chimney (fig.77-2). It is always possible to attain higher temperature in a downdraft kiln than in the updraft kiln and it is generally known that temperatures up to 1300° C are more easily obtained in a down-draft kiln when firing with wood (Hodges 1981:38; Rye 1981:25, 100, 104 and Rice 1987:159-161).

8.4 Thermal and X-ray analyses

Thermal expansion and X-ray techniques have been used in the present work to determine the firing temperature of the sampled Mesolithic and Neolithic ceramics in the Central Sudan as shown below.

8.5 Khartoum Province
8.5.1 West bank
8.5.1.1 Mesolithic Pottery
8.5.1.1.1 X-ray diffraction analysis
8.5.1.1.1.1 Sarurab2

As has been mentioned earlier (section 3.4.6) X-ray diffraction analysis of two samples (G93-06 and G93-07) from this site indicates that quartz is the most prominent mineral inclusion. Fine clay fractions, plagioclases, K-feldspars, mica and anatase are unclear or invisible. Hematite is imperceptible prior to firing. After refiring to 900°c for a period of one hour, the samples show a weak development of hematite (cf. table 11).

The most interesting feature is the complete absence of the main clay minerals (e.g. montmorillonite, Kaolinite, illite .....etc.). The absence of montmorillonite is indicative that it undergoes structural change above 300° C; vanishing of kaolinite points to firing temperature above 500° C, since at this temperature ranges, its structure becomes amorphous. Vanishing of poorly crystallized illite points to firing temperature exceeding 600° C whereas vanishing of well crystallized illite and clay-size muscovite indicates firing temperature above 800° C (cf. sections 3.4.6.1 and 6.3.2).

8.5.1.1.2 Thermal Expansion analysis

The thermal expansion curve (fig. 78) of Sarurab2 pottery is distinct from those obtained for the Mesolithic and Neolithic samples (except those of Kabbashi, Islang2 and Shaqadud Cave) derived from the central Sudan (see below) because of an extra reaction after the quartz inversion before the new formation peak. The thermal curve represents the linear value increase of the sample cylinder of approximately 4% to 6.5% with respect to the base line (Van Der Pals, pers. comm. 1994 and fig.12). According to the literature (see e.g. Grim 1968: 304-305 and Rice 1987: 90-92) such curve seems to be the

characteristic of clay minerals with appreciable amount of kaolinite next to an even larger amount of illite, next to montmorillonite/illite mixed structure. Therefore, it seems that the firing temperature was in the order of c.700 - 800°C because pronounced changes concomitant with formation of new crystalline phases occur above 800°C (cf. section 8.8.1 for more details).

8.5.1.2 Neolithic pottery

8.5.1.2.1 Islang2

8.5.1.2.1.1 X-ray diffraction analysis

X-ray diffraction photographs show that the analyzed samples (G93-16C and G93-17a) are characterized by high quartz content. Very fine-grained particles of clay minerals (020), K-feldspar and anatase show weak or very weak occurrence. As indicated earlier (see section 8.5.1.1.1), the absence of the key minerals (montmorillonite, kaolinite, illite....etc) points to firing temperature above 300° C, at which montmorillonite disappears and vanishing of kaolinite shows that the firing temperature is above 500° C. The absence of poorly crystallized illite points to firing temperature above 600°C, whereas vanishing of well crystallized illite and clay-size muscovite points to firing temperature exceeding 800° C. At all these temperatures, respectively, montmorillonite, kaolinite and illite undergo structural changes (cf. section 3.4.6.1 for further details). Hematite is observable prior to firing. After firing to 900°C, the samples show the development of hematite. It is noteworthy that a single sample (G 93-17a) from this site shows a weak presence of kaolinite, being identified on the basis of a single diffraction line (7.2 A) (cf. table 11).

8.5.1.2.1.2 Thermal Expansion analysis

The thermal expansion result (DLT) (figs.79-80) shows that it is similar to curve no.12 from Sarurab2 (see section 8.5.1.1.1.2), both of which tend to show an increase in size (the curve represent the linear volume increase of the sample cylinder) of approximately 4.6 to 6.5% with regard to the base line. The reaction at 930°C (fig.10) is pronounced and is a characteristic of the clay from which the sample had been taken (Van Der Plas, pers. comm.1994). Such type of curves is typical of clays that are characterized by appreciable amounts of montmorillonite/illite mixed structure, next to a fair amount of kaolinite, next to a considerable amount of illite (see e.g. Grim 1968: 304-305 and Rice 1987: 90-91). Therefore, a firing temperature in the range of 700 - 800° C could be

postulated for Islang2 ceramics since above this temperature range the above mentioned minerals become amorphous.

8.5.1.2.2 Nofalab2

8.5.1.2.2.1 X-ray diffraction analysis

The results indicate that quartz is the most prominent mineral constituent of the samples analyzed (G 93-16a and G 93-16b). Fine clay fractions, plagioclases, K-feldspar and anatase weak or very weak presence in the samples. The key clay minerals (e.g. montmorillonite, kaolinite, illite.....etc.) are absent in the composition of the samples analyzed (cf. table 11). This points to firing temperature over 300° C (vanishing of montmorillonite), over 500° C (vanishing of kaolinite), over 600°C (vanishing of poorly crystallized illite) and over 800° C (vanishing of well-crystallized illite and clay-size muscovite) (see section 3.4.6.1). The results indicate that the pottery samples of this site were fired at a relatively high temperature which causes destruction of crystalline structure of the main clay minerals present.

8.5.1.2.2.2 Thermal Expansion analysis

The thermal curve (fig.81) indicates a shrinkage after a plateau showing that the firing temperature changes again, a shrinkage followed by an expansion as a result of new formation of crystalline phases (see below). It is noteworthy that the peak of this new formation occurred at a temperature exceeding 1100° C. According to the literature (see e.g. Grim 1953:190 -249, 1968: 278-347, Tite 1969: 131-143; Rice 1987: 90-91 and Van Der Plas, pers. comm. 1994) it may have resulted through the interaction of new formed calcite with glass or clay relics. It is equally possible to have resulted from the formation of mullite and spinal (ibid.). It is noteworthy that the formation of mullite is enhanced by heating in the presence of air gases (Grim 1968: 305). Again, the firing temperature of this sample seems to be less or around 800° C. This is due to the fact that calcite decomposes in a temperature range of c.650-750°C (see Rice 1987:98). Therefore, it is possible that a rather medium-grade firing temperature was employed and that hydration and subsequent recarbonization of dissociated calcite occurred during burial, can not be neglected (see Tite 1969:141).

8.5.2 East bank of the Main Nile
8.5.2.1 Mesolithic Period
8.5.2.1.1 Kabbashi Haitah
8.5.2.1.1.1 X-ray diffraction analysis

X-ray diffraction photographs (table 12) show that quartz is the most abundant mineral constituent of the samples examined ((G93-09(3) and G93-09(4)). The fine clay fractions (020), plagioclases, calcite and mica are weak or very weak in occurrence, K-feldspar shows medium presence whereas hematite is imperceptible prior to firing. After firing to 900° C all these minerals, except K-feldspar and calcite, are present with almost the same frequency. Hematite shows weak occurrence for the first time. The absence of montmorillonite points to firing temperatures above 300° C, vanishing of kaolinite points to firing above 500° C, vanishing of poorly crystallized illite indicates firing tempeatures exceeding 600° C whereas the disappearance of well crystallized illite and clay-size muscovite points to firing temperatures above 800° C. (cf. section 3.4.6.2).

8.5.2.1.1.2 Thermal Expansion analysis

The thermal curve(fig.82)shows that contraction starting at about c.150° C due to the loss of absorbed water while the expansion occurring at 573° C was caused by the inversion from alpha to beta quartz (see Tite 1972: 299). This followed by continuous downwards dip smoothly going over in the sintering part of the reaction. The slight to very slight discontinuity in this plateau (marked by across) marks the change from a fired material into still reactive material, i.e. the highest firing temperature attained (see Tite 1969:131-143 and Van Der Plas, pers. comm. 1994). This followed by contraction to the limit of the experiment at 1106°C. The firing temperature could have been in a magnitude of 700° to around 800° C because the most spectacular changes concomitant with alterations in crystalline structure normally occurs above this range (see e.g. Grim 1968:278-347, Tite 1969:131-143 and Rice 1987:98).

8.5.2.1.2 Kabbashi
8.5.2.1.2.1 X-ray diffraction analysis

It can be seen from table 12 that the X-ray diffraction photographs show the predominance of quartz in the samples (G93-13 and G93-21a) analyzed. The fine clay fractions (020), plagioclases and calcite are weak or very weak

whereas hematite and mica are absent. After firing to 900° C, most of the minerals are still present with slight changes in frequency. Hematite shows very weak occurrence whereas calcite is lost. However, the key clay minerals (e.g. montmorillonite, kaolinite, illite .....etc.) are absent. This points to firing temperature exceeding 300 (vanishing of montmorillonite), above 550° C (vanishing of kaolinite) , above 600° C (vanishing of poorly crystallized illite) and above 800° C (vanishing of well crystallized illite and clay-size muscovite) (cf. section 3.4.6.2).

8.5.2.1.2.2 Thermal Expansion analysis

The thermal curve (fig. 83) indicates that slight contraction starting at about 150 C due to the loss of absorbed water. This is followed by a continuous plateau starting to change in size at the quartz inversion at c.573 C. An extra reaction occurred after quartz reaction before the new formation peak. This peak is rather pronounced indicating an increase in size (the curve represents the linear volume increase of the sample cylinder) of nearly 4% to 6.5% with respect to the base line (Van Der Plas, pers. comm. 1994). This curve is the characteristic of clays with appreciable amount of kaolinite next even larger amount of illite next to montmorillonite/illite mixed structure (see Grim 1953: 190-249, 1968: 278-347 and Rice 1987: 90-91). Again, the firing temperature seems to be in the magnitude of 700-800° C because the most pronounced changes do occur at higher temperature exceeding 550° C, vanishing of poorly crystallized illite points to firing temperature above 600° C and vanishing of well-crystallized illite and clay-size muscovite points to firing temperature above 800° C. At these temperature degrees the crystalline structure of the above mentioned clays, if already present in the composition of Kabbashi Haitah pottery, underwent changes due to heating (cf. fig.84, section 3.4.6.2).

8.5.2.2 Neolithic Pottery
8.5.2.2.1 Geili
8.5.2.2.1.1 X-ray diffraction analysis

It can be seen from table 12 that quartz is the most prominent mineral in all the pottery and modern local clay samples analyzed (G93-13a, G 93-20a and G93-20C). Fine clay fractions (20), plagioclases, K-feldspar and occasionally anatase tend to show weak or very weak occurrence. Mica is present in very weak amount in the composition of one sample (G93-20b) whereas hematite is

absent in all the samples prior to firing. The absence of the key minerals including montmorillonite points to firing temperature exceeding 300° C, vanishing of kaolinite points to firing temperature above 500° C, vanishing of poorly crystallized illite points to firing temperature above 600° C and vanishing of well-crystallized illite and clay-size muscovite indicates firing temperatures above 800°C (cf. section 3.4.6.2).

8.5.2.2.1.2 Thermal Expansion analysis

The thermal curve (fig.85) indicates a reaction at 573 C caused by the inversion from alpha to beta quartz (see Tite 1972:299). This reaction is followed by a continuous plateau followed by a continuous dip smoothly going over in the sintering part of the reaction. Then the change from slight to very slight continuity in this reaction indicates a shift from a fired material into a still reactive material, i.e, the highest firing temperature. Again, the firing temperature seems to have been in the order of 800° C because pronounced changes of the clay minerals do occur at higher temperatures exceeding this range (Grim 1953: 190-249, 1968:278-347, Rice 1987:90-91, Van Der Plas, pers. comm. 1994 and section 3.4.6.2).

8.6 White Nile Province
8.6.1 Mesolithic Pottery
8.6.1.1 Shabona
8.6.1.1.1 X-ray diffraction analysis

X-ray diffraction analysis (table 13 and section 4.4) shows that quartz is the most abundant mineral, being present in high proportions in all the samples analyzed (G93-17b and G93-17c). Fine clay fractions (020), plagioclases, K-feldspar, mica and calcite tend to show weak or very weak appearance in most of the samples. After heating from room temperature to 900° C (1hr), all the samples are still comparable. The sole exception, being hematite which is not visible prior to firing. After firing to that temperature range (see supra, this section), the samples developed hematite.

The absence of the key clay minerals including montmorillonite indicates firing temperature exceeding 300° C, vanishing of kaolinite points to firing a temperature up to 550° C and, vanishing of poorly crystallized illite points to a firing temperature above 600° C and vanishing of well crystallized illite and clay-

size muscovite points to a firing temperature exceeding 800° C. The results show that the clay minerals of the analyzed samples have undergone structural change due to heating (cf. section 4.4).

8.6.1.1.2 Thermal Expansion analysis

The thermal curve (fig.86) shows that a slight contraction starting at c.155° C due to the loss of absorbed water. Then the thermal behaviour tends to display a continuous plateau smoothly going over in the sintering part of the reaction at c.576°C; inversion from alpha to beta quartz (see Shepard 1956:29). This is followed by a lightly higher plateau at which an alteration from a fired material into still a reactive material occurred, i.e., the highest firing temperature (c.780°C). This peak is followed by a downward dip to the limit of the experiment at 1129.77° C. On the basis of this result firing temperature in the order of 700-800° C could have been attained because the pronounced changes (formation of new crystalline phases) do occur at temperatures exceeding this limit (see section 8.8.1 for detailed discussion).

8.6.2 Neolithic Pottery
8.6.2.1 Rabak (Khartoum Neolithic levels)
8.6.2.1.1 X-ray diffraction analysis

The X-ray diffraction results (table 13 and section 4.4) show that the analyzed samples (G93-06c and G93-07c, G93-11c and G93-12c) are characterized by high quartz content. Fine clay fractions (020), plagioclases, K-feldspar, calcite and anatase tend to show weak or very weak presence in the samples analyzed. Hematite and mica are absent prior to firing. After firing to 900° C (1hr.), mica is still absent whereas the samples yielded hematite.

The absence of the main clay minerals namely montmorillonite points to firing temperature over 300° C, vanishing of kaolinite points to a firing temperature over 550° C, vanishing poorly-crystallized illite points to a firing temperature over 600° C and vanishing of well crystallized illite and clay-size muscovite points to firing temperature above 800° C. (cf. section 4.4).

8.6.2.1.2 Thermal Expansion analysis

The thermal curve of sample "Kh. Neo. 16" (fig.87) shows a slight contraction (the thick curved line) starting at about 100° C due to the loss of absorbed water. Then the thermal behaviour tends to exhibit an expansion-curve till a change in size occurs after quartz reaction at 576° C. This is followed by a downward dip to the limit of the experiment at 874°C. The curve shows a rapidly melting material. This is perhaps due to the post-burial change within the sherd with a possible introduction of newly-formed calcite or salt minerals (Van Der Plas, pers. comm. 1994). The firing temperature seems to be below 800° C due to the incipient formation of glassy material (early sintering) as a result of the softening of constituents of the body (see Shepard 1956:83). Since the composition of the clay may lower the vitrification stage and because fluxing impurities (e.g. calcite or salt minerals) are common in the low grade of clay that primitive potters often used (ibid.), the incipient stage of vitrification could only be attained in open firing. These conditions are coeval with the thermal behaviour of Shabona pottery shown above (see supra, this section).

8.6.2.2 Rabak (Jebel Moya levels)

8.6.2.2.1 X-ray diffraction analysis

X-ray diffraction photographs (cf. table 13 and section 4.4) show that the samples examined (G93-18a and G93-21c) are characterized by abundant quartz inclusions. Fine clay fractions (020), plagioclases, K-feldspar are weak or very weak in occurrence. Mica is devoid in all the samples. After firing to 900 C in an electric furnace for a period of one hour, most of the samples are still maintaining the same mineral composition. The sole exception, being hematite which was invisible prior to firing and it shows a development after firing to that temperature range (see supra, this section).

The main clay minerals such as montmorillonite, kaolinite and illite are devoid in all the samples. This points to a firing temperature over 300° C (vanishing of montmorillonite, over 550° C (vanishing of kaolinite), over 600° C (vanishing of poorly crystallized illite) and over 800° C (vanishing of well crystallized illite and clay-size muscovite).

8.6.2.2.2 Thermal Expansion analysis

The thermal curve (fig.88) indicates a slight contraction starting at 100° C due to the loss of absorbed water. Then the thermal behaviour tends to show continuous expansion characterized by a change of size after the inversion from alpha to beta quartz reaction at 572° C (see Tite 1972:299). This is followed by a plateau followed by a downward dip indicating a shrinkage due to new formation of crystalline phases. The peak of this new formation is found at a temperature around 1125°C. This may have been caused through interaction of new-formed calcite with glass or clay relics. It may also be due to the function of mullite and spinel (see Grim 1968:278-347 and Ven Der Plas, pers. comm. 1994). The firing temperature of this sample could be estimated in the magnitude of 700-800° C because of the pronounced changes of the clay minerals (see supra, this paragraph, fig.89 and section 8.8.3).

8.7 The Western Butana region
8.7.1 Mesolithic pottery
8.7.1.1 Shaqadud midden (lower levels)
8.7.1.1.1 X-ray diffraction analysis

The X-ray diffraction photographs (table 14 and section 5.4) show that quartz is the most frequent mineral inclusion in all the samples analyzed (G93-18b, G93-19b, G93-19c, G93-20c and G93-21d). Fine clay fractions (020), plagioclases, K-feldspar, mica and anatase tend to show weak or very weak presence whereas hematite and often mica are absent. After firing to temperatures in the range of 700-900° C in an electric kiln for a period of one hour, all the minerals still maintain their relative abundance. The only exception, being hematite which is invisible prior to firing and it shows a pronounced appearance after firing.

The key clay minerals (e.g. montmorillonite, kaolinite, illite, ...etc.) are devoid in all the samples analyzed. This points to a firing temperature over 300° C (vanishing of montmorillonite), over 550° C (vanishing of kaolinite) and over 600° C (vanishing of poorly crystallized illite and over 800° C (vanishing of well crystallized illite and clay-size muscovite) (cf. section 5.4).

8.7.1.1.2 Thermal Expansion analysis

The thermal curve (fig.90) indicates a slight contraction at about 100° C due to the loss of absorbed water followed by a slight downward dip showing a shrinkage through the loss of dydroxl water. Then the curve is elevated up to 1.30% due to mechanical cause for example a void or vug in the sample trapped gas that caused bloating. This is behaviour occurs by the expansion of gases produced by decomposition of organic material, sulphides or calcites and trapped in the liquid phase formed during vitrification (Tite 1972:134-135). Because of these, gas-producing compounds were not removed during the original firing, they masked the shrinkage during the thermal expansion measurements. (see Rye 1981: 108-109 and Van Der Plas, pers. comm. 1994). However, this is followed by a downward dip followed by a peak of new formation at a temperature exceeding 1100° C. It may have been caused through the interaction of new-formed calcite with glass or clay relics. It may also be attributed to the formation of mullite or spinel (cf. Grim 1953: 190-245, 1968:278-347, fig.9-20). Again, the firing temperature could have been in the order of 700-800 c (cf. section 8.8.1) because pronounced changes concomitant with the formation of these minerals mentioned above (see supra, this section) started at temperatures below or around 800° C.

8.7.2 Neolithic pottery

8.7.2.1 Shaqadud midden (Upper levels)

8.7.2.1.1 X-ray diffraction analysis

X-ray diffraction photographs show that the main composition of the samples analyzed (G93-06b, G93-07b, G93-11b and G93-12b) as well as modern pottery samples (G93-10b and G93-14a) from this site is quartz-rich sand. Fine clay fractions (020), plagioclases, K-feldspar, occasionally mica, anatase and calcite show weak or very weak presence. Hematite is invisible in all the samples prior to firing. After firing to temperatures in the magnitude of 700-800° C in an electric oven for a period of one hour, hematite is conspicuous in all the samples. However, calcite is absent after refiring to that temperature range as it decomposes due to heating. Heating in the range of 750-850° C causes calcite decomposition (see Rye 1981:114 and Rice 1987:98).

The key clay minerals (e.g. montmorillonite, kaolinite, illite, ...etc.). are devoid in all these samples. This points to a firing temperature above 300° C (vanishing of montmorillonite), above 550° C (vanishing of kaolinite), over 600 C (vanishing of poorly crystallized illite) and over 800° C (vanishing of well crystallized illite and clay-size muscovite) (cf. section 5.4). The occurrence of calcite indicates (see supra, this section) that the firing temperature of these sherds is less than 800° C or a little above that degree, since calcite decomposes in the range of 750-850° C (cf. Rice 1987:98).

8.7.2.1.2 Thermal Expansion analysis

The thermal curve (fig.91) shows an inversion from alpha to beta quartz occurred at c.569° C after the plateau indicating that the material changes due to new formation of crystalline phases. This peak of new formation is found at a temperature below 1000° C. This is followed by a continuous downwards dip smoothly going over in the sintering part of the reaction to the limit of the experiment at 1082° C. The firing temperature seems to be in the order of 700-800° C because a pronounced change occurred within this range, i.e. a change from a fired material into a still reactive one (cf. Grim 1968:306-308 and Tite 1972:298-300).

8.7.2.2 Shaqadud Cave

8.7.2.2.1 X-ray diffraction analysis

X-ray diffraction photographs (table 14) show that the analyzed Neolithic pottery (G93-18c) and modern samples (G93-10a and G93-14a) are characterized by a high quartz content. Fine clay fractions (020), plagioclases, K-feldspar and occasionally mica show weak or very weak presence. Calcite presents moderate amount in the Neolithic pottery and very weak occurrence in the samples of modern pottery derived from the vicinity of the site. Hematite is absent in the samples prior to firing. After firing in an electric oven to temperatures in the magnitude of 700 - 800° C for nearly one hour, all the samples promoted hematite inclusions. It is noteworthy that nearly all the samples, with exception of anatase and hematite, still mainting their relative abundance after firing (see supra and section 5.4.).

The main clay minerals (e.g. montmorillonite, kaolinite, illite,....etc.) are absent in all the samples. This points to a firing temperature over 300° C

(vanishing of montmorillonite), over 550° C (vanishing of poorly crystallized illite) and over 800° C (vanishing of well crystallized illite and clay-size muscovite (ibid.).

The presence of moderate amount of calcite (se supra and section 5.4) gives further confirmation to the above results that the firing temperatures of these samples may be estimated as having been about 700 to 800° C or a little above, since this mineral decomposes at 750 - 850° C (cf. Rye 1981:31 and Rice 1987:98).

8.7.2.2.2 Thermal Expansion analysis

The thermal curve (fig.92) shows a slight contraction at 100°C due to the loss of absorbed water. This is followed by a continuos plateau till a change in size (shrinkage) occurs after quartz reaction (an inversion from alpha to beta quartz) at 573° C. An extra reaction after quartz reaction occurs at 930° C. This is followed by a continuous upward curve before the new formation peak. This last peak is rather pronounced showing an increase in size (the curve represents the linear volume increase of the sample cylinder) of 5.8% with respect to the base line. Then the peak is followed by a downward dip to the limit of the experiment at 1242.93 C (see below).

According to the literature (see e.g. Grim 1953:190 - 249, 1968: 278-34, fig. 9-20; Tite 1969:131-143, fig.2; Rice 1987: 90-91 and Van Der Plas, pers. comm. 1994) such curve is a characteristic of clays with appreciable amount of kaolinite next to an even considerable amount of illite next to montmorillonite/illite mixed structure. Therefore, the firing temperature which could be deduced from this thermal curve seems to have been in the order of c.700-800°C because pronounced structural changes do occur at higher temperature exceeding this range (see Grim 1968: 278-347, fig.9-20, Rice 1987:98 and section 8.8.1).

8.8.1 Firing Temperature

The X-ray diffraction analyses of the Mesolithic and Neolithic sampled ceramics from the central Sudan show that the main clay minerals such montmorillonite kaolinite and illite, were no longer present in the samples. Therefore, the basic pottery type of clay used by the makers of the sampled

vessels could not be determined. However, the absence of these clay minerals indicates a minimum firing temperature ≥ 800° c (see supra, this chapter).

In all the Mesolithic and Neolithic samples analyzed hematite was not perceptible prior to firing. After firing the samples in a temperatures ranging from 700° to 900° C, the X-ray diffraction photographs showed the development of hematite. According to the literature (Rice 1987: 335), the presence of iron oxide (hematite) is indicative that the firing temperature is c.900 - 950° C. because the full colour development of iron oxide occurs at this temperature range (ibid. and Shepard 1956: 150). Therefore, on the basis of X-ray diffraction results the firing temperature(s) of the Mesolithic and Neolithic ceramics in the central Sudan did not reach 900° C. But since the accuracy of this method has uncertainty anywhere between ± 30 and ± 100 (see Rice 1987: 434), the original firing temperature of the analyzed samples may be estimated as having been about 700-800° C as has been confirmed by thermal measurements (see below).

The thermal expansion measurements show that the firing temperature(s) of the Mesolithic and Neolithic sampled pottery can be estimated as having been about 700°-800° C. The thermal curves provided evidence showing that thermal expansions occurred as a result of new formation of crystalline phases. In all these cases, the firing temperature of the analyzed Mesolithic and Neolithic ceramics in the central Sudan seems to have been below 800° C due to the formation of mullite, spinal or glasses as a result of incipient sintering in firing temperatures ranging from 700-800° C. It may also be due to the presence of calcite inclusions in the original clays (cf. tables 11-14). Calcite decomposes on firing in temperatures range of 650-750° C (see Rice 1987: 98).

It is noteworthy that the uneven firing temperatures attained by the Mesolithic and Neolithic potters often caused noticeable thermal effects on the microstructure of ceramic composition (see sections 3.3.6.1.4, 3.3.6.2.2 and below).

In all the Mesolithic and Neolithic sampled specimens, inversion of quartz accompanied by a shrinkage occurs rapidly at 573° ± 5 c resulting in expansion of quartz grains, the expansion in volume, being 2% and the linear expansion 1.03%. This expansion of the quartz grains in the clay body may not have pronounced effect on the fired ceramics, however, because it occurs

simultaneously with the removal of large amount of water from the clay body (between 500 - 600° C) when the clay body is shrinking (cf. Rice 1987:95).

In the present work the present writer has noted shattering quartz grains on a number of thin sections derived from the late Mesolithic site of Kabbashi (Pl.10) and the Neolithic site of Geili (Pl.16), both of which are located on the eastern bank of the Main Nile in Khartoum Province (cf. sections 3.3.6.1.4 and 3.3.6.2.2). This feature of cracking has been seen in two thin section slides each from Kabbashi (specimens KAB3 and KAB10) and Geili (specimens GE1,20 and GE1,21) sites (ibid.).

Quartz shattering is not a common phenomenon in primitive open firing without kiln construction. It is worth mentioning that in studies of thin sections from American South West, Shepard (1956:29) did not observe cracking of quartz grains that could be attributed to inversion of quartz, perhaps, in part because of the very rapid heating used by the potters.

In the present work, quartz shattering is not a common phenomenon and has been observed in the microstructure of a few thin section slides (see supra, this section). Therefore, the present writer is opinion that such phenomenon is more likely due to exceptionally high firing temperatures.

The X-ray diffraction and thermal expansion analyses show that the firing temperatures of the Mesolithic and Neolithic sampled ceramics in the present work (see supra) are generally comparable with those of other ceramic groups from the central Sudan (see below).

In Khartoum Province, X-ray diffraction analyses show that the firing temperatures of the Neolithic ceramics from Kadero1, Zakiab and Um Direiwa1 may be estimated as having been in the magnitude of c.700 - 800° C (cf. Haaland 1987:242 and fig.1).

In northern Sudan the pottery of Khartoum variant examined by X-ray diffraction indicating firing temperature in the order of c.700 - 800° C for fabrics 1A (sand tempered ferruginous fabric) and 1B (micaceous Khartoum variant type) (Nordstrom 1972:48).

In the same area of northern Sudan (second cataract) (fig.1) X-ray diffraction results show that the firing temperature of fabric 1C (Abkan medium grade fabric with sandy paste) of Abkan ceramics may be estimated as having been of the order of 600 - 700°C (ibid.:49).

It is noteworthy that the ceramics of A-group Neolithic sites in Sudanese Nubia (Upper Nubia) (fig.1 and section 10.1.2.4) show relatively lower firing temperatures than that obtained from the Mesolithic and Neolithic sites in the central and northern Sudan (see supra, this section). For instance, the firing temperature of Fabrics 11A, 111A (shell tempered ferruginous fabric), 1D (coarse sandy ferruginous fabric with organic temper) can be estimated as having been about 600 to 650° C (Nordstrom 1972:50-53). This could be due partly to the exceptionally high content of calcitic inclusions which started its decomposition at relatively lower temperature and/or equally possible as a result of insufficient fueling and rather uncontrolled atmospheric conditions ;during firing process (ibid.).

Inversely, the firing index of the A-Group Neolithic ceramics in Upper Nubia is comparable to that of a series of Neolithic ceramics identified by X-ray diffraction analysis from Khartoum (K-2, K-11, K-23) in the central Sudan, Second Cataract (626-1, 626-10, 1045, D1W-5, D1W-50), Dongola reach (N13-4-17, N13-4-22, N40-2) Kashm el Girba (N110, N114-b, N128) in northern Sudan as well as Wanyanga (WAN-K) and Amekni (AM-1-F, AM-1-S) in central Sahara (cf. table 35).

Identification of 17 Neolithic pottery samples from these regions (see the above paragraph) show that montmorillonite and montmorillonite-chlorite mixed structure are present in most samples. The sole exception being Khartoum province where montmorillonite is absent in the tested samples. Chlorite in the form of mixed structure is present in all the samples except those from Dongola reach and Amekni, whereas its occurrence in the samples of the Second Cataract and Khashm el Girba is unclear (cf. Hays and Hassan 1974:77-78 and table 35).

From the results mentioned above, it is apparent that the presence of montmorillonite in almost all the samples is indicative that the firing temperatures, with the exception of those from Khartoum (samples K-2, K-11, K-23) are below 300°C (see supra, this section), since at this temperature the structure of montmorillonite undergoes change (Grim 1968:328). Chlorite is not

affected by heating below 800° C (heating period 1hr). Illite maintains its structure up to 700° C (table 35). Therefore, the presence of these minerals further confirm the very low firing index (≤300°C) of the ceramic groups derived from Dongola Reach Khashm el Girba and central Sahara. The sole exception, being the two samples from Khartoum district (see supra, this section) which suggest a firing temperature ranging from > 300 to 700° C on the basis of the absence of montmorillonite and the presence of illite (see table 35 and supra, this section).

Again, inadequate fueling and/or rather uncontrolled firing conditions may have been the cause for these relatively lower firing temperatures than those obtained for the Mesolithic and Neolithic pottery samples tested in the present work (see supra, this section).

8.8.2 Firing Atmosphere

The complete absence of forced draft kilns at the Mesolithic and Neolithic sites in Sudan (see e.g. Arkell 1949:81-92, 1953:68-77; Nordstrom 1972: 32-68; Hays and Hassan 1974:71-79, Mohamed-Ali 1982:43-86; 1991:65-93; Chlodnicki 1984:336-342; Fattovich et al 1984:173-188; Marks et al 1985:261-270, Robertson and Marks 1985:515-534; Haaland 1987:16-62, 144-180, 1989:359-367; Caneva 1983:7-278, 1988:65-114, 1991:262-268; Clark 1989:368-410; Krzyzaniak 1991:515-532; Robertson 1991:123-172; Haaland and Magid 1991:36-43, 1991:17-27 and Caneva et al 1993:1-76) raises the possibility that the pottery of this period was either fired directly on the ground or in simple pits. However, in open firing without kiln construction the atmosphere will be continuously changing during different stages of combustion. Even if simple pits are used which permit more control of atmosphere than is possible with open firing, fluctuations in atmospheric conditions occur. The unevenly oxidized surfaces of the sampled Mesolithic and Neolithic ceramics in the central Sudan which are considerable in number, reflect fluctuations in firing atmosphere. The pottery of these sites is partially oxidized. This can be deduced from the grey, black and dark brown cores of the pottery fabrics and the thin oxidation zones at the wall surfaces. (see section 8.8.3 and below).

The dark surface colours ranging from greyish-brown to dark grey and dark brown shades which characterize most fractures of the analyzed Mesolithic

and Neolithic ceramics from the central Sudan (cf. sections 3.7.2.3.1, 4.7.2.3.1 and 5.8.2.3.1) were, most likely, formed principally by the deposition of soot particles originating from fuel with which pottery was fired, and from organic inclusions that carbonized near or beneath the vessels immediately after firing rather than by carboneous matter inherent in the paste which was decomposed during firing.

The petrological analyses carried out by the present writer on selected Mesolithic and Neolithic ceramics in Khartoum (cf. section 3.3.), White Nile (cf. section 4.3) and Western Butana (cf. section 5.3) regions show that organic material is not present in the thin section slides. If it had been inherent in the original clays in significant quantities, dark cores should be in the center of the walls and cross sections underlying the surfaces are lighter coloured (see Rice 1987:334). But this was not what the fractures of the sampled Mesolithic and Neolithic ceramics indicate. Inversely, almost all the dark organic materials visible in cross-sections are present at or just below the surface than in the center (see below).

In Khartoum Province most pottery examples from the Mesolithic sites namely Sarurab2 (Pl.59), Kabbashi Haitah(Pl.62), Kabbashi (Pl.63) and Neolithic sites of Islang2 (Pl.60), Nofalab2 (Pl.61) and Geili (Pl.64) illustrate this tendency (cf. section 3.7.2.3.1).

In the White Nile region most of pottery sherds from the Mesolithic site of Shabona (Pl.95) and the Neolithic site of Rabak - Kh.Neo.L. (pl.96) and Rabak-J.M.L. (Pl.97) illustrate this feature of carbon deposition (cf. section 4.7.2.3.1).

In the Western Butana region the Mesolithic levels of Shaqadud midden (Pl.122), the Neolithic levels of the same locality (Pl.123) as well as Shaqadud Cave (Pl.124), most of the pottery sherds exhibit this tendency of deposition or carbonization of organic inclusions near or beneath the surface (cf. section 5.8.2.3.1).

The duration of firing which is rather short (cf. section 8.8.3) and the changing atmospheric conditions did not permit excess of oxygen over that required to burn the fuel and to bring these samples of Mesolithic and Neolithic ceramics in the central Sudan to the highest state of oxidation (see supra, this section).

From what has been mentioned above, it could be said that the atmospheric conditions are neither oxidizing nor reducing. The unevenly oxidized surfaces of the pottery examined are considerable in number and pointing to fluctuation in firing atmosphere.

8.8.3 Firing Time

X-ray diffraction and thermal analyses of the Mesolithic and Neolithic sampled pottery (cf. sections 8.4-8.7) suggest that firing time may have been rather short. This could be judged from the variety of colours displayed by the pottery fabrics of the sampled Mesolithic and Neolithic ceramics in the central Sudan (cf. sections 3.7.2.3.1, 4.7.2.3.1 and 5.8.2.3.1) and the development of hematite after refiring the tested sherds to 700 - 900° C in an electric oven for one hour (cf. tables 11-14).

The length of firing depends on the type of fuel used. Though ancient potters have no way of comparing heat value of different fuels, they can realize whether or not a particular fuel has a clean or sooty flame, burns quietly or snaps, falls to pieces or holds its form and keeps heat after the flame has burnt out (cf. section 8.2.4). It is reasonable to suggest that the short firing time of the samples resulted from the use of fast burning fuel such as chaff or grass. On the other hand, the relatively high temperature (c.700-800° C) attained makes it highly unlikely that it was obtained during a short period of time without frequent replenishment of fuel; most probably Accacia spp which is most prevalent type of wood distributed since Mesolithic times in the landscapes of the areas investigated (see Obeid and Mohamed 1971:177-198; Mubark et al 1982:143-163; Clark 1989:387-410 and Magid 1991:23-31 and the present author pers. obser.). In addition to that, such relatively high firing index could be achieved when burning in a pit that could allow more control of heat (see sections 8.3 and 8.8).

8.8.4 Conclusions

The preceding results indicate that the crystalline structures of the clay minerals of Mesolithic and Neolithic sampled pottery in the central Sudan have undergone marked changes due to heating. Heating and its effects on the

crystalline structure is one of the major problems in the identification of pottery mineralogy (see supra).

The X-ray diffraction and thermal analyses provided evidence indicating that the pottery of all the sampled Mesolithic and Neolithic sites in the central Sudan might have been fired at temperatures about 700-800° C. This conclusion was inferred from the absence of the main hydrated minerals (montmorillonite, kaolinite, illite,....etc) as shown by XRD analyses or the spectacular changes concomitant with the thermal expansion of several minerals (calcite, mullite, spinal, ...etc) due to new formation of crystalline phases.

The firing temperature(s) of the analyzed Mesolithic and Neolithic ceramics in the present work is generally comparable with specimens from several Neolithic sites in Khartoum Province (Kadero1, Zakiab and Um Direiwa1), Second Cataract (Abkan and Khartoum variant) district. The variation between these ceramics and their counterparts from other localities in the central (Khartoum), northern (Khashm el Girba, Dongola reach and the Second Cataract) Sudan and central Sahara (Wanyanga and Amekni) (see supra) could be due either to the differences in matrix composition or as a consequence of inadequate fueling and rather uncontrolled firing conditions.

The length of firing seems to be rather short. If that is the case, then the temperature could not have been held up to 800° C without frequent replenishment of fuel or partial control of firing temperature and atmosphere.

The atmospheric conditions are neither oxidizing nor reducing. The unevenly oxidized surfaces of the pottery examined are appreciable in number and pointing to fluctuation in firing atmosphere.

The complete absence of forced draft kilns at the Mesolithic and Neolithic sites in the Sudan and Neolithic sites in the Sudan (cf. section 8.8.2) raises the probability that the pottery of these periods was either fired directly on the ground or in simple pits.

The firing index of the sampled Mesolithic and Neolithic ceramics in the central Sudan is of a relatively high-grade (c.700-800° C) despite the fact that the length of firing is inadequate to bring the clay impurities (particularly iron

oxide) to the highest state of oxidation (cf. section 8.8.3). This relatively high firing index is a characteristic of well-fired ceramics.

The homogeneity of the firing index of the Mesolithic and Neolithic ceramics in the central Sudan tested in the present work seems to suggest the use of similar firing techniques.

Chapter 9

9. - Nature of Production and Mechanism(s) of Pottery Distribution

The role of exchange (trade) and the extent of cultural interrelations between contemporary cultures have been the subject of much debate (e.g. Peacock 1969:145-9; Renfrew 1969:151-63; Earle and Ericson 1977; Hodder 1978; 199-269 and Plog 1980). In this chapter the distributive mechanism(s) and mode(s) of pottery production for the various groups inhabiting the central Sudan (fig.1) during the Mesolithic and Neolithic periods will be discussed, a hypothetical model of the cultural processes underlying the distribution of pottery will be provided and tested by a series of physico-scientific analyses.

9.1 - Exchange Mechanisms and Trade

The exchange of goods and services is a basic and universal aspect of human behaviour which embraces all patterns of social and cultural integration (Rowlands 1973: 589). Three different types of exchange may exist in any traditional society and can be summarized as follows:-

9.1.1. - Reciprocal exchange

Types of reciprocal exchange may vary in accordance with the social distance between the partners involved (Sahlins 1965). In internal spheres of exchange, generalized reciprocity is the most prevalent. This includes sharing, hospitality, generosity and kinship dues. The second kind of exchange is balanced reciprocity, which takes place within the tribal sector. It involves simultaneous exchange of the same types of goods in the same amounts' (Sahlins 1972:194). Certain marital transaction, friendship compacts and much gift exchange and 'trade' are included here. Negative reciprocity is the third type of exchange it occurs outside the domain of social distance or in the inter-tribal sector involves such processes as barter, haggling and theft. This sort of exchange is impersonal and is the most 'economic' (Hodder 1978: 202-203). An example for reciprocal exchange can be taken from Begho area in Ghana where potters exchange their wares for

agricultural products which are seldom produced in their lands (Crossland and Posnansky 1978: 77-87).

9.1.2.- Redistributive exchange

This is a kind of reciprocal exchange in which transactions and gifts are centralized under the organization of some local or regional authority. Redistribution may take place over and above local reciprocal exchange and expands local networks into larger sets (Hodder 1978: 206). The Nyoro tribe in Western Uganda can be cited as an example for this type of exchange. The king of this state was the centre of a large exchange system partly organized through regional chiefs, who were, in turn, the centres of similar but smaller-scale systems of exchange (ibid: 207).

9.1.3. - Traditional market exchange

The term "market" has been defined by Hodder (Ibid), who equates it with the "market place" in which exchange is devoid of institutional kinship obligations and here it is different from redistributive and reciprocal exchange, although these three types of exchange may coexist (ibid: 208). The system of exchange between the Baggara and Fur of western Sudan is an example of this type of exchange mechanism (Haaland 1969).

9.2. - Definition of Trade

Weber defines "trade" (for gain) as a means by which goods move across cultural and ethnic boundaries (Weber 1950). However, trade may be defined in its widest sense "a reciprocal traffic exchange, or movement of materials and goods through a peaceful human agency" (Renfrew 1969:152).

9.2.1. - Types of Trade

Trade is of two kinds: of material commodities whose natural occurrence is restricted (e.g. salt, tin, opium .. etc) and of products which, through superior know-how or other economic factors, are best produced in a certain area (e.g.

Hittite iron, Swiss cuckoo-clocks). In prehistory the first type was more frequent and there is only sporadic evidence for a trade in commodities where the manufacturing skill was the main factor. The export of the Egyptian stone bowls to Early Minoan Crete is a good example of the second kind of trade (Renfrew 1969: 154).

9.2.2. - Long distance trade

Three different processes can be distinguished in long distance trade (Lamberg-Karlovsky 1974: 302-313):-

9.2.2.1. - Exchange (indirect contact trade)

In indirect contact trade, materials are passed by individuals from one place to another without administrative control. The goods are single and varied objects but virtually non-luxurious such as beads, animal-headed-pins .....etc. The presence of Red Sea shells at the eighth millennium site of Saggai I some 40 km. north of Khartoum and the exotic Egyptian flint in Nubia in the late seventh millennium, suggest an exchange network (indirect contact trade) in central and northern Sudan during Mesolithic times (Krzyzaniak 1990 : 6-7). Another example of exchange is the objects, often believed to be of Western Asian Indus origin, encountered outside those areas including metal utensils, ceramics, Figurines, beads, ... etc. These goods were found in a thin scatter in sites between the Indus and Mesopotamia (Lamberg-Karlovsky 1974: 306-7).

9.2.2.2. - Direct contact trade

Face to face contact may be established between two places for the purpose of trade. Goods are traded between sites A and B without direct assistance by or relations with intermediate sites. This kind of trade usually centrally organized and administered by one of the principals involved (ibid). The Nilotic trade between Egypt and Lower Nubia (including part of present day Sudan) from pharaonic times to the 19th century is a classic pattern of this type of trade, where various kinds of goods were exchanged for various raw materials. The commodities that moved northward included gold, ivory, ebony and leopard skins. While goods that

moved southward varied according to the tastes of particular ages; they included faience, bronze ware, glass and luxury food stuff....etc. (Adams 1988:21-36).

9.2.2.3. - Central place trade

In this type goods and services are produced and offered at a few central points and are consumed at many scattered points. The role of these central places is the dissemination of goods (transshipment), or the production of goods from a given source which they control. This kind of long distance trade is organized under administrative control. The early village occupations (C. 4500 B.C.) of Tepe Yahia in Iran and Bahrain are examples for central places engaged in the long distance trade between the Indus valley and the Arabian Gulf territories during mid-5th and early 3rd millennia B.C. (Lamberg- Karlovsky 1974: 313).

It is worth mentioning that these three types of trade are not mutually exclusive and may co-exist. The task of an archaeologist is to ascertain which process is involved in any trade mechanism at a given point in time and space (ibid).

9.3. Pottery and trade: Archaeological and Ethnographical evidence

9.3.1. Archaeological evidence

Evidence for trade between different culture areas has been of considerable importance for corroborating arguments pertaining to cultural growth and for establishing relative chronologies. In this sense, such goals do not require understanding how or why trade took place, but only the proof that it did occur. Thus, arguments for trade have been mainly geared towards (a) similarities and dissimilarities of artifact in terms of style, technology and function;....etc (b) whether morphologically similar objects must be of the same age, thus making trade a theoretical possibility, and (c) what sources of raw material could or could not have been exploited (Rowlands 1973: 589-600).

The topic of material exchange between prehistoric groups has received considerable attention in many areas (e.g. Berghe 1965: 248 - 53; Lamberg - Karlovsky 1975: 302-313; Earle and Ericson 1977; Plog 1980 and Deutchman

1980: 119-133). In prehistory we believe that trade exists when artifacts characteristic of one cultural assemblage are encountered in association with artifacts characteristic of another, more or less contemporary, cultural assemblage. The evidence of trade as an indicator of the movement of certain objects, as corollary to other possible mechanisms, depends on the frequency and quality of the objects, and the consistency of their distribution to 'trade routes' can be pinpointed (Rowlands 1973:590). Archaeological evidence that ceramics were exchanged in large quantities in some areas has come from petrographic studies such as the work of Shepard on Rio Grande glaze-painted pottery (c.1500-1550 A.D.) in the southwestern United States (Shepard 1965 : 62 - 87) and Peacock's investigations of early Neolithic pottery (Gabbroic ware) in southwestern England at about 3300-3000 B.C. (Peacock 1969 :145 - 9).

Several factors could lead to the exchange of pottery, despite the widespread abundance of raw materials suitable for potmaking. First, while the raw materials for pottery production may be available in several regions, not all such materials are of equal quality. Second, in some examples in which exchange has been demonstrated, it has been argued that the ceramic vessels were merely the utensils used to transport other resources that were differentially distributed so that some groups did not have access to them, (Plog 1980:20) or resources such as food which were in short supply. It is possible that ceramic containers were traded in this manner, as the ethnographic record indicates (ibid.). Two other hypotheses can be offered. First, even if economic factors are the prime reasons for exchange of goods, products that have no economic values may have an important functional role in the exchange system (ibid). In a system where exchange is direct between individuals, the system would not be applicable if only subsistence items were traded because of imbalances in production. This may be true mainly in linear systems where production groups can be separated by several intervening groups, formal trading contacts such as trade partners would not be satisfactory to develop the necessary exchange (ibid). As a result, insufficiencies would appear because the production of the commodities supplied by one village would not be necessiated by the demand for that community only but by the demand for the community for which it was exchanged (ibid). A good example of this is the tribes of Wagani and Wantendehue of southern Tanzania, where pottery is manufactured to satisfy local demands, the only exception being the large beer-drinking vessels which are known

to be particularly well-made in one village; these are traded distances up to 30 miles, to other villages in the peripheral regions (Dorman 1938:98).

Second, because the ceramics vessels in most regions would be classified as utilitarian goods, they may not have been essential in areas where suitable raw materials for potmaking were widely available. Hence, we can postulate that prehistoric pottery could have been exchanged for the purpose of aiding the distribution of essential utilitarian goods (Plog 1980:21).

The possible factors in ceramic trade outlined above result exclusively from the necessity of exchange caused by the regionalization in raw materials suitable for potmaking. But, trade may be the result of artificial differences in the production of craft goods that cannot be explained only in terms of differential distribution of natural resources but also by socio-cultural factors(ibid).

9.3.2. - Ethnographical evidence.

It is generally believed that pottery would not be traded extensively among people who possess a simple system of transport because it is a fragile and bulky item, and hence it is unequalled to stones and metals that serve for ornaments. Contrary to this notion, as ethnographic record has shown, pottery is often produced for trade than for self-consumption (Shepard 1956: 352). Of several examples illustrating the trading of pottery in traditional societies, the following have been cited:-

In New Guinea pottery is carried out by boat from villages in Port Moresby region and is traded to a distance of about 150 miles. The people who buy this ware in large quantities in turn distribute it further inland along the Gulf of Papua (Foster 1965:56).

In northern Malawi today, distinctive type of pottery named 'Rungwe' is seen in many homesteads and may be bought in local markets. These pots are characterized by their pale surface colour, in which they are differentiated from the local wares; they can be very large and highly durable and relatively expensive.

They are traded to areas across lake Malawi 45 km. or more from its production place on the Tanzanian shore (Hirlschmann 1987: 45-51).

It is noteworthy that the ethnographic record has shown some cases in which the quality of ceramic raw materials appears to have been one reason leading to specialization in ceramic production and promoting trade (Arnold 1980:31-44). An ethnographic example cited by Arnold (ibid: 198) shows that in the northern part of the valley of Guatemala, weathering process has created a poor land for agriculture but has exposed (clays, tempers and paints which are vital resources for pottery production. These excellent clays stimulate the craft towards full specialization and in turn amplify the trade network.

As noted above, trade may be necessitated by socio-cultural processes rather than by the nature of the physical environment. For example, among Yanamamo tribes of the American Southwest where trade is an essential element in alliance formation; one tribe even of abandoned the manufacture of pottery so as to rely on their allied tribe for it (Plog 1980 :21- 22).

The above cited examples seem to reinforce the notion that ceramic exchange may have been frequent in prehistory and, as Plog remarks "if it was, spatial variability in the distribution of ceramic designs may be explained by the spatial distribution of trade networks" (Plog 1980:22).

9.4. - Modes of pottery production

Two schemes (Van Der Leeuw 1976: 389-413 and Peacock 1982: 8-10) suggest that four modes of production that may have been operational in prehistoric contexts:-

9.4.1 - Household production

This is also known as the domestic mode of production. Since this mode of production is of secondary economic value, it will in most cases be organized under the direction of women (Balfet 1965: 162 and Peacock 1982:8). It has been argued that this type of production is primarily for domestic use with little opportunity for intensification (Rice 1987: 187)., and that hand-made prehistoric pottery was produced in this manner and, hence, the distribution of ceramic styles directly reflects cultural or ethnic groupings (Peacock 1982:8). However, the petrological work carried out by Peacock on the Neolithic pottery in Cornwall (1969 : 145-49) and Glastonbury ware from southwestern England (1968: 44-61) has shown this assumption to be invalid.

This kind of production is characterized by its simplicity, the occasional or sporadic nature of manufacture and the lack of elaborate technology, in which neither the wheel nor the kiln is used and perhaps not even the turntable will be in use. An obvious distinction between sedentary and nomadic households appears when the later procure clay from several areas of geological diversity and physico-scientific analyses will postulate multiple centre of production for identical types of ceramics (Van Der Leeuw 1976:402-3, Peacock 1982:8 and Rice 1987 : 184).

9.4.2. Household Industry

Production is somewhat continuous, but simple technology persists with slight investment in capital equipment. Because of its sporadic nature, pottery production is in the hands of a few skilled artisans who are working for the sake of profit to supplement their income (Peacock 1982: 8). This mode of production represents the onset of trade but it is still a part-time activity and people do not entirely depend upon it for their livelihood. Because of its secondary importance, it is expected that the craft is mainly in the hands of women. The degree of technological standard of this industry permits the use of a turntable but not a wheel and some form of oven or rudimentary kiln may be available (ibid). Much of the present production through this activity is oriented toward the tourist market, as in Guatemala and Peru (Rice 1987: 184). This type of production may be

sedentary or nomadic and clearly, if the latter turns out to have been the case, one would expect a complicated marketing system (Van Der Leeuw 1976:402 and Peacock 1982:8).

9.4.3. Individual workshops

In this mode of production pottery making is the main source of livelihood. It may be practised seasonally along with other activities such as farming but it remains the main source of income. Pottery production is essentially in the hands of men who have invested a considerable capital equipment. Workshops are normally isolated and therefore it lacks the great competition and the distribution may be by a rather "rudimentary" marketing system (Peacock 1982, 9, 32). This kind of production usually favours sedentary mode of life and the potters are full-time specialists (Van Der Leeuw 1976: 402). In some instances, transient production may occur if, for example, large vessels are being made or if markets are widely dispersed (Peacock 1982 : 9).

9.4.4. Nucleated workshops

This represents "clustered industrial complex." Nucleation may be necessitated by raw materials, labour, markets or any combination of the three. In this mode of production pottery making is the main activity and other sources of income may be of secondary importance. This type of activity is usually practised all the year round but seasonal production is governed by climatic conditions. Products are of high quality and standardized range. The scale of production favours the presence of middlemen traders with their wide distribution network and distinct specialized economic marketing (Peacock 1982:9, 38).

In workshops (individual or nucleated) division of labour is often quite conspicuous. This includes several individual participants at different stages of production. Moreover, workshop structure is typically divided into specialized activity areas for mixing clays, storing and drying clays, forming and drying pots for kilns (Van Der Leeuw 1976: 403 and Rice 1987 : 184).

9.5. Nature of pottery production in the Central Sudan: Mesolithic and Neolithic periods.

In the present study of the Mesolithic and Neolithic ceramics in the central Sudan, it seems that the entire ceramic output of these periods fit well with the first mode of production (Household production). Unlike reciprocal redistributive, (see supra), market exchange did not exist within such type of production. This is due to the fact that the Mesolithic and Neolithic groups in Sudan did not attain the stage of centralized hierarchical society (e.g. Arkell 1949: 1953:82-9; Caneva 1983:7-29, 1988:163-87; Haaland 1987 :205-7, 1991:127 -43; Mohamed-Ali 1982; Krzyzaniak 1984 : 309-15, 1991:1-17). A point worthmentioning here is that the earliest evidence for the emergence of this centralized society with political authority (chieftainate) in Sudan comes from pharaonic inscription dated to the sixth Egyptian dynasty (c.2420-2250 B.C.). An Egyptian named Harkhuf stated that he made four journeys to the country south of the first cataract in an attempt to discover a road that led to 'Yam'. The name of 'yam' comes from another Egyptian inscription of Uni (an Egyptian officer) during the reign of King Merenere of the fifth Egyptian dynasty (c. 2563 - 2423 B.C.) He was ordered by the pharaoh to dig canals in the first cataract and to build boats. Uni stated that the king of 'Yam' provided him with wood (Reisner 1923; and Trigger 1965 : 82). The exact location of 'Yam' in the northern region of the present day Republic of the Sudan has not as yet been determined with certainty. Nevertheless, some workers believe that it was located at Kerma on the eastern bank of the Main Nile near the third cataract (cf.fig.1)(Reisner 1923; and Trigger 1965:82). This early state in Sudan flourished during a period extending from approximately the mid third to the mid-second millennium B.C. (c. 2400 - 1500 B.C.) (Bonnet 1989:35-36)

9.5.1 - Mesolithic/Neolithic Economies in Central Sudan

9.5.1.1 - Mesolithic Communities

Our information about the economic processes in the central Sudan during the Mesolithic period is meagre. Little data has as yet been forthcoming for Mesolithic economic adoption - in addition to Arkell's observations (1949 : 107 - 12) - in comparison with much more data that has been written about the introduction and development of the Neolithic economy and its impacts on the

settlement patterns in the central Nile valley (e.g. Krzyzaniak 1978, 1989 : 1 -17; Haaland 1984 : 39 - 50, 1987 , 199; Caneva 1988 and Magid 1988; Marks and Mohamed - Ali 1991 : 253 and Caneva et al 1993:1-76).

It is a characteristic feature of Mesolithic communities in Sudan that the exploitation of aquatic resources becomes dominant subsistence activity. However, this situation stems from the wetter climatic conditions prevailed over most of the African continent in the 9th millennium B.C. and lasted till the third millennium B.C.. The water levels of lakes and rivers were high and some of the internal basins were temporarily connected, especially in central Africa. This comprises of southern Sahara and Sahel, extending from Upper Niger to the middle Nile valley, with a south-easterly extension into the upper Nile basin and the East African Rift valley (Sutton 1974:545). Wetter climatic conditions and thick vegetational belts during the Holocene times were reported by several workers in Sudan (Arkell 1949: 28 - 30, 1953:7-19; Adamson et al 1974:120 -123; Khabir 1981:170-171; Mohamed -Ali 1982:80-83; Wickens 1982:23-49; Haaland 1987:191-197; Marcolongo and Palmieri 1987:35-55; Magid 1988:97 and Clark 1989:388-390). There was a considerable aquatic fauna, including fish, in the rivers and swamps of the 'middle African' belt stretching from east African lakes right through the Sudan Savannah to the Atlantic. It played a dominant role in the adaptation of the population of that zone at least as far back as the 9th millennium B.C. (ibid:544-45). It is noteworthy that wavyline and dotted wavy line pottery along with barbed bone harpoons were recorded in association with river and lake-side settlements of the Holocene times across the middle African continent (Sutton 1974:527-554).

The Mesolithic people of the central Sudan occupied large settlements (fig.1) which are thought to have been base camps (e.g. Khartoum Hospital C. 5800 m2, Saggai I C. 36,000 m2 and Shabona C.52,000 m2) occupied for much of the year except where the rains in July or August made it impossible to exploit resources further distant from the river and to follow the games into Gezira and the desert west of the Nile (Clark 1980 : 560 - 61). There is no evidence for domestic animals and the game hunted consisted of elephant, hippo, a small buffalo, reedbuck, Nile lechwe, hartebeest and other game animals of equatorial savannah (e.g. Arkell 1949:28 - 30, 1953 :7-10, 1975: 20, Khabir 1981:170-171; Mohamed-Ali 1982:29 -

32; Caneva 1983:51-111; Haaland 1987 : 185 - 213; Magid 1988 : 40, 48, 62; Clark 1989: 387 - 410 and Peters 1991: 197 - 251).

The settled way of life for the Mesolithic communities inhabited Khartoum province (Khartoum Hospital 15° 36′N, 32° 32′E, Saggail - 15° 57N, 32° 33′ E, Sarurab 1&2-15° 56′N, 32° 32′E and Islang 1&2-15° 53′N, 32° 32′E) was confirmed by repeated occurrence of deep deposits (upto 1.6m at Kabbashi Haitah), the abundance of pottery sherds and emphasis laid on aquatic species, collecting and hunting of wild games all of which satisfied the dietary needs of the Mesolithic inhabitants of this district (Arkell 1949; Khabir 1981: 124 - 172; Magid 1981:42-45, 1982 and 1988; Haaland 1981, 1987; Mohamed-Ali 1982: 59 -104 and Caneva 1986:42-44, 1987: 53-55 and 1989: 38-39). Nevertheless, some smaller Mesolithic groups might have abandoned their home-base during certain periods to continue their activities in the inland areas. A good example illustrating this case can be drawn from Saggai I Mesolithic site (Caneva 1983). The population of this site performed resource scheduling within the site catchment area concomitent with cyclic movement of parts of the site folk into the hinterland. The presence of exotic marine shells at the site, originating from the Red sea, indicates relations with the east and confirm the idea of mobile groups (Gautier 1983: 110-11).

On the White Nile province, Shabona site, (14° 38′N, 32° 16′E) which lies C.110 km. south of Khartoum, is the most southerly in Sudan to produce Mesolithic culture and its subsistence economy is consistent with Early Khartoum tradition as represented by Khartoum Hospital (Arkell 1949) and related sites (Clark 1989: 387 - 410; chapters 2 and 4).

North of Khartoum district, in the Atbara reach, three large Mesolithic sites (Abu Darbein -33° 50′N, 17° 40′ E, Aneibis - 34° 35′N, 17° 58′E and Damer 34° 35′N, 17° 35′E) were surveyed and test-excavated by a joint-team from Khartoum and Bergen universities (El-Mahi and Haaland 1984:28-32; Haaland and Magid 1991:36 - 43, 1992:17-27). These sites have been radiocarbon-dated to 6650-6350 B.C., 6290-4870 B.C. and 6090-5830 B.C. respectively. The folks of these localities were living in large settlements and were apparently a sedentary population (Damer 6000 and Aneibis is 7000 square meters). In addition to the relatively large size of these settlements, cultural debris was around 50 to 60 cm. at the deepest, the presence of

graves, the high frequency of potsherds and the archaeological data which shows heavy reliance on aquatic resources all of which allowed a sedentary mode of life (Haaland and Magid 1992 : 17 - 27).

In the western Butana region, it has been argued that Shaqadud complex site might have been a seasonal camp (cf. Haaland 1987 : 193, 225 -27 and Peters 1991: 233) occupied temporarily by Nilotic groups for hunting wild games. Nevertheless, the excavators of this site (Marks and Mohamed-Ali 1991:254 - 55) believed that the site was occupied all the year round since the Mesolithic times onwards basing their argument on the following economic (subsistence) factors:-

Firstly, the relatively less numerous tool-kits oriented for hunting in the site (e.g. projectile points, lunates) in comparison with the Mesolithic sites along the Nile (e.g. Saggai I at Khartoum district and Shabona at the White Nile Province) raised the probability that the site was not a seasonal camp as seen by some workers (see supra).

Secondly, the predominance of grinding stones at Shaqadud as compared to the Nilotic site of Saggai1 led the excavators (ibid) to hypothesize that grinding stones might have been used for the activity of processing plants since the processing of fish is out of question (ibid).

Thirdly, the presence of aquatic fauna and the wooded-steppe nature of the site landscape as evident from the faunal data (peters 1991:197-235) led the excavators to assume that Shaqadud was not solely a settlement for permenant dwellers but could also have supported hunters and gatherers at any time of the year when the surface water was available. (see Marks and Mohamed-Ali 1991:237-259).

9.5.1.2. Neolithic communities

The onset of the Neolithic economy in the central Sudan may be ascribed to two distinct processes: the adoption of animal domestication into the area from the west (Sahara) (e.g. Arkell 1953:15 -30, Krzyzaniak 1978 : 159 - 72; Clark 1980 : 560-61, El-Mahi 1982 and Gautier 1984 : 317 -19) and the in situ development of

cereal cultivation (e.g. Arkell 1953 : 80 -105; Mohamed-Ali 1982 : 82-88; Haaland 1987:18-82 and Marks and Mohammed-Ali 1991:225). The latter may have been a slow process at best, with imperceptible line between the gathering of wild grasses and the planting of the same grasses (Magid 1988:224-40 and Marks and Mohamed-Ali 1991 :225)

Between the sixth and fifth millennium B.P., the Neolithic folk in a multi-resource adapation from Atbara reach (and possibly further to the north) to Rabak (and possibly further to the south) (fig.2) involved in a complex settlement pattern with base camps along the banks of the Nile for fishing and animal husbandry. It is noteworthy that the spatial distribution of Khartoum Neolithic settlements reflects clear differences (see supra and chapter 2) persumably due to differences in microenvironment (ibid). Compared with the Neolithic inhabitants of the eastern bank of the Main Nile in Khartoum district, it has been argued that their counterparts in the western bank seem to have been less dependent on cultivation. (Haaland 1987:222, Mohamed-Ali and El-Anwar 1988 : 61 - 68).

It is bewildering that the Khartoum Neolithic tradition as represented by Shaheinab and related sites (cf. chapter 2) pertained on the central Nile valley and hence has a much more limited distribution than that of Khartoum Mesolithic which has much wider distribution not only inside the Nile valley (e.g. Arkell 1949; Marks et al 1968:319-323; Shiner 1971a; Hays 1971a,b 1974:27-32 and 1975 :193 -20; Khabir 1981:124 -72; Mohamed -Ali 1982 :36-45, 148-150; Caneva 1983, 1986:42-43, 52-55, 1987a:75-86,1987:123-136 and 1989 :38-9; Clark 1989:387 - 410; Haaland and Magid 1991:36 -43 and 1992:17-27) but across the Sahara and the Sahel as well (e.g. Hugot 1963, 1982:585-661; Balout 1965: 157-165; Camps 1969:201-230; 1982: 548-657; Hays 1971a and 1975:193-204; Smith 1980:451-65; Clark 1980:527-80; McDonald 1991:41-52, 1992: 1-15).

The Khartoum Neolithic has flourished in the Khartoum district untill it reached its peak by 3050 B.C. when domestic stock formed over 80% of the fauna. (Krzyzaniak 1984:309-15). Neither aquatic steppic species were a significant part of the diet. At this stage a fully developed Neolithic adaptation, the Khartoum Neolithic made its appearance (Mohamed- Ali 1987-83), in the Khartoum district by the onset of the fourth millennium B.C.. This accounts for a two thousand years

gap in the cultural history of the Khartoum Nile environment till the appearance of Meroitic state early 11th century B.C. (Haaland 1984:39-51). The reason(s) behind that change is still unclear. Was it a change of economic subsistence associated with new settlement patterns, or migrations to other areas stimulated by climatic change or pressure from competing group?. The present level of archaeological evidence does not support either of these explanations (ibid).

One of the most perplexing questions in the later prehistory of the central Sudan is the relationship between the Mesolithic and Neolithic occupations of Shaqadud complex site in the Western Butana and their counterparts on the periphery of southern Butana and along the central Nile. However, three hypotheses have been put forward to explain this situation:-

The first one sees Shaqadud as a dry season camp reoccupied over a long period. For older occupational deposits (S21, S1-B), the presence of Pila and, perhaps, turtle gathering might indicate dry season activities. In the meantime, game hunting, the presence of mollusca remains such as Limicolaria Cailliaudia, Zanitarian cf. cailliandi, anurans, and possibly, Euxerus erythropus could indicate that the site was abondoned from time to time. The same situation is applicable to the cave site (S1.A). The presence of livestock could give further support for seasonal occupation. If livestock herding during the Neolithic period would be performed all the year round at Shaqadud, this would cause overgrazing (Peters 1991 : 233).

A second model sees Shaqadud as a wet season camp in which the bulk of Pila and turtle gathering might have occurred at the beginning of the rainy season. The higher incidence of rainfall, moreover, would result in green pastures and other plants and trees being attractive to hunter-gatherers as well as to the Neolithic pastoralists (cf. Peters 1991:233 and Haaland 1987: 193, 225 - 27).

In the writer's opinion, if either of the above hypotheses turned to have been operational during the occupation of the settlement, the ceramic evidence from Shaqadud would permit the following options:-

Firstly, it would be quite possible to find at Shaqadud (during a specific period of occupation: e.g. Mesolithic or Neolithic) the same type of pottery bearing the cultural tradition of the same potters (seasonal occupants) but its mineralogical composition is distinct from that manufactured within their living areas.

Secondly, it has been argued that the Neolithic people of the Nile valley must have kept their livestock in the Butana during rainy season (Haaland 1987 : 193). This postulate has been inferred from the fact that Butana is a grass land where trees and bushes are almost absent except along rare water-bodies. Today, the Butana provides the best pastures for domestic animals kept by the pastoral tribes in the area. (ibid: 255-257). If this hypothesis is accepted, then one would expect that the Neolithic levels of Shaqadud occupation to reflect a ceramic repertoire in conformity (typologically and technologically) with its counterpart of the Neolithic inhabitants of the Nile valley.

Though pottery is a fragile item and susceptible to breakage, yet ethnographic record has shown that pots are important to some mobile groups and they may be safely transported without breakage using adaptations such as carrying slings, net bags (Arnold 1985:110), or special shapes that are easily carried out or by cushioning pottery by careful packing (Nicklin 1979:453-4). Examples in support of this can be drawn, i.e. from Nurar tribes in Pakistan (Rye and Evans 1976:49) and Jidad village from southern Darfur province in western Sudan (Haaland 1978: 55). In the present writer's view it does not seem unlikely that the same or similar kinds of adaptations, perhaps, made of perishable material (vegetal fibres) must have been in use in Sudan during prehistoric times.

The latter possibility (see supra) that the pottery of Shaqadud (northwestern Butana) during later prehistoric times (the initial beginning of the Neolithic till the 3rd millennium B.C.) might have been produced by pastoralists, (either from the Nile valley or eastern Butana regions during their seasonal encapment in the northwestern part of the Butana grassland, gains further support from analogous mechanism of the present day pastoral production in the Butana region. The patterns of pastoral production in the Butana are noteworthy: short east-west movement between the Nile environment and long movement between the drier-areas of the northern Butana and western areas of the south (Haaland 1987: 193).

The former type is characterized by movements towards the Nile when the river recedes. The green pastures near the river bank provides important fodder at the season when the grasses away from the river are dried up (Barbour 1961:182). The latter type of migration is characterized by north-south movements between the areas of higher incidence of rainfall in the southern portions of the Butana and the adjacent parts of northern Butana. In the dessicated seasons, shortage of meadows and water compelled the pastoralists to move to other portions of the Butana, i.e. towards the Nile or the wetter regions of southern Butana. The basis for these two types of migration is that the northern districts of the Butana can best be exploited for pastoral activities in the rainy season (Haaland 1987 : 193).

However, potters were not always guided by the consideration of efficiency of production and in the absence of scientific theory, tradition and habit held control, and it may be well argued that when people migrated they would, for a period of time at least, have maintained some, if not all, elements of the aesthetic and technical tradition to which they had become accustomed and, in the long run, might have maintained some influence of the pottery styles of their new milieu (Shepard 1956:337-338 and Ehrich 1965:6). If that had been the case, and if we extend the ethnographic example of the Butana pastoralists movements (see supra) to the prehistoric times under consideration (Mesolithic and Neolithic periods), we could then expect to find zones of admixture, between the output of pottery of the Nile valley inhabitants and their counterparts of the eastern Butana, to have taken place at Shaqadud cultural deposits since the Mesolithic and Neolithic occupations of this settlement.

The third alternative regards Shaqadud as a permanent site in the western Butana that was reoccupied all the year round. Therefore, the Mesolithic and Neolithic occupants of this site were basically steppe-adapted, being accustomed to the steppe's raw material resources, its plants and animals. The large size of the site (cf. section 2.6.2), the thickness of cultural layers (cf. section 5.2) and lithic artifacts (cf. section 2.6.2) have been used to advocate this argument (Mohamed-Ali and Marks 1984 : 52-59; Marks 1985 : 1-20; Marks et al 1985 : 261 - 78; Marks and Mohamed-Ali 1991 : 233 -234 and Marks 1991 : 95 -122). In addition to that, as observed by Gautier (1983 : 110-111), the permanent nature of the site does not hinder resource scheduling in the site catchment area itself or by small

bands moving away from the settlement at certain time to perform some activities in the hinterland. In my opinion if this had been true, then one would expect the ceramic assemblages at Shaqadud site to yield distinct typological and technological features that could segregate them from their counterparts in the Butana region and along the Nile valley since the onset of the Mesolithic mode of life onto the site area. Moreover, the ceramic assemblages through the stratigraphic columns of Shaqadud site should, significantly, share much more affinities to each other (not merely typologically but technologically as well) than the Nile valley (Early Khartoum-Mesolithic-and Shaheinab-Neolithic-traditions) and Butana (Atbai ceramic tradition) assemblages are similar to them (cf. chapter 4).

9.6. Social organization

It could be seen from the above account that the Mesolithic hunters and gatherers have rather permanantly settled along the Nile over several millennia, depending for their subsistence upon water sources, and rich wild fauna (Caneva 1989:38-39). This intensive land occupation is evident from the central Nile (e.g. Khartoum province) by the presence of extensive Mesolithic settlements in comparison with relatively smaller occupations of Neolithic ones (cf. chapter 2).

It could be inferred from the areal extension of the Mesolithic sites (e.g. Shabona c. 52000 m2, Saggai c. 36000 m2 and Khartoum Hospital c. 5800 m2) (cf. chapter 2 and fig.1) and their relatively deep occupation deposits, e.g. Khartoum Hospital 2.5 m., Shabona c. 1.5 m. Kabbashi Haitah c. 1.6m and Sarurab 2 (0.8m) (cf. chapters2 and 3), that they are most likely permanent settlements. The presence of burials in association with the Mesolithic settlements, (e.g. Khartoum Hospital (Arkell 1975:20) and Kabbashi (Caneva 1987:55) in Khartoum district and Shabona on the White Nile province (Clark 1989:394-395) seems to provide further confirmation to the hypothesis of a settled way of life for Mesolithic communities along the central Nile (Haaland 1987 : 200 -201, Caneva 1987:55 and Clark 1989:394 -95). This does not mean for certain that they were static population but much more likely that they had practised relatively restricted range of mobility (chasing games), perhaps, around their home base and its vicinity (see below).

It is noteworthy that the Neolithic inhabitants of the central Nile, as evident from Khartoum and White Nile provinces, (cf. chapter 2) were mobile pastoralists whose settlements are generally characterized by relatiely small sizes (e.g. Shaheinab c.10,000 m2; Kadero II c.10,000 m2, Um Direiwa c.9000 m2 and Zakiab c. 2000 m2), moderate occupational deposits (e.g. Um Direiwa I c. 70 cm., Kadero I c.60 cm and Zakiab c.50 cm.) (cf. chapter 2) and they all seem to be clustered in rare extensive sites along the alluvial plain (Caneva 1989 : 43).

Settlements of pure late Neolithic nature were not found in Khartoum Province*(Caneva 1988:321-358 and Caneva et al 1993:1-76). Occupations of the latest Neolithic phase in this district, as pointed elsewhere (cf. chapter 2), are just but only ephemeral camps sparsely scattered along the narrow strip of the Nile in a much wider area than that occupied by the early Neolithic folks.

It is worthmentioning that both Mesolithic (hunters, gatherers and fishers) and Neolithic communities (mainly pastoralists) along the central Nile practised different cycles of mobility with regard to their economic adaptations such as gathering, hunting and pastoralism (Caneva 1983:266). The term "Mobility" has been used here as proposed by Binford (1968:313-41) distinguishsing between "residential" and "logistic" mobility. The former mobility requires a fairly permanent settlement whereas the latter does not necessiate compatibility with any type of settlement (ibid). In the present writer's view if these two mechanisms of mobility were opertional during prehistoric times, then the Mesolithic folks of the central Nile would be much more tied to their home base (gatherers, fishers but also hunters) whereas the Neolithic people were mainly pastoralists whose movements were frequently unrestricted to their immediate vicinity and might have reached the frontier of their neighboring groups (see supra and chapter 2).

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*By "Late Neolithic" the present writer refers solely to the late prehistoric settlements that immediately postdate the 'Khartoum Neolithic' sites (c.5000-3000 B.C.) as represented by Shaheinab and related sites (cf. chapters 2 and 9). The expression is used here in a chronological sense and it does not bear a connotation pertinent to change in subsistence economy or tool-kit production. The only change being the appearance of new shapes and/or decorative motifs that were not known during the early Neolithic (ibid.).

However, in the areas with high population growth, problems of transport of young and belongings would be reduced. Reduced mobility of social units in general and in the daily routines of females in particular would come about with reduction in the selective advantages pertaining to cultural means of controlling growth (Binford 1968:332). Therefore, as noted by Binford (ibid), under conditions of increased sedentism we would expect population growth. In this connection, the invention of pottery coupled with exploitation of aquatic resources has also generated resources that had a far reaching impact mainly upon population growth and sedentism (Haaland 1992: 48). It has also been argued that pottery and the use of boiled food would influence the fertility of women and come about with population growth because development of ceramic vessels enabled food to be boiled which might substitute for mother's milk. This would lessen the period of breast feeding and the duration of post-partum amenorrhea. Hence, shorter birth space in addition to relatively abundant fish resources are factors which stimulated increased sedentism (ibid).

In the case of central Sudan, it seems that during the 9th millennium B.C. there was a build up of the population of bigger and sedentary communities characterized by diagnostic cultural features such as wavy line, dotted wavy line and barbed bone harpoons with heavy emphasis on aquatic resources for subsistance (Haaland 1987:201 and Caneva et al 1993:1-76) The type of population growth cited above would result in "the increased relative importance of emigration as a mechanism for maintaining the local group within the optimal size and density limit" (Binford 1968:332). If this is the case, then the assumption that the development of techniques and exploitation of aquatic resources in concomitant with higher population growth and the expansion of people into geographical regions favouring such adaptation (Clark 1980:560-561 and Haaland 1987 : 201-202) does not seem unlikely.

The wavy line pottery which is the earliest type encountered in Africa has a restricted geographical distribution. The range of this distribution is virtually confined to the Nile valley (e.g. Arkell 1953, 1972: 22-27 and 1975: 19-23; Arkell and Ucko 1965:145-65; Marks et al 1968:319-323; Hays 1974:27-23, Mohamed Ali 1982: 36--87, 148-66; Caneva 1983; Haaland and Magid 1991:36-43 and

Haaland 1992a: 17-27). On the other hand, the very wide spatio-temporal distribution of the so-called "dotted wavy line" cultures (characterized late Mesolithic and early Neolithic occupations) encountered in sites as far separated as the Khartoum district (e.g. Shaheinab, c. 3300 B.C. - Arkell 1953 : 107), north-east Niger (Adrar Madet, Smith 1980:452, photo 18.1) and Libyan Sahara (Tin-Torha, c.7300 B.C.-Barich 1978:15-16). However, it has often been asserted that dotted-wavy line pottery is probably linked with the first experiments of pastoral mode of life (Caneva 1988:369) and the mobility of the first pastoralists in the central Sudan was restricted to the regional movements (ibid). In this respect, a model of seasonal east-west transhumance between the Nile and the Butana grassland (fig.1) was proposed by Haaland (Haaland 1987:224-225) (see supra). It has been postulated that overgrazing of the narrow strip of the Nile in the central Sudan was an outcome of the systematic animal husbandry concomitant with an increase in wild animal population as a result of no hunting (Caneva 1988:370). After a short period of time, the central Sudan pastoralists were compelled to follow a rigorous nomadic life style and their settlements became no longer conspicuous in the plain (ibid). Consistent with this "Logistic" mobility, the cultural traits of these mobile groups lost their distributive regional character and turned to become quite homogenous across a vast area including the entire Nile valley down to Dongola Reach (Caneva 1987:231-254). This high mobility of individuals and groups has also been noted during prehistoric times among Epi-palaeolithic and Neolithic communities widely spread across saharan Africa, thus confirming the relative rapidity with which innovations and technological advances were diffused throughout the desert (Clark 1980:571-572) (e.g. the invention of pottery and the very wide spread of the distinctive Mesolithic/Neolithic dotted wavy line decoration across the central Sahara and the Nile valley (fig.42).

In the central Sudan the example of Kadero I (fig.4) Neolithic site seems to fit well with this hypothesis (see supra). The evidence from Kadero I site as reflected in the burial customs, postulates a rather complex stage of cultural development attained by the early Neolithic people of the Sudan (Krzyzaniak 1991:10). This cultural development is characterized by high concentration of goods and, remarkably, also of power, in the hands of emerging social class. The economic base of this elite most likely originated from the long-distance trade and also from the control of surplus gained through pastoral economy, mainly

ownership of cattle. Other items which might have played a part were the rhyolite and high quality lithic raw materials quarried from the 6th cataract (Sabaloka) (fig.4) and used for manufacturing tools and weapons in Mesolithic and Neolithic times (ibid).

A contrary to this picture of social development at Kadero I is "Khartoum Mesolithic" represented by Khartoum Hospital site burials (see Arkell 1949: and chapter 4). Using criteria of cultural anthropological approach, such as mortuary practises, subsistence, population size .....etc, the Khartoum Hospital human group of Mesolithic times, would rather fit well into the model of "tribe" (Krzyzaniak 1991:10-11) whereas Kadero I early Neolithic groups seems to have attained, an incipient and not full, stage of "chiefdom" as expressed by Krzyzaniak (ibid). In my opinion this because full "chieftainate" and clear hierarchical society, as the level of archaeological information shows, had not seen the horizon in the Sudan till the emergence of the kushitic state at Kerma around the mid of the third millennium B.C, (see supra).

Patterns of this social development seems to have persisted in the late Neolithic of the central Sudan up to 3000 B.C.. The burial graves of Kadruka in the Dongola Reach (Reinold 1987:17-54) and at Kadada (see the map, fig 5) (Geus 1984:361-372, 1986:15-19, 37-38) north of Shendi and lately also from the Kaderol-site, seem to exhibit well the phenomenon of increasing concentration of goods and power by the social elite during this period (Krzyzaniak 1991:11). From upper and lower Nubia (fig.1) only a slender archaeological evidence of this period has been forthcoming with the appearance of A-group culture (late 4th to early third millennium B.C.). Exchange system seems to have been operational with predynastic/Early dynastic cultures. It has been argued that A-group economy relied heavily on a system of organized exchange with ancient Egypt. Numerous products of Egyptian provenance have been identified on most A-group sites in lower Nubia indicative of a continous and increasing interchange of goods, including ceramics, across the Egyptian-Nubian border ending up with the colonization of the whole lower Nubia during the dynastic Egypt (Trigger 1965 and Nordstrom 1972:52-32). A less organized but flourishing reciprocal exchange system during the late Neolithic time may have still persisted further south, down to Khartoum district, where Egyptian caravan did not set foot. In support of this, as

argued by Caneva (1988:371), is the sudden disappearance of late Neolithic cultures in the central Sudan repeating similar "disappearance" of the Nubian A-group. This was, seemingly, due, as caneva suggests, to a sudden change in the political power and/or economic power in the region (ibid). Haaland advocates the former possibility and believes that the Nilo-Saharan speaking people (Eastern-Sudanic) were, from 1550 B.C., replaced by Cushitic speaking people (Western - Sudanic) in pastoral adaptation because of superior political-military organization (Haaland 1991 : 133-134).

9.7. Environment and items of Exchange

In a uniform environment, exchange between communities is largely in functional items which reflect social, cultural and political relations between communities and between their component groups (Tourlellot and Sabloff 1969:128). The enviornments of the economic systems dealt with in the present research (see supra) may be characterized in the following way: The central Sudan enjoyed a relatively uniform environmental conditions throughtout the Mesolithic times with some minor fluctuations in between. During the early Holocene humid climatic conditions (Arkell1949:109-10; Wickens 1982:23-50; Mohamed-Ali 1982:171; Caneva 1983, 1987:52-54; Khabir 1987: 59 -60; Haaland 1987:191-97; Magid 1988:267-71 and Peters 1991:197-236) permitted extensive movements of people across the wooded-steppe at about 7050 B.C.. During this period settlements were encountered and some population acquired sedentary mode of life and relied heavily on exploitation of aquatic resources (see Marks and Mohamed-Ali 1991:258). However, with the ending of the first humid stage of the Holocene Wet Phase in Sahara around 5250 B.C. (Banks 1984a:2), there must have been a period of reduced contacts because of a drier episode at the end of this humid stage during which local ceramic traditions in the Sahara showed marked variations (ibid). With the advent of the Second Wet Phase before c. 4050 B.C. habitual local distant contact was resumed. This time seems to correspond with the late Khartoum Mesolithic in the Nile valley, during which dotted wavy line pottery, gouges and barbed bone harpoons spread widely (Marks and Mohamed-Ali 1991:258) across the saharan Africa (cf. sections 10.2.1 and 10.2.2).

During the Neolithic times the climate became drier and the paleoenvironmental evidence from Khartoum area suggests a drier episode marked by steppe-conditions and absence of swamp-loving animals (Arkell 1953:9).

Analogeous conditions were also prevailing in the Butana region during this period (Peters 1991:232) and it had witnessed a shift of the enviornment from a rather humid (450-500 mm precipitation) to a dry savannah (350 mm). between c. ± 5450 and about ± 1650 B.C.(Peters 1991:234). Such uniformity in climatic conditions during Mesolithic and Neolithic times in the central Sudan seems to discourage exchange of subsistence or "useful" items (e.g. foodstuff) while raising the probability of exchange in functional prestige ones (e.g. precious/high quality stones or even high quality or utilitarian wares as shown below) at the magnitude of interregional contact.

9.8. Evidence of non-ceramic material exchange: Mesolithic and Neolithic periods in the central and northern Sudan.

Krzyzaniak proposes a theory stating that: the adoption of domestic animals by Sudanese foodgatherers resulted from long-distance exchange network. Such networks seem to have been operational on the Nile already in the Mesolithic times. At the site of Saggai I near Khartoum (Caneva 1983, (fig.1), marine shells (used as beads) originating from Indian ocean - waters (which include the Red Sea), were encountered in association with the local Khartoum Mesolithic settlement (Gautier 1983 : 53-57) dated some 6080 ± 100 B.C.[T-5024] (Caneva 1983:152).

In upper Nubia, near the second cataract, people of the "Khartoum variant" tradition were using the exotic Egyptian flint available from the north-some several hundred kilometers away for making tools at c.6350 - 5500 bp. (Nordstrom 1972 :9,10). This has been taken as an evidence for the existence of a long-distance exchange contact in the area of the present day north Sudan functioning in the Mesolithic times.(ibid). This system of contact was evidently more intensively used with the beginning of the early Neolithic times in the Sudan when marine shells used as beads and the green amazonite/malachite start to occur in the district of Khartoum, probably having originated in the north (Krzyzaniak 1991:6-7)

This theory of the long-distance exchange system gets support from the fact that-aside from the apparent strong similarities in finely worked artifacts as knives and bifacial arrowheads manufactured in exotic raw materials-many of the artifacts shared by Dakhleh oasis of the western Egyptian Sahara and the Khartoum district - the amazonite beads, the ground stone axes, the marine shell pendants and beads - are of materials which would have been imported or traded into Dakhleh itself (Mc Donald 1992:15). Nevertheless, it is not clear how the operation of an exchange system already long in place could eventually at the end of the fifth millennium B.C., affects the dramatic changes in subsistence and artifact assemblages that marked the beginning of the Shaheinab Neolithic in Khartoum area (ibid, cf. chapter 2). Another example is the late Neolithic phase of Kadada (late fifth millennium B.P.) in the Shendi province (Reinold 1987:17-56) where many grave offerings made of materials whose provenance are well to the east, across the Butana in the Red Sea Hills, suggestive of existed economic contact between the folks of the Nile valley and the inhabitants in the eastern region of the Sudan (ibid).

Some Nilotic materials, from agate to shell, attested the Mesolithic levels of Shaqadud site (Marks and Mohamed-Ali 1991 : 225 and chapter 5). Though these materials are markedly little in quantity, it does not seem unlikely that it might have arrived at Shaqadud via some form of direct/indirect trade or cultural borrowing (ibid).

9.9. Ceramics spatial distribution and previous Mesolithic/Neolithic works in the central Sudan: Mineralogical and Typological evidence.

The results of Hays-Hassan mineralogical analysis (1974:71-79) of Mesolithic and Neolithic pottery fabrics (Group 11 bi and 11 ci, table 1 :74), Williams analyses of Sarurab1 pottery from Khartoum province (Williams 1982:174-176: Francaviglia and Palmieri (1983:191) examination of a series of Mesolithic ceramics from Saggai1 (Caneva 1983), Jebel Umm Murrahi (Abulgasim 1979:190) and Sarurab1 (Mohamed- Ali 1982:59 -87) (fig.1), indicate that the pottery from these localities in Khartoum district was locally made (cf. chapter 3). Evidence for ceramic exchange (exotic minerals in pottery) was not discernable in the samples examined. However, it is clear that the samples investigated are

inadequate to justify the attained conclusions (cf. chapter 3 and the references cited above). In the meantime petrographic analysis of the Kadero I Neolithic site (Khartoum Province, (fig.1) (Chittick 1955:75-81; Krzyzaniak 1974:30-32, 1977:45-46, 1988:34 and 1989:34) conducted by Chlodnicki (1989: 369-373) shows that some pottery of this site is characterized by admixture of rock fragments identified as being of granite-syenite group, with large amounts of perthite - a mineral that does not appear in the remaining samples. The result shows that a few fragments of pottery may have been imports to Kadero I site (ibid.:1989:372-373). The preceding example raises the probability that exchange networks might have existed during Neolithic times in the central Sudan.

The Mesolithic and Neolithic pottery from the Nilotic sites (Khartoum and White Nile provinces) and the Western Butana region (fig: 1,2,3) (Arkell 1949 : 86-116, Pls: 59-87, 1953, Pls: 29-38;. Khabir 1981, figs: 14 -21, Pls: 3-16; Mohamed-Ali 1982; 36-87, Pls: 34-37; Magid 1982: 68-79 and 1988: 106-24; Caneva 1983, figs:8-15, 1987, figs:21-35, Pls: 31-45; Chlodnicki 1984: 337-42, figs:1-4; Mohamed -Ali and Marks 1984:52-59, fig:4, Marks et al 1985:261-87, figs: 714; Haaland 1987: 16-47, figs: 14, a,c,i-n; Elamin and Khabir 1987: 175-87, fig:2; Clark 1989 : 402-5; Caneva and Marks 1990, fig:1-IX; Robertson 1991:123-174, figs: 7-5,7-7,7-10, 7-13 and Mohammed Ali 1991: 65-90, figs: 5-1, 5-14) show unmistakable similarities which are conspicuously restricted to decorative motifs and surface treatment. Hence, there is enough ceramic data which suggest cultural links between the central Nile valley and the western Butana region during late prehistoric times. These cultural similarities indicate some kind of cultural contact. However, in any contact situation a variety of different mechanisms may operate at the same time under varying conditions and between different groups/individuals (Well 1980:138). If that is the case, then one would not exclude the possibility that the ceramic corpus from the Mesolithic and Neolithic sites examined in the present work (cf. chapters 3,4 and 5) bring about an evidence pertaining to exchange network. Whether that was real or apparent in the context of the central Sudan could best be answered through a hypothetical model explaining the nature of cultural mechanism(s) underlined the ceramics distributive system and further tested via detailed physico-scientific analyses of the pottery types which have established that cultural link (see below).

9.10. Hypothetical model explaining the nature of distribution of Mesolithic and Neolithic ceramics in the central Sudan.

9.10.1 Theoretical considerations

Recently the need for models in archaeological interpretation has been advocated by some workers such as Clarke (1972:1-60); Hill (1972:61-107); Hodder (1978:199-269); Van Der Leeuw (1976); Binford (1977); Renfrew (1977 : 71-90) and Peacock (1982) and it is implicit in earlier works such as that of Balfet (1965:161-77) on North African pottery and Shepard classic text entitled "Ceramics for Archaeologists" (1956).

The model concept is among the most debated, and the least defined, of concepts generally referred to in the study of scientific procedure (Van Der Leeuw 1976: 66). Clarke believed that it is "more appropriate to describe models rather than to attempt a hopelessly broad or a pointlessly narrow definition for them". In accordance with his description "Models are usually idealized representations of observations, they are structured, they are selective, they simplify, they specify a field of interest and they offer a partially accurate predictive framework" (Clarke 1972:2). It may be defined in "analytical" concept as a conceptual or material tool designed to solve specific problems in relation to a certain set of phenomenon (Van Der Leeuw 1976:66).

The goals of models are manifold (Chorley and Haggett 1967:24):-

a) Models provide a theoretical basis for data organization.
b) Models enable comprehension and visualization of groups of phenomenon which could be too large or too complex without such a tool.
c) Also for the definition, collection and ordering of new data.
d) Models permit the maximum amount of information to be illicited from the data.
e) Models help to explain how particular phenomenon comes about.
f) Models preceive phenomenon in terms of interlocking systems.
g) Models promote the communication of scientific ideas.

9.10.2. The model

My model (fig.93) consists of two levels of exchange, implying the probability of two different exchange mechanisms operating during the Mesolithic and Neolithic times in the central Sudan. These two levels represent the distinction originally observed between local and long distance trade in addition to a further division in the latter (see supra). In other words, within the class of long distance trade, the distinction has been made between regional (within social or spatial units) and external exchanges (across cultural boundaries.)

It is noteworthy that trade (exchange) in the intraregional level has not been sought in the present model for such type of evidence is difficult to be discerned in the archaeological record because potters had access to overlapping clay and temper resources (cf. Deutchman 1980:111-13 and Arnold 1980:149). In the present work the selected Mesolithic and Neolithic settlements from Khartoum Province (Kabbashi, kabbashi Haitah and Geili : east bank of the main Nile and Sarurab2, Islang 2 and Nofalab2: west bank of the main Nile) (fig.4) are the only assemblages that are located in close proximity, clustering within 2-4 km of one another (fig.4) and they exhibit ceramic repertoire from geologically similar environment (cf. chapter 3). On the other hand, though the rest of the Mesolithic and Neolithic assemblages in Western Butana (Shaqadud complex site- midden and cave) (fig.1) and the white Nile province (Shabona and Rabak settlements) (fig.1), are from geographically separated areas, in either areas these sites do not form a spectrum of contemporary/synchronous occupations-they are rather sporadic settlements of diachronic nature - that would permit testing the probability of exchange network at the interregional level.

The present model is consistent with the archaeological evidence, as well as the ethnographic record hitherto, available and its two levels of exchange networks (interregional and external) are described in turn as follows:-

9.10.3. Interregional exchange

Ethnographic record shows seasonal activities and movements of people such as the Nilotic people on the upper Nile to the south (Evans-pritchard 1940) and the Rufaa al-Hoi tribe seasonal movements (north-south direction) between the northern Butana and its southern parts and the Gezira till recently when this transhumance system was ceased as a result of the onset of cotton cultivation scheme (Haaland 1987:193, 1989 : 366-367 and Clark 1989 : 407 -409). The basis for these movements is the fact that the northern parts (Upper Nile and southern Butana) can best be exploited for pastoral production during the rainy season. In the dry season, shortage of pastures forces the pastoralists to move to the southern parts of the Butana and the Gezira area. On the basis of this ethnographic evidence, as has been noted elsewhere (see supra, this chapter), the possibility that the Mesolithic and Neolithic ceramic ties of the White Nile Province with that of Khartoum district and the Butana region (chapters 3,4 and 5 respectively) caused by such north-south seasonal movements (fig.93), should be tested.

As indicated earlier (see supra), the relationship between the central Nile and Butana during Mesolithic and Neolithic times has not as yet been adequately tested. Nevertheless, two different situations have been proposed as an explanation to the nature of cultural mechanism(s) that have existed in these two regions: either Shaqadud complex site was a seasonal camp occupied temporarily by Nilotic folks (Haaland 1987: 193, 225 - 27 and Peters 1991 :233) or a permanant settlement being occupied all the year round (Mohamed-Ali and Marks 1984:52-59 and Marks and Mohamed-Ali 1991:233-234, see also supra). On the basis of the typological and chronological evidence reviewed elsewhere (see supra this chapter and sections 3.7-5.7,10.1.1) a 1-way exchange process and an exchange in either direction have been proposed in the present model as an explanation to the mechanism(s) of ceramics distribution between the central Nile (Khartoum and White Nile Provinces) and the Western Butana during the Mesoslithic/Neolithic and (late Neolithic periods respectively (fig.93). The possible exchange mechanisms have been indicated by a continuous line (south-north) or a set of two lines (either direction) representing the level of exchange (interregional) whereas

the letters, inside the circles (M, N and LN) representing the Mesolithic, Neolithic and the last phase of the later period respectively.

When the early ceramics of the eastern Butana compared with their counterparts on the Nile, near Khartoum, certain similarities and differences can be observed. While wavy line, dotted straight and dotted zigzag lines are encountereed in both areas (Mohamed-Ali and Jaeger 1989:476-477), dotted wavy line motifs are only found at the Khartoum Mesolithic sites in the central Nile valley (see e.g. Arkell 1949: 81-92, Pl.72: Khabir 1981:124-172, fig.4: Mohamed-Ali 1982:59-87, fig.43:b; Caneva 1987:53-55, 1989:37-39; Magid 1988: 105-120 and Clark 1989:386-410 and Caneva et al 1993:12-18 figs.7:2,6:8). On the other hand, the knobbed decoration of the Pre-Saroba and the format decorations of the eastern Butana in general have not been found on the central Nile (Fattovich1984:480-498; Fattovich et al 1984:178-179; Marks and Sadr 1988:73 and Mohamed-Ali and Jaeger 1989:476). By Saroba times pottery similarities with Khartoum Neolithic assemblages disappeared (Fattovich et al 1984:178 and Mohamed-Ali and Jaeger 1989:476-477). However, all the decorative traits that characterize the 'Khartoum Neolithic' (such as straight lines, triangle patterns, burnishing and/or slipping) are absent in the Saroba ceramics (see Hays 1971C; Mohamed-Ali and Jaeger 1989:476-477). Based on the evidence reviewed above, the present model suggests an eastward ceramic contact radiating from Khartoum area towards the eastern Butana. On the other hand, the relationship between the eastern Butana and Shaqadud complex site has been suggested by a two-way exchange. This is due to the close resemblances in pottery decorations (such as wavy lines; dotted straight lines and dotted zigzag lines) between Pre-Saroba phase of the eastern Butana (Fattovich et al 1984:173-188; Marks and Sadr 1988:72 and Mohamed-Ali and Jaeger 1989:474-475) and the Mesolithic levels of Shaqadud midden (Caneva and Marks 1990:11-34 and Mohamed-Ali 1991:65), whereas the ceramics of the late Neolithic phase of Shaqadud Cave (such as parallel grooving, punctations and striations with brush) (Robertson and Marks 1984:515-534; Mohamed-Ali and Marks 1984:52-59, fig 4:top row; Marks et al 1985:261, fig.12:f,h and fig.14) parallel those of the Atbai ceramic tradition derived from Atbara and Gash Delta in the eastern Sudan (Fattovich et al 1984: 180, 183, fig. 4:5, fig.6: 3,6-7).

The early phase of the Jebel Moya pottery was made only with rocker stamp technique. The most prominent design is rectilinear and wavy bands of dotted lines. Two main types of dotted lines were observed : one with deep and narrow curves executed with combs with short edge (Caneva 1991: 262-268, fig.3:1,2,4); the other with short, wide, somewhat angular curves obtained with combs with a long edge and with sharp cut teeth (ibid:, fig 3:3). This kind of decoration is atypical to that reported from the central Nile (cf. Arkell 1949: pl.72; 1953: pl.29, fig.1; Khabir 1981:fig.5 a and b; Mohamed-Ali 1982:pl.34:b and Caneva 1983:Pls: 15:1-7, 18:7). The only exception being the late Mesolithic site of Kabbashi (6500±80 B.P.), on the eastern bank of the Nile north of Khartoum (Caneva 1987:342 and personal communication 1993) and Shaqadud midden (phase 2) where Jebel Moya types of dotted wavy line have been found. At Shaqadud midden (Mesolithic cultural levels) these dotted wavy line ceramics represent a late Mesolithic phase and were found at a context immediately above the lowest layers that have been dated to 6050-5050 B.C. (Caneva and Marks 1990:21-23 and Caneva 1991:267).

The Khartoum Neolithic pottery (cf. Arkell 1953:68-77, 97-101, pls 29-39) was absent at Jebel Moya site (cf. Caneva 1991:262-268, fig 3 and Addison 1949).

The latest Neolithic phase of Jebel Moya (5th millennium B.P.) shows close similarities with the upper part of occupation midden (level 2) at Rabak site on the White Nile Province and Shaqadud Cave in the Western Butana region (fig.2) (Haaland 1987:45-47). All sites exhibit common ceramic features characterized by open -mouthed globular pots with rounded bottom, surfaces of the pots were often impressed and rarely burnished (Addison 1949, Pls: XCI, XCIII, B.No.2,3 and Haaland 1987, fig. 14). However, the latter sites (Rabak and Shqadud Cave) display another common feature which is absent at Jebel Moya. This is manifested in the presence of pottery with parallel grooving or chord marks, wiped surfaces and fingernail impressions (see Mohamed-Ali 1984:57, fig.4 and Haaland 1989:362-365, figs. 2-3).

On the basis of the outlined evidence, a one-way exchange mechanism has been postulated to represent the kind of ceramic contact that might have linked Jebel Moya with eastern and western Butana and the White Nile regions. On the other hand, an exchange mechanism in either direction has been proposed to

represent the type of ceramic connection that could have existed between Jebel Moya levels of Rabak (White Nile) and Shaqadud Cave (Western Butana) late Neolitic sites.(fig.93).

The earliest pottery types at Shendi reach (El-Kadada, El-Ghaba, Taragma and Shendi) recalling Khartoum Neolithic pottery as represented by Shaheinab at Khartoum area (cf. Arkell 1953: 68:77, Pls 29-39) and related sites (cf. chapter 2). The pottery is mainly incised and impressed, while zigzag and dotted decorative motifs are the most frequent. However, Shendi site has a very high index of rippled pottery (Geus 1981:37-42, 1983, 1984:361-372, fig. 6 and Reinold 1987:17-56; Reinold and Lenobe 1987:46-48). On the basis of the available evidence, a northward ceramic contact between Khartoum area and Shendi reach could be postulated (fig.93).

North of Khartoum in the Atbara reach, three large Mesolithic sites, namely Abu Darbein, Aneiba and Damer (fig.2) (cf. section 9.5.1) yielded ceramics of Early Khartoum types. Wavy line (Haaland and Magid 1991:41-42, figs.3 and 5) and dotted wavy line patterns (Haaland and Magid 1992:26, fig. 8a) were encountered. These pottery motifs are well known in the Khartoum area (e.g. see Arkell 1949; Khabir 1981, Mohamed-Ali 1982:59-87 and Caneva 1983:49-152). From Sarurab2 site on the west bank of the Main Nile (see fig.3) (cf. chapter 2, and supra, this chapter) and Saggai, on the east bank of the Main Nile, near Khartoum (see fig. 3, chapter 2, supra, this chapter), two radiocarbon dates (based on charcoal from the former site and four others (based on Nile oyster shell) from the latter are in the range of 7350-6050 B.C. respectively. Therefore, in the present model (fig.93) a south-north direction has been proposed to delineate the nature of relationship between Khartoum district and Atbara reach.

In the northern Sudan, the pottery of Dongola reach (Early Khartoum and Karat groups) shows resemblances to that encountered near Khartoum and north of the Second Cataract. At the same time the Dongola reach settlements on the basis of lithic typology and technology are unrelated to those near Khartoum and the north of the Second Cataract (Marks et al 1968:319-23 and Hays 1974: 28-32). This has been taken as an indication that the presence of Kharotum Mesolithic and Khartoum Neolithic ceramic traits does not necessitate movement of people but

rather shows that certain pottery styles and techniques spread over a vast area along the Nile by diffusion to autonomous groups of populations (ibid) (see below and section 10.1.2.2.).

In the second cataract area most pottery of Khartoum variant and Abkan assemblages is comparable with the Mesolithic (Shiner 1968 : 626) and Neolithic of the central Sudan (Haaland 1972:105) respectively, whereas lithic technologies and other material culture are different (cf. chapter 10). The ceramic assemblages of Abkan (Nordstrom 1972:17) and Khartoum variant (Hays 1974 : 27-32) groups point to generic links with the south (Khartoum district) rather than the north (Egypt). The apparent resemblances in typological and technological features between Mesolithic/Neolithic ceramics of Upper Nubia (Abkan and Khartoum variant) (cf. Nordstrom 1972: 8-17) and the Khartoum district (Hays 1974 : 71-79) coupled with the disparate nature of their lithic technologies and typologies have been considered as signs of diffusion of ideas to local groups of people(cf.Hays 1974:27-32). In the present writer's opinion, if such hypothesis is accepted, it does not preclude the possibility of, at least, a reciprocal exchange (indirect contact trade) for the term "diffusion", as noted by Renfrew (1969:153), in its broadest sense sometimes includes people movement (persumably in a limited scale or individual level). A l-way ceramics movement (south-north direction) has been suggested in the present model to delineate the nature of ceramic ties between Dongola reach/Second Cataract area and Khartoum district (fig. 93). The lack of ceramics which can be ascribed to the Mesolithic/Neolithic settlements in Dongola reach and Second Cataract area in Khartoum district, (pers. obser.) seems to confirm the proposed directionality of ceramics movement between these districts.

Wavy line pottery motifs of Early Khartoum type were reported from several sites (84/2; 84/50 and 80/87) in Wadi Howar basin (Richter 1989:431-441, fig.2: 4,7,9-13,15). Rocker stamp pattern in zigzag bands (ibid., fig.4: 4,5) or in regular bands of nearlly parallel impressions (ibid, fig. 4:1,2) which are characteristic of 'Khartoum Neolithic' found at Shaheinab site (cf. Arkell 1953: Pl 31:7, fig.4:4, Pl 32:6, fig.4:5, Pl 32:3,5) and related sites (cf.chapter 2), have been discovered at a dune deposit on the the southern banks of Wadi Howar (fig.2). These are the earliest pottery decorations reported from Wadi Howar basin. On typological grounds they could be of similar age as their counterparts in Khartoum area (see

e.g. Khabir 1981; Mohamed-Ali 1982: 59-87; Magid 1982; Caneva 1983:149-152 and Haaland 1987a:60-62). Hence, a westward contact from Khartoum area towards Wadi Howar (fig. 93) can be postulated.

Further afield, as already indicated (see section 9.6., this chapter) trade and exchange were clearly of utmost importance across Egyptian-Nubian border particularly during the Classic (c. 3240 ± 70 B.C.Hassan 1986:92) and Terminal A-group phases (c. 3070 ± 70 B.C. (ibid). The products of Egyptian Provenance such as wine, transported in necked jars of varied sizes (Nordstrom 1972 : Pls. 187 - 188). Other utensils such as wavy-handled and cylindrical jars (ibid., Pl: 185) in addition to non-ceramic products such as copper implements and objects were most likely brought to Nubia as well as stone-vessels, pendants, amulets .....etc. This late Neolithic period, c.3000 B.C., witnessed a sudden disappearance of flourishing cultures in the central Sudan (e.g. Khartoum Neolithic as represented by Shaheinab (Arkell 1953) and related sites. Nonetheless, reciprocal exchange system during this period may still persisted down to Khartoum district where Egyptian caravan routes did not arrive (Caneva 1988 : 371 and section 10.3).

Since the present research deals with Mesolithic and Neolithic ceramics in the central Sudan, as envisioned from the areas investigated (Khartoum, White Nile and Butana districts), a comparative empirical ceramic data pertaining to the long distance trade between the study areas and the peripheral zones (outside the boundary of the study area) will not be provided. Instead, I would keep to the level of archaeological evidence available.

9.10.4 - External exchange

Direct evidence of contact between Nilotic people in Upper Nubia and central Sudan and their neighbours in Upper Egypt during the Mesolithic and Neolithic times was absent. However, the predynastic cultures Badarian: 5th millennium B.C.; Naqada I "Amratian": early fourth millennium B.C. and Naqada II "Gerzean", C. mid 4th millennium B.C.) (Brunton and Caton-Thompson 1928 and Hassan 1985 : 85-115), have brought an evidence pointing to similarities of some cultural traits down and up the Nile which were probably a result of exchange networks concomitant by limited population movements. As far as pottery is

concerned, it has been argued that Badarian ceramic tradition has southern antecedants and the black-topped rippled wares - characteristic of Badarian pottery- might have descended from the black-topped ware of Khartoum Neolithic which were often burnished over incised decorated surface giving them an incipient ripple (Arkell 1953 Pl. 33, figs 10,11; Arkell and Ucko 1965 : 151 and Hays 1984:218). Moreover, Arkell held a belief that the black-incised wares in the Predynastic Egypt were certainly an import from the south (Nubia) (Arkell 1953:82.) It has also be argued that there might have been a 2-way exchange: Burnishing acquired by Khartoum Neolithic people whereas ripple-burnishing acquired by Badarian via persistent contact (Kennedy 1965:160).

The ceramic sequence of Naqadal (Amratian) which succeeded the Badarian culture (cf.section 10.2.1), shows that the black-topped red ware, ripple and keel which are of the main diagnostic features of the Badarian, prevailing at the onset of Naqada I but decreasing steadily during the course of time whereas red polished wares continued roughly throughout. Other ceramic traits such as the white cross-lined painted pottery persisted during the whole period of this culture. However, the latter ceramic design lies outside the norm of Mesolithic and Neolithic ceramics of the Sudan (cf. sections 3.7-5.7). Arkell suggested a local derivation for this ceramic tradition on the basis of motifs (human and animal scene) which show no foreign influence (Arkell 1975 : 40, figs. 17, 18-19)

Despite the fact that many cultural traits of Naqada I (Amratian) persisted during Naqada II (Gerzean), other artifactual remains such as wavy-handled pottery and zoomorphic designs in pottery recalling Mesopotamian examples and bear evidence of trade with Uruk and Jemdt Nasr period in Iraq (Arkell and Ucko 1965: 153-154).

Fayum culture in Upper Egypt (Caton-Thompson and Gardner 1934) shares very little in common with Khartoum Mesolithic culture of the central Sudan. Both possessed barbed-bone harpoons whereas ceramics in both cultures are typologically and technologically different (Arkell and Ucko 1965:145-48 and section 10.2.1). Unlike Khartoum Mesolithic, Khartoum Neolithic seems to have general cultural parallels with Fayum. Both have burnished ceramics though

typological and technological features of the ceramic artifacts are basically different (ibid. and section 10.2.1)

In the present writer's opinion, despite the lack of direct evidence for the long distance contact between some Neolithic riverine cultures up (Badarian and Fayum A-Upper Egypt) and down the Nile (Khartoum Neolithic cultures- northern and central Sudan) (see supra), resemblances in some ceramic traits and other material culture (see supra) are in favour of indirect cultural contact. The easy communication via the Nile seems to facilitate that kind of contact.

But since the evidence of ceramic similarities between the Central/Northern Sudan and Upper Egypt, during the Mesolithic and Neolithic periods, respectively, is absent or very slender (see section 9.6), the present model will only be confined to the Western Egyptian Sahara (see below and section 10.2.2). Therefore, in the present model (fig.41), a two-way exchange of ceramic vessels has been postulated and indicated by a set of two parallel broken lines terminating in the form of arrowheads.

It has been evident that ceramic ties in the early to mid-Holocene between the central Sudan and settlements further west in the Sahara are conspicuous, and expressed in such terms as the "Neolithic of Sudanese Traditon" or "Saharo-Sudanese Neolithic" (e.g. Hugot 1963, 1982 : 585-661; Balout 1965 : 156 -57; Camps 1969, 1982 : 548 - 657; Hays 1971 and 1975: 193 - 204; Banks 1980 : 299 - 314; Wendorf and Schild 1984 : 406 - 428 and Soleihavoup 1988 : 49 - 71).

Apart from Hays-Hassan mineralogical analysis (1974:71-79) of "Sudanese Neolithic Ceramics" which embraces ceramics from southern (Wanyanga) and central (Amekni and Meniet) Sahara (fig.41) and Banks (1980:299-314) analyses of Neolithic ceramics from western Egyptian Sahara (Nabta Playa, Wadi Bakht, Bir-Kiseiba, Bir-Takhis, Jebel Uweinat and the Fayum), the petrographic analysis of a few ceramics from the Tibesti (Chad) and the chemical analysis of the Tadrart Acacus pottery in south-west Libyan Sahara (Palmieri 1987:221-29), the remaining works in the Saharan Mesolithic/Neolithic ceramics are devoid of such types of physico-scientific investigations (e.g. Camps 1982: 548-657; Hugot 1982 : 585 - 661; Close 1984 : 292-93; Kobusiewicz 1984:157 - 161; Wieckowska 1984 : 117 -

119; Wendorf and Close 1984 : 239 - 247; Soleilhavoup 1988 : 49-71; Edward and Hope 1989 : 232 - 242 and Tangri 1992 : 141 - 143). In my view despite the fact that these four projects have virtually been geared towards the provenancing of pottery (see supra), the scale of resolution, geographically, at which fabric groupings appear to be rather distinguishable - in temper than in paste- is not entirely satisfactory as to clearly identify ceramics movements at the interregional level (cf. chapters 3-5 and 10).

The well attested "Khartoum Horizon Style" in the central Nile valley (e.g. Arkell 1949 and 1953; Chittick 1955 : 75-78); Arkell and Ucko 1965: 145 - 166; Marks et al 1968:319-323, 1985:261-278; Shiner et al 1971; Hays 1971a, 1974:27-32, 1975:193-204; Krzyzaniak 1974: 30-32; Geus 1976, 1977, 1979, 1984: 361-372; Clark 1980:558-561, 565-568; Caneva 1983, 1988, Mohamed - Ali and Marks 1984 : 52-59; Elamin and Khabir 1987 : 175 - 185; Haaland 1987, 1991: 127-144, 1992a:17-27, 1992b: 43; Magid 1988 and Haaland and Magid 1991:36-43) coupled with the oldest radiocarbon dates - c.9110-7390 B.C.- so far obtained - for the onset of this ceramic-horizon style in north-eastern Africa (see section 10.1.1.1) seem to reinforce the probability that exchange mechanism(s) (if any) - at least at the initial stage of "Khartoum Horizon Style" appearance in north-eastern Africa - would have taken a westward direction rather than vice versa.

A corollary to the present writer's argument (see supra, this section) is the rarity and high standard of workmanship of the eastern Saharan ceramics during Mesolithic and Neolithic times which would suggest, as Close argues (1992:162-63), that these pots might not have been strictly utilitarian. It is probable that, at least in these early stages (early to mid Holocene), Saharan pottery gained importance from social significance than usefulness in cooking food (ibid). It is most likely that the Saharan groups during Mesolithic and Neolithic times were moving over shorter distances and this social movements would accord with the level of archaeological evidence which points to long-term or, at least, recurrent settlements as could be inferred from the greater density of occupation (Wendorf and Schild 1984:423-28; McDonald 1991:41-52 and Close 1992:162-63). Nevertheless, there were ties between the Sahara and the Nile valley (early to mid-Holocene) envisioned in contacts and movements of goods (Close 1992: 172). Importation of Egyptian flint, from Sinn el Kadab scrap in Upper Egypt, by the east

Saharan dwellers' of Bir Kiseiba (Wendorf and Schild 1984:424) the cowrie shells from the Red Sea found at Nabta playa (Gautier 1980 : 326f) and the occurrence of "Khartoum Horizon style" ceramics at a site near Abu Ballas all of which in the Western Egyptian Sahara (Kuper 1989:200) are examples in support of the close contacts and a westward influence of the Nile valley and its peripheries (the Eastern Sahel). If that had been the situation, then it could be argued that in the present hypothetical model of Mesolithic and Neolithic pottery exchange in the central Sudan (fig.93), a unilinear ceramic movement from the central Nile valley towards the eastern, central and southern Sahara becomes much more likely.

9.11 Test of the hypothetical model

9.11.1. Central Sudan

The typological evidence presented earlier (cf. section 5.8) tends to show that the common decorative motifs linking Shaqadud (midden) Mesolithic levels (c.82% of the total) with the Neolithic ones (c.18%) outnumber the differences. With the exception of wavy line pottery which is the diagnostic feature of Early Khartoum (Khartoum Mesolithic) tradition found in the lower levels of Shaqadud midden and triangules/vees, fishnet decorations which are solely restricted to the upper levels of the midden (Neolithic period), the remaining decorations are analogous in both stratigraphic columns but with varied proportional frequencies (ibid. and tables 32-33, 41-43).

If we turn to the central Nile (cf. sections 3.7-4.7, 9.5-9.10), the Mesolithic and Neolithic ceramics in Khartoum (tables 3-19, 18-22) and White Nile (tables 23-25,30-31) do share much more decorative motifs with each other than with their counterparts in the Western Butana (tables 32-33, 41-43).

Most of the decorative motifs of the Mesolithic (c.60%) and Neolithic (c.64%) periods of the central Nile (tables 3-9, 18-24, 30-31) tend to display common elements with the Mesolithic and Neolithic ceramics of the Western Butana (cf. tables 32-33, 41-43). These mainly include wavy line, dotted wavy line, zigzag, dotted straight lines and mat impressions. On the other hand, certain decorative motifs including semicircular panels, chevrons, zoned, linear impressions, fingernail, herring-bone and triangles/dots which are, in most cases,

exhibit infrequent distribution among the Mesolithic and Neolithic ceramics of the central Sudan are missing in the ceramic corpus of the Western Butana (ibid.).

The results of the analyses of the overall data set (see infra) indicate a marked homogeneity between the Mesolithic, Neolithic and modern pottery samples of the central Nile (Khartoum and White Nile regions) and Western Butana regions.

On the basis of the above reviewed evidence, the possibilities that Shaqadud might have only been a seasonal camp occupied during wet or dry episodes have proven invalid. If either of these possibilities turned to have been operational during the occupation of Shaqadud settlement in the Western Butana, then the mineralogical compositions of the pottery and/or its typological features linking this complex site (midden and Cave) with the central Nile (Khartoum and White Nile) must significantly outnumber the differences shared.

The results of the petrological analyses indicate that there is no significant variability amongst the Khartoum and White Nile Mesolithic and Neolithic ceramic fabrics in the proportions of different minerals which could suggest the use of similar temper (Nubian Sandstone and Basement Complex) and clays (Nile silt and alluvial clays) (cf. sections 3.3, 3.3.7, 4.3.4). On the other hand, the results of the petrological analyses of Shaqadud Mesolithic (lower midden) and Shaqadud Neolithic (upper midden) are characterized by variability in mineral components rather than proportional occurrences (cf. sections 5.7, 5.3.5, 5.7.3). This phenomenon seems to suggest the use of diversified sources for tempering inclusions.

X-ray diffraction results did not provide any characteristic groupings. In addition to the absence of the key minerals (montmorillonite, kaolinite, illite, chlorite....etc), the samples of all the Mesolithic, Neolithic and modern local pottery tend to show a fair homogenous range of occurrences of the most minerals identified. The sole exception, being a single sample from Islang2 (G93-17a-table 11) in Khartoum Province which shows a weak absence of kaolinite (cf. sections 6.3.2, 6.5.3). This unfortunate, because the distribution of the key minerals particularly montmorillonite which is the dominant mineral in the clays of the central Sudan versus kaolinite would be helpful in deciphering the source (s) of the ceramics in the study area (cf. section 6.3.2).

On the basis of pottery chemistry, a couple of triangular diagrams (cf. figs.57-58 and sections 3.5-5.5, 6.3.3.3) tends to show that Al203, Ti0 and Mg0 of the central Nile (Khartoum and White Nile) are distinct from those of the Western Butana in having relatively high concentrations of Al203 and low proportions of Tio2 and Mg0.

The similarities in the clay matrices of the Mesolithic and Neolithic pottery samples of the study area (X-ray diffraction and geothite norm calculation results) and the fair homogeneity of the chemical compositions (XRF analysis) do not seem to constitute a unitary source (see below).

With respect to the Western Butana, alluvial deposits which extends along the seasonal water flow system of Western Butana (fig. 52) are formed on Wadi beds with their bulk of loose sediments and probably washed down by rains from the clays of the Basement Complex where the Wadis originate (see Ahmed 1984:88-89). These are most probably the source of clays utilized by Shaqadud Mesolithic and Neolithic potters, some of which are within easy reach to this settlement, being located at 4-5 km distance (cf. sections 6.3.2, 6.5.3). On the other hand, the Nile silt quarried from the Nile flood plain was the most probably accessible source to the Mesolithic and Neolithic potters of Khartoum Province (fig.4) and White Nile region (fig. 39) with least effort as it is in close proximity to the sites examined in the present work (see figs.1, 4, 39 and sections 6.3.2, 6.5.3).

On the basis of the evidence reviewed above, the possibility that Shaqadud might have solely been a seasonal camp occupied during the wet (Peters argument) or dry season (Haaland argument) (cf. section 9.5.2 for detailed discussion) has proven invalid.

If either of these possibilities turned to have been operational during the occupation of the settlement, then the typological and mineralogical features connecting this site with the central Nile (Khartoum and White Nile regions) should reflect close similarities, significantly outnumbering the differences. This is specially so, even if we take into account that the central Nile potters, particularly those from Khartoum, might have practised the manufacture of pottery during their

seasonal encapment in the Western Butana rather than carrying with them their own utensils (see below).

A shown in the ethnographic record (see Shepard 1956: 33-338), in such conditions one would expect potters to work under the grip of their own tradition at least for specific period of time before acquiring influence(s) of pottery styles of their new milieu. On the other hand, zones of admixtures of the Mesolithic and Neolithic ceramic counterparts from the central Nile (Khartoum and White Nile regions) and the eastern Butana (cf. sections 9.5.2, 9.10.3) have not been encountered in the Mesolithic and/or Neolithic levels of Shaqadud midden and Cave (see Mohamed-Ali 1991:65-93 and Robertson 1991:123-174). This would weaken the possibility that Shaqadud complex site might have been a seasonal camp occupied only during dry or wet periods as shown above. Therefore, 1-way exchange/distribution process during the Mesolithic (c.8000-5000 B.C.) and early Neolithic periods (C. 4800-4000 B.C.) radiating from Khartoum area towards the Western Butana and an inverse process from the latter area (Western Butana) towards the former one (White Nile) during the late Neolithic period (cf. sections 9.5.2, 9.10.3) seem conceivable explanations delineating the mechanisms of pottery exchange operating in the central Sudan.

In the central Nile (figs. 4,39), both in respect of technological (cf. sections 3.3., 4.3-4.6, 6.3, 6.4.2) and typological (cf. sections 3.7, 4.7) aspects, the Mesolithic and Neolithic ceramics of Khartoum and White Nile regions, are similar in an essential way. With regard to the typological aspects, there is a remarkable overlap between the decorations of the Mesolithic and Neolithic ceramics of the two regions. While the unburnished wavy line and dotted wavy line are confined to the Mesolithic period, zigzag, dotted and impressed straight lines, are the most commonly encountered in both regions during the Mesolithic and Neolithic periods. However, a few decorations including parallel groovings and wiped surfaces are present among the White Nile Mesolithic and Neolithic collections of the Western Butana are entirely absent in the Khartoum district (ibid. and section 9.5.1).

The physico-scientific analyses indicate that the Mesolithic and Neolithic pottery samples, in most cases, display a fair degree of physical and chemical

homogeneity with little variations at intraregional and interregional levels, perhaps, reflecting the amount of temper present (e.g. Mesolithic and Neolithic pottery samples) and the particularity of the ceramic phase (e.g. modern pottery samples). The most distinct variation, being the presence of calcitic tempered ceramics at the late Neolithic period (cf. sections 3.3-3.6, 4.3-4.6, 5.3 - 5.6, 6.3-6.6).

On the basis of the evidences reviewed above, physico-scientific analyses have not been able in yielding information to show probable movements of the Mesolithic and Neolithic ceramics from Khartoum Province to the White Nile region or vice versa. At the same time, a high degree of typological similarities between these regions (see supra, this section) coupled with the relatively earlier Khartoum Mesolithic and Khartoum Neolithic radiocarbon dates versus the White Nile ones which are partially synchronous, it does not seem unlikely that the common ceramic traits found at the latter region were a result of a return contact from the former. If that is the case, then a north-south direction of pottery movement (fig. 93) to delineate the nature of relationship between these two regions becomes plausible.

9.11.2 North Sudan

9.11.2.1 Shendi reach

El-Kadada Pottery (fig.1) which is mainly characterized by burnished incisions, parallel dots and rippled decorations (cf. section 10.1.2) is reminiscent of Geili pottery (fig.1) in Khartoum Province (cf. section 10.1.1.1) and the Classic A-Group in Wadi Halfa (fig.2) (cf. section 10.1.2.4), all of which are dated to the late Neolithic period (c. 3590-3000 B.C.) (cf. chapter 10).

Mineralogically, the sandy fabrics of El-Kadada Neolithic site are comparable with their counterparts in Khartoum, White Nile and Western Butana regions (cf. section 6.4.2.2.). Yet, the site lacks typical "Khartoum Neolithic" ceramics (triangles and fishnet) and its radiocarbon dates (c.3530 ± 60 B.C.) place it in Post-Khartoum Neolithic period (cf. sections 9.5.2, 10.1.2.1). It is thus contemporary with the late phase of Nofalab2 Neolithic and the early phase of Shaqadud Cave in the Western Butana (cf. sections 10.1.1.1, 10.1.1.3, 10.3). Therefore, on the basis of the relatively older Neolithic sequences in both

Khartoum and Western Butana (ibid.), a south-north movement, perhaps, via Western Butana region towards Shendi reach seems a likely explanation to the general similarities in the ceramic repertoire of these regions.

9.11.2.2 Atbara reach

In the absence of comparative mineralogical data from the Atbara reach, only decorative motifs of the Mesolithic ceramics from this area (Abu Darbein, Aneiba and Damer) particularly wavy line and dotted wavy line forms a cultural link with Khartoum, White Nile and Western Butana counterparts (cf. El-Mahi and Haaland 1984:28-32, Haaland and Magid 1991:36-40, 1992: 17-27). But since the oldest radiocarbon dates from Khartoum area (c. 7350 - 6050 B.C.) are older than those of the Atbara reach (c. 6527-6085 B.C.) (cf. sections 10.1.1.1, 10.1.2.2), a south-north contact seems a much more likely explanation to the nature of mechanisms articulating the human groups in Khartoum Province and Atbara reach during the Mesolithic period.

9.11.2.3 Dongola reach

The sandy fabrics of Early Khartoum related Groups (N 13-4-7, N 13-4-22, N402) are comparable with their contemporaneous of the central Sudan (cf. sections 6.4.2.2). The Mesolithic ceramics of the central Sudan have got older radiocarbon dates in comparison with the remaining parts of the Sudan (cf. section 10.1) and in the lack of radiometric dates for Dongola reach Early Khartoum related Group (cf. section 10.1.2.3), cultural contact(s) could hardly be traced. But since the Mesolithic settlements are more pronounced in the central Sudan particularly in Khartoum Province and have got older radiocarbon dates in comparison with other regions in the Sudan as shown above (see supra, this section), the possibility that a south-north contact as an explanation to the decorative and fabric analogies between the Mesolithic ceramics of the central Sudan and Dongola reach does not seem unlikely.

The ceramics of Karat and Tegris groups which are typologically comparable with the "Khartoum Neolithic" examples of the central Sudan (cf. section 10.1.1) and Upper Nubia (cf. section 10.1.2.4) have not as yet been subjected to fabric

analyses. Moreover, they are lacking radiometric dates. But since they are closely similar to "Khartoum Neolithic" ceramics in Khartoum Province which are firmly dated to c. 4000 B.C. (cf. section 10.1.2.3) in comparison with their counterparts in Upper Nubia (cf. section 10.1.2.3), a south-north influence explaining the nature of these stylistic similarities does seem fairly likely. On the other hand, El-Malik group ceramics (cf. section 10.1.1.2) are atypical to those of Khartoum and Upper Nubia and hence the nature of cultural connections between these areas could not be determined for certain.

9.11.2.4 Upper Nubia

Further afield in the Second Cataract district, the ceramics of Abkan (mainly plain and often ornamented with impressed motifs) and Khartoum Variant (overwhelmingly woven mat) (cf. section 10.1.2.4) are reminiscent of "Khartoum Neolithic" pottery from the central Sudan (cf. sections 3.7-5.7, 10.1.1). Moreover, the sandy fabrics and the montmorillonitic nature of the clay matrices tend to show that the make-up of the ceramic groups (Abkan and Khartoum Variant) was a derivation from local lithological provenances (cf. section 6.4.2.2.).

Inspite of the partial contemporaneity, the radiocarbon dates of the central Sudan ceramics (cf. section 10.1.1) are, in general, relatively earlier than those of the Second Cataract (cf. section 10.1.2.4). If we add to that the disparate nature of their lithic typologies and technologies (cf. sections 2.2.- 2.6, 10.3) the proposed south-north directionality of the Neolithic ceramic traits between the Second Cataract area and central Sudan seems fairly likely as a delineation to the nature of the cultural ties between these two regions (see fig. 93).

In Wadi Halfa district (see fig.1) post-Shamarkian Neolithic pottery has not as yet been studied. Therefore, generic connections with the central Sudan could not be traced (cf. section 10.1.2.40).

The early A-Group pottery of the same area (see supra, this section) is mainly characterized by black-topped vessels recalling predynastic (Naqada I and Naqada II) ceramics of Egypt (cf. section 10.1.2.4). Nevertheless, the oldest date of the early A-Group (c. 4500 B.C.) overlaps with the early dates from the central

Sudan (cf. section 10.1.2.4). Similarly, Classic (C. 3400 B.C.) and Terminal A-Groups (c. 2890 B.C.) which are, respectively, characterized by black-mouthed and egg-shaped vessels, lie outside the norm of "Khartoum Neolithic" ceramics despite their temporal link with some Neolithic ceramics from the central Sudan (cf. section 10.1/2/4 for further information). Therefore, in the present level of information, reciprocal exchange system during the Neolithic period between the ceramics of Wadi Halfa (see supra, this section) and the central Sudan (cf. sections 9.10, 10.1.1) did not seem to have taken place.

9.11.3 Eastern Sudan

The early ceramics of the eastern Butana (Pre-Saroba phase) (cf. sections 9.10.3, 10.1.4.1) are comparable with the Mesolithic ones of the central Nile near Khartoum (cf. sections 3.7, 10.1.1) or on the White Nile Province (cf. section 4.7) with respect to wavyline and dotted wavy line decorations. Yet, the knobbed decorations of the eastern Butana (Saroba and Kassala phase) have not been found in the ceramic collections of Khartoum Province, Western Butana and the White Nile regions (ibid.).

The eastern Butana Neolithic ceramics from the Gash delta (K1-11) near Kassala (cf. Fattovich et al 1974: 173-190, Marks and Sadr 1988:69-90 and fig.2) were not subjected to physico-scientific analyses. Hence, fabric comparisons with the central Sudan is not possible. On the other hand, the petrological analysis of the eastern Butana Neolithic pottery of Atbara reach (N110, N114-0, N114-6, N128) near Khashm el Girba town (cf. section 6.4.2) and fig.2) shows that its mineral suite is composed of diabase, basaltic rock fragments and small fragments, of augite, hypersthene and hornblende indicative of a derivation from the Abyssinian basalts which are drained by the Atbara river in eastern Sudan (ibid. and fig. 2). Thus the eastern Butana Neolithic pottery as seen from Khashm el Girba (see supra, this section) shows marked differences in mineralogical composition in comparison with the contemporary Neolithic pottery from the central Sudan (cf. sections 3.7-5.7).

The early eastern Butana pottery (Pre-Saroba phase) which shows ties with the central Sudan examples has not yet been examined for fabric composition by

physico-scientific analyses (see supra, this section, Fattovich 1974:173-190; Marks and Sadr 1988:65-90). Therefore, fabrics of Khashm el Girba Neolithic ceramics of this region would not be helpful not only because of their exotic mineral suite (see above) but also they are atypical and of a much later date (c. 3125-3060 B.C.) in comparison with the central Sudan (mainly c.4500-3500 B.C.) (cf. section 10.1.1).

It is worth repeating that Shaqadud Cave pottery (cf. section 5.7) of the Western Butana (central Sudan) is the sole example showing typological comparisons with the eastern Butana ceramics of Khashm el Girba (cf. Fattovich 1974: 171-190, fig. 4:5, fig.5 and Marks and Sadr 1988:65-90) are restricted to brushed (scraped) vessels, parallel groovings and zoned impressions (ibid.).

On the basis of the present evidence reviewed above and apart from the lack of the evidence pertinent to pottery importation (exotic minerals) in the eastern, Western Butana, Khartoum and White Nile during the Mesolithic and Neolithic periods, the possibility of a west-east ceramic movement, perhaps via Western Butana, becomes a likely explanation to the general affinities shared.

9.11.4 South eastern Sudan

9.11.4.1 Jebel Moya

The petrological and chemical analyses (cf. sections 6.3.1 - 6.3.3) have presented evidence suggestive of movement of calcitic inclusion pottery from the late Neolithic site of Shaqadud Cave (Western Butana) towards Rabak site-Jebel Moya levels. (White Nile). The analyzed calcitic samples of both sites are characterized by parallel grooving decoration (cf. sections 5.5.3, 6.3.1-6.3.3), a motif which is absent in the Neolithic ceramics of Khartoum (cf. section 3.7), White Nile (Shabona Mesolithic and Rabak-Kh.Neo. L) (cf. section 4.7) and Western Butana (Shaqadud midden) (cf. section 5.7). This type of decoration is common in the Atbai ceramic tradition described from Kassala area in the eastern Sudan (cf. Fattovich 1984: 180, 183, fig.5:4,6) and therefore, raises the question of cultural connection between the eastern, western Butana and the White Nile regions during the late Neolithic period (cf. sections 10/.1.1.2-10.1.1.3, 10.4.1).

In the absence of comparative mineralogical analyses for Jebel Moya Neolithic ceramics (cf. Addison 1949 and fig.2), the nature of pottery distribution of this site (Jebel Moya) and its contemporaneous of Rabak (Jebel Moya levels) (White Nile) and Shaqadud Cave (Western Butana) could hardly be traced.

The common ceramic features linking Jebel Moya late Neolithic occupation (cf. Addison 1949, Pls. XC1, XCIII, B.no.213 and Haaland 1989:46-47, fig.4) with Rabak-Jebel Moya levels - of the White Nile (cf. sections 4.7, 9.10.3 and Haaland 1989: 359-361) and Shaqadud Cave of the Western Butana (cf. sections 5.7, 9.10.3 and Robertson 1991:123-172) are globular shaped vessels, impressed, wiped decorations and burnishing. However, in the light of the above cited resemblances, the absence of the typical decoration of Shaqadud Cave and Rabak-Jebel Moya levels-and the relatively earlier uncalibrated radiocarbon date of Jebel Moya (c.3800-c.2400 B.C.) (see Haaland 1984:43) in comparison with Rabak-Jebel Moya levels (c. 3500-2915 B.C.) (see Hassan 1986:86, table 1) and Shaqadud Cave (c. 2970-1735 B.C.) (ibid.), the probability that the later two sites (Rabak - Jebel Moya levels - and Shaqadud Cave) absorbed these ceramic traits from Jebel Moya settlement becomes fairly likely.

9.11.5 Western Sudan

In the Western Sudan, the diagnostic Mesolithic ceramics namely wavy line and dotted wavy line that are tempered with quartz-rich sand are encountered in Wadi Howar (fig.41). However, the associated radiocarbon date of these ceramics (4450 ± 95 B.C.-KN-2961) is younger than those of the Mesolithic settlements of the central Sudan (c. 9000-5000 B.C.)(cf. section 10.1.1).

During the Neolithic period rocker stamp motifs which are prominent in the central Sudan Neolithic sites (cf. sections 3.7-5.7, 9.9) have been recorded from a dune site east of Wadi Howar. Nevertheless, a date in the magnitude of c.3600 B.C places Wadi Howar Neolithic pottery in the time scale of the late Neolithic sequence in the central Sudan (e.g. the late phases of Geili Neolithic site, c.3600 - 3500 B.C.), though significantly later in date than "Khartoum Neolithic" as represented by Shaheinab and related sites in the later area (cf. section 10.1.1.1).

Therefore, an east-western mobility radiating from the central Sudan, resulting in the occurrence of rocker-stamped pottery in Wadi Howar does seem fairly possible.

After the disappearance of "Khartoum Neolithic" pottery at Wadi Howar, a new group of pottery known as "Hou Hou" mainly characterized by plain, unburnished style and often geometric designs appeared (see below).

It has no generic connections with the Mesolithic or Neolithic styles of the central Sudan (cf. section 10.1.3). Though its date (c.3160 - 2060 B.C.) is partially contemporaneous with the late Neolithic sequence of Shaqadud Cave (c. 2970-1735 B.C.) and the Jebel Moya levels of Rabak site (c.3500-2915 B.C.) in the central Sudan (cf. section 10.1.1.3), yet ceramic link between the central Sudan and Wadi Howar during this time does seem unlikely on the basis of the typological differences shown above.

9.11.6 Saharan Africa

9.11.6.1 Egyptian Sahara

The diagnostic Mesolithic (unburnished wavy line and dotted wavyline) and Khartoum Neolithic (triangles and fish-scale motifs) of the central (cf. sections 3.7-5.7, 10.1.1) and northern (cf. section 10.1.2) Sudan are absent in the western and southern Egyptian Sahara. Nevertheless, some decorations mainly woven mat motifs characterizing the "Middle Neolithic" of Bir Kiseiba pottery, chevrons and linear impressions which are the diagnostic features of Wadi Bakht bear general resemblances to the Mesolithic and Neolithic ceramics of the central Sudan (cf. sections 3.7-5.7, 6.4.3.1, 9.10.2, 10.1.2, 10.2.2).

As previously indicated (cf. section 6.4.3.1), the Neolithic pottery of Nabta playa which is tempered with metamorphic gneiss with or without intrusive acidic igneous, containing microcline, polycrystalline quartz, hornblende, though bears some resemblances to fabrics group B of Geili and group C of Rabak (Kh. Neo. L) and Shaqadud Cave in the central Sudan, is basically different from the main mineral suite of ceramics from the later area which is mainly characterized by quartz-rich sand (ibid).

The Neolithic pottery temper of Bir Kiseiba which is distinguished by calcareous metamorphic fabrics bears some resemblances to the metamorphic fabrics of Nabta Playa and central Sudan (Geili, Rabak and Shaqadud Cave) (see supra and sections 3.3.6.2, 4.3.3, 5.3.4, 6.4.3.1) was most likely quarried from similar source. Similarly, the sedimentary (mainly quartz and little feldspar) and igneous (mainly microperthite) fabrics of Wadi Bakht ceramics seem to have a fairly local derivation from the Nubian Sandstone on which the site is situated and the Basement Complex in its vicinity (ibid.).

Exchange mechanism does not seem unlikely despite the fair possibility of local procurement of raw material being used for manufacturing ceramics of the Egyptian Sahara (cf. section 6.4.3). There were ties between the Sahara and the Nile valley since the early mid Holocene envisioned in contacts of movements of people and goods (cf. section 9.10.4 for further information).

Inversely, the general ceramic parallels and the fair likely local derivation of mineralogical composition of the Egyptian Sahara Neolithic ceramics (see supra, this section) coupled with their relatively later dates ($\leq$ 7000-4000 B.C.) in comparison with their counterparts in the central Sudan ($\geq$ 8200 - 4000 B.C.) (cf. sections 6.3, 6.4, 9.5-9.9, 10.1.1, 10.2.2) raise the probability that these general parallels do not constitute, at least, a substantial ceramic movement (if any) from the central Sudan.

The scale of resolution as seen from the physico-scientific analyses (cf. sections 6.3.1-6.3.4) is not quite satisfactory as to clearly identify ceramic movements between the central Sudan and the Egyptian Sahara (see supra and sections 6.3-6.4). Nonetheless, the evidences of people and items movements (see supra and section 9.10.4) seem to strengthen the probability of some kind of contact, perhaps indirect one (reciprocal exchange) accounted for the presence of parallel Mesolithic and Neolithic ceramics in the Egyptian Sahara and the central and northern Sudan (central Nile valley) (see supra, this section).

Given the relatively older radiocarbon dates of the Mesolithic and Neolithic ceramics in the central Sudan in comparison with their contemporary counterparts in the Egyptian Sahara coupled with the frequent contacts of people across the

wooded-steppe of the present day eastern Sahara, the probability that the later area received its Khartoum Mesolithic and Neolithic pottery styles from the central Sudan, perhaps, via the Second Cataract (fig.93) becomes fairly likely.

9.11.6.2 Central Sahara

Despite the general resemblances in decorations (cf. section 10.2.2), the petrological analyses of central Saharan Mesolithic and Neolithic ceramics indicate heterogeneous fabrics (cf. section 6.4.2). While Amekni (Algeria) Mesolithic is, solely, distinguished by quartz-rich sand along with schists, rock fragments and hornblende, Wanyanga (Chad) Neolithic pottery is characterized by quartz- rich sand and vegetal fibres (ibid.).

It is interesting to note that these Mesolithic and Neolithic fabrics have their counterparts in northern (Dongola reach) and central (Khartoum) Sudan (cf. section 6.4.2). Nevertheless, the vegetal fibre which is the prominent feature of Wanyanga ceramics (Chad) is absent in the ceramics of the central Sudan and the non-plastic inclusions of the latter are more finer in texture than those of Wanyanga (ibid.).

Since the provenances of the central Sahara Mesolithic and Neolithic ceramics are fairly likely to be present locally, cultural networks, perhaps, in the form of movements of individuals and small mobile groups might have accounted for the distribution of the common decorative motifs in the central Sahara and central/northern Sudan (central Nile valley). But since the main suite of the radiocarbon dates of the central Nile valley Mesolithic and Neolithic ceramics (cf. sections 10.1.1-10.1.2) is relatively earlier than that of the contemporary central Sahara (cf. section 10.2.2), an east-west contact seems a much more likely explanation delineating the nature of cultural connections between the two regions. This probability seems to get further support from the evidence of movements of non-ceramic items from the Nile valley (Egyptian flint) and Red Sea (cowrie shells) during the first humid period (c.5150 B.C) and the second wet phase (c. 4050 B.C) of the Holocene (cf. section 9.10; Banks 1984:2 and Close 1992:170-172).

9.11.7 Lower Nile Valley

In the presence of very slender evidences (Fayum A and Badarian) or absence (Naqada 1 and Naqada II) of ceramic ties between the Neolithic cultures of upper Egypt (fig.1) and their contemporary counterparts in the central Sudan (cf. sections 10.1.1, 10.2.1), the present writer has confined himself in the present model (fig.93) to the Neolithic ceramics of the Western Egyptian Sahara where such ceramic links are conspicuous (see section 10.2.1 for further discussion).

9.12 Conclusions

The results of the physico-scientific analyses presented above (see section 9.11 and chapters 3- 6) are suggestive that the Mesolithic and Neolithic ceramics in the central Sudan fit well with the household mode of production which is sedentary during the Mesolithic period and semi-sedentary or nomadic during the Neolithic one (cf. section 9.5.1). However, the later mode of production (nomadic) became more pronounced during the late phase of the Neolithic period. The calcitic inclusions pottery presented at Shaqadud Cave (Western Butana) and Rabak-Jebel Moya levels- (White Nile) sites are in favour of raw material procurement from sources lying outside the immediate areas of the pottery-sites of find (cf. sections 4.3.4, 4.4-4.5, 5.3.4, 5.4-5.5, 6.3.1, 6.3.32, 6.4.2.2). The pastoral nature of the late Neolithic mode of life in the central Sudan which points to "logistic mobility" of dwellers frequently unrestricted to their home base and might have reached the frontier of their neighboring groups (cf. section 9.61) seems to strengthen this probability.

The present evidence (cf. chapters 3-8) tends to show that the Mesolithic and Neolithic ceramics in the central Sudan lack any evidence for kilns (forced draft), wheel or turntable and are devoid of sophisticated shapes (cf. sections 3.7-5.7). On the basis of this information, the Mesolithic and Neolithic ceramics of the central Sudan may, therefore, be interpreted as a representative of a possible household (domestic) production. However, this type of production was more likely to have been operational within reciprocal rather than redistributive or market exchanges (cf. section 9.1).

In the present study, the absence of full "Chieftainate" and clear hierarchical society in the Mesolithic and Neolithic communities of the central Sudan (cf. section 9.9) reinforces the possibility of reciprocal networks as a plausible explanation to the nature of the ceramic ties articulating the human groups inhabiting this area during the late prehistoric era (cf. section 10.1).

The diverse lines of evidence reviewed above (see infra) seem to indicate that the Mesolithic and Neolithic ceramic-bearing sites in Khartoum Province enjoyed settled way of life as confirmed by the deep occupational deposits of most sites coupled with abundant aquatic remains in comparison with those of the White Nile and Western Butana regions (cf. chapter 2 and sections 9.5-9.7, 10.1.1)

Taking into account that the Khartoum Province contemporaneous dates with White Nile and Western Butana, western, eastern and northern Sudan Mesolithic and Neolithic settlements (cf. section 10.1.1) which are, in general, relatively older, the possibility of dispersion of ceramic traits from Khartoum area to the other regions of the central Sudan (White Nile and Western Butana) since the Mesolithic period does not seem unlikely despite the marked homogeneity in the results of the physico-scientific analyses carried in the present work on selected samples from the central Sudan (cf. chapters 3-6 and sections 9.10-9.11).

During the late phase of the Neolithic period (c.3500-1735 B.C.) the appearance of new decorative motifs (parallel grooving and wiped surfaces) concomitant with experimentation of calcitic temper, as seen from Shaqadud Cave and Rabak-Jebel Moya levels-ceramic constitute a departure from the Mesolithic and early Neolithic ceramics in the central Sudan. This was, seemingly, accompanied by a shift in the orientation of ceramic movements (Khartoum) which might have taken a north-south direction radiating from the Western Butana towards the White Nile region (cf. sections 4.7-5.7, 6.3.1-.6.4.2.2, 9.111, 10.1.1.2, 10.1.1.3).

The local availability of clay and temper sources for both central Sudan and Saharan Africa Mesolithic and Neolithic ceramics coupled with the absence of ceramic evidence pertinent to importation to either area, the scale of resolution on

the basis of present results of the physico-scientific analyses (cf. sections 6.3-6.4) is unsatisfactory. Yet, in my opinion, it is highly unlikely that the common ceramic ties were a result of independent inventions at one time in the Saharan Africa and the central Nile valley. This is because the Sahara did not form a barrier during the Holocene and early Pleistocene times and movements of Mesolithic and Neolithic groups are evident (see Barich 1992:186-204 and Close 1992:156-183). If that is the case and taking into account that the evidences of the Mesolithic and Neolithic ceramic communities in the central Sudan (c. 8000-4000 B.C. are, in general, more pronounced with relatively earlier radiocarbon dates than those of their counterparts in the central Sahara (c.7000-4000 B.C.) coupled with evidences of frequent movements of people during the Holocene and early Pleistocene episodes (see supra, this paragraph and sections 10.1, 10.2.2), the possibility that the latter received its ceramic technology from the former becomes fairly likely. Therefore, on the basis of this argument, an east-west direction of ceramic movements, as already proposed (fig.93), seems a conceivable explanation to the Mesolithic and Neolithic ceramic connections between the central Sudan (central Nile valley) and central/eastern Sahara (cf. section 9.11).

Chapter 10

Chronology and Cultural Interrelations

10.1 Local interrelations

10.1.1 Central Sudan

The central Sudan in the present context includes Khartoum (Lat. 15° 11'-16° 41' N and long. 32° 34' E), White Nile (Lat. 13° 4' - 14° 38' N and Long. 32° 16' - 32° 34' E) and Western Butana (Lat. 15° 30' N and long. 33° 7'-33° 56' E) regions (fig. 1).

10.1.1.1. Khartoum Province

In this region Khartoum Mesolithic and Khartoum Neolithic ceramics have been recorded from several localities in the western and eastern bank of the Main Nile (see section 3.2. and fig.4).

The pottery of Early Khartoum tradition which is characterized by unburnished wavy line and dotted wavy line (cf. section 2.2.1) has been unearthed from the undated type-site of Khartoum Hospital (cf. Arkell 1949:81-97, Pls. 59-86:1) located at the confluence of the Blue and White Niles (fig. 1). On typological comparisons with similar ceramic assemblages in the central Sudan (e.g. Sarurab2 and Saggai1) (cf. sections 2.2.2, 3.7, 10.1.1.1) a date in the magnitude of 9th-8th millennium B.C. could be postulated for this type-locality of the Early Khartoum potting tradition.

In the western bank of the Main Nile Khartoum Mesolithic pottery was recorded from three sites namely Sarurab1, Sarurab2 and Jebel Umm Murrahi. (fig.1).

The first two excavated areas (Sarurab1 and Sarurab2) have got a series of radiocarbon dates. Test pits at Sarurab site labelled as Sarurab1 produced two radiocarbon dates associated with pottery and material culture of Early Khartoum tradition. One associated with a hearth in level 4 yielded a date of 4458 ± 80 B.C. (Q-1536) (Mohamed-Ali 1982:86); no charcoal was found with the hearth, and the sample came from a large shell identified as Burtoa nilotica (Mohamed-Ali 1982: 43, 45). A collection of bones from the Upper levels

provided a date of 3600 ± 350 B.C. (Q-1534). Most of the bone fragments collected were highly fossilized and had to be combined and diluted four times before a date could be obtained, and the excavator, therefore, suspected that the date was too recent (see Mohamed-Ali 1982:86). On the basis of the first date, he suggested that Sarurab1, which shows close affinities with Khartoum Hospital site (Arkell 1949 and section 2.2.1), indicated a latter survival for the Early Khartoum tradition (Mohamed-Ali 1982:86). The Sarurab1 dates are, however, incompatible with those obtained for Sarurab2, which the material culture recovered indicates is undoubtedly Khartoum Mesolithic. In my view the cultural similarities between the two portions of the site, outweigh the differences (cf. sections 3.1.1.2.1, 3.2, 3.7, appendix 7 and Mohammed Ali 1982:43-86) and the dates of Sarurab1 are apparently recent.

Two radiocarbon dates obtained for Sarurab2, excavated by the present writer, came from square 27, level 3 and level 4,c.30 cm and 40 cm. below the surface respectively. These levels are composed of clayey material mixed with occupational remains and ashes. The artifacts recorded in full association with the charcoal-producing levels include various types of wavy line pottery, stone grinders, disk rubbers, microliths and a complete barbed bone harpoon with a grooved butt. The virtual contemporaneity of the two dates obtained - 7380 ± 110 B.C. (HAR-3476) for the level 3 and 7420 ± 110 B.C. (HAR- 3475) for the level 4- is consistent with the uniform distribution of the artifacts. Since the charcoal was in close association with the cultural material, this adds to the credibility of these two dates for Sarurab2 of the Early Khartoum tradition (cf. also section 3.2.1.1).

The study of ceramics and other material culture from Jebel Umm Murrahi Mesolithic site is still in preparation (Al-Abbas and Elamin 1994, pers. comm.), however,a preliminary inspection (Abul Gasim 1979:191) indicates that the site yielded "Khartoum Mesolithic" type of pottery namely wavy line, dotted wavy line together with lithic artifacts showing close affinities to that reported from khartoum Hospital (cf.Arkell 1949), the type-site of the Early Khartoum tradition. Two radiocarbon dates - based on shell- are available for the site ; the oldest (level 3:30cm. below the surface) gives on age of 6870 ± 80 B.C (T-5300) and the youngest (level 2:20 cm. below the surface) being 6290 ±120 B.C.(T-5301) (Al-Abbas, pers. comm. 1994).

The Neolithic pottery on the west bank of the Main Nile is derived from Shaheinab (cf.section 2.2.1 and Arkell 1953:68-77)) Islang2 and Nofalab2 sites (cf.sections 3.2.1.2 and 3.2.1.3).

Burnished dotted wavy line pottery of Khartoum Neolithic type is present at Shaheinab site together with other decorations mainly triangles, fishnet and zigzag. The pottery of this site has got a series of radiocarbon dates with large standard errors. One date based -based on shell gave uncorrected age of 3440 ± 380 B.C. (T-754), the other - based on charcoal - gave an age of 3110 ±450 B.C. (c-753) (see Arkell 1953:68-77,107). Subsequent determinations from the same site, yielded three calibrated estimates of 4560 ± 80 B.C. (T-3222)(a sample obtained from square p-87 c.47 cm. below surface); and 4520 ± 60B.C. (T-3222) (a sample obtained from square P-87 c.5cm. below surface); 4440±60 B.C. (T-3699) (a sample obtained from square G-61 c.10 cm. below surface). The average of these acceptable dates with appropriate standard deviation is 4506 ± 65B.C. (see Haaland 1987:60-61 and Hassan 1986:85).

Islang2 site has got a series of corrected radiocarbon dates; the oldest (based on shell) being 4490 ± 150 B.C. (SMU-2575) and the youngest (based on charcoal) is 4330 ± 90 B.C. (SMU - 2565) (see appendix 3.1-3.2). A radiocarbon date of 4706 ± 170 B.C. (T-3880) was already obtained for the same site labelled as Islang (see El-Anwar 1981:44). The impreseed burnished pottery of this site resembles that of Khartoum Neolithic as represented by Shaheinab and related sites (cf. sections 2.2.-2.6, 3.2.).

The Neolithic pottery of Nofalab site is dated by two corrected C-14 dates; the oldest being 4380 ± 80 B.C. (SMU - 2577) and the youngest is 2705 ± 295 B.C. (SMU-2561). The site was previously dated by two corrected radiocarbon ages (T-3700, T-3701), the average of which gives a date of 4290 ± 130 B.C. (El-Anwar 1981:42). The pottery of this locality which is mainly characterized by vees and zigzag decorations shows close affinities with Khartoum Neolithic (Sheheinab) and related assemblages (cf. section 3.7, 5.8). The radiocarbon dates (see above) indicated that the ceramics of these assemblages are partially contemporary. The typological similarities (ibid.) seem to confirm this partial synchronism.

On the east bank of the Main Nile the early Mesolithic site of Saggai1 produced pottery mainly decorated with wavy line and dotted wavy line

(Caneva 1983: 149-189) reminiscent of Early Khartoum tradition. Four radiocarbon dates were based on Pila shell were obtained for the site and they are as follows: 2580 ± 100 B.C. (T - 5024), 5460 ± 100 (T-5025), 5300 ± 110 B.C. (T-5026), and 5280 ± 110 B.C. (T-5027) (ibid: 152). A single radiocarbon date on Nile oyster shell dated the Khartoum Mesolithic to 8130 ± 110 B.C.; this is the oldest bearing ceramics site in the central Sudan (see section 10.2.4).

The Mesolithic pottery of Kabbashi Haitah has got a single radiocarbon date-based on Pila shell-of 5520 ± 90 B.C. (T-6654) whereas the late Mesolithic pottery has a date based on Pila shell-of 4200 ± 80 B.C. (T - 6645). The temporal gap between the two ceramic assemblages seems consistent with variation in frequency distribution manifested on pottery decorations particularly wavy line and dotted wavy line (see sections 3.2, 4.2 and 5.2). During Kabbashi occupation the proportion of dotted wavy line has shown a relative increase (c.6%) in comparison with the wavy line one (c.4%) (see sections 3.2.2.2 and 3.7.2.2). However, a problem arises as the dates obtained for Kabbashi places it in the time magnitude of 'Khartoum Neolithic' sites in the central Sudan (see the foregoing discussion in this section) whereas its ceramics and other material culture (ibid.) argue for a relatively earlier date.

An interim report on a series of Early and late Khartoum Mesolithic ceramics unearthed on a number of small test-excavations at the east bank of the Main Nile has recently been forthcoming (Caneva 1993:38-50). The Early Khartoum Mesolithic pottery from El-Ahamda was undated but on typological grounds it could have a similar age as those of Khartoum Mesolithic assemblages in Khartoum Province and related sites (cf. this section and section 10.1.2). Awald el Imam gave a corrected age of 6520 ± 90 B.C. (T- 6655), Umm Singid has a calibrated date of 6100 ± 90 B.C. (T-6644), whereas the late Mesolithic assemblage of El-Temeyim was radiocarbon dated to 5132 ± 90 B.C. (Rom - 263) and El-Qala'a gave a corrected age of 5530 ± 90 B.C. (T-6656) (Caneva 1993:23). Shell was the sole material used for obtaining these radiometric determinations.

The main types of pottery decorative motifs of Khartoum Neolithic (cf. Arkell 1953:68-77, Pls.. 29-37) have been found in similar proportions at Kadero 1 and Kadero II sites. Decorative motifs made up of continuous or dotted lines either straight across the rim top or oblique are markedly frequent

(see Chlodnicki 1984:337-342, fig.2). Zigzag, herring-bone, criss-cross, cresents, triangles and other impressed decorations are present (ibid.).

Kadero I has got a couple of radiometric dates derived from shell material. Sample (T-2189) (obtained from sq. 15 c.8-10 cm below surface) gave a date of 4380 ± 50 B.C., whereas sample (T-2188) (obtained from sq.12 c.8-18 cm. below surface) gave a date of 4555 ± 85 B.C. (Haaland 1987:59). The average of the two dates is 4467 ± 65 B.C.. A single date-based on shell taken from a test pit- from Kadero II has been calibrated to 4535 ± 55 B.C. (T-3260) (ibid). The typological similarities between Kadero and Khartoum Neolithic ceramics shown above are justified by the partial contemporaneity of the two assemblages.

The pottery of Zakiab is mainly decorated with vees/dots, catfish impressions, plain red burnished and curvilinear motifs (Haaland 1987:144-180) which are represented by Shaheinab (cf. Arkell 1953:68-77, Pls. 29-31, 33:1-5, 34:8) and related localities (cf. sections 8.7, 4.7, 5.7).

Two radiocarbon dates-based on shell-were obtained for the ceramics and material culture of this site. The oldest (sq. 102X/98Y c.15 cm below surface) gave a calibrated age of 4530 ± 70 B.C. (T-2818); the youngest (sq. 102X 102 Y c.35 an below surface) gave an age of 4850 ± 160 B.C. (T-3050) Haaland 1987:59). The dates indicated that this site falls within the time range of Shaheinab (see supra) and related Khartoum Neolithic assemblages (e.g. Kadero 1, 11, Um Direiwa, 1,11, Islang, Nofalab, Rabak (lower levels) and Shaqadud midden (upper levels), (see below).

Umm Direiwa yielded ceramic corups showing close affinities with Zakiab and Shaheinab (see supra this section). The ceramics of this site include mainly vees/dots, catfish impression and plain red burnished vessels with nearly the same proportions as those encountered at Zakiab site (see Haaland 1987:40, 144-152 and section 3.7).

This site yielded three corrected dates for one assemblage (Umm Direiwa I) one of which (T-361) is too young by comparison to others and will not be considered here. The acceptable determinations (T-4045, T-3697) give an average of 4800 ± 100 B.C.. Another occupation (Umm Direiwa II) has got a single date of 3800 ± 390 B.C. (T-3698)(obtained from test pit c. 5-10 cm below

surface). The reason for this high standard deviation is the small sample of shell C. 0,7 gram (Haaland 1987:59 and Hassan 1986:86).

Geili ceramics (see section 3.7 and Caneva 1987:65-114), as previously mentioned, are mainly characterized by dotted line, rippled and incised motifs sharing close affinities with the late Neolithic pottery corpus unearthed from several localities in Khartoum district (cf. section 3.7). A single uncorrected radiocarbon date on shell is 3520 ± 100 B.C. (T-5022) placing the ceramic assemblage of this locality in the time range of Umm Direiwa II, Nofalab2 and Rabak (Jebel Moya Horizon), though significantly later in date than Khartoum Neolithic as represented by Shaheinab (cf. Arkell 1953:68-77) and contemporary ceramic assemablages (see the foregoing discussion in this section).

10.1.1.2. White Nile Province

On the White Nile Khartoum Mesolithic pottery with its distinctive types: wavy line and dotted wavy line has been found and dated at Shabona site (fig.2). The site is the most southerly in Sudan (Lat. 14 48 N, Long. 32 16 E) to produce this tradition (Clark 1989:387-410). Two radiocarbon dates of 5100 ± 120 B.C. (SUA-298) on Pila shell and 5520 ± 240 B.C. (SUA-440) on human bone suggest that Shabona was occupied in the 6th millennium B.C. though the excavator considers it earlier (ibid:389). The pottery of Shabona resembles that of Khartoum Mesolithic one in Khartoum Province sites namely Khartoum Hospital (Arkell 1949), Sarurab2 (cf. sections 3.2.1.1, 3.7), Saggai I (Caneva 1983:149-189), Kabbashi Haitah and Kabbashi (Caneva 1993:1-76 and sections 3.2.2 and 3.3.6). If its dates are accepted, they indicate a gap of c.1500-2000 years between these Mesolithic ceramic assemblages and Shabona and the close cultural affinities between them argue against such a hiatus.

The Neolithic pottery of this Province, as already indicated (cf. sections 2.5.2, 4.2-4.7, 9.11) is represented by data recovered from Guli and Rabak sites (fig. 1,2). Guli site yielded ceramic repertoire showing resemblances with Khartoum Neolithic as represented by Shaheinab (cf. Arkell 1953:68-77), plas. 30-32) and related sites (cf. sections 2.3, 2.6.2.1.2, 3.2.1.2, 3.2.1.3, 3.2.2.3). The bulk of the pottery which seems to come from deepish bowls is decorated with rocker stamp technique and only one sherd ornamented with chevron design which rarely occurs at Shaheinab (cf. Arkell 1953:pl. 37:25). However, a single

radiocarbon date-based on shell from a depth of 30-35 cm in the midden -was obtained (3530 ± 90 B.C, SUA-211) suggesting that this site can be fitted in the late Khartoum Neolithic sequence (Adamson et al 1974:122-123) and, therefore, contemporary with Geili, Umm Direiwa II, Rabak (Jebel Moya levels) and the latest phase of Nofalab2 ceramics and related sites (cf. section 10.1.1.1). In my view, the absence of burnished specimens in the ceramics of this site coupled with the absence of typical motifs of Khartoum Neolithic (Shaheinab) tradition (cf. Arkell 1953:68-77 and Adamson et al 1974:120-123) such as opposed triangles and fishnet raises the probability that Guli site could belong to an early phase of 'Khartoum Neolithic' despite its single radiocarbon date which places it in the time magnitude of the late Khartoum Neolithic sequence (cf. section 10.1.1.1).

Rabak ceramics, as previously noted (cf. sections 2.5.2, 4.2-4.7) present two types of decorations. Almost all the pottery from levels 14-4 (square 107x100Y) is identical with that of Khartoum Neolithic tradition (cf. Haaland 1987:45-47, fig.14, 1989:362-363, fig.2, section 4.7 and Pl.X). The ceramics from levesl 3 indicate a transitional phase, both pottery types of Khartoum Neolithic (cf. Haaland) 1987, fig. 14:d-f) and sherds similar to those of Jebel Moya site (Addison 1949 and fig.2) occur. The ceramics from level 1 and 2 are mostly of Jebel Moya type (cf. Haaland 1989, fig.2:4-6,11,13).

Four calibrated radiocarbon dates-based on shell-have been obtained from one square (107x100Y) dating the ceramics of this site to the range of Neolithic assemblages from Khartoum district (see section 101.1.1). The oldest level (L15) is 4890 ± 120 B.C. (T-5134) and the youngest dated level (level 2) is 3270 ± 100 B.C. (T-5132). An average date of 4350 ± 100 B.C. is obtained for the site. The oldest date of this site is contemporaneous with that of level 1 (10 cm below surface) from Umm Direiwa and levesl 2 (20 cm below furface) from Zakiab Neolithic sites in Khartoum area (cf. Haaland 1987:60-61 and fig.1). The date is older than Shaheinab, Kadero, Umm Direiwa (test pit) and Zakiab level (ibid.) providing a gap of 300-620 years. On the other hand, the youngest date associated with Jebel Moya ceramics (see supra) falls in the late 4th millennium B.C. when Khartoum Neolithic settlements were absent in Khartoum district (cf. sections 2.2 and 9.5.2.).

10.1.1.3. Western Butana region

The Shaqadud midden, as discussed in detail earlier (section 5.7), represents two ceramic assemblages. The Mesolithic levels yielded ceramics overwhelmingly decorated with banded motifs, wavy line decoration is present in small amount, whereas dotted zigzag and mat impressions are frequent (cf. section 5.7).

Four radiocarbon dates were obtained from the Mesolithic midden (S1-B). A date (based on seeds) derived from level 42 (205-210 cm below datum) gave an age of 5835 ± 445 B.C. (SMU-1736) with apparently high standard deviation and has been suspected by the excavator as aberrent (Marks 1991:61). The oldest level (3.10-295 cm below datum) is dated to 5920 ± 300 B.C. (SMU-1290). A middle level (250 - 245 cm below surace) was dated to 5760 ± 130 B.C. (SMU-1186). The upper level (145-150 cm below surace) was dated to 4630 ± 130 B.C. (SMU - 1287). The four acceptable dates averages 5436 ± 185 B.C.. All these dates were based on charcoal and corrected for isotopic fractionation (see Marks 1991:61 and appendix 6). Remarkably, there is a time lag exceeding 1000 years between the dates of the lower and top units of the Mesolithic midden which is not concomitant with a marked change in ceramic traits (cf. Mohamed-Ali 1991:88-92 and section 5.7). The Neolithic levels, as reviewed elsewhere (cf. section 5.2.1) provided distinct pottery virtually different from the Mesolithic levels (cf. sections 5.7.3 and 5.8). Two radiocarbon dates (based on seeds) obtained from different Neolithic levels of the midden, yielded corrected estimates of 4880 ± 180 B.C. (SMU-1735) and 4430 ± 180 B.C. (SMU-1134). The samples were obtained from spits of level 12 (55-60 cm. below datum) and L18 (85-90 cm. below datum) respectively.

In the writer's opinion, the results tend to show that the time difference between the top and bottom layers of the midden is consistent with the observed frequency distribution pertaining to the Khartoum Mesolithic and Khartoum Neolithic ceramics through the stratigraphical column of the midden (cf. sections 5.2.1 and 5.2.2). It is also noticeable that the dates of the Khartoum Mesolithic and Khartoum Neolithic levels, seem to place the ceramic assemblages of the midden in the time magnitude of their counterparts in Khartoum province (cf. section 10.1.1.1) and the White Nile region (cf. section 10.1.1.2).

With regard to Shaqadud Cave, as previously noted (cf. sections 5.2.2 and 5.8), its diagnostic ceramic traits (unslipped, wiped with striations of brush, hachured zones and fingernail impression) are markedly different from those encountered at Shaqadud midden (cf. section 5.2.1), the latter ceramics are akin to the Khartoum Mesolithic and Khartoum Neolithic ceramics of the central Nile (Khartoum and White Nile Provinces). (cf. sections 10.1.1.1 and 10.1.1.2). The pottery of Shaqadud Cave (cf. section 5.2.2) which falls outside the norm of Khartoum Mesolithic and Khartoum Neolithic corpus, shows clearly the diagnostic traits of the Atbai ceramic tradition in the Gash Delta from Kassala area, the eastern Sudan (cf. section 5.7 and Fattovich et al 1984:180, 180, fig.4:5, fig.6:3, 6,7). Five radiometric dates were obtained for the Cave, but they cluster into two groups:between 2030 ± 200 B.C. (SMU-1697) and 1990 ± 130 B.C. (SMU-1133) and between 2755 ± 135 B.C. (SMU-1128) (see Hassan 1986:table 1) 2710 ± 140 B.C. (SMU-1128) and 2600 ± 170 B.C. (SMU-1208) (see Marks 1991:61 and appendix 6). The oldest dates provide an average of 2655 ± 150 B.C. whereas the youngest are in the magnitude of 2000 ± 165 B.C.. Therefore, these radiocarbon dates suggest that Shaqadud Cave is partly contemporaneous with the early Kassala ceramic phase of the Gash Delta (cf. section 10.1.4.1), whereas the youngest date overlaps with the early phase of the Gash Group (Mahal Teglinos). In the meantime, this partial synchronism may explain the stylistic similarities between the late Neolithic ceramics of the Western Butana (Shaqadud Cave) and the Gash Delta (Mahal Teglinos) in the Kassala district.

10.1.2 Northern Sudan

The northern Sudan includes Shendi, Atbara, Dongola Reaches and Upper Nubia (fig.1).

10.1.2.1 Shendi Reach

The pottery of El-Kadada in Shendi area (fig.2) which is mainly decorated with burnished incisions, parallel dots and ripples has got five corrected radiocarbon dates (G1F-4675, G1F-5770, G1F-5508, G1F-5771) (Geus 1984:367-368, figs. 6:1-2,7:1). The oldest (KDD 76 Grave3) gave a date of 5507 ± 120 B.C. (G1F-5771) which is too old in comparison with other dates and may belong to an early occupation. The youngest (KDD22 Grave5) is 3390

± 120 B.C. (G1F - 4675). The average of the four dates is 3530 ± 60 B.C. (Hassan 1986:87-89). The available radiocarbon dates place this site in the post-Khartoum Neolithic period, (cf. section 9.5.2). The lack of the diagnostic Khartoum Neolithic ceramics (triangular and fishnet impressions) (cf. Arkell 1953, Pls.40: 11,41;15 and Reinold 1987a: 51-61, 1987b:61-62, 1987c:17-56; Reinold and Lenoble 1987:47-48) is consistent with the relatively later date of this site in comparison with the early Khartoum Neolithic ones (cf. section 10.1.1).

10.1.2.2. Atbara Reach

The Mesolithic pottery of the Early Khartoum type (cf. Arkell 1949:81-97, Pls. 59-86:1) which is characterized by wavy line and dotted wavy line decorations was unearthed from three sites at Atbara Reach namely Abu Darbein(33° 50'N, 17° 40'E), El-Damer (34° 35' N, 17° 35'E) and Aneibis (34° 35', 17° 58' E) (see El-Mahi and Haaland 1984:28-32, Haaland and Magid 1991:36 - 40, figs:3,5; 1992:17-27, figs:5,6 and section 9.5.1).

The pottery of Abu Darbein site has got the oldest radiocarbon dates (six examples) with an average age of 6438 ± 120 B.C.; the oldest is 6860 ± 120 B.C. (T-8624) whereas the youngest is 5910 ± 140 B.C. (T-5728) (Haaland and Magid 1992:23 and section 9.5.2).

El-Damer Mesolithic pottery has got 13 radiometric dates, seven of which were obtained from graves. The oldest calibrated date for the site is 6527±110 B.C. (T-8637), whereas the youngest is 6085±110 B.C. (T-8631) (Haaland and Magid 1992:23).

Aneibis site has yielded seven radiocarbon dates, providing time span ranging from 6855±100 B.C. (T-8644) to 5690±170 B.C. (T-7481) with an average age of 6504±110 B.C. (Haaland and Magid 1991:36-40,1992:17-27). The ceramics of the three sites are comparable (ibid.) and tend to show close affinities with their Mesolithic contemporaneous groups on the central Nile. (Khartoum province and White Nile)(cf.sections 50.7.3, 10.1.1.1 and 10.1.1.2).

10.1.1.2 Dongola Reach

Several prehistoric ceramic - bearing sites came to light as a result of a reconnaissance covering an area of 160 km2 in the Dongola Reach (fig.1)(lat.19 5-19, long. 30 10-30-40) and four ceramic assemlages were distinguished (Marks et al 1968:319-323 and section 9.10.3).

Seven Early Khartoum Related Groups (N 13, N 15, N 40-41, N62, N 79, N92) were reported with large number of thick and unburnished wavyline and dotted wavy line (Marks et al 1968: 321-323, fig.5) showing clear affinities to those reported from Khartoum Hospital (cf.Arkell 1949:81-95 and similar Mesolithic sites in Atbara Reach (cf.section 10.1.2.2) and central Sudan (cf. section 10.1.1) Pls.59-86:1). No radiometric date is available for the Early Khartoum Related Group. On typological grounds (cf.section 10.1.2.3) they could have been contemporaneous with their dated counterparts in the Atbara Reach and central Nile (Khartoum and White Nile regions)(ibid.).

Nineteen sites of karat Group produced very thin burnished pottery tempered with sand. Decorative motifs include shallow punctate some of which are similar to the typical 'Khartoum Neolithic' designs (cf.Marks etal 1968:321 and Hays 1971a:187-190) and bands of 'zigzag' design which also occurs in 'Khartoum Neolithic' (see Arkell 1953:Al.32:2-6) and early A-Group sites of the second cataract (see Adams and Nordstrom 1963:18). On the basis of typological comparisons with the dated Khatoum Neolithic and early A-Group ceramics, the karat Group pottery could have been dated to the mid fifth millennium B.C. (cf.supra and sections 10.1.1.1 and 10.1.2.3).

The pottery of Tegris was unearthed from five sites (N3, N30, N55, N57, N90). The pottery is rare, burnished and when present it is sand-tempered decorated with punctate and cord impressed bands (Marks 1968:322 and Hays 1971a:75, fig.10). These decorations coupled with burnishing exteriors on the pottery suggest connection with Khartoum Neolithic as represented by Shaheinab (cf. Arkell 1953:68-77, Pl. 37:13) and some related sites (cf. sections 3.7 and 10.1.1.1 and 10.1.1.2). Therefore, contemporaneity, at least partially, with Khartoum Neolithic could be postulated.

The pottery of El-Melik Group was studied from four sites (N25, N47, N50 and N89). It is rare and when present ornamented with simple incisions (Marks et al 1968:322 and Hays 1971b:267-290. In the absence of typical Khartoum Mesolithic and Khartoum Neolithic ceramics, cultural connection with the central Nile (Khartoum and White Nile Province), the western Butana and related ceramic assemblages (if any) (cf. sections 3.7, 4.7 and 5.7) could hardly be traced.

10.1.2.4 Uppper Nubia

By Upper Nubia it is meant Sudanese Nubia which was affected by the water of the High Dam (fig.1). Early ceramic assemblages in this area include post-Shamarkian, Abkan, Khartoum Variant and A-Group (see below).

Post-Shamarkian Neolithic (sites D11W40 and D1W50) pottery (n=210 specimens) has not as yet been studied and hence no correlation could be made with ceramics from the early Nubian sites. Two radiocarbon dates of 3640±200 B.C. (WSU-174) for D1W50 and 3260±50 B.C. (WSU-103) for D1W40 were obtained (Schild et al 1968:757-766). On the basis of this information ceramic connection (if any) with the Neolithic of the central Sudan could not be traced.

The Abkan pottery of the Second Cataract and Wadi Halfa reach which is mainly plain and often decorated with impressed, incised and zigzag motifs. (Myers 1960:174-81; Nordstrom 1972:74-77). The impressed decoration (ibid., Pls. 132:5, 137:4, 139:1-3, 5-6) is very often similar to that of Khartoum Neolithic (Shaheinab) (cf. Arkell 1953, Pls. 29:2,31:25-29, 32:1-5).

Four radiocarbon dates (not stated what type of material used) have been obtained for the Abkan ceramics. The oldest is 4010±400 B.C. (M-803) (Myers 1960-177). The other three dates (based on shell) from sites AS16-S-10 in Ambikol east are 3310 ± 90 B.C. (U-2490), 3640 ± 150 B.C. (U-4001) and 3760 ± 160 B.C. (U-802) (Nordstrom 1972:25 and Hassan 1986:93-94). These radiocarbon determinations place Abkan Neolithic ceramics in the time range of Khartoum Neolithic as represented by Shaheinab and related sites (e.g. cf. section 10.1.1).

The pottery of Khartoum Variant which is overwhelmingly decorated with woven mat, linear motifs and rarely ornamented with dotted wolf-tooth and

wavy line (see Shiner 1968:768-790, Nordstrom 1972:8-12, Pl. 60:1-11; Hyas 1974:27-32, fig. 1) shows similarities with ceramics of 'late Khartoum Mesolithic' at Dongola Reach (Marks 1968:321-323, fig.5) and Khartoum area (cf. Caneva et al 1993:39, fig.8 and sections 4.7, 10.1.1.1).

Three radiocarbon dates were obtained for the ceramics of Khartoum variant sites. A single date-based on ostrich egg-shell-from Dibeira West5 gives a corrected age of 5410 ± 140 B.C. (TX-1155), whereas the other two-based on charcoal-from Soleb12 and Soleb13 provide corrected age of 5070 ± 115 B.C. (P-721) and 5005±90 B.C. (P-722) respectively (Hassan 1986:94).

The three dates obtained for the Khartoum Variant are older than those obtained for the Abkan (see supra) and A-Group ceramics (see infra). Yet, they are coeval with those obtained for the 'late Khartoum Mesolithic' assemblages in the central Sudan (e.g. Kabbashi, shabona and Shaqadud midden-lower levels) (cf. sections 10.1.1.1, 10.1.1.2 and 10.1.1.3).

The A-Group contexts in Nubia provided a rich ceramic repertoire (see below).

The A-Group pottery from a series of sites (Afeyeh, Kubania and Khor Bahan) in lower Nubia (figs.1-2) is mainly characterized by black-topped vessels (cf. Nordstrom 1972:28, Pls.38, A1h:1) recalling Amratian and Naqada types of predynastic Egypt (cf. Arkell and Ucko 1965:153, fig. 24 and Arkell 1975:40, fig.18:1-3). Two radiocarbon dates (TF-47 and TF-48) from the A-Group site (AFH-7) at Afeyeh provide a corrected average date of 3025 ± 120 B.C.. However another date from the same site gives a much earlier age of 4535 ± 205 B.C. (UW-30) (Hassan 1986:95).

The Classic A-Group pottery is characterized principally by black-mouthed rippled ceramics with a lustrous red of Type Group AX (e.g. cf. Nordstrom 1972:29, 90, Pls. 167, 168:3, 4, 169-170). Four radiocarbon dates (U-806, U-807, U-818, U-819)-based on hair removed from a cow hide-obtained for a classic A-Group context at Halfa Degheim (SJE 22/65:4), gave an average age of 3415 ± 120 B.C. (Nordstrom 1972:29 and Hassan 1986:95).

The Terminal A-Group pottery is mainly characterized by thin egg-shell vessels with painted designs (type Group AV111) (cf. Nordstrom 1972:29, Pls.

42:1-10, 175:1-4) being mostly deep bowls and cups. Four radiocarbon dates were obtained from Halfa district (sites SJE 277/49:12, SJE 340/SE1L:5, SJE340/SE11:4); two of which (SJE 277/49:12) (U-835, U-834)-based on a cow hide-gave an average date of 3295 ± 120 B.C., whereas the other two (U-242, U 2425) (SJE 340/SE11:5 and SJE 340/SE11:4) provided an average date of 2890 ± 130 B.C. (see Hassan 1986:95).

On the basis of the evidence reviewed above, it is apparent that A-Group is temporary related to the 'Khartoum Neolithic' of the central Sudan. (cf. section 10.1.1). The earlier date of 4535 ± 125 B.C. from the early A-Group context of Afeyeh (see supra) overlaps with the early Neolithic dates from the central Sudan (e.g. Shaheinab, Kadero 1,11, Um Direiwa 1, Zakiab, Islang, Shaqadud midden (Neolithic levels), Rabak (Khartoum Neolithic levels))., whereas the latest dates from the A-Group contexts (see supra), ranging between c.3400 - 2800 B.C., are partially contemporary with Geili, latest phase of Nofalab2 (cf.section 10.1.1.1), the average age of El-Kadada (cf. section 10.1.2.1) and the early phase of Shaqadud Cave (cf. section 10.1.1.3). Despite this temporal link, the pottery of the A-Group (see supra) does not show common elements with that of 'Khartoum Neolithic' in the central Sudan (cf. sections 3.7, 4.7, 5.7, 5.8). However, its forms (cf. Nordstrom 1972, Pls. 160:2-3, 161:1-5, 163:3, 164:1, 169:1-2, 173:2, 176:3) are often reminiscent of Omdurman Bridge pottery (Proto-dynastic date) (cf. Arkell 1949:99-104, Pls. 91:13,-6, 93:4, 1953: Pls.40:11, 42:1-3, 43:1).

10.1.3 Western Sudan

10.1.3.1 Wadi Howar

The Wadi Howar basin lies at the intersection of long. 22 38 E and lat. 14 46 N in northern Darfur Province and extending into Chad Republic (fig.2).

Khartoum Mesolithic-type of pottery, namely wavy line (Richter 1989:431-442, fig.2: 9,12,13) and dotted wavy line (ibid, fig.2:9, 11-15) in association with lithic implements (ibid., fig.2:10) are comparable to contemporaneous objects from the central Sudan (cf. Arkell 1949: Pl. 34) have been radiocarbon dated from the site of Rahib Wells. The radiocarbon sample-based on shell material-gave an age of 4455 ± 195 B.C. (KN-2962) (Hassan 1986:93). This date is later than the ones obtained for the Mesolithic sequence

in the central Sudan and corresponds with the early Neolithic sequence in that area. (cf. section 10.1.1.).

The Khartoum Neolithic ceramics decorated with rocker stamp technique (e.g. Arkell 1953:68-77, Pls. 31:7 and Pl.32:3,5-6) have been recorded from a dune site east of Wadi Howar (cf.Richter 1984:444, fig.4:1-2,4-5). A single radiocarbon date of 3650 ± 110 B.C. (KN-2938) was obtained for this ceramic phase of Wadi Howar basin (see Hassan 1986:93) indicating that the Neolithic of Wadi Howar is later than the early Neolithic sequence in the central Sudan and it is contemporary with the late sequence in the same region (cf.sections 9.11, 10.1.1).

Nearly three hundred years after the disappearance of the 'Khartoum Neolithic' ceramics at Wadi Howar, a new ceramic group known as "Hou Hou" pottery had seen the horizon. The pottery is mainly characterized by plain unburnished style and often geometric designs (see Mohamed-Ali 1982:88-104, figs.39-40). It is markedly different from the Mesolithic and Neolithic style of the central Sudan (cf.section 10.1.1). On the basis of a single radiocarbon date-based on charcoal-"Hou Hou" pottery has been dated to 2610±550 B.C. (Q-1537) (Mohamed-Ali 1982:173). This date is similar to ones obtained for a series of late Neolithic sites in the central Sudan (Shaqadud Cave and the late phase of Nofalab2) (cf.sections 10.1.1.1 and 10.1.1.3). Yet, ceramic links between the central Sudan and Wadi Howar during this time, seem unlikely on the basis of the diversity shown above.

10.1.4 Eastern Sudan

10.1.4.1 Eastern Butana

The earliest ceramic phase of the eastern Butana between Atbara and the Gash Delta (fig.29) is represented by one site (KG14) found between Atbara and khashm el Girba. It yielded ceramics known as Pre-Saroba (cf. Fattovich et al 1984:173-188: Marks and Sadr 1988:72-73 and section 9.10.3) showing some affinities with Khartoum Mesolithic pottery of the central Sudan (cf.section 10.1.1). Pre-Saroba pottery has got a radiocarbon date of 5120±75 (SMU-1139) (Marks and sadr 1988:73). This date places pre-saroba ceramics in a relatively later age than that of Sarurab2 (average age:7400±110 B.C.), Kabbashi Haitah (6300±100 B.C.T(T-6654)), Shaqadud Midden (lower levels)(average date is 5436±185 B.C.) but as old as kabbashi (5120±120 B.C. (T-66450)) and

Shabona (5100±120 B.C. (SUA-298)) all of which are located in the central Sudan (cf. section 10.1.1)

Saroba ceramic phase which is mainly characterized by unburnished, impressed docoration (cf.Fattovich et al 1984:178-179, fig.3 ; Marks and Sadr 1988:72-73) has no counterpart in the contemporary Neolithic ceramics of Khartoum province, white Nile and Western Butana regions. Though two radiometric dates of 4540 ± 60 B.C. (SMU-1285) and 4552 ± 70(SMN-1181) (Marks and Sadr 1988:72-73) put the saroba ceramic phase in the time range of 'Khartoum Neolithic' period of the central Sudan (cf.section 10.1.1), yet, this period did not witness a ceramic contact radiating from the central Sudan as was the case during 'pre-Saroba' times (see supra and section 9.10.3).

The Kassala ceramic phase succeeded Saroba one in the eastern Butana. The transitional period of this phase (site KG28) shows clear similarities with Saroba ceramics (scraped and rippled decorations) (see Fattovich 1984:178, figs. 4 and 5). This transitional period was dated based-on charcoal-to 4018 ± 67 B.C. (SMU-1193) (Marks and Sadr 1988:73). The pottery of this phase which is mainly characterized by brushed incised, fingernail and zoned impressions has received three radiometric dates based on charcoal. The earliest (site K67) is calibrated to 3351 ± 68 B.C. (SMU-1151), whereas the latest (site KG 96A) is corrected to 984 ± 10 B.C. (SMU-1187). The average age of this phase is 3222 ± 87 B.C. It is noteworthy that Kassala phase pottery shows no connection with the contemporary Neolithic ceramics from the central Sudan (cf. sections 9.11, 10.1.1).

10.1.4.2. Kassala Province

The latest phase of Atbai ceramic tradition which is known as Kassala phase (see supra) is represented in Kassala Province by two large sites (Mahal Teglinos sof the Gash Group and site K23 of the Butana Group) (Fattovich and Vitagliano 1987:57-58). The early ceramic phase of Mahal Teglinos which is mainly characterized by scraped and dash rouletted-decorations (ibid.) has got four radiocarbon dates (Gif-7651, Gif-7652, fig-7653, fig-7654), the average of which is 2128 ± 138 B.C. The oldest is 2270 ± 90 B.C. (Gif-7654), whereas the latest is 2060 ± 90 B.C. (Gif-7652). On the other hand, the Neolithic ceramics of the Butana Group (K23) which show close ties with the Gash Group (Mahal Teglinos) and both of them are characterized by the scraped ware with varying

proportions (cf. Fattovich et al 1984:180, figs. 4:1-3), has got three radiocarbon dates (Marks and Sadr 1988:73). The oldest date is 3544 ± 154 B.C. (SMU-1201); the youngest is 3319 ± 253 B.C. (SMU-1155) (ibid.). The average of the three dates is 3382 ± 158 B.C. With the exception of the radiometric dates from the Butana Group which cluster around mid fourth millennium B.C. (See supra), the remaining dates of the Gash Group ceramics are of the post-Khartoum Neolithic period (cf. section 10.1.1). The pottery of Kassala phase (see supra) shows no resemblances with the Neolithic ceramics of Khartoum, White Nile and Western Butana (Shaqadud midden) (cf. section 10.1.1). However, the scraped pottery which is the main feature of this ceramic phase is comparable with specimens derived from Shaqadud Cave (see section 5.7 and Pl.50).

10.1.5 Southern Sudan

Given the spatial distribution of the Neolithic ceramics south of Khartoum, it is clear that Rabak, to date, marks the most southerly site at which Khartoum Neolithic tradition has been found (fig.2). In the southern Sudan the oldest evidence for pottery making which came from Jebel Tukyi rockshelter (5 9N, 30 2 E) (fig.2) is later in date than that obtained for Neolithic assemblages in other districts of the central Sudan. A series of radiocarbon dates were obtained for this site representing iron age ceramic tradition. The oldest- based on unburnt bone-being 180 ±290 B.C. (GU-1306) and associated with combed impressed pottery tempered with quartz- sand (see David et al 1981:27-28, Pl.11) recalling that of Khartoum Neolithic tradition as represented by Shaheinab (cf. Arkell 1953, Pls. 29:2, 31:2-3,32:2-3), Rabak (cf. Haaland 19916:139, Pl.16) and related sites (e.g. cf. section 10.1.1).

10.2 External interrelations

10.2.1 Lower Nile Valley

The Mesolithic pottery of the Central Sudan (cf. Arkell 1949:81-97, Pls. 59-86:1; sections 3.7, 4.7, 5.7, 3.3.5.1, 3.3.6.1, 4.3.2 and 5.3.2) is typologically and technologically different from that of Fayum (fig.43) in lower Egypt. It is sand tempered mainly decorated with comb impression, well-fired and unburnished with simple rims and forms mainly bowls (see surpra), whereas Fayum pottery is mainly sand-tempered and often tempered with chaff. Unlike Khartoum Mesolithic (Early Khartoum), Fayum pottery is frequently burnished with sophisticated variety of shapes often including vessels with flattened,

knobbed, hemispherical or spherical bellies in Fayum A or vessels with cylindrical necks, spherical bellies and conical bottoms as shown in Fayum B ceramic material (see Kozlowski and Ginter 1989:166-169).

The Khartoum Neolithic (Shaheinab) which followed Khartoum Mesolithic in the central Sudan (cf. section 10.1.1) seems to have cultural parallels with Fayum A (burnishing of pottery, presence of lithic implements namely gouges, adzes and amazonite beads)(see Arkell 1953:107; Arkell and Ucko 1965:145-150; Kozlowski and Ginter 1989:157-174). However, there are basic typological and technological ceramic differences between them. While Khartoum Neolithic (Shaheinab) is mainly decorated and sand-tempered (see Arkell and Ucko 1965:145-150, Arkell 1975 and Khabir 1981:63-65), Fayum (A,B) is mainly plain, tempered with organic inclusions (chaff and shell) and sand (Arkell and Ucko 1965:145:150; Kozlowski and Ginter 1989:166-169).

The radiocarbon dates available seem to suggest that Fayum A is earlier in date than Shaheinab, whereas the latter is partly contemporary with Fayum B (see infra). Fayum A has got five radiometric dates (Gd-2021, Gd-149, Gd-695, Gd-708, Bldn-2335) based on charcoal. The oldest being 5350 ± 115 B.C. (Gd-2021)and the youngest is 4955 ± 80 B.C. (Bln-2335) (Kozlowski and Ginter 1989:159-162). Two dates-based on charcoal-were obtained for Fayum B; the oldest is 4350 ± 150 B.C. (Gd-895) whereas the youngest is 3400 ± 100 B.C .(Gd-978)

On the basis of this information and if the dates of Fayum A (see supra) which are older than Shaheinab ones (c.4560-4440 B.C.), have been taken into consideration, they would suggest a southward dispersion of ceramic traits. However, the basic differences between Shaheinab and Fayum A (see supra) seem to weaken this possibility. In the meantime, cultural similarities between Shaheinab ceramics and the late prehistoric ceramics of Upper Egypt could be traced through the occurrence of black-topped red ware which was recorded from Shaheinab (see Arkell 1953:75, Pl. 34, fig.3 and 1975:12-19,30-42), Badarian and Naqada1 cultures of predynastic Egypt (cf.Arkell and Ucko 1965:150-156, fig.16 and section 9.10.4).

Four thermoluminescence dates (ox TL 131 b11, ox TL 131, b12, oxTL131 b13, ox n 131 614) were obtained for Badarian culture (Hays

1984:213 and Hassan 1985:106). The oldest is 5580±420 B.C. (ox TL 131 b14) whereas the youngest is 4510±475 B.C. (ox Tl 131 B12) (ibid).

Despite the fact that these thermoluminescence dates are coeval with the radiocarbon ages obtained for Shaheinab (c.4570-4450 B.C)(cf. section 10.1.1.1), Arkell (1975:30) believed that the presence of copper at the Badarian suggest a later date for this culture than Khartoum Neolithic (Shaheinab) and hence-according to him-the black-topped red ware of Khartoum Neolithic in the central Sudan as shown at Shaheinab site was ancestral to that of predynastic Egypt (ibid.). However, more recently, new radiometric dates based on charcoal from Badarian sites in Upper Egypt (Hays 1984:214) seems to reinforce Arkell's earlier hypothesis (see supra). The oldest date from El-Khattara is 3320 ± 100 B.C. (WSU-2256) and the youngest is 2830 ± 70 B.C. (SMU-353), while the oldest date from the site of Hierakonpolis is 2770 ± 94 B.C. (UW-104) and the youngest is 2767 ± 94 B.C. (UW-105).(Hassan 1986:92,95).

On the basis of the evidence reviewed above, it is clear that the late prehistoric pottery from Upper and lower Egypt (Fayum, Badarian, Naqada1 and Naqada 11) shares no similarities with that of Khartoum Mesolithic (Early Khartoum) and bear very little in common with that of Khartoum Neolithic as represented by Shaheinab (cf. Arkell 1953) and related sites (e.g. see section 10.1.1). While the predynastic pottery recalling the Near Eastern styles (cf. section 9.10.4), Khartoum Mesolithic and Khartoum Neolithic ceramics (cf. sections 9.11, 10.1-10.2) are devoid of Asian influence.

10.2.2. Saharan Africa

The Sahara in the present context has been used to mean the central, southern and eastern Sahara which consists of a large semi-circular plateau extending from Darfur Province in the Republic of Sudan westwards to Ennedi in Chad. An extension extending westward to Tibesti and Hoggar range. The eastern Sahara here is used to mean western and southern Egyptian Sahara (cf. fig.94). Western and northern Sahara will not be dealt with here since their pottery falls outside the norm of Khartoum Mesolithic and Khartoum Neolithic ceramics. The western Sahara has impressed and incised decorations (e.g.see Camps 1982:582-594, fig.8.9) which are distinct from the central and northern Sudan (cf.section 10.1.1). Similarly, northern Sahara pottery of the "Capsian tradition" which is very limited in decoration, mainly ornamented with

cuneiforms, crescents and circles (ibid:595-611), figs. 8.12-8.14) is devoid of the Nile valley influences (cf. sections 9.11, 10.1, 10.2.1).

Two radiocarbon dates in association with Khartoum Mesolithic and Khartoum Neolithic ceramics have been obtained in Wanyanga between Ennedi and Tibesti. The oldest is associated with unburnished dotted wavy line gave a date of 5230±300 B.C. (Gif-35) and the other came from a layer contained Khartoum Neolithic pottery gave a date of 4950±300 B.C. (Gif-352) (Flight 1973:537).

From Amekni in Hoggar (Algeria), pottery embellished with wavy line and unburnished dotted wavy line was radiocarbon dated 6720 ± 150 B.C. (MC-212) and 6100 ± 100B.C. (UW-87) (Camps 1969:206-207). Unburnished dotted wavy line has been reported from Fozzigaren and Uan Tabu (Hays 1975:195). The first locality has got a radiocarbon date of 6122 ± 100 B.C. (Pi) and the second gave on age of 5095 ± 175 (Geo) (Barich et al 1984:413).

Burnished dotted wavy line pottery of Khartoum Neolithic has been attested at Delibo dated to 4950 ± 300 B.C. (Gif-352) (Arkell 1959:20). A few burnished dotted wavy line sherds were reported from typological ground, they could have a similar age as those reported from other localities in the central Sahara (see supra).

In the Tadrart Acacus in the Libyan Sahara the best information pertaining to the earliest ceramics in this area lies in the sequence of nearby shelter of Ti-n-Torha yielded unburnished dotted wavy line pottery. The earliest date is 7400 ± 70 B.C. (R 1036 OC) and the second one is 6980 ± 60 B.C. (R-1163 OC) (Barich et al 1984:413; Barich 1987:97-112 and appendix 7). The pottery of Torha site has been associated with sendentary groups but who had nothing to do with food-production (Barich 1987:102-116).

In the eastern Sahara Khartoum Mesolithic and Khartoum Neolithic ceramics were recorded on scattered sites in the southern and western Egyptian Sahara (figs 1, 94). Of these are two main sites (E-79-8 [Connor 1984:220-243) and E 80-4 [Close 1984:346]) near Kiseiba and one (E-77-7 [Haas and Haynes 1980:table A 7.1]) near Nabta playa which is only 100 km from the Nile valley.

The early Neolithic of Nabta Playa was dated by C-14 dates ranging from 6180 ± 60 B.C. (SMU-225) to 5760 ± 70 B.C. (SMU-191). The average of these dates gives an age of 5733±80 B.C.. The middle Neolithic from the same area (E-75-8) was dated by 13 radiometric samples, providing time range in the magnitude of 6950 ± 80B.C. (SMU-472) as the oldest date and 4290±70B.C. (SMU-361) as the youngest (see Banks 1980:374-375). The late Neolithic pottery was dated to 3860±80 B.C. (SMU-473)(Haas and Haynes 1980:374-375).

Unlike the late Neolithic, the early and Middle Neolithic phases of Nabta playa (see supra), tend to show essential differences between particular ceramic inventories in respect to typology and technology (Banks 1980:301-307) However, the dated ceramics of the Early and Middle Neolithic, which are overwhelmingly decorated with woven mat and fern branch techniques (cf.Bank 1980:301-306) are reminiscent of Abkan (cf.Nordstrom 1972:139 [3] and Khartoum variant of the Second Cataract (ibid.Pl.k[1]) and some Khartoum Neolithic ceramics of the central Sudan as represented by Shaheinab and related sites (cf.section 10.1.1).

The pottery of Bir kiseiba (fig.43) is similar to Nabta playa (see supra) as regard the presence of vertical incised and woven mat (Banks 1980:307, fig.A.3.2) atypical wolf-tooth (ibid.A3.4a) and chevrons (ibid. fig.3.4c and Banks 1984:152, fig.2:c-e) which are the commonest decorative motifs. Affinities with Khartoum Mesolithic and Khartoum Neolithic of the central Sudan could be seen in the occurrence of woven mat motif (e.g.see Arkell 1949.Pl.65, 1953, fig.29:2d).

Eight uncalibrated radiocarbon dates-based on charcoal-were obtained for the Mesolthic/Neolithic sequence of Bir kiseiba and they give ages ranging between 7870-6970 B.C.. The oldest (site E-79-8) provided uncalibrated age of 7870 ± 380 B.C. (SMU-858), whereas the youngest (site E-79-8) is 6970 ± 130 B.C. (SMU-757). The average of the eight dates places Bir Kiseiba Mesolithic/Neolithic sequence in a time magnitude of c.6466 ± 165 B.C.

It is interesting to note that the diagnostics features of Khartoum Mesolithic (unburnished wavy or dotted wavy line) and Khartoum Neolithic (triangles, fish-scale motifs) (cf.section 10.1.1) are absent in Bir kiseiba ceramics (cf.Banks 1980:307). Threrefore, the woven mat motif, characterizing

the "Middle Neolithic" of Bir kiseiba pottery (Wendorf and Schild 1984:416) is suggestive that the time span during which this type of decoration appeared in the eastern Sahara corresponds with Mesolithic and early Neolithic phases in the central Nile valley (see supra and sections 9.11, 10.1.1., 10.1.2.3.). In the later area this decoration appeared in relatively earlier Mesolithic and Neolithic contexts (e.g. Khartoum variant in upper Nubia, Khartoum Hospital, Kabbashi Haitah, Shabona and Shaqadud midden of the central Sudan) which are almost exclusively dated to ≥5200 B.C. (see Arkell 1949:82-83; Hassan 1986:94, Clark 1989:402-405; Marks 1991:61 and Caneva 1993:23).

The Neolithic pottery collected from a survey in Wadi Bakht indicates that it is mainly ornamented with linear and chevron impressions (see Banks 1980:307-309, fig. A3.5). These decorations bear general resemblances to the Nabta "middle Neolithic" phase (cf. Banks 1980, fig. A.3.2b, fig. A.3.4C) and some Neolithic ceramics from the central Nile (e.g. Arkell 1953:74,Pl.33, fig.6; Chlodnicki 1984:341, fig.2, and section 3.7 in this thesis). Uncalibrated radiocarbon date associated with pottery-based on ostrich egg-shell-gave an age of 5030±80 B.C.(SMU-273) for this site (Haas and Haynes 1980:375). More recently, ten uncalibrated radiocarbon dates - based on charcoal- have been obtained for the Wadi Bakht; the earliest is 4300±50 B.C. (KN-3086) and the latest is 1870±130 B.C. (KN-3184). The average of these dates gave an age of 4023±220 B.C. (see Kuper 1989:201, table 1). The later date falls within the early Neolithic sequence in the central Sudan (cf.section 10.1.1).

Information pertaining to the ceramics of Abu Ballas is very scanty. However, an interim report of the excavator of this site claims that the site yielded ceramics comparable to those of the Khartoum Neolithic period in Khartoum area (see Kuper 1989:200).

10.2.3. Eriteria and Ethiopian highlands

Archaeological information about Eriteria and Ethiopian highlands is scanty. The earliest pottery so far known in Eriteria came from four sites at Agordat in Baraka valley (fig.2) (see Arkell 1954:33-36). The pottery of Agordat is generally red with narrow, short necks and basket-like shapes. It shows marked combing from inside (see Arkell 1954:53-62, Pls. V1-VII) as in some Nubian ware from Kerma, being red, decorated with clay-balls and incised dots (see Reisner 1923:322-340, Pls. 70, 71 and 77). The presence of copper

objects seems to suggest a later date for Agordat sites (see Arkell 1954:53, fig.16) than the Khartoum Neolithic contexts in the Central Sudan. (cf. section 10.1.1).

The information so far available about the oldest pottery in Ethiopia is derived from an interim report of Mansel Spratling (see Spratling 1959:59). He discovered east of Abbai valley two areas of boulders c.50 km. apart among which were pottery and stone artifacts. According to him, the finds compare well with Shaheinab (ibid.), the type-site of Khartoum Neolithic tradition (no illustrations have been provided, pers. obser.). On the basis of this evidence, it has been suggested that the practise of pottery making and agriculture might have been introduced from the Sudan up from the Blue Nile (ibid.). No radiometric dates are available for these finds.

An early pottery from Tigray region in Ethiopia tends to show similarities with Darotai and Gibral pottery, near Agordat. The latter is mainly decorated with impressed parallel lines, zigzag, chevrons, grids and crosses and it is dated on typological grounds to the late Aksumite (end of the Ist millennium A.D.) and post-Aksumite period (Fattovich 1982:8).

Recent archaeological work in Tigray region showed that the black-topped red ware which formed the main ceramic component of site Ona Enda Aboi Vague can be placed in the late pre-Aksumite period (late Ist millennium B.C. (Bard and Fattovich 1993:14-17). Unfortunately, no radiometric dates are available for these sites.

10.2.4 The Lakes Region

The earliest discovery of pottery related to the Khartoum Mesolithic was recorded from Gamble's cave of "Kenya Capsian" industry. A sherd with dotted wavy line impression was found according to the excavator - in situ near the base of the lowest occupation without any possibility of being a stray from a later period of occupation in this rockshelter. The base of these deposits has been estimated to a date between c.6560-6160 B.C. (Sutton 1974:534).

Recent archaeological work in the East African lakes region has shed new light on the geographical extension of the Khartoum Mesolithic pottery in this region. Two sites were excavated in the East African Rift Valley of Kenya both

of which contain wavy line pottery. One of which had nine sherds eroding in situ in the Lake Turkana basin. The wavy line pottery is olive in colour and quite gritty. No examples of dotted wavyline were found. A number of uniserial bone harpoons were found in association with these ceramics (Barthelme 1977a:35, 1985:119).

A single sherd bearing wavy line decoration was reported from lowasera site (Phillipson 1977a:27). It has been reported on the surface and may be associated with early or middle Holocene settlements (Barthelme 1985:119). A radiocarbon date-based on shell-gave on age of 7470 ± 200 B.C. (HEL-867) for beach deposits (Unit 8) where this wavy line pottery was encountered on the surface. However, the radiocarbon date was not in association with the sherd. The excavator believed of a much later date for this wavy line potsherd prior to 5th or 4th millennium B.C. (see Phillipson 1977:27 and section 10.3).

10.3 General Discussion and Conclusions

Reading through the present radiometric dates for the Mesolithic ceramic assemblages (Saggai 1, Sarurab2, Kabbashi Haitah, Kabbashi, Shabona, Sarurab1 and Shaqadud midden-lower levels) it has become clear that they cover a time-span ranging from ≥ 7000-5000 B.C. (cf. section 10.1.1). With the exception of Saggai1 which was suspected by the excavator (see Caneva 1983:152) as aberrant, the remaining dates are suggestive of a hiatus in the magnitude of ≥ 2000 years between these ceramic assemblages. The absolute dates for Saggai 1 (8th millennum B.C.), Sarurab2 (8th millennium B.C.), Kabbashi Haitah, Shabona, Shaqadud midden (lower levels) (c.6th millennium B.C.), Kabbashi and Sarurab1 (5th millennium B.C.) show marked chronological variations and are inconsistent with the close typological and technological affinities reflected in the ceramics of these sites (cf. chapters 2-5, appendices 2-16 and the foregoing discussion in this section).

Dates for the Khartoum or Shaheinab-related Neolithic within the central and northern Sudan fall, in general, within the fifth millennium B.C. (Shaheinab, Islang 1,2, Kadero 1, 2, Zakiab, Umm Direiwa 1, 2; Rabak (Kh.Neo.L. and J.M.L.); Shaqadud midden-upper levels; Abkan and Khartoum Variant). The dates of the earlier ceramic assemblages are contemporaneous and this may explain the close decorating analogies between their ceramics (cf. sections 10.1.1 and 10.1.2).

It is noteworthy that some Neolithic sites in Khartoum Province (Kadero 1 and Nofalab2) may have functioned long enough (c.4300-2400 B.C.) to be contemporary with some dated late Neolithic ceramic-producing groups in the northern Sudan (cf. section 10.1.1). The occurrence of a few potsherds with dotted wavy line motif at Kadero 1 site (cf. Chlodnicki 1984:340, fig.2:111) similar to those reported from the early phase of Shaheinab (cf. Arkell 1953:68, Pl.29:1) coupled with rather compatible radiocarbon dates of the two sites (see section 10.1.1.1) seem to suggest that both ceramic assemblages may have been partly contemporary. But the presence of some potsherds, contemporary with the settlement and with rather complex decorations (wickerwork immitation and concentric squares) atypical to that found at Shaheinab (cf. Arkell 1953:68:77, Pls. 29-39) and identical to ornaments depicted on the polished ware of the C-Group (see Bietak 1979:107-127, fig.3:4-9, fig.4:7-9, fig.5:4), raises the probability that Kadero1 ceramic assemblage may have functioned markedly longer than Shaheinab (cf. section 10.1.1.1) to be partly contemporary with the early phase of the C-Group in Nubia (c. 2300 B.C.) (see Bietak 1979:116). However, the apparent anomaly between the radiocarbon dates of the late Kadero 1 (c. 4300 B.C.) and the early C-Group (c.2300 B.) does not support the probability of contemporaneity between the ceramics of the two cultural contexts.

The youngest date of Nofalab2 ceramic site (2270 ± 259 B.C.) places it in post-Khartoum Neolithic time and, therefore, partialy contemporary with the Shaqadud Cave of the Western Butana (see below).

The average dates of the late Neolithic sequence in the central Sudan (Nofalab2, Geili and Shaqadud Cave) range from c.3300-2400 B.C. suggesting that the Neolithic squence in this area may have lasted through the mid of the third millennium B.C.. It is worthnoting that the radiocarbon dates obtained from Shaqadud Cave in the Western Butana region (SMU-1127, SMU-1128, SMU-1208, SMU-1133, SMU-1697) and a single date from Nofalab2 (SMU-2561) in Khartoum Province (cf. sections 10.1.1.1, 10.1.1.3) are contemporaneous with the Neolithic sequence of the eastern Sudan (Gash Group) (cf. section 10.1.4.1). Nevertheless, this partial contemporaneity was not invariably concomitant with ceramic ties. While the ceramic traits of the late Neolithic sequence of the Western Butana (Shaqadud Cave) tend to bear close affinities to the eastern Sudan (Gash Group), the central Nile (Khartoum and

White Nile Provinces) is devoid of such ceramic links (cf. sections 3.7-5.7, 9.11).

The balance of evidence reviewed above, tends to postulate that the Western Butana and the Central Nile, during the third millennium B.C., underwent dissimilar cultural changes in ceramic inventory.

Turning to the north, it is clear that the Neolithic ceramic assemblage of El-Kadada in Shendi Reach postdates the Khartoum Neolithic sequence in the central Sudan. (cf. section 10.1.1.). The average of the accepted date for this locality, as previously noted, is 3530 ± 60 B.C. (see section 10.1.2.1). Therefore, it is contemporary with the late phase of Nofalab2 Neolithic in Khartoum Province and the early phase of Shaqadud Cave in the Western Butana. However, the coeval dates from these assemblages are inconsistent with the ceramic diversity recognized (cf. section 3.7, 10.1.1.3, 10.1.2.1).

On the basis of the radiometric dates, the Mesolithic/Neolithic ceramic assemblages are comparable with those of the central Sudan (Khartoum, White Nile Western Butana regions), ranging between the 7th and 6th millennium B.C. (cf. sections 10.1.1 and 10.1.2.2). On the basis of the older radiocarbon dates for ceramic-producing groups in Khartoum district, c. 9th-8th millennium B.C. (Sarurab2 and Saggail sites) (cf. section 10.1.1.1), it does not seem unlikely that the appearance of Khartoum Mesolithic ceramic traits of the Atbara Reach (7th-6th millennium B.C.) is a result of a return contact from Khartoum district.

Further north, in the Dongola Reach, no absolute dates have as yet been forthcoming for the early ceramic-bearing sites in the area. By cross-dating, the Mesolithic and Neolithic ceramics of the Dongola Reach (Early Khartoum and Karat Group respectively), through a comparison of pottery decorative motifs and often technology (see supra), it is plausible to be regarded as most probably contemporaneous with Khartoum Mesolithic and Khartoum Neolithic ceramic assemblages of the central Sudan (cf. sections 3.7, 4.7, 5.7-5.8, 9.4, 10.1.1) as well as the Neolithic pottery of the Second Cataract in Upper Nubia (cf. section 10.1.2.3). It does seem conceivable that the Khartoum Mesolithic and Khartoum Neolithic ceramics of the Dongola Reach (see supra, and section 10.1.2.2) were absorbed from the central Sudan (cf. section 10.1.). The Mesolithic and Neolithic ceramics of the latter are, respectively, older than those of the Atbara Reach (cf. section 10.2.1) and Upper Nubia (cf. sections 9.10.3 and 10.1.2.2)

coupled with the easy communication between the Mesolithic/Neolithic groups via the Nile, seem to reinforce this suggestion. Furthermore, as has been indicated elsewhere (cf. e.g. Arkell 1949:41-47, Pls. 10-45:1-2, 1953:27-55, Pls.6-24; Mohamed-Ali 1982:41-74, figs. 4-5, 8-9, 11-14, 16-20-26; Hays 1974:27-32; Krzyzaniak 1974:30-32, 1977:45-46, 1989:1-17, 1991:551-532; Caneva and Zarratini 1983:209-233, figs. 1-10; Haaland 1987:63-115, figs. 15-31; Caneva 1988:115-147, figs. 1-34; Marks 1991:95-122, figs.:6.1-6.10; appendices 7-9 and section 9.10.3), the disparate nature of the pottery/lithic typology and technology between the Mesolithic/Neolithic ceramic-groups of the Dongola Reach, central Sudan and the Upper Nubia (Second Cataract) could be taken as an indication that the Khartoum Mesolithic and Khartoum Neolithic ceramic traits were not, perhaps, concomitant with substantial movements of people but rather shows that certain pottery styles and techniques spread over vast areas, perhaps through individuals or small mobile groups along the Nile to autonomous groups of population. If such were the case, then the Khartoum district (cf.chapters 3,4,5 and section 10.1.1.1) which embraces the oldest Mesolithic and Neolithic radiocarbon dates so far obtained in the Sudan (ibid.) is the most likely dispersion point for these widely-spread ceramic traits.

Further afield, in Upper Nubia (Second Cataract area), the three radiocarbon dates from Khartoum variant sites (TX-115, P-721, P.722) which cluster around c.5000 B.C. are older than those for Abkan, Post-Shamarkian and A-Group (cf. section 10.1.2.4). These radiocarbon dates put the ceramics of Khartoum Variant in the time scale of some Mesolithic sites in Khartoum (Kabbashi), White Nile (Shabona), and Western Butana (Shaqadud midden-lower levels) regions (cf. sections 10.1.1.1, 10.1.1.2 and 10.1.1.3 respectively), all of which are in the magnitude of the first quarter of the six millennium B.C..

During the Mesolithic (c.4450-4250 B.C.) and Neolithic (c. 3650-3540 B.C.) periods of Wadi Howar (western Sudan) the ceramic traits are comparable to their counterparts in the central Sudan (cf. sections 10.1.3 and 10.1.1 respectively). However, upon the appearance of "Hou Hou" pottery at the end of Neolithic phase in this area (c. 2600-2060 B.C.), Khartoum Mesolithic Khartoum Neolithic styles gave way to new styles characterized by basket-work and geometric designs similar to pottery reported from Ennedi in the central Sahara (cf. sections 10.1.1-10.13, 10.2.2). The single radiocarbon date of "Hou Hou" pottery from the Sahara -3050 ± 250 B.C. (Gif-354) (Bailloud 1969:40)- is earlier than the one obtained from Wadi Howar-2610 ± 550 (Q-1537) -

Mohamed-Ali 1982:173 - and, therefore, it seems possible that this type of pottery could have originated in the central Sahara.

The Pre-Saroba ceramics of the eastern Butana (c.7045-5120 B.C.) which bear general resemblances to the Khartoum Mesolithic pottery (cf. section 10.1.4.1) are relatively younger in dates than those obtained for most of the Mesolithic ceramics (c.7400-5400 B.C.) in the central Sudan (ibid.). The Saroba ceramic phase which succeeded the previous one (c.5620-5480 B.C.) is devoid of Khartoum Mesolithic and Khartoum Neolithic ceramic influences. The last ceramic phase in the eastern Butana which is known as "Kassala Phase" (c.3700-3220 B.C.) bears no affinities to the Khartoum Neolithic ceramics from Khartoum, White Nile and Western Butana (Shaqadud midden) (cf. section 10.1.1). Nevertheless, it is akin to pottery specimens derived from Shaqadud Cave of the Western Butana (cf. section 10.1.1.1).

Turning to the South, it is obvious that the ceramics of oldest levels at Rabak site (c. 4300 B.C.) are similar to those reported from Khartoum Neolithic (Shaheinab) (cf. section 10.1.1.1, 10.1.1.2), whereas the Upper levels (c.3270-3160 B.C.) produced ceramics reminiscent of Jebel Moya tradition (cf. section 10.1.1.1).

Though the pottery of Guli site lacks the typical Khartoum Neolithic ceramic traits (burnishing, triangles and fish-scale decorations), yet the single radiocarbon date availabe for this site (c. 3530-3620 B.C) places it in the time span of Khartoum Neolithic sites (ibid.). Therefore, on the basis of the availabe chronometric data, the acquisition of the Neolithic ceramics by Guli and Rabak occupants as a result of contact with their neighbours in Khartoum district seems much more conceivable.

In the far south no ceramic assemblage of Khartoum Mesolithic and Khartoum Neolithic has as yet been excavated. The oldest ceramics in this region were recorded from Jebel Tukyi rock shelter. Though the impressed ceramics from this site recalling that of Khartoum Neolithic but the radiometric dates (c. 188 B.C. - 1380 A.D.) are, clearly, later than those obtained for Khartoum Neolithic assemblages (cf. sections 10.1.1, 10.1.5).

The predynastic pottery from Upper (Badarian, Naqada 1 and Naqada 11) and lower (Fayum) Egypt is devoid of Khartoum Mesolithic traits and most of

which (Badarian, Naqada 1 and Naqada 11) shares very little in common with that of Khartoum Neolithic (Shaheinab) (cf. section 10.2.1). While the Fayum Neolithic ceramic traits are characterized by chaff and sand-tempered pottery, Khartoum Neolithic (Shaheinab) pottery is mainly decorated and exclusively sand-tempered. Though on the basis of chronological evidence, they have overlapped, the radiocarbon dates of Fayum A (c. 5350 - 4900 B.C.) are older than those of the Khartoum Neolithic (Shaheinab) (c. 4560 -4440 B.C.). On the basis of radiocarbon dates only, a southward dispersion of ceramic-traits seems most likely. Nevertheless, the basic differences seen on ceramic typology and technology of both assemblages (see supra and section 10.2.1) argue against such possibility.

The cultural link between Khartoum Neolithic (Shaheinab) and predynastic Egypt could be traced through the black-topped red pottery of the former in some assemblages of Badarian culture in Upper Egypt. Inspite of the slightly older thermoluminscene dates of the Badarian (c.5240-4080 B.C.) which have been regarded aberrant, they have overlaped with Khartoum Neolithic (Shaheinab) (c. 4560 - 4440 B.C.) (cf. sections 10.1.1.1 and 10.2.1). Therefore, the possibility of cultural link due to some form of cultural contact, perhaps limited mobility of people which resulted in exchange of ceramic traits down and up the Nile, does not seem unlikely.

It is noteworthy that Khartoum Mesolithic and Khartoum Neolithic ceramics (cf. sections 10.1.1-10.13, 10.1.5) are devoid of Asian influence which is clear in predynastic Egyptian pottery (cf. section 10.2.1). Unlike the situation in the central Nile Vally (cf. sections 10.1.1, 10.1.3, 10.1.5), the Neolithic ceramics of the lower Nile Valley (Fayum and Naqada 1) have been exposed to levantine and Mesopotamian inspirations (ibid.).

The earliest pottery of Eriterian and Ethiopian highlands is undated and in shapes and decorations, it falls outside the norm of Khartoum Mesolithic and Khartoum Neolithic pottery of the central Sudan and adjacent area (cf. section 10.2.3).

The occurrence of a few sherds bearing wavy line decoration reminiscent of Khartoum Mesolithic, in the East African lakes region, some of which dated to 8th millennium B.C., seems to bridge the distance between the lakes region, Upper Nile and central Sahara implying some form of cultural contact whose

nature is as yet to be deciphered. This is due to the meagre information available (cf. section 10.2.4).

From the evidence reviewed earlier (cf. section 10.2.2), the discovery of wavy line and dotted wavy line ceramics which are the diagnostic features of the Khartoum Mesolithic (Early Khartoum) and Khartoum Neolithic (Shaheinab) potting traditions in the central Sudan at several sites in Saharan Africa (fig. 43) has established Nilo-Saharan cultural interaction as early as 8th millennium B.C. (see below).

It is apparent that both wavy line and dotted wavy line have been attested in different localities in central, southern and eastern Sahara but with varied modes of distribution. Unburnished dotted wavy line has an enormously wide distribution west of the Nile valley across the Sahara. Remarkably, its distribtuion within the Saharan context is much wider in the southern and central rather than in the eastern part (see section 10.2.2). On the other hand, the wavyline pottery has, seemingly, a rather restricted range within the Saharan context. The evidence of this distinctive pottery is scanty throughout the Sahara. Except for two sherds which have been reported from Wanyanga (Arkell 1964:6) and a few others recorded from Delibo Cave (Bailloud 1969:37) in the Ennedi south of Chad and a few from Gilf Kebir, the remaining wavy line sherds come from uncertain chronological and cultural contexts (see Caneva and Marks 1990:22) and almost all of which are confined to the southern and central Sahara (pers. obser., see fig. 43).

The burnished dotted wavy line sherds and other characteristic traits of Khartoum Neolithic witnessed a wide distribution throughout the Sahara. While the burnished dotted wavy line has been confined to southern and central Sahara (Wanyanga, Ennedi, Tibesti, Amekni, Delibo, Fozzigaren and Uan Tabu), woven mat, rippled and vertical incisions have been the most prevailing pottery motifs in the eastern Saharan sites (Nabta playa, Bir Kiseiba and Wadi Bakht) (cf. section 10.2.2).

From chronological standpoint, it seems that the overall radiometric dates of the Mesolithic ceramics from the central and northern Sudan are, generally, in accord with those of the early pottery-producing groups in Saharan Africa, several of which are dated to the 7th millennium B.C. (cf. sections 10.1.1, 10.1.2, 10.2.1, 10.2.2 and appendix 7). Of the total suite of the early dates from

north Africa (appendix 7), the dates from Saggai 1, Sarurab2 of the central Sudan and Ti-n-Torha site of the Libyan Sahara are worthy of particular consideration, since they represent the earliest evidence of pottery making so far known in Africa.

As noted earlier (cf. section 10.2.2), from Ti-n-Torha site in the Libyan Sahara came the earliest evidence of pottery in Saharan Africa. Four levels from this site containing pottery of unburnished dotted wavy line decoration with ages ranging from c.7400-6900 B.C.. Unlike the situation in the Nile Valley where wavy line decoration is the hallmark of the Mesolithic contexts, in the eastern Sahara the oldest radiometric dates of pottery production have been associated with unburnished dotted wavy line decoration (cf. sections 10.1.1-10.14, 10.2.2, 10.2.2).

Of the radiocarbon dates from Saggai1 site, a single sample on Nile Oyster shell dated the Mesolithic pottery context to 8130 ± 110 B.C. (Lab.no. not stated) (Caneva 1983:149). This date has been considered by the excavator as too early (ibid.), this is the earliest date so far obtained not only for Khartoum Mesolithic (Early Khartoum potting tradition) in the central Sudan but for a ceramic-bearing site in Africa and the Middle East. However, the early dates for the Mesolithic pottery in Saharan Africa and the Nile Valley which tightly cluster around 8th-7th millennium B.C. led some workers (cf. Close 1991:3) not to reject out of hand the final 9th millennium B.C. date for Saggai1, although other radiocarbon dates from the same site cluster in the second half of the six millennium B.C. (see supra and section 10.1.1.1).

The radiocarbon dates from Sarurab2 site in Khartoum Province (c.7500-7310 B.C.) excavated by the present writer (cf. sections 3.2.1.1 and 10.1.1.1) are often unaccepted by some workers on face value (see Marks and Mohamed-Ali 1991:239) since-according to them-they are much earlier than any accepted for Khartoum Mesolithic assemblage and they interpreted the ceramic assemblage with the dates as being late Mesolithic. Nevertheless, they have not excluded the possibility that the dates of Sarurab1 (c.4538-4338 B.C.) and Sarurab2 are correct, each for the site area sampled, since these sites have potential for considerable horizontal stratigraphy (ibid.). In my view, though the latter possibility does seem acceptable, yet the cultural similarities between the two portions of the site outweigh the differences and Sarurab2, which the material cultural indicates, is undoubtedly typical "Early Khartoum" site and in

close association with Khartoum Hospital (cf. Arkell 1949, Khabir 1981: 142-146, sections 3.7 and appendix 7). In addition to that, the earlier dates for Sarurab2 which are based on charcoal may be more reliable than those obtained for Sarurab1 which are derived from shell material (see supra, Close 1988:155 and section 10.1.1.1). Moreover, the radiometric dates of Sarurab2 are not, in any case, discordant with the suite of early dates for pottery production in North Africa (cf. appendix 7) and hence, these dates are on a firmer ground.

Sarurab2 radiocarbon dates, are the earliest found in full association with wavy, dotted wavy line and other material culture of the Khartoum Mesolithic (Early Khartoum tradition) (cf.section 10.1.1.1). However, of the oldest radiocarbon dates for a ceramic horizon in Saharan Africa, a single uncalibrated radiocarbon date-based on charcoal-from Temet site in Niger, providing an age of 7600 ± 100 B.C. (Roset 1987:220-225; Close 1991:2,32 and appendix 7). The sample was not found in association with ceramics but with a fibrolite comb believed to be used by a potter (see Close 1991:2). The two earliest radiocarbon dates from Bir Kiseiba (site E-79-8) are 7870 ± 380 B.C. (SMU-858) and 7660 ± 150 B.C. (SMU-928) (see appendix 7) are not in close association with the potsherds encountered (Close 1991:3). Therefore, on the basis of the available evidence, the dates of Sarurab2 Mesolithic site recorded in full association with pottery and other material culture of Early Khartoum tradition (cf. section 10.1.1.1) are the oldest conceivable date for this potting tradition.

It would seem that the origin (s) of the Khartoum Mesolithic and Khartoum Neolithic cermics in the central Sudan are much more complex than was once thought (see supra). On the basis of the chronological evidence reviewed above, it is noticeable that the absolute radiocarbon dates obtained for the Mesolithic ceramic contexts of Saggai1 (9th millennium B.C.), Sarurab2 (mid 8th millennium B.C.), Kabbashi Haitah, Kabbashi and Shabona (6th millennium B.C.), Sarurab1 (5th millennium B.C.), all of which are located in the central Sudan, exhibit marked differences and are inconsistent with the close affinities manifested in the ceramics and other material culture of these sites (see sections 2.3.1, 2.5.1.1, 3.2.1.1, 3.2.2.1-3.2.2.2, 3.3.5.1, 3.3.6.1, 3.5-3.9, 4.2.1.1, 4.3-4.9). These radiometric dates are coeval with those obtained for the Mesolithic ceramics of the Atbara Reach in the northern Sudan (cf. section 10.1.2.2), being older than the earliest dated ceramics reported from Ti-n-Torha site in the Libyan Sahara (early 8th - mid 7th millennium B.C.). (cf. section 10.2.2).

In the light of the absolute dates from the earlier sites in the central Sudan (see supra), it seems that the study of the Sudanese Mesolithic and Neolithic in terms of linear development from Early Khartoum (Khatroum Mesolithic) to Shaheinab (Khartoum Neolithic) requires reassessment as a historical and cultural reality. Sarurab2 site has provided the earliest radiocarbon dates in Africa-based on charcoal-found in full association with ceramics and other material culture of the Khartoum Mesolithic tradition (cf.section 10.1.1.1) and thereby increased the probability that, as has been postulated by Arkell (1975:21) and Clark (1980:561), the wavy line and other wares of the Khartoum Mesolithic were an early and independent development in the central Sudan.

Chapter 11

11. Summary and Conclusions

In the preceding chapters the specific results of this study pertaining to ceramic technology (petrological, X-ray diffraction, chemical [X-ray spectrometry and goethite norm calculations], thermal [DLT and XRD]), lithological provenance, textural analyses, mechanisms of pottery production and distribution as well as chronology and cultural interrelations have been presented. In these conclusions it is proposed to examine-at rather a wider scope - a representative sample of Mesolithic and Neolithic ceramics from the central Sudan to test the objectives of the present research (see the 'abstract' and section 1.7). However, the broader target of the work is to develop a better understanding of the Mesolithic and Neolithic ceramics in the central Sudan by applying a series of the most recent physico-scientific analyses.

The petrological results (cf. sections 3.3-5.3, 6.3.1) tend to show that the examined ceramic groups from the central Sudan -Khartoum, White Nile and Western Butana - (figs 1-2, 4, 39, 52) are rather comparable. They can be divided into four major groups including sedimentary, igneous, metamorphic and mixed lithography. However, sedimentary fabrics are the most common. On the basis of mineralogical content, proportion and temper origin two main sedimentary fabrics are discernable; one is characterized by a high proportion of quartz inclusions (c.80%) in the bulk of the samples, the remaining minerals including feldspar which is little in amount in the majority of the samples of fabrics groupA from the Mesolithic sites of the Western Butana (Shaqadud midden-lower levels, White Nile (Shabona) and Khartoum province (Sarurab2), fabric subgroup A1 of the Neolithic sites from Khartoum (Islang2 and Nofalab2) and groupB from the White Nile (Rabak-Khartoum Neolithic levels.). It is devoid in the remaining Mesolithic and Neolithic pottery samples of the selected sites in the central Sudan (ibid.).

Accessory minerals including zircon, epidote, tourmaline, hypersthene are almost absent in all the thin sections, being present in the magnitude of $\leq 1\%$ (ibid.).

Group2 of sedimentary fabrics is characterized by frequent amount of inclusions of calcitic nature, ranging between 6-40% at the Neolithic fabrics

subgroupA2 of Rabak-J.M.L. (White Nile Province) and Shaqadud Cave (Western Butana) (ibid.).

Igneous fabrics are less frequent (c.27%). They are characterized by relatively high proportions of microcline, perthite (c.18-67%) and infrequent amounts of aplastic quartz (c.15-37%). However, a series of Mesolithic fabrics from Khartoum (Sarurab2, A2-B), White Nile (Shabona, B) and the Neolithic assemblages from the first (Islang2, B) and the second (Rabak-Kh. Neo.L., A) areas as well as the Western Butana (Shaqadud midden-upper levels, B) illustrate this tendency (ibid.).

Metamorphic fabrics (c.9% of the total) are distinguished by the occurrence of considerable aplastic minerals of metamorphic source such as hornblende, muscovite mica and rock fragments, Subgroups of this class include appreciable hornblende with little or scarcity of feldspar and lack of calcitic inclusions; the other group comprises considerable proportions of quartz together with frequent muscovite mica and occasional rock fragments (ibid.).

Mixed lithography (c.12% of the total) is characterized mainly by abundant non-polycrystalline, K-feldspar (igneous source) coupled with varying amounts of hornblende. Examples to illustrate this tendency came from Khartoum (Kabbashi Haitah-fabric B) and Western Butana (Shaqadud Cave-fabric B). (ibid.).

X-ray diffraction results indicate that all the Mesolithic, Neolithic and modern pottery samples consist of high proportions of quartz grains with varying fine earth fractions (020), plagioclases, K-feldspar, mica, anatase and calcite. Hematite inclusions were not detectable prior to firing and after firing to c.700-800° C, the samples promoted hematite. However, the sole exception, being the weak occurrence of kaolinite clay in the composition of a single sample from Islang2 site in Khartoum Province (G93-17a, table 10) and the steady increase of calcite from the early Neolithic (Shaqadud midden-upper levels) to the late Neolithic phase (Shaqadud Cave) in the Western Butana (cf. sections 3.4-5.4, 6.3.2, 6.5.3).

The X-ray diffraction results of the sampled Mesolithic and Neolithic ceramics are homogenous suggestive of similar sources for pottery making in the central Sudan (see infra). Therefore, on the basis of these results, it is not possible to pinpoint any characteristic groupings. The present work indicates the

absence of the key clay minerals in the composition of the tested examples (e.g. montmorillonite, kaolinite, illite, ...etc.). Conversely, contemporary examples mainly from northern Sudan and adjacent areas (Saharan Africa) indicate the occurrence of these key clay minerals. The only exception, being kaolinite which is devoid in the sediments of northern Sudan and it is extremely rare in the tested samples from the central Sudan. This could be attributable to the low abundances of this mineral group in the recent sediments of both areas (cf. section 6.3.2).

The results of the X-ray spectrometric analyses - as shown by ternary diagrams -indicate that the Mesolithic, Neolithic and modern pottery samples of the central Sudan (Khartoum, White Nile and Western Butana) are chemically comparable. The high SiO2 contents show that all the samples are distinguished by high amounts of incorporated quartz grains derived from Nubian Sandstone Formation. Aluminum (Al203) which is the rough index of feldspar is relatively high in all the Mesolithic, Neolithic and modern pottery samples (cf. sections 6.3.3, 6.5.4). Such pottery with appreciable Al203 content is consistent with the abundance of K-feldspar as shown by X-ray diffraction analyses (cf. section 6.3.2).

On the basis of pottery chemistry, patterning in the composition of the tested samples during the passage of time-Mesolithic and Neolithic periods-was not observed at the intraregional and interregional levels. The sole exception, being the experimentation with clays that are rather rich or moderately-rich in calcitic material during the late Neolithic period (3rd millennium B.C) in the White Nile (Rabak-Jebel Moya levels) and Western Butana (Shaqadud Cave) (cf. section 6.3, 3.3).

Goethite norm analyses indicate that the original fine-earth fractions of the Mesolithic, Neolithic and modern pottery samples from the central Sudan might have held kaolinitic-illite, quartz-rich clays together with small amounts of montmorillonite and sparse proportions of chlorite (see infra).

Kaolinite (mainly, 62-75% of the samples, c.27-52 wght%) and illite norm minerals (c.62-75%, c.20-49 wght%) are rather comparable and present in relatively high proportions in the composition of the Mesolithic, Neolithic and modern pottery samples from the central Sudan. On the other hand, quartz norm minerals are less frequent (c.63-75%, 8-35 wght%), chlorite (c.19-25%, c.3-15

wght%) and montmorillonite (c.75-93%, c.0.2-15 wght%) occur in low or rare amounts (cf. sections 3-6-5.6, 6.3.4, 6.5.5).

The X-ray diffraction (XRD) and thermal (DLT) analyses provided evidence showing that the pottery of all the tested Mesolithic and Neolithic ceramics in the central Sudan might have been fired at temperatures in the magnitude of c.700-800° C. This could be deduced from the absence of the key hydrated minerals (e.g. montmorillonite, kaolinite, illite, chlorite, ...etc.) as shown by XRD analyses or the spectacular changes concomitant with the thermal expansion (DLT) of several minerals (calcite, mullite, spinal, ...etc.) as a result of formation of new crystalline phases (cf. sections 8.4-8.8).

The firing temperature(s) of the present Mesolithic and Neolithic samples is generally comparable with those derived from several Neolithic sites in Khartoum Province (Kadero1, Zakiab and Um Direiwa1) and the Second Cataract (Abkan and Khartoum Variant) district. The variations between these ceramics and their counterparts in other localities in the central (Khartoum), northern (Khashm el Girba, Dongola reach and the Second Cataract) Sudan and central Sahara (Wanyanga and Amekni) could be attributable to either differences in matrix composition or as a consequence of inadequate fueling and rather uncontrolled firing conditions (cf. section 8.8.7).

The firing time seems rather short as could be inferred from a variety of colours depicted on the Mesolithic and Neolithic pottery surfaces and the development of hematite after refiring the tested sherds to c.700-900° C in an electric oven for one hour (cf. section 8.8.3).

The atmospheric conditions are neither oxidizing or reducing. The unevenly oxidized surfaces of the pottery examined are appreciable in number and point to fluctuation in firing atmosphere. This could be deduced from the grey, dark brown and black cores of the pottery fabrics and the thin oxidation zones at the wall surfaces (cf. sections 3.72.3-5.7.2.3). On the other hand, the complete absence of forced-draft kilns at the Mesolithic and Neolithic sites in the Sudan, (cf. sections 8.8.2-8.8.4) strengthens the probability that the pottery of these periods was either fired directly on the ground or in simple pits.

The firing index of the sampled Mesolithic and Neolithic ceramics in the central Sudan is of a relatively high-grade (c.700-800° C) despite the fact that the

length of firing is insufficient to bring the clay impurities particularly iron oxides to the highest state of oxidation. This relatively high-grade firing index is a characteristic of well-fired wares (cf. sections 8.2.1, 8.8.40).

The firing index of the Mesolithic and Neolithic ceramics examined in the presented work is comparable with other ceramic groups from the central (Khartoum district:-Kadero1, Zakiab and Um Direiwal)and northern (Khartoum Variant) Sudan, all of which are in the time magnitude of c.700-800° C. On the other hand, the Neolithic ceramics from the later area (Second Cataract and the A-group sites in Upper Nubia) indicate that the firing temperatures of fabrics may be estimated as having been in the order of c.600-700° C. Therefore, such general resemblances in the firing index between the Mesolithic and Neolithic ceramics of the central and northern Sudan at the intraregional and interregional levels seem to suggest the use of similar firing techniques (cf. sections 8.8.1-8.8.2).

Synthesizing the data of lithological provenance, the petrological results (see supra and sections 3.3-5.3, 6.3.1, 6.5.2) have shown the presence of four types of temper (sedimentary, igneous, metamorphic and mixed lithography) featuring the Mesolithic and Neolithic pottery fabrics in the central Sudan. The sources of nearly all these tempers are fairly accessible to the potters, being derived from Nubian Sandstone deposits, pockets of Basement Complex underlying Nubian Sandstone or present within easy reach outcrops. These geological formations are widely spread in the Sudan including the study area. The sole exceptions, being limestone fragments representing the Neolithic pottery fabrics of subgroup A2 of Rabak (J.M.L) in the White Nile province and Shaqadud Cave in the Western Butana whose sources lie outside the immediate vicinity of their place of find (cf. section 6.5.2 for further discussion).

The results of chemical analysis (X-ray spectrometric technique) which are characterized by high silicon (SiO2) and aluminum (AL203) contents tend to add a credibility to the petrological results that the pottery of all the periods (Mesolithic, Neolithic and modern) from the study regions of the central Sudan (Khartoum, White Nile and Western Butana) is highly homogenous with little variations at the intraregional and interregional levels. However, these minor chemical variations seem to reflect the amount of temper present (e.g. Mesolithic and Neolithic pottery samples) and the particularity of the ceramic phase (e.g. modern pottery samples) (see supra and sections 6.3.3, 6.5.4).

The X-ray diffraction results (see supra and sections 3.4-5.4, 6.3.2, 6.5.3) of the sampled Mesolithic and Neolithic ceramics versus the local pottery samples - at the intraregional and interregional levels - are highly homogenous suggestive of similar sources for pottery. The most likely source, being the Nile silt quarried from the flood plain by the Mesolithic and Neolithic potters in Khartoum and White Nile regions and the alluvial Butana deposits in the form of clay and silt quarried by their counterparts from the Western Butana.

The results of the goethite norm calculations (see supra and sections 3.6-5, 6.3.4, 6.5.5) differ from the X-ray diffraction ones (see supra and sections 3.4-5.4, 6.3.2) which are devoid of the key minerals (montmorillonite, kaolinite, illite and Chlorite) in the composition of the pottery samples analyzed. The only exception, being a single example from the Neolithic site of Islang2 in Khartoum Province which contains very small amount of kaolinite (cf. sections 3.4, 6.3.2, 6.3.4.1).

As reviewed above, the petrological, chemical (X-ray spectrometric technique), petrochemical (Norm calculations) and X-ray diffraction analyses have shown that the mineral make-up of tempers and clay matrices of almost all the analyzed Mesolithic and Neolithic ceramics from the central Sudan was a derivation from local lithological provenances (see also chapters 3-6 for further information).

The degree of difference in fabric between all the Mesolithic, Neolithic pottery and the geographical separation of their sites of find (Khartoum, White Nile and Western Butana regions) is almost imperceptible. In most instances, petrological, X-ray diffraction, chemical and petrochemical analyses tend to show that the pottery samples of the Mesolithic and Neolithic periods in the central Sudan are highly similar at both intraregional and interregional levels. An appropriate explanation to this phenomenon may be that the sources of raw clay (Nile silt and alluvial deposits) and temper (Nubian Sandstone and Basement Complex) are rather homogenous. The general uniformity of the local geology favours this assumption. Moreover, the mobility of the Mesolithic and Neolithic folks in the areas of the central Sudan (Khartoum, White Nile and Western Butana) does seem likely particularly at the end of Neolithic period when people became mainly pastoralists whose movements frequently unrestricted to their immediate vicinity (cf. section 9.6).

The results of textural analysis indicate significant differences in the frequency of grain sizes of the aplastic mineral inclusions and several groups were distinguished in the chronological developments (see infra).

The aplastic mineral grains of the Mesolithic and Neolithic groups examined in the present work are dominantly angular or subangular, occasionally rounded or subrounded. This weakens the probability that the grain-size measurements between the tested ceramic-groups are due to the nature of the material used in its original state (cf. section 7.4-7.9).

The T-tests carried out by the present writer show that the variations between the groups' combinations at the intraregional or interregional levels, in most cases, point to significant differences at .000 and .05 level of confidence. Therefore, it appears plausible that these variations are neither due to sampling errors nor to the material used in its original condition. But since the tested ceramic-groups follow each other chronologically, beginning with the Mesolithic period and followed by the Neolithic one, it does seem conceivable that these marked variations in the grain sizes of the test-ceramic groups are indicative of a deliberate change in methods of tempering preparation during that passage of time. If that is the case, then this phenomenon would mark the tendency of the Mesolithic and Neolithic potters in the central Sudan to provide more fine-grained and refined ceramic-output through time. On the other level, the affinities in grain sizes between the ceramics from the eastern and western bank of the Main Nile (Khartoum Province) may point to the adoption of similar techniques in temper preparations (cf. section 7.10).

The present writer has proposed a hypothetical model in an attempt to explain the nature of pottery production and distribution in the central Sudan and adjacent areas during the Mesolithic and Neolithic periods. It consists of two levels of exchange, implying the probability of two exchange mechanisms; one is regional (within social and spatial units) and the other is external (across cultural boundaries) (cf. section 9.10.4, fig.93).

In the central Sudan (fig.1) the Mesolithic (mainly unburnished wavy line, dotted wavy line and dotted straight line) and Neolithic (mainly burnished dotted wavy line, triangles, zigzag, dotted straight and mat impressions) ceramic assemblages in Khartoum and White Nile do share much more common

decorations with each other than with their counterparts in the Western Butana (mainly banded motif). Other decorations such as semicircular panels, zoned, linear, fingernail, herring-bone, triangles/dots of the central Sudan are missing in the ceramic corpus of the Western Butana (cf. sections 3.7-5.7, 10.1).

With respect to technological features, the petrological, X-ray diffraction and goethite norm analyses indicate a fair degree of similarity in mineralogical composition of the pottery from the three regions investigated. Nonetheless, on the basis of pottery chemistry, a couple of triangular diagrams (cf. section 9.11.1 and figs.57-58) tends to show that Al203, Ti0 and Mg0 of the central Nile (Khartoum and White Nile) are distinct from those of the Western Butana in having relatively high proportions of Al203 and low proportions of Ti02 and Mg0. Moreover, the loose sediments of Wadi beds in the Butana and the Nile silt quarried from the Nile flood plain were the most accessible clay sources for the Mesolithic and Neolithic potters in the Western Butana and the central Nile respectively (ibid.). Therefore, on the basis of the evidence reviewed above, the possibility that Shaqadud complex site might have been a seasonal camp occupied during the wet or dry season has proven invalid (see sections 9.5.1.2, 9.10.3, 9.11.1).

In the central Nile (Khartoum and White Nile) both in typological and technological aspects, the Mesolithic and Neolithic ceramics are similar in an essential way. There is a remarkable overlap between the decorations of the two regions. While the unburnished wavy line, dotted wavy line are restricted to the Mesolithic period, zigzag, dotted and impressed straight lines are the commonest in both regions. Exceptions are a few decorations including parallel groovings and wiped surfaces which are absent in Khartoum district (cf. sections 9.5.1, 9.11.1).

The physico-scientific analyses indicate a high degree of homogeneity with little variations between the regions at the intraregional and interregional levels. Therefore, on the basis of the evidence reviewed above, the physico-scientific analyses have not been able in yielding information pertinent to probable movements of the Mesolithic and Neolithic ceramics from Khartoum towards the White Nile or vice versa (ibid.).

In the northern Sudan (fig.1) sandy fabrics of El-Kadada ceramics which date to the post-Neolithic period (cf. sections 9.5.2, 9.11.2.1, 10.1.2) are

comparable with their counterparts from the Neolithic sites in the central Nile (Khartoum and White Nile) and the Western Butana. On the basis of older sequences in the later areas, a south-north movement, perhaps via Western Butana (Shaqadud Cave) seems a conceivable explanation to the shared similarities (cf. sections 9.11.2.1, 10.1.2.1).

In the absence of comparative mineralogical data from the Mesolithic ceramics of the Atbara reach (Abu Darbein, Aneiba and Damer) only decorative motifs (wavy line and dotted wavy line) form a cultural link with Khartoum, White Nile and Western Butana counterparts. But since the earliest radiocarbon dates from Khartoum (c. 7350-6050 B.C.) are older than those of the Atbara reach (c.6527-6085 B.C.), "south-north contact radiating from Khartoum district seems a much more conceivable explanation to delineate the nature of cultural mechanisms articulating the human groups in both areas during the Mesolithic period (cf. sections 9.11.2.1, 10.1.2.2).

The sandy fabrics of Early Khartoum related Groups in the Dongola reach (N13-4-7, N13-4-22, N40-2) are comparable with their contemporaneous of the central Sudan. In the absence of radiometric dates from Dongola reach, relations could hardly be traced. But since Khartoum Mesolithic ceramics have got older radiocarbon dates in comparison with other regions in the Sudan, the possibility that the fabrics and typological analogies of Dongola reach Mesolithic ceramics were a result of a return contact from the south (central Sudan) does seem conceivable (cf. sections 9.11.2.3, 10.1.2.3).

The Neolithic ceramics from Dongola reach (Karat, Tegris) are comparable with their counterparts from the central Sudan. Inspite of the lack of radiometric dates at the former, the close similarities with the Khartoum Neolithic ceramics (c.4000 B.C) suggest a south-north influence. On the other hand, al-Melik group ceramics are atypical to the central Sudan and Upper Nubia. Hence, at the present level of information the nature of cultural connections (if any) could not be deciphered (ibid. and section 10.1.2.4).

The ceramics of Abkan (mainly plain and often impressed) and Khartoum Variant (overwhelmingly woven mat) which are reminiscent of Khartoum Neolithic ceramics from the central Sudan tend to display fabrics derived from local lithological provenances (cf. section 9.11.2.4). Inspite of contemporaneity, the radiocarbon dates of the central Sudan are, in general, relatively older than

those of the Second Cataract. If we add to that, the disparate nature of lithic typologies and technologies, a south-north contact seems a conceivable explanation to the shared cultural ties (ibid.).

Genetic connections between the central Sudan and post-Shamarkian Neolithic pottery could not be traced because the pottery of the latter has not as yet been studied. On the other hand, the Early A-Group (c.4740-4530 B.C.) pottery (black-topped) recalls predynastic Egyptian (Naqada1 and Naqada 11) ceramics, whereas the black-mouthed and egg-shaped vessels of the Classic (c. 3535-3415 B.C) and Terminal (c. 3020-2890 B.C.) A-Group falls outside the norm of "Khartoum Neolithic" tradition. Therefore, in the present level of information a reciprocal exchange system did not seem to have taken place (ibid.).

In the eastern Butana, the Mesolithic (Pre-Saroba) and Neolithic (Saroba and Butana group) ceramics have not as yet been studied for fabric composition by physico-scientific methods. However, Shaqadud Cave pottery is the only example showing a typological link with the eastern Butana ceramics which are of a much later date (c.3125 - 3060 B.C) in comparison with the central Sudan (mainly c.4500-3500 B.C). Therefore, the possibility of a west-east ceramic movement, perhaps via Western Butana becomes a likely explanation to the general affinities shared (ibid.).

In the absence of comparative mineralogical analyses for Jebel Moya Neolithic ceramics (cf. Addison 1949, section 9.11.4 and fig.2), the nature of pottery distribution of this site and its contemporaneous at Rabak-J.M.L. - in the White Nile region and Shaqadud Cave in the Western Butana could hardly be traced. However, the radiocarbon dates of Jebel Moya (c.3800-2440 B.C.) are relatively earlier than those of Rabak -J.M.L.- (c.3400-2915 B.C.) and Shaqadud Cave (c.2990-2620 B.C). Therefore, the probability that the latter absorbed its ceramic traits (globular vessels, impressed and wiped decorations) from the former becomes fairly likely (ibid.).

Rocker-stamp motifs which are prominent in the central Sudan have been recorded from a sand-dune site east of Wadi Howar in the western Sudan (fig.2). But since the time-scale of this site (c.3600 B.C) lies in the late Neolithic sequence of the central Sudan (c.3600-3500 B.C.), an east-west

movement from the central Sudan, resulting in the occurrence of rocker-stamped pottery in Wadi Howar does seem fairly possible (cf. sections 9.1.1.5, 10.1.1.1).

The general ceramic parallels (mainly chevrons and linear impressions) and the fairly local derivation of mineralogical composition (mainly metamorphic gneiss with or without intrusive acidic, igneous containing microcline, polycrystalline quartz and hornblende) of the Neolithic ceramics from the Egyptian Sahara coupled with the relatively later dates (≤ 7000-4000 B.C.), strengthen the probability that these traits do not constitute, at least, a substantial ceramic movement (if any) from the central Sudan (cf. sections 6.4.3.1, 9.10.2, 9.11.6, 10.1.2-10.2.2).

Despite the general resemblances in decorations between the Mesolithic and Neolithic ceramics of the central - Khartoum, White Nile and Western Butana - (cf. sections 3.7 - 5.7) and northern (Dongola) Sudan (cf. section 10.1.2.3) and their counterparts from the central Sahara (cf. sections 9.11.6.2, 10.2.2), the similar pottery fabrics are most likely to be present locally (ibid.). But since the main suite of the radiocarbon dates of the central and northern Sudan (cf. section 10.1.1-10.1.2) is relatively older than that of the contemporary central Sahara (cf. section 10.2.2) an east-west contact seems a plausible explanation deciphering the nature of cultural connections between the two regions.

The scale of resolution as envisioned from the physico-scientific analyses is not quite satisfactory as to clearly identify ceramic movements at the interregional (central and northern Sudan) and external (central and eastern Sahara) levels (cf. sections 6.3.1-6.3.4). Nevertheless, a series of evidences pertinent to people and items movements seem to reinforce the possibility that some form of contact, perhaps indirect one (reciprocal exchange) accounted for the occurrence of parallel Mesolithic and Neolithic ceramics in central, eastern Sahara and the central and northern Sudan (cf. sections 9.10.4, 9.11).

With respect to the chronology, the radiocarbon dates of the "Khartoum Neolithic" assemblages within the central (Shaheinab, Islang1,2; Kadero 1,2, Zakiab, Zakiab, Um Direwia 1,2, Rabak-Kh. Neo.L. and J.M.L.-; Shaqadud midden-upper levels) and northern (Abkan and Khartoum variant) Sudan fall, in general, within the fifth millennium B.C.. The dates of these ceramic

assemblages are contemporary and this may explain the close decorating analogies between them (cf. sections 10.1.1-10.1.2, 10.3).

Turning to the south, it is clear that the pottery of the oldest levels at Rabak (4300 B.C) is similar to that recorded from the Khartoum Neolithic (Shaheinab) where the upper levels (c.3270-3160 B.C.) provided pottery recalling Jebel Moya tradition. On the other hand, the ceramic traits of Guli (burnishing, triangles and fish-scale ornaments) have been dated to c.3530-3620 B.C., being contemporary with "Khartoum Neolithic" sites. Hence, on the basis of the available evidence, the acquisition of Neolithic pottery by Guli and Rabak dwellers as a result of a return contact from the north (Khartoum) becomes much more likely (cf. sections 10.1.1.1-10.1.1.2, 10.3).

During the Mesolithic (c. 4450-4250 B.C.) and Neolithic (c. 3650 - 3540 B.C.) periods of Wadi Howar in the western Sudan (cf. section 10.1.1.3) the ceramic traits are comparable to their contemporaneous in the central Sudan (cf. sections 10.1.1, 10.1.3, 10.3). At the end of the Neolithic period (c. 2600 - 2060 B.C.) basket and geometric designs recalling pottery from the central Sahara (Ennedi) were reported. But since the single radiocarbon date of "Hou Hou" pottery from Wadi Howar (c.3160-2060 B.C.) is later than that obtained from Ennedi in the Sahara (c.3300-2800 B.C.), it is more likely that this type of pottery could have originated in the later area. (ibid. and section 10.3).

In the eastern Sudan, the eastern Butana ceramics (c. 7045-2150 B.C.) bear general parallels to the Khartoum Mesolithic pottery whereas Saroba phase (c. 520-5480 B.C.) which succeeded the previous one is devoid of Khartoum Mesolithic and Khartoum Neolithic influences. On the other hand, the early "Kassala phase" (c.3700-3200 B.C.) bears no affinities to the "Khartoum Neolithic" potting tradition from Khartoum, White Nile and Western Butana (Shaqadud midden-upper levels). Yet, it is akin to pottery derived from Shaqadud Cave (c. 2805-1935 B.C.) from the later area. But since the dates of "Kassala phase" are not contemporary with those of Shaqadud Cave (see supra), cultural contact was not possible. However, the radiocarbon dates of the latter are contemporary with the early "Kassala phase" (Mahal Teglinos) of the Gash Delta (c. 2360-1970 B.C.). Moreover, the scraped (brushed) decorations of both ceramic groups (Shaqadud Cave and Mahal Teglinos) had relatively older dates at sites KG28 (c. 4018-3951 B.C. - Saroba/Kassala transition) of the eastern Butana and KG23 (c.3382-3540 B.C.) of the Butana-group from Kassala

province. Therefore, a common origin radiating from the later regions, may explain the stylistic affinities between the ceramic-groups of Shaqadud Cave in the Western Butana and Mahal Teglinos in Kassala district (cf. sections 10.1.1.3, 10.1.4.2).

From chronological standpoint, it appears that the overall radiometric dates of the Mesolithic ceramics (mainly ornamented with wavy and dotted wavy lines) from the central (Sarurab2, Saggai1, Kabbashi Haitah and Kabbashi) and northern (Damer, Abu Darbein and Aneibis) Sudan (cf. section 10.1.1) are generally consistent with those of the southern, central Sahara (Wanyanga, Ennedi, Tibesti, Amekni, Delibo, Fozzigaren, Gilf-Kabir and Uan Tabu), most of which are dated to the 7th-6th millennium B.C. On the other level, the Mesolithic and early Neolithic ceramics of the eastern Sahara (e.g. Nabta playa, Bir Kiseiba and Wadi Bakht) which are mainly decorated with woven, rippled and vertical incisions have been dated to the same time span (7th -6th millennium B.C.), being obtained for the Mesolithic assemblages of the central, northern Sudan and southern/central Sahara. The sole exception is Ti-n-Torha site in the Libyan Sahara whose dotted wavyline levels gave an age of 7400-6900 B.C. (cf. section 10.2.2) and Temet site (Niger) which gave a radiocarbon date believed to be the oldest for a ceramic horizon in Africa (c. 7700-7600 B.C.). However, the later sample was not associated with ceramics but with a comb claimed to be used by a potter (ibid., section 10.3 and appendix 7).

In the central Sudan the total suite of early dates especially those from Saggai1 (c. 8240 - 8130 B.C.) and Sarurab2 (c. 7500 - 7130 B.C.) are worthy of particular consideration since they represent the earliest evidence for pottery making so far known in Africa, being in close association with ceramics and other material culture of the Khartoum Mesolithic tradition. The Saggai1 site has been considered by the excavator as too early and it is, however, not solely the earliest date for Khartoum Mesolithic tradition in the central Sudan but for a ceramic-bearing site in Africa and the Middle East. On the other level, the radiocarbon dates from Sarurab2 in Khartoum district excavated by the present writer (see supra) are often unaccepted by some workers on face value, since - according to them - they are much earlier than any accepted for Khartoum Mesolithic assemblage with the date (see supra) being late Mesolithic. Nonetheless, they have not rejected the probability that the dates of Sarurab1 (c.4538-4338 B.C.) and Sarurab2 (c. 7500 - 7130 B.C.) are correct, each for the

site area sampled, since these sites have potential for considerable horizontal stratigraphy (cf. section 10.3).

Though the latter possibility does seem acceptable, the present writer is of the opinion that the cultural similarities between the two portions of the site outweigh the differences and Sarurab2, which the material culture indicates, is undoubtedly a typical "Early Khartoum" site and in close association with Khartoum Hospital (ibid., Arkell 1949; Khabir 1981: 142- 146 and appendix 7). Moreover, the earlier dates for Sarurab2 which are based on charcoal may be more reliable than those obtained for Sarurab1 which are derived from shell material. Furthermore, the radiocarbon dates of Sarurab2, in any case, are not discordant with the suite of early dates for pottery production in north Africa (cf. appendix 7). Therefore, these dates are on a firmer ground.

In the central Sudan it would seem that the origin(s) of the Khartoum Mesolithic and Khartoum Neolithic are much more complex than was once thought. On the basis of the chronological evidence reviewed above, it is remarkable that the absolute dates obtained for the Mesolithic ceramic contexts of Saggai1 (8th millennium B.C.), Kabbashi Haitah, Kabbashi and Shabona (6th millennium B.C.), Sarurab1 (5th millennium B.C.) display marked variations and are inconsistent with the close affinities reflected in the material culture of these sites (cf. sections 2.3.1, 2.5.1.1, 3.2.1.1; 3.2.2-3.2.3, 3.3.5.1-3.3.6.1, 3.3-3.9; 4.2.1.1, 4.3-4.9;10.3). These radiocarbon dates are coeval with those obtained for the Mesolithic ceramics of the Atbara reach in the northern Sudan (cf. section 10.1.2.2.), being earlier than the oldest dated ceramics recorded from Ti-n-Torha site (cf. section 10.2.2) in the Libyan Sahara (early 8th - mid 7th millennium B.C.).

On the basis of the radiocarbon dates from the earlier ceramic assemblages in the central Sudan (see supra, this chapter), it seems that the study of the Mesolithic and Neolithic periods in terms of linear development from Early Khartoum (Khartoum Mesolithic) to Shaheinab (Khartoum Neolithic) requires reassessment as a historical and cultural reality. However, the present writer excavation at Sarurab2 site in Khartoum district (see supra, this chapter and sections 3.2.1.1, 10.1.1.1) has provided the earliest radiocarbon dates in Africa-based on charcoal -found in full association with ceramics and other material culture of the Khartoum Mesolithic tradition and thereby increased the probability that, as has been postulated by some workers (see

Arkell 1975: 21 and Clark 1980 : 561), the wavy line and other wares of the Khartoum Mesolithic were an early and independent development in the central Sudan (cf. section 10.3).

Appendix 1:
Outline of Geology of the Central Sudan

A.1.1 Introduction

The Republic of Sudan is the largest country in Africa. It occupies 967498 square miles. It lies between Lat.4° and 22´ N and 22° and 38´ E. It constitutes a major part of the Nile Basin (see Figs. 1 - 2) but small parts of the country drain into the Chad basin, for example Wadi Azum and its tributaries which drain the eastern slopes of Jebel Marra into Darfur. A small area in the south-east drains into Lake Rudolf (Whiteman 1971:1).

A.1.2 Geological units

Sudan is divided into a number of clearly defined geological units (Fig.4). However, these units are as follows:-

A.1.2.1 Wind blown sand and superficial deposits.
A.1.2.2 Silts and clays of the Gezira plain and Umm Ruwaba Formation type.
A.1.2.3. Tertiary volcanic rocks.
A.1.2.4 Nubian Sandstone Formation.
A.1.2.5 Ancient Post-orogenic igneous complexes.
A.1.2.6 Basement Complex - metamorphosed and igneous rocks.

Each unit is easily recognizable in the area (Figs 3-4.39,52) but the amount of outcrops and type of exposure differs considerably. The central part of the country which embraces the study area contains elements representing all units known in other parts of the Sudan Republic (see Vail 1982:51).

A.1.2.1 Wind blown sand and superficial deposits

This is the most modern cover of the area and is composed of sedimentary deposits which are still being formed today or which are of relatively recent origin. To the west of the White Nile, a narrow strip of sand occurs, known as Qoz Abu Dulu. The probability has been considered that this sand belt might represent a Levee course of an ancient Nile stream (Whiteman 1971: and Vail 1982:60-61).

The wind blown sands are usually of frosted rounded grains of quartz occasionally stained red by iron oxides, but in depth they are usually white. Gravel deposits are notable east of the Nile, particularly around the northern part of Butana plain (Vail 1982:60).

Alluvial deposits composed mainly of silt clays are present along the valleys of the three Nile branches. They are important to inhabitants, away from Gezira, it is the main area for irrigation and cultivation (Whiteman 1971:124-125 and Vail 1982:60).

A.1.2.2. Silts and Clays of the Gezira plain and Umm Ruwaba Formation Type.

The Gezira is roughly triangular in shape. The apex of the triangle is at Khartoum, the sides are formed by the Blue Nile on the east, the White Nile on the west whereas the base of the triangle is drawn arbitrarily at Sennar-Kosti railway line (Whiteman 1971:124). The silts and clays are the most common features of the Gezira region in the central Sudan (Figs 3-4,39,52). In the central Gezira region, silts and clays are named the Gezira Formation. The formation consists of unconsolidated clays, silts, sand and gravels. It rests unconformably on the Nubian Sandstone Formation and is overlain by blown sand and other superficial deposits (Vail 1982:55-60). Worral recorded the following minerals from Gezira formation: calcic, plagioclase, augite, hornblende, biotite and olivine (Worral 1956:1-8). Typical Blue Nile minerals, for instance pyroxene, especially the purple variety and zeolites are common and characteristic of the Gezira clay (Whiteman 1971:125).

A. 1.2.3. Tertiary volcanic rocks

The Tertiary volcanic rocks of central Sudan include parts of the Blue Nile Province and south-eastern Sennar. In this area, coarse grained basalt known as the Sennar teschenite crops just below the dam wall and it is surrounded by Nubian-type sediments. Similar rocks are reported from drill hole in the Nubian Sandstone Formation between Jebel Aulia and Khartoum, and no doubt other buried intrusive masses are present elsewhere in the region (Whiteman 1971:79-109 and Vail 1982:58-59).

A. 1.2.4 Nubian Sandstone Formation

It is the most metamorphosed sedimentary sequence in Sudan. It crops in most parts of central Sudan (Figs. 3-4,39,52). Outcrops of Nubian Sandstone within the Gezira plain are rare, but boreholes and wells have proven the presence of the beds beneath most of the area. In all areas of the central Sudan the Nubian Sandstone Formation rests unconformably on a surface of Basement Complex rock that had considerable relief (Vail 1982:58).

It is evident from lithological and palaeontological evidence that the Nubian Sandstone Formation in the central Sudan is probably a fluvial continental deposit, which perhaps accumulated in point bars, delta fans and flood plains on relatively flat basement surface of subdued relief (Whiteman 1971:53 and Vail 1982:58).

The most commonly encountered minerals of this formation include coarse poorly sorted pebbly sandstone, quartz pebble conglomerate, arkoses and lesser shales and mudstones. The heavy mineral fraction (0.15 per cent by weight) consists mainly of tourmaline kyanite, staurolite, rutile and opaque minerals (Whiteman 1971:58).

A.1.2.5 Ancient Post-orogenic igneous complexes

Three large igneous complexes are recognized in the central Sudan. These include Sabaloka Gorge at the Sixth Cataract north of Khartoum, the smaller buried complex of Sileitat-es Sufur north of Khartoum North and the ring-complex of Jebel Qeili in the West Butana Plain (see Figs. 3-4,39,52) (Vail 1982:57).

The three complexes are perhaps of similar age, although they are geologically somewhat varied. The Sabaloka Complex consists of a ring-dyke of porhyritic microgranitic encircling a down faulted central Cauldron in which are preserved in the south a thick pile of extrusive rocks and in the north the floor rocks of gneissic basement (Whiteman 1971:22-23 and Vail 1982:56-57).

The Sileitat-es-Sufur Complex is mainly covered by Nubian Sandstone Formation sediments. The main rock type of this Complex is riebckite quartz

syenite. It is a medium grained, white rock speckled by black amphiboles. It probably belongs to a ring-complex similar to Sabaloka, but not large, and without the preserved volcanic rocks (ibid).

Jebel Qeili is also a ring complex that lies 125 km east of Khartoum (Fig. 39). It consists of a number of intrusives of sodic syenites and small intrusions of gabbro and dolerite (ibid.).

A.1.2.6 Basement Complex - metamorphosed and igneous rocks

This formation is composed of igneous, metamorphic and sedimentary rocks that are overlain by palaeozic or Mesozoic sedimentary or igneous rocks and they are assumed to be of Pre-Cambrian age (Whiteman 1971:11).

Representatives of this unit crop out in the central Sudan in four main places, namely, in the Sabaloka dyke north of Khartoum (Fig. 4), west of the White Nile between Omdurman and Ed Dueim, east of the Blue Nile in parts of the Butana plains (Figs.1,52) and south of the Gezira between Sennar and Kosti (Figs.1,39). Elsewhere they are overlain by younger deposits, but have been found in depth in boreholes and wells throughout the area (Vail 1982:53-54).

It is characterized by the presence of quartzites, schists gneiss, limestone marbles, graphite-slates, granitic and dioritic rocks. It also includes intrusive igneous rocks, acid, intermediate basic and ultra basic types comprising gabbro, diorite, hornblende, plagioclase gneiss, pyroxenite, ...etc. (Whiteman 1971:11 - 47 and Vail 1982:53-54).

Appendix:2

RADIOCARBON DATING CERTIFICATE

Sample sent for analysis by:

Mr. Abdelrahim M. Khabir CODE 320:
Dept. of Archaeology,
Khartoum University,
P.O.Box 321, Khartoum, Sudan.

Result:

1 HARWELL REF.	2 SENDER REF.	3 TYPE	4 DELC 13 (%/10)	5 AGE 13 (YRS)	6 bp-1950	7 COMMENT REF.
HAR-3475	SRB-11-31	Charcoal	-25.0	9370 ± 80	7420 bc	

Comments:

About 30km North of Omdurman (Khartoum Province) SRB-II site 15 56. 15 N. c.32 32 30 E.

Found at the South eastern part of sq. 27 at a depth of 40 cm below the present surface covered by stone slabs and overlain by compacted soil composed of gravels and silty deposits.

This certificates that the sample give above has been analysed for RADIOCARBON at this laboratory. This results, expressed at DELC 13, bp and bp-1950, are given in accordance with method outlined in the accompanying Notes Sheets, NS/1/75, to which due reference should be made.

CARBON-14/TRITIUM MEASUREMENTS
LABORATORY NUCLEAR PHYSICS
DIVISION, AERE, HARWELL, OXON, OXII
ORA BUILDING 10.46

(SIGNED)

R.L. Otlet.

Date: 14/12/79

(After Khabir, A.M., 1981:257)

Appendix:2.1

RADIOCARBON DATING CERTIFICATE

Sample sent for analysis by:

Mr. Abdelrahim M. Khabir CODE 320:
Dept. of Archaeology,
Khartoum University,
P.O.Box 321, Khartoum, Sudan.

Result:

1 HARWELL REF.	2 SENDER REF.	3 TYPE	4 DELC 13 (%/10)	5 AGE 13 (YRS)	6 bp-1950	7 COMMENT REF.
HAR-3476	SRB-11-30	Charcoal	-25.0	9330 ± 90	7380 bc	

Comments:

About 30km North of Omdurman (Khartoum Province) SRB-II site 15 56. 15 N. c.32 32 30 E.

Found at the South eastern part of sq. 27 at a depth of 30 cm below the present surface covered by stone slabs and overlain by compacted soil composed of gravels and silty deposits.

This certificates that the sample give above has been analysed for RADIOCARBON at this laboratory. This results, expressed at DELC 13, bp and bp-1950, are given in accordance with method outlined in the accompanying Notes Sheets, NS/1/75, to which due reference should be made.

CARBON-14/TRITIUM MEASUREMENTS
LABORATORY NUCLEAR PHYSICS
DIVISION, AERE, HARWELL, OXON, OXII
ORA BUILDING 10.46

(SIGNED)

R.L. Otlet.

Date: 14/12/79

(After Khabir, A.M., 1981:256)

Appendix: 3

Report on Radiocarbon Dating

Radiocarbon Laboratory
Institute for the study of Earth and Man / 214.692-3429
Southern Methodist University / Dallas, Texas 75275-0274

Project: Neolithic sites in Khartoum Province, Sudan. Sample submitted by Mr. Abdel Rahim M. Khabir. Received March 13, 1991.

Sample ID: Islang 2 square (3, 4) E L2, 20cm b.s.

Sample material:.....	charcoal
Laboratory date number:.....	SMU 2565
Uncorrected radiocarbon age:.....	5480 ± 90 BP
Corrected radiocarbon age:.....	5475 ± 90 BP
Stable isotope ratio σ 13/12 C:.....	-25.3 °/°°
Calibrated age:.....	4330 ± 90 BC

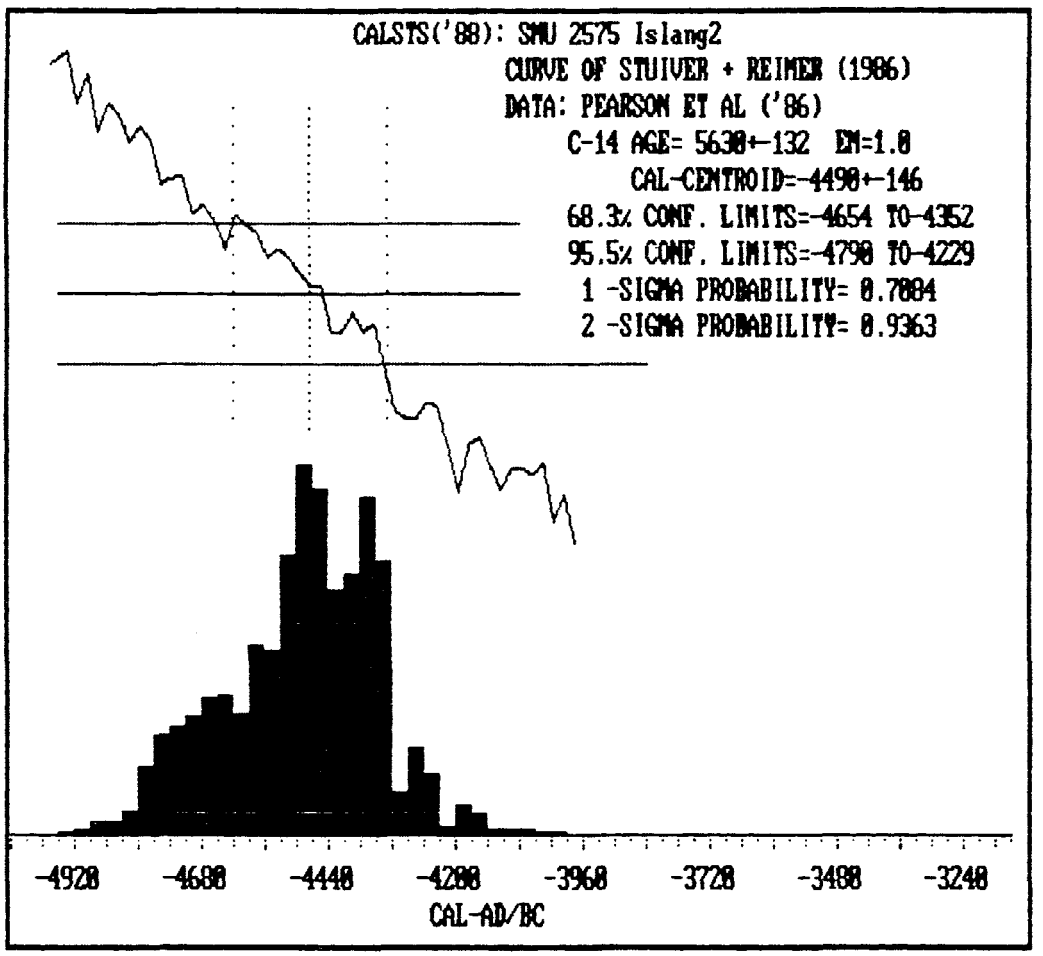
Calibration data used: Stuiver and Pearson, Radiocarbon vol. 28 No.1B, 1986.

Computer program used: S.W. Robinson, version 1991, described in: Hassan FA and Robinson SW, 1987: "High-precision radiocarbon chronometry of ancient Egypt, and comparisons with Nubia, Palestine and Mesopotamia" Antiquity 61: 119-35.

Standards used: NBS Oxalic Acid
Constants used: C-14 half-life= 5568 years, reference age (present)= 1950AD

Dated: Nov. 18, 1991

(Signed)
Herbert Haas, Ph.D.
Director


CALSTS('88): SMU 2575 Islang2
CURVE OF STUIVER + REIMER (1986)
DATA: PEARSON ET AL ('86)
C-14 AGE= 5630+-132 EM=1.0
CAL-CENTROID=-4490+-146
68.3% CONF. LIMITS=-4654 TO-4352
95.5% CONF. LIMITS=-4790 TO-4229
1 -SIGMA PROBABILITY= 0.7884
2 -SIGMA PROBABILITY= 0.9363
-4920
-4680
-4440
-4200
-3960
-3720
-3480
-3240
CAL-AD/BC

Appendix: 3.1

Report on Radiocarbon Dating

Radiocarbon Laboratory
Institute for the study of Earth and Man / 214.692-3429
Southern Methodist University / Dallas, Texas 75275-0274

Project: Neolithic sites in Khartoum Province, Sudan. Sample submitted by Mr. Abdel Rahim M. Khabir. Received March 13, 1991.

Sample ID: Islang 2 square (1) A L3, 30cm b.s.

Sample material:.....	shell
Laboratory date number:.....	SMU 2575
Uncorrected radiocarbon age:.....	5290 ± 130 BP
Corrected radiocarbon age:.....	5630 ± 130 BP
Stable isotope ratio σ 13/12 C:.....	-4.5 °/°°
Calibrated age:.....	4490 ± 150 BC

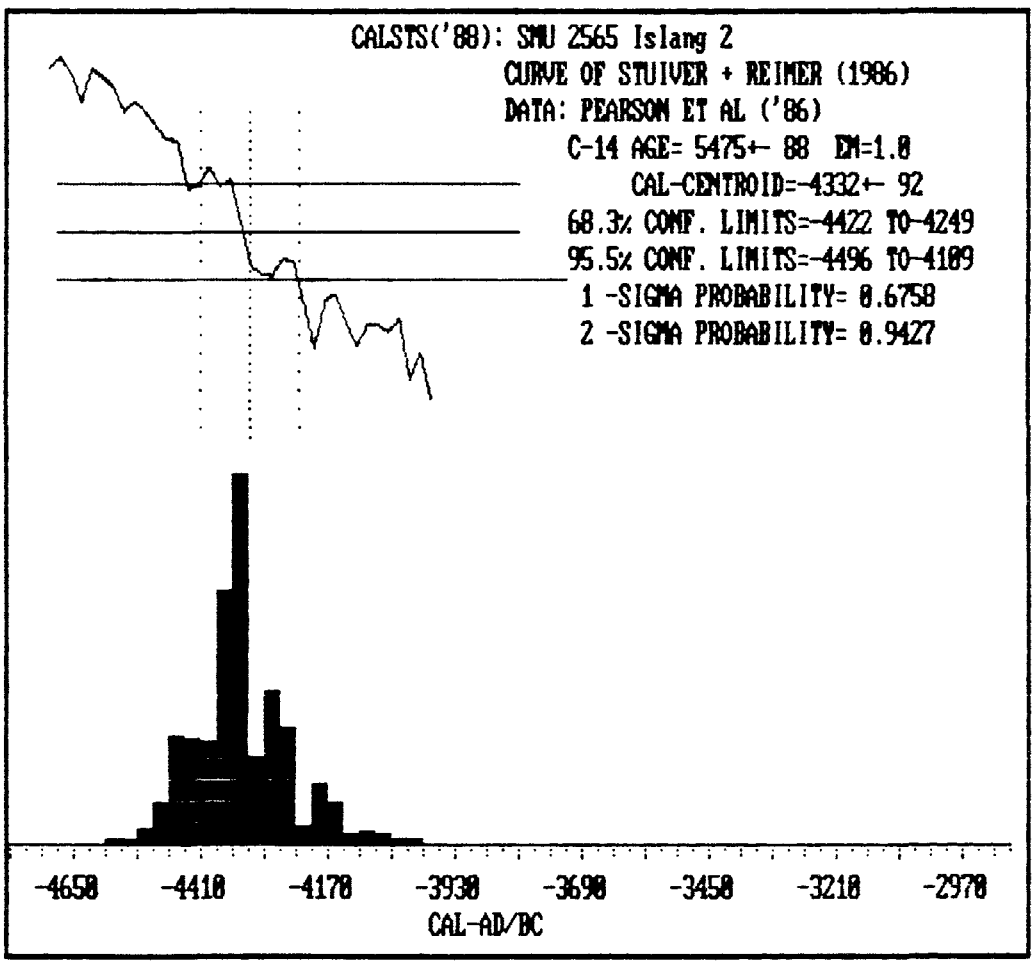
Calibration data used: Stuiver and Pearson, Radiocarbon vol. 28 No.1B, 1986.

Computer program used: S.W. Robinson, version 1991, described in: Hassan FA and Robinson SW, 1987: "High-precision radiocarbon chronometry of ancient Egypt, and comparisons with Nubia, Palestine and Mesopotamia" Antiquity 61: 119-35.

Standards used: NBS Oxalic Acid
Constants used: C-14 half-life= 5568 years, reference age (present)= 1950AD

Dated: Nov. 18, 1991

(Signed)
Herbert Haas, Ph.D.
Director


CALSTS('88): SMU 2565 Islang 2
CURVE OF STUIVER + REIMER (1986)
DATA: PEARSON ET AL ('86)
C-14 AGE= 5475+- 88 EM=1.0
CAL-CENTROID=-4332+- 92
68.3% CONF. LIMITS=-4422 TO-4249
95.5% CONF. LIMITS=-4496 TO-4189
1 -SIGMA PROBABILITY= 0.6758
2 -SIGMA PROBABILITY= 0.9427
-4650
-4410
-4170
-3930
-3690
-3450
-3210
-2970
CAL-AD/BC

Appendix: 4

Report on Radiocarbon Dating

Radiocarbon Laboratory
Institute for the study of Earth and Man / 214.692-3429
Southern Methodist University / Dallas, Texas 75275-0274

Project: Neolithic sites in Khartoum Province, Sudan. Sample submitted by Mr. Abdel Rahim M. Khabir. Received March 13, 1991.

Sample ID: Nofalab 2 square (4, 6) B L3, 30cm b.s.

Sample material:.....	charcoal
Laboratory date number:.....	SMU 2561
Uncorrected radiocarbon age:.....	4170 ± 220 BP
Corrected radiocarbon age:.....	4130 ± 220 BP
Stable isotope ratio σ 13/12 C:.....	-27.5 °/°°
Calibrated age:.....	2705 ± 295 BC

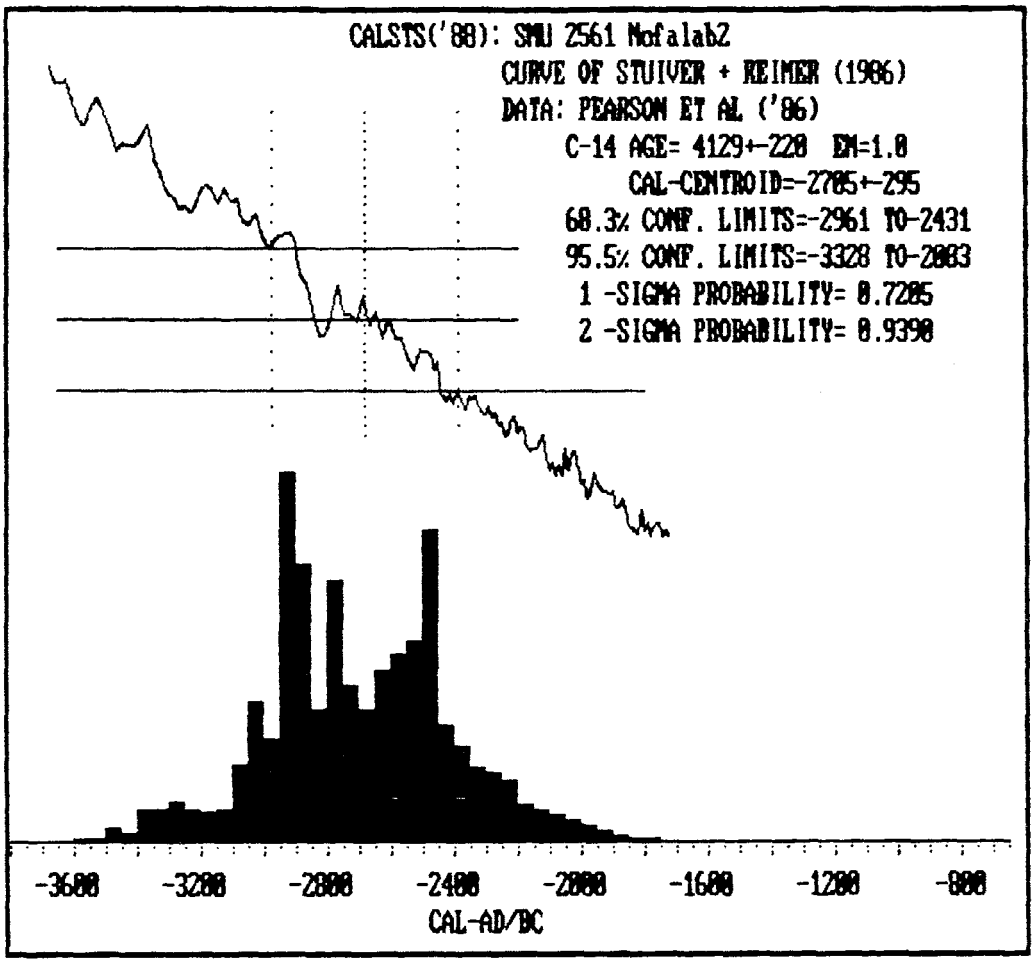
Calibration data used: Stuiver and Pearson, Radiocarbon vol. 28 No.1B, 1986.

Computer program used: S.W. Robinson, version 1991, described in: Hassan FA and Robinson SW, 1987: "High-precision radiocarbon chronometry of ancient Egypt, and comparisons with Nubia, Palestine and Mesopotamia" Antiquity 61: 119-35.

Standards used: NBS Oxalic Acid
Constants used: C-14 half-life= 5568 years, reference age (present)= 1950AD

Dated: Nov. 18, 1991

(Signed)
Herbert Haas, Ph.D.
Director


CALSTS('88): SMU 2561 Mofalab2
CURVE OF STUIVER + REIMER (1986)
DATA: PEARSON ET AL ('86)
C-14 AGE= 4129+-220 EM=1.0
CAL-CENTROID=-2705+-295
68.3% CONF. LIMITS=-2961 TO-2431
95.5% CONF. LIMITS=-3328 TO-2883
1 -SIGMA PROBABILITY= 0.7285
2 -SIGMA PROBABILITY= 0.9390
-3600
-3200
-2800
-2400
-2000
-1600
-1200
-800
CAL-AD/BC

Appendix: 4.1

Report on Radiocarbon Dating

Radiocarbon Laboratory
Institute for the study of Earth and Man / 214.692-3429
Southern Methodist University / Dallas, Texas 75275-0274

Project: Neolithic sites in Khartoum Province, Sudan. Sample submitted by Mr. Abdel Rahim M. Khabir. Received March 13, 1991.

Sample ID: Nofalab 2 square (4,3) A L7, 70cm b.s.

Sample material:.....	shell
Laboratory date number:.....	SMU 2577
Uncorrected radiocarbon age:.....	5140 ± 80 BP
Corrected radiocarbon age:.....	5530 ± 80 BP
Stable isotope ratio σ 13/12 C:.....	-1.4 °/°°
Calibrated age:.....	4380 ± 80 BC

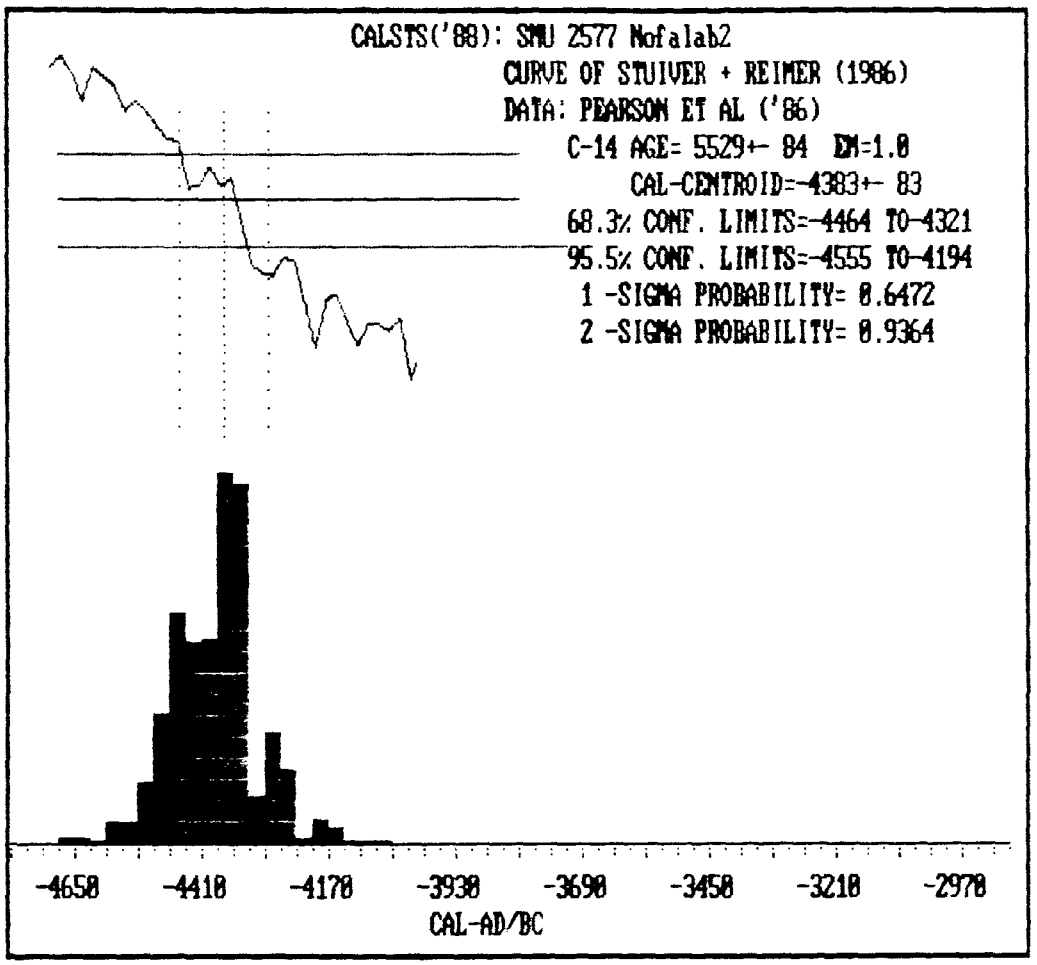
Calibration data used: Stuiver and Pearson, Radiocarbon vol. 28 No.1B, 1986.

Computer program used: S.W. Robinson, version 1991, described in: Hassan FA and Robinson SW, 1987: "High-precision radiocarbon chronometry of ancient Egypt, and comparisons with Nubia, Palestine and Mesopotamia" Antiquity 61: 119-35.

Standards used: NBS Oxalic Acid
Constants used: C-14 half-life= 5568 years, reference age (present)= 1950AD

Dated: Nov. 18, 1991

(Signed)
Herbert Haas, Ph.D.
Director


CALSTS('88): SMU 2577 Nofalab2
CURVE OF STUIVER + REIMER (1986)
DATA: PEARSON ET AL ('86)
C-14 AGE= 5529+- 84 EM=1.0
CAL-CENTROID=-4383+- 83
68.3% CONF. LIMITS=-4464 TO-4321
95.5% CONF. LIMITS=-4555 TO-4194
1 -SIGMA PROBABILITY= 0.6472
2 -SIGMA PROBABILITY= 0.9364
-4650
-4410
-4170
-3930
-3690
-3450
-3210
-2970
CAL-AD/BC

Appendix:5

5.1. Radiocarbon dates from Rabak Site

Rabak.

4490±100 B.P.	(T-5132,MASCA calibrated to 3270±100 B.C.)(Sample obtained from square 107x/100y c.18 centimeters below surface.
6050±100 B.P.	(T-5133 MASCA calibrated to 4490±110 B.C.)(Sample obtained from square 107x/90y, c.56 centimeters below surface).
6020±130 B.P.	(T-5134 MASCA calibrated to 4890±120 B.C.)(sample obtained from square 107x1100y c.145 centimeters below surface).
5860±80 B.P.	(T-5726 MASCA calibrated to 4750±150 B.C.)(sample obtained from square 107x/100y c.30 centimeters below surface).

5.2. Correction of dates.

These dates are corrected for the isotopic fractionation (S 13C) and correct. (After Haaland, R., 1987:59).

Appendix:6

Radiocarbon Dates from the Shaqadud Complex

					MASCA(4)
Period	Site	Level(1)	Date	Material(2)	Calibrated Date
	S1-A	16	3,615 B.P.± 88 (SMU 1133)	C	1990±130 B.C.
Post-Khartoum	S1-A	23	3,640 B.P.±140 (SMU 1697)	C	2030±200 B.C.
Neolithic	S1-A	38	4,123 B.P.± 86 (SMU 1128)	C	2710±140 B.C
	S1-A	51	4,059 B.P.± 65 (SMU 1127)	C	2620±120 B.C
	S1-A	71	4,046 B.P.±101(SMU 1208)	C	2600±150 B.C
	S1-D	TP3,14	2,120 B.P.±120 (ETH 045-0447)	C	2700±150 B.C.
Khartoum	S1-B	12	5,970 B.P.±290 (SMU 1735)	S	4880±330 B.C.
Neolithic	S1-B	18	5,584 B.P.± 74 (SMU 1134)	S	4430± 80 B.C.
	S1-B	30	5,752 B.P.±103 (SMU 1287)	C	4630±130 B.C.
Khartoum	S1-B	42	7,785 B.P.±445 (SMU 1736(3)	S	
Mesolithic	S1-B	50	6,893 B.P.±131 (SMU 1186)	C	5760±130 B.C.
	S1-B	59	7,056 B.P.±321 (SMU 1290)	C	5920±300 B.C.
	S21	6	7,417 B.P.± 67 (SMU 1310)	LS	6250± 90 B.C.

1. Level number refers to the bottom of a 5 cm. spit below datum. Thus, level 16 is the spit 75 to 80 cm below datum. TP3 refers to Test Pit 3
2. C=charcoal:S=seeds: LS=pila.
3. This date is clearly aberrant.
4. Robinson program used.

(After Marks, A.E., 1991:61)

Appendix 7

Radiocarbon-Dated Sites in North Africa with Early (≥8500 B.P.) Pottery

Site	Country	Age B.P.	Ref/Lab No.	Sample
Temet	Niger	9550 ± 100	Roset 1987	charcoal
Adrar Bous 10	Niger	9130 ± 65	Roset 1987	charcoal
Adrar Bous 10	Niger	9100 ± 150	Roset 1987	charcoal
Adrar Bous 10	Niger	9030 ± 190	Roset 1987	charcoal
Tagalagal	Niger	9370 ± 130	Roset 1987	charcoal
Tagalagal	Niger	9330 ± 130	Roset 1987	charcoal
Tamaya Mellet	Niger	9350 ± 170	Gif-1728	bone
Gabrong	Chad	8560 ± 120	Hv-3715	?
Launey	Algeria	9210 ± 115	UW-97	charcoal
Ti-n-Torha East	Libya	8670 ± 60	R-1163α	charcoal
Ti-n-Torha East	Libya	8640 ± 70	R-1035α	charcoal
E-77-7 (Nabta)	Egypt	8960 ± 110	SMU-440	charcoal
E-77-7 (Nabta)	Egypt	8870 ± 80	SMU-2591	charcoal
E-79-8 (Kiseiba)	Egypt	9820 ± 380	SMU-858	charcoal
E-79-8 (Kiseiba)	Egypt	9610 ± 150	SMU-928	charcoal
E-79-8 (Kiseiba)	Egypt	9440 ± 230	SMU-758	charcoal
E-79-8 (Kiseiba)	Egypt	9350 ±120	SMU-927	charcoal
E-79-8 (Kiseiba)	Egypt	9180 ± 140	SMU-914	charcoal
E-79-8 (Kiseiba)	Egypt	9060 ± 80	SMU-861	charcoal
E-79-8 (Kiseiba)	Egypt	8920 ± 130	SMU-757	charcoal
E-80-4 (Kiseiba)	Egypt	9220 ± 120	SMU-925	charcoal
Sarurab	Sudan	9370 ± 110	HAR-3475	charcoal
Sarurab	Sudan	9340 ± 110	HAR-3476	charcoal
Saggai	Sudan	10060 ± 150	Caneva 1983	shell
Abu Darbein	Sudan	8640 ± 120	T-8624	shell
Abu Darbein	Sudan	8560 ± 35	Q-3230	shell
Abu Darbein	Sudan	8500 ± 100	T-6381	shell

(After Close 1993:32)

Appendix:8

An interim report on lithic artifacts from Sarurab2

The following artifact classes and raw materials were found:-

1. Retouched tools

Retouched tools (n=228-c.18% of the total flaked stone) composed of scrapers (c.20%), bifacial pieces (0.4%), geometrics (2.6%), composites (2.6%), retouched pieces (14%), utilized pieces (6.5%), denticulates (10.9%), notched pieces (7.8%), lunates (6.5%), points (3%), backed pieces (7%) perforators (7.8%) and truncations (3.9%).

2. Debitages

Primary and secondary flakes (n=560-43.8%), blades (n=25-1.9%), cores (n=51-3.9%) and fragments (n=246-c.21%) were countered.

3. Ground artifacts

Some 150 specimens including grinders (n=33-22%), rubbers (n=19-12.6%), stone rings (n=1-0.6%) and fragments (n=97-c.65%) were found.

4. Raw material

Quartz has a high index amongst flakes (c.73%), blades (88%), cores (82%), relatively high in debris (60.2%) and less frequent in retouched tools (51%). Rhyolite is favoured for retouched tools (c.26%). Ferrocrete (c.1.8%), mudstone (0-12%), chert (0.7%) and fossilized wood are generally infrequent. Grinding stone were exclusively made on sandstone. The material is accessible locally (cf. section 3.1.2 and appendix 1).

Appendix:9

A brief note on lithic artifacts from Islang2

The following artifact classes and raw materials were recovered from the site:-

1. Retouched tools

Retouched tools (n=207-18,5% of the total faked stone) include lunates (49% of the total retouched tools), scrapers (31.1%, denticulates (1.9%) perforators (borers and groovers) (0.9%), points (0.9%) gouges (0.5%), utilized pieces (21.7%) and retouched pieces(c.15%).

2. Debitage

Primary and secondary flakes (n=239-21.4% of the total flaked tools), blades (n=13-c.1.2%), cores (n=11-0.9%) and chips (n=537-48.2%) were found.

3. Ground artifacts

Some 106 examples comprising grinders (n=33-31.1%), rubbers (n=14-13.2%) and fragments (n=59-55.6%) were encountered.

4. Raw material

The raw material utilized consists primarily of quartz (c.56-88%). Rhyolite (c.36%) was mainly used for retouched tools. Over 70% of flakes and 60% of debris were made on quartz pebbles. Ground stone artifacts were exclusively made on silcrete sandstone. The material is available locally (cf. section 3.1.2 and appendix 1).

Appendix 10

A concise note on lithic artifacts from Nofalab2

The following artifact classes are raw materials were identified:-

1. Retouched tools

Retouched tools (n=243-c.15% of the flaked stone) include lunates (c.36% of the retouched tools), scrapers (19.7%), gouges (1.2%), geometrics (7.4%), backed pieces (c.2%), retouched pieces (17.6%), utilized pieces (c.16.5%).

2. Debitage

Primary and secondary flakes (n=697-44% of the total flaked tools), blades (n=14-c.0.8%), cores (n=11-c.0.7%) and debris (n=606-c.39%).

3. Ground artifacts

Some 119 specimens comprising grinders (62-52.1%), rubbers (n=21-17.6%) and fragments (36-30.2%) were found.

4. Raw material

Quartz is high amongst flakes (c.62-81%), blades (c.71%), cores (c.92%) and relatively high in debris class (c.62%) and less frequent amongst retouched tools (c.52%). Rhyolite is favoured for the retouched tools (c.31%). It exhibits low frequencies (c.0-10%) among the rest of artifact types. Ferrocrete (c.0-2%), mud stone (c.0-33%), Nile chert (c.0-8.3%) and fossilized wood are generally infrequent. All these raw materials are available locally (cf. section 3.1.2 and appendix 1).

Appendix 11

A report on Mollusca Remains from Sarurab2 site, Khartoum Province

Dr. M. El Nour, Hydrobiological Research Unit, Faculty of Science, Khartoum University

The material (31 specimens) - and since fossil -was identified only from shell characters. The following species were found:-

1. Pila ovata (n=15) freshwater amphibious snail
2. Lanistes carinatus (n=4) freshwater snail
3. Etheria elleptica (n=8) bivalve (Nile oyster)
4. Aspatharia spathopsis rubens (n=3) bivalve
5. Limicolaria flammata var. gracilis (n=1) land snail

The commonest species is P. ovata, followed by E. elleptica, then L. Carinatus, A.S. rubens while L. flammata var. gracilis is rare. All these species were recorded by Arkell in his work at Khartoum Hospital site (1949). Recently, the distribution of these species is different than in the past. P.ovata is now mostly found in the savanna zone south of Kosti, specially in the swampy habitats. L. carinatus seems to be loving standing waters as well as A.S. rubbens. These two species are now found upstream Jebel Aulia dam, but not near Khartoum. The Nile oyster is known both from running and standing waters and, therefore, it is of little value in indicating the physical nature of its habitats. Finally, the land snail L. flammata var gracilis. It is difficult to say that this species is now living in Khartoum region, since no living specimen up to now has been collected. It is likely that its range as well shifted southwardly with the rain belt. Empty shells could be collected from the surface at places like Dinder. It could be concluded from the above, that the habitats of these molluscs could be similar to that prevailing today in the region between Malakal and Kosti and with a swampy character and higher rainfall than now. This is supported by the fact that the nearest assemblage of molluscs to this of Sarurab2 could be found there.

The collection as it appears, is most probably for individuals which died naturally and then embeded in the sediments. Their small sizes may discourage

using them as food material. The presence of P. ovata with empy shells may also support this.

	Lat.		Long.	
Khartoum	15	30	32	30
Jebel Aulia	15	3	32	30
Kosti	13		32	40
Dinder	13		34	30
Malakal	9	40	31	50

Appendix:12

Identification of Mollusca Remains from Islang2, Khartoum Province

Dr. M. El-Nour, Hydrobiological Research Unit, Faculty of Science, Khartoum University.

The Specimens from Islang2 came from seven different levels within the site.

Level 1 (0-10 cm. below surface)

Some 5 mollusca shells were reported and they exclusively belong to species P. ovata.

Level 2 (10-20 cm.)

A total of 7 mollusca remains was identified, 4 as P. ovata and 3 as Lanistes carinatus oliv.

Level 3 (20-30 cm.)

Some 9 specimens were recorded, 3 P. ovata, 5 are specimens of Lanistes carinatus oliv. and a single specimen of Limicolaria flammata var. gracilis.

Level 4 (30-40 cm.)

Shell amounting to 11 specimens, mostly P. ovata)n=8) were identified. Three specimens probably L. caillaudi which is known from several prehistoric sites near Khartoum, e.g. Khartoum Hospital (Arkell 1949:28-29) and Shaheinab (Arkell 1953:10) was encountered.

Level 5 (40-50 cm.)

Some ten shells were found of which three are in fragmented condition, were recorded. They are, without exception, species of P. ovata.

Level 6 (50-60 cm.)

Six shells of Limicolaria flammata var. gracilis and a single specimen of Etheria elliptica were recovered from this level.

Level 7 (60-70 cm.)

Some 3 shells were found, 2 are species of Ampullaria wernei Phil. and a single specimen of Lanistes carinatus oliv.

For detailed information pertaining to the natural habitat and distribution of these species, see the report on the mollusca remains of Sarurab2 site (appendix 11).

Appendix:13

A note on Mollusca Remains from Nofalab2 Khartoum Province

Dr. M. El Nour, Hydrobiological Research Unit, Faculty of Science, Khartoum University.

The specimens from Nofalab2 came four different levels within the site.

Level 1 (0-10 cm below the surface):

A total of 12 shells were recorded. Nine of them belongs to species Pila Ovata (freshwater amphibious snail), 2 specimens identified as Lanistes carinatus (freshwater snail) and only one shell of species Etheria elliptica bivalve (Nile Oyster).

Level 2 (20-30 cm):

The commonest species is Pila ovata (n=6). Other species are represented by only one shell include Ampullaria wernei Phil, Limicolaria flammata Caill and Lanistes carinatus Oliv.

Level 3 (20-30 cm):

P.Ovata is represented by 4 shells, whereas each of Etheria elliptica and Ampullaria wernei is represented by two shells.

Level 4 (30-40 cm):

Three shells of species Pila ovata were recorded.

With the exception of Ampullaria wernei and Limicolaria falmmata Caill, detailed information about the habitat and distribution of these species have been provided in the mollusca report of Sarurab2 site (cf. appendix 11). Ampullaria wernei and Limicolaria flammata were reported from Shaheinab (Arkell 1953:10) and Khartoum Hospital (Arkell 1949: 28-29) sites in the vicinity of Khartoum.

Appendix:14

A report on Mammalian Fauna from Sarurab2, Khartoum Province.

Dr. M.E. Hamad, Zoological Lab., Faculty of Science, Khartoum University.

Some 225 specimens of animal bones, a few of them in fragmented condition, were reported from four squares within the site.

Sq. SRB2-5
Level 4 (30-40 cm. below surface)

Some 45 bone remains mainly mandibles and limbs were identified and classified into the following species:

1. Small antelope (Ourebia Ourebi) 44.4%
2. Hartebeest (A. Buselaphus) 55.5%
3. Undetermined 11.1%

Level 5 (40 - 50 cm)

A total of 55 specimens comprising limbs, maxillae and manidbles was reported and classified into the following species:-

1. Gazelle (G. Rufifrons) 54.5%
2. Hartebeest (A. Buselaphus) 18.1%
3. Medium-sized cat (F. caracal) 27.3%

Sq. SRB2 - 10
Level 3 (20-30 cm.)

A group of 35 specimens (limbs, mandibular rami, a few horn-cores and some specimens in fragmented condition) was identified into the following species:-

1. Antelope (Kobus Kob) 57.1%
2. African wild cat (F. Silvestris) 14.2%
3. Undetermined 28.5%

Level 6 (50 - 60 cm.)

Some 30 specimens including limbs, maxillae, mandibles and small fragments, mainly in crushed condition were found. They were classified into the following species:-

1. Small antelope (Ourebia ourebi) 33.3%
2. Medium-sized cat (F. caracal) 33.3%
3. Gazelle (G. Rufifron) 13.3%
4. Undetermined 20%

Sq. SRB2-37

A collection of 90 specimens (limbs, vertebrae, mandibular rami, phalanges and some specimens in fragmented condition) was reported. The following species were recognized:

Level 2 (10-20 cm).

1. Small antelope (Ourebi ourebi) 55%
2. Small unidentified rodents 20%
3. Undetermined 25%

Level 4 (30 - 40 cm)

Some 30 specimens mostly small fragments in crushed condition in addition to several examples of limbs, vertebrae and mandibular rami were classified into the following species:-

1. Hartebeest (A. buselaphus) 33.3%
2. Small unidentified rodents 23.3%
3. Undetermined 43.3%

Level 5 (40 - 50 cm)

Twenty examples comprising vertebrae, limbs, mandibles and fragments were found. They can be classified into the following species:-

1. Small antelope (Ourebia oureibi) 40%
2. African cat (F. silvestris) 10%
3. M. Rat (T. swinderianus) 10%
4. Undetermined 40%

Appendix: 15
Identification of Faunal remains from Islang2, central Sudan

Dr. M.E.Hamad, Zoological Lab; Faculty of Science, Khartoum University

Site Islang 2:

Sq (4 - d) 1990

L4

A large collection of faunal remains were recovered from this test-pit in 1990. They were dated to the Neolithic period. This data includes various vertebrate animal remains and some fish bones. Nearly all the bones are broken.

This osteological data was studied and identified in the zoological Laboratory of the faculty of Science, University of Khartoum, Sudan.

The collection was classified firstly as follows:-

1- Terrestrial mammals such as elephants, lions, gazelles, etc.....
2- Riverian mammals such as crocodiles, hippopotamus, etc...
3- Reptiles, Amphibians and fish.
4- Birds.

Some 120 mammalian fauna were also identified and classified into the following sub-groups:-

1- B. Primigenus	20.9%
2- A. Buselaphus	33.3%
3- G. Rufifron	33.3%
4- E. Amphibious	12.5%

The collection seems to be dominated by three species as below:-

1- Aurochs (B. primigenius).
2- Hartebeest (A. Buselaphus).
3- Gazelle (G. Rufifrons).

A large collection of fish bones were also reported but the collection is fragmentary and unrepresentative.

Inspite of this we were able to identify only 40 specimens in the following fish families:-

1- Claries	25%
2- Borgus	12.5%
3- Synodontis	25%
4- Talapia	37.5%

A part from these faunal remains 40 fragmented bones by different nature were unidentified because they are very tiny in crushed condition.

Generally this scientific report shows that the faunal collection in this part of the country is suggestive of both watered and dry environment with the predominance of the later.

Appendix: 16

Identification of Faunal remains from Nofalab2,central Sudan

Dr. M.E. Hamad, Zoological Lab., Faculty of Science, Khartoum University.

Site Nofalab 2: Sq (4, 6) A
L2

A large collection of faunal remains were recovered from this test-pit in 1990. They were dated to the Neolithic period. This data includes various vertebrate animal remains and some fish bones. Nearly all the bones are broken.

This osteological data was studied and identified in the zoological Laboratory of the Faculty of Science, University of Khartoum, Sudan.

The collection was classified as follows:-

1- Terrestrial mammals such as elephants, lions, gazelles .....etc.
2- Riverian mammals such as crocodiles, hippopotamus....etc.
3- Reptiles, Amphibians and fish.
4- Birds.

Some 124 mammalian fauna were also identified and classified into the following sub-groups:-

1- B. Primigenus	5.61%
2- A. Buseluphus	22.44%
3- G. Rufifron	60.69%
4- E. Amphibious	11.21%

The collection seems to be dominated by three species as below:-

1- Aurochs	(B. Primigenius).
2- Hartebeest	(A. Buselaphus).
3- Gazelle	(G. Ruffians).

A large collection of fish bones were also reported by the collection is fragmentary and unreprensentative.

Inspite of this we able to identify only 20 specimens in the following fish families:-

1- Claries	15%
2- Borgus	15%
3- Synodontis	20%
4- Talapia	50%

A part from these faunal remains 35 fragmented bones of different nature were unidentified because they are very tiny or in crushed condition. Some 70% were derived from:

$$\text{Sq} \frac{(4 - 3)}{L4} E$$

Generally this scientific report shows that the faunal collection in this part of the country is suggestive of both watered and dry environment with the predominance of the later.

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Abbreviations

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B.I.E.A	- British Institute in East Africa.
C.B.A	- Council for British Archaeology

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