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The significance of biface-rich assemblages: An examination of behavioural controls on lithic assemblage formation in the Lower Palaeolithic.

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Thesis submitted for degree of PhD

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October 2002

This thesis was submitted for examination in October 2002.

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

FACULTY OF ARTS

ARCHAEOLOGY

Doctor of Philosophy

THE SIGNIFICANCE OF BIFACE-RICH ASSEMBLAGES

By Matthew Ian Pope

Biface-rich assemblages are a problematic and widespread feature of the Early and Middle Pleistocene. They do however form part of a potentially significant pattern of Lower Palaeolithic assemblage variability. Acheulean industries appear to be restricted to localised areas within palaeolandscapes and are sometimes absent from entire regions during particular time periods. The factors leading to the formation of biface-rich assemblages are, however, ambiguous. Many are recovered from fluvially disturbed contexts suggesting a possible hydraulic role in their formation. The close association with fluvial activity complicates the analysis of this phenomenon by obscuring any role that may have been played by hominins in assemblage formation.

This thesis sets out to examine biface-rich assemblages and their significance for wider patterns of assemblage variability in the Lower Palaeolithic. This is achieved through the taphonomic analysis of two key assemblages from the Middle Pleistocene site of Boxgrove. The results suggest that the observed bimodality between assemblages rich in bifaces and those lacking these tools is primarily a behavioural phenomenon. In addition, the distribution of assemblages within the Boxgrove palaeolandscape is taken to demonstrate that archaic Homo sapiens sometimes operated complex and structured systems of tool transport and land use.

This thesis concludes by suggesting that structured patterns of artifact discard are a recurrent feature of the Lower Palaeolithic record. Biface-rich assemblages should be viewed alongside the increased transport of raw materials, standardised artifact forms and evidence for predation as forming part of a suite of more complex behaviours seen to emerge during the Middle Pleistocene.

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Preface

This thesis is the product of research undertaken while registered in postgraduate candidature at Southampton University. The impetus for this work stemmed directly from my involvement in the analysis of stone tool assemblages from the Middle Pleistocene site of Boxgrove, West Sussex. I was engaged between 1997 and 1999 on the taphonomic study of assemblages from the site, including those from the high-resolution horse butchery site (GTP17) and fluvially modified assemblages from the hominin locality (Q1/B). This was as part of multidisciplinary research project, consequently elements of my work have inevitably overlapped with the concurrent research of my colleagues. Where this has been the case, I have been careful to make it clear within the text. For example, the technological study of lithic material discussed in Chapter 5 was initially undertaken by Dimitri De Loecker, however the taphonomic analysis of this material submitted in this thesis was entirely my own work. Aspects of the faunal taphonomy for site GTP17, relevant to the study of the stone tool assemblage, was based on data collected by Simon Parfitt.

During my study of the GTP17 and Q1/B assemblages, it became apparent that the assemblages were of very different natures, contrasting both in length of formation and composition. It was, however, unclear how much of this variation related directly to hominin behaviour and the degree to which these differences were significant in terms of wider patterns of Lower Palaeolithic assemblage variability. I perceived that a study of broader scope was required to address this problem, one that utilised taphonomic analysis but which could use the results to isolate hominin behaviour patterns.

At the outset, it was decided that the rich palaeolandscape record of Boxgrove could be incorporated into such a study. By viewing intra-assemblage differences at the site against the background of variation in hominin land use it was hoped that patterns of behaviour could be more successfully isolated from natural agencies of site-formation. Through the utilisation of datasets with broad scope, at levels of resolution including 15-minute knapping scatters and the longer-term development of 'scatters and patches', some basic behavioural models of assemblage formation could be developed.

The purpose of these analyses was not simply to provide an account of the Boxgrove evidence. Rather it was always my intention that this thesis be ultimately directed towards explaining broader patterns of assemblage variation in the Lower Palaeolithic. In particular I considered that the Boxgrove record could most usefully be applied to the phenomenon of biface-rich assemblages. The compositional differences present within the Boxgrove assemblages had direct analogies within other Acheulean contexts. The biface-rich signature from Q1/B shared compositional and contextual similarities with others across Europe, Africa and the Near East. These assemblages, which are highly conspicuous in the archaeological record, can be characterised as dense concentrations of highly visible tool forms associated with fresh-water contexts within open landscapes. I considered that, even if the study were to show that these assemblages were partly natural phenomena, such accumulations could still have played a significant role in hominin land use patterns.

The following research, while based on data from stone tool assemblages, is therefore directed towards the wider study of hominin behaviour and society. Throughout, I have worked from the assumption that archaic *Homo sapiens* were not agents of tool transport and discard alone. Rather I have attempted, within this thesis, to isolate the ways in which hominins were able to operate within and interact with an evolving and dynamic cultural environment.

Acknowledgements

This research would have not been possible without the access I have been granted to the Boxgrove artifact collections. For this and much else I am indebted to Mark Roberts, Director of the Boxgrove Project. Other co-workers from the Project (Simon Parfitt, Francis Wenban-Smith, Dimitri De Loecker) also helped this work to take shape through their insights, comments and discussions.

I would like to express my thanks to Clive Gamble for his advice and inspiration during the writing of this thesis and to others who have helped through their valued comments on earlier drafts and chapters (John McNabb, Rob Hosfield, Nick Ashton).

Thanks are also due to Claire Lawson-O'Brien, Keith Watson and others who helped in the preparation of the GTP17 material and to Alex Holmes and Kate Russell for proof reading the manuscript.

This work was partially funded through a gratefully received three-year tuition award from the AHRB. The Boxgrove Project was funded by English Heritage.

For Eleanor and Samuel

Chapter 1: Introduction. Biface-rich assemblages and the structured use of space in the Middle Pleistocene.

"Bifaces occur very rarely in complete isolation.'

Glynn Ll. Isaac 1977,80.

"These assemblages suggest a more structured pattern of behaviour following the appearance of Homo erectus and Acheulian stone tool traditions."

J. Desmond Clark 1987,809.

1.1 Overview.

This thesis sets out to investigate a specific phenomenon of Middle Pleistocene archaeology: the recurrent and geographically widespread occurrence of large accumulations of bifacial tools. Localised concentrations of bifaces, which are found throughout Africa, Europe and the Near East during this period, represent a characteristic of the Acheulean almost as defining and persistent as the bifacial tool-form itself. Just as the shape and symmetry of the classic Acheulean biface indicates a level of technological sophistication exceeding that demonstrated in earlier Oldowan assemblages, the occurrence of large concentrations of these tools might indicate that Middle Pleistocene hominins were using space in new and more structured ways. If such behaviour could be satisfactorily demonstrated, it would indicate that artifact scatters were more than simple accumulations of debris. Rather, from an archaeological perspective, such assemblages could be considered as having inherent meaningful 'content'. This meaning would be derived from the association of deliberate and selective artifact discard behaviours with specific ecological contexts and demonstrable character change through time.

1.2 Isolating behavioural signatures from natural processes.

In a period of prehistory apparently lacking clear evidence for the structured use of space, in hearths, postholes and other features of organised 'settlement', the potential significance of a contextual basis for the distribution and content of artifact assemblages is great. However, demonstrating that such phenomena are real behavioural products is far from easy (Gamble 1999; Kolen 1999). The archaeological record of this period is notoriously ambiguous, it being almost impossible to distinguish between, for example, natural areas of burning and hearths, 'paved' surfaces and lags of natural clasts (Mania 1991), circular tent spaces and trees (Thieme 1983: Stapert 1992), cleared areas and shelters (De Lumley 1975; Villa 1976). In a similar manner, biface accumulations give the impression of being behavioural products, yet their repeated association with fluvial sediments raises the possibility that some might be products of natural and not human processes. As a result, the history of research into this phenomenon has been largely focussed on taphonomic analysis, with the isolation of human behavioural factors addressed only to a lesser degree.

The blurring of natural and human mechanisms as explanations for structured elements of the Lower Palaeolithic record is perhaps unsurprising. Regular and unambiguous structured settlement does not become securely documented until the Late Pleistocene (Kolen 1999). We should, however, expect to see precursors to such behaviour emerging earlier in the record. These threshold behaviours might be expected to have a close association with natural phenomena and so, for example, we may expect hominins to have first sought out naturally paved surfaces in river margins long before such surfaces are deliberately constructed. Similarly, tree boles, rock shelters and open sandy environments would lend themselves to habitation long before the actual construction of shelters was undertaken. Perhaps it is better to recognise that, throughout the Middle Pleistocene, we are dealing with the emergence of new behavioural packages that include increasingly sophisticated structured patterns of land use and assemblage formation. Thus it is important not to begin with an overly polarised approach to the Lower Palaeolithic record. It is possible that emerging patterns of modern complex behaviour may have taken many cues from naturally structured aspects of the environment.

1.3 Approaches and datasets.

In this thesis the formation of biface-rich assemblages is addressed through a contextual, palaeoecological approach. Instead of addressing the subject directly, assemblage variability is examined across a range of preservational environments and across a wide spread of spatial/temporal scales. At the heart of this approach is the acceptance that it is impossible to explain large accumulations of bifaces without reference to wider variation in assemblages in the Middle Pleistocene. While such an undertaking is demanding, in that it requires exceptional datasets to implement, I am fortunate enough to have been able to utilise assemblages from excavations at the Middle Pleistocene site of Boxgrove, West Sussex. At the site, an excellent example of a biface-rich assemblage was recovered from the excavation area Q1/B. At this locale hundreds of mint-condition bifaces were recovered from a relatively restricted suite of freshwater deposits alongside butchered mammalian remains.

The evidential basis of this thesis rests on the stone tool assemblages from the Q1/B locale and other Boxgrove activity areas, yet this is not a study of Middle Pleistocene lithic technology. Rather these assemblages are utilised as proxies for the hominins themselves to reconstruct aspects of their palaeoecology, land use and social behaviour. Even where detailed reconstructions of biface production are supplied, as in the analysis of the horse butchery area GTP17, these are used to reconstruct aspects of hominin behaviour relating to tool use, transport and discard and not simply to document the mechanisms of tool manufacture itself. Through this approach it is intended to promote the idea that lithic assemblages in general, and specific tools or knapping scatters in particular, can be used to infer activities beyond the specific spatial/temporal context of the assemblage itself. For this reason, I have been careful in this thesis to describe the characteristics of assemblages and not of 'sites'. While bifaces might not be recovered from a given location, their possible use and subsequent discard away from the area should be considered in the analysis of the assemblage. Even small quantities of biface thinning debitage or tranchet sharpening flakes are of great significance when isolated in an assemblage otherwise lacking bifacial tools. Assemblages that contain relatively low numbers of bifaces are therefore directly relevant to the subject of this thesis, especially when comparable and contemporary contexts contain dense concentrations of such tools.

It also important to establish here, at the outset, that the term palaeolandscape is not taken to stand as an exact analogy for a modern landscape or landsurface. Rather the terms are here employed in the same manner suggested by Potts *et al.* (1999), as a sedimentary unit relating to particular, temporally defined, terrestrial environment. Studies at Koobi Fora and Olorgesailie have suggested that such discrete horizons can sometimes take thousands of years to form. The archaeological records of such contexts can, therefore, be greatly time-averaged (Stern 1994). At Boxgrove, the Unit 4c horizon relates to a much more limited period, within the range of 10-100 years (Macphail in Roberts *et al.* 1997; Roberts and Parfitt 1999). In spite of this exceptional level of resolution the term 'palaeolandscape' is employed to describe an environment occupied over an extended period by different generations, or even social groupings, of hominins.

1.4 Structure of the thesis.

My aim in this thesis is to provide some possible explanations for the occurrence of biface accumulations. In Chapter 2 a review is provided of previous studies and approaches to the question of Lower Palaeolithic assemblage variability. This is achieved by exploring three broad research themes: taphonomic and behavioural studies of Acheulean assemblages, the relationship between artifact distribution patterns and hominin land use and attempts at modeling land use patterns. While recognising that there is a repeated contextual link between such assemblages and fluvial contexts, it is suggested that the composition of many such assemblages might be a real product of differentiated hominin behaviour at specific locations in palaeolandscapes.

In Chapter 3 the Boxgrove evidence is introduced. A brief review of previous archaeological studies both within the Boxgrove Quarry and at other locales on the West Sussex Coastal Plain is undertaken. It is demonstrated that repeated patterns of assemblage variability appear to be present in this record and that the dataset is ideally suited to addressing the research aims of this thesis. Through this review it is shown that a generalised pattern of selective tool discard appears to have been in operation at Boxgrove. Asymmetries in the composition of different assemblages from the site are shown to conform to wider assemblage bimodalities between biface-rich and flake-tool assemblages in the Lower Palaeolithic record (Isaac 1977). Furthermore there is the suggestion that some of these differences might be contextually underpinned by environmental variation within the Boxgrove palaeolandscape.

In Chapters 4 and 5, the key Boxgrove locales of GTP17 and Q1/B are studied utilising a range of taphonomic and technological analyses. Assemblages are shown to form part of a wider pattern of assemblage variability within the Boxgrove landscape; variability directly related to the use of particular habitats, patterns of hominin movement and the possible effects of hunting strategies on social group structure. The Q1/B assemblage is unique at Boxgrove both in terms of sedimentary context and composition. It appears, uncritically, to suggest a distinctive pattern of tool discard associated with the repeated occupation of a waterhole area. The assemblage is contrasted with that from the horse butchery level at GTP17, which was excavated as a series of *in situ* knapping scatters associated with a single terrestrial landsurface. This assemblage is distinctive in that it contains large quantities of biface manufacturing debitage, yet contains no bifaces and very few other tool forms. The assemblage was not, however, chosen just because of its atypical composition but also due to its unique context. Unlike Q1/B, the assemblage relates to a very short time-frame, a single occupation episode lasting as little as a few hours in an open, undifferentiated landscape rather than at a fixed topographic feature such as the Q1/B waterhole.

GTP17 will therefore provide the starting point for this study, as its spatial and temporal scales of inference are both extremely limited. As a classic example of a fine-grained, high-resolution signature, the site provides the best example from the Boxgrove record of an assemblage for which taphonomic controls can be tightly applied and consequently aspects of human behaviour can be brought sharply into focus. Having established the character of human assemblage formation at GTP17, the results will then be utilised as a benchmark in the detailed taphonomic analysis of the Q1/B assemblages. The aim here will be to isolate behaviour from natural agencies at the site.

In Appendix 2 and Chapter 6, the contrasting behavioural signatures from GTP17 and Q1/B are further explored through the application of a 'scatters and patches' analysis of artifact spreads from the Unit 4c palaeosol. The scale of analysis will therefore be widened in Chapter 6 to encompass more than 90 excavation areas from the Unit 4c palaeosol horizon at Boxgrove. The assemblages from this context, while representing a palimpsest of hominin activity over tens of years, provide a record of land use variation. To study this patterning a contextual approach was required, directed at relating the spatial distribution, composition and ecological context of assemblages to each other. Through such a framework the asymmetries between the GTP17 and Q1/B lithic assemblages are then addressed.

In order to achieve this aim, a methodology is employed directed at the quantification of the 'scatters and patches' phenomenon of artifact distribution investigated by Glynn Isaac during the 1970's and early 1980's (Isaac 1981b; Appendix 2). An attempt is made to characterise the range of observed artifact densities for the Unit 4c palaeolandscape and to examine the relationship between assemblage composition and the overall spatial configuration of the artifact assemblages. The results of this 'scatters and patches' analysis appear to confirm Isaac's suggestion that dense spreads of material are qualitatively different from the background scatters of artifacts in Pleistocene landscapes. The results demonstrate that overall distribution patterns are not simply quantitative phenomena but relate to patterns of land use and tool transport/discard patterns. The analysis shows that the discard of certain artifact types was a highly contextualised activity. A clear positive relationship is established between the frequency of biface discard and proximity to spatially discrete and static resources. This relationship not only provides a possible explanation for the occurrence of large concentrations of bifaces but also predicts the existence of the larger and denser biface concentrations found elsewhere in the Middle Pleistocene.

In Chapters 7 and 8 these results are discussed in relation to the wider Lower Palaeolithic record. The implications are explored in an attempt to account for assemblage variation at broader spatial/temporal scales and to explore the social and palaeoecological significance of the land use behaviours suggested by the study. In Chapter 7 an evolutionary perspective is adopted in order to examine wider evidence for patterns of structured land use and artifact discard within the Lower Palaeolithic record. Through discussion of palaeolandscape studies at Olorgesailie, Olduvai and other key sites, it is suggested that the appearance of distinctive assemblage types during the Early Pleistocene coincides with more structured use of space, more habitual tool use and longer raw material transport distances. It is suggested that this suite of emerging behaviours, conventionally linked to the appearance of Developed Oldowan assemblages, initiated a progression in the complexity of land and tool use behaviour. Furthermore, where demographic and ecological conditions allowed, this behavioural trajectory could be invoked to explain the regular appearance of biface-rich assemblages and standardised tool forms that characterise the Middle Pleistocene Acheulean.

Chapter 8 will also address the social significance of these behaviours and their implications for explaining patterns of continental occupation and colonisation.

In this chapter it is suggested that structured land use patterns, reinforced partly through contextualised routines of tools transport and discard, helped to maintain group cohesion and effectiveness as exploited territories expanded during the Middle Pleistocene. It is therefore suggested that the contextually controlled discard of artifacts during the Middle Pleistocene was a product of emerging patterns of subsistence and land use. These discard patterns may have partly facilitated such developments by providing some of the earliest structured human environments. This thesis concludes by suggesting that the Acheulean and its characteristic biface-rich assemblages should be more readily accepted as a social and palaeoecological phenomenon, rather than simply a technological or taphonomic one.

1.5 Summary.

This thesis is therefore an attempt to integrate different scales of evidence, each with specific levels of inference, in order to develop a more integrated and controlled approach to the archaeology of hominin behaviour. This is achieved by utilising different components of the archaeological record, from high-resolution signatures with relatively low levels of possible inference to coarser elements relating to long-term, repeated behaviours. One of the great strengths of this approach is that the limitations of one component of the record can always, in part, be mitigated through reference to other scales of inquiry. In this way it is hoped to achieve the kind of evidential 'tacking' suggested by Gamble (1996b, 1999) as a productive approach to addressing Middle Pleistocene hominin behaviour.

Chapter 2: Stone tool assemblage variability in the Lower Palaeolithic: approaches and methodologies.

2.1 Introduction.

While the primary focus of my research is the phenomenon of Acheulean biface-rich assemblages, this thesis takes the form of a wider analysis and discussion of Lower Palaeolithic assemblage variability. During the course of considering suitable methodologies for this work it became apparent that biface-rich assemblages could only be successfully studied with reference to wider scales of evidence. While the subject initially presented itself as a taphonomic problem, it required a detailed consideration of behavioural processes relating to hominin land use patterns, tool-use and palaeoecology. These aspects of the record are not easily accessible from biface-rich assemblages, which tend to be recovered from disturbed, fluvial contexts. These limitations necessitated that elements of both fine-grained archaeological contexts and wider palaeolandscape artifact distributions would have to be used to pursue the subject. In this chapter I review some taphonomic and palaeolandscape approaches that have been previously applied to Lower Palaeolithic assemblage variability. In addition, previous research on the nature of biface-rich assemblages will be considered.

2.2 Assemblage variability in the Acheulean.

Despite a number of suggested schemes, usually based on relative quantities of bifaces (Kliendienst 1963; Leakey 1971; Klein *et al.* 1999), it remains impossible to clearly define what constitutes an Acheulean assemblage. Bifaces begin to regularly appear in the archaeological record from 1.4 Ma (million years ago), with the assemblage from Konso Gardula providing an early example. Assemblages containing bifaces then continue to overlap in time and space with those containing few bifacial components. In the Early Pleistocene it has been traditional to term non-biface industries as Oldowan (Leakey 1965b), given their obvious similarity and continuity with industries from Olduvai Beds I and II (Leakey 1971) and Koobi Fora, East Africa (Isaac and Isaac 1997). Assemblages containing bifacial elements during this period (e.g. Gadeb, Melka Kunture, HWK) have been termed Developed Oldowan (Leakey 1971; Clark 1987). This terminology reflects an interpretation of the technology as simply being a variant of the Oldowan with bifacial elements 'grafted' onto the existing industry (Chevaillon *et al.* 1979; Leakey 1971). From such a perspective, it could be argued that this situation continues for over a million years until Middle Palaeolithic/MSA technologies begin to appear after 0.5 Ma (McBrearty 2001). Across Africa and Europe a simple dichotomy between assemblages with dominant bifacial elements and those lacking these can be documented. There are reasons, however, for viewing the appearance of Developed Oldowan assemblages as indicative of major behavioural changes in the Early Pleistocene. Their appearance coincides with changes in habitat preference from lake-margin to fluvial channels and increases in the distance of raw material transport. Other researchers have emphasised that the appearance of regularly formed bifacial tools constitutes a discontinuity with previous Oldowan technologies, suggesting cognitive development (Wynn 1979; Gowlett 1984).

The complex spatial and temporal variation in technology has given rise to a wealth of classifications for different assemblage types during this period. While non-biface assemblages have been variously termed Clactonian (Wymer 1968), Buda, Tayacian (Rolland 1986) or Hope Fountain (Clark 1950), assemblages containing bifacial elements are notable for their remarkable uniformity across Pleistocene Europe, Africa and Asia both in terms of site configuration (Gamble 1999) and artifact form (Gowlett 1988). While this repetition and uniformity have helped to define the Acheulean, it is perhaps the presence of a few well-documented and spectacularly rich concentrations of bifaces that helped to make the Acheulean such a compelling and persistently invoked concept.

Well researched biface-rich assemblages are few in number, with four African sites, Kalambo Falls (Clark 1969), Isimilia (Howell 1961), Kilombe (Gowlett 1978) and Olorgesailie (Isaac 1977) having come to dominate the literature of the East African Acheulean. Yet analysis of these sites has shown that the taphonomic history of some of these assemblages is highly complex with significant fluvial action involved in the formation of each (Isaac 1977; Howell *et al.* 1962, 1972). Given the repeated fluvial context of such assemblages and the suspicion that they might represent lag-deposits, some have come to be viewed as taphonomic phenomena. Studies of site-formation have indeed proved the involvement of fluvial process at these sites (e.g. Schick 1987a, see below), yet this has often been seen as the end point of such studies, with little attempt made to isolate what behavioural controls were involved in assemblage formation. However, many examples of biface-rich assemblages have been documented where fluvial processes are less clearly implicated in their formation. Assemblages from Kilombe (Gowlett 1978), Isenya (Roche *et al.* 1988), Boxgrove (Roberts and Parfitt 1999) and Melka Kunture (Chevaillon *et al.* 1979) provide examples of large biface concentrations that might represent behavioural rather than hydraulic accumulations (McBrearty 2001).

That biface-rich assemblages might sometimes be a behavioural phenomenon is important. That hominin activity in some landscape contexts was geared entirely towards biface manufacture (Howell 1966) would suggest that the dichotomy between biface-rich and 'small artifact arrays' previously observed was a real feature of hominin tool use behaviour. The persistent reoccurrence of large concentrations of standardised tool forms stands in contrast to Oldowan artifact scatters which tend to be more diffuse and have a wide range of less-standardised tool forms (Schick 1992; Toth and Schick 1986). These facts, combined with an apparent change in preference for occupation in channel as opposed to lake-margin environments, would begin to suggest changes in the adaptive behaviour of *Homo* during the Early Pleistocene. For these reasons, I considered that biface-rich assemblages might provide a suitable starting point for the study of Early-Middle Pleistocene hominin behaviour. Some key biface-rich assemblages for which an attempt has been made to isolate behavioural from natural formation processes are listed below.

2.2.1 Olorgesailie

Within the Olorgesailie lake basin, Kenya, are preserved a series of Middle Pleistocene sediments containing a number of rich Acheulean find localities. The basin has been the focus for a series of survey and excavation projects, originating with the 1942-45 seasons carried out by L.S.B. and M.D. Leakey and continuing with projects by Glynn Isaac in the 1960's and Richard Potts from the late 1980's onward. The sediments represent a diverse mix of depositional environments including fluvial channels, lake-margin and deltaic contexts. In addition, Potts identified and excavated archaeology associated with a continuous palaeosol horizon traced across part of the basin. The Olorgesailie formation as a whole has been dated on the basis of 40Ar-39Ar laser-fusion to between 0.9 and 0.22 Ma. (Potts 1989a). The sequence therefore spans much of the Early and Middle Pleistocene.

At Olorgesailie there are two distinct contexts from which archaeology has been recovered. The earlier projects undertaken by the both the Leakeys and Isaac focussed on archaeology associated with fluvial deposits found throughout the Olorgesailie formation. These contexts stand in contrast to the fine-grained palaeosol context of Potts' excavations, which initially targeted an outcrop of the Upper Member in the vicinity of the 'Friday-Beds' locale (Potts 1989a; Potts *et al.* 1999). The fluvial sites were more productive in archaeological terms, preserving dense biface-rich clusters of artifacts with associated faunal remains. Twenty of these archaeological localities were excavated and examined in detail by Glynn Isaac. Isaac's analysis of assemblage composition identified a non-random pattern of variability in which assemblages divided into those in which bifaces were clearly dominant over small tools, those which lacked bifaces and those in which bifaces and small tools were present in equal quantities (Isaac 1977).

Researchers had previously claimed that two cultures were present at Olorgesailie, one Acheulean utilising bifaces and another with a technology based on flake tool production, perhaps a variant like the 'Hope Fountain' or Clactonian (Leakey 1954; Cole 1963; Kleindienst 1961). While Isaac did identify a bimodal tendency for a biface/non-biface split in the assemblages, there was enough of a spectrum of sites with a mix of bifacial and non-bifacial technology for him to argue that even if two cultures had existed at the site, they both shared the same basic technological repertoire. The variation appeared to be determined by the degree to which each utilised bifacial technology (Isaac 1977). A similar mechanism of continuous and variable 'cultural' drift was also employed by Isaac to account for variation in biface form throughout the long stratigraphic sequences at the site.

In addition to his detailed examination of assemblage and tool form variability, Isaac undertook a relatively detailed and early taphonomic study of some of the Olorgesailie assemblages. The association of Acheulean sites with fluvial sediments had been previously addressed (e.g. Clark 1969: Howell *et al.* 1962), and the general assumption was held that, depositional context aside, there appeared to be little evidence to indicate the secondary reworking or modification of associated artifacts (Isaac 1977). At Olorgesailie, however, the number of localities, long duration of the depositional sequence and the "repeated associations of high concentrations of artifacts with sand lenses"(Isaac 1977, 81) suggested either a strong ecological preference for such environments by the hominins or a process of hydraulic modification. The importance of distinguishing between these two possibilities required the situation to be addressed in more detail than the usual degree of consideration that depositional context provoked in the Acheulean researchers of the day. Isaac applied the results of experimental site studies he had conducted at Lake Magdi (Isaac 1967b) which suggested that fluvially modified biface assemblages showed upstream tilting of bifaces, transverse arrangement of bifaces and the spatial separation of bifaces and flakes.

These criteria, when applied to the Olorgesailie evidence, showed only occasional and inconsistent evidence for fluvial modification of the assemblages. While the results were inconclusive, Isaac proposed that perhaps both an ecological preference and minor fluvial modification were working together to lead to the high-concentration of artifacts in channel contexts. In addition, Isaac suggested that the Olorgesailie evidence showed that hominin activity was concentrated on the banks and margins of streams, cutting through the basin and that at certain sites seasonal floods further concentrated these scatters into denser patches (Isaac 1977). These fluvial processes would have created varied kinematic flow patterns concentrating cobbles into regularly spaced clusters (Leopold *et al.* 1966). Isaac's model of site formation provided a dual mechanism to account for the formation of biface-rich, channel context assemblages and suggested that natural hydraulic processes were concentrating and exaggerating a real behavioural association between artifact discard and channel contexts. While Isaac's approach addressed the hitherto avoided problem of hydraulic disturbance in channel contexts, it failed to adequately document the extent and nature of assemblage transformation or isolate behavioural from natural processes. Yet by utilising experimental observations, detailed field measurements and the depositional models used by sedimentologists, Isaac helped to develop the multidisciplinary, geoarchaeological and taphonomic approaches commonly applied to in modern Lower Palaeolithic research.

2.2.3 Kalambo Falls

A number of Lower Palaeolithic archaeological localities have been discovered within the Tanganyika Rift close to the Kalambo Falls, Zambia. Throughout the 1950's and 60's, excavations led by J.Desmond Clark recovered substantial Acheulean assemblages from three main sites: B1, B2 and B5. These assemblages are still in the process of being studied but details of the depositional context and taphonomic history of the assemblages have been published (Clark 1969; Schick 1992). Kathy Schick was instrumental in pioneering the application of taphonomic techniques, developed and applied in faunal analysis during the 1960's and 70's, to stone tool assemblages. Through a series of well recorded experiments, the effects of low, moderate and high-energy fluvial processes in lake margin and channel contexts were documented, allowing Schick to provide empirical frameworks through which the degree of assemblage modification could be assessed (Schick 1986; 1987). Schick's work at Kalambo Falls is significant as it provides the first detailed application of stone tool taphonomy to biface dominant assemblages.

Kalambo Falls is also a useful example as its context is so unequivocally fluvial and the evidence for some significant degree of fluvial modification obvious without the application of sophisticated taphonomic tools. The assemblages were recovered from pebble lines forming the contact between sandy beds (Clark 1969). Both natural clasts and pebbles within the horizons suggested a mixed depositional history with both sub-angular and rounded pebbles lying alongside 'mixed' condition assemblages of fresh and abraded artifacts.

At site B5, some 539 artifacts were recovered including 94 bifaces, 57 cores and 19 retouched tools. The assemblage was not only distinctive because of the relative numbers of bifaces, but also for the density at which artifacts occurred (27per m^2) and an extrapolated biface count for the whole locality of c.700 over $150m^2$. The site therefore represented an early example of the kind of dense, biface-rich occurrence, with evidence for fluvial modification that came to characterise a classic 'Acheulean' site. Under Isaac's model of Acheulean site formation, the mixed condition of the artifacts confirmed that fluvial processes were reconcentrating artifacts discarded over time by hominins occupying the channel margins. To Schick however, such an explanation was not sufficient and failed to address the crucial questions of scale and extent in assemblage transformation. She suggested that the phenomena of biface-rich assemblages had such important behavioural implications, that simply identifying a mixture of hominin and fluvial agents in their formation was insufficient. Instead, Schick thought it necessary that the precise degree to which hominins were responsible for the formation of a biface-rich assemblage should be determined.

"Thus, when we find artifact assemblages with prodigious quantities of bifaces the possible implications are even more serious: what behaviour patterns....could have produced such concentrations? We must also consider aspects of site context at Acheulean sites to assess the effect of natural processes in the formation of these enigmatic artifact concentrations". (Schick 1992, 3)

While Schick therefore acknowledged that both behavioural and hydraulic processes had been involved in the formation of such sites (as suggested by Isaac's 'site drift' model), more detailed taphonomic analysis was required to isolate the processes that led to assemblage formation within each depositional context. The analytical procedures Schick employed and her results are summarised below:

1. Debitage Size Distribution: a unimodal peak for debitage in the 4-8cm size range immediately indicated a modified assemblage. The strong negative skew indicated that smaller components of the assemblage were absent. The curve characteristics suggested to Schick that either a) fluvial sorting had taken place or b) that hominins had transported flakes >2cm to the site and had a preference for flakes with a maximum dimension of 4-8cm and that knapping did not occur at the site.

2. Artifact Condition: Artifact condition was mixed. While a few of the artifacts showed a significant degree of abrasion these accounted for only 1.4% of the

assemblage. As most of the artifacts were in a relatively fresh condition, Schick suggested that a complex and multi-phase depositional history had formed the assemblage and that artifacts were largely incorporated into the sediments during short depositional events.

3.Refitting: Only a single refit, the conjoining of two elements of a single broken flake was achieved during 100 person hours of refitting. The lack of refits, in an assemblage which is both manageably small and composed of relatively large pieces argued against the possibility that intact knapping scatters were present the site. Thus Schick claimed that despite the high proportions of debitage "there is no evidence for preserved stone working residues" at Kalambo Falls. (Schick 1992,19).

4.Orientation Patterns: A clear E-W preferred orientation was documented at area B5. However, butt orientation combined with similar orientations at other close sites indicates a dominant N-S orientation pattern for flow in the channel as a whole.

5.Spatial Distribution patterns: Artifacts are densely distributed across the whole area but in a configuration that appeared to indicate a concentration towards the southern end of the site. This would also be consistent with a N-S axis of flow.

Evidence from these analyses overwhelming indicated that the Kalambo Falls assemblages had been subject to significant fluvial modification, sufficient enough to remove smaller components and concentrate larger artifacts from a wide area. The sedimentary context of the assemblages, which contained a variable artifactual component in otherwise pebbly layers, suggested to Schick that the artifacts could be considered as indistinguishable from other clasts in terms of their depositional history. Schick's model contrasts heavily with Isaac's 'site drift' scenario for assemblage formation at Olorgesailie, which suggested that hominin activity had been a prime factor in the channel association of Acheulean artifacts. Schick stated,

> " At the present time, however, in view of the strong evidence for fluvial involvement in site formation here at Kalambo Falls, it is not possible to rule out the fluvial concentration model, i.e., that these artifacts have moved appreciably from their original place of deposit and have become artificially reconcentrated by various fluvial process" (Schick 1992, 19)

"Artificial" was inappropriately used here to suggest that the Kalambo Falls assemblages, and by implication those from other classic Acheulean sites, were simply hydraulic accumulations. Furthermore, these accumulations were both temporally unrelated and associated spatially only by their discard within the same drainage basin. There are however a number of reasons why it is possible to consider Schick's assessment of the assemblage rather pessimistic and the discounting of a 'site drift' explanation for the assemblage premature. While the size-class distribution analysis is unequivocal in demonstrating size sorting, in isolation it is impossible to distinguish between a fluvial reaggregation of similarly sized particles, as Schick suggests, and the winnowing of an assemblage *in situ* or within the same broad locale. The overall condition of the artifacts does not really support Schick's claim that "these artifacts have moved appreciably from their original place of deposit" (Schick 1992, 19) given that only 1.4% of the assemblage exhibited any evidence for abrasion. Given that Schick would have us consider the artifacts as clasts deposited within 'pebble beds', the artifacts exhibit an unusually low degree of evidence for significant movement. The preferred orientation patterns, including preferred transverse alignments across the proposed N-S direction of flow, do not necessarily indicate high-energy fluvial activity of the sort required to fulfil Schick's proposed mechanisms.

Voorhies (1969) has demonstrated, through flume experiments, that preferred orientations could be created under low-energy conditions where objects are partially emergent from the water. Indeed, Voorhies experiments showed that transverse alignments were more common under low-energy conditions (Voorhies 1969), with parallel alignments more indicative of higher energy flows. The spatial distribution evidence, in which Schick suggests that the apparent separation of smaller and larger artifacts (Figure 2.1) is indicative of fluvial sorting. While inspection of the distribution pattern would appear to support Schick's claim, the separation is only of a few metres (the excavation area being only $20m^2$ in size). Creating the separation would only require movement of a few metres, certainly not the kind of extensive transport required to disregard the 'site drift' model in favour of a higher-energy process involving greater mixing and fluvial sorting. It also has to be remembered that the excavation area at the site covers only 10% of the known extent of the artifact concentration. In light of this fact and the evidence for limited artifact movement, it is hardly surprising that the refitting programme, carried out by inexperienced students, was so unsuccessful. Certainly the failure of such a limited programme can probably be accounted for without resorting to explanations involving dynamic fluvial processes.

I would argue that, while recognising that the Kalambo Falls assemblages are fluvially modified, winnowed and spatially rearranged, the overall condition and disposition of the artifacts provides no evidence to suggest that the material does not relate directly to hominin behaviour within the channel margins. This being said, the presence of abraded artifacts confirms that some of the material has been reworked and that the assemblage may well relate to many occupation episodes, some represented by extensively moved and sorted components while other, more recently discarded material, remains less modified. These criticisms only serve to reflect the complexity of the subject and the ambiguity of the results from taphonomic studies.

While the analytical procedures employed by Schick are still widely employed and little refined some ten years after her examination of Kalambo Falls (see below), such studies now appear to have moved away from trying to choose between behavioural or fluvial models to account for artifact concentrations. The role of both processes is now accepted as being integral to Acheulean assemblage formation in

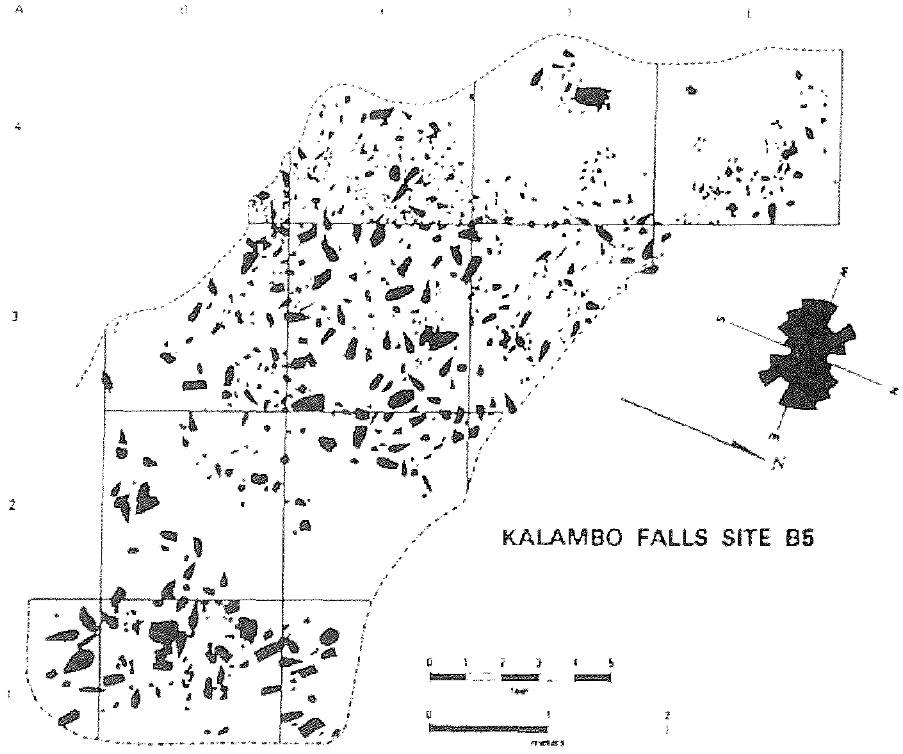


Figure 2.1: Hydraulic jumble? Spreads of bifaces and debitage at Falls (Schick 1992. Reproduced with the permission of John Wiley & Sons, Inc).

channel contexts and taphonomic studies are now aimed at establishing where, on a sliding scale, of modification a particular assemblage can be placed

2.2.4 Ain Hanech

Uncritical interpretations of Acheulean assemblages had a two-fold detrimental effect on attempts to account for Middle Pleistocene assemblage variability. On the one hand, too many assemblages were interpreted at face value, without sufficient consideration to taphonomic controls while, conversely, many Acheulean assemblages found in fluviatile contexts had been unwarrantedly written off as useless for behavioural analysis. The development of stone tool taphonomy throughout the nineteen-eighties, typified and pioneered by Kathy Schick, had the effect of both encouraging the routine taphonomic analysis of Lower Palaeolithic assemblages and removing the *in situ*/disturbed dichotomy that had previously existed in consideration of assemblage preservation. Taphonomic techniques had become refined enough to detect even the smallest amount of artifact movement in assemblages even to the point where micro-debitage studies had shown small size-classes to be so mobile as to be almost irrelevant in considerations of site preservation (E.g. Fladmark 1982). Whether by vertical movement (Wilhelmson in Roberts and Parfitt 1999), trampling (Austin in Roberts and Parfitt 1999) or fluvial events, stone tool taphonomy showed that it was virtually impossible, outside of a laboratory, for an assemblage to remain *in situ*. The site- formation studies therefore offered the possibility to not only identify, but also to account for the extent of disturbance and suggest how processes of modification had affected both assemblages composition, artifact distribution and the subsequent interpretation of the archaeology (Schick 1986).

The combination of new perspectives and techniques allowed the reexamination of a number of Acheulean sites that had previously been written off as 'disturbed', 'in secondary context' or 'derived' (Clark 1987; Sahnouni 1998). The assemblage from Ain Hanech, Algeria is recent example of one such re-evaluation, where taphonomic techniques largely derived from Schick's works have been applied to a site previously disregarded on the basis of its fluvial context. Sahnoumi was able to demonstrate that the Ain Hanech assemblage was in a fresh condition and compositionally intact. The slight preferred orientations suggested only the minimal reorganization of an *in situ* assemblage, rather than a fluvial reaggregation, but without sufficient energy to either introduce material from elsewhere or remove even light flakes <20mm in size. The situation at Ain Hanech reflected a common feature of many of the Acheulean sites discussed in this section, that they are associated with dynamic, fluvial environments that have effected variable degree of transformation; from minimally disturbed assemblages at Olorgesailie to the more significantly altered artifact spreads at Kalambo Falls. Across the Acheulean world, these sites reflect only part of a spectrum from well-preserved open air and cave sites (e.g. Montagu Cave, Boxgrove) with virtually *in situ* preservation, to the vast hydraulic jumbles, the true 'derived' assemblages from terrace gravel deposits typical of the river valleys of North-Western Europe (e.g. Abbeville, Warren Hill, Cuxton).

2.2.5 Gadeb

Clark addressed the complexities of assemblage variability within the Acheulean in his reexamination of archaeological localities at Gadeb, Ethiopia. Clark thought that the archaeology of Gadeb best typified Acheulean sites of the Lower and Middle Pleistocene, being "multi-context, multi-component concentrations, most probably reflecting regular reoccupation" (Clark 1987, 809). The archaeological horizons are found within fluviatile and weathered tuff deposits, the earliest of which were dated to 1.5 Ma. For the purposes of this discussion, two of the Gadeb sites illustrate the range of variability within a single sedimentary basin.

Site 8E (Figure 2.2) was a 100m^2 excavation area located within fluviatile sediments indicative of shallow channel margin conditions. An extensive assemblage of 20,176 artifacts was recovered, and of the 898 retouched tools, handaxes comprised 25%, cleavers 10% and scrapers 16%. The high counts for choppers, polyhedrons and sub-spheroids indicated that this assemblage had Developed Oldowan affinities, but the site provided an early example of an association between bifaces and channel contexts frequently documented throughout the Lower and Middle Pleistocene. Clark contrasted this site with area 8F, which was recovered from a palaeosol context over a 40m^2 area. The scatters were less concentrated than at 8E, only 385 artifacts were recovered of which 5.7% were retouched pieces. The artifacts were found associated with the remains of a single butchered hippopotamus and Clark interpreted the assemblage as a single-episode butchery site, that was in "marked contrast to the large stream-side sites....of Acheulian type" (Clark 1987, 811).

Clark interpreted the large accumulations of Acheulean material in behavioural terms. The subject of taphonomy as a controlling factor was addressed and largely dismissed. Clark noted that small assemblage components (<10mm) were virtually absent in the assemblages, a phenomena he ascribed to winnowing, and some evidence for artifact realignment and imbrication was also evident. However, on the basis of the overall condition and low-energy nature of the sediments, Clark envisaged that such artifact accumulations resulted from "aggregations in the slack water on the inside of a channel meander" and that "they are accumulations resulting from a number of reoccupations of site, perhaps seasonally, before it was sealed by fine laminated clays" (Clark 1987, 811). As the assemblages appeared not to have undergone any significant fluvial rearrangement, Clark argued that the channel sites represented localities favoured by hominins for their abundant and predictable resources.

Aside from the possibility that Clark did not fully take account of the taphonomic history of the Gadeb sites, they presented a simple and easily modelled explanation for large Acheulean assemblages. The artifact residues found at Acheulean sites appeared, where discernable at fine-grained high-resolution sites like 8F, to be associated with single butchery episodes. The larger accumulations were simply the superimposed signatures of these single episodes in favoured and reoccupied localities. While the model was neat, four Obsidian bifaces from Gadeb hinted at a more complicated picture, suggesting the transport of finished tools manufactured from a raw material type unobtainable within 100km of the site.

The possibilities that a more complex relationship between tools and butchery sites had, in fact, been in operation was further confirmed by examination of sites in the Middle Awash, also located in Ethiopia's Afar Rift. Here, artifact assemblages recovered from the Upper Bodo Beds, while also of a Developed Oldowan/Early Acheulean nature, are quite different in character to that from the Gadeb locality. Here assemblages preserved within fluviatile deposits show a clear split between those dominated by bifaces and those at which a core-flake industry is present. At most of the single-episode butchery sites no bifaces were found, indicating the possible removal of the tools after butchery. Yet at the site of HAR-A4 a hippopotamus carcass was found in direct association with 55 bifaces and five cleavers with no associated debitage or artifacts. This implies that the bifaces were manufactured elsewhere and brought onto the site for use in the butchery task. The Middle Awash sites suggested that assemblage variability within the Acheulean, rather than being a result of simple cumulative reoccupation episodes may also be due to a more dynamic system of tool transport and artifact discard. The evidence from the Obsidian bifaces at Gadeb suggested that such transport could be very spatially extensive. Clark had previously argued that bifaces had played only a peripheral role in butchery activities (Clark and Haynes 1970), a point made more strongly by Binford who disregarded their role in butchery altogether (Binford 1972). The Gadeb and Middle Awash evidence suggested that, as bifaces were evidently transported, a negative pattern of association could no longer be upheld on a presence/absence basis alone.

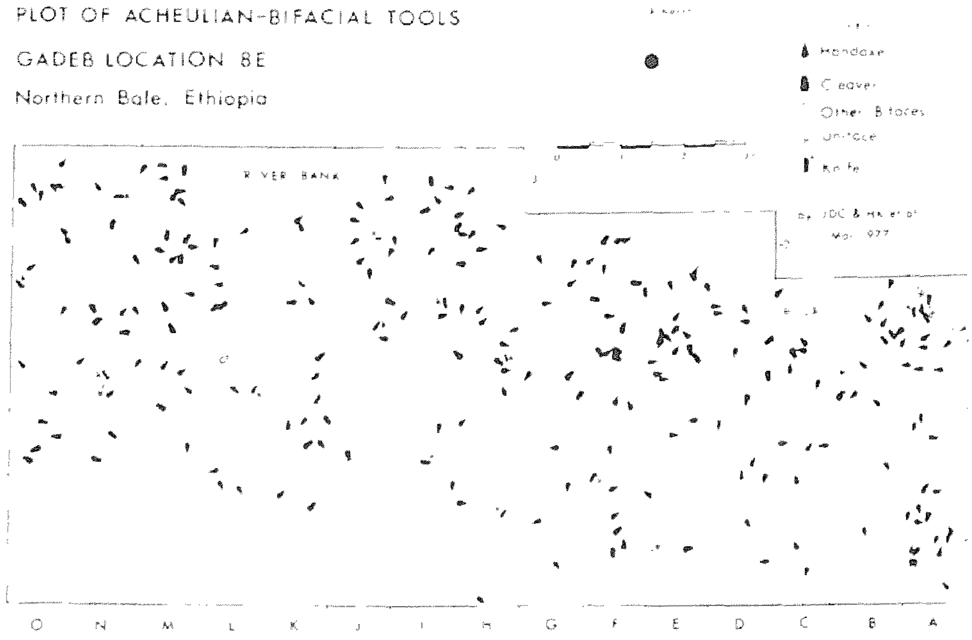


Figure 2.2: Biface-rich assemblage spread from Gadeb 8E (Clark 1987. Reproduced with the permission of Elsevier Science).

2.2.6 Torralba and Aridos

The archaeology from two exceptional Middle Pleistocene localities were similarly contrasted by Paola Villa to illustrate the potential complexities involved in Acheulean assemblage variability. The two Aridos sites both represent single butchery localities, each preserving the remains of elephant individuals associated with preserved landsurfaces. While no direct evidence for hunting was archaeologically discernable, both sites appeared to indicate "a pattern of meat acquisition through early access to a carcass in a non-competitive situation" (Villa 1990,229). At Aridos, 18% of the assemblage was refitted and the range of raw material units at the sites appears to suggest a minimally disturbed series of knapping scatters. 16 flint cores indicate on-site tool production which appeared to involve the manufacture of a series of retouched tool types and a small quantity of bifaces. A pattern of biface transport was also indicated, with evidence for the off-site transport of flint bifaces at Aridos 1 and the on-site discard of quartzite bifaces at Aridos 2. To Villa this suggested that the pattern "may have to do with the desirability of flint versus quartz" (Villa 1990, 231). Again this data suggests that the actual role of bifaces in butchery may have been underestimated in butchery activities (Clark and Haynes 1970; Binford 1972) exactly because they were more likely to be subject to transport than other retouched tool types.

The associated elephant bones and lithic artifacts at Torralba had also been assumed to provide evidence for an elephant kill site. Binford's re-examination of the site in the 1980's threw doubt on this interpretation, suggesting that the archaeology represented a palimpsest signature. Stone tools were only rarely associated with elephant individuals and denticulates and notches dominated the assemblages, both facts suggesting marginal scavenging. It was thought that bifaces would be more likely to dominate at whole carcass sites (Binford 1987). Binford thus argued that the Torralba site represented the opportunistic, marginal scavenging of elephant carcasses by unprepared hominin groups, a scenario that to Villa sat uneasily with the evidence for early carcass acquisition and systematic butchery at Aridos. Villa pointed to the complexities of the Torralba assemblage, notably the inverse proportions of debitage to tools to argue for the possible transportation of tools. On the very conservative estimate of a minimum 7-10 flakes per biface, the debitage at the site could not possibly account for the number of bifacial tools. In all, the debitage levels at Torralba were extremely low, suggesting that either tools had been transported on site in large numbers, arguing for more planning depth than Binford envisaged, or that the site had been severely modified by post-depositional processes. In either case the Torralba evidence was an unsuitable dataset on which to build a case for marginal scavenging. Critically, the Torralba evidence reinforced the centrality of both tool transport and taphonomic rigour in the consideration of Acheulean assemblage variability.

The examples discussed above illustrate the ways in which biface-rich assemblages are pertinent to wider discussions of Lower Palaeolithic assemblage variability. Modern taphonomic analysis now allows a moderate appreciation of the degree to which assemblages from dynamic sedimentary contexts can still provide useful behavioural information. The results confirm that the character of biface-rich, channel-associated assemblages are in part real behavioural phenomena, probably reflecting the preferred habitats of hominin communities. These analytical techniques also indicate a wide spectrum of preservational quality from assemblages only minimally disturbed and rearranged through low-energy processes, to those representing full-secondary context hydraulic jumbles. These results illustrate that one unfortunate consequence of shifting habitat preferences during the period was that hominin activity appeared to become concentrated in areas of dynamic and destructive sedimentary processes. It is such conditions that push our current range of taphonomic techniques to the limit.

In even moderately affected assemblages, water flow will winnow smaller size-classes of artifact and concentrate large artifact types such as bifaces. The actual occurrence of biface-rich assemblages may therefore have been over-exaggerated in the archaeological record. Where long sequences or wide palaeolandscapes have been investigated, biface-rich assemblages account for one end of a wide spectrum of variation in which bifacial elements are a fluctuating component (Isaac 1977). While Oldowan assemblages might contain some bifacial elements, technological variants such as the Hope Fountain and Clactonian simply reflect the degree of variety in assemblage composition, while the Acheulean has been a term traditionally applied to assemblages where only 40% of tool forms were bifacial (Kleindienst 1961).

It has sometimes been the view that Middle Pleistocene assemblages lacking bifaces provide ‘cases to answer’. Yet in many ways it is the presence of bifaces, or at least of classic biface forms, which varies against a more constant and continuous distribution of largely non-biface industries. The scale and determining factors of this variation has to be addressed before explanations for geographic/temporal hiatuses of bifacial technology and the adaptive significance of the biface and its role in hunting/butchery practice can be provided. Such explanations also need to take account of the role of artifact transport and discard in assemblage formation.

This last point emerged as crucial in all the attempts to account for assemblage variability. Assemblage variability seems to relate, once taphonomic processes are isolated, to the transport and discard of tool forms within the landscape (Clark 1987;

Villa 1990). Extended artifact reduction histories across more than one location also emerged as a recurrent explanation for assemblage composition from previous studies at Boxgrove (Chapter 3). Tool transport and discard behaviour might therefore be a critical variable, responsible for at least part of the observed differences in assemblage composition within the Early/Middle Pleistocene. In order to study these processes, detailed technological and taphonomic analysis of individual assemblages need to be considered alongside wider patterns of assemblage distribution and composition at landscape scales.

2.3 Assemblages in context: The 'scatters and patches' approach.

It was fortunate that many of the most exceptional palaeolandscapes were investigated or reinvestigated during the emergence of the 'new' archaeology of the early 1970's, as the methodological approaches were perfectly suited to the challenge the rapidly increasing Palaeolithic datasets presented. With its emphasis on the quantitative analysis of archaeological processes and its concern for the detection of patterning in the record, it permitted a new perception of stone tool scatters previously unavailable to Palaeolithic researchers. As opposed to being purely a technological phenomenon, subjected to metrical and typological study, artifacts potentially offered to tap deeper into the fabric of hominin life. The combination of fine-grained, spatially extensive contexts and a new mature, analytical approach to archaeology allowed artifacts to be seen as the product of the dynamic inter-play between hominin groups and natural processes. As well as offering this new potential, new demands were to be made on the scale and methodological approaches of research projects, requiring increasingly detailed recording in the field and the collaboration of many researchers with detailed expertise to process the recovered material. Nowhere was this better illustrated than in the Koobi Fora Project, which became a model for this kind of multi-disciplinary endeavour during the mid-late nineteen-seventies. The project was coordinated by Glynn Isaac and centred on the excavation of 12 main localities in East Turkana where deposits dated to between 2 and 1.3 Ma preserved both archaeological and faunal remains. One of the more original and innovative features of the Koobi Fora project was that its design aimed to meet specific research aims and to address particular research questions, rather than simply being a collection and documentation exercise. Earlier work at Koobi Fora and Olduvai had documented recurrent patterns in the record that required more investigation and explanation. Primarily, the repeated occurrence of dense accumulations of artifacts and bones from Early and Middle Pleistocene landscapes required investigation and became a major research aim, one that offered a challenge to traditional analytical approaches. While being a clearly definable feature of the Palaeolithic record, it remained impossible to determine the degree to which some assemblages truly represented hominin occupation sites or were secondary hydraulic accumulations. This was especially the case where sites occurred in fluvial contexts (Leakey 1971; Binford 1977a). Isaac had encountered this problem previously, during his work at Olorgesailie (see above) which, like a number of other Middle Pleistocene sites, showed repeated association of bifaces, knapping debris and bone accumulations within sandy channel contexts. (Isaac 1977)

Another research topic Isaac was keen to address was the archaeological record of more marginal, less densely occupied areas. These areas, which were to become known as the 'scatter between the patches', were perceived as both neglected and potentially important by Isaac. Given the association of high density, low-resolution archaeology with fluvial contexts, Isaac thought higher resolution archaeology might be found occurring at low densities across the large areas surrounding the traditional sites. This archaeology was important in that did not "represent accumulations involving many events and activities that are hard to separate" (Bunn *et al.* 1980, 111). Isaac saw that, as the great extent of Palaeolandscape archaeology is encountered as scatters of material at very low densities, the focus of field archaeology on the isolation and excavation of large, non-representative sites was compensatory (Isaac *et al.* 1981).

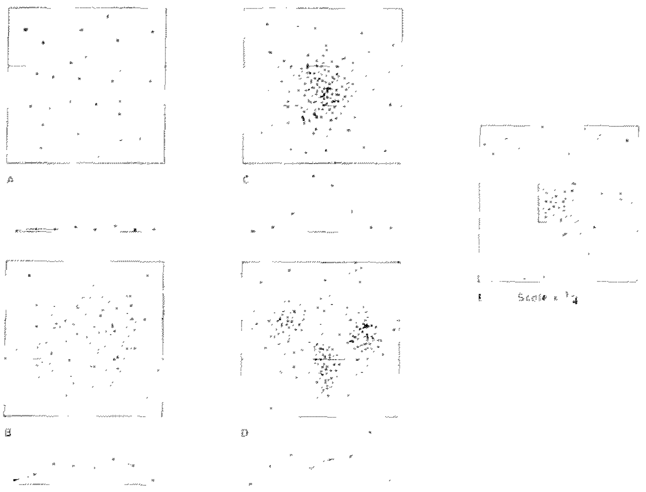


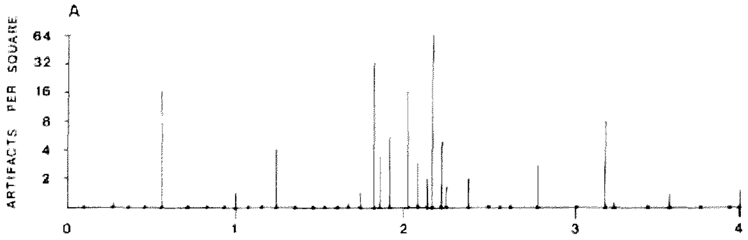
Figure 2.3: Typical 'scatters and patches' distribution patterns and how these would translate into observed changes in artifact density in transects (Isaac 1981b. Reproduced with the permission of the Cambridge University Press).

At Koobi Fora, an opportunity was given to address this imbalance and properly document the true distribution of the archaeological record; thus, the earliest research at Koobi Fora focused on the extensive sampling of exposures in order to produce a detailed and accurate picture of the total site configuration. The 1974 field season saw the sampling of transects dug across sediment outcrops augmented by a more focused 'target horizon' approach in the 1977 survey. Here the sandy-silty beds of the Okote tuffaceous beds were targeted. This allowed the horizon to be traced through transect excavation along a sinuous outcrop over 4km in length (Isaac 1981b, Isaac and Harris 1975, Isaac *et al.* 1981). The results of this survey were to see the first formulation of the 'scatters and patches' approach to artifact distribution analysis (Figure 2.3), an approach which this thesis intends to demonstrate is still essential to the study of hominin land use. In the first formulation of this essentially hierarchical approach Isaac isolated three distinctive site configurations in the assemblages of the target horizon at Koobi Fora, see also Figure 2.4.

1. *Low background level.* For the majority of the landscape (up to several km in extent) artifacts occurred at very low densities. Within the $25m^2$ sampling units artifact densities were recorded at level of between 0-3 items. Occasionally within these areas small clusters of material were encountered but these were rare.
2. *Intermediate levels.* These were spatially discrete areas up to 500m across where find levels per $25m^2$ varied between 4 and 20 artifacts. The increased density was not only due to an increase in individual artifacts but also of small clusters containing between 30-100 artifacts.
3. *Peak levels.* At particular sites, localised concentrations of between 20 and 100 artifacts per $25m^2$ were encountered. Some were clusters of >1000 artifacts in spreads between 10 and 30m in diameter. Another characteristic of peak level sites was that they not only occurred as peaks of density within intermediate level areas, but also as 'anomalies' within the low background density areas. Such occurrences are recognised in the archaeological record as classic 'sites', and it was this part of the record that had been traditionally targeted by excavation. (Isaac *et al.* 1981).

This was the first manifestation of the hierarchical model of site configuration that was to be later refined into Isaac's atomic or 'fundamental particle' model, discussed below. Its main strength and originality was that it attempted to describe the whole range of the archaeological record as part of a continuous but variable distribution, while at the same time allowing recurrent configurations to be identified and categorised. Once such configurations were isolated then contextual associations could be identified. Isaac and Harris were able to show that the two higher levels of were associated with the banks and beds of channels while low-density archaeology occurred across the surrounding landscape. With this approach it became possible to address the true complexity of the archaeological record as a product of hominin land use, artifact transport and discard behaviour. In order to take such analysis further, to the detailed level of analysis that the 'scatters and patches' approach demanded, it became necessary to implement an increasingly multi-disciplinary approach to the analysis of archaeological 'sites'. This was particularly true in the emerging study of stone tool assemblage taphonomy, which was shown to be an essential component of research, given the repeated association of dense high level sites with fluvial and alluvial deposits.

The analysis of one locality, FxJj50, powerfully demonstrated the potential of the emerging scientific, multi-disciplinary approach which was revolutionising Lower Palaeolithic studies at the time (Roe in Isaac 1997). This was an extraordinarily focused and detailed site analysis completed as an interim report within months of the end of the excavation itself. It was a collaborative work undertaken by Henry Bunn, John Harris, Zefe Kaufulu, Ellen Kroll, Kathy Schick, Nick Toth and Kay Behrensmeyer. The site was relatively complex, being an accumulation of butchered bone and stone tools in the sandy-silty flood deposits of a watercourse. Given the fluvial context, the number of individual animals and reduction episodes at these sites, there were obvious questions about the depositional history, the number of episodes of hominin activity, the role of water in site formation and the length of time represented by the accumulation. The multi-disciplinary team allowed these questions to be approached through geoarchaeological analysis of the sediments, animal bone taphonomy, stone tool taphonomy, stone tool and animal bone refitting programmes, the detailed reconstruction of butchery, stone reduction strategies and the analysis of the overall spatial arrangement of the site. The analysis concluded that there had been some degree of post-depositional modification of the material at FxJj50: carnivore gnaw marks were present on some bone, there had been a slight winnowing of the stone



A IDEALISED CONFIGURATION OF COUNTS AT RANDOMLY SPACED 5 x 5 m OBSERVATION POINTS

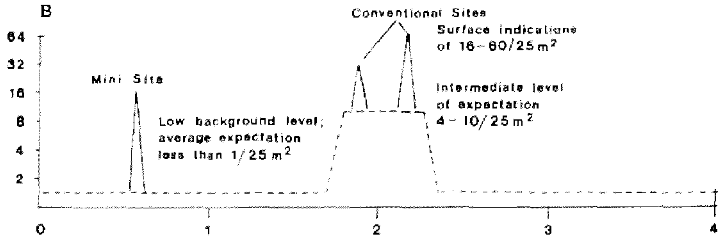


Figure 2.4: First formulation of site hierarchy based on a 'scatters and patches' approach (Isaac *et al.* 1981. Reproduced with permission of the Cambridge University Press).

tool assemblage and there was evidence for bioturbation. Despite this, the taphonomic and refitting analysis had concluded that the faunal material had been buried within a relatively short time (up to a year) and that the stone tool assemblages were compositionally intact above 20mm and spatially clustered broadly in their original arrangement. The analysis concluded that the site represented the resulting residues from series of short-lived episodes of hominin butchery and that despite the fluvial context was a direct product of hominin activity rather than the hydraulic reaggregation of material by water flow (Bunn *et al.* 1980; Isaac 1997).

While an excellent example of archaeological practice, the importance of the FxJj50 analysis was that it was undertaken, through Isaac's direction, to inform the wider investigation of hominin land use patterns and behaviour across the entire record of a Palaeolandscape. The 'scatters and patches' approach allowed the realisation that, while there would always be focus on high level sites like FxJj50, the inevitable nature of these sites was that they represented multi-episode occurrences, often in channel contexts, with complex depositional histories. While the multi-disciplinary approach went a long way towards isolating the various processes involved in site formation at such localities, the only way of understanding the actual scale and nature of hominin behaviour was through the complementary study of mini-sites. Within the Okote formation as a whole it was Isaac's mini-site, being an isolated scatter of up to 100 artifacts, that was by far the most common kind of archaeological occurrence (Isaac *et al.* 1981). Being small-scale and often in non-fluvial contexts, controls over site formation, habitat setting, tool reduction and vertebrate taphonomy were easy to achieve. A typical mini-site is FxJj64, excavated by Kay Behrensmeyer in 1979. The assemblage consisted of 83 artifacts and 353 fragments of elephant rib-cage (including a cut-marked fragment) spread over an area of 7m^2. While minimally disturbed by overbank deposits, the stone tools and faunal material was tentatively interpreted as being associated and representing a single event in which locally available lava cobbles were flaked to facilitate the butchery of a large mammal. The important feature of sites like FxJj64 is that they contrast markedly with FxJj50 type configurations. If the former is truly indicative of a single episode it becomes possible to test this by comparing assemblage composition with the latter. Providing the solutions to such problems characterised the nature of the Koobi Fora research. Isaac and Harris had begun to document the complete array of the archaeological record on a landscape scale, the 'scatters and patches' approach allowed questions of site function and formation to be addressed within the wider framework of hominin land use. As Isaac realised, this approach allowed hominin behaviour patterns to be viewed inter-contextually, addressing the degree to which dense accumulations of artifactual material represented the product of distinctive activities.

> "Ultimately we hope to determine whether concentrations such as these (FxJj50 type sites) could represent the additive combination of materials found in a whole series of mini-sites or whether there are some features or components that qualitatively distinguish major sites from all mini-sites." (Isaac *et al.* 1981, 265).

It was to be through such applications that the 'scatters and patches' approach was to develop to the point where Isaac began to perceive that the approach might be applied in a more formalised and analytical way. What perhaps underlay this development was the realisation that, by the beginning of the nineteen-eighties, a number of spatially extensive Plio-Pleistocene Palaeolandscapes had been identified and sampled offering a chance to document in detail hominin land use patterns across different time scales/sedimentary contexts. As the 'scatters and patches' configuration documented at Koobi Fora had also been documented along sinuous outcrops at Omo, Olorgesailie and Olduvai, an analytical approach was required that could characterise artifact configurations from a landscape and allow the inter-contextual analysis of the entire data set. In order to accomplish this ambitious aim, the artifact and faunal configurations had to be isolated along with the environmental, behavioural and taphonomic controls underpinning the spatial patterning from the essentially two dimensional record of the bed outcrops.

In Isaac's 'Stone-Age Visiting Cards' paper (Isaac 1981b) possible approaches to this problem were considered, approaches which had developed through the nineteen-seventies as part of the rise of analytical archaeology and had been successfully applied to land use studies in later prehistory. These included the creation of detailed distribution maps plotting the position of 'sites' against the distribution of known environmental variables, an approach successfully applied in the study of Holocene land use (Hodder and Orton 1976). An extension of this was site-catchment analysis, which allowed the full range of resources accessible from a site to be documented in terms of ethnographically derived limits of energy expenditure (Vita-Frinzi and Higgs 1970; Jarman 1972). Both methods failed in their application to Plio-Pleistocene contexts both in their requirements for complete 'site' distribution maps and the detailed mapping of environmental variables within the study area.

Isaac considered that the special character of the Plio-Pleistocene evidence demanded approaches that were specifically geared to the particular opportunities the data offered as well as its obvious limitations. Unlike land use studies in many

Holocene contexts there did not have be such a focus on the kind of 'site' based archaeology common to both the classic distribution map and site catchment analysis approaches outlined above. The archaeology from palaeolandsurfaces can sometimes be more complete and of a far higher resolution than that from later prehistoric contexts, as "...sediment blankets have preserved comprehensive, articulated broadcast sets of remains" across spatially extensive areas (Isaac 1981b, 211). While the limits of sampling sinuous sediment outcrops meant that two-dimensional data sets could only be reconstructed into three-dimensional models, the transects through these landscapes did provide detailed cross-sections through the entire configuration of the faunal and artifact distribution. Isaac perceived that in order to investigate the distribution pattern unencumbered by preconceptions of what a particular configuration might represent, a wholly reductionist approach had to be implemented.

> "I have treated the archaeological record as a patterned array of points in space. If one is to build a theory or model that will allow the array to be intercepted one should start by asking what are these points? What are the irreducible units of spatial analysis? What is the archaeological equivalent of a fundamental particle?" (Isaac 1981b, 211).

This was again recognition of the hierarchical nature of artifact configurations originally outlined in the earlier discussion of site patterning at Koobi Fora (Isaac and Harris 1975; Isaac 1981b). It was realised that more complex sites could only be approached, identified and documented through the analysis of the entire record and that in order for this to be done it was essential that the documentation of the array was done at the most fundamental level possible. Isaac's final formulation of the hierarchy was as follows:

1. Fundamental particles: 'Irreducible items' such as individual flakes and bones but also possibly pits, stake holes and hearths.
2. Atomic elements: Single activity clusters such as knapping scatters, bones from a single carcass relating to a 'behavioural event which is indivisible'.
3. Compound cluster: Equivalent to the molecular level being composed of associated atomic elements, although whether these behavioural units can be isolated is immaterial. Such levels are usually classed as sites.
4. Regional settlement patterns: The overall configuration of sites.

The value of reducing the archaeological record to basic 'fundamental particles' is obvious and at a general level underpins modern archaeology. There is, however, a problem in the identification and use of the higher level entities and it is at this end of the hierarchy that the limits of Isaac's scheme become apparent. Level 3 configurations, the classic 'sites', require particular attention due to their centrality in archaeological analysis and potential complexity. While recognising that such compound clusters may have a wide variety of behavioural and taphonomic origins no attempt is made to sub-divide the category. An obvious sub-division would be between sites relating to a single behavioural episode and a multi-episode occupation site, but other possible distinctions might be made on the range and at the site. As Isaac suggested, an approach that was based on the distribution of individual artifacts always allowed the possibility of developing new hierarchies from the results of individual studies and applications. This was possible with the 'scatters and patches' approach as, unlike the classic 'site' based methodology, there was no initial prescriptive definition for particular archaeology. In this sense, Isaac shared Clarke's concern with archaeological units of analysis and the role of the individual artifacts, issues that were also addressed by Robert Foley in his development of 'Off-site archaeology' (Foley 1981a, 1981b). Isaac distinguished his approach from Foley's by recognising that Early and Middle Pleistocene research would inevitably be 'site' based (Isaac 1981). Yet, having accepted this limitation, the approach allowed sites to be defined critically within their true local archaeological context as part of the entire array of the archaeological record and not as assumed, clearly defined *a priori* entities. Thus, in the first statement that indicated the possible future development of the 'scatters and patches' approach into a more substantial analytical framework Isaac stated,

> "I would prefer a designation that makes it clear that sites are concentrations of special interest....I would suggest the interim rubric of 'scatters and patches analysis'." (Isaac 1981b,216).

Unfortunately suitable analytical techniques were never outlined by Isaac, only some possible research aims and applications emphasising the need to fully address assemblage variability and the contextual factors underpinning it. Essential to such ends was a random sampling strategy that allowed the full array of the archaeological record to be determined across the survey area. From such a starting point assemblage variability could be measured in terms of artifact density, technology and raw material type and these variations plotted against environmental variables such as distance from known raw material sources and local topography. In this way the overall aims of the 'classic' distribution map analysis could be met within the limitations of the Early and Middle Pleistocene record.

'Scatters and patches' analysis offered the potential to provide new approaches to the subject of inter-assemblage variability. Given that the 'site' assemblages could be viewed against the immediate 'off-site' record, comparisons could be drawn between the composition of assemblages in the two areas. The continued priority was to determine the degree to which on-site assemblages were either accumulations of material from the same behavioural activities occurring across the environment or the product of unique and spatially limited behavioural signatures (Isaac 1981a). Sites could be viewed in their true context and only within such a framework could the importance of mini-sites, characterised by artifact densities only slightly elevated above the background scatter, be appreciated (Isaac 1981b). This approach also makes it possible to distinguish between large artifact accumulations that are anomalously conspicuous within a wide area of low-density occupation and contrast them with sites forming part of a variable, but locally dense, spread of material. It was clearly not possible to incorporate such subtle distinctions into Isaac's hierarchical schemes, the true value of the 'scatters and patches' approach is that it enhances our perception of the archaeological record not in a neat schematic framework but in its true, raw and complex reality.

Unfortunately the development of 'scatters and patches' analysis never seems to have been completed, whether this was due, in the short term, to problems of implementation or just another sad outcome of Glynn Isaac's death is unknown. It is however curious that in the eventual publication of the Koobi Fora archaeological sites the 'scatters and patches' approach received only two short mentions and played no part in the systematic interpretation of the archaeology. This is particularly disappointing given that one of the central aims of the project, as initially conceived, was the systematic integration of low-density archaeology with traditional site-based approaches. To Isaac it seemed that the overall aim of archaeological research was the distillation of complex data sets into relatively simple insights into early hominin behaviour. This would account for his apparent frustration with an archaeology that had failed to appreciate just how complex the record of these relatively simple stone tool technologies was, and in doing so reversed the very distillation process Isaac was aiming for.

> "Perhaps because of the meagreness of the record, we archaeologists have sought unconsciously to compensate in various ways. We have habitually located our excavations, not in places that are representative of the ancient litter of discarded material, but in places that are unusually crammed with material.... but field work in a remote, arid area brings with it opportunities to sit under thorn trees and contemplate. Out of this there has emerged an interest in trying to develop alternative approaches to research that accepts the meagreness of the record, and indeed moves to recognise sparsity and simplicity as real reflections of the patterns of life and states of mind that prevailed in remote prehistory" (Isaac *et al.* 1981, 258).

A similar approach to prehistoric land use worth considering here in more detail is Robert Foley's concept of 'off-site' archaeology. While Isaac made a point of distinguishing 'scatters and patches' analysis as having separate priorities to off-site archaeology, the approaches have similar aims and underlying principles. From a historical/theoretical perspective they both represent products of the new archaeology of the period and both approaches were published together in the volume 'Patterns of the Past' (Hodder *et al.* 1981). For the purposes of the present discussion I wish to show how the principles that underpin Foley's 'off-site' archaeology provide some elements that should be considered critical in the implementation of a 'scatters and patches analysis'. The approaches share as their basic unit of analysis the fundamental particle of individual artifacts as a mapped distribution pattern across a study area. Foley recognised that the arrangement of the archaeological record could be quite simply documented using this approach although the processes leading to the formation of the record were varied and complex (Foley 1981a).

"The pattern is simple enough taken in its static form....however archaeological discard is a continuous process through time, and thus for the archaeologist studying the accumulated effects of years of discard, further complexity must be incorporated into the model." (Foley 1981a, 12)

The further development of 'scatters and patches analysis' would almost certainly have necessitated a temporal element to the framework. It would have to recognise that the configuration of the archaeological record as encountered through excavation was not simply a three dimensional distribution pattern, but the result of natural and behavioural modification over sometimes extensive time periods. Worked into Foley's 'off-site' archaeology was a concern to integrate the complex nature of site formation processes drawn from the emerging study of taphonomy developed during the previous decade. (Behrensmeyer 1975; Hill 1975; Brain 1969; Schiffer 1976). Such an approach recognised that the artifacts themselves, the 'fundamental particles' of the record arrived at their final positions through a series of processes.

The processes of discard, post-depositional transformation and final recovery all acted as filters on the correct assessment of the true behavioural contexts of the artifact (Foley 1981a). Ethnographic studies (Binford 1977b; Gould 1977) showed that even the relationship between use and discard is a complex one with numerous factors determining the degree to which different artifacts types are discarded and where. In Binford's study of Nunamuit groups it was the replacement costs and future use potential of an object that determined exactly where and when it was discarded. Further to this it was shown that the value of an artifact, and thus likelihood of discard, fluctuated greatly depending on context (Binford 1978). Taphonomy, ethnographic analogy, temporal awareness and a critical approach to assumptions about the nature of the archaeological record were all of central importance in Foley's 'off-site' approach. One of the key questions the approach was suited to addressing was the degree to which behaviour documented at 'sites' could be detected in the 'off-site' record, with Foley suggesting a continuum in behaviour and a quantitative not qualitative difference between the two records. This was the same basic research question for which the 'scatters and patches' approach had initially been developed. Foley's work demonstrates that had the approach being fully applied, its success would have depended on its ability to address the archaeological record not just as spatial array but as a temporal entity capable of great transformation.

'Scatters and patches analysis' as conceived by Isaac was never fully developed into an applied analytical framework and after his death it was only in the early nineteen-nineties that the approach was further explored. Its most immediate legacy was to demonstrate the potential that existed in the Lower Palaeolithic and helped to open the way for an entirely new archaeology of the period. Previously, excavation projects had been site-based and artifact analysis typological in nature.

With the new availability of a number of extensive preserved landsurfaces, hominin land use could be directly tackled as a subject. Artifacts could be now be viewed as more than just technological phenomena, as trace fossils of hominin behaviour. Isaac's approach left, through the 'scatters and patches' approach, one of the first descriptions of the entire array of the Palaeolithic record. While limited and open to much further refinement the framework demonstrated that potentially significant patterning existed in the archaeological record and that the study of this apparently structured variability offered a way of directly accessing hominin behaviour.

Despite the fact that a full, 'scatters and patches' analysis of the Okote formation was never to materialise after the loss of Isaac, the approach has been generally applied in a number of other contexts. Although, not always explicitly described as a 'scatters and patches' analysis, palaeolandscape research projects throughout the late 1980's and early 1990's have utilised transect approaches and emphasised the importance of accounting for spatial variability in assemblage composition and artifact density. The following few examples serve to illustrate such applications of the approach.

2.3.1 Olduvai Lower Bed II

The target layer for this study (Blumenschine and Masao 1991) was the Lower Bed II of the Olduvai sequence. Within this bed, a waxy-clay tuff was revealed along a 2km erosion front and was found to contain *in situ* lithic and faunal remains. The deposition of this horizon was bounded by datable tuffs. Through $^{40}Ar/^{39}Ar$ dates the deposit was dated to c.1.71 Ma and was shown to have a short period of formation. Consequently, this exposure allowed the sampling of a broadly synchronous landscape for which temporal resolution and archaeological integrity were controlled. 17 trenches of $1.5m^2$ were excavated over a $1km^2$ area. 222 artifacts were recovered alongside faunal remains. The lithic industry was composed of cores, flakes and retouched pieces, essentially Oldowan in character and consistent with the potassium argon dates for this horizon.

The authors utilised two Palaeogeographic landmarks against which to analyse variation in the archaeological record. The Nabor Soit inselberg 3km to the north of the study area was the suspected outcrop from which raw material was derived, while the shore of palaeo-lake Olduvai lay c.2km to the west. These two known landmarks provided base lines against which to examine variation in transport/discard patterns in relation to raw material proximity and environmental zonation. The researchers utilised these markers to apply a transect approach whereby this variation could be spatially quantified. Actual density of artifact numbers showed no change with distance from the shore or the Inselberg. The authors conclude from this that 'hominid land use was not constrained by the logistics of quartz procurement and transport' (Blumenschine and Masao 1991, 457). Patterning was shown to be present in assemblage composition. Flakes dominated assemblages to a greater degree near the shoreline, while cores and manuports were more common in sites 2km from the lake. The authors noted that the shore line may have exercised a pull on hominins due to greater game aggregations but that the lack of raw material in the lake margin area led to less discard and more transport/curation than in the distal lake margin area. However, I do not feel that the palaeo-ecological differences between the two area had been fully explored; what looked like a response to out-crop proximity could be a particular pattern of butchery that was context-specific. Had the authors also examined the relationship between mean artifact weight and distance from the lake this pattern may have been clearer. So while there was no direct evidence for raw material proximity constraining land use, the authors did not fully explore the degree to which hominin behaviour may have responded to it. The evidence might, instead, be showing more intensive core reduction in the proximal lake margin, or that core/manuport discard occurred more frequently in areas where resupply is easier.

2.3.2 Olorgesailie

Potts' investigation of a palaeosol outcrop in the Olorgesailie formation also attempted to analyse hominin behaviour against known palaeogeographic vectors. As with Blumenschine and Masao's study, Potts was able to sample several kilometres of palaeosol outcrop for which there were tight controls over site formation and temporal resolution (Potts 1994; Potts *et al.* 1999). Here material appeared to be early Acheulean and was dated to 0.9 Ma.

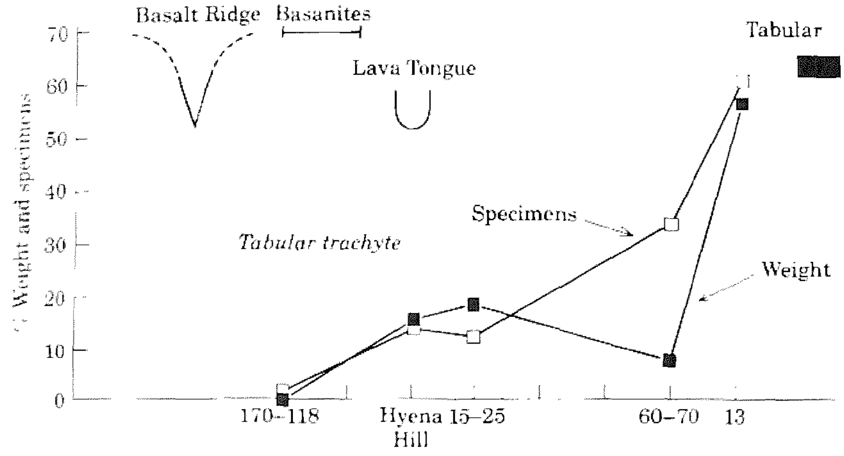


Figure 2.5: Relationship between the quantity of raw material type and distance from outcrop at Olorgesailie (Potts 1994. Reproduced with permission from Elsevier Science).

Artifacts from the sampled horizon were manufactured from four rock types, the sources for which were known and spatially restricted. This allowed Potts to analyse the degree to which material was transported/curated within the landscape and the overall effect of 'resource tethering' on hominin populations. The distribution of two rock types (tabular trachyte and lava tongue) indicated a dramatic fall in density with distance from outcrop (Potts 1994; Figure 2.5). This indicated minimal transportation for artifacts of these materials. The distribution of basanite and basalt ridge showed no relationship to distance from source. Potts made little attempt to explain the differences in the transportation of different raw material types. It would, however, be interesting to know something of the suitability of each rock-type for tool manufacture.

2.3.3 Maastricht Belvedere

This project sought to examine a series of fine-grained sediments and associated archaeology over a 6 hectare area of Weichselian and Saalian river deposits (Roebroeks *et al.* 1992). This provided an opportunity to examine variation in the density and nature of archaeology across both time and space and to investigate the possible contextual controls over artifact discard. The study upheld Isaac's (1981) observations of a near continuous distribution of artifacts across preserved palaeo-landsurfaces and was one of the few research projects during the period to explicitly describe itself as utilising a 'scatters and patches' approach. This 'scatter between the patches' of denser artifact concentrations seemed to relate to the discard of isolated pieces as part of non-maintenance (subsistence) activities.

Through refitting analysis areas of denser archaeological material could be examined. The study sought to see the degree to which they represented distinct signatures in terms of hominin behaviour or just quantitatively larger accumulations of the same range of artifacts occurring at a low level in the surrounding scatters. At site K, refitting separated the debitage forming the concentration from the apparently isolated finds that comprised the background noise. Site N was an area of low-density scatter and contained an assemblage of entirely imported artifacts. The high count of 'core trimming flakes' led the authors to conclude that these may have been tools (there being no other rationale for their selection and transport). Had such finds occurred in dense patches of knapping residues there would have been little contextual support for such an interpretation. This is one good example of how low density scatters can be effectively utilised in the modeling of hominin tool use and land use behaviour.

Despite these studies, a more cautious approach to land use emerged during the 1990's, partly as loss of impetus given the relative dearth of new landscape scale research projects, but also as a direct result of Stern's re-examination of the Okote Member research. Stern's work focused on the evidence for time-averaging at Koobi Fora and indicated, through a detailed study of the micro-stratigraphy that the sedimentary context of many of the sites, broadly assumed to be contemporary, actually represented a time-averaged unit spanning up to 0.07 Ma (Stern 1993, 1994). Such an enormous time-span rendered claims for contemporaneity unsustainable in any useful sense and thus challenged the premise underpinning the whole 'scatters and patches' approach.

"Scatters and patches are arbitrary divisions of variable density aggregates of debris" (Stern 1994b, 172)

The research implied that the 'scatters and patches' configuration identified by Isaac at Koobi Fora, could not be utilised to model the behaviour patterns of individual hominin groups. Given the indicated potential for discontinuous occupation by diverse groups under undoubtedly changing and varied environmental conditions. Stern's research served as a timely warning. Archaeological method, being more adapted to the analysis of small-scale depositional/formational features, perhaps led to over-optimistic interpretations of the formation periods of geological units, however well defined and vertically limited they appeared in the field.

Stern's work was, however, simply a reinterpretation of the Lower Okote Member and only questioned the premise of Isaac's research and not the approach in general. Indeed, even at Koobi Fora the degree of patterning in assemblage composition with regards to the similar nature of 'scatter', as opposed to 'patch' assemblages, would seem to counter Stern's assertion that the archaeology of the unit cannot be considered as a coherent, behaviourally related whole (Juell and Edwards 1994). Stern however accepts the possibility of patterning in artifact distributions from time-averaged contexts, but refutes the possibility that hominin land use studies are yet theoretically equipped to interpret the true significance of those patterns. Stern thus believes that application of land use models either derived from, or on a similar scale to, ethnographic observations cannot be upheld (Stern 1993, 1994).

"Only by ignoring the time dimension of these data is it possible to invoke interpretative theories that are based on ethnographic scale observations" (Stern 1994a, 1)

Thus, two major considerations emerge from Stern's work, which are of direct relevance to the development of a landscape approach for the Boxgrove evidence. Primarily, contemporaneity cannot be assumed, it has to be demonstrated and the degree of time averaging for any given context has to be bracketed prior to any analysis. Secondly, in attempting to apply a 'scatters and patches' approach, the actual existence of a 'scatters and patches' configuration should also not be assumed.

Stern's characterisation of the record should not however be invoked to disregard palaeolandscape studies altogether. 'Scatters and patches analysis' was only intended as an "interim rubric" to describe assemblage variability within palaeosols (Isaac 1981b, 216), as descriptive shorthand rather than a prescriptive framework. The aim of the approach is simply to characterise this configuration in objective, quantifiable terms without prior assumption of behavioural relevance. In the context of the Boxgrove evidence, its application could allow the identification of atypically dense occupation areas and an understanding of features of assemblage variability within a relatively well-defined palaeolandscape framework.

2.4 Accounting for variability and the modeling of hominin land use and assemblage variability in the Plio-Pleistocene.

Despite the potential that 'scatters and patches' analysis holds for the appreciation of hominin land use patterns, the application of its principles were not to been seen in the years immediately following Glynn Isaac's death. Instead approaches to assemblage variability and site patterning during the 1980s were less directly concerned with the isolation of patterning in the archaeological record than with the development of interpretational frameworks to account for that variation. The shift in emphasis was is part due to the growing body of data from a number of highly detailed African field projects, and the degree of hitherto unrecognised complexity in the archaeological record that was coming to light. The arrangement of artifact and bone clusters at some Olduvai localities appeared to demonstrate an unexpected degree of structured patterning. Circular accumulations of material were identified at FC West, FLK Zinj and FLK north, but it was the clearly defined circular arrangement at site DK1 which strikingly suggested the controversial idea that Early Pleistocene hominins structured their space (Leakey 1971;Bunn and Kroll 1986; Shipman 1981; Potts 1988). The true significance of these circular structures has yet to be determined, no convincing natural explanation has yet to be provided (Gowlett 1996), although tree rooting and geological weathering processes have been suggested. The circles are problematic because no comparable degree of intra-site spatial structure is unambiguously found anywhere else in the Lower Palaeolithic. In contrast, less controversial evidence for patterning in tool discard at wider landscape scales was being isolated through both 'scatters and patches' analysis and the study of changes in habitat preferences (Isaac and Harris 1975; Isaac 1984; Hay 1976).

As with the Olduvai circles, biface-rich assemblages appear at first to indicate highly structured discard behaviour. However, the close association of these assemblages and particular sediment types implicates the possible involvement of natural agencies in their formation. As we have seen, a number of localities excavated during the 1960's and 1970's produced large accumulations of handaxes and bifacial tools associated with the sandy bases of channels (Schick 1986; Isaac 1977; Clark 1987). This added to the growing appreciation of the wider possibilities and applications of the analysis of stone tool assemblages. The apparent complexity of the record implied that these assemblages were not simply the product of technological activities, but could be viewed as trace fossils documenting a wide range of hominin behaviour related to land use, raw material strategies, subsistence and social structure.

These patterns, having been identified demanded sophisticated explanations that considered both palaeoecological context and temporal change. An interpretative leap of this kind was beyond the limits of 'scatters and patches' analysis. The approach could enable the total artifact array for a landscape to be accessed and described in detail, yet made no provision for moving from a static description of the archaeological record as encountered, towards the isolation of controls underpinning the pattern itself. While this limitation was recognised by Robert Foley and accounted for in the formulation of the 'Off-site' approach, no immediate attempt was made to apply a more time-sensitive and process-aware methodology to the archaeological record by contemporary palaeolithic researchers. Instead, approaches to complexity in the Plio-Pleistocene artifact record throughout 1980's were largely limited to the modeling of data. Rick Potts (Potts 1994) has given an excellent summary of these competing models, but it is worth outlining the detail of some of the more important and influential models here.

- *Home Base Hypothesis (Isaac 1983)*

Also known as the 'Central Place Foraging' theory, this model was developed by Glynn Isaac to try explain the documented 'scatters and patches' configuration of artifacts identified through his research at Koobi Fora. The model was based on the fundamental premise that large accumulations of artifacts represented locales that were repeatedly visited by hominin groups. Given the wide overall distribution of resources, the bone refuse accumulated at these sites had to have been introduced by the hominins which suggested that foraged resources were being centralised by hominins for redistribution. Isaac saw in the 'scatters and patches' configuration evidence for food sharing by small foraging groups who converged regularly on fixed points in the environment (Isaac 1984).

- *Routed Foraging and Local Hominid Networks (Binford 1984; Gamble 1993d)*

Binford suggested that hominin land use patterns were very much based on a series of fixed points in the landscape that offered predictable resources. Such fixed points might include topographic features, raw material outcrops, water holes, game interception points and even more ephemeral features such as 'shady trees' (Isaac 1984). The routed foraging model suggests that hominin groups would have movement patterns dictated by the distribution of these resources and artifacts would thus tend to accumulate at particular locations rather than in the landscape in general. The land use aspects of this model are found, in part, in the concept of the local hominin network (LHN) developed by Gamble, who described hominin movements patterns as being tracked along 'pathways' which linked nodes representing fixed resources (Gamble 1993d). Gamble's off-site approach to hominin land use suggests that we try to develop perspectives of land use more equivalent to the experience of hominin life as lived (Gamble 1996a). Viewing land use in terms of paths and not surface area allows hominin land use, through the concept of the LHN, to be viewed as part of the wider systems of hominin ecology, subsistence, technology and society. The nature of routed foraging, within its distinctive pattern of land use comprised of paths and nodes, would have strongly influenced these other facets of hominin life. At Boxgrove, linear distribution patterns of artifact density were suggested as representing such 'pathways' although these were only established from the investigation of relatively small areas of the palaeolandsurface (Roberts *et al.* 1997).

One of the aims of the present study will be to assess how movement patterns may have been structured in the Boxgrove landscape and examine the ways in which artifact discard was both constrained by and controlled these patterns.

- *Static and mobile resource model (Ashton et al. 1998)*

Ashton, from his interpretation of artifact scatters at Elveden and Barnham and the apparent integration of resource exploitation models developed by Binford and Blumenschine, described a balanced and useful division in hominin land use patterns. Ashton suggested that the 'scatters and patches' configuration related to the exploitation of fixed *vs.* mobile resources. In this model, large concentrations of artifacts were seen as the product of repeated occupation around fixed locations, such as a freshwater bodies, while the more diffuse but variable background scatters of debitage was seen as resulting from the exploitation of a non-predictable resource such as scavenged or hunted carcasses.

- *Stone cache model (Schick 1986; Potts 1988)*

Two models, each forwarded in the 1980's, suggested more mechanical, economic models to explain the formation of large artifact accumulations in palaeolandscapes. Both Schick's and Potts' models suggested that hominins both habitually transported tools and raw material to exploitation sites that were at distance from stone sources. Where tools and raw material blocks were discarded in association with resource exploitation activities, then accumulations would at sites that were repeatedly visited by hominins. Given time, this would lead to *de facto* caches of stone tools and raw material at regularly visited sites. In Schick's model this phenomena is seen as resulting from a 'feed-back' mechanism wherein hominins would be more likely to discard artifacts within locales rich in useable, previously abandoned tools and raw material. Ultimately, such a process would lead to the formation of large accumulations (Schick 1986). In neither model is an intentional strategy of stock-piling resources suggested, each simply implies that the unconscious formation of caches would have presented a useful and successful solution for negating some of the transport costs, through the supplying of important resource locales with raw material.

2.5 Summary.

The models outlined above provide useful conceptual frameworks through which assemblage variability might be approached. They reflect a range of repeated and widespread research questions which have come to dominate the study of Lower Palaeolithic archaeology for much of the last 20 years. In a recent review of Palaeolithic settlement studies Nick Conard emphasised the way in which the subject has realised the importance of using multiple threads of data across different parts of the archaeological record.

"The study of Palaeolithic settlement systems necessitates using multiple data sets and parallel lines of inquiry. Both faunal and lithic data as well as environmental data should be examined using syn- and diachronic temporal scales" (Conard 2000, 7).

These sentiments reflect a general move in recent years towards integrating datasets across a variable and discontinuous archaeological record (Gamble 1999; Potts 1994; Gowlett 1996). As shown in Chapter 3, the Boxgrove record contains datasets from a broad range of depositional environments each requiring a specific methodological approach specifically suited to the preservational context. Perfectly preserved assemblages recovered from fine-grained silts, *in situ* 'scatters and patches' accumulations from the palaeosol and slightly disturbed channel accumulations provide the three core datasets. These datasets, each relating to varying scales of spatial/temporal inference, provide opportunities for both detailed behavioural and taphonomic studies as well as allowing the wider palaeolandscape context to be addressed. With reference to known topographic/environmental features, variation in artifact density and assemblage composition will be studied along predetermined transects.

Through the integration of evidence from single sites, favoured localities and the landscape as a whole it is intended to provide a possible explanation for the observed differences in transport and discard apparent at Boxgrove and throughout the Lower Palaeolithic. The wider questions of assemblage variability within the Early/Middle Pleistocene will then be addressed in order to see if models established for variation at landscape scales can be extrapolated to account for the wider temporal and regional variation in the character of lithic assemblages.

Chapter 3: A preserved Middle Pleistocene palaeolandscape at Boxgrove: Previous studies and current research aims.

3.1 Introduction.

The datasets which form the basis for this research were recovered from the Middle Pleistocene site of Boxgrove, West Sussex. Between 1977 and 1996, a series of archaeological investigations were undertaken at Boxgrove during the course of gravel and sand extraction at Amey's Eartham Pit. From 1982 these investigations were carried out under the direction of Mark Roberts as part of an interdisciplinary research project based at the Institute of Archaeology, UCL. Detailed descriptions of the archaeological, geological and palaeoenvironmental research from the site have been previously published (Roberts 1986a; Roberts and Parfitt 1999). Consequently it is intended, in this chapter, to provide only a basic introduction to this research, in order that the following analysis and discussion of the evidence for hominin behaviour at the site can be considered in light of previous work. This chapter is therefore intended to provide a summary of previous attempts to account for identified characteristics of assemblage variability and patterns of hominin behaviour at the site. Through the discussion of earlier work on the Boxgrove stone tool assemblages a series of repeated features of the archaeological record, isolated by other researchers, will be highlighted as potentially significant. Through the identification of recurrent or anomalous features which I consider warrant further detailed study, the data-specific research themes of this thesis will be introduced. Alongside the discussion of archaeology, the palaeoenvironmental and geological context will also be discussed as these provide the framework for attempts to model land use at the site in Chapter 6.

3.2 The Geology of Boxgrove.

The site of Boxgrove (Figure 3.1) is situated approximately 60km SSW of London, England. Topographically, it occupies a position at the northern margin of an extensive and low lying coastal plain where it meets the rising dip slope the South Downs, a well defined and extensive chalk escarpment with a broadly north-south axis of strike. The coastal plain, which attains a maximum width of 12km to the south of Boxgrove, flanks the southern margins of the South Downs along 25km of Britain's south coast and comprises a series of bench features overlain by head deposits. These features relate to a succession of cliff and wave-cut platforms eroded from Cretaceous and Tertiary bedrock by marine action during the Middle and Upper Pleistocene. At its northern margin the oldest of these beaches, designated the Goodwood-Slindon Raised Beach, attains a maximum platform height of 40m O.D. (Roberts 1986a). It is thought to be preserved for over 15km between Arundel and Westbourne. At the traceable eastern and western limits of this beach younger marine deposits appear to have removed the older bench.

A number of archaeological localities have been documented along the course of the Goodwood-Slindon Raised Beach in addition to the site of Boxgrove. Prior to the discovery of the archaeological horizons at Amey's Eartham Pit, Slindon Park Pit SU951083) provided the most extensively investigated site of the Goodwood-Slindon Raised Beach. The site was initially investigated by Curwen in 1912 who documented a core and an ovate handaxe associated with a bed of rounded flint beach cobbles, which rested on a chalk platform and was overlain by angular gravel (Curwen 1925; Woodcock 1977; Pope 2001). Further investigations at the site by Fowler (1932), Calkin (1934) and Woodcock (1977) led to the discovery of material including 63 bifaces, 16 cores, 68 retouched tools and 436 pieces of waste. While

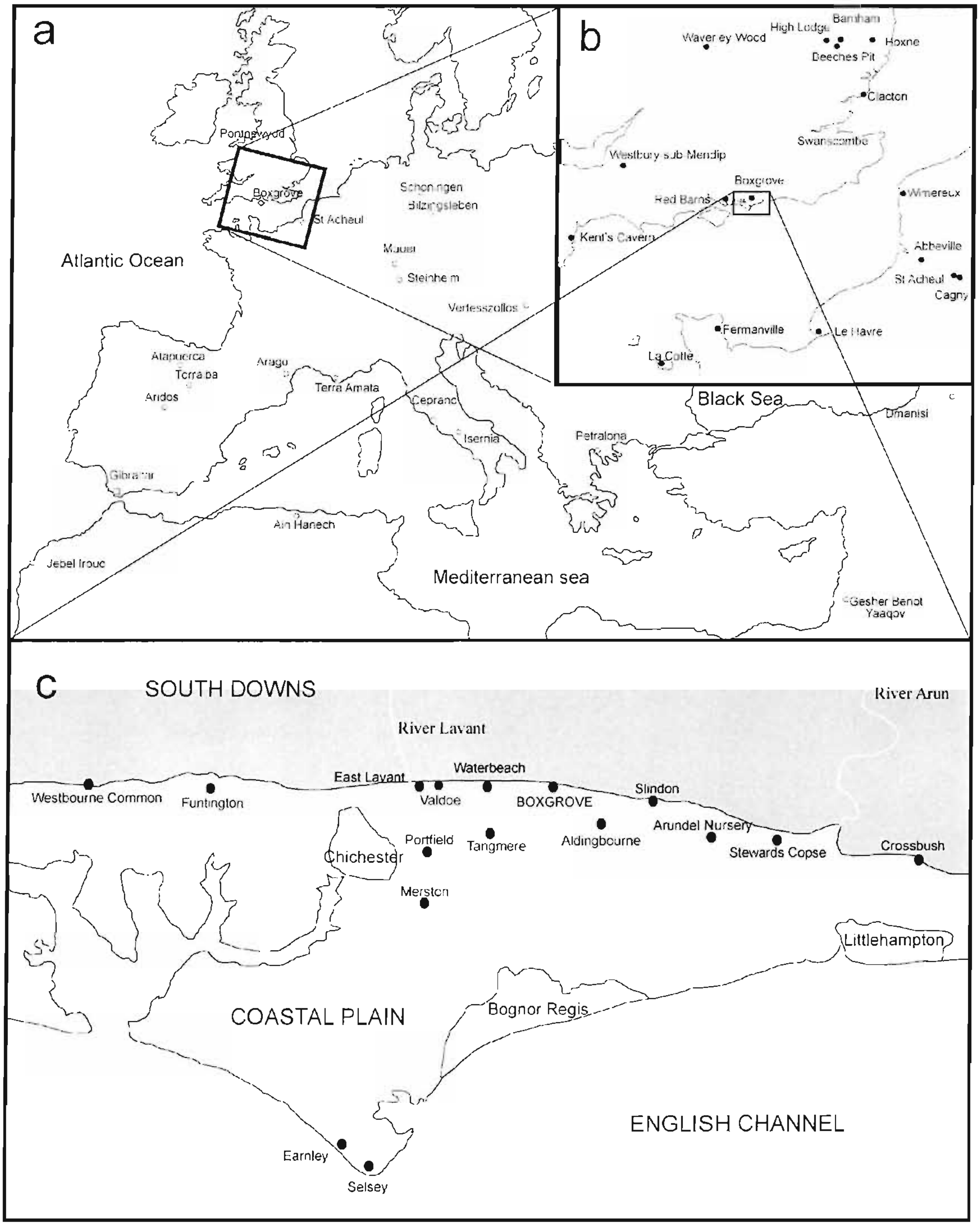


Figure 3.1: Location map showing: a) Principle Palaeolithic sites of Europe, the Near East and North Africa. b) Principle Lower Palaeolithic sites of North-West Europe. c) The location of Boxgrove and other Quaternary sites on the Sussex Coastal Plain.

some of this material was recovered in a relatively fresh condition, the artifacts were generally found rolled within the body of the beach or resting on its surface in a partially weathered condition. Calkin interpreted this surface material as representing an occupation level or 'Acheulean Floor'. However, subsequent investigation made by Woodcock rendered this interpretation untenable, given that the floor was overlain by solifluction deposits containing both abraded and fresh artifacts. Woodcock proposed that a more convincing mechanism for assemblage formation would involve the disturbance, transport and reaggregation of artifacts in the body of the beach (Woodcock 1978).

At Penfolds Pit (SU974079), six bifaces and a single retouched flake were discovered within 'coombe-rock' at its junction with underlying marine sands (Jefrries 1957; Woodcock 1977). Four of these bifaces were in a sharp, unabraded condition despite the fact that none were recovered from primary context. A further 66 bifaces have been recovered from surface exposures of apparently weathered raised beach deposits in the East Lavant area. Many of these were recovered from Woodcock's controlled excavation of a dried pond at Manor Farm, East Lavant (SU 25880827), while the rest have been discovered at various times in ploughsoils contexts (Woodcock 1981). The topography of the area indicates that sub-aerial erosion and ploughing is currently weathering the Slindon Formation around Lavant and many of the fresh condition bifaces may have been eroded directly from *in situ* deposits.

These sites, along with other isolated surface finds in the area suggest that archaeology is preserved along the whole extent of the Goodwood-Slindon Raised Beach, and while often found in a relatively fresh condition it is only rarely recovered from primary context or excavated *in situ*. It is therefore the exceptional degree of preservation and accessibility that marks out the Amey's Eartham Pit site as being of importance, rather than any reason to suggest that the locale was favoured by hominins over others across the palaeolandscape. The unique preservational conditions at Boxgrove are due to the combination of local topography and the dynamics of solifluction processes in the area. These have led to the preservation of a 500m strip of fine-grained sediment overlying both the beach and marine sand deposits at the site. In turn the substantial depth of these gravels has protected these fine-grained deposits over a substantial area, leading to the preservation of a series of palaeolandsurfaces, including at least one preserved soil horizon. A consideration of the detail of this sequence, in particular the fine-grained deposits, is therefore required in order that the preservational and environmental context of the archaeology can be understood.

Figure 3.2 provides a schematic breakdown of the conformable geological sequence documented at Boxgrove, comprising elements of the Slindon Formation (lower marine, lagoon and terrestrial deposits) and the Eartham Formation (Brickearth and solifluction gravel deposits). The Slindon Formation sequence documents a transition from fully marine temperate conditions, through a series of regressive lagoon/estuarine environments (Roberts 1986a). These represent land exposed by a fall in sea-level that led, in time, to the formation of a stable terrestrial landsurface open to colonisation by grassland vegetation communities. The overlying Eartham Formation appears to have been deposited during conditions of increasing climatic deterioration associated with the on-set of periglacial conditions. Brickearth lenses and fine pellet-gravels of chalk give way to massive seams of flint gravel which, where undecalcified, are preserved in a chalky matrix. These deposits represent lobes of soliflucted material eroded from the Downs to the north of the site. Archaeology has been recovered from all of these contexts and includes some apparently *in situ* material from brickearth seams within the main body of the solifluction gravels.

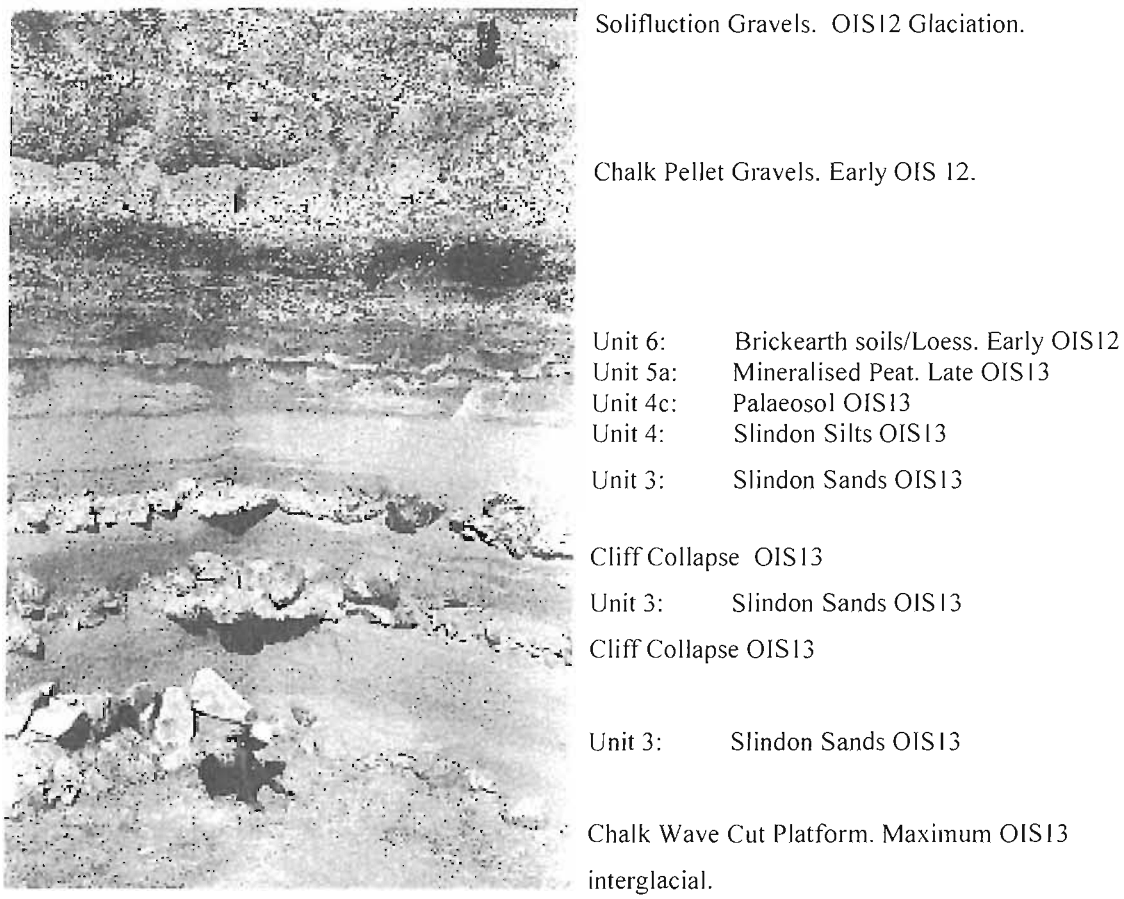


Figure 3.2: Type section of the Slindon Formation.

3.3 Previous archaeological investigations at Boxgrove.

The following sites have been the subject of previous research over the twenty years of the project's existence. Due to the constraints of an on-going excavation project, it has only been possible until now to undertake relatively isolated technological analysis of each assemblage at the expense of more integrative, synthetic considerations of the archaeology as whole. Thus the following summaries have been produced from previously published papers and from the Boxgrove monograph. In the summaries, I have attempted to extract potentially significant observations made by the individual researchers in order to highlight common features and difference between the assemblages.

3.3.1 Site Q2/A/4c.

Site Q2/A is located in Quarry 2 approximately 250m to the south of the fossil cliff line, almost at the southern limit of the archaeologically investigated area. It was the first large area excavation to be carried out at the site and provided the first detailed picture of technology and reduction strategy. The archaeology consisted of a spread of flint debitage some 7m across dispersed within the Unit 4c horizon (Roberts and Bergman 1988; Bergman *et al.* 1990; Roberts and Parfitt 1999). The assemblage comprised 1,236 flakes (>10mm) as well as four bifaces and two cores. The debitage showed that all stages of the reduction sequence were represented, from the initial roughing out of biface blanks to the final thinning of the tool and preparation of its cutting edge. However, refitting provided a more detailed picture of reduction strategy and technology at the site showing, for the first time, a persistent characteristic of Boxgrove assemblages. Despite the presence of material from all stages of biface manufacture, no complete reduction sequences could be documented either through refitting or through the isolation of spatially discreet scatters of material from individual raw material units (Bergman *et al.* 1990).

The continued on-site reduction of partially complete or existent tools was however both directly and indirectly documented at the site. One refit group represented only the late stages of a biface reduction sequence, the removal of cortex and roughing-out of the original nodule having occurred elsewhere. Furthermore, the biface resulting from this reduction sequence was not recovered, suggesting that the tool was subsequently transported off-site. Of the four bifaces discarded at the site material could only be refitted to one. It was possible to conjoin three relatively small softhammer flakes to the tip of the tool, these perhaps represented an attempt to tranchet sharpen the implement. The refitting evidence suggests that the tool was transported on-site in a finished state and was subsequently modified prior to discard. Similarly, the other three bifaces recovered from the site appear to have been manufactured elsewhere and introduced as finished tools, in addition the authors suggested that large unmodified flakes of distinctive raw material types may also have been introduced for use as flake tools (Bergman *et al.* 1990). The authors explained the Q2/A assemblage composition in terms of a simple and economic transport model in which the talus slope at the base of the cliff provided both a ready source of all raw material and a possible area for the primary reduction of nodules. Rough-outs and finished tools produced in these primary production areas could then be transported to other locales for use.

3.3.2 Q1/A/Unit 4c

The artifacts from site Q1/A formed a dispersed spread of material across the 90m^2 of the excavation area. 317 flakes >20mm were recovered from the site in an assemblage which included identifiable components from all stages of biface production (Austin 1994; Roberts and Parfitt 1999). However, comparison with the debitage from experimentally manufactured bifaces suggested that the assemblage contained an over-represented element from the thinning and finishing stages of manufacture and did not therefore represent a series of complete reduction sequences. Some material from the early stages of reduction was found, a series of small refitting groups of 2 or 3 flakes. However, given their small number, Austin felt that they must represent the continuation of primary reduction begun prior to transportation on-site. The largest refits group contained 23 flakes indicative of on-site thinning of a previously prepared biface rough-out. Another group of refits also seemed to show the thinning of a partially reduced rough-out.

The remaining refit groups all originated from a single tool in the final stages of manufacture. They show the reduction of a cortical edge on the tool prior to subsequent thinning and the removal of three tranchet flakes. The removal of these tranchet flakes as the final stage of the manufacture of this tool echoes the biface with three failed tranchet removals from site Q2/A. In the latter case the artifact had been introduced to the site in a finished form and modified, perhaps as part of a resharpening process (Austin 1994). Austin was unable to identify a single flake that conjoined with any of the five bifaces despite extensive attempts at refitting. The site was interpreted as an accumulation of material resulting from a number of short term occupation events in which existing tools were subjected to short episodes of late-stage thinning and finishing. The Q1/A evidence further suggests that both partially complete and finished bifaces were transported within the local landscape.

3.3.3 Q1/A/Unit 4b

The 4b assemblage at Q1/A consisted of a single discrete scatter of material some 25cm across (Roberts and Parfitt 1999). The scatter was so well defined that it preserved the outline of the hominin's legs and the accumulation of flakes on the inside of his/her right thigh. Austin managed to refit 65% of the material from this scatter and formed two major refitting groups. Both these groups related to the thinning of a break surface on a previously prepared rough-out/core. Numerous smaller refit groups seem to relate to the same reduction sequence and appear to have resulted from the thinning of the artifact's opposite end (Austin 1994). Austin interprets this sequence as the production of a tool from one fragment of a nodule that was roughed-out, thinned and broken by end-shock at another location. One other important aspect of this scatter was that a small group of large flakes lay to the right of the scatter shown in Figure 3.3. Austin interpreted the separation of these pieces from the knapping scatter as selection by a hominin of potential flakes tools.

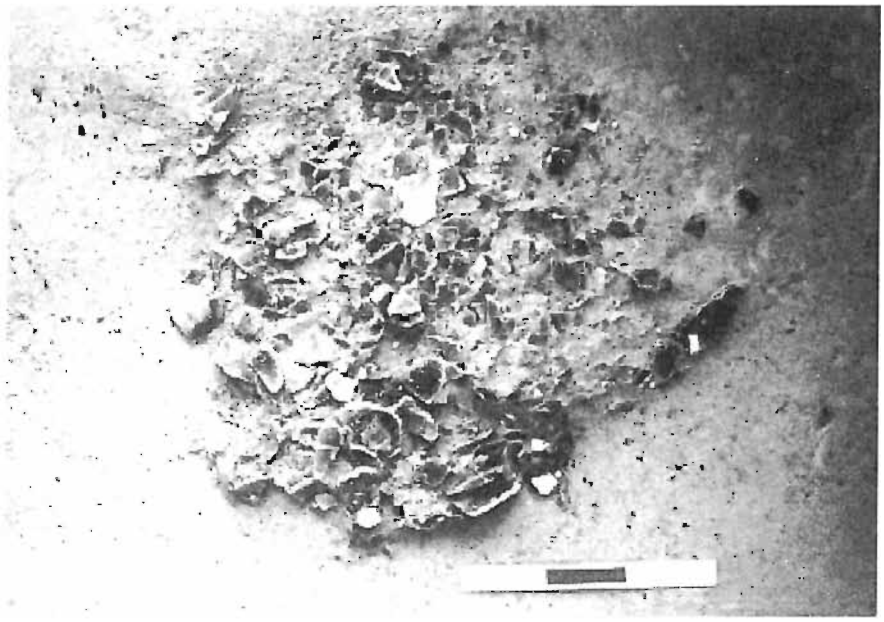


Figure 3.3: Scatter of flint debitage, refitted by Austin, preserving the outline of the knapper's legs. (Photograph: Boxgrove Project)

Austin concludes her analysis with three observations: that there is no evidence for complete reduction sequences occurring at any single location, that the process of biface manufacture appeared not to be prompted by any immediate need for its use and that "from the moment of initial choice of the nodule, (the knapper) has a concept of the initial tool for which it is intended" (Austin 1994, 125). It is true that there are currently no complete reduction sequences demonstrated through refitting. However, some bifaces recovered from recent excavations involved only four or five flake removals in their manufacture and it seems hard to conceive that their production occurred at more than one location.

One of our most complete nodules, a refit group of c.50 flakes from GTP17, shows prior platform preparation off-site and lacks invasive soft-hammer flakes indicative of the final thinning/finishing stage. We might infer from this nodule that the resultant biface rough-out was transported off-site for further reduction. This again demonstrates that tool production may have been an activity that regularly occurred over relatively long time periods and at more than one location. The importance of this issue is tied up with Austin's last assertion, that the knapper had a concept of the finished tool right from the time of nodule choice and preparation. On the basis of the current evidence, I believe this is hard to sustain. With reduction sequences apparently spanning several locations it is impossible to adequately demonstrate continuity in the manufacturing process, consequently it is also impossible to demonstrate that a single mental template was used for the entire chaîne opératoire.

Instead, given the widening spatial and temporal scales in which bifaces were made and used, I believe that we have to be open to the possibility that, in some contexts, bifaces were very much works in progress being subjected to repeated episodes of resharpening and shape modification. Austin's detailed reconstruction of reduction sequences (Austin 1994; Roberts and Parfitt 1999) confirmed and developed the analysis of the Q2/A assemblage, further suggesting that hominin reduction strategies may be spatially and temporally complex. However these findings somewhat undermined her further suggestion of a very linear chaîne opératoire for the tools. In attempting to explain this apparent complexity Austin has highlighted a significant paradox. Why should the repeated, 15 minute manufacture of pre-determined tool forms require such a complex system of curation and multi-location reduction?

3.3.4 The Project B Test Pit Survey

Boxgrove Project B was essentially a rescue operation aimed at recovering archaeological material from a 12,000m^2 sand extraction area. The threatened area was sampled by 17x 6m^2 test pits equally spaced across the sand extraction area (Roberts *et al.* 1997). At each of the investigative pits artifactual material was encountered associated with Unit 4c palaeosol, indicating that hominin activity was continuous across the survey area. Thus the survey provided an opportunity to look in some detail at patterning in the character and density of archaeology across a single synchronous palaeolandsurface, albeit within a relatively limited area. The archaeology of the test pits showed that hominin activity was not evenly distributed across the sampled area of the Unit 4c palaeosol. Test Pits O and L produced the highest artifact densities with over 8 pieces >20mm per m^2, however the general level of artifact density was very low with 7 sites exhibiting densities of less than one artifact per m^2 (average 2.2 per m^2).

In terms of assemblage composition, debitage from the later thinning stages of biface manufacture dominated all assemblages across the survey area, with only a single tool and three tranchet flakes being recovered. Quantities of small debitage found associated with these flakes suggested that the flakes had been struck off bifaces *in situ* and had not been transported to the site, evidence that matches similar observations made in Test-pits in Quarry 1. This pattern showed that throughout the palaeolandscape bifaces were being transported and subjected to short episodes of late-stage modification involving the thinning and edge modification of apparently finished tools, the behaviour was generally interpreted as tool resharpening. Two particularly dense occupation areas were identified within the survey area with artifact concentrations at levels of 6.9 and 8.3 artifacts per m^2. These apparently represented ‘patches’ of dense artifact spreads that may have represented favoured localities of hominin activity. These were excavated on a larger scale and became the main areas Q2/D and Q2/C. Debitage from all stages of the biface reduction sequence were present at both sites, although analysis of the assemblages suggested potentially significant differences in terms of composition.

3.3.5 Q2/C/4c

Francis Wenban-Smith undertook the analysis of this assemblage, alongside that of Q2/D, as part of Boxgrove Project B (Roberts *et al.* 1997). The bulk of the assemblage consisted predominantly of debitage representing the later stages of biface manufacture, with biface edge preparation indicated by the presence of 30 tranchet sharpening flakes. The spatial arrangement of the debitage indicated a minimally disturbed but perhaps superimposed and dispersed series of knapping scatters. In addition to debitage, eight bifaces and two cores were recovered. Working from the assumption that 50-70 flakes would be produced in the manufacture of a single biface (Newcomer 1971; Wenban-Smith 1989), the analysis indicated that there were not enough bifaces to account for the quantity of debitage and tranchet flakes. While the quantities of debitage recovered from the site suggested that between 10 and 15 tools could have been manufactured, only eight were recovered. The additional presence of 30 tranchet flakes could also be taken as an indication of originally higher biface numbers. Wenban-Smith suggested that some bifaces manufactured or finished at the site were subsequently transported elsewhere.

3.3.6 Q2/D/4c

The analysis of the Q2/D assemblage was also undertaken by Wenban-Smith as part of Boxgrove Project B (Roberts *et al.* 1997). The assemblage comprised 751 artifacts but, significantly, no cores or bifaces were recovered. The original presence of bifaces at the site could be demonstrated by the presence of 11 tranchet flakes and other characteristic elements of biface manufacturing debitage. The number of flake removals documented through debitage analysis suggested that between six and ten tools had been manufactured while none were recovered from the excavation area. At Q2/D the data suggested that the site had been a focus for biface manufacture but that in every case the resulting tool had been transported out of the excavation area (Roberts *et al.* 1997). Wenban-Smith noted that the evidence for primary reduction at Q2/D, matched observations from the nearby Q2/A locality, that largely unmodified blocks of raw material were being transported from the cliffline over distances in excess of 250m. Primary material appeared to be much more common at Q2/D than Q2/C despite the latter being 30m closer to the source of raw material. This showed a relatively complex and counter-intuitive pattern of assemblage variability, in which assemblages at greater distances from the cliff might contain higher proportions of primary material than activity areas closer to the cliffline (Wenban-Smith in Roberts *et al.* 1997). In addition, the Project B survey further confirmed the apparent mobility of bifaces across the Unit 4c landscape showing both that tools were manufactured at more than one location and the apparent spatial separation of manufacture and use in some cases.

3.3.7 GTP17 (Unit 4b)

At GTP17, lithic artifacts associated with a fine-grained intra-Unit 4b horizon were traced over a 68m^2 area. During the excavation of this surface a series of eight visible scatters of debitage were identified associated with the butchered remains of a single horse individual. The taphonomy of the horse carcass has been described previously by Parfitt (Roberts and Parfitt 1999), while the taphonomy and technology of flint artifact assemblage forms a major part of this thesis and a forthcoming monograph (Roberts *et al. in prep*). Analyses of the faunal remains shows damage from both carnivore gnawing and flint tool cutmarks, although where superimposed the primacy of the latter is demonstrable (Roberts and Parfitt 1999). The site therefore appears to conform to the expected configuration of a short-term butchery locality, with all the stone artifacts contextually associated with the processing of the horse carcass. Analysis of debitage and refitted artifacts indicated that biface manufacture predominated at the site, with material from all stages of the biface reduction sequence represented within the assemblage. Yet, apart from two flake-derived bifacial tools, no bifaces were recovered. This evidence, appears to match that from site Q2/D, indicating that despite the manufacture of a quantity of bifaces, all of these tools were subsequently removed from the site.

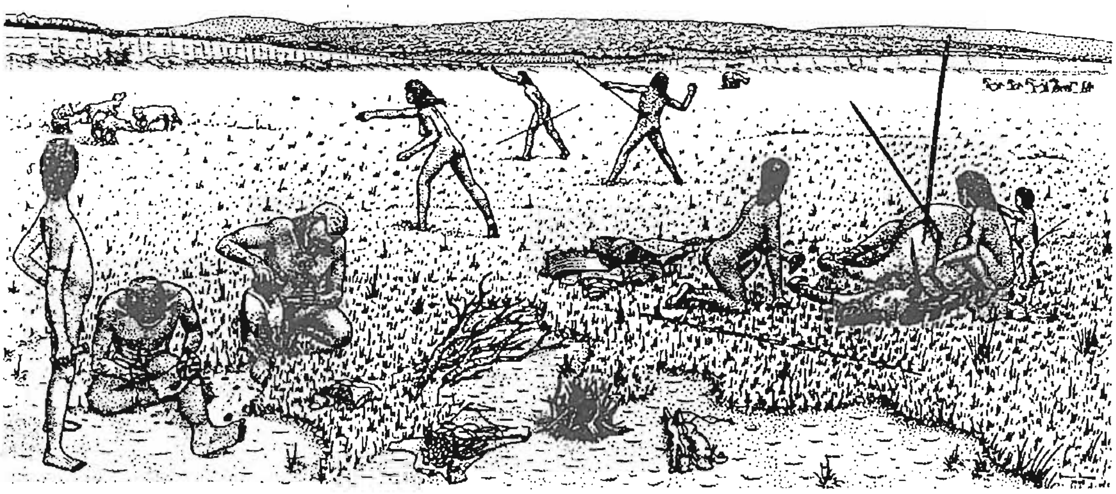


Figure 3.4: Reconstruction of the butchery of a horse at GTP17. (Illustration by Simon James)

3.3.8 Q1/B (Unit 4c equivalent Units)

At area Q1/B a complicated atypical geological sequence became the focus of a test-pit sampling exercise in the early 1990's. During the course of these limited 'keyhole' investigations a hominin tibia, associated with a concentration of faunal and lithic material led to two seasons of subsequent area excavation (Roberts *et al.* 1995; Stringer *et al.* 1998). Q1/B became the single largest excavation project undertaken at Boxgrove and involved the detailed recovery of 20,000 lithic artifacts, 3000 pieces of fauna and environmental evidence from 13 sedimentary units. While the investigation of this material is still on going, preliminary results suggest that the geological sequence represents a series of erosive fluvial events, associated with variations in discharge from springs at the base of the cliffline, short periods of soil formation and channel infilling. Ostracods species indicate that, for a substantial part of the infill sequence, a stable freshwater body appears to have been present at the site. The atypical units appear to have been deposited during a time-span broadly coeval with the formation of the Unit 4c palaeosol. Thus the site appears to represent a seasonally wet waterhole throughout the 20-100 year span of the palaeolandsurface.

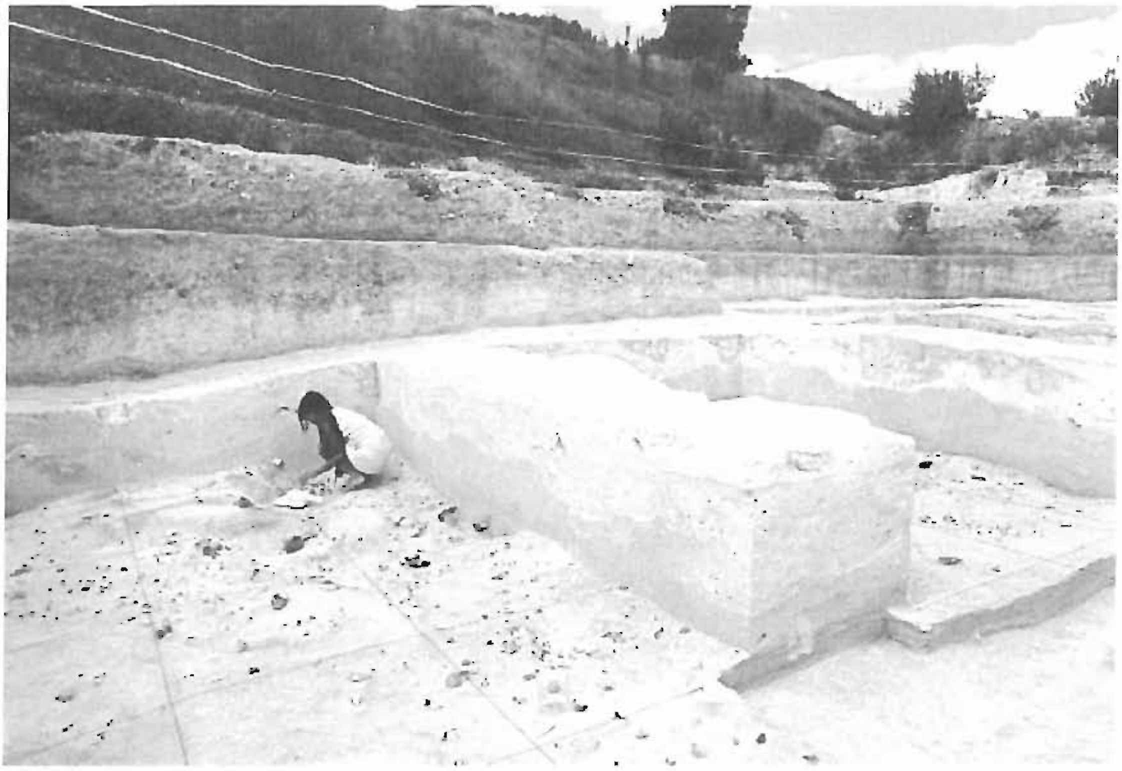


Figure 3.5: Excavating the main find horizon at Q1/B. (Photograph: Boxgrove Project)

The artifacts were recovered alongside the butchered remains of numerous mammal species including red deer, rhinoceros, bovids and horse. Dense concentrations of artifacts and fauna were found throughout the freshwater deposits, but notable spreads of material were recovered from the truncated surface of the marine sand on the edge of small channels (Figures 3.5 and 3.6). The stone tool assemblages appeared to contain a large proportion of bifaces. This fact, combined with the evidence for butchery from the faunal remains, appeared to suggest that the site formed a focus for hominin activity on numerous occasions, perhaps representing a favoured locality. In addition to the bifaces, an apparent abundance of flake tools, percussors and the presence of at least three antler soft hammers, not previously recovered from a Middle Pleistocene context, marked the artifactual assemblage as atypical. When viewed alongside single episode sites, characterised at Q2/D and GTP17 by low tool counts, the Q1/B assemblage appears to represent a distinctive archaeological signature.

Figure 3.6: Scatters of flint artifacts and butchered bone at Q1/B. (Photograph: Boxgrove Project)

However, the atypical geological context of the site, with the evidence for punctuated and possibly moderate to high energy fluvial episodes opens up the possibility that, as with many other Acheulean sites, the assemblages may have been spatially moved and compositionally altered (see Chapter 2). The possibility for movement of artifacts, winnowing of small debitage components and the size of the assemblage may have produced an assemblage with unique characteristics from the reaggregation and winnowing of more typical looking assemblages. Thus, a primary research question, which arises from Q1/B, is whether taphonomic analysis can be successfully applied in order to isolate the direct characteristics of human behaviour. Only once behavioural aspects of assemblage formation have been successfully isolated from the Q1/B record could the assemblage be directly compared to those from the contemporary Unit 4c sites or from GTP17.

3.4 Summary: characterising the archaeology of Boxgrove and primary research aims.

It was recognised from an early stage in the Boxgrove excavations that the overall character of technology at the site was very consistent; with most assemblages relating to the manufacture and use of ovate bifaces (Roberts 1986; Bergman and Roberts 1988). In accounting for the relatively minor differences observed in assemblage variability prior to the discovery of the Q1/B locality, a fairly restricted series of explanations appear to have been repeatedly employed, it is also possible to see that repeatedly observed characteristics of hominin behaviour emerge from the archaeology. At the centre of these accounts is the recognition that assemblages appear to have formed as a result of interplay between patterns of artifact transport and discard. Each of the previously investigated sites discussed above provided detailed evidence, sometimes directly documented through refitting, for the movement of bifaces and biface rough-outs in the landscape. The observations can be summarised as follows:

1. Variation exists in the ratio of debitage to bifaces: some assemblages exhibiting a net export of bifaces over time and some indicating a net import.

2. No demonstrably complete knapping sequences from rough-out production to biface discard have been recorded in one location. All documented biface reduction histories appear to involve more than one location. The scarcity of refitting between bifaces and debitage may be due to this pattern of biface transport.

3. Biface thinning and finishing debitage appears to make up much of the background artifact distribution (Roberts *et al.* 1997). This appears to indicate that the 'scatter between the patches' (Isaac 1981b) for Unit 4c formed almost entirely as a result of the modification and transportation of existing bifaces within the local landscape.

Thus, the evidence from the Boxgrove assemblages indicates that bifaces, in varying stages of completion, were routinely transported within the Boxgrove landscape, with assemblage composition reflecting the net product of variation in tool discard and transport behaviour. The duration and extent of this import-export system appears to be controlled partially by the sedimentary context of the assemblage, the Unit 4c sites represent a time averaged palimpsest signature, the GTP17 (Unit 4b) assemblage does not. The GTP17 (Unit 4b) material occurs in virtual spatial isolation without a clearly discernable background scatter signature. Thus, rather than occurring as part of a palimpsest record the assemblage gives the impression of having been 'parachuted in' (Roebroeks *et al.* 1992). The GTP17 (Unit 4b) assemblage indicates, at face value, a contextual association between hominin behaviour involving the removal of bifaces and a single episode, short-term butchery event. This possibility has to be tested. Conversely, at Q1/B a possible association between high biface discard rates and re-occupation of the site is indicated. However, the complex sedimentary context of the assemblage also means that this apparent contextual association has to be confirmed through detailed taphonomic analysis.

In Chapter 2 it was suggested that, given the eventual goal of explaining the formation of biface-rich assemblages, assemblage variability would have to be examined across a range of spatial/temporal scales and across different preservational environments. The Boxgrove record is ideally suited to such demands in providing assemblages from a range of contexts. In terms of resolution and spatial/temporal inference the Boxgrove record provides three contrasting datasets: *in situ* scatters associated with Unit 4b, <100year palimpsest signatures from the palaeosol and the fluvially modified biface-rich assemblages from Q1/B. Despite differences in sedimentary regime and local ecology a number of variables are common to all three records: namely distance to raw material source, technology and environment. Addressing each different part of the Boxgrove record requires a unique approach in order to both compensate for preservational inadequacies and to fully exploit evidential potential. In the next three chapters, each of these datasets will be studies in turn utilising different approaches developed to suit the taphonomic complexity and potential level of resolution afforded by each:

1. In Chapter 4 taphonomic and detailed technological analysis of the GTP17 horse butchery assemblage will be undertaken to determine if claims for the short period of formation and *in situ* preservation can be fully substantiated. In addition, the distinctive composition of the assemblage, lacking bifaces and flake tools will be investigated to determine whether this was a product of selective transport/discard or functional differentiation.

2. As discussed in Chapter 2, the apparent association of a biface-rich assemblage with a fluvial sedimentary regime is a recurrent feature of the Acheulean (Schick 1992; Isaac 1977). The detailed recovery and broadly low-energy nature of these deposits at Q1/B will be utilised in Chapter 5, to provide a thorough, taphonomically sensitive examination of variability throughout the Q1/B assemblages. This will be used to determine whether any real behavioural differences can be detected in tool use and discard at the site. The results can then be applied to other comparable biface-rich assemblages, often characterised as taphonomic products, found throughout the Acheulean world in order to determine the degree to which behaviour was responsible for the aggregations.

3. The time-averaged but temporally discrete palaeosol horizon Unit 4c offers a wide range of well documented assemblages all relating to the exploitation of an extensive grassland environment (MacPhail in Roberts and Parfitt 1999). A small number of these assemblages have been subjected to detailed taphonomic and technological analysis in the past suggesting that while disturbed and spatially dispersed, these assemblages are compositionally complete and in primary

context. This dataset will be utilised in Chapter 6 and Appendix 2 in order to develop and apply a 'scatters and patches' analysis aimed at the documentation of variability of both the spatial distribution and composition of assemblages. Isolated patterns of variation will then be examined in light of known environmental gradients and a contextual explanation for patterning will be forwarded.

From these datasets an attempt will be made to model hominin land use patterns in order to explore the wider ecological, behavioural, functional or social frameworks of this behaviour. In the final chapters, this framework will be applied to the wider Pleistocene record. Through this approach is hoped to test the results of the analysis and to provide explanations for both the phenomenon of biface-rich assemblages and wider regional/temporal variations in Lower Palaeolithic technology.

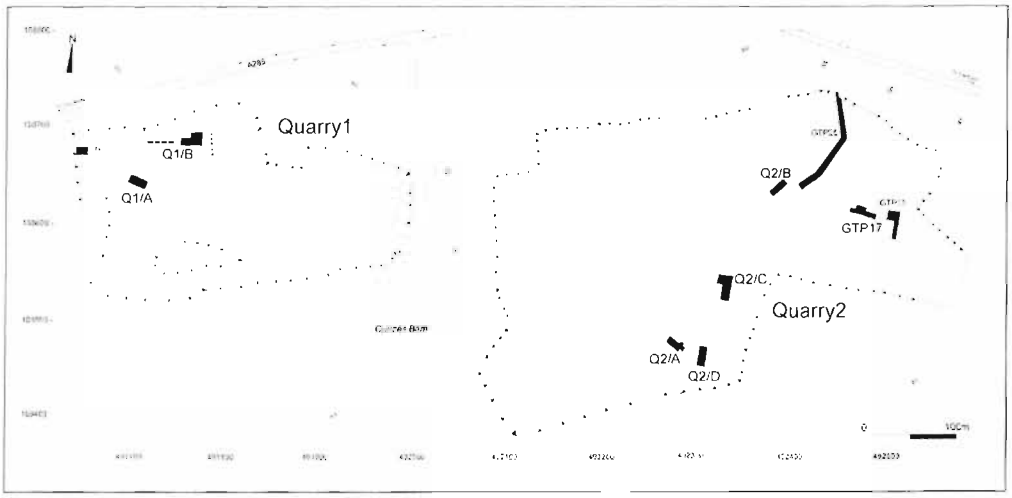


Figure 3.7 Map of the Boxgrove quarries showing the position of main areas.

Chapter 4: Inferring short-term behaviour from the fine-grained archaeological context of GTP17.

4.1 Introduction.

The methodological approach adopted in this thesis, as outlined in Chapters 1 and 2, is aimed at the eventual integration of evidence from different preservational contexts at Boxgrove. The starting point for this analysis is that part of the record preserving the highest degree of resolution, Unit 4b. While archaeology within Unit 4b is highly restricted in its stratigraphic/spatial distribution and allows only small scales of spatial/temporal inference, it is only from this part of the record that we can confidently document individual and group behaviour. In documenting how assemblage composition relates to patterns of tool use, transport and discard in the unmodified, apparently *in situ* Unit 4b assemblages it is then possible to go on to build behavioural frameworks within which coarser, time-averaged and taphonomically altered assemblages can be better interpreted. Within the Boxgrove archaeological record there are only two or three locations preserving what appears to be completely *in situ* artifact scatters. Of these only the Unit 4b level at GTP17, preserves a series of such scatters in direct association with the butchered remains of mammalian fauna and provides a large area excavation suitable to utilise as a high-resolution foundation for the subsequent stages of analysis in this thesis. The site, which is located in Quarry 2 (Figure 4.1), was excavated between 1997 and 1991 as part of Boxgrove Project C. Artifacts were found throughout the local stratigraphic sequence with an assemblage of 325 flakes and bifaces being recovered from the upper Units 5a and 4c alone. However, it was not until a particularly rich horizon

Figure 4.1: The GTP17 excavation area in Boxgrove Quarry 2 (looking east). Picture: The Boxgrove Project.

Figure 4.2: Excavation of an *in situ* knapping scatter at GTP17. Picture: The Boxgrove Project

was encountered within the main body of the Slindon Silts (Unit 4b) that the locality became a major focus for research. Once this layer was identified the excavation was widened beyond the original test pit to an area of some 75m^2, the site was gridded into 0.25m squares and detailed xyz recording of both artifactual and faunal assemblages was undertaken. By the time excavations ceased, 1,800 artifacts at been recovered from the locality consisting mainly of debitage from eight *in situ* knapping scatters (Figure 4.2 and 4.3). In direct spatial and contextual association with this remarkable lithic assemblage were the axial elements of a single horse carcass. Many of the bones exhibited either cutmarks from flint tools or impact damage, mostly from stone hammers but in one case possibly from a wooden projectile. Impact damage was particularly prevalent on the few pieces of limb bone recovered, this was inferred as occurring during marrow extraction (Roberts and Parfitt 1999).

From the start it was thought highly likely that the site represented a short term episode of occupation almost certainly centered on activities relating to the butchery of a single horse carcass. The context of the site, being a fine intra-unit lamination, was known to be both intertidal in origin and to have preserved other lithic scatters *in situ* to an exceptional degree such as the single triangular scatter at Q1/A (Roberts and Parfitt 1999; Austin 1994). In addition the carcass was only moderately gnawed by carnivores and had suffered only a minor degree of dispersal. The gnaw marks could also be seen to supercede cutmarks in a number of cases suggesting that the hominin butchers had primary access to the carcass. Preliminary analysis of the stone artifact assemblage confirmed the apparent degree of preservation, with many intra-scatter refits being established during the course of the excavation and in the early stages of post-excavation. Intriguingly, the site produced no complete bifaces at the Unit 4b level, which led the excavators to wonder if some industrial variant had not been employed by the hominins at the site (Gamble 1999). It was even suggested that the site might represent a Clactonian industry despite the fact that the debitage clearly contained elements of biface trimming debitage and an end shocked biface fragment. Given the apparent excellent degree of preservation, the atypical lithic industry and the direct evidence for the acquisition and butchery of a single large mammal, a detailed programme of analysis was undertaken during the late 1990's. The results of this analysis are to be published in the forthcoming monograph (Roberts *et al. in prep)*

For the purposes of this thesis, the detailed evidence for tool using behaviour documented during this analysis provides a good starting point for the consideration of wider behaviour patterns. After testing the degree of preservation through a series of taphonomic analyses it will be shown that the archaeology does indeed appear to represent a short-lived episode and that the both lithic and faunal assemblages were rapidly preserved under low-energy condition prior to any significant dispersal and rearrangement. As such, the evidence provides a snap-shot of behaviour, recording the actions of individual hominins as they engaged in a short episode of group activity geared directly towards the acquisition of animal resources. Within these clearly defined parameters the evidence provides a starting point for our wider discussions of land use and tool using behaviour in the Middle Pleistocene. Through technological analysis and refitting it will be demonstrated that almost all the recovered lithic material relates to the production of bifaces and that the absence of bifaces at the locality relates to transport/discard practice and not to industrial tradition. From this fact a null hypothesis is formulated proposing that the suppressed discard of bifaces is directly related to the fact that this assemblage derives from only a single occupation episode. So that, by inference, hominins only discarded bifaces in great numbers at regularly occupied localities or within habitually occupied landscapes. This chapter thus represents the first of three levels of analysis. The GTP17 data provides a fine-grained record, the study of which will form the basis for the analysis and discussion of coarser signatures with wider temporal and spatial significance.

My approach draws heavily on taphonomic techniques originally applied to studies of carcass dispersal, especially those of Voorhies (1969) and Shipman (1977, 1993). However, it is the work of Kathy Schick that provides the overall basis for many of the techniques utilised here (Schick 1984, 1989). Schick suggested that taphonomy should be the primary aim of stone tool researchers ahead of technological analysis and she developed a range of analytical tools and frameworks to achieve that aim. Modern studies of Lower Palaeolithic assemblages (especially in Britain and America) follow these criteria closely (e.g. Ashton *et al.* 1998). The range of techniques employed below will be applied to the Q1/B assemblage in Chapter 5.

4.2 Taphonomy: establishing degree of preservation.

In Figure 4.3, the gross distribution of stone artifacts is presented. Visual inspection of the distribution patterns appears to indicate a series of discrete lithic artifact scatters and a more dispersed spread of carcass elements. Prior to any assessment of the behavioural processes that led to this arrangement, the degree of spatial and compositional integrity has to be established alongside a consideration of the degree to which the two assemblages are associated. It is apparent from the sedimentary context of the GTP17 assemblage that some degree of post-depositional transformation has occurred. The presence of carnivores, the inter-tidal setting and the evidence for hominin occupation at the site indicates that a complex array of agents may have affected and modified the lithic and faunal assemblages.

Establishing the degree to which these agents have influenced the distribution of material at GTP17 is necessary if an accurate account of hominin behaviour patterns, at the correct degree of temporal resolution, is to be drawn from the evidence. In this section analytical techniques are employed to provide an assessment of post-depositional processes. In addition, some taphonomic aspects of the horse carcass are addressed in order to examine the differential ways in which the faunal and artifact assemblages have been subjected to transformation. The faunal assemblage from GTP17, studied by Simon Parfitt, has been previously described (Roberts and Parfitt 1999).

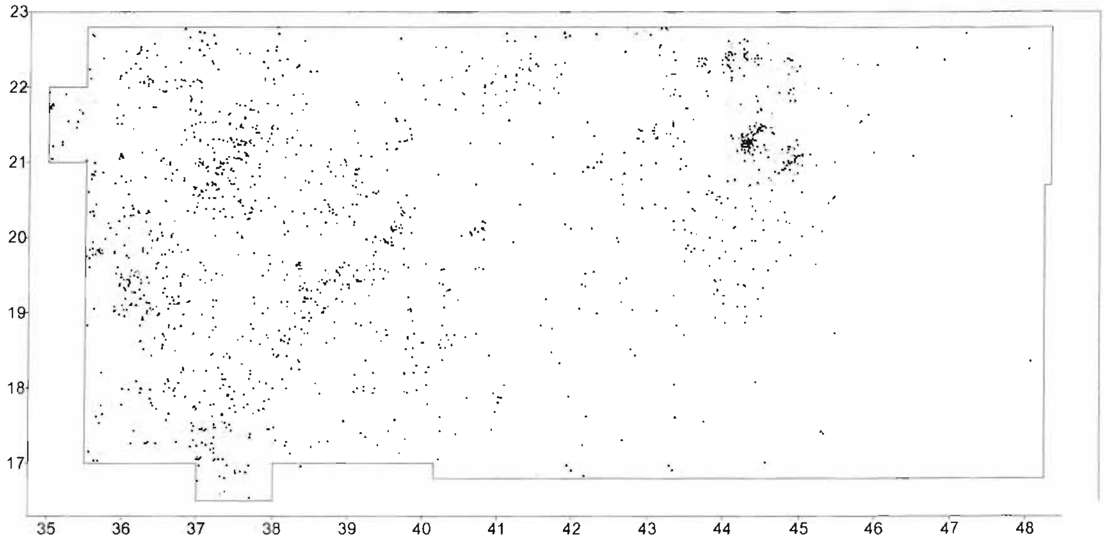


Figure 4.3: Distribution of artifacts for GTP17 Unit 4b

With the data an attempt will be made to examine evidence for the differential modification of the faunal assemblage compared to the stone artifacts. It is hoped that, through this approach, the contextual integrity of both assemblages can be assessed and the role of hydraulic, carnivore and hominin agents in assemblage modification and dispersal can be isolated.

4.2.1 Sedimentary context, condition and disposition of the GTP17 assemblages

While archaeology was encountered at several levels during the excavation of GTP17, the substantial faunal and lithic assemblages were recovered from a single sedimentary context within the main body of the Slindon Silts (Unit 4b). In this section an attempt will be made to characterise the nature of this horizon, its depositional regime, the local environmental conditions it represents and the possible effects of its subsequent development on assemblage composition and distribution.

Unit 4b is a spatially extensive unit, recorded through numerous exposures and previously described in detail, (Roberts 1986; Roberts and Parfitt 1999). The unit forms part of the regressional/lagoonal sediments of the Slindon Formation, which throughout the sequence show a general shift in dominance from an estuarine/lagoonal regime to one influenced by fresh water and soil development. Unit 4b is comprised of calcareous clay loams inter-bedded with quartz silts and small amounts of both sand and organic material. The sediments continue the trend indicated in the lower Unit 4a for marine regression, with an increased contribution from alluvial and terrestrial deposition. However, the lack of freshwater ostracods and the suppressed development of rooting structures attest that these deposits were still largely inter-tidal in nature. The 4b horizon has been interpreted as a saltmarsh deposit resulting from a series of depositional events within an enclosed or partially enclosed tidal lagoon. The depositional regime appears to have been low-energy in nature, although sedimentation was both relatively rapid and continuous, apparently precluding the establishment of long-lived terrestrial landsurfaces. Freshwater appears to have been involved in the formation of Unit 4b, although the absence of clear channelling structures suggest this was as a result of sheet wash rather than established patterns of drainage. It is possible that sheet wash, along with leaf fall from the forested Downlands and algal mats within the lagoon, contributed the detrital organic matter found within the sediments. Vegetation would have developed to varying degrees across the surface of the Unit 4b landscape and at different times during its formation. Higher and drier areas of the Unit 4b landscape, such as that indicated in part of the sequence at GTP10 (Roberts *et al.* 1997), may have supported some sparse grassland vegetation. With time, the continued fall in sea level would have extended this process, eventually leading to the development of the subsequent Unit 4c soil horizon.

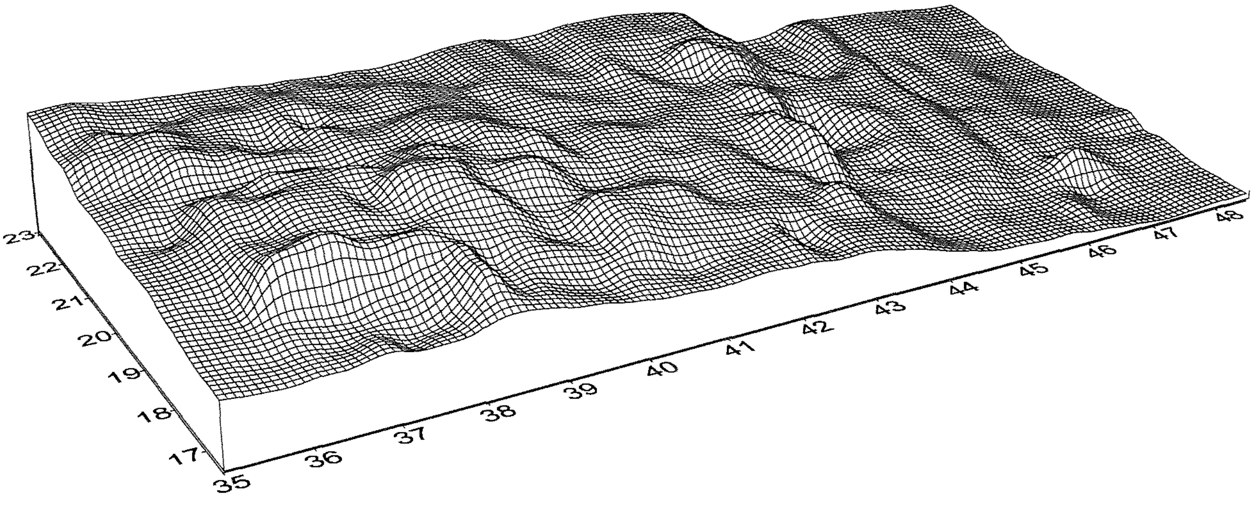


Figure 4.4: Isometric surface of the GTP17 Unit 4b Horizon

At GTP17 disperse scatters of artifacts were found associated with the Unit 4c soil horizon at the top of the Slindon Silts (Roberts and Parfitt 1999). However, the material under discussion in this chapter originated from an intra-Unit 4b horizon located some 25cm below the soil horizon, and visible as a continuous clay lamination within the silts. This horizon was traced during excavation and relief-mapped to produce the isometric surface in Figure 4.4. This surface almost certainly represents the original topography of the Unit 4b landsurface, indicating a relatively flat area in the north-west of the excavation area sloping away to the south and east. While the surface appears uneven, no trampling structures identifiable through the analysis of sediment were present, although a localised patch of distorted sediment associated with a knapping scatter has been interpreted as compression by a hominin foot or knee (Roberts and Parfitt 1999). The Unit 4b sediments encountered at site GTP17 only differed significantly from the unit as a whole by the presence of an atypically coarse, sand-sized component; this has been interpreted as possibly representing microdebitage produced during tool production at the site (Roberts and Parfitt 1999).

The good condition of the recovered flint artifacts is suggestive of a rapid incorporation into the sedimentary matrix of Unit 4b. All artifacts are fresh, unrolled and retain sharp edges, with an almost complete absence of edge abrasion. While some of the material is patinated, much of the assemblage appears to have buried very rapidly having escaped exposure to the air. Microwear analysis carried out by John Mitchell indicated a fine polish on some of the flakes consistent with light abrasion by sediment loaded water (*pers. com.*). This fact, coupled with the varied degree of patination has unfortunately precluded any study of microwear on the artifacts. The condition of the recovered finds therefore seems consistent with the process of site formation suggested by the sedimentary context, being largely a product of rapid burial by low-energy tidal processes. Due to the discreet vertical distribution of the material and the apparently rapid rate of sediment deposition it might be possible to determine that the entire faunal and lithic assemblages are ‘contemporary’ at a time-scale more precise than simply the geological. It is possible, given the intertidal nature of the deposits sealing the archaeological horizon, that the material may have been deposited within a period of time bracketed by either the diurnal or 28 day tidal cycles. This interpretation of the sedimentary context suggests that the archaeological material was deposited and incorporated into Unit 4b under a very low energy regime within a period of a few hours to a maximum of four weeks. This interpretation can now be tested through the analysis of differential movement of finds and flow patterning.

4.2.2 Evidence for size sorting in the GTP17 assemblage

As the sedimentary evidence suggests that low-energy tidal processes were involved in the formation of the site, it is now important to try and gauge the degree to which the observed faunal and lithic distribution represents the *in situ* remains of hominin knapping and butchery activity. The degree to which assemblages remain intact can be accessed by the analysis of the distribution of particular size classes of artifact. Differences in the distribution, composition and mobility of particular elements occur as a result of a process or activity having a selective effect on the assemblage as a whole. Examples of this might be the removal of small particles by water action or the selective removal/destruction of limb bones by hominins. The following analyses will together provide a rigorous assessment of both the degree and nature of post-depositional process at the site.

4.2.3 Trend surface analysis

In an unmodified assemblage, different size components should be spatially distributed in a manner consistent with the simple dynamics of the initial depositional process. In the case of knapped lithic material there should be a definite spatial superimposition in the distribution of differently sized artifacts centred on each knapping scatter. While we would expect the distribution of smaller size-classes to be somewhat less clustered than large components, due to their greater mobility; should their distribution be excessively diffuse or dislocated from the parent scatter, then winnowing by hydraulic activity would might be indicated. With faunal remains, due to the uneven distribution of bone sizes within a carcass, no simple spatial coincidence of size-classes would be expected. However, should the spatial analysis reveal discreet clusters of a particular size-class of faunal material within the site, this might be an indication of post-depositional transformation by hydraulic, carnivore or hominin agents (Schick 1986; Sahnouni 1998). The analysis of spatial size-class distributions involved the production of trend surface plots of three size-class populations for both the bone and lithic assemblages. For the lithic assemblage there are three plots (Figure 4.5) showing, respectively the distribution of material <1-20mm, 20-22.9mm and >23mm. For the faunal assemblage the size-class limits were

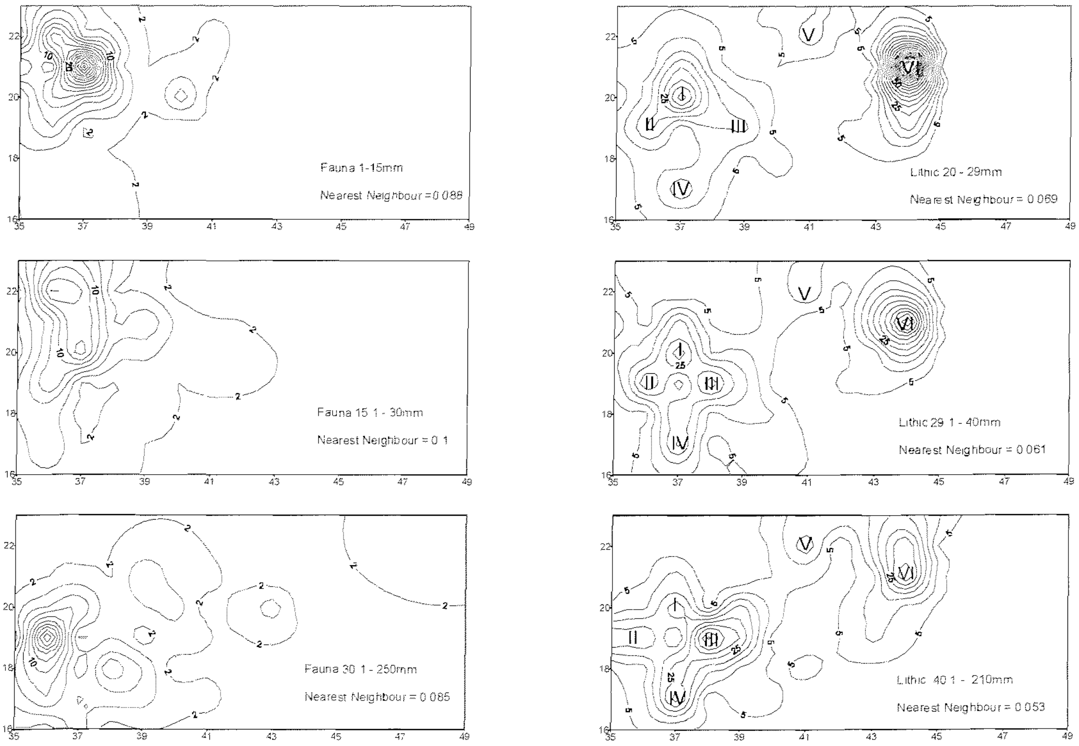


Figure 4.5: Distribution of different size classes of lithic and faunal material at GTP17, Unit 4b.

set so that each population comprised approximately 33% of the assemblage. Each population was then plotted as a contour diagram showing variation in find density per $0.5m^2$ across the site.

The three lithic artifact plots indicate patterning consistent with a largely *in situ* assemblage. Seven concentrations (labelled I-VII) are apparent across all the size-classes with no apparent horizontal movement. There are relative variations in density between the concentrations but these can be accounted for by technological differences. Scatters resulting from secondary flaking will have higher proportions of smaller debitage than primary knapping scatters. The degree to which the lithic assemblage is intact was further investigated through the application of size-class distribution analysis. Experiments have shown that, for any given raw material type, size distribution curves are extremely similar (Schick 1986; Roberts *et al.* 1997). By comparing these experimentally derived curves with those from the lithic assemblage at the site, we can test the findings of the trend surface analysis.

Figure 4.6 presents the debitage size-class curve alongside the limits of observations from biface reduction experiments. In general the curve from GTP17 conforms extremely well to that of the intact experimental assemblage. Counts for the 20-30mm size range are slightly depressed but well within the range of expected variation shown in our experiments. Lithic material <20mm was systematically collected only as part of the bulk sampling program. As most of the samples were small there was not a sufficient quantity of small debitage to analyse. Evidence from the Project B test-pit survey (Roberts *et al.* 1997) suggested that size ranges of debitage between 2-20mm were good indicators of low-energy hydraulic manipulation of lithic assemblages. Consequently, while the lithic assemblage >20mm appears to be intact there is a high probability, given the inter-tidal context, that smaller size components may have been winnowed. Any future work at the GTP17 locality should include a microdebitage recovery programme aimed at resolving this issue.

In Figure 4.5 plots are shown for the distribution of three size classes of faunal material. Unlike the spatial distribution of the lithic assemblage, with consistent spatial patterning across all three size classes, faunal material <15mm is concentrated in the north-west corner of the site with density falling sharply to the east and south. The centre of this concentration is mirrored in the 15.1 - 30mm size class distribution, but here the overall pattern appears more diffuse.

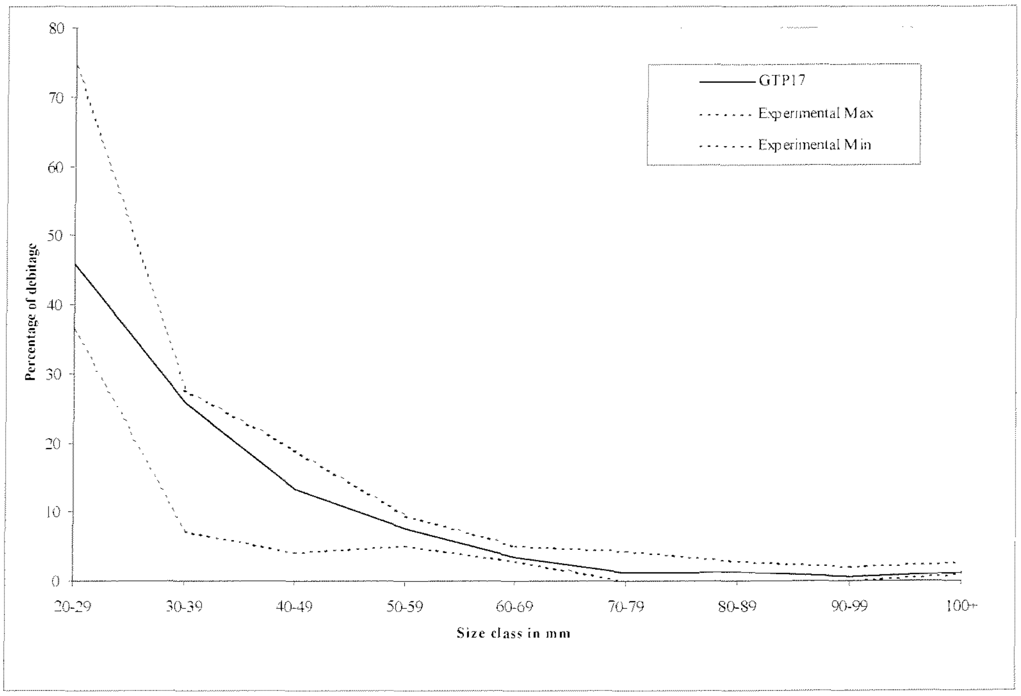


Figure 4.6: Size class distribution curve for GTP17 Unit 4b artifacts

Material >30mm forms a completely different distribution pattern, with a single large concentration in the western part of the site forming part of a more extensive spread of material centred on the south-west of GTP17. The small degree of spatial coincidence between the population clusters suggests that post-depositional processes may have acted differentially on particular size components of the faunal assemblage. Further to this, the mechanism for this transformation apparently had no significant effect on the lithic assemblage. Some possible fauna-specific mechanisms would include low-energy hydraulic activity, the effect of hominin butchery activity, scavenging by carnivores and the original position of the carcass itself.

While the sedimentary context of the site suggested that both assemblages had been subject to low-energy hydraulic processes, the trend surface analysis indicated that the lithic assemblage was recovered essentially *in situ,* while the spatial arrangement of the faunal assemblage suggested some spatial size-sorting. While it can be determined that larger faunal elements exhibit a spatial distribution pattern distinct from that of the smaller components, it is impossible from this analysis to determine which carcass elements are more mobile, and consequently the degree to which these postulated mechanism are responsible for the observed pattern.

4.2.4 Determining size sorting through the analysis of refits.

The results of the trend surface analysis indicate that there is a high degree of differential movement between the faunal and lithic assemblages. The analysis of refit distances (Figure 4.7a) indicates the relative proportions of faunal and lithic refits that occur at particular distances. Our experimental work indicates that flakes produced by a standing knapper rarely travel further than 2m, results that are broadly in line with the finding of previous researchers (Schick, in Bunn *et al.* 1980). The curve for lithic refits indicates a sharp fall in the number of observations at increasing distance. In general this appears to confirm that the lithic assemblage had remained largely *in situ,* suggesting that over 90% of refitted lithic artifacts occur within 2m of each other. However, the 5% of lithic refits with distances in excess of 3m do require some further explanation, especially considering the apparent lack of high-energy hydraulic influence at the site. Of the eighteen refits with distances exceeding 3m, fifteen form part of three larger refitting sequences in which the knapper changed location during the manufacture of the tool (detailed descriptions of the refitting sequences are given below). The remaining three refits are distinguished only by the fact that they each contain a large flake over 70mm in length. This may suggest that they were specially selected for use as tools by hominins, but the lack of use damage and poor visibility of microwear at this site renders any support of this supposition impossible. However, given that all the flakes in these refit groups are of a size that both the trend surface and debitage size analyses suggests are unaffected by hydraulic processes, transport by hominins appears to be the most probable and economic reason for their movement.

Had the horse been buried rapidly with no modification to the distribution of particular carcass elements then we would expect, as in the case of the lithic assemblage, for refit distances to be fairly restricted. However, as the gross spatial distribution of the horse exceeds 150m^2 it is readily apparent that the carcass has been significantly disturbed and this should be reflected in a comparison of faunal and lithic refit distances. Figure 4.7a presents an interesting pattern for the distribution of faunal refits quite distinct from that of the lithic assemblage. The curve indicates that 25% of faunal refits are limited to distances of less than 0.5m, however a secondary peak in the distribution indicates that a further 27% of faunal refits exceed 3m. The separation of the two peaks suggested that particular elements in the faunal assemblage were significantly more mobile, one possibility was that the more mobile population was more prone to hydraulic transport.

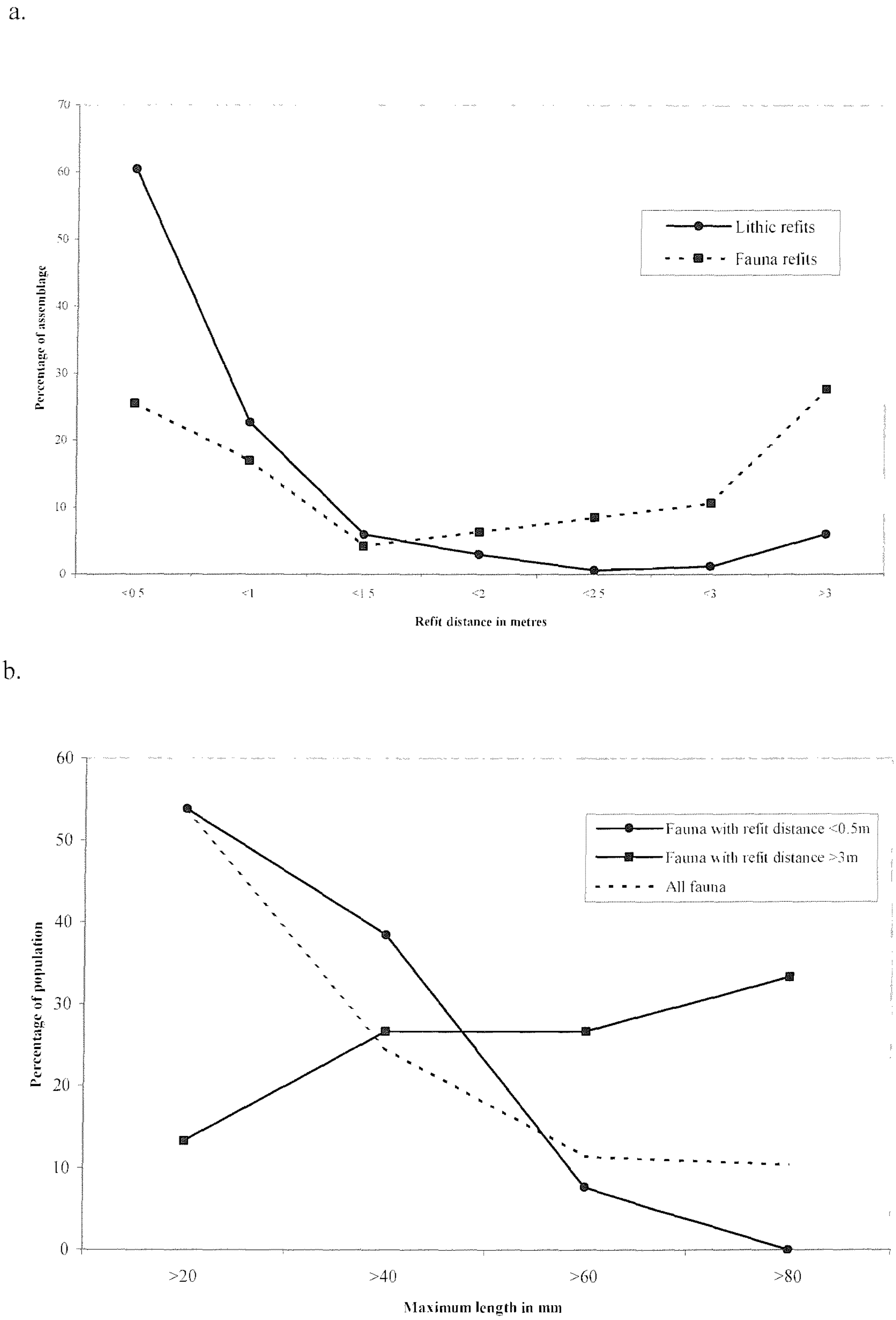


Figure 4.7: Comparison of refit distances for a) lithics *vs.* fauna and b) fauna size classes.

To test this, the distribution of the size-class distribution of refitting faunal pieces was compared for three populations: all faunal finds, refitted fauna distances under 0.5m and refit distances in excess of 3m (Figure 4.7b). The curves appear to suggest that bones with larger maximum lengths are moving further apart than smaller pieces. These analyses, when examined alongside the trend surface plots (Figure 4.5), demonstrate that the faunal assemblage has been subject to a process of size-discriminant transport. Larger pieces of fauna appear to have been more mobile, resulting in a tendency towards spatial separation of larger carcass elements from the main area of bone distribution at the site. As no significant hydraulic process has been implicated in the formation of the lithic assemblage by either analysis, it would appear that a biological agent such as hominin or carnivore activity is probably responsible for the movement of these larger pieces.

To summarise, the results of refit distance analysis indicate that elements of both the faunal, and a small part of the lithic assemblages, were significantly more mobile than the rest of each assemblage. With the exception of three flakes, the distribution of the entire lithic refit assemblage can be accounted for by hominin knapping activity. The fauna presents a more complicated situation, with all size-classes relatively more mobile over relatively small distances, but with large pieces of the horse carcass exhibiting a high degree of mobility; a situation which appears consistent with movement by biological, as opposed to hydraulic, agents. The differential movement of large pieces of the faunal assemblage may explain why the trend surface plots indicate a lack of coincidence for the different size elements of the horse carcass.

4.2.5 Determining fluvial disturbance through the analysis of orientation data and refits

While the lithic assemblage appears to have remained largely *in situ* the results of trend surface, nearest neighbour and refit distance analyses indicate that the faunal assemblage has been subject to a greater degree of post-depositional modification. While hominin and carnivore activity is implicated in this process, it is first important that we establish the degree to which hydraulic action may have influenced find distribution patterns. Any hydraulic activity will generally leave traces through the orientation of artifact long axis and the direction between refitting finds. In the latter case the direction almost always indicates the direction of flow, but in the case of long-axis orientation finds may either be aligned along the direction of flow or at 90° to it (Schick 1986; Shipman 1981; Voorhies 1969). Rose diagrams were produced for both long-axis and refit orientations for each of the assemblages and these are shown in Figure 4.8.

The results of the earlier analysis suggested that the lithic assemblage had not been modified significantly by any fluvial process and this is largely confirmed by the rose diagram analysis for both lithic finds and refit orientations. The long axis of lithic artifacts (Figure 4.8a) showed no significant preferred orientations and this confirmed the findings of earlier analyses in suggesting that no significant hydraulic process was at work. However, the proportion of lithic refits with bi-directional orientations of 160-179° was significantly depressed, a result which would be consistent with flow occurring at approximately 90° to this axis (Figure 4.8b). If this process had been more substantial we would expect to see the additional development of a preferred orientation to the lithic refits, as well as evidence to this effect in the trend surface and nearest neighbour analyses. The combined results indicate that a low-energy and shallow hydraulic process was involved in the formation of the lithic assemblage. This process was not strong enough to significantly effect the overall distribution of material.

Unfortunately the number of faunal refits obtained from the site (n=49) was too small to carry out a statistically significant analysis of orientation preference, the procedure requiring a minimum of at least 72 observation (Shipman 1981). The analysis of faunal long axis alignment was however possible and indicated a statistically significant orientation of 160-179^0 (Figure 4.8c). This alignment is especially significant as it coincides exactly with the suppressed refit orientation results from the analysis of the lithic assemblage. While it initially appears that the two analyses are contradictory, experimental research suggests that this configuration is possible under certain conditions. Work by Voorhies has suggested that under specific flow conditions, particular bones will tend to align themselves transversely to the direction of flow (Voorhies 1969, Shipman 1981). This occurs under relatively low-energy currents and where bones are emergent from the water, in such conditions bones are subject to rolling action rather than drag. While more detailed taphonomic analysis and a larger faunal refit sample is required, the long-axis orientation results further implicate the action of low-energy, shallow water flow in the formation of the assemblage. While this action appears to have acted differentially on the lithic and faunal assemblages, the forces involved do not appear to have been strong enough to account for both the greater mobility of large carcass elements or the spatial differentiation of faunal size classes in the trend surface analysis.

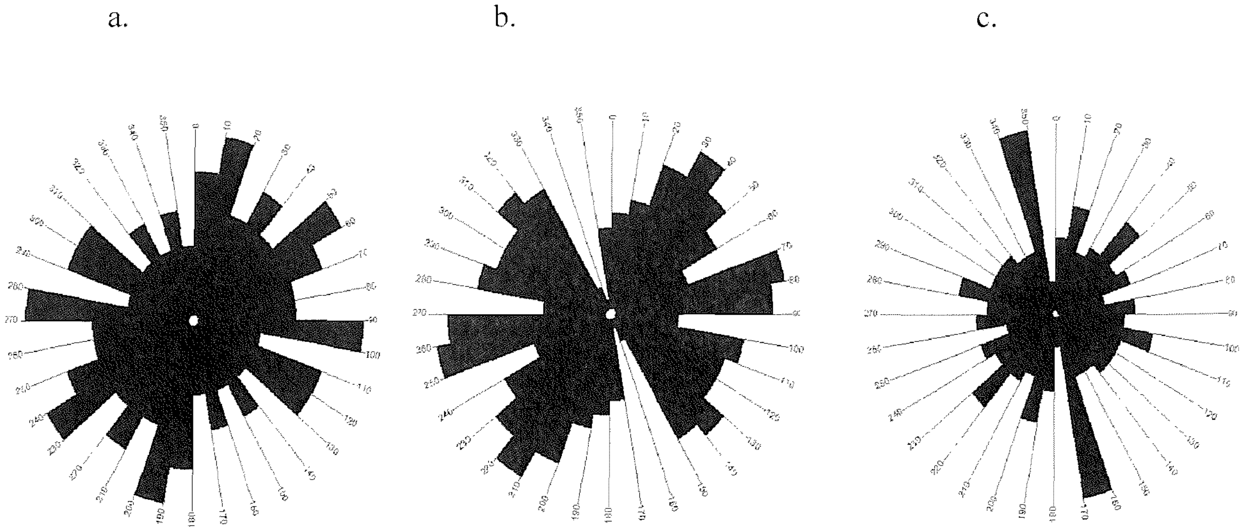


Figure 4.8: Rose diagrams for a) Artifact long axis b) Artifact refits c) Faunal long axis.

4.2.6 Summary: A taphonomically derived model for site formation and patterning.

The results of the taphonomic analysis suggest that both the faunal and lithic assemblages appear to be directly associated and were preserved in a single short-term depositional event. The distribution of the lithic artifact assemblage appears to represent a series of largely *in situ* knapping scatters, compositionally intact above 20mm. That a low-energy fluvial process was involved in the sedimentation of the site is indicated by artifact and refit orientation patterns, all of which suggest a broad NE-SW flow axis. The particular transverse alignments of the bones to this flow, would be inconsistent with high-velocity flow suggesting that rather than being part of a large estuarine channel, a shallow and marginal process effected the GTP17 site. While the distribution, condition and incomplete nature of the faunal assemblage indicate disturbance by both carnivore and hominin activity, the close association of many anatomical elements of the horse indicates fairly rapid burial. Thus the context and arrangement of material at GTP17 indicates that the site was located at the edge of the tidal range within the lagoon-edge/estuarine environment. The falling relief indicated towards the south and east of the site might represent superficial topography or channelling in the mudflats. As the landsurface appears to fall away along an axis broadly coincident with the indicated direction of flow, it is further suggested that the lagoon 'over-banked' at tidal extremes, flooding the site with shallow, sediment loaded water. Due to the lagoonal/estuarine setting of the depositional environment, there would have been little significant wave action at work and the site would have been rapidly buried over the course of a series of short, low-energy and shallow flood episodes. Given this context and the degree of post-depositional change, the maximum time scale for this process would be set at a few weeks.

In addition to tidal action, non-hydraulic processes are also indicated at the site. All detectable movement of the lithic artifacts can be accounted for by hominin activity. The presence of long distance refits and the high mobility of large elements in the faunal assemblage implicates the involvement of both hominin and carnivore activity in the formation of the site. This is also born out by the differential patterning of size-classes within the faunal assemblage indicated by the trend surface analysis.

The taphonomic analysis also provides an insight into the spatial arrangement of the site at a reasonably detailed level. The lithic clusters have been demonstrated to be knapping scatters produced by short, individual episodes of reduction/tool manufacture. These clusters sit along the edge of a gentle fall in relief at the site which might have been the product of superficial tidal channelling or otherwise predetermined local topography. Analysis of the bone distribution pattern shows that faunal remains are most dense in the north-west corner of the site and that large elements are more mobile and have a wider distribution across the site. It is suggested on this basis that the carcass was originally located in the north-west corner of the site. It was probably in this location that primary butchery of the carcass, including the breaking of limb bones took place. Subsequent to this large, elements were widely distributed across the site, either by hominins for further butchery or by carnivores feeding on the carcass after the hominins had abandoned it. The combined evidence indicates that both assemblages are contextually related and in primary context. While the stone tool assemblage can be considered essentially *in situ,* the carcass has been rearranged by low energy hydraulic processes and more significantly by carnivore and hominin activity.

4.3 GTP17 Stone Tool Technology.

This section is concerned with the reconstruction of Middle Pleistocene stone tool technology and hominin behavioural patterns from the GTP17 flint artifact assemblage. From the outset the hope was to fully exploit the potential the assemblage offered in the study of hominin technology, land use, palaeoecology and demography. The approach has been to combine a limited refitting program, aimed at directly reconstructing reduction sequences, with the technological classification of the flint artifact assemblage. The analysis aimed to document the full range and nature of technological behaviour at the site. Both during excavation and in earlier accounts of the GTP17 (Pitts and Roberts 1997; Roberts and Parfitt 1999), attention was drawn to some apparently distinctive features of the flint artifact assemblage. The material appeared to include a high proportion of large hard hammer, primary flakes, a lack of finished tool forms and contained scatters of *in situ* debitage from spatially discrete reduction sequences. The apparent abundance of hard hammer flakes and the lack of tools was so acutely perceived during excavation, that it was suggested that core and flake working had dominated over biface manufacture at the site (Gamble 1999). The incomplete nature of some reduction sequences suggested the possible spatial separation of tasks such as 'nodule dressing' and 'biface reduction', that might possibly reflect real divisions in the hominin chaîne opératoire (Roberts and Parfitt 1999). The suggestion that two of the artifact scatters might preserve a complete biface reduction sequence, was also crucially important, apparently providing the first example of a complete reduction at Boxgrove. In this section these previous observation will be considered in light of more detailed analysis. Table 4.1 provides a summary of the GTP17 flint artifact assemblage in terms of its technological composition. The assemblage is divided into four classifications: debitage, tools, 'core' elements and percussors. These groupings inevitably overlap, the 'core' element group comprises some reworked debitage, abandoned but partially worked nodules and knapped blocks subsequently utilised as percussors. Similarly, three of the four recovered tools were manufactured on debitage.

4.3.1 Waste flake (debitage) analysis

1781 pieces of debitage (>20mm) were recovered from the GTP17 excavation area. Each artifact in this assemblage was subjected to the metrical and technological analysis outlined in Appendix 1. The assemblage was initially split into two sub-divisions: Class 1 flakes, which were either unbroken or possessed a striking platform and Class 2 flakes which were the distal and medial elements of broken flakes. The assemblage contained 1034 Class 1 flakes, this number represents the minimum number of flake removals present within the assemblage. While all material was measured and scored for cortex and dorsal scar count, only the Class 1 flakes were

		N	%
A.	*Lithic Assemblage components.*		
	Bifacial Tools	2	0.1
	Flake Tools	1	0.1
	Cores	7	0.4
	Percussors	6	0.3
	Debitage	1781	99.1
	Total	1797	100
B.	*Sub-Division of debitage by breakage.*		
	Class 1: Proximal & Whole	1034	58.1
	Class 2: Medial & Distal	747	41.9
	Sub-Total	1781	100
C.	*Sub-Division of Class 1 debitage by Platform type*		
	Cortical	174	16.8
	Plain	318	30.8
	Natural	26	2.5
	Facetted	66	6.4
	Retouched	78	7.5
	Dihedral	144	13.9
	Polyhedral	54	5.2
	Punctiform	126	12.2
	Bruised	48	4.7
	Sub-Total	1034	100
D.	*Sub-Division of Class 1 debitage by reduction stage.*		
	Primary	186	18.0
	Thinning Flakes	236	22.8
	Tranchet	3	0.3
	Indeterminate	609	58.9
	Sub-Total	1034	100
E.	*Sub-Division of Class 1 debitage by percussion type.*		
	Hard Hammer	99	9.6
	Soft Hammer	301	29.1
	Indeterminate	634	61.3
	Sub-Total	1034	100

Table 4.1: Technological classification of the GTP17 Unit 4b assemblage

assessed for reduction stage, percussion and platform type. 186 Class 1 flakes were judged to have come from the primary 'roughing-out' stages of reduction. These flakes had a wholly cortical dorsal face, cortical or natural platforms and many appeared to be of hard hammer percussion. Included in this group were a number of irregular nodule fragments trimmed during the initial preparation of a nodule and a small number of flakes with one or two dorsal scars but clearly derived from the same part of the reduction sequence. 200 Class 1 flakes appeared to derive from the later stages of biface reduction and were described as secondary flakes. These flakes were largely, but not exclusively, non-cortical and were thin, often broken and of soft hammer manufacture. Many of the broken Class 2 flakes also appear to have derived from the secondary stage of manufacture, a fact that is consistent with previous observations of increased breakage frequency during soft hammer reduction. Only three true tranchet flakes (preserving the tip of a biface on both the ventral and dorsal face) were recovered from the site, but a number of secondary flakes (36) did preserve retouched working edges from bifacial tools, either on their butt or on part of the lateral flake edge. These flake removals do not appear to be part of the thinning process but may represent modification of an existing tool, either to reshape or to resharpen the tool edge. The remaining 610 Class 1 flakes were considered too ambiguous to be firmly ascribed to either primary reduction or secondary thinning stages. Much of this material almost certainly derives from the production of biface blanks or rough-outs from prepared nodules.

4.3.2 Analysis of stone tools

Despite the large amount of biface manufacturing debitage no complete bifaces were recovered from GTP17. Unmodified flakes may have been utilised as tools but unfortunately this cannot be tested as flakes sent for microwear analysis were too patinated or abraded to determine if they had been so used. A single end-shocked butt fragment of a biface, two bifacial flake tools and one flake showing utilisation damage were recovered and these are described below.

4.3.3 Bifacial tool 1039

This is a large partially cortical hard hammer flake with a maximum dimension of 90mm (Figure 4.9). On the ventral surface of the flake a number of small flake scars and damage areas are visible. Either these scars represent irregular, non-invasive retouch, use damage or a combination of both. In experiments conducted by the author, similar scars have been produced by heavily scraping and chopping at bone. In addition to the scars, flexion breaks are visible on the same lateral edge and on both the distal and ventral surfaces, these also may have derived from use but trampling cannot be ruled out. A small amount of retouch and two larger flake removals are also present on the dorsal surface towards the proximal end of the flake. The flake is both relatively large and thick and falls within the size-range of bifaces at Boxgrove. On this basis it is possible that the flake was selected and modified to be used in the same range of butchery tasks envisaged for bifaces at the site. Rather than attempt to bifacially reduce the entire ventral surface of the tool, particular parts of its edge were minimally modified prior to use, presumably in the butchery of the horse. However, given the limited and non-invasive nature of the bifacial retouch this piece has been classified as a bifacial scraper.

4.3.4 Biface 1086

This is a small bifacially worked tool manufactured on a flake measuring 92x68x18mm (Figure 4.10). The flake, given its size, may have been of hard hammer origin but this cannot be determined, as the proximal end has been removed through reduction. Subsequent to production of the flake the ventral surface was worked along the right lateral edge through the removal of nine flakes. At least two of these flakes appear to have been of hard hammer origin and left distinctively pronounced inverse bulbar scars. As the flaking is relatively invasive and present around roughly half the tool's perimeter the piece can be classified as a biface. However, given that it is flake-derived and has not been well finished the piece would fall into the classification of 'non-classic' biface as proposed by Ashton and McNabb (1994).

4.3.5 Biface Fragment 7458

This artifact is the only fragment of a formally manufactured biface to be recovered from the site apart from the three tranchet flakes. It is the butt of a biface broken by end-shock and measures 84x41x23mm. The butt has been worked on both faces through both conventional flaking and retouch. It was possible to refit a single, broken soft-hammer flake to the tool fragment, which possibly indicates that the thinning of this tool took place on site. However, the scar from the refitting flake terminates at the end-shocked surface and appears to truncate two small scars on this face. While it is probable that the scars were produced spontaneously during the break, as another obviously spontaneous scar is visible on the face, there is the possibility that the biface fragment was flaked subsequent to end-shock. Similar occurrences of reworked end-shocked fragments are known from site Q1/A and EQP/TP1.

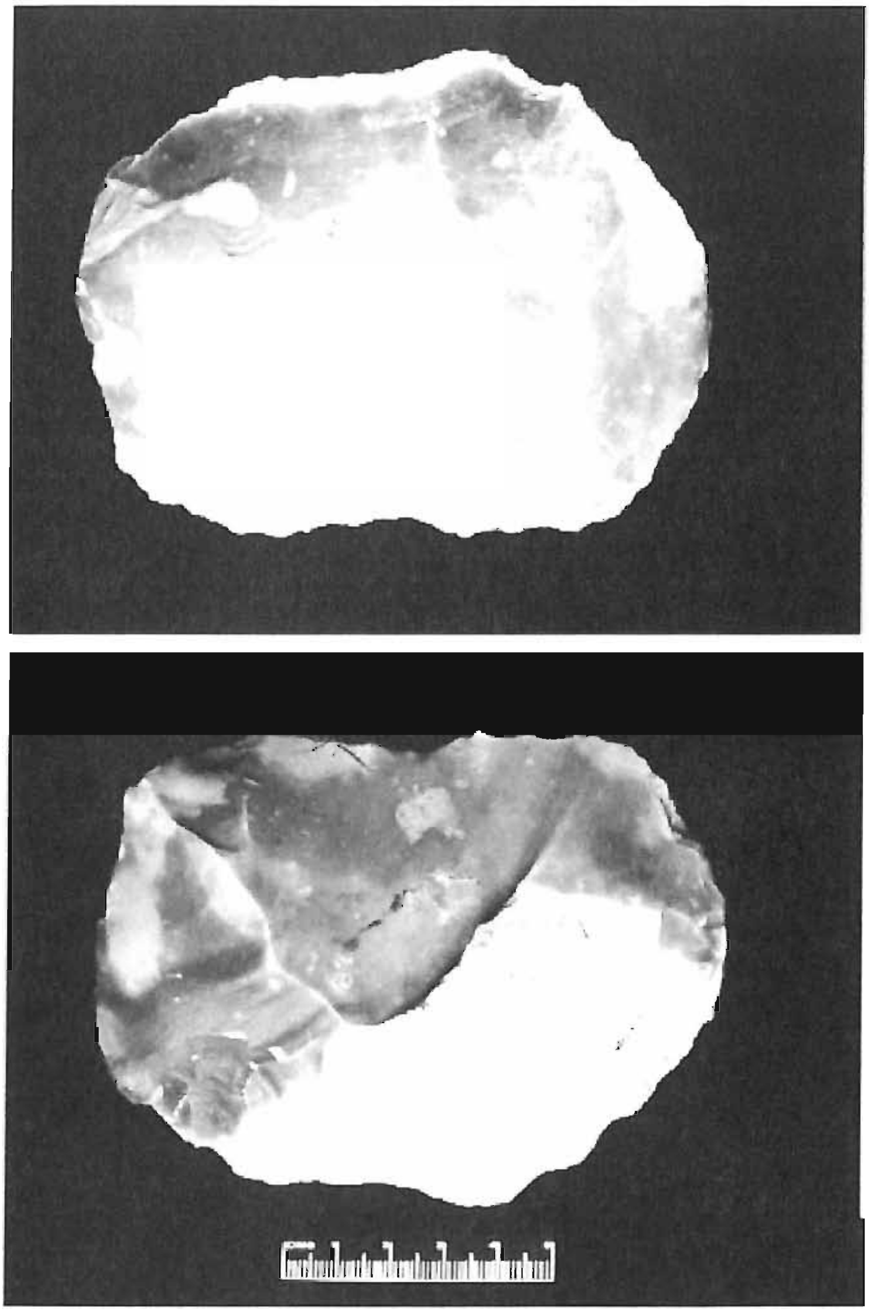


Figure 4.9: Bifacial Tool 1039

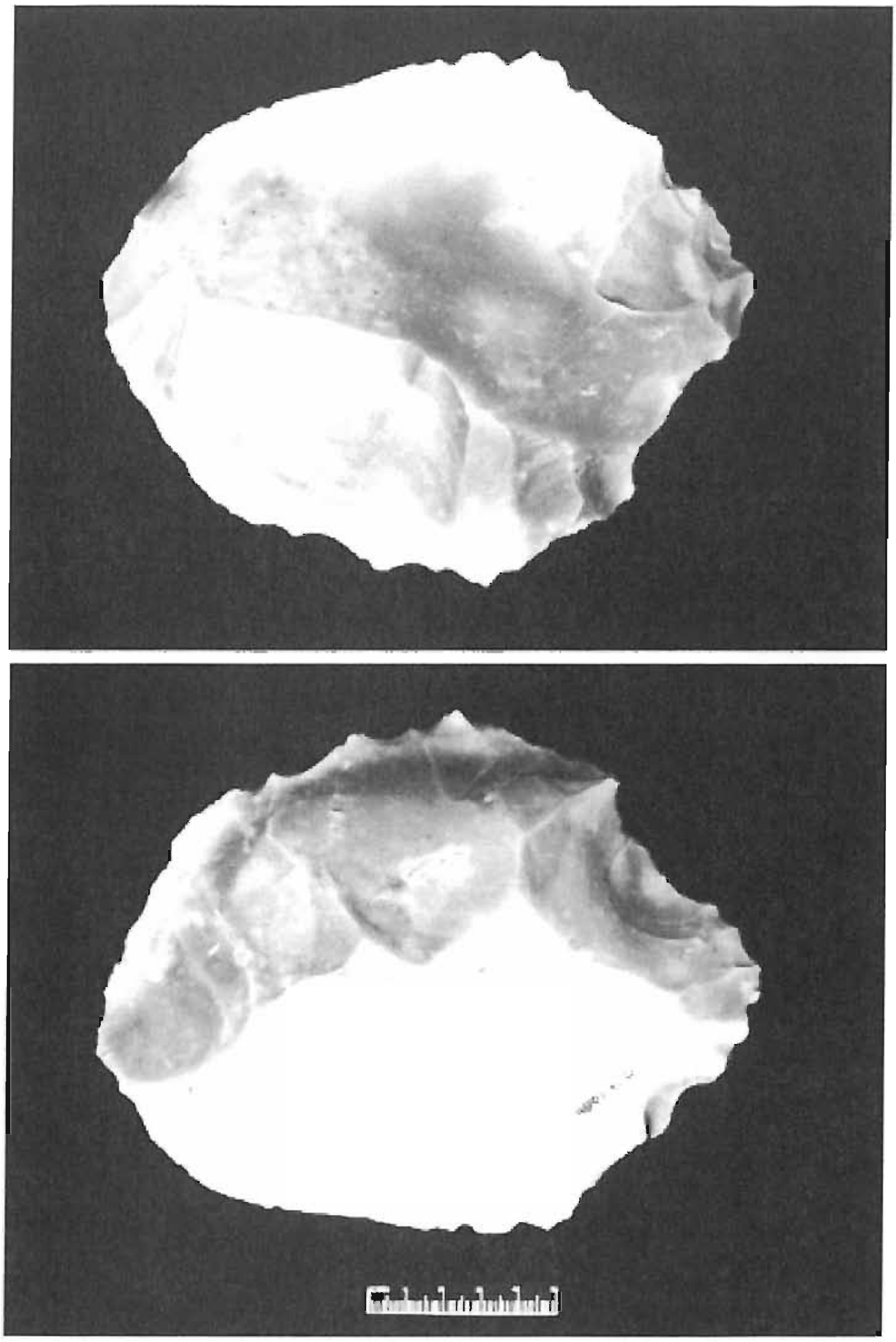


Figure 4.10: Bifacial Tool 1086

4.3.6 Utilised Flake 4068

This is a small, non-cortical flake measuring 55x28x4mm. The flake is damaged along the right edge, towards the distal end. This damage takes the form of small, irregular flakes, too superficial to be intentional retouch, which perhaps formed spontaneously through use. What further suggests this artifact as a tool is the fact that it is manufactured out of a raw material type that cannot be found anywhere else in the assemblage. Given the low energy processes involved in site formation the artifact must have been introduced by hominin transportation. It is suggested here that the flake may have been brought on site with the intention of utilising it in the butchery of the horse. In the absence of supporting evidence such as microwear traces, this interpretation of the artifact remains conjecture.

4.4 'Core' artifacts and percussors.

Eleven blocks of flaked raw material were recovered from the excavation area at GTP17. Almost all the blocks consist of fresh unweathered flint that originated from the cliff or talus slope 25-40m north of the site, but in addition two percussors were utilised water-rolled pebbles that could have been acquired from the lagoon foreshore. As the nodular material shows no sign of being water-rolled, and given the depositional environment, it would appear that hominins are responsible for the introduction of all the fresh raw material. The blocks present a typological challenge given the fact that other localities at Boxgrove have produced direct evidence for both biface production and core flaking technology (Bergman and Roberts 1988; Roberts *et al.* 1997; Roberts and Parfitt 1999). While documented refitting sequences such as the 15 removals from a small core at Q2/A show, quite unambiguously, that flake production was the sole intention of the knapping event there are many cases where the aim of the reduction is not so clear. Blocks with few, apparently *ad hoc* flake removals have often been characterised as tested raw materials abandoned after initial investigation revealed their apparent unsuitability. Conversely visibly reduced, flattened cores have often been interpreted as rough outs or blanks for biface manufacture. In addition to this there exists fragments of larger nodules with fracture planes forming their 'ventral' surface. These blocks appear to have been detached through the quartering of nodules and are essentially larger flakes detached along natural fault lines in the parent material. Amongst the assemblage there are no unambiguous biface rough-outs even though we have good evidence, through refitting, that they were produced on site. In addition to this there is a complete absence of extensively flaked globular cores common in Clactonian and some Acheulean assemblages, such as those recovered from the Boxgrove excavations Q2/A and Q1/B (Roberts and Parfitt 1999; Bergman and Roberts 1988; this volume). Consequently the large blocks of raw material appear to mainly represent rejected pieces of raw material abandoned at an early stage in the reduction sequence due to flaws in either shape or quality. As so many of the blocks were not sufficiently worked to determine if the aim of the knapper was flake or biface production, interpretation is inevitably a subjective matter based on judgements of raw material shape and reduction strategy.

Four nodule fragments were utilised as percussors, each exhibiting one or more localised areas of bruising. In each of these cases the percussors had been previously flaked. As none of these percussors have yet been integrated into refitting groups, it is impossible to determine if they were introduced to the site for use as percussors or picked out from the scatters due to their suitability. At Q1/B cores utilised as percussors have been shown, through refitting, to derive directly from on-site reduction sequences. Until similar evidence is produced from GTP17 the possibility remains that these percussors were imported. In the following section each 'core' element and percussor is described below and assigned to one of the following classes.

1.	Quartered nodule fragment	Nodule fragments, often detached along a natural fracture surface from the parent body.
2.	Biface rough-out	Bifacially worked core where knapping has aimed to reduce core thickness with minimal loss to overall size.
3.	Flake production core	Cores with single or multiple platforms where flake production appears to have been the intent.
4.	Indeterminate core	Core where knapping has not proceeded to a point where intention is clear.
5	Percussor	Artifacts exhibiting fresh, localised bruising.

Block 2824: Quartered nodule fragment.

This artifact is a large sub-rectangular block of flint detached along a single large ventral flake surface. The surface of the nodule fragment indicates that the original nodule was globular in shape and freshly derived from the chalk cliff. There are two natural fracture scars on the surface of the artifact, these scars are patinated and in comparison to the fresh condition of the ventral surface appear to have resulted from a much earlier breakage episode, probably as a result of natural percussion or pressure. In addition to these natural planes are five unpatinated flake scars which suggest flaking episodes from at least two different platforms prior to the detachment of the nodule fragment. If the nodule does therefore represent 'quartering' of a block, this occurred subsequent to an episode of primary flaking. One of the flake scars appears to have been a failed attempt to remove a protuberance from the nodule surface. After a second episode of flaking, a large blow removed the whole 'quarter' of the nodule containing the irregularity, subsequent to this the fragment was neither further reduced or utilised.

4.4.1 Block 2069: Quartered nodule fragment

This artifact is a sub-oval block of cortical flint detached along a ventral surface from a larger nodule. On the upper cortical surface five flake scars are present which appear to have been aimed at removing cortex from this face. The ventral surface was not subsequently flaked. Given that no serious attempt has been made to thin this piece and that it has not been bifacially worked, this piece has been classified as a quartered fragment of a nodule that surface irregularities rendered unreducable through normal hard hammer flaking.

4.4.2 Block 734: Biface rough-out

This is a flaked nodule of medium size with cortex present on both the upper and lower faces. The upper surface appears to be slightly patinated suggesting a degree of weathering took place prior to reduction. This patination might indicate that the nodule derived from the talus slope as opposed to straight from *in situ* flint seams in the chalk. The lower surface has seven flake scars, removed centripetally around 60% of the circumference of the nodule. Despite the fact that this nodule has not been bifacially worked it is suggested on the basis of the nodule form and knapping strategy that flaking was aimed at biface rather than flake production. The nodule was abandoned as none of the flake scars successfully travelled across the lower surface, each truncating prematurely due to a region of low relief. The failure to thin the lower surface combined with the globular irregular nature of the upper surface rendered the emerging biface rough-out useless, despite the overall ovate shape of the nodule.

4.4.3 Block 4692: Quartered nodule fragment

This is a sub-rectangular block of flint forming part of a refitting group with three other flakes. The group as a whole suggests a multi-episode reduction sequence occurring at up to three locations and described in the refitting section. The block itself has had a single large flake removed from one face, which also appears to have partially broken along a natural fracture plane and may well have been removed as part of the quartering process.

4.4.4 Block 4145: Biface rough-out

This sub-oval block has a relatively flat underside with three centripetal flake removals. The upper surface is irregular and has three failed flake removals apparently aimed at reducing irregular prominences on the surface. The intended thinning and centripetal, bifacial reduction indicates biface as opposed to flake production.

4.4.5 Block 739: Indeterminate core

This artifact consists of a flat, circular cortical nodule. The nodule has natural fracture planes around 50% of its circumference and only a single flake removal scar on its upper surface, apparently aimed at removing a prominence. On the surviving cortical edge of the artifact some bruising is apparent and of a nature consistent with that produced by use as a hammer. However, the positioning and limited extent of the bruising might suggest that it resulted from failed flake removals in an attempt to thin the piece rather than through use as a percussor. It is impossible to classify this core on the basis of a single flake removal and it has therefore been described as an indeterminate core. It is plausible however, given the flat shape of the nodule, that the piece was originally chosen and transported due to its suitability for biface manufacture.

4.4.6 Block 2884: Indeterminate core

This is a large globular nodule of cortical flint forming part of Refit Group 51. The nodule appears to have been previously quartered with a fractured edge and a large ventral flake surface. The flake surface has been utilised as a platform for the removal of four flakes. The core does not provide evidence for bifacial working or centripetal flaking usually associated with biface manufacture. However, as will later be described in the refitting section, the knapping strategy employed in the reduction of the nodule appears to have been aimed at thinning the nodule rather than flake production. The core was abandoned when this thinning process failed although further flake removals would have been possible if this had been the intention of the knapper. Despite the suspicion that biface manufacture was intended, the block does not conform to the traditional concept of a rough-out and has therefore been classified as an indeterminate core.

4.4.7 Block 3245: Percussor/Indeterminate core.

This artifact is a small, flat, cortical nodule (Figure 4.11). One edge of the nodule has an irregular natural break surface but the remaining two edges have both been flaked and bear bruising from percussion episodes. The two flakes scars, one from each face of the nodule, are both associated with bruised regions of the nodule edge. It is impossible to determine whether the flakes were detached as a result of use as a percussor or whether the bruising resulted from repeated failed attempts to remove the flakes. From the nodule alone it is impossible to resolve this problem, however two flakes were discovered to refit to one of the surface flake scars.

Figure 4.11: Percussor/core 3245

The cortical dorsal surface of one of these flakes was partially covered by bruising consistent with percussion damage prior to detachment. Given the position of the battering, it is entirely unrelated to any attempt at reducing the nodule. The association of the flake removals and the edge battering appear unequivocal, although the possibility exists that after use as a percussor further flake removals were part of an abandoned attempt to thin the nodule. Given the overall shape of the artifact, the knapper might have intend to produce a small biface from the block.

4.4.8 Block 6113: Percussor/ Quartered nodule fragment

This is a fist-sized sub-spherical block of flint apparently detached along a natural fracture line from a globular parent nodule. The cortical face of the nodule bears at least three flake scars resulting from attempts to reduce the irregular surface of this quarter prior to its detachment from the parent body. The centre of the cortical face contains a single circular area of bruising with a diameter of 15mm. The overall nodule shape and size, as well as the nature and positioning of the bruising indicate that this is a percussor.

4.4.9 Block 5152: Percussor/Quartered nodule fragment

This artifact is a relatively small sub-spherical nodule fragment detached from a narrowing region of the parent body. The fragment was not apparently flaked after detachment but bears a lozenge shaped area of bruising, some 30mm long, on its cortical surface. The artifact appears to be a small percussor.

4.4.10 Block 5746: Percussor

This artifact is a water-worn beach pebble. While the whole surface of the artifact has been subject to battering and abrasion through hydraulic action the pebble bears a single flake scar associated at its proximal end with a localised area of battering. The battered region has a rough, fresh texture identical to the bruising on cortical flint hammer stones. Unit 4b contains numerous clasts such as this pebble and it is suggested that the pebble was found by hominins at the site and used *ad hoc* until it fractured.

4.4.11 Block 6959: Percussor.

This is a heavily abraded beach pebble bearing no flake scars but a small, localised area of bruising that appears to be fresh and unabraded. The bruised region is very limited in extent and indicates only a short period of direct percussion.

4.4.12 Block 6111: Percussor

This artifact is a large water worn beach pebble. Like Block 5726 this artifact has a single fresh flake scar associated with a small area of bruising on the nodule surface. While the flake scar is fresh enough to suggest an episode of direct percussion, there is so little surviving bruising on the pebble surface that it is impossible to fully confirm the use of this artifact as a hard hammer.

4.5 Analysis of refitted artifacts.

305 artifacts were refitted from the GTP17 assemblage comprising 16% of the 1795 artifacts recovered. Of these, 46 flakes were refitted into simple proximal/distal conjoins, a further 50 into small ventral dorsal groups and the remaining 209 formed part of eight much larger reduction sequences. In the initial description of the assemblage it was stated that eight discreet scatters of material were identified within the excavation area. All have been at least partially reconstructed through the refitting analysis as can be seen in the distribution of the major refit groups in Figure 4.12. In the following descriptions each major reduction sequence is given a refit group number indicating one of the groups marked in Figure 4.12. Summaries of each reduction sequences, reconstructed through both refitting and technological analysis, are presented. In addition to the documentation of on-site flaking as indicated by the refits, an assessment is given of the condition of the introduced nodule, core or tool

prior to reduction. Finally, the type of artifact that would have been produced from each reduction sequence is suggested.

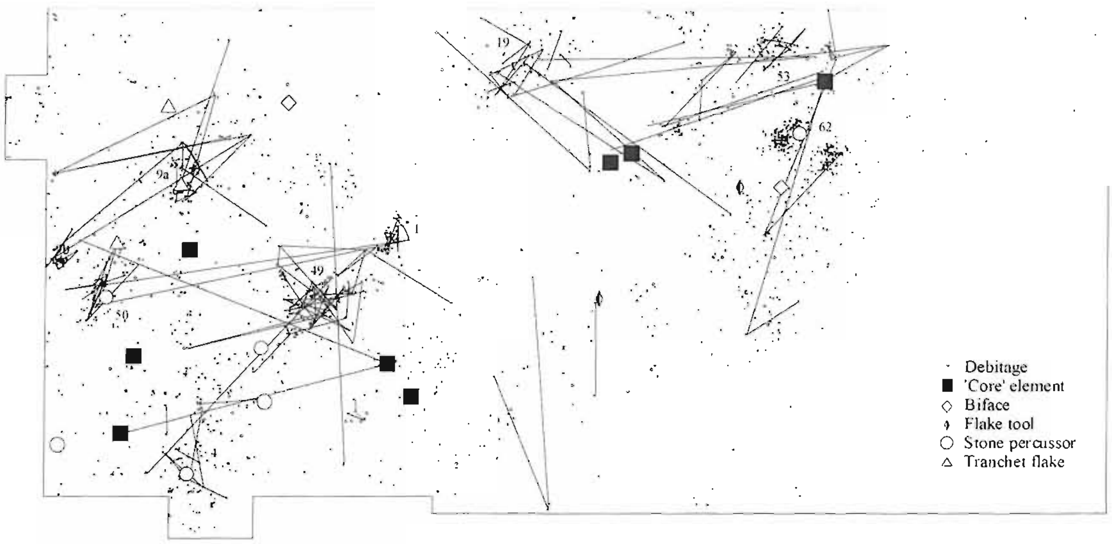


Figure 4.12: Distribution of refits groups, debitage and non-debitage artifacts.

4.5.1 Refit Group 1

Pre-introduction: Original nodule had minimum dimensions of 300mm x 280mm x 100mm. The nodule appears to have been introduced in a partially reduced form. Five irregular protuberances may have been removed. The left side of the core was already reduced by a series of at least six hard hammer blows, which removed the cortex from this edge. The right hand edge appears to have fractured under impact, possibly during an attempt to remove the cortex from this edge. Little of the obverse face remains and it is impossible to tell how much of it had been reduced prior to introduction (Figure 4.13).

Phase 1: 10 part-cortical hard hammer flakes were removed from the left-hand side of the nodule using the relatively flat obverse surface of the nodule as a platform.

This not only removed the cortex from this entire edge of the nodule but partially thinned the nodule at its thickest end.

Phase 2: Reduction of the left side of the nodule. Here internal fractures prevented proper flaking and the side was reduced by a series of blows apparently aimed at removing the fractured material. Angular cortical fragments were produced during this phase, presumably by hard hammer reduction. Reduction ceased along a stable natural fracture in the flint, which was to form the striking platform for Phase 3.

Figure 4.13: Refit Group 1.

Phase 3: Using a natural fracture plane in the flint a series of 6 cortical hard hammer flakes were removed from the top face of the nodule.

Post-flaking: No flaking appears to have continued on-site after Phase 3. The reduction sequence would have resulted in a core/rough-out 220mm long, 130mm wide and varying from 30 to 80mm in thickness. No further trace of this raw material has yet been located within the excavated area and it appears that the resultant core was transported 'off-site'. As no thinning debitage has been attributed to this raw material group there is no evidence to suggest that core was intended for biface production. However the overall 'ovate' shape of the core might indicate a rough-out.

4.5.2 Refit Group 9

Refit Group 9 consists of a group of 21 largely cortical hard hammer flakes. The raw material consists of fine dark grey to black flint with fine grey inclusions (Figure 4.14). The cortex is thin, smooth and blue-white in colour. The refit group was initially considered, on the basis of similarities in raw material and flaking technique, to have formed part of the decortification sequence in Refit Group 1. However no such link could be proved through refitting and it now considered to represent a separate reduction sequence. Four stages can be determined in the knapping sequence and these are described below.

Pre-introduction: The refit group indicates that a number of flake removals had been made prior to introduction. Although the size of the original nodule cannot be known it appears that it had already been significantly reduced across one face. The preponderance of dihedral butts indicates that the opposing face had not only been decortified but that centripetal flaking had significantly reduced the surface and prepared platforms for the reduction of the opposing face. This may suggest that a partially complete rough-out was introduced to the site.

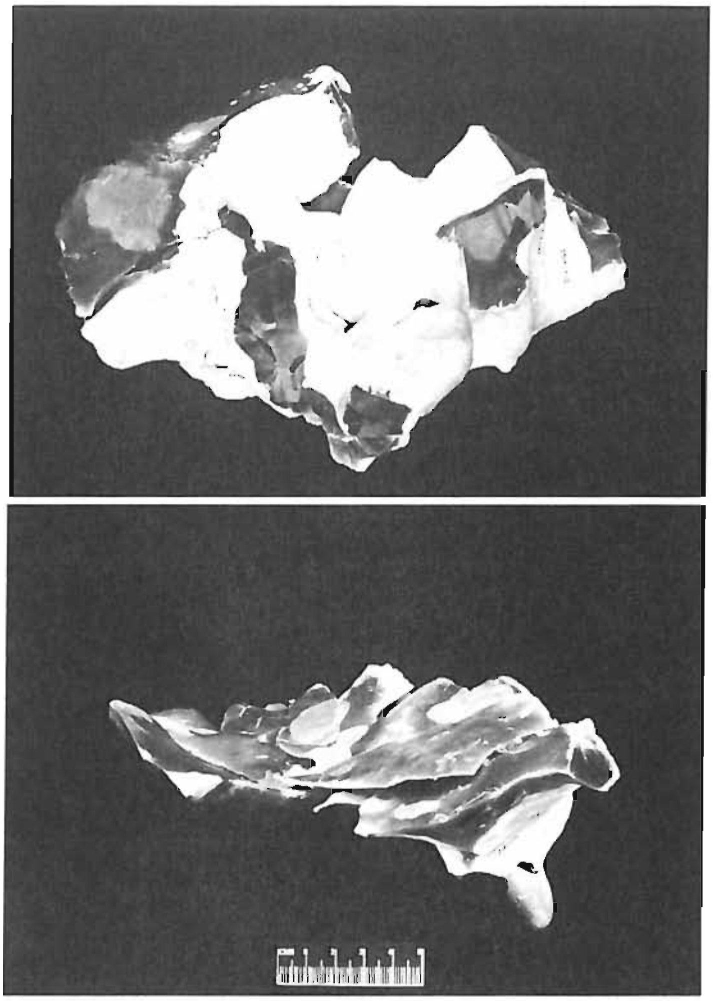


Figure 4.14: Refit Group 9

Phase 1: A series of seven cortical, hard hammer flakes were removed from the left-hand side on the nodule. The initial four flake removals aimed to reduce a protuberance from one of the nodule while the subsequent removals completed the decortification and roughing out process. The rough-out at this stage retained very little cortex and had been bifacially worked.

Phase 2: The nodule was then rotated by 90° in a clockwise direction and two large hard-hammer flakes were removed. The nodule was then apparently flipped by 180° and a series of thinning flakes (missing from the sequence) were removed from the opposite face. The nodule was flipped by 180° again to bring it back to its original position prior to the removal of a further two flakes.

Phase 3. The nodule was then flipped by 180° and rotated by a 90° before the removal of several (missing) thinning flakes. The nodule was flipped again by 180° before the removal of a series of six further thinning flakes. The platforms of some of these flakes are indeterminate although at least two bear indications of soft hammer usage.

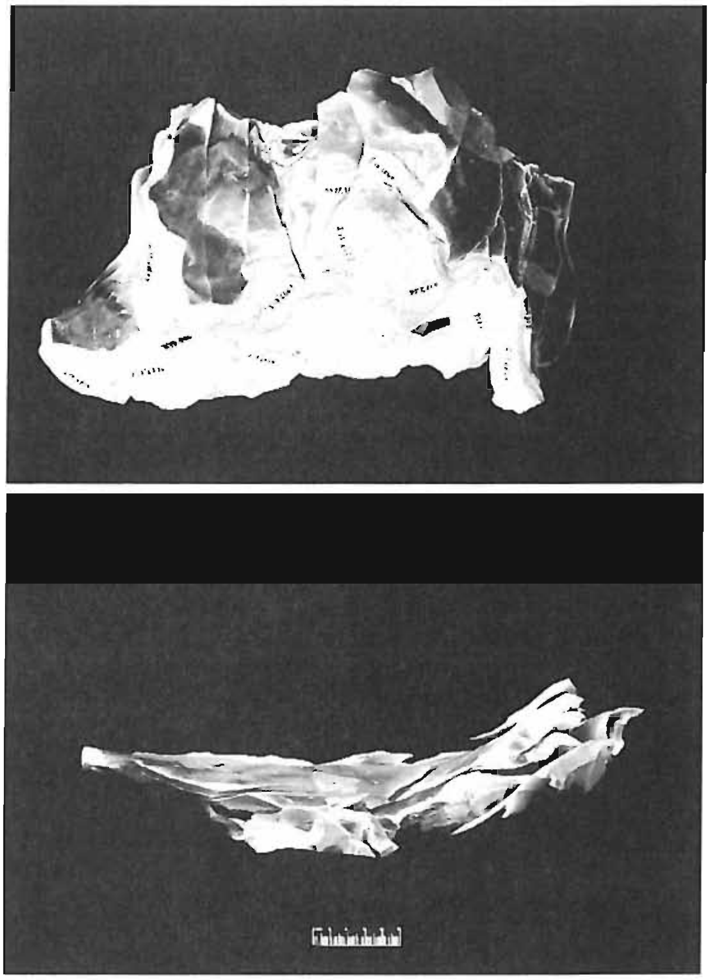


Figure 4.15: Refit Group 19

Despite the fact that many of the flakes failed to travel across the entire surface of the nodule the knapping techniques employed in phases 3 and 4 resulted in the production of a tool blank with an elegant convexity on at least one face. The blank had minimum dimensions of 190mm x 120mm. Many other flakes manufactured from the similar raw material lie in close proximity to this refit group and there is a strong possibility that these resulted from the reduction of the other face of the nodule.

4.5.3 Refit Group 19.

Refit Group 19 consists of a group of 27 partially cortical flakes resulting from the trimming of a rounded nodule edge (Figure 4.15). The raw material consists of a variable dark-grey to olive flint with light grey inclusions, some flakes have a very light patination on part of their surface suggesting a period of exposure, however this process appears to have continued during the time the material has been under analysis. The cortex is relatively thick and off-white in colour and has a particularly coarse internal consistency. Artifacts manufactured from identical raw material have a distribution limited to the northern part of the site. Three phases of reduction are identifiable in the refit group.

Pre-introduction: At least two flakes had been removed from the parent nodule prior to the refitted reduction sequence. The scars of these flakes served at the striking platforms for the initial removals in phase 1.

Phase 1: A series of flakes were removed from a single prepared platform. At least seven removals were made in this phase although only two of the flakes have been successfully incorporated into the refit group.

Phase 2: The nodule was flipped 180° to present the flakes scars from phase 1 as a new striking platform. A series of at least nine flakes were detached from this platform, none of which have been incorporated into the refit group.

Phase 3: The nodule was further rotated to present the original worked edge from which a series of at least twelve flakes were removed (two of which are missing). These flakes appear to cross the edge of the nodule but stepped fractures on the ventral surface of the flakes attest to difficulties in the reduction of this face.

Phase 4: The nodule was rotated anti-clockwise by 90° and two flakes were detached from the lower cortical surface. Through the broadly discoidal pattern of soft hammer flaking employed in phases 3 and 4 the resultant 'core' would present a gentle convexity on its lower surface and would have minimum dimensions of 150 x 80mm. The high platform angles produced by the flaking in phase 2 would require a further episode of thinning of the upper surface of the 'core' to produce a suitable blank for biface manufacture.

Post-flaking: The resultant core element was not recovered and it is assumed it was removed from the excavation area.

4.5.4 Refit Group 4.

Group 41 consists of 11 soft hammer flakes from the thinning of an existent biface rough-out (Figure 4.16). The raw material is a coarse grey-yellow flint with localised brown mottling. The refitted artifacts are all from a localised cluster of similar raw material in the south-west corner of the site.

Pre-introduction: The refitting sequence appears to derive from a previously prepared rough-out that was broadly circular in plan with a diameter of c.150mm. Both faces of this rough-out must have been significantly flaked as indicated by high dorsal scar counts and heavily facetted platforms. The obtuse platform angles on one edge of the block suggest that thinning of the upper face of the rough-out had yet to be fully accomplished.

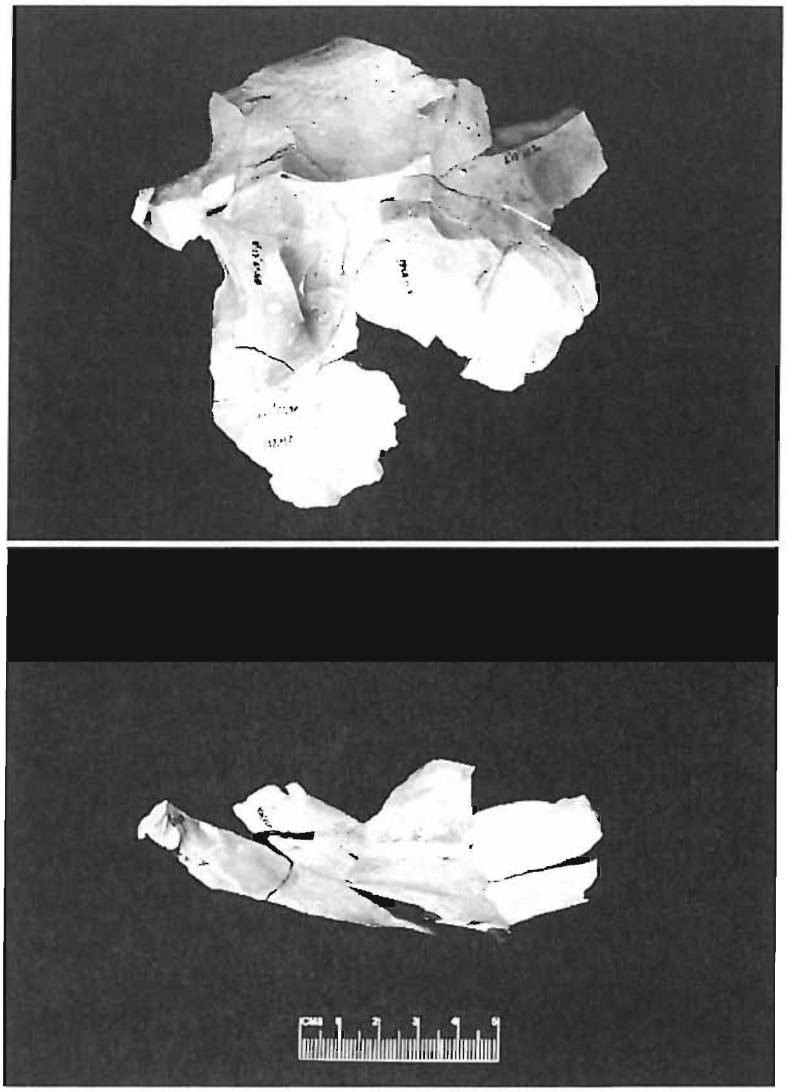


Figure 4.16: Refit Group 4.

Phase 1: The reduction sequence commenced with the removal of two thin flakes that terminate before traversing the rough-outs underside. This resulted in the formation of a high ridge on the underside that was subsequently removed with a single, more substantial blow. The rough-out was then spun by 180° and two flakes were removed but both failed to travel across one face. The rough-out was spun clockwise by 90° and a single flake removal was made which successfully managed to cross the whole lower surface of the rough-out.

Post-flaking: By the shape and overall size of the refit group it would seem apparent that the production of a bifacial tool was intended by the knapper. Despite the high flaking angles, the upper surface of the rough-out appears to have been significantly worked prior to introduction and may have only needed a minimal amount of work to complete the reduction sequence. There is a high possibility that this process was continued *in situ* as many flakes from the same raw material type were found in the vicinity that are consistent with further thinning of the same rough-out. No tool fragments or tranchet flakes were recovered that appear to belong to the same raw material unit. The resultant biface was removed from the area.

4.5.5 Refit Group 49.

This refit group consists of 53 flakes and results from the primary reduction of a large globular nodule and the production of a single biface rough-out (Figure 4.17). It is the most complete and, from a technological point of view, the most informative of all the refitting groups. The group is also distinguished by that fact that it was complete enough to allow Lorraine Cornish of the British Museum of Natural History to make an internal cast of the resultant biface rough-out.

Pre-Introduction: Prior to the refitted knapping sequence at least two removals had been made from the nodule. A single large primary flake had been detached at a point where the nodule surface presented an easily exploitable platform angle. Further flake removals also appear to have been made across this face leading to decortification along a natural fracture surface. The result of this phase of the reduction sequence was to reduce the convexity of this surface and allow it to be subsequently exploited as a striking platform.

Phase 1: A further cortical flake was removed from the same platform described above to remove a protuberance from the surface and further prepare the surface. The nodule was turned so as to present the prepared platform and a series of large, apparently hard hammer flakes were detached across the entire surface of the nodule. The knapper worked from right to left trying to ensure that the flakes travelled across the face of the nodule. At one point the knapper struck too marginally and the flake truncated at the base of a protuberance, but this was corrected by a subsequent, non-marginal blow that removed the irregularity. The entire face was decortified in eight blows but the same process of hard hammer reduction continued from the same platform for a further ten blows.

Phase 2: The nodule was then rotated by 180° in order to keep the same platform in play but to allow it to be worked from the other face. A series of five blows removed an irregularity from this face and a further two large flakes completed the decortification of this entire face. Remaining patches of cortex were then removed from around the intersection of the two flaked surfaces.

Phase 3: The nodule was rotated again by 180° to bring the originally worked edge of the platform back into play and a further ten hard hammer flakes were removed in order to further reduce the bulk of the nodule. The knapping style was non-marginal resulting in well-developed bulbs of percussion. Although the aim of these flakes was to thin the nodule, the strategy appears to have no relationship with techniques employed in the thinning of biface rough-outs. No attempt is made at centripetal working.

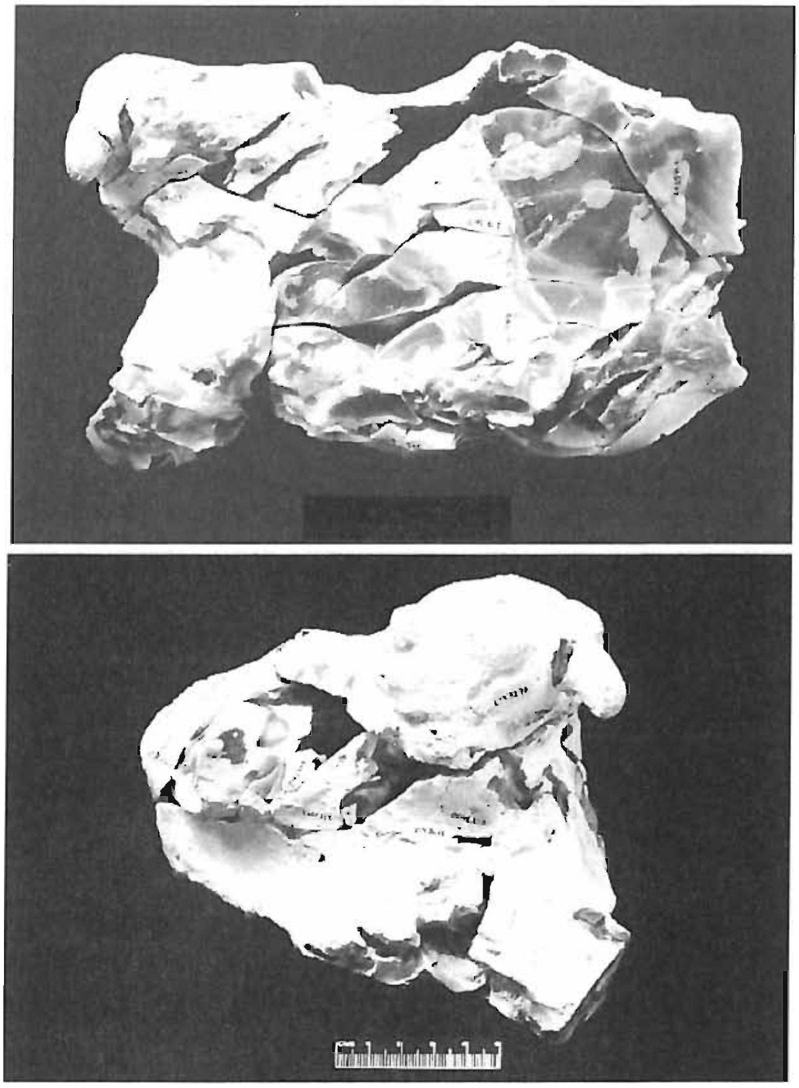


Figure 4.17: Refit Group 49.

Phase 4: The remaining flakes in the refitting group appear to indicate a change in knapping style. Rather than working from the single established platform these flakes are removed centripetally from around the edge of the rough-out. The flakes themselves are thinner, more marginally knapped and appear to be removed in way that is more concerned with controlling the shape and convexity of the resultant 'core' than simply reducing its bulk. Unfortunately only twelve of these flakes have been refitted into the group but a number of other flakes from the parent scatter appear to derive from the same reduction stage and raw material type. None of these flakes is irrefutably from soft hammer percussion but a switch in hammer type at this point is highly likely.

Post-flaking: The internal cast of the refitting sequence produced a core element 200x150x70mm. While a general convexity was apparent on both faces of the core, the remains of the prepared platform and the intrusive nature of the hard-hammer percussion scars suggest that a rough-out rather than a finished tool resulted from the reconstructed reduction sequence. The thinning debitage derived from the same raw material type and scatter indicates that reduction continued beyond this point and that the rough-out was further shaped. However none of this debitage had heavily facetted, retouched platforms or tranchet edges that can definitely confirm the finishing of a biface. What is certain is that the resultant tool or tool blank was eventually removed from the excavation area

4.5.6 Refit Group 50.

This group consists of 17 flakes from the thinning and finishing of a well-developed rough-out or partially finished biface (Figure 4.18).

Pre-introduction: A partially complete biface/rough-out was introduced with at least six large flake removals from one face. The faceted platforms on the flakes comprising this refit group suggest that, in addition to this, extensive thinning of the opposite face had taken place. All the previous removals have a blue-white patina suggesting that the tool may have been in existence for some time prior to this flaking episode. However such differential patination might also be a product of a period of partial burial.

Phase 1: Six flakes were removed from the right side of the rough-out. All appear to be of soft hammer manufacture, two lack their proximal parts and of the remaining flakes two are facetted and two quite bruised along their platforms. All flakes are partially cortical but consistent with the thinning stage of biface manufacture.

Phase 2: At least five small soft hammer flakes are removed from the tip. The knapping at this stage is marginal and concerned with working the edge of the tool rough-out. The flakes, which are thin and soft hammer derived, are consistent with the final finishing stage of biface manufacture. Similar attention appears to have been paid to the opposite edge of the tool. The tip and the bruised left lateral edge of the tool is then removed by three more substantial blows apparently aimed at thinning and rejuvenating the bruised edge of the tool. This part of the sequence suggests a switch from thinning to finishing and back again as the tip and cutting edge of the tool is constantly prepared and modified.

Phase 3: Two long soft hammer thinning flakes were removed from the tip in order to remove the last trace of cortex from around the tip of the tool and to reduce the thickness of the tool at this end. Once more the knapper switched to removing smaller flakes from the tip of the tool in a manner apparently consistent with the final finishing of a bifacial tool. Once prepared the tip was partially removed with a non-marginal soft hammer blow from a left-hand side. The knapper switched back to retouching the tip before again employing a more invasive soft hammer blow, this time from the right hand edge. This blow may have been an attempt to remove a badly bruised portion of the tool edge in preparation for retouching. However, the flake took with it the entire prepared tip of the tool and truncated in a hinge fracture half way across the tool surface. On morphological grounds the flake has been

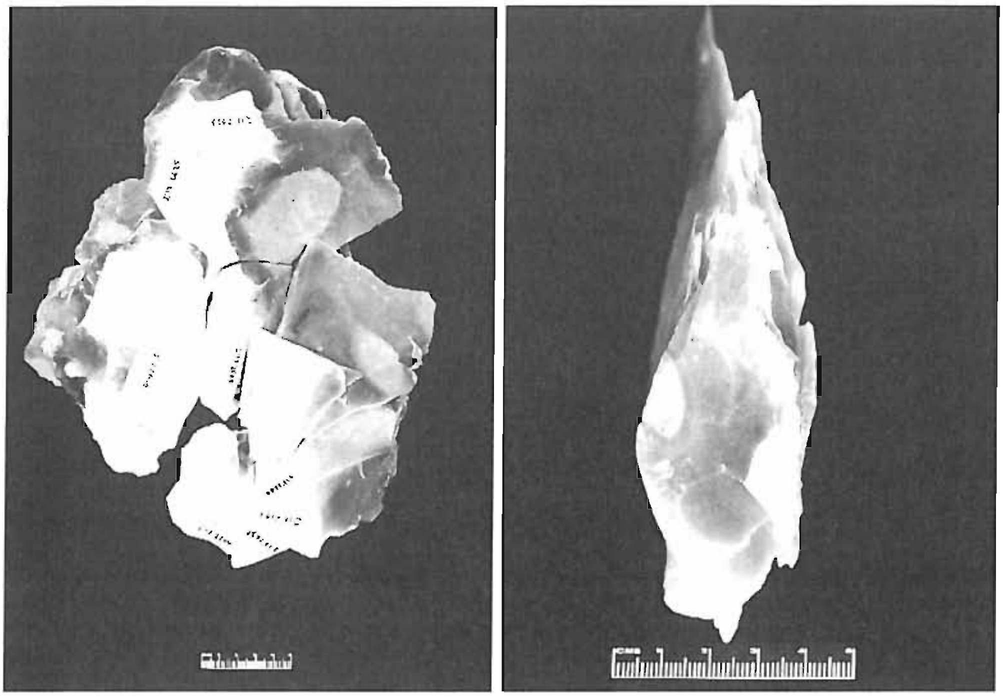


Figure 4.18: Refit Group 50.

interpreted as a tranchet and it is possible that the flake was intentionally removed to produced a cleaver like tip to the tool.

Post-flaking: The resultant tool was removed from the area.

4.5.7 Refit Group 51.

This group consists only of five flakes refitting to a large cortical nodule. The raw material consists of a fine-grained black to brown flint with some large, coarse grey inclusions. The cortex is white, relatively fine-grained with a mottled appearance and includes many small coral fossils. Two reduction phases are present and these are described below.

Pre-introduction: Prior to introduction to the excavated area the nodule appears to have been quartered. Two opposing lateral ends have been removed resulting in the shattering of the flint along internal fractures. Some older, patinated fracture scars suggest that the nodule had already begun to break up prior to hominin modification. The fracture plane at the narrow end of the nodule revealed a heavily faulted surface apparently unsuitable to further reduction as this end was not further modified. The broader fracture plane on the opposite face of the nodule revealed a face of black unfractured flint, relatively free of faults or inclusion save for a small portion of the upper surface.

Phase 1: After introduction to the excavated area the broad fracture plane was used as a platform for a series of four flake removals. While the fracture plane provides a wide, broad area for reduction these flakes were all struck from edge of the plane which was particularly fractured and contained coarse inclusions. While the intention may have been to remove these inclusions two other factors may have influenced the location of these removals. The upper edge provides a good acute angle between platform and dorsal face for successful flake removal, whereas the obtuse angles of the underside would have prevented successful reduction at this point. The upper surface also contains a series of four protuberances on the nodule surface, which it may have been the intention of the knapper to remove.

The initial flake removal appears to have been aimed at removing one such protuberance but the flake failed to travel and terminated in a hinge fracture where the flint began to thicken out. A second more powerful blow was made from directly behind the first that successfully removed the protuberance but terminated at the base of a second larger one. The two further flakes may have also been removed at this point as they were detached along fractured planes shared by the initial flake removal. However the flakes were recovered from the site at significant distances from each other and from the core suggesting possible movement between the removals. The scars left by these three flakes resulted in the loss of a usable platform angle offering no hope of successfully thinning the nodule further.

The sequence appeared at first to be an episode of simple core reduction from a single platform. As such it conforms to the kind of *ad hoc* reduction of raw material that characterises both Clactonian and Acheulean non-bifacial Acheulean technology. Yet had flake production be the sole aim of the knapper in this case, failure to thin one face of the block would not have prevented further reduction of the core. That the core was abandoned at this stage may suggest that the intention was to thin the nodule for biface manufacture. If this was the case then we might view the quartering and removal sequence as a technique for producing bifaces from globular raw materials. In this process a single broad platform is produced for the removal of large hard hammer flake from both the upper and lower surfaces of the nodule, this results in the flattening of the nodule and the production of a blank for biface manufacture. This method is identical to that employed in Refit Group 49 which led to the successful production of a biface rough-out from a globular nodule.

4.5.8 Refit Group 53

Group 53 consists of flakes from a short episode of hard hammer reduction. The raw material consists fine-grained flint with varied colouring from yellow with beige inclusions to dark blue with grey inclusions. The cortex is also fine grained, relatively thin and pure white in colour. Three knapping episodes can be identified and these are described below.

Pre-introduction: The distal ends of five flake scars are preserved on the striking platforms and cortical edges of flakes in this refit group. They suggest decortification of the upper surface of the nodule.

Phase 1: The nodule was rotated 90° to position the flakes scars produced off-site for use as striking platforms. At least sixteen flakes were then removed from this platform including the nine included in the refit group. All the recovered flakes are partially cortical and this episode appears to have been undertaken in order to remove the edge of a cortical nodule at the point where it thinned to an approximate thickness of 70mm. This phase includes the removal of flake 2069, a large block of flint interpreted in the technological analysis as a 'quartered' nodule fragment

Post: The reduction sequence described above resulted in the production of a core with a convex underside and approximate dimensions of 100 x 150mm. No remains of this core have been recovered and only a small number of debitage fragments in the GTP17 assemblage appear to derive from the same raw material type. It is therefore suggested that further reduction of the core took place at an off-site location. Given the size and convexity of the resultant core it is suggested that it would have formed a blank for biface manufacture and therefore Refit Group 53 has been interpreted as part of a roughing-out sequence.

4.6 Technological Overview.

The analysis of assemblage composition indicates that all stages of biface production (roughing-out, thinning and finishing) had taken place at the site. Beyond establishing this fact, it was only possible to determine the exact nature and sequencing of the hominin reduction strategy through refitting analysis. Seven distinct knapping scatters were identified in the distribution of lithic material at the site, all have been at least partially reconstructed through refitting and are at least suggestive of biface manufacture. In four cases we can document the production of biface rough-outs and at least two sequences appear to result in the production of finished bifaces. However, none of the refitted sequences as yet document a complete reduction sequence from initial roughing-out to the final finishing and edge preparation of the tool itself. While this evidence is potentially significant, it must be stated that there are inherent problems with determining the extent of the reduction sequence from refitting analysis alone. One of the biases worked into the process of refitting is the difficulty in conjoining material from the later stages of biface manufacture. Large cortical flakes are easier to refit that the thinner, fragmentary elements produced by soft-hammer thinning and finishing. Consequently it is possible that many of the postulated rough-outs may have been further reduced on-site, especially in cases where debitage of consistent raw material type and diagnostic of biface finishing was recovered from the associated scatter. The relative ease with which large cortical flakes can be refitted does however mean that evidence for previous flaking episodes prior to introduction to the site is more compelling. In all cases part of the initial reduction sequence was absent, and in two cases it appears that biface rough-outs had been partially thinned prior to introduction to the site. As refitting favours the incorporation of primary flaking elements it is suggested that their absence in the sequences is a real phenomenon of hominin behaviour. Only further refitting can properly test the validity of this theory.

Two distinct biface reduction strategies appear to have been employed at the site. The employment of each appear to have been dependant on the shape of the original raw material.

1. Where the raw material was relatively flat, flakes were struck centripetally across one face of the nodule, removing the cortex and further reducing the overall convexity of the face. The nodule was then flipped to present the opposite face and the flake scars from the first knapping phase were used as platforms for the subsequent

removals. The process of centripetal flaking apparently continued throughout the reduction sequence with the roughing-out stage blending seamlessly with thinning of the tool blank. Flaking becomes more marginal throughout this process and soft hammer flaking is often more plainly evident in the final stages. Reconstructing the final stages of the reduction sequence (finishing) is difficult as it results in debitage too fine to extensively refit. Finishing has only been documented where, as in Refit Group 50, a prepared edge has been removed as a result of tranchet removal or in a switch to more invasive thinning reduction after a short episodes of edge preparation. Interestingly, in the case of Refit Group 50, no firm phase division can be made between thinning and finishing, with the two processes sometimes alternating as platforms are prepared, retouched and then 'rejuvenated'.

2. A second, distinct reduction strategy was employed where the raw material was more globular, with an overall rounded surface presenting no immediate opportunity for bifacial reduction. In these cases (documented in Refit Groups 1, 49, and 51) the initial stage was the attempt to remove a large segment of the nodule through heavy percussion to produce a platform. In practise this process may have been quite variable, for example in Refit Group 49 a natural, flattened part of the nodule was emphasised by the removal of three hard hammer flakes. The nodule in Refit Group 51 was broken in half by a massive blow while the original nodule in Refit Group 1 was more formally quartered. In each case the break surface allowed the globular nodule to be bifacially worked from a single platform. The crucial factor in producing a workable biface rough-out was the successful reduction of the bulk of the nodule through the removal of large, hard hammer flakes. If achieved, this preparation allowed an irregular, globular nodule to be worked into a biface rough-out with relative ease. The successful employment of this strategy can be seen in Refit

Groups 1 and 49, but an irregularity on the surface of nodule 51 prevented the preparation of one face and the nodule was subsequently abandoned. Once a bifacially reduced and relatively flat rough-out had been prepared, the single platform technique was abandoned and the apparently usual method of centripetal flaking, previously described, could have been employed to complete biface manufacture. The transition between the two techniques is only documented in Refit Group 49.

It has previously been suggested that where local raw materials tend to be globular in shape, core and flake production would predominate over biface manufacture (White 1998a). The evidence from GTP17 appears to indicate that hominins could develop techniques to successfully utilise raw material shapes that were initially incompatible with easy biface manufacture. If the interpretation of Refit Group 51 as an abandoned attempt at biface production is correct, then it is possible that in some cases it would be impossible to distinguish between the early stages of biface manufacture from globular raw materials, and some flake production cores. At GTP17 there is no clear evidence for direct flake production from cores although discarded flakes were utilised with minimal modification or bifacially worked into non-classic bifaces.

4.7 Discussion: Behavioural implications of the GTP17 stone tool assemblage.

The evidence from the debitage analysis, refitting and the nature of the abandoned artifacts suggests that the technology of the GTP17 assemblage is largely the product of biface reduction. All stages of biface manufacture are present at the site although in no single case has an entire biface reduction sequence been demonstrated in either a single spatial scatter or refit group. There exists a degree of fluidity between the thinning and finishing stages of biface manufacture as apparently finished tools introduced to the site were subjected to short episodes of edge modification and thinning, in Refit Group 50 this was especially evident in flakes removed from the tip of the tool. The movement and modification of a finished tool within the landscape has previously been postulated (Roberts *et al.* 1997) but never before so clearly demonstrated through refitting. The evidence indicates that the modification of tools, through thinning, edge preparation and tranchet flake removal, possibly helped to increase the useful life of a biface and formed part of a general but contingent strategy of tool transport by the Boxgrove hominins. With material being introduced to the site at various stages of completion and apparently finished tools being subjected to short episodes of reshaping, it would certainly appear that the hominin chaîne opératoire was occasionally protracted across more than one location. Francis Wenban-Smith has suggested that bifaces would have been well suited to extensive transport and reuse in situations where access to raw material sources was restricted (Wenban-Smith 1998). Given the evidence for transport at Boxgrove over short distances and in close proximity to an abundant flint resource, the evidence from GTP17 and other Boxgrove sites suggests that the tools were also extensively transported without such pressures.

While the full extent of tool transport and reutilisation cannot be determined through the analysis of the GTP17 assemblage in isolation, simple on-site/off-site behaviours can be reconstructed. Such an approach has been successfully applied to Lower Palaeolithic sites before, suggesting that from the earliest stages of tool use hominins operated complex systems of raw material transport and multi-location reduction sequences (Schick 1987a; Conway *et al.* 1996). A summary of the evidence from GTP17 for the transport of raw materials and finished tools is shown in Table 4.2. Some possible implications of this evidence are outlined below.

Refit Group	Transported to site as	On-site reduction	Transported off-site as
1	Tested nodule	Primary hard-hammer flaking	Biface rough-out/core
9	Partial rough-out	Primary flaking /subsequent thinning	Biface/rough-out
19	Tested nodule/rough-out	Some soft-hammer thinning	Biface/ rough-out
4	Rough-out/Biface	Predominantly soft-hammer thinning	Biface
49	Tested nodule	Primary flaking subsequent thinning	Rough-out/biface.
51	Tested nodule	Soft-hammer thinning	Rough-out
50	Biface	Finishing (tranchet removal)	Biface
53	Tested nodule	Primary hard-hammer flaking.	Rough-out/core
62	Indeterminate	Soft-hammer thinning	Biface

Table 4.2 : Summary of refit groups from GTP17 Unit 4b.

4.7.1 Raw material provisioning/on-site transport

The silts comprising Unit 4b regularly contain archaeological material but it is generally of a low-density nature (Q1/TP1, Q1/TP10 this volume) or comprises a discrete and isolated scatter as at Q1/A (Austin 1994, Roberts and Parfitt 1999). The continuous distribution of archaeological material seen in the 4c horizon, is unknown within Unit 4b (Roberts *et al.* 1997). The rapid and constant accretion of sediment during the formation of the unit appears to have prevented stable landsurfaces from forming. Consequently, any hominin occupation of the lagoon edge during the formation of Unit 4b would have taken place in a virtual vacuum of visible and accessible archaeological material. This would have meant that the GTP17 assemblage could not have formed over an extended period of time and would not have occurred as part of a locally visible distribution of artifacts. The archaeological signature of the 4b environment was therefore quite different to that described by Glynn Isaac at Koobi Fora. Here it was possible to see that large accumulations of artifacts formed against a background of continuous but variably dense spreads of artifactual material, this distribution pattern was to form the basis for Isaac's 'scatters and patches' approach to hominin land use analysis (Isaac 1981). However, a situation comparable to GTP17 was encountered during the excavations of Middle Palaeolithic sites in the Maastricht-Belvedere region (Roebroeks *et al.* 1992). Site J, which similarly formed within a locality virtually devoid of previous occupation traces, was described as being 'parachuted' into its location.

With the occupation episode at GTP17 occurring at a locality devoid of any previous archaeological signature, all materials used at the site would have to be provisioned from elsewhere. It has already been established that large, minimally worked units of raw material, as evidenced in some abandoned 'cores' and Refit Groups 1 and 49, were probably fetched from the talus slopes of the cliff 25-40m to the north of the site. In all of these cases some primary flake removals appear to have been made prior to introduction to the site. This evidence supports previous analysis of other Boxgrove assemblages in suggesting that hominins may have routinely tested or partially prepared materials at source prior to transporting nodules to activity areas for further reduction and use (Bergman and Roberts 1988; Austin 1994; Roberts and Parfitt 1999). Through this precaution the unnecessary transportation of internally flawed or otherwise unsuitable raw material was reduced. If such a strategy were in operation at GTP17, the high incidence of abandoned part-worked or internally flawed nodules would indicate that it was only partially successful. It is possible that a balance was struck between the energetic expense of transporting unsuitable raw material and the obvious advantage of maintaining a strong presence around the horse carcass in order to prevent intervention from other carnivores. It has already been suggested that the provisioning of the site with flint implied social co-operation within the hominin group with part of the group acquiring flint, while others kept the carcass secure (Roberts and Parfitt 1999).

The apparent introduction to the site of more extensively prepared material and partially finished tools requires more consideration. The observation itself might be spurious and simply a product of incomplete refitting or the spatial limits of the excavation area, but both possibilities have already been considered and seem unlikely. However, spatial separation of the chaîne opératoire has been previously documented in the investigation of other Boxgrove localities. At Q1/A a broken element from a partially reduced biface was introduced to the site prior to further reduction (Austin 1994; Roberts and Parfitt 1999), while at Q2/A a finished biface was introduced to the site and tranchet-sharpened prior to discard (Bergman and Roberts 1988). The evidence suggests that material at all stages in the chaîne opératoire, including both finished tools and unmodified raw material, was routinely transported within the landscape.

4.7.2 Discard and 'off-site' transport

After reduction and use at the GTP17 locality, material was either immediately discarded or transported out of the excavated area. Discard behaviour was documented through the direct recovery of both manuports and finished tools at site, while the transportation of artifactual material had to be inferred through the failure of incorporating finished or partially reduced rough-outs into the major refitting groups. It has been demonstrated in previous studies that hominin transport and discard behaviour is highly variable at Boxgrove. Francis Wenban-Smith, in comparing the Unit 4c assemblages from Q2/C and Q2/D, contrasted the relatively high number of discarded bifaces at Q2/C with the absence of such tools at Q2/D, despite the fact that similar quantities of biface manufacturing debitage were recovered from both sites. In addition to this, Wenban-Smith was further able to demonstrate, through comparison with knapping experiments, that some of the bifaces manufactured at Q2/C were subsequently removed from the site (Roberts *et al.* 1997). Sites Q1/A and Q2/A similarly indicate the 'off-site' transport of finished or partially finished tools (Austin 1994; Bergman and Roberts 1988; Roberts and Parfitt 1999), a situation that contrasts with the relatively high proportions of discarded finished tools at Q1/B and Q1/TP1 (this volume). Beyond Boxgrove other landscape studies suggest that spatial variation in discard/transport behaviour is a common feature of the Acheulean, examples of these include Olorgesailie (Isaac 1977; Potts 1994), Olduvai Gorge and Barnham (Ashton *et al.* 1999).

The GTP17 flint assemblage, comprised as it is of debitage, 'cores' and tools, represents only the discarded elements of the material produced and utilised at the site. The 'core' elements appear to represent either failed attempts at biface production, quartered elements from larger blocks or minimally reduced nodules. None of the 'core' elements appear to have been discarded due to being 'worked out', although such artifacts were recovered from Q1/B (this volume) and Q2/A (Bergman and Roberts 1988). The small assemblage of four tools comprises one flake with a trace of use damage, two bifacially worked flakes and a broken biface fragment. The two bifacially worked flakes are both broadly ovate in shape and could have been used in an identical manner as a biface, with the larger of the two tools showing macroscopic edge damage which most probably derived from use. Given the technological context and overall morphology of these tools they could be considered non-classic bifaces (Ashton and McNabb 1994).

The refitting analysis makes it possible to infer the 'off-site' (or at least off-excavated area) transportation of artifacts. It can be established, through refitting, that possibly seven finished or partially finished tools were in existence at the site. These tools were essentially core elements produced through *faconnage* (Boeda *et al.* 1990), not flake-derived tools such as the recovered tools. The evidence suggests that, after reduction and use, these bifaces and rough-outs were removed from the excavation area to another locality. 'Off-site' transport was not limited to stone tools, as while analysis of the debitage suggests that soft hammer reduction had certainly taken place at the site (Wenban-Smith in Roberts and Parfitt 1999), none of the bones recovered from the site appear to have been used as a percussor. This evidence combined with the find of an apparently curated soft-hammer at Q1/B suggests that organic percussors were routinely transported by hominins.

The destination of the departing hominins and the eventual location of discard for the transported material is impossible to determine. If it is accepted that the site represents a single horse butchery event then it is probable that the site would have been abandoned before nightfall, due to the obvious dangers of 'nesting' around a carcass. It is sometimes suggested, although impossible to prove, that the forested downs above the cliffline would have made a suitable nightly refuge, it is therefore feasible that some of the tools were removed from the lagoon-edge environment altogether. As our excavation area comprises only a portion of the true extent of the horse butchery site, the possibility exists that the inferred 'off-site' material actually lies within a few metres of the site edge. While the eastern and southern limits of the distribution of material can been seen within the excavation area itself, the distribution of butchered bone and stone tools extends westward by a further 3m and an undetermined distance to the north. Given that artifact densities fall towards the north and west of the excavated area and that most of the axial elements of the horse have been recovered, we might conservatively expect to have majority of the activity area within our excavation. To suggest that discarded tools and primary reduction stages of the refit groups lie in the unexcavated portion of the site would therefore require accepting a high degree of intra-site spatial organisation. Accepting this hypothesis would require the butchery site to have specialised 'activity' areas with the spatial separation of tool production stages and biface discard and the discard of hard and soft percussors. Such an explanation, in requiring a degree of spatial organisation beyond that generally accepted to be present in the Lower Palaeolithic, would be less economic than envisaging movement to another location altogether.

The patterns of inferred 'off-site' movement of material from GTP17 indicates that a discriminate pattern of artifact discard and transport was in operation by hominins at Boxgrove. In documenting both the discarded and transported elements it is possible to directly access the discriminatory decisions being made by the hominin group. From this it is possible to argue that formally reduced 'classic' bifaces were selected over 'non-classic' flake-derived bifaces and that soft-hammers curated in preference to stone percussors. The discard of substantial blocks of raw material and large, usable flakes is unsurprising given both the proximity of the raw material source and the emphasis on biface production at the site. The other striking feature is that all complete bifaces were selected for removal from the site.

4.8 Conclusion: Towards a model of Acheulean assemblage variability and site development.

The archaeology at GTP17 appears entirely consistent with a short episode of group activity involving the manufacture of flint bifaces in direct association with the butchery of a single horse carcass. Given the unremarkable inter-tidal setting of the site no reason other than the presence of a horse carcass can be offered for its location (Roberts and Parfitt 1999). The activity occurred within a local environment devoid of visible or usable artifactual material other than naturally occurring water-rolled cobbles and so had to be directly provisioned with raw materials. This was accomplished by both the introduction of partially finished rough-outs and by individuals transporting tested material from the cliffline 30-40m to the north of the site. Bifaces and flake tools were manufactured and possibly used at the site in order to butcher the horse carcass. Once butchery was complete the hominins abandoned the site taking with them deliberately selected artifactual material and possibly some carcass elements. Formally manufactured ovate bifaces were selected for transport over 'non-classic' flake-derived bifaces and organic soft hammers chosen over flint pebble percussors. Given the sedimentary context, the single carcass, the minimal evidence for utilisation of debitage and the absence of cut-marks super-imposed over carnivore gnaw marks it is suggested that the site was not a focus for further hominin activity.

The GTP17 flint artifact assemblage has a number of features that could usefully be used to directly compare the site with other Acheulean assemblages including the other Boxgrove excavations. The assemblage comprises a number of relatively complete biface reduction sequences including a large quantity of primary material. Complete classic handaxes are absent from the site, 'non-classics' and tranchet flakes are present. Some of these variables have been indicated as potentially significant, such as the differences in primary debitage and biface counts between the sites of Q2/C and Q2/D (Wenban-Smith in Roberts *et al.* 1997). At GTP17 the assemblage characteristics are particularly significant in that we have a clear contextual association with a single short-term episode of butchery.

Having such a distinctive archaeological signature clearly associated with a very specific functional and temporal context offers an excellent opportunity in the future to begin modeling assemblage variability. Beginning from the premise that short-lived group butchery episodes in the Acheulean will produce archaeological signatures similar to GTP17, the model might help to determine the controls underpinning Lower Palaeolithic assemblage formation. The model derived from the GTP17 evidence suggests that sites with high numbers of finished tools might indicate established occupation within a locality and easy access to tools or raw materials, negating the need for hominins to habitually curate material. The possibility therefore exists to distinguish and contrast assemblages on the basis of archaeological signatures indicative of 'single-episode' or 'established' occupation within a given palaeoenvironment. Further to this we might begin to model the overall effect on assemblage composition that the progression from a single episode 'pioneer' site to an established 'multi-phase' occupation area might have. Schick has already suggested that in an area of established, repeated occupation, tool discard rates will increase as the perceived pressure on raw material availability is lessened (Schick 1987a) due to 'passive storage' of abandoned artifacts in the vicinity. A similar model has been forwarded by Potts (1988). The model can also be link to Ashton's Static Resource model, which contrasts the archaeology of sites based on the exploitation of mobile resources, such as game, with sites based on predictable, fixed resources such as a water-hole (Ashton *et al.* 1998).

The GTP17 artifact evidence suggests that where an assemblage starts to become tool-rich, through re-use, selective discard of particular forms over preferred types would have occurred. Given the compelling evidence indicating a hominin preference for ovate bifaces during the Middle Pleistocene (White 1998a), it follows that selective discard would result in the more extensive curation of these types than pointed or 'non-classic' forms. Such a model might also be usefully applied to distinctive assemblage types such as the Clactonian, where the occurrence of non-classic bifaces has been documented (Ashton and McNabb 1994) as well as the juxtaposition of developed Oldowan and early Acheulean assemblages (Leakey 1971; Schick and Toth 1993). The model suggests that selective artifact transport and discard should be considered alongside technological, environmental and functional factors in explaining morphological and technological variations in assemblage composition.

In seeking to explain the formation of biface accumulations the analysis of GTP17 raises two important points. Firstly, bifaces were not simply discarded at butchery sites after use and biface accumulations do not just simply represent aggregational by-products of site re-use. The GTP17 evidence suggests that the discard of bifaces was somehow contingent on other factors or possibly controlled by context. Secondly, these factors had an effect on group behaviour as well as that of the individual, the GTP17 evidence shows that all those hominins manufacturing tools subsequently removed those tools from the occupation area. The corollary of this observation is that, given the right conditions, all hominins would discard their tools at other locations away from their initial manufacture and first use.

If we are dealing here with group behaviour patterns, the effect of context on assemblage composition is going to be marked; especially when dealing with sites which maintain particular characteristics over a period of time and which was visited on numerous occasions. In the next chapter, assemblages from such a locale, the Q1/B waterhole, will be examined in light of the GTP17 evidence. Q1/B represents a biface-rich but taphonomically altered and repeatedly occupied site. What the assemblages lack in resolution they make up in terms of the wider significance of inferences drawn from their analysis, being the product of repeated, long-term behaviour patterns. Accessing and correctly interpreting this record will however require detailed consideration of site formation processes. Through the application of taphonomic analysis and the use of the GTP17 evidence as a high-resolution benchmark it is hoped that wider, habitual behaviour patterns underpinning assemblage variability at the site can be isolated.

Chapter 5: Isolating behaviour patterns at repeatedly occupied locales. Evidence from the hominin locality Q1/B.

5.1 Introduction.

In this chapter it is intended to develop and test the results of the GTP17 study (Chapter 4), through comparison with assemblages excavated from a locale within the Boxgrove palaeolandscape which was repeatedly occupied. While GTP17 provided an exceptionally fine grained record relating to a single vertically discrete occupation horizon, at the Q1/B locality a more complex configuration of assemblages were recovered from a series of freshwater beds. Within these silts and sands, over 15,000 artifacts >20mm were found in direct association with the butchered remains of large mammals (Figure 5.1). Given the number of carcasses, the quantity of artifacts and spread of material throughout the sequence it was considered from that outset that this might represent a locality repeatedly exploited by hominin groups over a long period of time. The freshwater context provides an adequate explanation for the attraction of the site, with its access to drinking water, concentrations of game and, presumably, vegetable resources. However, the freshwater sediments, sometimes contained coarse clast components and often exhibited erosive boundaries suggesting an occasionally dynamic depositional environment, with major implications for the integrity of the assemblage. Thus, Q1/B represents a very different type of dataset to GTP17, this difference will be utilised here to apply the results of the GTP17 study at a higher level of spatial and temporal inference. In addition, differences in assemblage integrity and time-averaging effects between the two contexts requires a change in analytical approach to one based more on taphonomic analysis than detailed reconstructions of artifact histories. Thus, in this chapter it is intended to exploit the differences between the two sites in order to isolate the controls underpinning biface discard patterns indicated at GTP17. Through the somewhat coarser record of Q1/B such behaviour will be related to the nature of occupation and wider patterns of land use. Given the taphonomic problems with Q1/B this chapter will rely more on a detailed reading of site formation processes in order to isolate real behavioural controls over assemblage composition.

The technological features of this assemblage were recorded by Dimitri De Loecker as part of Boxgrove Project D (Roberts *et al.* in prep). In this chapter, compositional differences in assemblages from the site identified by De Loecker will be analysed in terms of taphonomic indicators of assemblage modification. This must be done in some detail in order to establish the degree to which observed characteristics are a product of post-depositional modification of hominin behaviour. A thorough consideration of taphonomy has, during the past 20 years of Lower Palaeolithic research, become an established precursor to technological analysis and behavioural interpretation. Its role is especially important in the study of open-air sites, as within any given sedimentary basin, depositional environments can be extremely variable. Broadly contemporary assemblages are located in contexts as diverse as fluvial channels, lake margin silts, palaeosols or colluvial flow deposits. Within each context, stone tool assemblages are likely to undergo specific and distinctive processes of transformation directly related to the speed and nature of sedimentary and post-depositional processes (Stern 1993; 1994, Isaac 1977, Schick 1986). Changes in composition and distribution by these processes should

Figure 5.1: Excavating at Q1/B. Artifacts (mainly bifaces) resting on erosive contact with overlying freshwater silts.

now be isolated before possible functional, behavioural or technological inferences can be drawn from the archaeological record. The need to account for natural agents in assemblage formation has led to the regular application of a number of recognised analytical techniques, many borrowed from vertebrate taphonomy, in the analysis of Lower Palaeolithic assemblages (e.g. Schick 1986, 1987b; Isaac 1977; Sahnoumi 1998; Ashton *et al.* 1998; see also Chapter 2). By applying this raft of techniques, it is possible to establish the degree to which an assemblage is compositionally intact and has been size-sorted or rearranged by hydraulic activity. However, the eventual goal for such studies, where possible, should be the isolation of anomalous or distinctive assemblage characteristics that have no obvious natural origin and might therefore be product of behavioural processes.

While in Chapter 3 a taphonomic analysis was undertaken for GTP17, the sedimentary context and spatial arrangement of the artifacts indicated that material was either *in situ* or minimally disturbed. In many ways the analysis here was employed simply to test the assumed high degree of preservation. At Q1/B, however, the depositional context of the artifact assemblages was quite different, being preserved in a complex, atypical sedimentary sequence reflecting a range of apparently more dynamic and diverse depositional environments. The atypical stratigraphic sequence at the site reflected the involvement of fluvial activity at the Q1/B locale, both in the initial incision of a channel at the base of the sequence and throughout the series of later spring-fed, freshwater sediments. During the excavation of these sediments it was recognised that the artifact assemblages were also atypical in terms of their composition, appearing to contain a high proportion of bifaces compared to previously excavated sites. This was particularly evident during the excavation of the marine sand surface where a concentration of bifaces, and associated large faunal remains, were recovered. Further to this, artifacts were recovered at relatively high densities throughout the sequence, in contrast to the more usual presence of vertically discrete artifact spreads usually encountered in the Slindon Formation. The site gave the impression of being a locale intensively occupied over an extended period and reflecting a pattern of tool discard, distinctive from that observed at other Boxgrove sites. Thus, it was critical that taphonomic analysis was undertaken to establish the degree to which the assemblage characteristics were truly atypical and whether these features were a product of natural, as opposed to behavioural, factors.

These problems presented by the archaeology of Q1/B have a wider significance in the study of Acheulean artifact assemblages. While the biface-rich assemblages from the site were atypical within the context of other Boxgrove assemblages, they reflect a wider phenomenon of Middle Pleistocene archaeology.

The association of bifacial tools with fluvial contexts is a regular and important feature of Acheulean archaeology and one in which taphonomic analysis has struggled to separate the role of behavioural and hydraulic processes in assemblage formation (Isaac 1977, Schick 1986). At sites such as Olorgesailie, Kalambo Falls, Gadeb, Cuxton, Warren Hill and Nadaouiyeh Ain Askar, varying degrees of hydraulic activity can be identified in the formation of dense concentrations of bifaces. However, the often dynamic nature of the depositional context has made it difficult to identify the degree to which hydraulic action is either masking or exaggerating a real behavioural phenomena (Isaac 1977; Schick 1992; Clark 1969, 1987; also discussed in Chapter 2). At the heart of the problem is the apparent shift in habitat preference, documented in Africa, from fine-grained lake margin contexts for Oldowan assemblages, to sandy channel contexts for Acheulean assemblages (Leakey 1971; Schick 1987a). In this chapter, it will be shown that it is possible to assess the degree of natural modification of assemblages by fluvial agents and to separate out real behavioural assemblage characteristics. It will be shown that the Q1/B assemblages really do represent distinctive compositional groupings that reflect real differences in hominin behaviour when compared to modes of operation at GTP17 and other locales.

5.2 Assemblage context.

In total, 15,000 flint artifacts >20mm were recovered from the Q1/B locality. These were encountered within a complex stratigraphic sequence that had to be necessarily subdivided, sometimes on the basis of subtle changes in sedimentary characteristics. Thus, artifacts from Q1/B form some 13 assemblages, divided on the basis of sedimentary context. In order to simplify the taphonomic analysis, these units have been grouped into three major divisions with some small assemblages subsumed into larger ones where they have been demonstrated to be either stratigraphically equivalent or relate to part of the same depositional event. The three major divisions are as follows:

1.Upper Units: These comprise a series of conformable and unconformable units that appear to post-date the deposition of Unit 4c. They include spring and marsh deposits (Units 4d1 and 5a) in addition to colluvial and soliflucted silts, clays and gravels (Units 8ac, 8a, 6b, 4d2, 4d3).

2.Middle Units: These Units comprise the fresh water silts that form the main body of the Q1/B sequence and contain the two significant, large assemblages. The sequence is divided in to two major silts bodies (Unit 4 and Unit 4u) and two further assemblage subdivisions that relate to artifacts found lying directly on the Unit 3 surface underneath the silt bodies (Units 4/3 and Unit 4u/3).

3.Lower Units: The assemblages of the Lower Units were recovered from either the upper layers of the marine sands, which were archaeologically sterile below 5cm, or from the fill of channels cut directly into the sand itself. Theses are Units 3, Unit 3pc, Unit 3c, Unit 4.4u and Unit 4.4us. The channel fill units, while of a relatively high energy nature at the base of the sequence, are separated from the Middle Units on the basis that they appear to relate to more restrictive channel contexts and not the kind of larger water bodies represented by Units 4 and 4u.

Where the quality of data allows, the assemblages from each of these major units are assessed in terms of the sedimentary context, condition, spatial configuration, size-class distribution, artifact orientation, refit distances and alignments. Through this assessment it is hoped to isolate assemblages that may contain an *in situ* component and, where hydraulic rearrangement is implicated, establish whether the assemblage can be at least considered compositionally intact and in primary context. Beyond this, the analysis may help to identify where reworked material forms a part of an assemblage and establish the degree to which some units may have been truncated by subsequent depositional events. What detailed taphonomic analysis cannot provide is a clear-cut assignment for each assemblage, it cannot simply define an artifact group as being *in situ* or disturbed. The evidence from taphonomic studies at Boxgrove and other sites suggests that, given a sufficiently detailed analysis, it will always be possible to identify a modified component of an assemblage (Schick 1986; Sahouni 1988). Rather, it is hoped that this assessment can isolate the degree to which the Q1/B assemblage has undergone transformation and establish the possible implications of these processes for making behavioural inferences from the arrangement and composition of the stone artifact assemblages at the site.

5.3 Assemblage composition.

In Table 5.1, key characteristics of the assemblages from Q1/B are shown alongside those from previously excavated sites from the Slindon Silts, illustrating the apparently atypical nature of the Q1/B material. In this way, it is hoped to isolate certain features that fall outside the expected range of observed hominin behaviour in the analysis of the high-resolution sites and then subsequently test the degree to which these characteristics are the product of behavioural or hydraulic agents. During the course of excavation, the apparent abundance of bifaces marked the Q1/B assemblages as distinct; a fact born out by comparison of the Q1/B material with that from the Slindon Silts (Table 5.1). Of these assemblages, that from Q1/A had been the most biface-rich (1.6% of the 322 recovered artifacts), while within other assemblages bifaces constituted between 0 and 0.6% of recovered artifacts (average 0.5%). However, at Q1/B only the assemblages from Units 8a and 4d1 have biface quantities within this range. The assemblages from Unit 4u contains significantly higher proportions of bifaces than site Q1/A, while all other assemblages contain proportions of bifaces in excess of levels observed for the Slindon Silts: between 2.4% (Unit 8ac) and 8.9% (Unit ¾). Thus, in almost all of the assemblages from the freshwater sediments at Q1/B, bifaces form a much higher percentage of assemblages than those typically encountered in the Slindon Silts, with quantities of bifaces being up to six times greater at Q1/B than elsewhere in the Boxgrove landscape.

A similar, but less striking pattern can be observed in the proportions of other 'core' artifacts (flake production cores, biface rough-outs and tested blocks of raw material). While these typically form between 0 and 0.7% of assemblages from the Slindon Silts (average 0.3%), these proportions are exceeded at Q1/B in all units except Unit 8a. 'Cores' comprise 1% of the 8ac assemblage and 8.3% of the 4u/3 assemblage (Q1/B average, 2.5%). Other atypical features of the Q1/B assemblages are the higher proportion of tranchet flakes identified within the debitage which form an average of 1.3% of the Q1/B assemblage compared to an average of 0.8% of Slindon Silts assemblages. Similarly flake tools appear to be far more abundant at Q1/B, with retouched flakes forming an average of 1.8% of assemblages here

Unit	Total	Bifaces		Cores		Tranchet Flks		Retouched Flks		Flakes >20mm		Flaked artifacts		Flake to flaked ratio
		n	%	N	%	n	%	n	%	n	%	n	%	(expected 40-100)
Upper Units														
8a	227	1	0.4	0	0.0	1	0.4	1	0.4	224	98.7	1	0.4	224 (Atypical.high)
8ac	206	5	2.4	2	1.0	2	1.0	2	1.0	195	94.7	7	3.4	28 (Atypical.low)
5a	280	4	1.4	7	2.5	10	3.6	3	1.1	256	91.4	11	3.9	23 (Atypical.low)
4d1	338	1	0.3	4	1.2	4	1.2	0	0.0	329	97.3	5	1.5	66 (Typical)
Middle Units														
4	7057	182	2.6	106	1.5	112	1.6	87	1.2	6570	93.1	288	4.1	23 (Atypical.low)
4/3	689	61	8.9	22	3.2	7	1.0	34	4.9	565	82.0	83	12.0	7 (Atypical.low)
4u	4791	67	1.4	75	1.6	50	1.0	85	1.8	4514	94.2	142	3.0	32 (Atypical.low)
4u/3	276	11	4.0	23	8.3	3	1.1	0	0.0	239	86.6	34	12.3	7 (Atypical.low)
Lower Units														
4.4u	318	8	2.5	3	0.9	4	1.3	5	1.6	298	93.7	11	3.5	27 (Atypical.low)
3c	544	32	5.9	9	1.7	12	2.2	27	5.0	464	85.3	41	7.5	11 (Atypical.low)
3	682	23	3.4	40	5.9	3	0.4	18	2.6	598	87.7	63	9.2	9 (Atypical.low)
Q1/B average			3.0		2.5		1.3		1.8		91.3		5.5	
Other Sites														
GTP17 (4b)	1802	1	0.1	13	0.7	2	0.1	2	0.1	1784	99.0	14	0.8	127 (Atypical.high)
Q1/A (4c)	322	5	1.6	0	0.0		0.0	0	0.0	317	98.4	5	1.6	63 (Typical)
Q2/A (4c)	1244	4	0.3	1	0.1	3	0.2	0	0.0	1236	99.4	5	0.4	247 (Atypical.high)
Q2/D (4c)	752	0	0.0	1	0.1	11	1.5	1	0.1	750	99.7	1	0.1	750 (Atypical.high)
Q2/C (4c)	1371	8	0.6	7	0.5	30	2.2	17	1.2	1339	97.7	15	1.1	89 (Typical)
Other average			0.5		0.3		0.8		0.3		98.8		0.8	

Table 5.1: assemblage characteristics for Q1/B compared with other Boxgrove sites.

compared to 0.3% of assemblages from elsewhere in the Boxgrove landscape. Percussors appear to be, on average, represented in similar quantities at Q1/B when compared to other sites. In the following analysis each of the assemblages will be tested through taphonomic analysis, to determine the degree to these distinctive features have been a product of hominin or natural agencies.

5.4 The Taphonomy of the Upper Units at Q1/B.

5.4.1 Spatial distribution and refits.

Unit 8a: The distribution pattern for artifacts >20mm from Unit 8a (Figure 5.2a) matches the mapped extent of the sediment. The artifacts form a low-density spread across the north-eastern and central parts of the site with an apparent relative concentration towards the southern extent of the unit. This gives the impression that had Unit 8a been mobile and moving in a southerly direction, artifacts were disturbed during this process at the front of the gravel body. No localised concentrations of artifactual material are discernable and the overall distribution pattern appears immediately inconsistent with *in situ* knapping scatters. Only three non-debitage elements are present, including one biface that falls outside the overall distribution of debitage.

Unit 8ac: The narrow north-south distribution of artifacts (Figure 5.3a) closely matches the mapped extent of Unit 8ac. Artifacts form a relatively even spread throughout the unit but with an apparent concentration towards the south-western extent of the distribution. Non-debitage elements, including three bifaces, are also concentrated in this area. While the overall distribution of material appears unstructured there is no indication of the spatial size-sorting of artifacts. The distribution pattern (Figure 5.3b) of the spalls conforms well to that of the larger artifacts. but exhibits no discernable concentration towards the south of the Unit's excavated extent.

Unit 5a: Artifacts from unit 5a are broadly distributed to the west, south-east and east of the site (Figure 5.4a), a pattern which is consistent with the overall mapped distribution of Unit 5a. Artifacts are not evenly distributed within this area, but form three main concentrations that can be readily isolated from an irregular background scatter. The first concentration, centred at 195/099, is approximately 4m^2 in extent and contains four tranchet flakes. The second concentration centred at, 210/095, is more dispersed being approximately 8m^2 in extent; it includes a single tranchet flake. Another possible concentration is apparent at 221/110. This small scatter 3m^2 in extent and comprising 23 flakes is distinguished by the presence of three closely spaced cores. The spatial association of non-debitage elements with one of these scatters, as well as the overall presence of localised artifact concentrations immediately suggests the possibility of *in situ* archaeology within Unit 5a. The distribution of spalls (Figure 5.4b) conforms well to that of larger artifacts, with the main clusters of artifacts >20mm represented by spatially coincident spall concentrations. A possible exception to this is the scatter indicated at 210/095 which is represented by a relatively small and quite localised spall concentration. An intact knapping scatter would be expected to produce higher densities of smaller debitage, and the anomalous lack of small debitage requires further explanation.

Unit 4d1: The distribution of Unit 4d1 artifacts is variable across the site (Figure 5.5a). At the centre and at the eastern edge of the site the distribution pattern is very dispersed and artifacts occur at very low densities. To the west of the site, the artifact distribution pattern is still quite dispersed but denser in character and includes a single high-density concentration of material centered at 210/095. This concentration spatially matches an observed cluster in the overlying Unit 5a, suggesting that the clusters are one and the same. It is also possible that the small cluster of finds centered at 221/110 in Unit 4d1 may be the lower extent of the core-associated cluster recorded for Unit 5a at the same location. The suggestion here is that some of the Unit 4d1 assemblage is archaeologically indivisible from that of Unit 5a. No localised concentrations of debitage appear to be present towards the west of the site and the cluster of three bifaces at 197/094, given the low energy nature of this unit, appear to be a direct product of hominin discard. Unit 4d1 was not mapped as a continuous horizon across the central area of the site, artifacts shown in this area on the distribution plan came from small blocks of 4d1 found reworked within units 8ac, 8a and 4. The spatial evidence suggests that while part of the Unit 4d1 assemblage has been subject to post-depositional modification associated with the Unit 8ac channel and sediment deformation, areas of intact 4d1 at the margins of the excavated area contain a significant *in situ* component. The spall distribution pattern for the assemblage broadly matches that observed for the larger debitage elements (Figure 5.5b). Interestingly the largest concentration of spalls is located at 210/095, coincident with the scatter of flakes >20mm in the overlying Unit 5a. As spalls were anomalously absent from this scatter at the Unit 5a level it would appear that we are seeing the vertical differentiation of the same scatter. It may be that the scatter was formed by a knapping event of the surface of Unit 4d1 prior to the deposition of Unit 5a that covered the scatter. During excavation larger flakes would have appeared to have been concentrated within the Unit 5a while smaller material at the base of the scatter appears more embedded in the Unit 4d1 sediment.

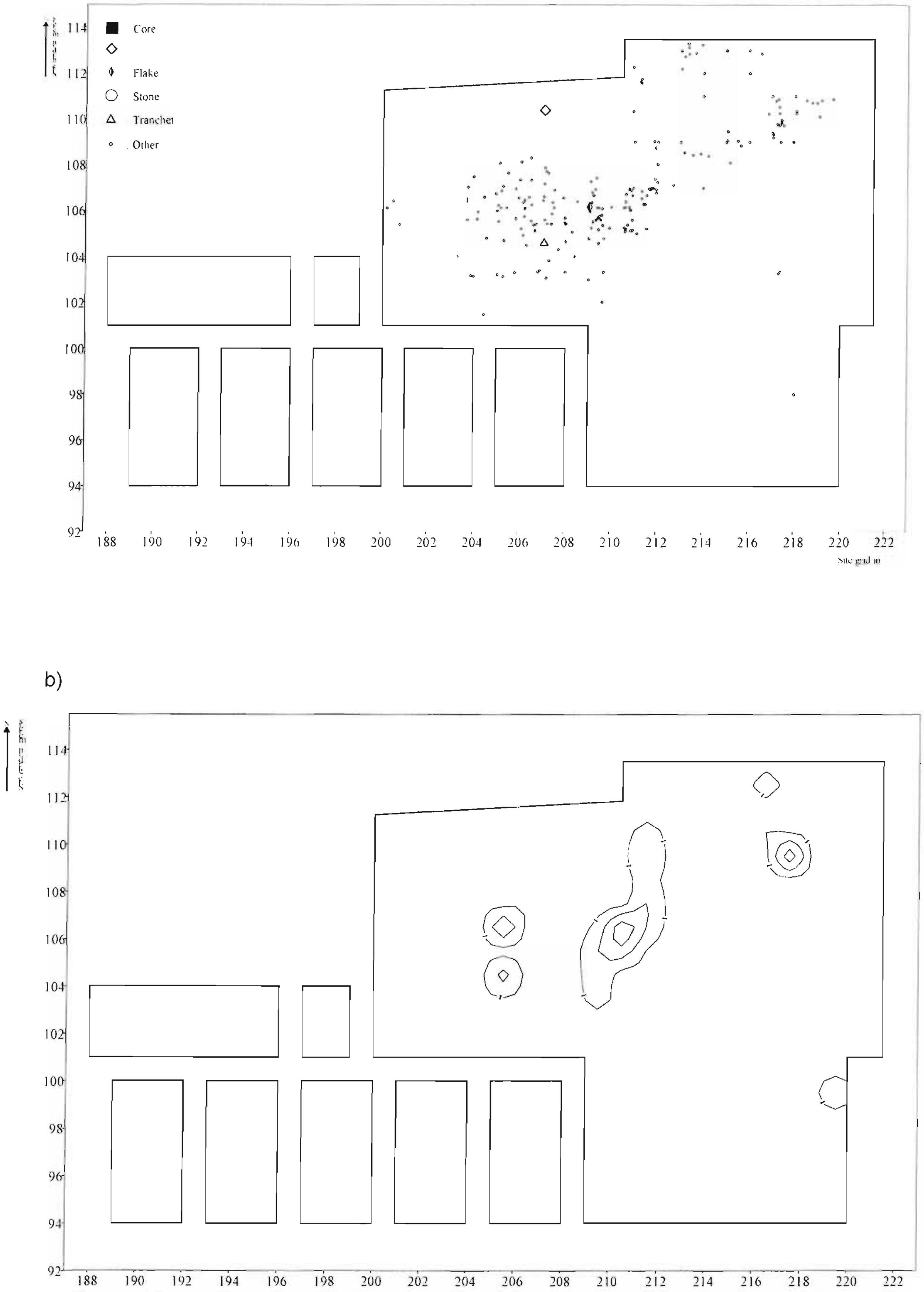


Figure 5.2: Artifact distribution plots for Unit 8a at Q1/B. a) lithics b) spalls.

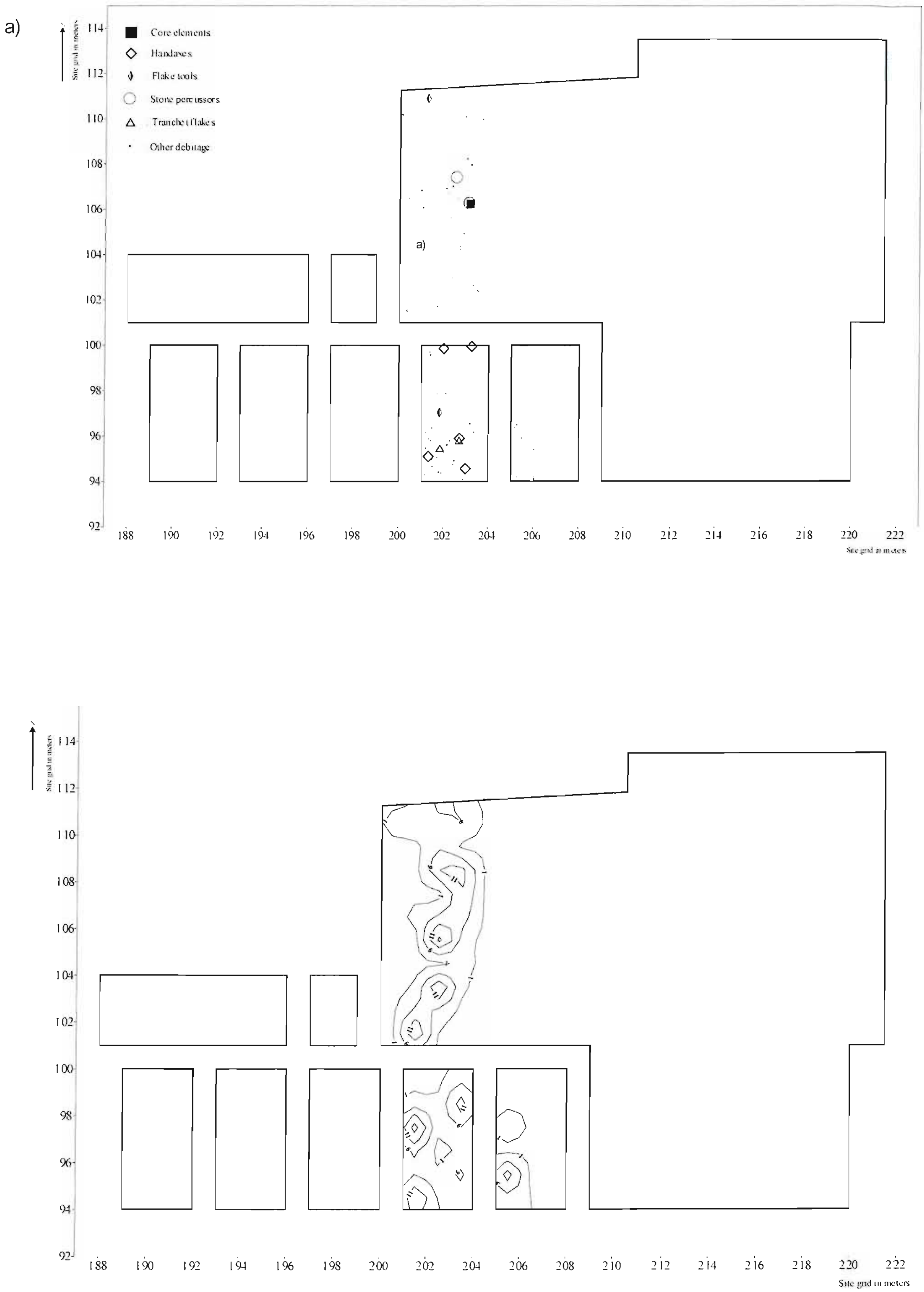


Figure 5.3: Artifact distribution pattern for Unit 8ac at Q1/B a) lithics b) spalls.

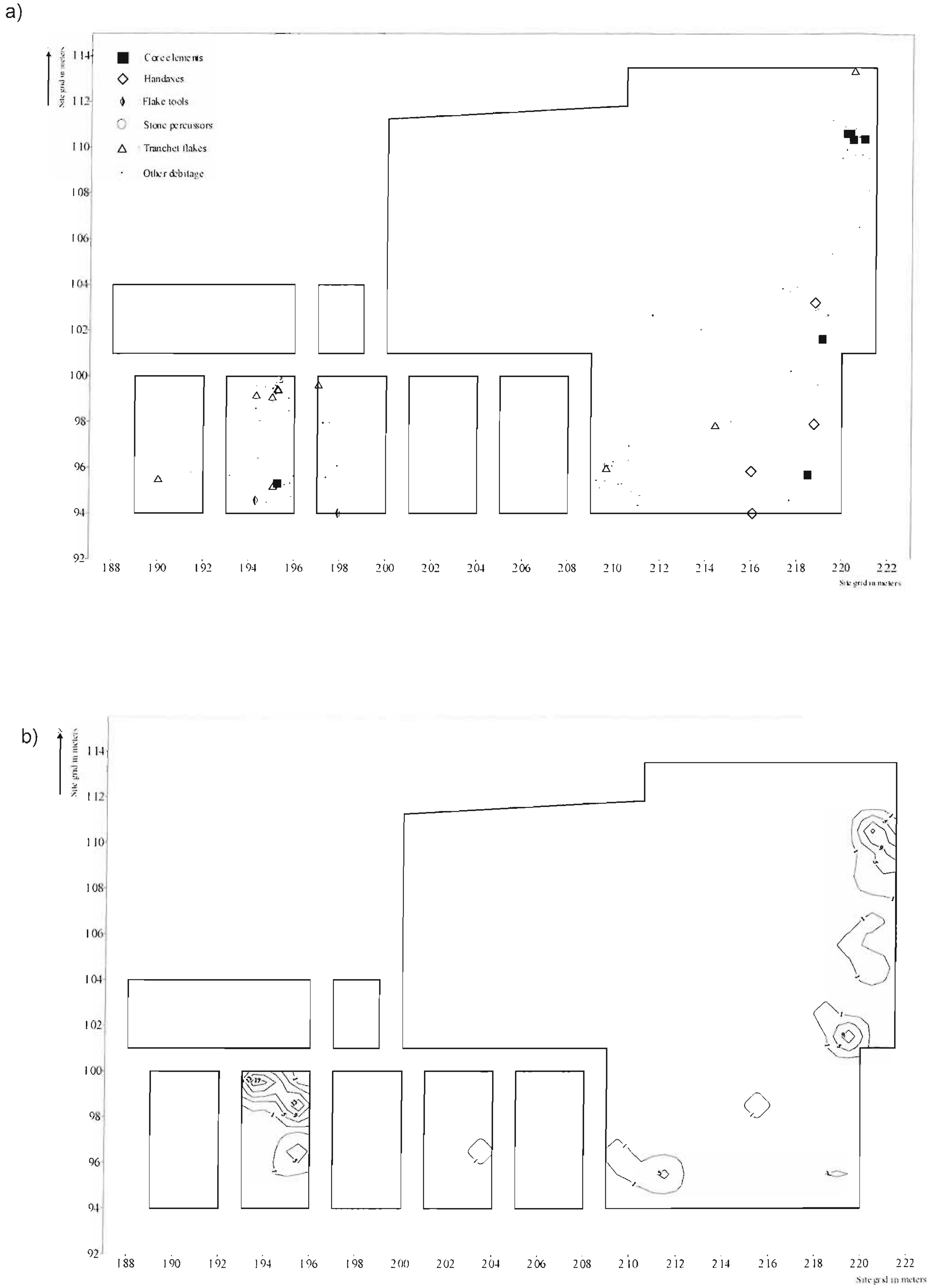


Figure 5.4:Artifact distribution pattern for Unit 5a at Q1/B. a) lithics b) spalls.

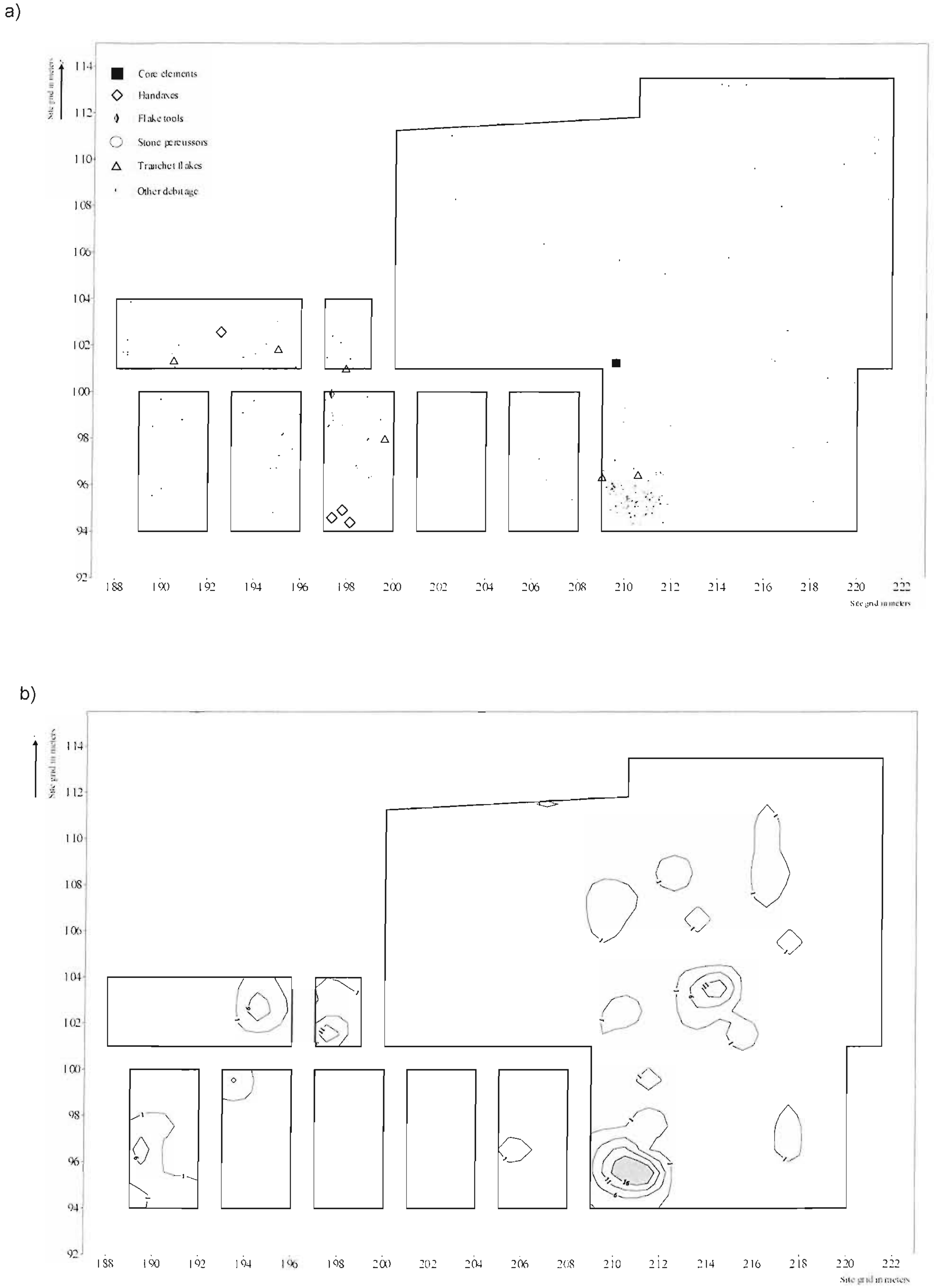


Figure 5.5: Artifact distribution pattern for Unit 4d1, Q1/B. a) lithics b) spalls.

Refits are clustered at 210/095 and 218/102 respectively (Figure 5.6). The first cluster had previously been identified in the spatial distribution pattern as a potential *in situ* knapping scatter distributed between units 4d1 and 5a. The refit evidence would appear to confirm this, the vertical refit distribution plot showing this to be an undifferentiated scatter at the boundary of the two units. The second scatter, which is not immediately apparent in the artifact distribution plots, suggests a knapping sequence spread across a 10m^2 area. Knapping experiments indicate a much more concentrated distribution pattern for artifacts from a single knapping episode (Newcomer 1971), the greater spread in this case may either be a result of post-depositional rearrangement or movement by the knapper during the reduction sequence. However, the average refit distance of 0.88m for Units 4d1 and 5a, is generally consistent with the presence of unmodified *in situ* knapping scatters and compares well with the observed refit distance average for the GTP17 (4b2l) assemblage (Table 5.2).

To the west of the site two refit groups can be seen with a different configuration. The most westerly group shows links between Unit 8ac channel fill and two of the units cut by the channel, 5a and 4d1. This suggests that Unit 8ac contain a reworked element from the underlying units. The second group contains debitage from Units 8ac and the higher silty components of the same broad colluvial sequence (Units 4d2 and 4d3). The vertical spread of refits across Units 8ac, 4d2 and 4d3 suggests either the reworking of Unit 8ac during the deposition of the higher units or the introduction of refitting material from another source during the course of at least three depositional events. The relatively large average refit distance of 3.82m also indicates post depositional modification for Unit 8ac.

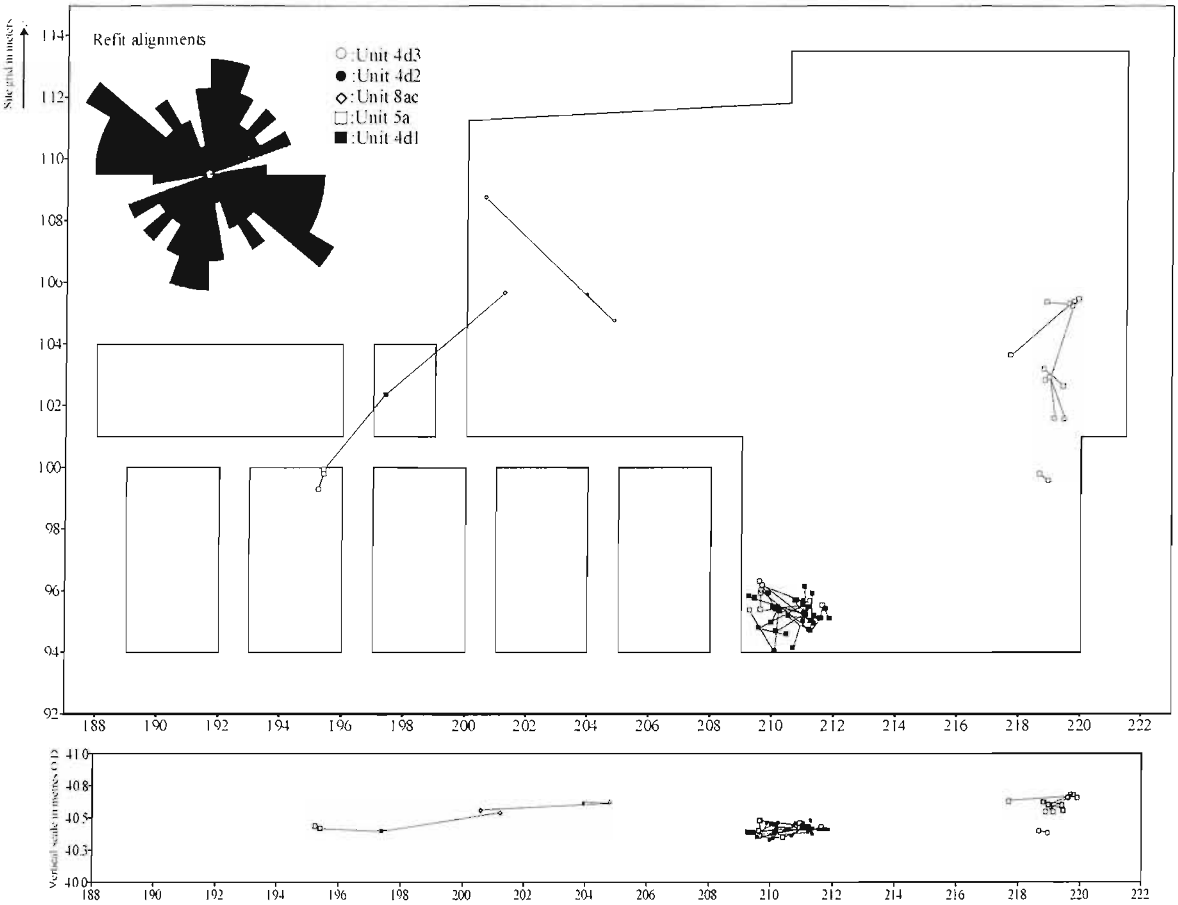
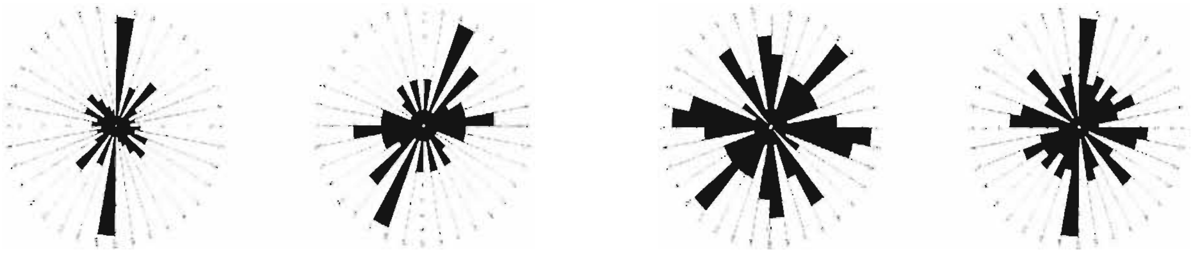


Figure 5.6: **Horizontal and vertical refits for Upper Units at Q1/B.**

5.4.2 Orientation

8a: Long-axis orientations from Unit 8a (Figure 5.7a) show a marked preferred north-south alignment consistent with the supposed direction of the solifluction flow. The spatial distribution of artifacts, which appear to be concentrated towards the southerly extent of the unit, would also be consistent with north-south movement.



a) b) c) d)

Figure 5.7:Artifact orientations for a)Unit 8a b)Unit 8ac c)Unit 5a and d)Unit 4d

Unit 8ac: A preferred orientation can be observed along a NNE-SSW alignment (Figure 5.7b). This does not strictly conform to the north-south alignment of the unit's distribution but does confirm that the formation of the unit involved either a hydraulic or colluvial process resulting in the rearrangement of some elements of the assemblage.

Unit 5a: No apparent preferred orientation can be detected in the long-axis alignments of artifacts from Unit 5a (Figure 5.7c). This suggests that material in this unit has not been subjected to alteration by fluvial or colluvial processes.

Unit 4d1: A distinct north-south alignment of preferred orientation can be observed for this unit indicating that a significant proportion of the assemblage has been rearranged by, given the depositional context, fluvial processes (Figure 5.7d).

5.4.3 Size class distribution

Unit 8a: In broad terms assemblage components between 20-60mm are correctly represented (Figure 5.8), falling within the observed limits of the biface manufacturing experiments. Larger components do however appear to be either under represented or fall towards the lower limit of the experimental observations. The evidence suggests that larger material has been selectively separated from the assemblage either through differential movement associated with the solifluction flow or the selective removal of larger pieces by hominins. Another possibility is that the knapping activities produced fewer large flakes than observed in the experimental biface reduction sequences.

Unit 8ac: Curves for artifacts >20mm from this unit indicates an intact and correctly represented assemblage.

Unit 5a: The curves for artifacts >20mm from Unit 5a broadly conform to the experimentally defined limits of the experimental samples with only a slight over representation of artifacts 60-69mm in length.

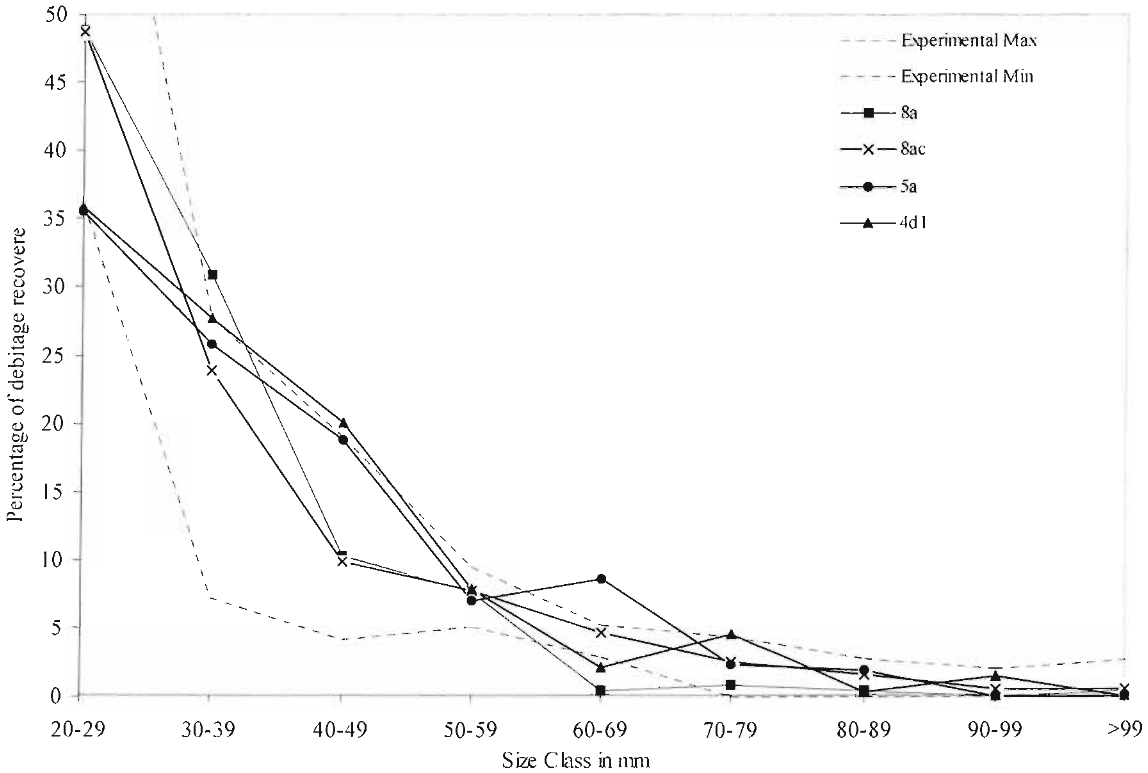


Figure 5.8: Size class curve for assemblage from Upper Units at Q1/B

Unit 4d1: The 4d1 curve for artifacts >20mm is erratic with a number of small transgressions from the experimentally derived limits. However the assemblage is relatively small and overall the assemblage exhibits neither winnowing of smaller material or the consistent over-representation of larger assemblage elements. It should be noted that the curve for the combined assemblages of Unit 5a and 4d1 produces a normal profile, a fact consistent with the suggestion that material from both units forms part of a single, but vertically dispersed assemblage.

5.4.4 Summary

Unit 8a: This unit appears to contain a post-depositionally modified assemblage. The assemblage has a slight under-representation of larger elements, which may be due to an anthropogenic process such as the selective removal from the original knapping scatters of tools and useful large flakes. However the lack of clustering within the overall distribution suggests that the observable spread of artifacts relates to processes associated with the formation of the unit and not the spatial distribution of hominin behaviour. The concentration of material towards the south of the unit and the north-south alignment of elements might suggest that this material has become incorporated into the toe of a solifluction flow, possibly being 'bull-dozed' out from underlying sediments truncated during the formation of Unit 8a.

Unit 8ac: Unit 8ac contains a compositionally intact assemblage. The unit has been shown to have truncated Units 5a, 4d1 and 4 during its formation and may have had a colluvial origin. While the preferred alignment of the assemblage would seem to confirm that a colluvial/fluvial agent was involved in the formation of the unit, no evidence for winnowing is apparent from the size-class distribution curves and the overall spatial distribution of artifacts. However, the assemblage does appear to contain a post-depositionally modified component indicated by artifact orientations, inter-unit refits and overall refit distances. Reworking was also indicated by observations made during the excavation of artifacts from Unit 4 partially protruding into the overlying sediment of Unit 8ac. The differential patination of the protruding elements suggested a period of exposure following the erosion of Unit 4, prior to the deposition of Unit 8ac.

Units 5a and 4d1: All indicators suggest that the Unit 5a assemblage is compositionally intact and contains elements that are spatially *in situ*. Spatial association and refitting demonstrated that at least one knapping scatter was vertically spread across Units 5a and 4d1 with the suggestion that smaller artifacts were distributed towards the base of the scatter. Overall however, the Unit 4d1 assemblage exhibited a number of characteristics that distinguish it from Unit 5a including a preferred north-south orientation and more dispersed spall and flake distribution pattern.

The evidence shows that, while both assemblages share characteristics, discard in each case is occurring within very different depositional regimes. Thus, while it is suggested that the site was occupied throughout the formation of both units, during the formation of Unit 4d1 the processes leading to the deposition of calcium carbonate across the locality led to the rearrangement of artifacts. The formation of the 210/095 scatter appears to have occurred towards the end of the deposition of Unit 4d1 when these processes had become weaker in intensity. The subsequent formation of Unit 5a led to the apparent incorporation of larger assemblage elements into the unit. Other material from the Unit 5a assemblage, represented by the scatters at 195/099, 221/111 and 218/104 appears to be confined to Unit 5a and may relate to a period coeval with its formation.

5.5 The Taphonomy of the Middle Units at Q1/B.

5.5.1 Spatial distribution.

Unit 4: The distribution of artifacts >20mm in Unit 4 (Figure 5.9a) indicates a dense but laterally variable spread of artifacts across the full extent of the site, matching the ubiquitous distribution of this unit across the site. While variable, the distribution exhibits no localised clustering of artifacts that immediately indicate the presence of *in situ* knapping scatters, although the dense concentration of artifacts at the western end of the site may be masking such patterns. Some localised areas with a relatively low density of artifacts are apparent. One of these patches, centred at 201/095, can be explained by the almost complete truncation of Unit 4 in this part of the site by the overlying Unit 8ac. Another broadly linear area with low artifact density can be observed to run in a NNW-SSE direction between 214/094 and 211/106. These patterns are also apparent in the distribution pattern for artifacts <20mm (Figure 5.9b). The concentration of material in the western part of the site identified is indicated in the spall plot, forming part of a more general spread of spalls across the north-western part of the site. Another separate spread with a north-south orientation can be observed with its central axis between eastings 213 and 218. By comparing this pattern to the distribution of artifacts >20mm, it is possible to discern a similar concentration of larger artifacts flanking the eastern edge of the linear low-density area previously identified. The identification of broadly linear areas of variable artifact density can be taken, along with the lack of discernable knapping scatters, to suggests the probable post-depositional modification of the Unit 4 assemblage (Schick 1986, Shipman 1981). However, the broad agreement between the spatial distribution of the two artifact size classes suggests that differential movement and winnowing of assemblage components was limited.

Unit 4/3 contact: The distribution pattern for artifacts >20mm recovered from the contact between the marine sand and the overlying Unit 4 can be seen to form a spread of material originating in the north-western corner of the site and narrowing towards the south (Figure 5.10a). This distribution conforms to the horizontal limits of the contact between the two units, which was clearly defined across the extent of the site as an unmixed junction. No localised clusters of material are observable but the apparent high density of bifaces in the northwestern part of the distribution is noteworthy. This accumulation is further distinguished by the relative lack of debitage in this area of the site with flakes being more densely clustered further south towards the centre of the site. This pattern is further shown in distribution of artifacts <20mm (Figure 5.10b) which shows that spalls are almost entirely limited to the central part of the distribution, being poorly represented in the north-west and completely absent in the south of the site. This distribution pattern is strongly indicative of post-depositional sorting and appears to indicate the movement of smaller artifacts across parts of the Unit 3 surface.

Unit 4u: Artifacts >20mm from Unit 4u can be seen to form two separate but converging clusters of material (Figure 5.11a). The western cluster is oriented NW-SE while the eastern cluster is oriented in a north-south direction between eastings 210 and 220. This pattern broadly conforms to the distribution of the unit, which either did not form in the centre of the site or was locally removed by the subsequent deposition of Unit 4 here. Within this overall distribution three relatively dense patches of material are discernable, centred at 198/103, 206/098 and 215/100. The first two patches are quite discrete being c.4m^2 in extent and provide the kind of localised clustering that could indicate *in situ* scatters of material. However inspection of the distribution plot for artifacts <20mm (Figure 5.11b) shows no corresponding spall concentrations, suggesting that the clusters either represent winnowed knapping scatters or secondary reaggregations of artifacts. The third patch forms a much larger spread of material c.40m^2 in extent, but appears to contain three or more localised clusters. The spall distribution plan also indicates localised clusters within this spread of material at 218/097, 218/100 and 214/102. These can, in turn, be identified in the plot for larger material and may potentially indicate the position of relatively intact knapping scatters. The entire configuration of material suggests a relatively extensive period of formation and differential preservation of material leading to a combination of relatively intact and winnowed artifact clusters.

Unit 4u/3 contact: Across a limited part of the site, between eastings 208 and 216, artifacts were recovered from the junction of Unit 4u and the surface of the marine sand (Figure 5.12a). Artifact densities are quite low and there is an apparent spatial separation in the arrangement of debitage and non-debitage components, the latter having a more northerly extent to their distribution. Small debitage components have an entirely different arrangement, having a dense accumulation centred on 215/103 in an area almost completely devoid of larger artifacts (Figure 5.12b). The overall arrangement does not indicate any clear directional winnowing but the spatial separation of different size-classes of artifacts suggests that the assemblage is not *in situ*.

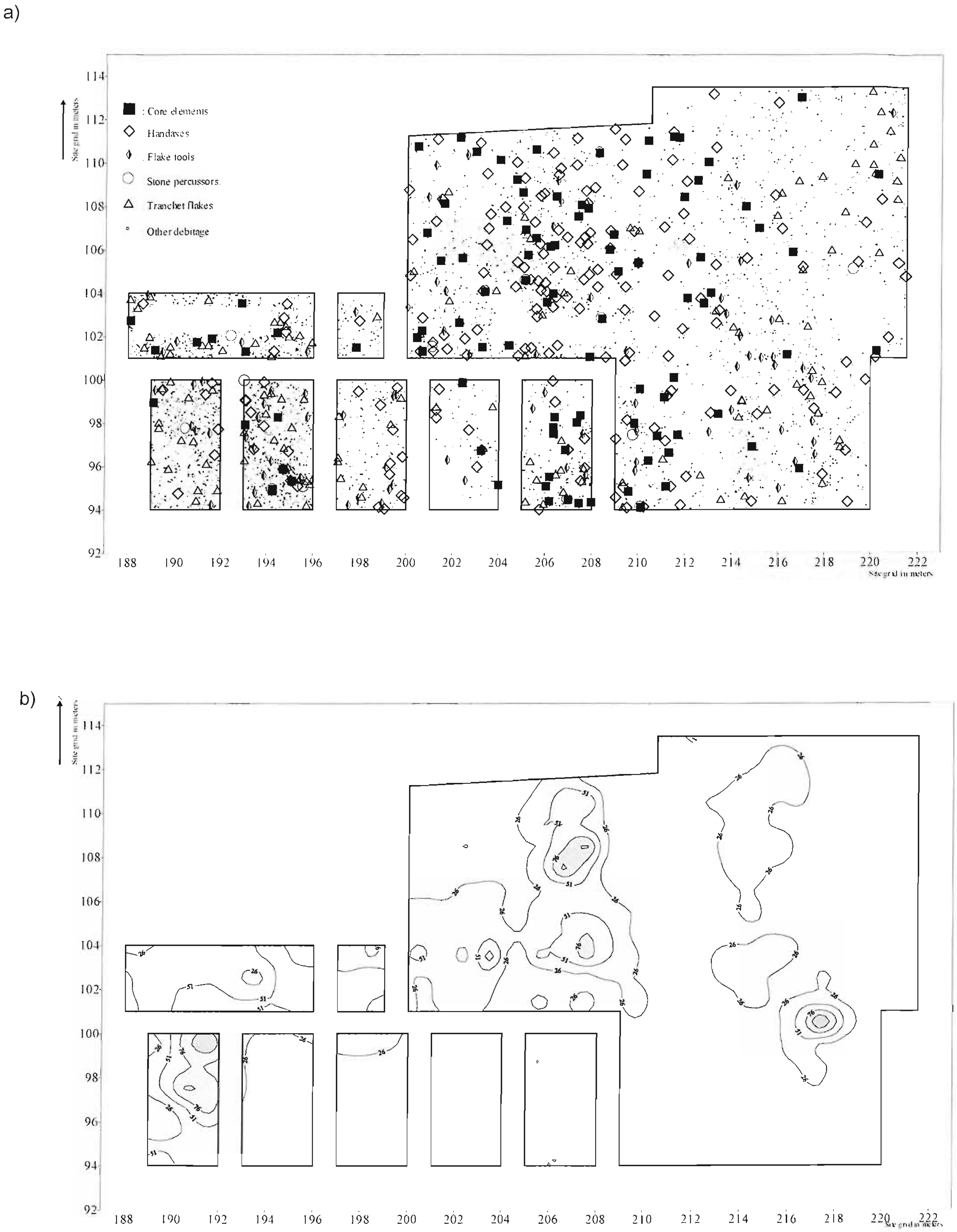


Figure 5.9:Artifact distribution for Unit 4, Q1/B. a) lithics b) spalls.

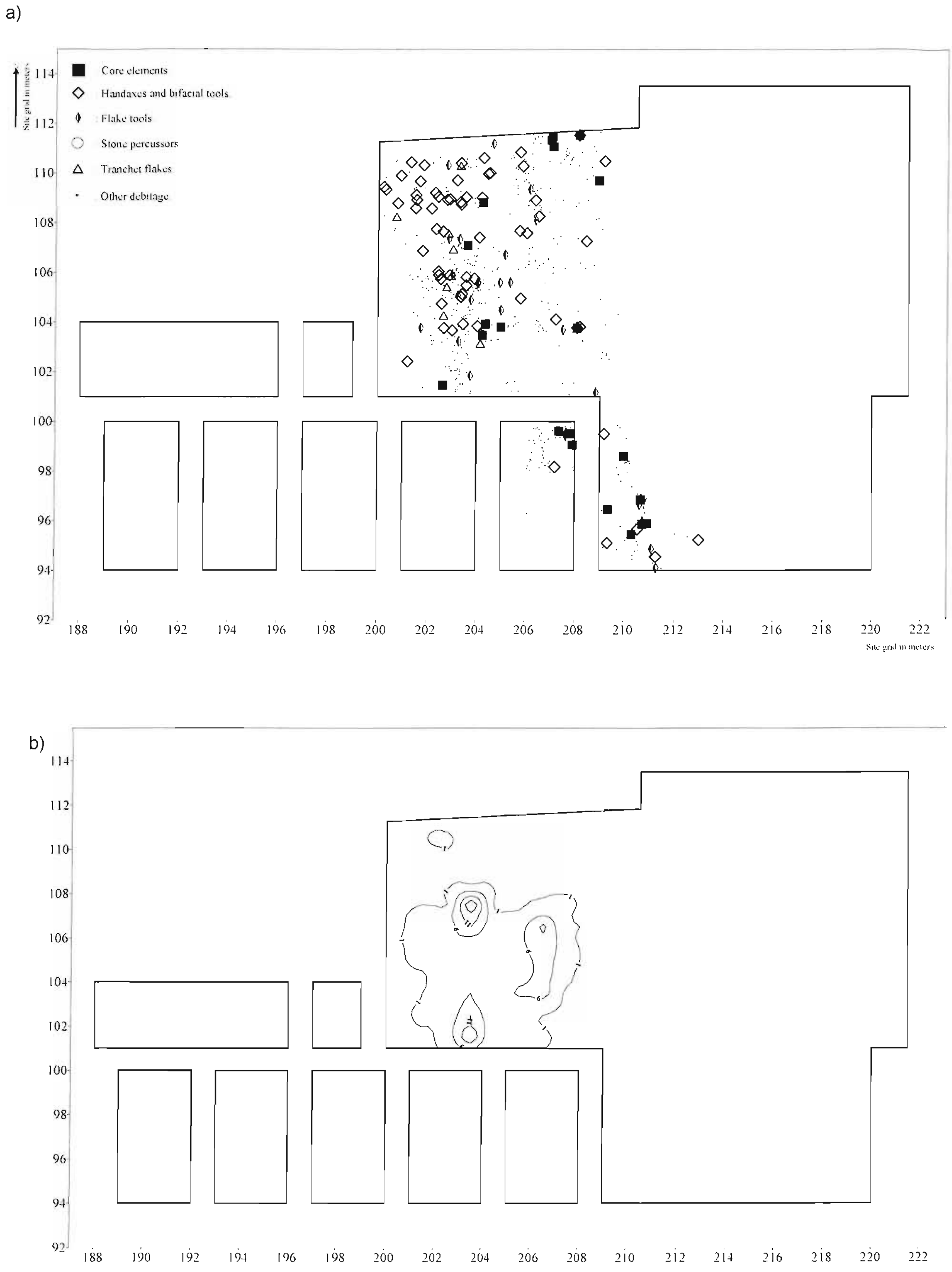


Figure 5.10:Artifact distribution for Unit 4/3, Q1/B. a) lithics b) spalls.

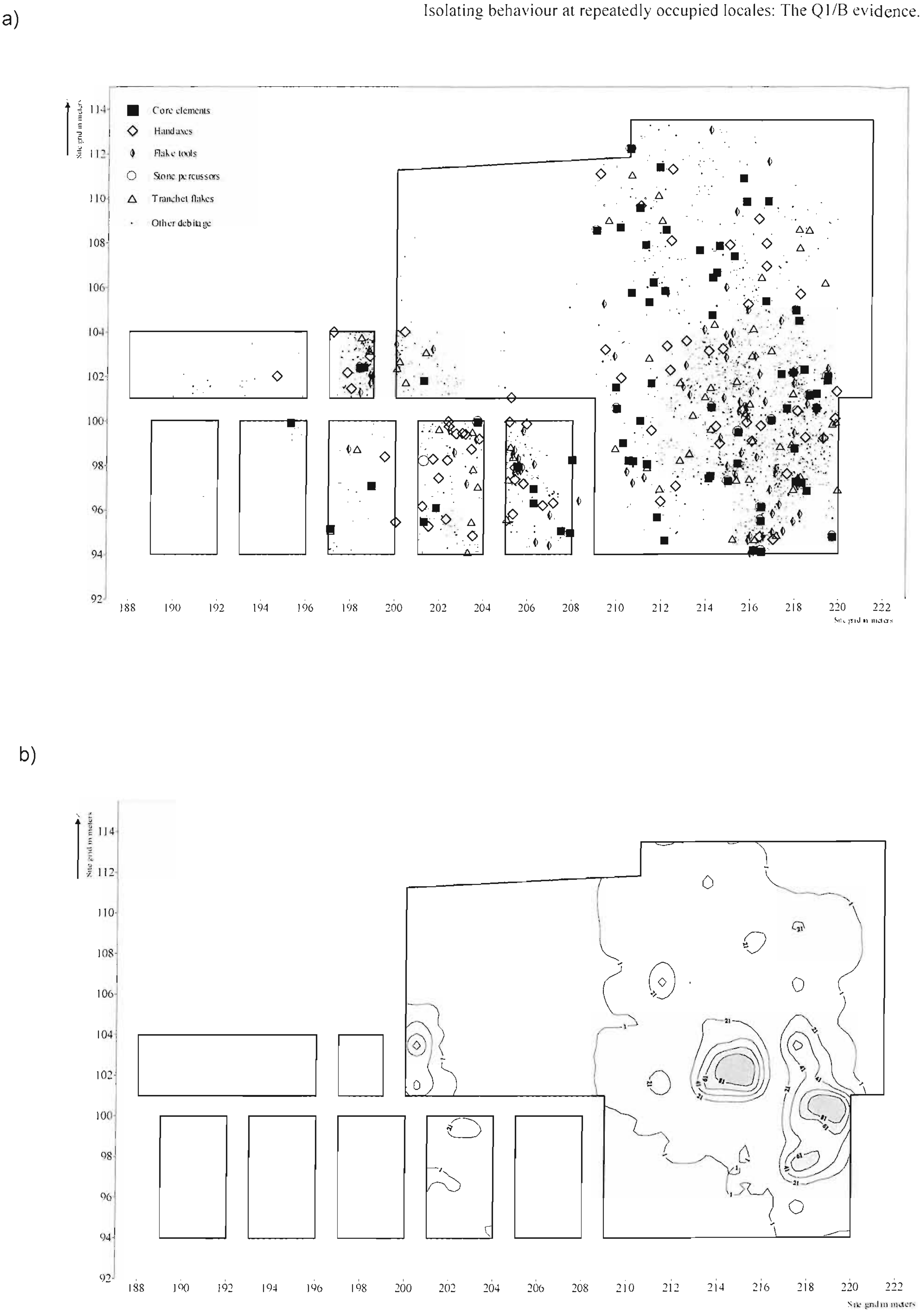


Figure 5.11:Artifact distribution for Unit 4u, Q1/B. a) lithics b) spalls.

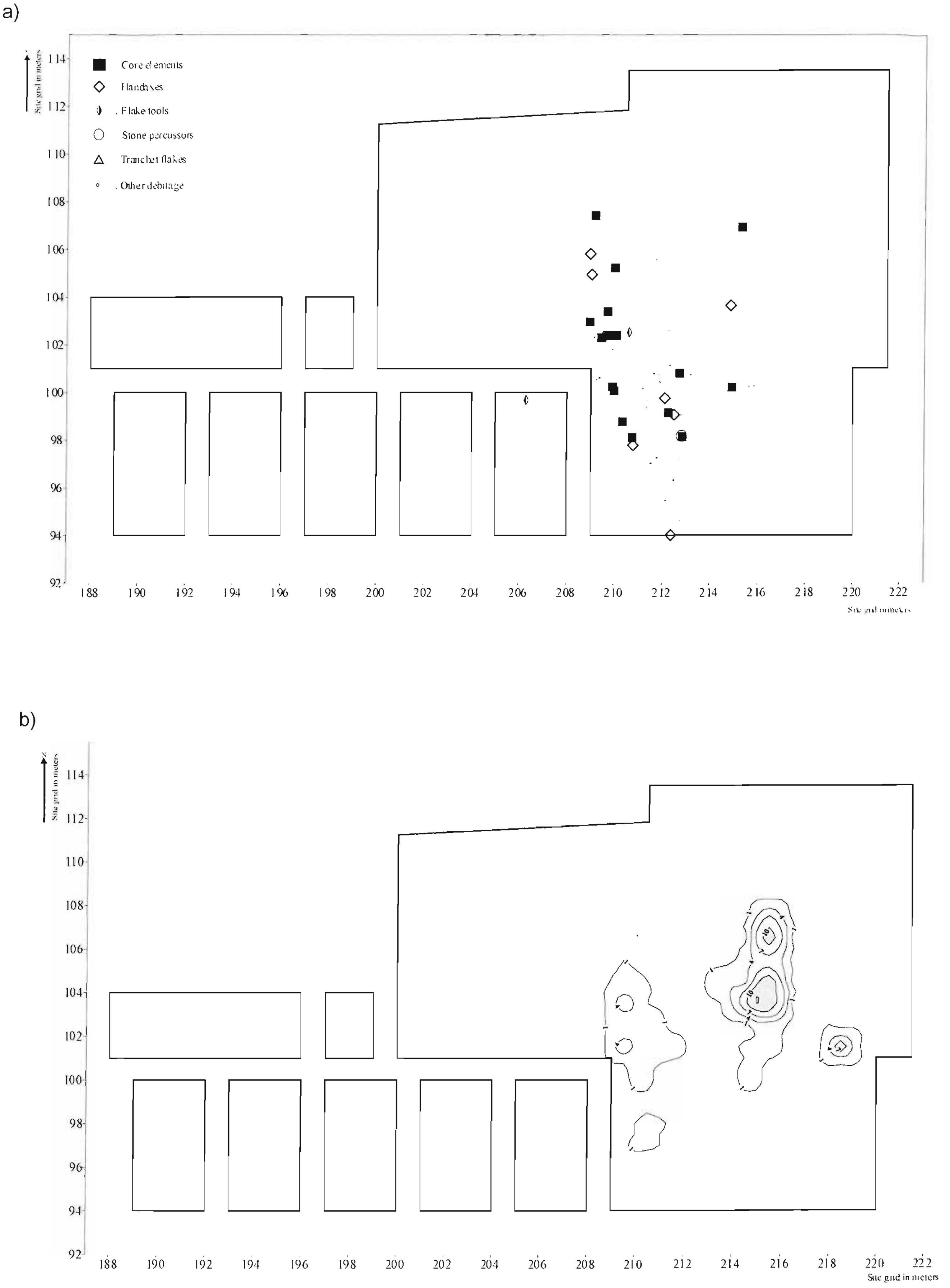


Figure 5.12: Artifact distribution for Unit 4u/3, Q1/B.

5.5.2 Refitting

Unit 4 (including Units 4/3): Refits from Unit 4 and its basal contact with the marine sand (Unit4.3) are shown in Figure 5.13. Refits are concentrated in the western part of the site and while this is largely explained by the high density of material in this area, it may also suggest that artifacts from individual reduction sequences are less dispersed here. There are a number of vertically and horizontally dispersed refits between Units 4 and 4/3 with a north-south orientation located within the middle of the site suggesting that throughout the deposition of Unit 4 material originally deposited on this surface was being reworked. There is a pronounced NE-SW preferred orientation for the refits and refits have an average length of 4.67m (table 5.2) the second highest for any of Q1/B Units, both facts appear to suggest that the assemblage is not *in situ*.

Unit 4u (including Unit 4u/3): Refits from Unit 4u and its basal contact with the marine sand (Unit 4u/3) are shown in Figure 5.14. Whilst the main bulk of refits are concentrated in the south-eastern part of the site this concentration appears to reflect the area of greatest artifact density within Unit 4u. In general refits are vertically and horizontally dispersed with an average horizontal refit distance of 3.15m (Table 5.2) and a slight preferred orientation along a NE-SW axis can be observed. The refit evidence suggests a post-depositionally modified assemblage but not to the same degree as observed in Unit 4.

Inter 4 and 4u: Refits between Units 4 and 4u (including their basal contacts) are shown in Figure 5.15. The average length of these refits is 5.63m, which was the highest observation for any of the Q1/B units and two preferred refit orientations are apparent along NNE-SSW and E-W axis. However, the Unit 4u components

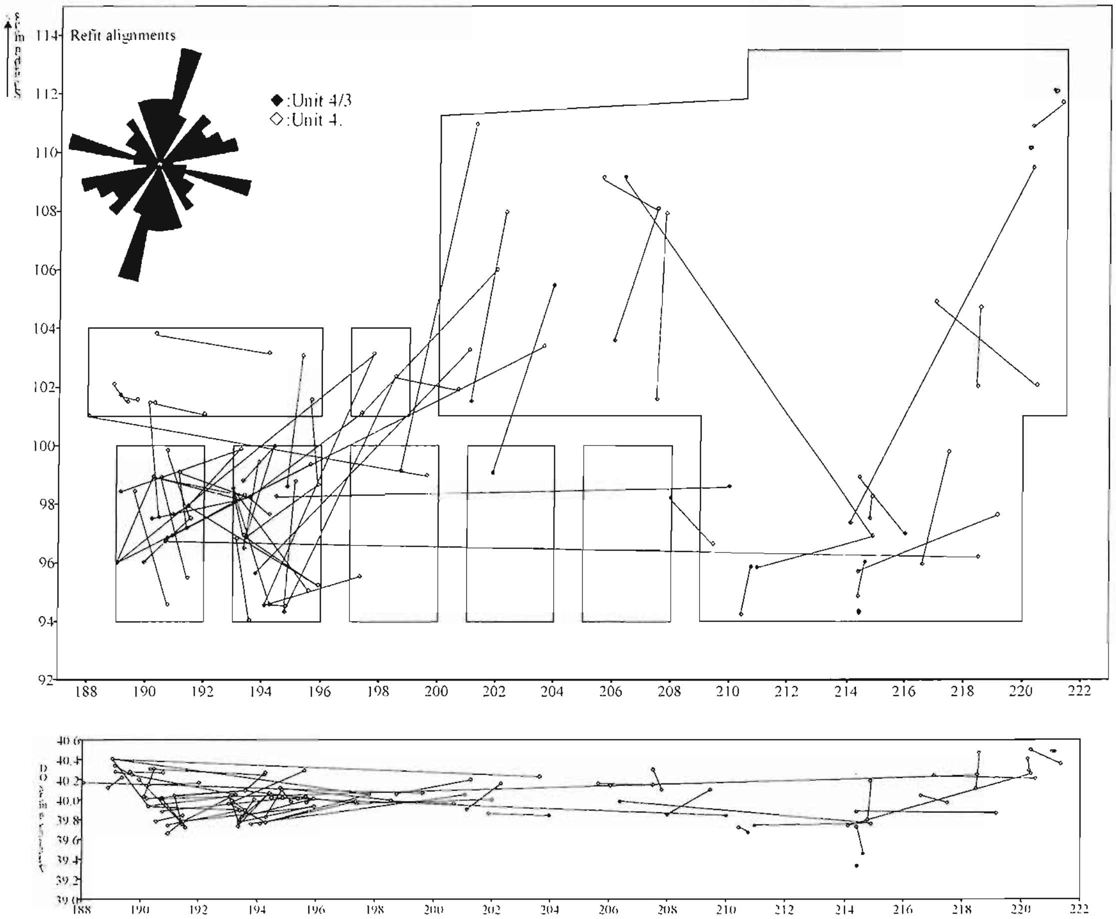


Figure 5.13:Horizontal and vertical refits within Unit 4, Q1/B.

of these refit groups are sometimes found to be some distance to the north of the Unit 4 artifacts. This evidence suggests that, while Unit 4 contains a reworked component from Unit 4u, no simple N-S flow process can be employed to entirely explain the refit distribution pattern. It is possible that Unit 4u was truncated by a number of episodic fluvial events that widely dispersed derived material prior to the formation of Unit 4.

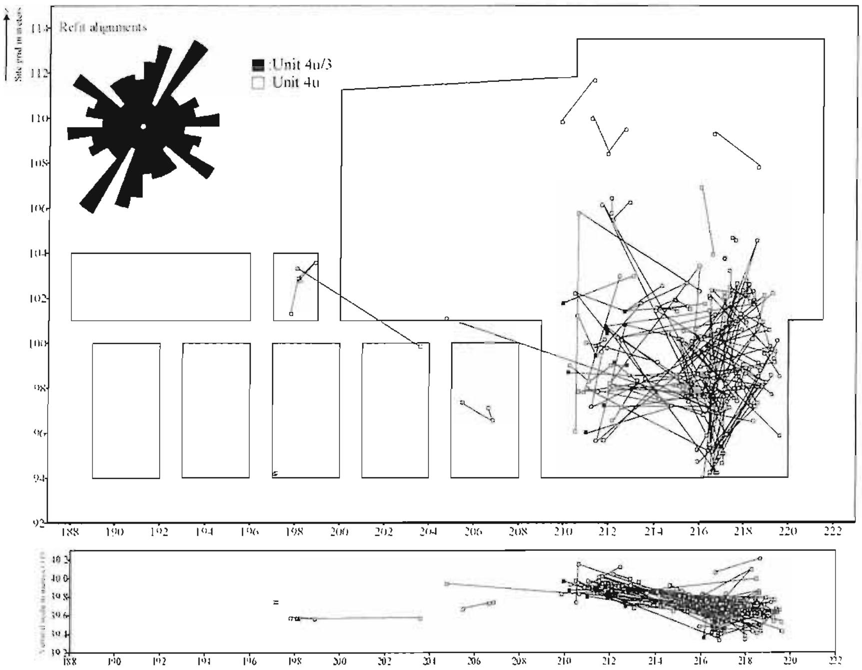


Figure 5.14: Horizontal and vertical refits within Unit 4u, Q1/B.

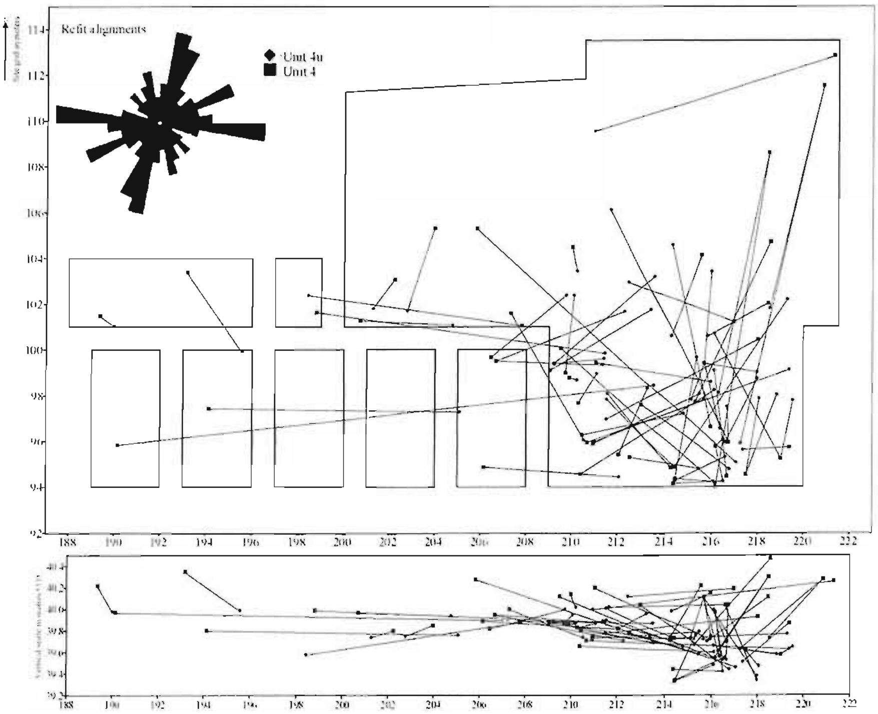


Figure 5.15:Horizontal and vertical Refits between Units 4 and 4u, Q1/B.

5.5.3 Orientation

Unit 4: Long axis orientations for Unit 4 show two clear preferred alignments running north-south and east-west (Figure 5.16a). The fact that these alignments are at right angles to each other probably suggests a single direction of flow that not only realigned material with the current but also rolled material transversely to it. Rolling was observed in Voorhies flume experiments to be a feature of partially submerged particle movement (Voorhies 1969), suggesting that flow conditions in Unit 4 were relatively shallow.

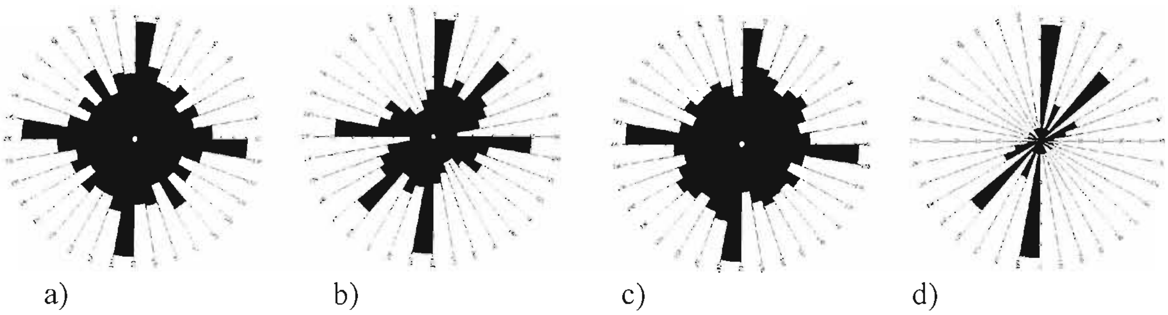

a) b) c) d)

Figure 5.16: Rose Diagrams for artifact orientations for Units a) 4, b) 4/3, c) 4u and d) 4u/3.

Unit 4/3 contact: The same north-south, east-west alignments are observable at the contact between Unit 4 and the underlying marine sand (Figure 4.16b) In addition a third potentially preferred alignment along a NE-SW axis can be observed.

Unit 4u: Unit 4u also exhibits two alignments of preferred orientation along north-south and east-west axis (Figure 5.16c). Again this arrangement may reflect persistent but shallow flow along a N-S axis.

Unit 4u/3: Due to the small assemblage size only 33 long axis observations were available for the contact between Unit 4u and 3. Such a small sample is unfortunately not sufficient to produce an accurate rose diagram. However, given the clear preferred north-south orientation (Figure 5.16d), which matches the consistently observed flow direction throughout the formation of Units 4 and 4u, the results can be cautiously accepted as an indication of fluvial activity during the initial deposition of Unit 4u.

5.5.4 Size class distribution

Unit 4: The Unit 4 size curve shows an essentially intact size-class distribution for the artifact assemblage >20mm (Figure 5.17). While counts for the 20-29mm range are towards the lower limit of the observed experimental range, there is no evidence for winnowing.

Unit 4/3 contact: Comprising only 34% of the assemblage, artifacts 20-29mm are under-represented at the 4/3 contact. This suggests either the slight winnowing of smaller artifacts, the downward movement of larger artifacts through the main body of Unit 4 or the introduction of larger elements to the site through either reworking or hominin activity.

Unit 4u: The Unit 4u curve suggests a normal size-class distribution and closely matches that for Unit 4. The slight deviation above the observed experimental limit for artifacts 30-39mm is not thought to be significant

Unit 4u/3: With artifacts 20-29mm comprising only 22% of this assemblage and a pronounced inflection in the curve at 30mm, the size-class distribution curve for Unit 4u/3 is strongly suggestive of winnowing. As a result, larger size classes appear relatively more abundant but still fall within experimental limits.

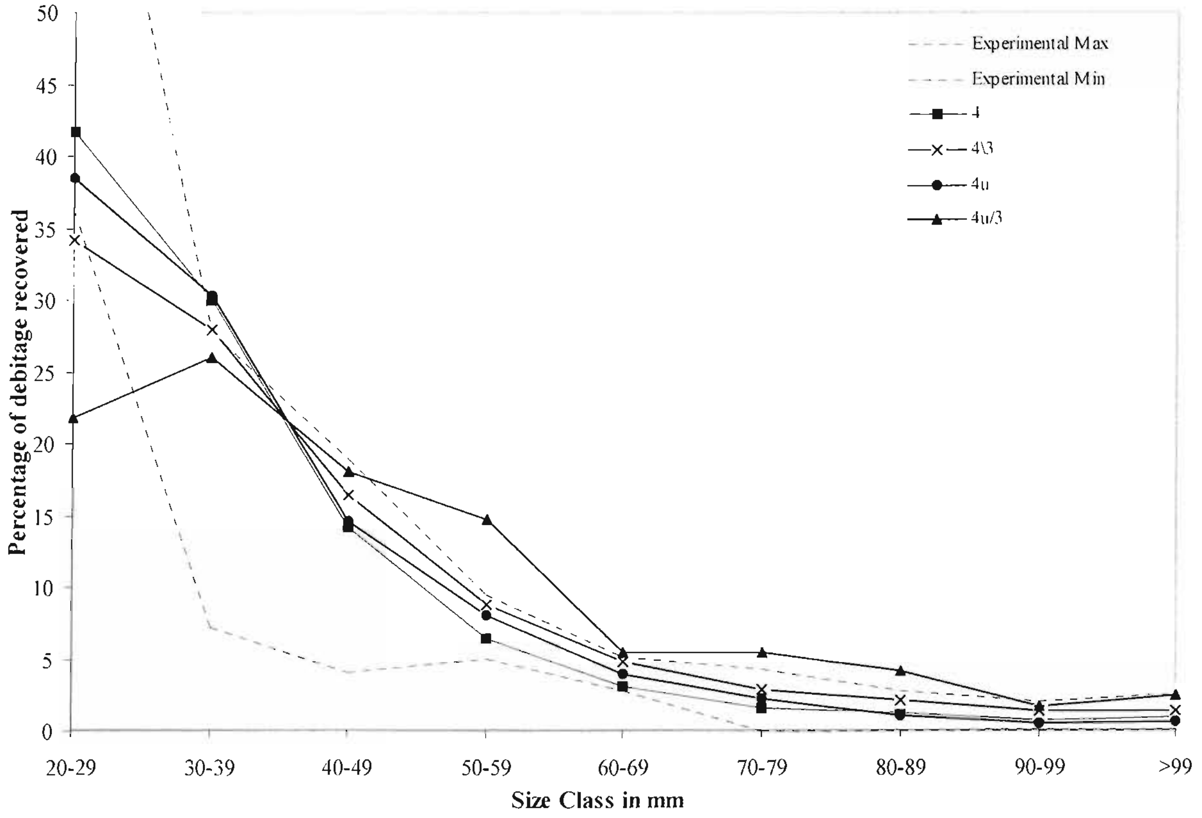


Figure 5.17: Size class distribution curves for Middle Units at Q1/B.

5.5.5 Summary

The taphonomic analysis of the 4 and 4u assemblages shows that we are dealing with a relatively long depositional sequence involving periods of quiet water deposition occasionally punctuated by more dramatic erosional events. The base of each unit can be differentiated from the main body on taphonomic grounds, appearing relatively more winnowed. Possible explanations for this would include the reworking of material from existing deposits during each erosional event or the winnowing of occupation debris discarded directly on the erosional surface of the marine sand. Throughout the depositional sequence of these middle units there is consistent preferred N-S and E-W artifact long-axis alignments suggesting continuity in the direction of fluvial activity during the deposition of the units. The secondary, transverse axis suggests shallow flow conditions, presumably along a N-S axis.

The assemblage from the main body of Unit 4u does appear to have a relatively intact component, and may possibly include some localised occurrences of *in situ* material. This is indicated by clustered patterning in the spatial distribution of artifacts and within the distribution of refits. The evidence suggests that, although the deposition of Unit 4u began with a relatively high-energy fluvial event, the subsequent deposition of the unit was variable and at times allowed a relatively high degree of archaeological preservation. Similarly, the main body of Unit 4 also seems to be compositionally intact but no localised clusters of debitage or refits are detectable. Refits distances appear shorter in the western part of the site suggesting that the integrity of the assemblage is laterally variable, but in general material appears to be horizontally and vertically dispersed. Unit 4 contains a component reworked from Unit 4u suggesting that the latter was once more extensive and that an erosive episode separated its deposition from that of the overlying Unit 4.

Assemblage	Sample Size Refits (n)	Max	Min	Average	Std Dev
GTP17 (4b21)	212	8.85	0.01	0.81	1.08
8ac	4	5.85	1.21	3.82	1.80
5a/4d1	48	2.53	0.03	0.88	0.61
4, 4/3	70	27.80	0.05	4.67	4.69
Inter 4, 4u	65	23.53	0.33	5.63	4.28
4u/ 4u/3	174	12.49	0.02	3.15	2.38
4,4u, 3c	14	7.67	0.05	1.95	2.41
3	44	11.74	0.01	3.10	2.73

Table 5.2: Refit distance summary for Q1/B assemblages.

5.6 The Taphonomy of the Lower Units at Q1/B.

5.6.1 Spatial distribution

Unit 4.4u: The distribution of Unit 4.4u is limited to the western part of the site and forms a broadly linear spread of sediment with a pronounced NW-SE axis. Artifacts were recovered across the whole distribution of the unit although artifact density was apparently higher towards the north (Figure 5.18a). There is one notable cluster of five bifaces at 191/101 and debitage appears to be more widely distributed than larger, non-debitage elements of the assemblage. In addition a diffuse spread of debitage is present towards the south-eastern extent of the unit which might suggest the differential movement of smaller components in this direction.

Unit 3c: Artifacts from Unit 3c can be seen to form a linear spread of material with a pronounced NW-SE axis (Figure 5.18a). This coincides with the mapped extent of the unit that appears to represent the fill of a linear channel feature. While the distribution of artifacts is uneven there is no obvious sign of the differential movement of debitage and non-debitage components. However there are apparent localised clusters of non-debitage elements at 199/099, 202/096, 204/097 and 195/102 which might indicate the post-depositional modification of the stone tool assemblage.

Unit 3: The Unit 3 assemblage consists of artifacts found buried or partially buried within the top of the marine sand.. Artifacts were recovered from the top of Unit 3 across the whole extent of the site although appear to be significantly less common towards the western end (Figure 5.18b). A fairly dramatic fall in the density of artifacts can be seen to the west of a line stretching from 199/103 to 207/094, this coincides with the distribution of Unit 3c. Two explanations could account for this coincidence: either the formation of the 3c channel removed artifacts from the marine sand during the formation of the channel or artifacts were deposited in Unit 3 subsequent to the formation of the Unit 3c channel sediments.

5.6.2 Refitting

Unit 4.4u and 3c: Artifacts from Unit 4.4u can be seen to refit across the whole distribution of each Unit (Figure 5.19). There are five inter-unit refits, one with Unit 4u and four with Unit 4 suggesting the latter truncated unit 4.4u during its formation and contains material derived from it. While some reworked material from Unit 4u may be present in Unit 4/4u no evidence for derived material from Unit 3c has been found. Apart from a single refit with Unit 4, suggestive of reworking, all refitting material from 3c is confined to the unit. The average refits distance of 1.95m for Units 4.4u and 3c is the second-lowest observed at Q1/B, after the essentially *in situ* 5a/4d1 assemblages (table 5.2). There is an apparent preferred NW-SE orientation for the refits, which is consistent with the alignment of the channel itself.

Unit 3: Unit 3 refits are shown separately in Figure 5.20. Material from Unit 3 commonly refits with artifacts from Units 4 and 4u. Unsurprisingly refits are also common between Unit 3 and the basal contact of Units 4 and 4u with the marine sand. There are no recorded refits between Unit 3 and Units 3c and 4.4u. The refit evidence suggests that we should consider that at least some of the Unit 3 artifacts form part of a common assemblage with material from Units 4 and 4u having been incorporated into the top of the marine sand during the formation.

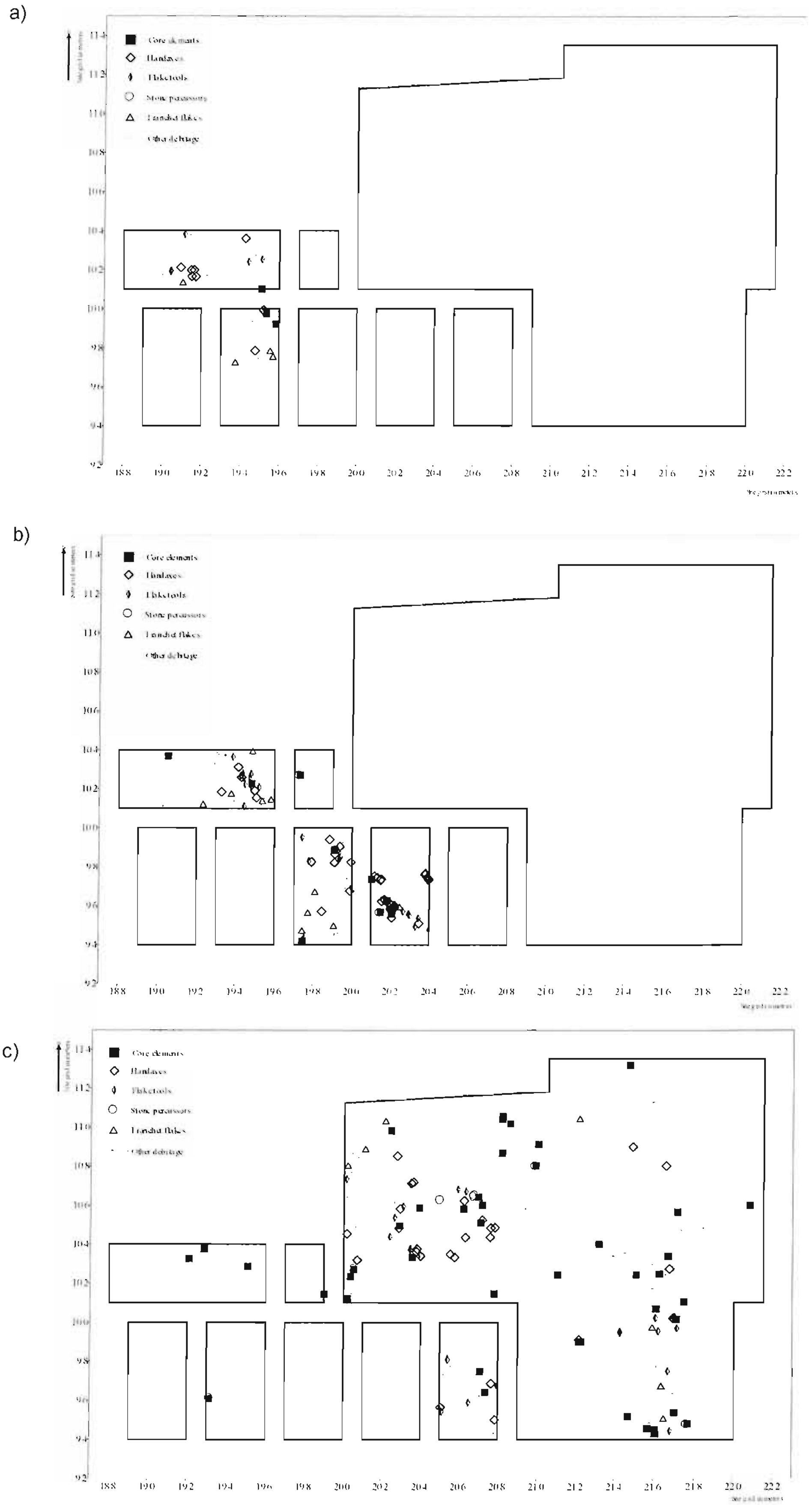


Figure 5.18:Artifact distribution for Lower Units Q1/B. a)4.4u b)3c c)3

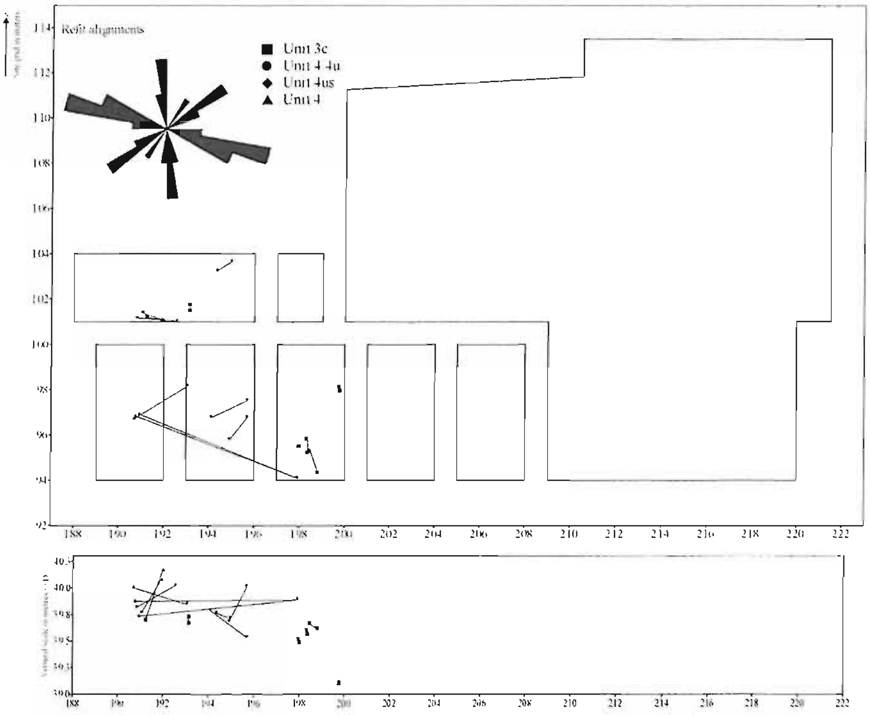


Figure 5.19:Horizontal and vertical refits for the Unit 3c channel at Q1/B

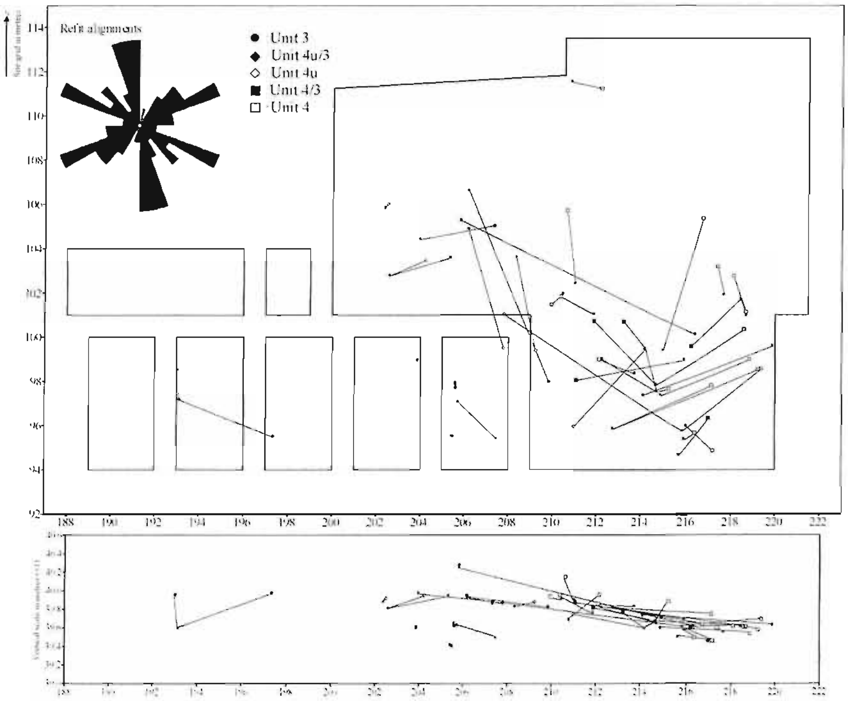


Figure 5.20:Horizontal and vertical refits between Unit 3 and Lower Units at Q1/B.

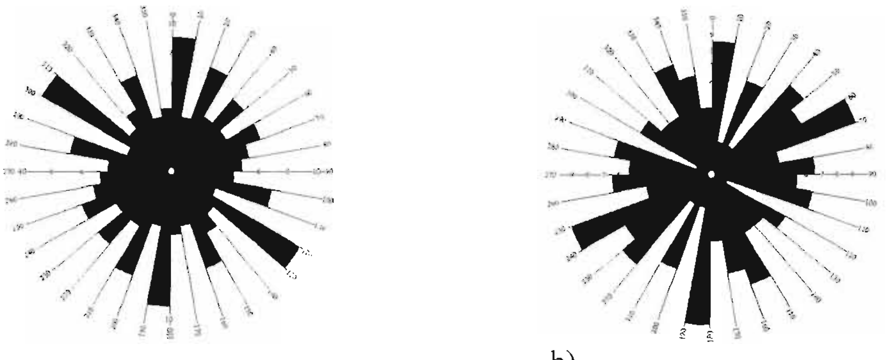
5.6.3 Orientation

Unit 3c: The artifacts from Unit 3c appear to have a preferred long-axis orientation along a NW-SE alignment (Figure 5.21a). This direction is consistent with the observed orientation of the channel itself and indicates the realignment of artifacts by hydraulic action.

Unit 3: No single preferred alignment is discernable in the arrangement of artifacts from Unit 3 (Figure 5.21b). While the all other indicators suggest that the Unit 3 assemblage is disturbed, the lack of a clear preferred orientation may be due to the fact that the Unit 3 assemblage relates to at least two separate depositional events. Broadly dominant orientations along a north-south and a northeast-southwest axis provide some confirmation of this.

5.6.4 Size class analysis

Unit 4.4u: The artifact size-class distribution for this unit appears to indicate a post-depositionally modified assemblage (Figure 5.22). Artifacts 20-29mm are under



a) b)

Figure 5.21: Artifact orientations for a) Unit 3c and b) Unit 3, Q1/B.

represented by 15% compared to the experimentally derived limits suggesting winnowing of this smaller material.

Unit 3c: The artifact size-class distribution curve for Unit 3c indicates the under representation of material 20-2.9mm by 16%. There is a reasonably consistent over-representation of larger elements but the overall profile of the curve indicates that the assemblages should be considered intact above 30mm.

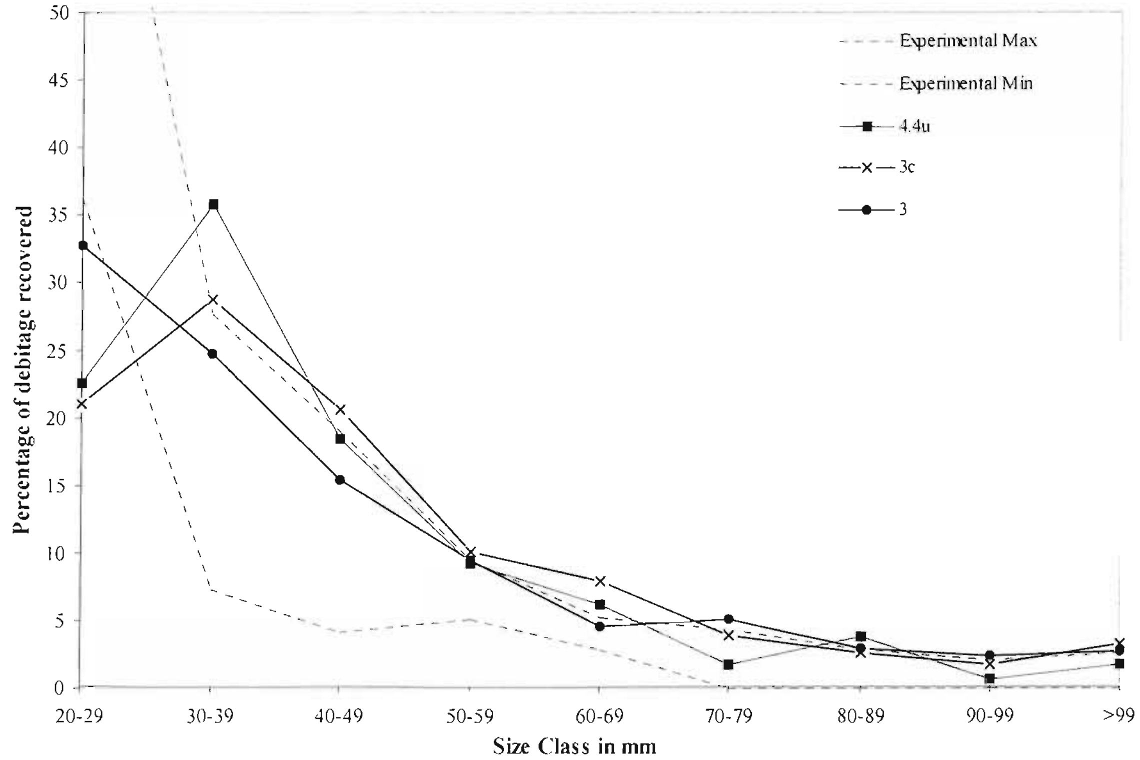


Figure 5.22: Debitage Size-class curves for Lower Units at Q1/B.

Unit 3: Artifacts from Unit 3 also appear to be slightly under represented in the 20-29mm size-class, although not to the extent of Units 4.4u and 3c. In terms of the general shape of the distribution, the curve appears to be closer in shape to those of the middle units (4, 4u and their basal contacts) than to either of the lower 'channel units' (3c and 4.4u). Its is suggested here that had the Unit 3 assemblage formed during the same depositional events as the Unit 3c channel it would appear to be much more winnowed.

5.6.5 Summary.

Unit 4.4u: Artifacts from Unit 4.4u form a diffuse spread of material along the western margins of the Q1/B channel feature. There is nothing in the disposition of the artifacts to indicate *in situ* knapping scatters and long axis orientation suggests movements of artifacts under low-velocity currents. Flakes 20-29mm are under-represented by 15% suggesting possible winnowing and refits between Unit 4.4u and the overlying Unit 4 indicates that the latter contains derived elements of the Unit 4.4u assemblage. It is suggested that Unit 4.4u represents the fine-grained upper fill of the channel and that, prior to truncation by the deposition of Unit 4, it had been more vertically extensive

Unit 3c: Artifacts from Unit 3c are distributed throughout the fill of a linear channel feature cutting through the western part of Q1/B. Artifacts are generally diffusely spread within the channel but there are some clusters of larger, non-debitage elements. There is a preferred artifact orientation along an axis consistent with the orientation of the channel feature and the under-representation of small debitage elements 20-29mm also appears to indicate some winnowing of smaller elements.

Unit 3: Unit 3 artifacts were encountered as spread of material lying across the eastern and southern parts of the site, buried within the top of the marine sand. The size class distribution curves do show an under-representation of artifacts in the 20-29mm size range but the assemblage does not appear winnowed to the same degree.

Units 4.4u and 3c. The curve shape more closely resembles that of Units 4, 4u and their basal components, in addition the refit evidence suggests that Unit 3 assemblage should be grouped with these units. On these grounds it is suggested that the Unit 3 assemblage relates to the deposition of Unit 4 and 4u. The taphonomic evidence suggests that the formation of Units 4u and 4 involved initial erosive episodes resulting in the truncation of underlying sediments, it is suggested that the Unit 3 assemblage are the artifacts entrapped within the marine sand during these episodes. Thus its is suggested that the Unit 3 material relates to depositional events post-dating the initial erosion of the marine sands and the Unit 3c channel formation. The Unit 3 assemblages would appear to relate to at least two depositional episodes associated with the early stages of the formation of Unit 4 and 4u.

5.7 Discussion: Isolating hominin behaviour from natural processes.

At the beginning of this chapter a number of distinctive features of the Q1/B assemblages were noted. These included a general abundance of bifaces/cores and high counts for retouched artifacts and tranchet flakes for most of the recovered assemblages. However, given the evidence for dynamic fluvial activity throughout much of the depositional sequence at the site, the above analysis has attempted to establish the degree to which these distinctive features were really a product of hominin behaviour, rather than the results of natural processes associated with fluvial depositional environments. The results have shown that concerns over the integrity of the assemblages were warranted, with evidence to suggest that each of the Q1/B assemblages have, to some degree, been modified as a direct result of fluvial or colluvial sedimentary activity. The site preserved virtually no evidence for intact, *in situ* knapping scatters and while most of the material was confirmed to be in primary context, evidence for significant reworking at some levels was isolated. Thus, given the evidence for assemblage modification, notably the evidence for winnowing in some assemblages, it becomes impossible to uncritically accept the distinctive character of assemblage composition at the site as a real function of hominin tool using behaviour.

The most significant feature of the Q1/B assemblages was the apparent relative abundance of bifaces and cores. Crucially, the analysis has demonstrated the winnowing of smaller debitage elements from some of the assemblages and in these cases it is almost certain that the relative abundance of larger artifact forms is, in part, a product of fluvial modification. However, given that bifaces are abundant throughout even parts of the sequences with little or no evidence for winnowing, such natural processes are probably only exaggerating real behavioural characteristics of the assemblages. This was particularly apparent in the assemblages recovered from the contact of Unit 3 with the overlying Units 4 and 4u. Both these assemblages had high quantities of bifaces compared to other assemblages from the Slindon Silts and both assemblages appeared to be missing significant quantities of smaller debitage. Yet crucially, the assemblages from the main bodies of Units 4 and 4u also had high counts for bifaces and cores and yet were compositionally intact with little or evidence for winnowing. In these cases it is almost certain that the relative over abundance of these non-debitage artifacts was a real, distinctive feature of hominin behaviour at the site.

The relative abundance of flake tools throughout the freshwater sequence cannot be accounted for by size sorting. However, the high counts for retouched flakes both within the basal channel context of Unit 3c (5% of assemblage) and at the erosive contact between Units 3 and 4 (4.9%) raises concerns over the possibility for the natural retouching of some flakes within in these relatively dynamic depositional environments. Yet given the localised nature of retouch on these artifacts, combined with the lack of evidence for more general abrasion within the assemblage, it is cautiously suggested that the frequency of retouched tool forms is a real behavioural feature of the archaeology of all the freshwater units. Generally, high tranchet counts occur throughout the sequence, but particularly within Units 5a and 3c. This characteristic also appears to have no natural origin and almost certainly relates directly to the on-site finishing or resharpening of bifaces.

5.7.1 Taphonomically derived model of assemblage formation

In Table 5.3, a taphonomic model of assemblage formation for the sequence is shown. Working up through the sequence, Phases 1-3 represent similar cycles initiated by relatively high-energy erosive events followed by periods of more stable, quiet water deposition. During the initial erosive events, artifacts from earlier deposits are reworked and 'lag' assemblages, characterised by low counts for smaller debitage size-classes, are formed at the basal contacts. The deposits from the subsequent periods of quiet water deposition contain intact but spatially disturbed assemblages. Phase 4 represents the formation of a more stable but still very wet landsurface, initially through the deposition of calcareous spring deposits and then as part of a more extensive marshland phase. Here at least, minimally disturbed but essentially *in situ* spreads of material can be identified. Phase 5 represents another localised erosive event, the 8ac channel, which appears to have locally reworked artifacts from units 4d1, 4 and 5a during its formation and subsequently filled with a mixture of colluvial and fluvial deposits. It is impossible to identify which artifacts, if any, from this unit are coeval with the deposit's formation. The final phase discussed here is the deposition of a lobe of chalk pellet gravel containing a dispersed assemblage at its front. This appears to be a wholly derived assemblage of artifacts either picked up from the surface of cliff collapse deposits to the north, or from fine-grained parts of the truncated Slindon Sequence.

Within the context of this depositional framework it is suggested that throughout Phases 1-3 the locally dynamic, freshwater environment of Q1/B was particularly attractive to hominins and led to a dense concentration of activity, possible reasons for this will be discussed in Chapter 6. The episodic nature of the depositional sequence may mean that we are dealing with a seasonal pattern of sediments drying out and being open to occupation, followed by a 'wet season' (ie. winter) of floods, beginning with erosive events. Rather than hominins attempting to occupy the site during the evidently muddy conditions of the 'wet season', it is suggested that artifacts were discarded during occupation on temporary dry landsurfaces that would have seasonally formed within the local environment.

It is envisaged that during dry seasons the waterhole would have exerted a greater pull on herbivores than at other times of the year. During occupation, knapping associated with the production of bifaces and other tools forms took place at the site. However, it appears that finished tools were repeatedly imported into the area, leading to a relative abundance of bifaces and cores at the site. This feature appears to be the product of hominin behaviour, but one compounded by the winnowing of smaller assemblage components from the basal levels of some units. This process is envisaged as occurring during wetter, more fluvially active periods, where discarded artifacts on the temporarily dry landsurfaces were subject to rearrangement and limited winnowing during the initial flush of water. This process led to the reorientation and dispersal of artifacts and to both the horizontal and vertical dispersal of scatters.

Phase	Units	Depositional envrionment	Assemblage character	Av. Refit dist	Pref orient	Size sorting	Interpretation
6	8a	Solifluction flow	Low biface count	No refits	Yes	Yes	Derived assemblage.
5	8ac	Fluvial channel with colluvial fill.	Biface and 'core' rich	3.82	Yes	No	Significant reworked component.
4	5a/4d1	Spring and marsh deposits	High 'core' and Tranchet counts	0.88	Yes	No	Minimally disturbed. primary context assemblage. With *in-situ* Component.
3	4 (4/3)	Freshwater deposits	High counts for bifaces. 'cores' and retouched flakes	4.67	Yes	At base	Disturbed, primary context assemblage with basal lag. some reworked elements.
2	4u (4u/3)	Freshwater deposits	High counts for bifaces. 'cores' and retouched flakes	3.15	Yes	Only at base	Disturbed, primary context assemblage. With basal Lag. Some reworked elements. Some *in situ* component.
1	3c. 4.4u	Channel deposits	High counts for bifaces. 'cores' and retouched flakes	1.95	Yes	Yes	Disturbed, primary context assemblage. Basal lag. Some reworked elements.

Table 5.3: Summary of taphonomic analysis of Q1/B assemblages

Despite the dynamic nature of the Q1/B depositional environment, the vast majority of the recovered artifacts, specifically from the large Unit 4 and Unit 4u assemblages, can be considered to be in primary context and compositionally intact.

Thus many of the isolated distinctive characteristics of these assemblages relate to the nature of hominin tool-using behaviour within the vicinity. Of all the assemblages from freshwater contexts at Q1/B, that from Unit 4u shows less horizontal and vertical dispersion and contains virtually no reworked components. It would therefore appear to represent the assemblage with the highest integrity, a fact that would accord well with sedimentary analysis of the unit which indicates a low-energy terrestrial/channel-edge context.

5.7.2 Implications

The assemblage characteristics of Unit 4u, and to a lesser extent Unit 4, can be seen as direct reflections of hominin behaviour at the site. This behaviour, as expressed through higher biface and core import/discard rates and use of retouched flakes would appear to be distinctive when compared to assemblages from contemporary sites from typical Slindon Silts contexts. Thus, the Q1/B assemblage demonstrates one example of a real association between biface discard and a local freshwater environment. Concerns by some researchers that fluvial activity may be entirely responsible for biface-rich signatures are upheld as warranted but overly pessimistic in the case of Q1/B (Schick 1990; Isaac 1977). Rather, the Q1/B evidence suggests that fluvial activity is simply compounding and exaggerating an underlying, and no doubt ecologically dependent, aspect of Middle Pleistocene land use and tool using behaviour. The Q1/B and GTP17 evidence taken together would therefore appear to represent two extremes of hominin tool using behaviour at Boxgrove. The former site would appear to represent a single-episode butchery episode in open country and is characterised by an assemblage lacking in bifaces, flake tools and other 'valued' items such as soft percussors. Q1/B represents a diametrically opposite configuration being a regularly revisited site, with a localised and unique resource base (fresh water) and an associated assemblage rich in tool forms, including bifaces and soft hammers. The above detailed analysis of assemblage composition, taphonomy and technology at these sites serves to provide a framework through which to understand features of variation in the Boxgrove record (Chapter 3) and within the wider Acheulean world (Chapter 2). The data indicates that hominin land use patterns and tool using/transport behaviour were intimately linked during the Middle Pleistocene and that assemblage composition relates directly to patterns of resource exploitation and movement. Such a possibility now has to be tested though a wider, landscape-based analysis of assemblage variability at the site. Thus, having established a dichotomy between behaviour at single episode and revisited sites, in Chapter 6 the scale of analysis will widen further in order to both test the validity of this association and search for possible behavioural mechanisms to explain it.

Chapter 6: Isolating contextual relationships between tool using behaviour and the Boxgrove palaeolandscape

6.1 Introduction.

In Chapters 4 and 5 analysis of stone tool assemblage composition and taphonomy has shown that the differences between the GTP17 (Unit 4b) and Q1/B assemblages relate primarily to variation in the tool using behaviour of hominins at the site. In this chapter these assemblages will be discussed in relation to wider patterns of land use to test the validity of these conclusions. In order to move beyond the detailed analysis of particular locales and towards the identification of wider patterns of land use behaviour, a new approach and scale of analysis is required. The wider context of assemblage variation now has to be considered and associations between particular assemblage types and the palaeolandscape identified. In this chapter it is therefore hoped to complete the analysis of the Boxgrove data by finally progressing towards a coherent model of land use and tool using behaviour for Middle Pleistocene hominins at the site. It is intended to achieve this through the integration of results from the analysis of the fine-grained record at GTP17 and the coarser record of the multi-episode occupation layers at Q1/B within a wider study of variability across the Boxgrove palaeolandscape.

In addressing the some of the initial aims of this thesis, accounting for differences between the assemblages from Q1/B and GTP17, the analysis provides evidence to suggest that the dichotomy forms part of a wider pattern of assemblage variation within the Middle Pleistocene. As such, it is proposed that the differences in assemblage composition between the two sites reflect real and repeatable aspects of hominin behaviour as opposed to atypical or idiosyncratic aspects of activity or site-formation. The concluding analyses in this chapter will therefore show that patterning exists in the spatial distribution of artifact types and that this patterning reflects an apparently structured system of artifact transport and discard. It will be further demonstrated that the assemblages recovered from areas of the palaeolandscape within 150m of the cliff differ from those at greater distances, that assemblages rich in bifaces and other non-debitage artifacts are largely restricted to freshwater contexts close to the cliff.

Apparent patterning in biface discard suggested by the Boxgrove data will be then be tested. Utilising a transect approach, biface discard rates will be measured in relation to distance from the fossil cliffline, a transect which accounts for much of the measurable change in the distribution of vegetation, fresh water and raw material resources. The results of this analysis, which show that bifaces were discarded in much greater numbers at limited locales close to the cliff, will then be used to derive a model for site formation and hominin land use at Boxgrove. Clear relationships between environmental vectors and hominin behaviour are identified, the 'scatters and patches' configuration changes with distance from the cliff and biface-rich sites are shown to be tethered to freshwater areas. Thus, in this chapter it will be demonstrated that the discard of bifaces at Boxgrove was a contextually sensitive aspect of hominin behaviour. These findings reinforce my earlier conclusions that the biface-rich assemblage at Q1/B was primarily a behavioural phenomena.

6.2 Variation in the spatial distribution of assemblage types.

While a full spatial analysis of artifact distribution is not possible (see Appendix 2), our sample does provide a dataset adequate for the investigation of lateral variation across known environmental transects. While a similar transect approach was applied pragmatically at Koobi Fora, its nature was entirely dictated by the erosion of the Okote Formation due to the sinuous nature of the outcrop of the target horizon. At Boxgrove however, we have a spatially extensive, uninterrupted target horizon and a wholly random distribution of sample points. This situation allows a suitable transect to be chosen, either along given directions (such as eastings or northings) or in relation to known palaeogeographic features. For the purposes of this study, variation in artifact density will be viewed in relation to distance from the fossil cliff line, a palaeogeographic feature that marks the northern limit of the palaeosol (Roberts and Parfitt 1999). While distance along the transect has been worked out in relation to distance from the mapped cliffline, the general east-west orientation of the cliff gives us a convenient north-south transect orientation. More importantly, the cliffline is by far the most important palaeogeographic feature in the Boxgrove landscape. The cliff provided the source of all raw materials utilised by hominins in the palaeolandscape, access ways to the chalk plateau, freshwater from springs along the cliff base and associated localised vegetable resources.

The transect approach is useful in two primary ways: it allows the data to be related directly to local environmental conditions and allows datasets from different Palaeolandscapes to be directly compared (eg. Potts 1994, 1999; Blumenschine and Masao 1991). Thus, this approach can provide an effective overview of the range of variation in observed artifact densities across a palaeolandscape, whether in relation to a known palaeogeographic feature (e.g. Nabor Soit Inselberg, Lake Olduvai margin), a known raw material source (e.g. Tabular Trachyte outcrop at Olorgesailie) or, pragmatically, just as distance along an eroding outcrop (Okote Formation, Koobi Fora).

6.2.1 Intra-landcape variation in 'scatters and patches' patterning

In Appendix 2 an attempt is made to develop an objective means of classifying assemblages within a given palaeolandscape in terms of its unique 'scatters and patches' configuration. A provisional methodology for a 'scatters and patches' analysis is proposed in which Isaac's tripartite peak, intermediate and background artifact density levels are equated with outliers and inter-quartile ranges of a box and whisker diagram. This method is applied to the assemblages from Unit 4c at Boxgrove and the results summarised in Table 6.1.

Classification		**Artifacts**	**Density Per m^2**	**Ml**	**Wt**	**Pc**	**Dsc**	**Flks**	**Ft**	**Tr**	**Bf**	**Cr**
Background	Total	161	-	-	-	-	-	151	1	6	3	0
Background	As % of Total	100	-	-	-	-	-	93.8	0.6	3.7	1.9	0.0
Intermediate	Total	3046	-	-	-	-	-	2975	4	45	20	2
Intermediate	As % of Total	100	-	-	-	-	-	97.7	0.1	1.5	0.7	0.1
Peak	Total	6471	-	-	-	-	-	6146	92	72	82	79
Peak	As % of Total	100	-	-	-	-	-	95.0	1.4	1.1	1.3	1.2
Background	Average		0.9	34.5	7.5	0.6	2.5		-	-	-	-
Background	Std Dev		0.8	12.8	9.2	0.8	0.9		-	-	-	-
Intermediate	Average		6.6	35.1	15.9	10.0	2.5		-	-	-	-
Intermediate	Std Dev		2.2	6.6	18.2	15.4	0.4		-	-	-	-
Peak	Average		16.4	41.4	19.4	20.7	3.1		-	-	-	-
Peak	Std Dev		1.7	1.2	2.0	15.1	0.6		-	-	-	-

Table 6.1: Comparison of assemblages from 'background', 'intermediate' and 'peak' groups. See Appendix 1 for guide to measured attributes.

Figures 6.1 and 6.2 show how the transect approach combined with classification of assemblage types by the box and whisker method (Appendix 2) can isolate variation in land use within given palaeolandscapes. In Figure 6.1 artifact density for each of the Unit 4c sites is simply shown against distance from the cliff, this plot broadly illustrates the overall 'scatters and patches' configuration of artifact density. Three sites with densities greater than 14 artifacts per m^2 clearly show the rare, dense concentrations of material while the bulk of observations fall at less than 2 artifacts per m^2, with a moderate number of sites exhibiting densities of between 2 and 10 artifacts per m^2. The three 'peak' assemblages appear to be evenly distributed along the transect, however there is an apparently higher proportion of sites with no artifacts in areas closer to the cliff compared to the more variable and slightly higher densities of assemblages in distal areas.

This patterning is further highlighted through the use of the site-types defined in Appendix 2. Each individual observation in the scatter plot has been assigned a shape/colour on the basis of the 'peak-intermediate-background' divisions made through the application of the box and whisker technique. In addition, those sites with no archaeology have also been plotted with a different symbol. Instead of making subjective observations about the distribution of the off-site and on-site record, in this plot we already have a statistically derived set of assemblage classifications through which we can confidently dissect and describe the spatial distribution of each assemblage type. Thus we can confirm that there are three 'peak-level' sites distributed quite evenly across the transect, 'intermediate' sites appear to be relatively absent from areas close to the cliff while relatively few sites at greater distance from the cliff produced no archaeology.

Visual inspection of the scatter plot would seem to indicate that there is some patterning in the distribution with regard to distance from the cliff, indicating proportionally more sites with archaeology in areas away from the cliff, and generally lower artifact densities for 'intermediate' and 'background' assemblages.

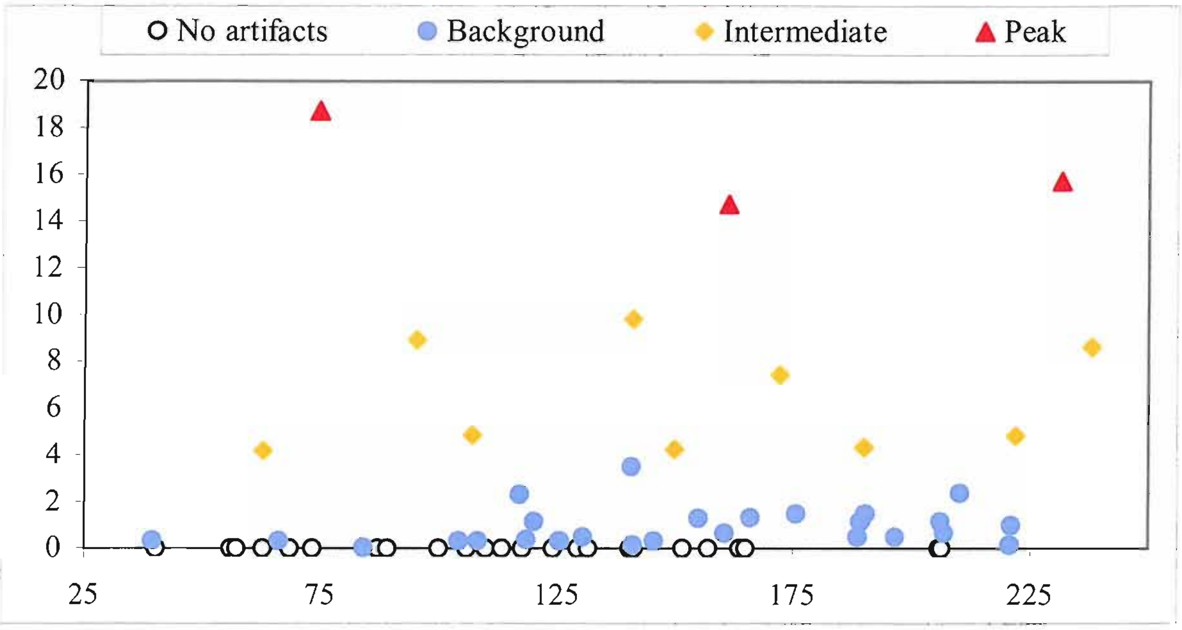


Figure 6.1 : Observed artifact densities along a n-s transect from the cliffline at Boxgrove (Densities in artifacts per m^2, transect distance in metres).

In order to determine the degree to which the 'scatters and patches' signature varies across this transect the next stage of analysis divides the sample into two, based on distance from the cliffline. This division is illustrated in the two histograms in Figure 6.2. These histograms directly compare proportions of each assemblage-type within two populations: the first containing the 50% of observations proximal to the cliff, the other comprised of the remaining 50% from the distal zone. The most obvious difference illustrated by these plots is the number of excavated sites with no recovered artifacts in the two zones. The data shows that while 55% of sites in the proximal area contained no archaeology only half that number (27%) were archaeologically sterile beyond 130m from the cliff. This data is valuable for future prospection at the site suggesting that while there is a relatively even chance of encountering archaeology at a particular locality close to the cliff these odds shorten considerably at greater distances to the south. Therefore, in archaeological terms, this data indicates a more constant spread of discarded artifacts across the distal zone and a more discontinuous, localised distribution closer to the cliff.

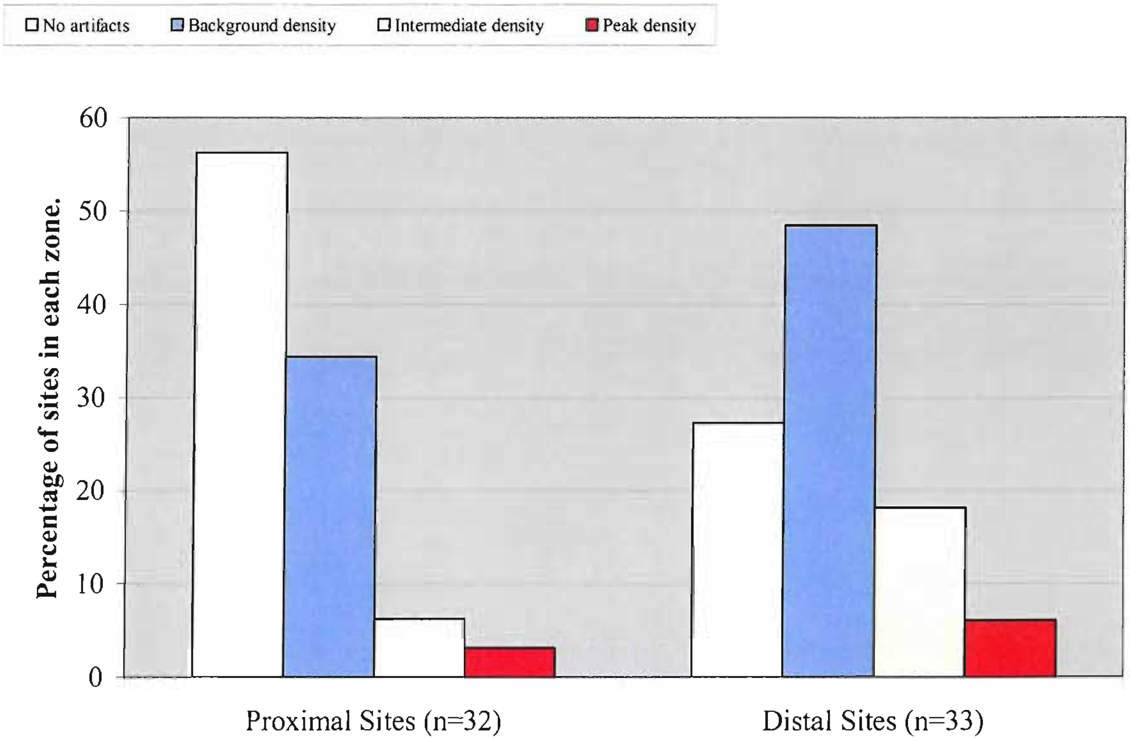


Figure 6.2: Comparison of ratios of assemblage types for proximal and distal zones.

While further refinements and larger samples are required to fully explore the implications of these differences, these techniques indicate how the 'scatters and patches' approach can developed into a more rigid, quantifiable analytical technique suited to the identification and comparison of artifact distribution patterns at landscape scales.

6.2.2 Inferring land use behaviour from the data

From the above data we can begin to broadly interpret some of the basic characteristics of hominin land use at the site. The proximal zone (within 130m of the cliff) has a very well developed 'scatters and patches' asymmetry, with the large and extremely dense distribution of artifacts at the Q1/B locality occurring against a background of very low-density activity. Hominin activity close to the cliff would appear to have been limited to particular locations, which were repeatedly visited, forming over-printed, palimpsest signatures of tool-rich assemblages. In contrast, the distal zone appears to have a more continuous spread of artifacts and a more constant, less punctuated range of observed densities. This suggests a much less structured pattern of land use occurred away from the cliff, with hominin activity occurring across the landscape rather than repeatedly at particular locales. Once we go beyond this basic level of interpretation and begin to look at other environmental factors within the Boxgrove palaeolandscape, other patterning emerges. Two of the three 'peak' assemblages (Q1/B and EQP TP1) were recovered from atypical, freshwater sediments that were deposited at the same time as the development of the palaeosol. Both are located in the western Quarry 1 at Boxgrove and excavation of surrounding test pits suggest that the sediments at each site relate to the same linear area of freshwater drainage which appears to have cut through the palaeolandscape in this area. Thus a more complex but more fully contextualised picture of assemblage formation becomes possible through reference to position in relation to the cliff and local depositional conditions. To illustrate these relationships, the map in Figure 6.3, shows the sample sites plotted by assemblage type in relation to the position of the unconformity, the proximal-distal zone boundary and the area of freshwater deposits in Quarry 1.

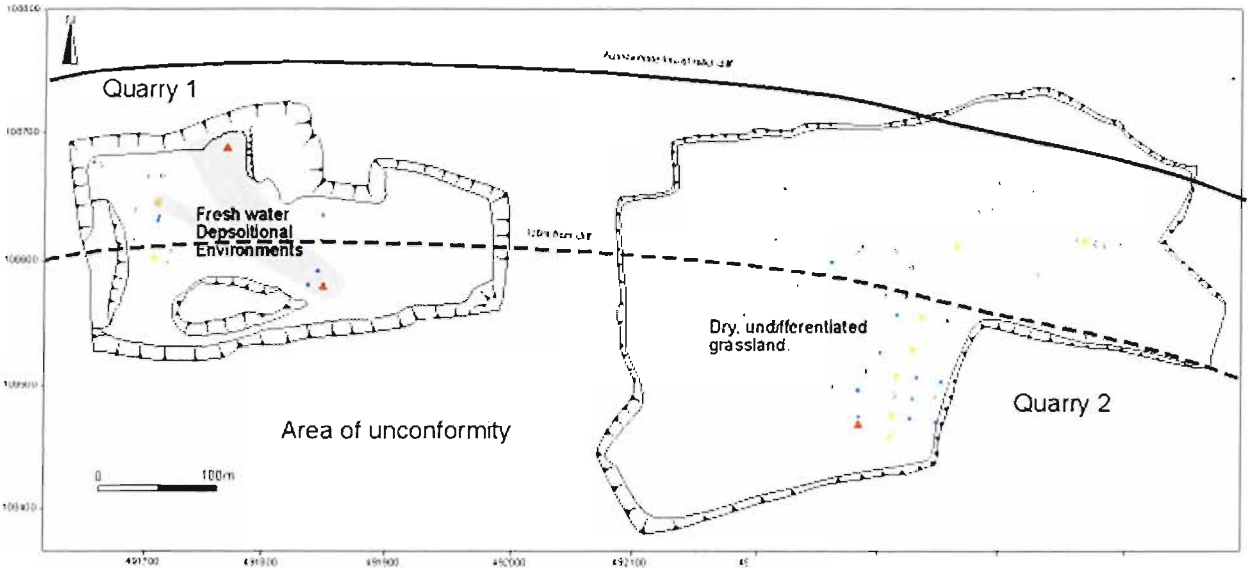


Figure 6.3: Map Showing the position of assemblage types in relation to proximal, distal and freshwater zones.

Artifact discard in the 'proximal zone' is more restrictive in distribution, with most investigated localities producing little or no archaeology. Only two intermediate assemblages were recovered in this zone, GTP3 and GTP17 (Unit 4c), interestingly both of these produced relatively high proportions of bifaces given the size of the assemblages. Because of the low-levels of activity across much of this area the large concentrations of material at Q1/B and EQP/TP1 stand out as high asymmetrical peaks. This pattern implies that hominin activity was restricted to localised areas within the proximal zone, that these areas were regularly occupied and became the focus for the discard of large quantities of tools. These features may well be reflecting structured patterning in the use of space at Boxgrove, with hominin land use focusing on localities which provided fixed, repeatedly accessible resources in the palaeolandscape. The proximal zone provided more localised resources (waterholes, springs, flint outcrops debris slopes and access ways) which are absent in the distal zone, it is therefore possible that close to the cliff hominin movement patterns were more routed between and tethered to these affordances (Binford 1981; Potts 1994). The more asymmetrical 'scatters and patches' configuration in the proximal zone can therefore be taken to equate with a more highly structured pattern of land use.

In the distal zone, the lower 'scatters and patches' asymmetry and more general spread of artifacts, indicated by the low number of test pits with no archaeology, is interpreted as reflecting a less routed, less structured use of space. The more generalised nature of the environment here, being a variably drained area of flat, seasonally wet grassland would not have produced a great deal of variation in the distribution or variety of resources. In this part of the landscape the sediments suggest a relatively uniform grassland environment (Roberts and Parfitt 1999; Appendix 2) and it is hard to envisage any resource other than mobile herds of grazing game being of interest to hominins here. It is suggested that more uniform and continuous distribution of artifacts in this zone relates almost exclusively to the exploitation of game in the form of a series of small, short term and occasionally superimposed butchery sites.

6.3 Variation in tool discard patterns.

The above evidence shows that a potentially complex pattern of land use was in operation at Boxgrove that could account for the size, composition and distribution of assemblages and, crucially, the transport and discard of bifaces. This thesis began (Chapter 3), by outlining a number of repeated patterns in the archaeology of

Boxgrove. Together this evidence suggested that bifaces were routinely transported within the landscape. In addition these observations showed that the reduction of individual tools took place at more than one location and that there were great differences in discard rates for bifaces between particular locales. The analysis of the assemblages from GTP17 and Q1/B confirmed these observations by providing evidence to show that large differences existed in assemblage composition that could largely be explained by differences in the transport and discard of tools.

This patterning appears to have resulted from a spatially extended chaîne opératoire underpinned by behavioural and contextual controls. Through the application of 'scatters and patches' analysis it has been demonstrated that some of these controls relate to patterns of land use within a landscape characterised by patchily distributed resources. Assemblages from locales close to the cliff therefore appear to relate to the exploitation of fixed resources and have assemblages that are richer in bifaces and other tool-forms. In order to test the validity of this model, it is first necessary to prove a direct relationship between the discard of artifact forms by hominins and the environments inhabited at Boxgrove. Rather than trying to tackle this complexity directly by either attempting to account for a whole raft of potential assemblage variables, or becoming too focused on the detailed reconstruction of individual reduction sequences, a more measured approach aimed at tracking simple behavioural elements seems appropriate. In the context of the Boxgrove evidence, the discard of bifaces presents itself as a potentially significant but simple behavioural variable. By isolating variation in the distribution of this simple action we can assess whether there is any contextual control over this aspect of behaviour, as suggested by the GTP17 (Unit 4b) evidence.

In order to determine the relative degree to which bifaces were discarded at the Unit 4c sites, assemblage characteristics were compared to the results of on-going biface manufacturing experiments. For each of the Unit 4c assemblages the relative abundance of bifaces was expressed as a percentage of the minimum numbers of flake removals (MND) documented through debitage analysis. The knapping experiments indicated that 40-100 flake removals were usually required to produce an ovate biface, from flint nodules sourced from seams known to have been exploited by the Boxgrove hominins. By comparing MND counts from each site with the experimental limits it was possible to broadly establish the range of biface numbers that could have manufactured at each locality. By then comparing this range with the actual biface count a broad indication biface export and discard behaviour was possible. This approach is both effective and relatively simple and has been successfully applied previously in Lower Palaeolithic contexts (McNabb 1998; Roberts *et al.* 1997). The methodology has its limitations, relying on experimental data, which can only provide a general guide for the assessment of net import/export levels. In addition, the present study takes no account of non-biface reduction at each locality, which we know to form a small part of each assemblage, or the fact that none of the reconstructed biface reduction sequences were totally complete.

In Table 6.2 levels of biface representation at each of the Unit 4c sites are shown. Included in the Unit 4c sample is the assemblage from Q1/B (Unit 4u), this deposit is part of a series of freshwater sediments that form a temporal correlative of the palaeosol (Stringer *et al.* 1998). The assemblage from the Unit 4c horizon at GTP17 could also have been included in the sample; this assemblage is distinct from that previously described in Chapter 4 which was recovered from the lower Unit 4b level. In the analysis the assemblage from Q2/D scored lowest on biface representation, no bifaces were recovered from the site despite the

Site	Distance from cliff (m)	MND	Bifaces (n)	% of MND	Expected at 100 flakes per biface	Expected at 40 flakes per biface	Representation
Q1/B (Unit 4u)	50	2483	74	2.98	25	62	Over
Q1/A	80	205	5	2.44	2	5	In range
EQPTP1	145	228	4	1.75	2	6	In range
Q2/C	155	751	8	1.07	8	19	In range
Q2/A	225	533	4	0.75	5	13	Under
Q2/D	245	480	0	0	5	12	Under
GTP17(4b)	40	1034	1	0.10	10	26	Under

Table 6.2: Biface representation in key Boxgrove assemblages

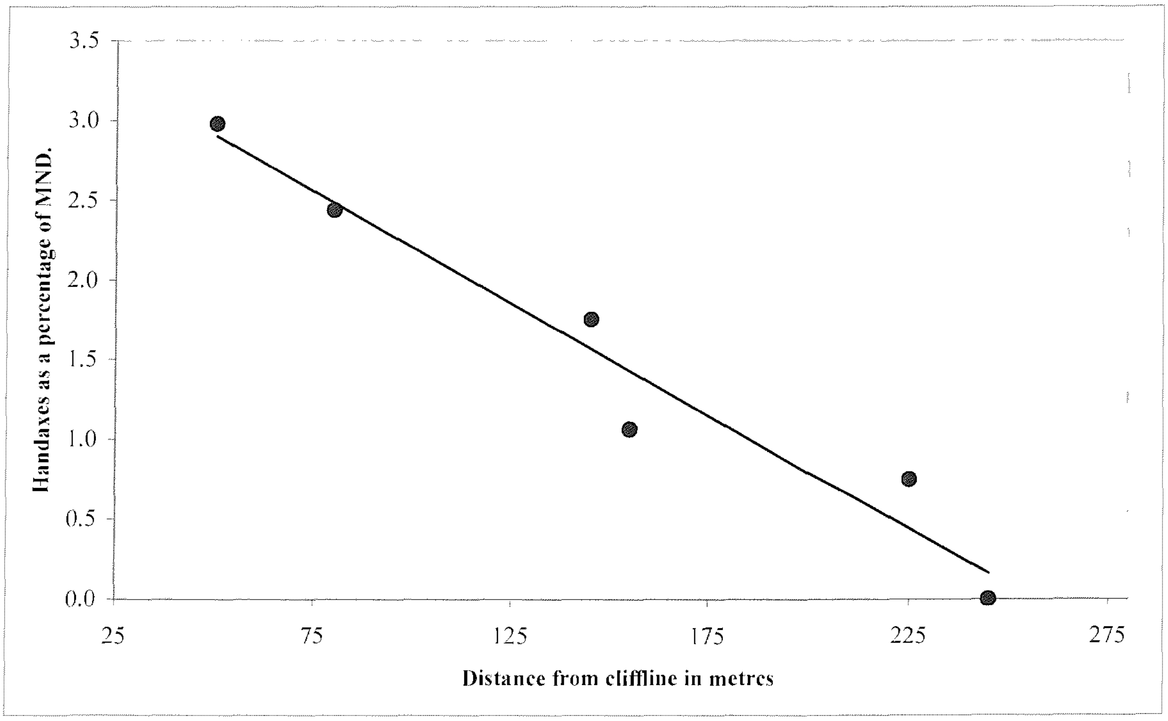


Figure 6.4: Variation in bifaces as a percentage of assemblage composition with increasing distance from the cliffline.

assemblage containing enough debitage to account for 6-9 bifaces (Roberts *et al.* 1997). The assemblage from GTP17 (Unit 4b) also scored low; the assemblage contained enough flake removals to account for between 14 and 20 bifaces and yet only a single non-classic biface (Ashton and McNabb 1993), manufactured on a flake was recovered from the site accounting for 0.1% of MND. At the opposite end of the range is the large assemblage Q1/B (Unit 4u), where bifaces accounted for 3% of MND. The other sites all exhibited less pronounced asymmetries with bifaces represented within the experimentally derived, expected limits; biface counts were relatively high at Q1/A and under represented at Q2/A and Q2/C.

In order to try and make sense of this variability a spatial approach was considered most appropriate on the assumption that hominin behaviour might be contextually controlled by environmental differences in the local landscape. As such, it was considered appropriate to determine whether any relationship between biface discard/transport and distance from the cliff-line could be identified. In Figure 6.4, biface representation for the Unit 4c palaeosol assemblages, expressed as a percentage of MND, are plotted against distance from the cliff, which provides an obvious and well-defined palaeogeographic feature. The plot indicates that bifaces become proportionally less common with distance from the cliff, a fact confirmed by regression analysis which gave a r^2 of 0.95, indicating that much of the relative variation in the proportion of bifaces at each site is directly related to distance from the cliff. The relationship implies that hominins operating 130m or more from the cliff were more likely to transport their tools off-site when abandoning a locality than when leaving a site closer to the cliff.

6.4 The significance of biface discard.

Having established apparent spatial patterning in one aspect of hominin behaviour it is now possible to move towards attempting to isolate the factors controlling this behaviour. Following Isaac's step-wise approach to inter-assemblage variability (Isaac 1981), the emphasis must always be on determining whether the patterns are not simply a product of raw material provisioning before more complex factors such as functional, cultural or even evolutionary differences are examined. In the context of the Boxgrove landscape, given the strong relationship with distance from the only local raw material source, the most obvious of these explanations to begin with is hominin raw material provisioning behaviour. It would be easy to assume that hominins operating at increasing distances from a raw material source would be more likely to transport bifaces and other finished tools rather than discard them. From such a perspective, we would expect the distribution of bifaces in any given landscape to be effectively 'tethered' to the source of raw materials (Potts 1991). Blumenschine and Masao (1991) demonstrated raw material tethering in their analysis of Oldowan assemblages from Bed I at Olduvai. The evidence from Olduvai not only indicated the extensive movement of flaked pieces within the landscape (see also Leakey 1971; Stiles 1991; McNabb 1998) but an apparently suppressed degree of discard of these artifacts at increasing distances from the known raw material sources. 'Tethering' was also invoked to explain the fall in the relative abundance of particular raw material types with distance from source at Olorgesailie (Potts 1994).

There are however a number of reasons why accepting a 'tethering' explanation for the variation in biface discard behaviour at Boxgrove, should be looked at critically. Primarily it must be recognised that the distances involved in the analysis are relatively small, the archaeology is preserved little further than 250m from the cliff. Raw material provisioning costs are likely to have been minimal and the apparent abundance of cores, manuports and primary debitage at sites >200m from the cliff is not immediately suggestive of any kind of short-distance 'tethering' (Bergman and Roberts 1988; Roberts *et al.* 1997). Environmental factors other than transport costs must be considered. For example, the local sedimentary context of two of the sites close to the cliff (Q1/A and Q1/B) indicate at least seasonally wet conditions suggesting a possible relationship between biface discard and proximity to freshwater sources. The evidence for a biface-rich assemblage from freshwater deposits at Q1/TP1, currently under analysis by the author, adds weight to the idea of a possible relationship between biface discard and freshwater bodies.

Similar associations have been observed in Middle Pleistocene contexts before, notably at Olorgesailie where bifaces form up to 62% of assemblage components in channel related sites and <5% in the flake-dominated assemblages of lake-margin zones (Isaac 1977; Hay 1976; Potts 1989a). The evidence from Olorgesailie also suggested that bifaces were 'carried but seldom discarded while foraging' when hominins were exploiting areas away from fluvial contexts (Potts 1989a, 481). Large quantities of bifaces found associated with these sandy-bottomed channels indicated that these locales were the focus for biface discard and possibly preferred habitats for the hominins (Potts 1989a; Isaac 1977). As shown in Chapter 2, the repeated association between bifaces and fluvial contexts is a consistent feature of Acheulean archaeology requiring adequate explanation. While size sorting, winnowing and other hydraulic processes are often implicated at such sites, the suspicion is that such processes are simply confusing and exaggerating what may be a real feature of Acheulean assemblage variability in both Africa and Europe (Clark

1986; Schick 1992). In Chapter 5, the results from the taphonomic analysis of assemblages from wetter depositional contexts at Boxgrove suggests that the relatively high proportion of bifaces in these areas is primarily a product of behavioural rather than hydraulic phenomena.

Establishing that hominins at Boxgrove were discarding bifaces more readily in areas close to the cliff and in association with freshwater bodies indicates that the distinctive assemblages characteristics at GTP17 (Unit 4b) are not atypical but form part of a range of variation in biface transport and discard behaviour. Now in attempting to account for this patterning, the high-resolution evidence from GTP17 (Unit 4b) can be used utilised as a calibrational tool offering a benchmark from which spatial variation in the palaeosol can be interpreted. As an extremely short term, single episode butchery site the GTP17 (Unit 4b) assemblages has a clear contextual basis from which its distinctive characteristics can be translated into a behavioural explanation/model of assemblage formation. Pertinently, the removal of all bifaces and biface rough-outs at GTP17 (Unit 4b) appears to be behaviour directly associated with the abandonment of a single-episode butchery site. When applied to the observed spatial variation in biface discard within the Unit 4c landscape, this contextual association indicates that assemblages recovered away from the cliff, having fewer bifaces, could relate to short-term occupation episodes. Conversely, sites closer to the cliff with assemblages containing higher proportions of bifaces were more routinely occupied.

A useful concept that helps to make sense of this pattern is the static resource model of assemblage variability proposed to explain assemblage variability at Barnham (Ashton *et al.* 1998). This model suggests that patches of high artifact density are likely to form in association with essentially 'static' resources such as fresh water and raw material sources. In addition to these dense patches are more diffuse scatters of material which relate to short term activity episodes based on the exploitation of an unpredictable, 'mobile' resource such as game. This model provides a useful framework that integrates 'scatters and patches' approach to hominin land use (Isaac *et al.* 1981; Isaac 1981b; Roebroeks *et al.* 1992) with approaches to hominin land use based on the controlling effects of resource tethering on hominin movement and artifact discard (Binford 1984; Blumenschine 1986). The static resource model makes sense of the Boxgrove data with biface-rich locales close to the cliff offering access to fixed resources (raw material, freshwater, plant foods, game aggregations) while biface-poor locales away from the cliff front represent grassland that supported the exploitation of mobile resources (i.e. game).

From this perspective, distance from the relict cliff appears to have only been significant in as much as waters seeps, talus slopes and spring fed streams and pools in this area provided microhabitats with predictable, static resources while to the south lay a relatively undifferentiated grassland offering grazing for animal herds. It is therefore perfectly feasible, indeed highly likely, that had freshwater bodies existed beyond 200m, they would have become routine foci for hominin activity and biface discard. Its is also apparent that the preponderance of wetter environments documented in Quarry 1 suggests that differences in biface representation between the western part of the palaeosol and the generally drier zone of Quarry 2 might also be significant, although this remains to be tested.

The Boxgrove evidence shows that variation in the distribution of resources within a landscape will not only produce quantitative variation in the distribution of artifacts, giving rise to a 'scatters and patches' configuration, but also qualitative asymmetries resulting from the cumulative effect of individual transport and discard choices. This has important implications for how inter-assemblage variability is interpreted, requiring that models take account of the effects of filtering by hominins on assemblage composition. While there is good data to show that Middle Pleistocene hominins had a preference for manufacturing ovate biface forms where raw material was suitable (White 1998a); it is possible that this preference also informed individual discard and transport choices by hominins. Such behaviour may have led to the selective discard of particular tool forms over others, for example pointed biface forms over ovates. If this was the case, the composition of an assemblage as excavated may not directly reflect the true range of forms utilised by hominins at the site. Further to this, the potential for large variations in the degree of curation and tool reuse also stresses the importance of considering biface resharpening as an essential and routine aspect of hominin tool using behaviour, in addition to the possible effect of resharpening on tool morphology (McPherron 1996; White 1998b).

As shown in Chapter 2, Schick and Potts have each forwarded quite mechanistic models for the formation of artifact concentrations at Lower Palaeolithic sites in Africa (Schick 1987a; Potts 1988). In Schick's study, artifact concentrations are seen to form as part of a cyclical process involving the habitual transport of material and increased discard at sites occupied for extended periods. In Potts' stone cache model, a similar process was envisaged as leading to the redistribution of resources and the *de facto* storing of raw materials at regularly exploited locales. These models require no conscious intent or planning on the part of the hominins and could easily be applied as a base level explanation for the movement of bifaces demonstrated at Boxgrove and the formation of large accumulations of bifaces found regularly in Middle Pleistocene contexts. However, possible differences in the scale and nature of artifact transport in different Middle Pleistocene contexts might have had significant implications for the ways in which hominins exploited local resources and the range of environments open to particular groups.

Perhaps these patterns of artifact transport and discard could be viewed alongside the colonisation of northern latitudes, evidence for hunting (Thieme 1997; Roberts and Parfitt 1999) and longer raw material transport distances (Gamble and Steele 1999; Gamble 1999; Steele 1996) as part of a suite of behavioural developments during the Middle Pleistocene. Bifaces, which appear to have been a habitually transported component of the Acheulean tool kit (MacRae 1989; Hallos in prep; Pope in prep; Potts 1994) may have played a crucial role in this behavioural package, perhaps enabling the increased mobility and efficient use of raw materials demanded by hunting.

While in this chapter a contextual link between variation in biface discard and the exploitation of different micro-habitats has been proposed, establishing the possible functional, adaptive and social significance of this behaviour will be addressed in the following concluding chapters of this thesis. Here the issue will be approached through evolutionary/technological framework, allowing possible differences in the nature of artifact transport and discard between biface and non-biface industries to be identified. Thus, in next two chapters, the evidence for patterns of structured tool discard and transport behaviour in the wider Lower Palaeolithic record will be discussed. By examining the identified patterns of land use and tool discarded at Boxgrove against the wider Lower Palaeolithic it will be shown that relationships between assemblage variability and environmental context are a recurrent feature of the Lower Palaeolithic. While structured discard patterns can be identified in the archaeological record prior to the Acheulean, it will be suggested that biface-rich assemblages reflect increasing complexity in hominin social and ecological behaviour during the Early and Middle Pleistocene.

Chapter 7: The evolution of structured artifact discard in the Lower Palaeolithic record. Applying the Boxgrove results.

7.1 Introduction.

The analysis of the Boxgrove data has provided a detailed picture of hominin activity at the site. Through both statistical analysis and repeatedly identified contextual association, the discard of specific artifact types (bifaces) has been shown to be a structured aspect of hominin behaviour. The Boxgrove data suggests an apparently routinised pattern of land use which might help to explain some of the features of Middle Pleistocene assemblage variability set out alongside the aims and approaches of this thesis (Chapter 2). In this section I will return to the wider Lower Palaeolithic record, and to some of the sites discussed earlier, in order to test the wider validity of the inferences made from the Boxgrove data. These inferences can be tested on the basis that if assemblage variability at Boxgrove does relate to distinctive hominin behaviours at single episode *vs.* reoccupied locales, then it should be possible to find contextual corroboration for this at other Middle Pleistocene sites.

If, as argued in this thesis, the evidence for structured land use at Boxgrove forms part of a deeply embedded and widely distributed aspect of Middle Pleistocene hominin behaviour, then such behaviour must have origins predating the period. Thus, in this chapter, the evidence for structured discard in earlier archaeological occurrences will also be discussed. The long chronological spread of sequences at Olduvai (Leakey 1971), Olorgesailie (Isaac 1977; Potts 1989a, 1994, 1999) and Koobi Fora (Isaac 1997) provides workable datasets through which to trace the possible evolutionary development of structured discard. Utilising the broad chronological and geographical scope that these datasets afford, the kinds of land use models suggested by the Boxgrove data can be further developed. Through the discussion of this evidence I wish to return to the main research theme of this thesis, and further define the behavioural mechanisms involved in the formation of biface-rich assemblages. Such assemblages can be seen as forming one extreme of a broad range of assemblage variability in the Pleistocene, contrasting the false caricature of a uniform and static Acheulean with the more complex reality of spatial and temporal variation in assemblage composition (Gowlett 1986). In this chapter it is intended to unravel some of this complexity and try to explain the relatively heterogeneous nature of Middle Pleistocene assemblages at both landscape and continental scales. An evolutionary perspective will be adopted in order to try and identify the development of particular characteristics of variation before, in chapter 8, I explore its wider social implications and possible significance in the development of some aspects of modern human behaviour.

7.2 Late Pliocene/Early Pleistocene: The Oldowan colonisation of landscapes.

The Early Pleistocene records of Olduvai and Koobi Fora provide highly detailed evidence for the routine use of stone tools across a variety of environments. It is therefore reasonable to assume that if the Acheulean, emerging at the end of this period, is a product of structured land use patterns as suggested by the Boxgrove data, that the origins of this behaviour will be found in the Oldowan. Within the Late Pliocene assemblages of Olduvai and Koobi Fora the stone tool record shows little evidence for such structured land use patterns. Within Olduvai Bed I, which spans 1.9-1.75 Ma, stone tool discard appears to have been extremely restricted, with artifacts entirely limited to the lake margin zone (Leakey 1971; Potts 1999), an apparently open and homogeneous environment. Where larger assemblages are identified at Olduvai, they reflect long-term and stable patterns of land use. This stability is apparent in the number of discrete localities in lake margin contexts that persist as the focus for tool using activity over long time spans (Leakey 1971; Potts 1994, 1999). These sites contrast with the complete absence of archaeology in fluvial systems away from the lake margin (Hay 1976). Thus it would appear that tool use at Olduvai during this period was a highly restricted but routinely embedded activity limited to particular tasks and distinct locales (Potts 1999). A similar picture is presented for the earliest tool-using levels at Koobi Fora dating to 2.3 Ma. These Late Pliocene assemblages were also completely restricted to confluences within alluvial fans of the proto-Omo river. Unlike the earliest levels at Olduvai, where at least 20% of raw material had been transported, at Koobi Fora raw material was both locally sourced and discarded (Rogers *et al.* 1994). Thus, the earliest levels at both sites indicate a very limited, task-specific and tethered pattern of land use and tool discard. It is interesting, although of questionable relevance, that modern chimpanzee tool use can be characterised in similar ways. Recent excavations of the stone tool assemblages of Ivory Coast chimpanzees showed a simple pattern of raw material transport from local outcrops to nut-bearing trees (Boesch and Boesch 1984; Mercader *et al.* 2002).

“ As a result, chimpanzees left behind stone and plant refuse that accumulated at specific loci. This patterns resembles some of the behavioural landmarks of early hominin stone assemblages and site formation.” (Mercader *et al.* 2002, 1455)

The archaeological record does not provide any clear evidence to show that a continuous, habitual system of tool use was employed by Early Pleistocene hominins. Tool use at this time was repeatedly focused on specific, discrete locations over long periods of time. While chimpanzee behaviour is almost certainly a misleading analogue for that of early *Homo*, the similar restricted patterns of tool discard might suggest that early *Homo* employed tools only in limited contexts. Such functions might include the exploitation or processing of seasonal plant resources or the occasional butchery of scavenged carcasses.

Where distribution patterns can be determined they occur at small, intra-site spatial scales. The series of circular stone clusters at Olduvai Bed I, typified by the DK circle (Figure 7.1), have been seen as representing primitive wind break structures (Leakey 1971), stone caches (Potts 1988) or natural agencies such as tree root action or weathering (Binford 1982; Gowlett 1996). However, given the later emergence of more structured patterns of discard (see below) and the evidence from chimpanzee studies for the transport of tools (Boesch and Boesch 1984), some indication of a predisposition or even pre-adaptation to structured discard would not be unexpected from these early sites. At wider landscapes scales, however, the relationship between tool use and land use in these early contexts is unquestionably simple and unstructured. This contrasts greatly with the evidence from Boxgrove and other Middle Pleistocene sites (Kolen 1999), suggesting an evolutionary gradient in land use behaviour between the two periods.

Evidence for changes in hominin land use patterns begin to appear at Olduvai in Bed II. While there is still a tendency for specific sites to remain in use over long periods of time (e.g. MNK), the use and discard of stone tools is no longer restricted to limited habitats, but occurs in a much wider range of environments (Hay 1976;

Potts 1999). A widening of activity areas within the lake margin zone immediately precedes the first evidence for exploitation beyond this zone around 1.6 Ma (Hay 1976). Crucially, the Blumenschine and Masao study (1990) of Bed II land use patterns (see Chapter 2) demonstrated the restrictive discard of tools close to the shore line but showed that cores were more likely to be discarded in close proximity to raw material sources. The evidence for raw material transport at this time similarly shows a wider use of space, with evidence for the routine transport of raw material over distances of up to 10km. I would argue that the Bed II evidence indicates that new patterns of tool transport and discard were developing within the Oldowan in response to the widening range of exploited environments. It is at this time, perhaps, that tool use became more habitual, routinised and more widely applied to a degree not firmly indicated for Late Pliocene hominins.

The exploitation of a wider range of environments associated with more structured tool transport and discard behaviour is also shown at Koobi Fora during the Early Pleistocene. From 1.8 Ma, evidence emerges within the KBS member for the exploitation of habitats beyond the interfluves of the proto-Omo and into lacustrine environments developing in the basin at this time (Isaac 1997; Potts *et al.* 1999). Here changes in the drainage of the proto-Omo River perhaps led to the exploitation of new environments and the adoption of new behavioural patterns by hominin groups. By 1.6 Ma, we can see some of these behaviours developing in through changes in patterns of tool and land use. At Olduvai and Koobi Fora there is a rapid widening of exploited environments, with evidence at the latter site that for the first time that all parts of the Omo basin were being exploited (Isaac and Behrensmeyer 1997). At this time a more varied tool kit, making use of a wide variety of non-local rocks and foreshadowing the Developed Oldowan in character, begins to be employed (Bunn 1994; Isaac 1997).

Figure 7.1: DK circle from Olduvai Bed I. (From Leakey 1971, fig 7. Reproduced with the permission of the Cambridge University Press).

The picture of the Oldowan provided by the detailed records of Koobi Fora and Olduvai is of a developing and adaptable repertoire of tool using and tool transport behaviour. These new behaviours (increased transport distances, wider range of tool forms and more heterogeneous ecology) develop from an essentially static and highly context specific pattern of tool use documented in earlier levels at both Olduvai and Koobi Fora. The increasingly rapid shifts of both depositional regime and ecology within these East African basins during the Early Pleistocene would presumably have been at odds with the habitat-specific tool using behaviour exhibited by Late Pliocene hominins. A widening in the range of exploited environments and the scale of habitual tool use and transport I suggest reflect a necessary behavioural response to ecological change at this time. From the outset, part of these new behaviours involved the structured discard of artifacts types and increasing distances of raw material transport. Artifact transport and discard patterns appear highly economic (Isaac 1984; Potts 1988; Blumenschine and Masao 1991), suggesting that the provisioning or even caching of raw material was essential for the exploitation of these larger, more varied and changeable landscapes (Schick 1986; Potts 1988). Importantly these signatures show that, well before the Acheulean, environmental structure and palaeoecological relationships were beginning to firmly underpin both the overall distribution of the archaeological record and the nature of assemblage variability.

Thus, while the patterns of assemblage variability in the Oldowan show land use patterns that lack the structural complexity of the Boxgrove evidence, a clear progression can be seen towards more complex use of space. Simple but increasingly varied tool kits and patterns of routine and structured stone transport/discard (Potts 1988) seem at this stage in human evolution to be essential to a widening of hominin activity away from specific, albeit seasonally shifting, habitats (Clark 1987) towards the occupation of entire landscapes.

7.3 Transitions?: The Developed Oldowan and the Early Acheulean.

The appearance of bifaces in otherwise characteristically Oldowan assemblages began around 1.7 Ma. The significance of these early tools stimulated much debate during the past fourty years. These discussions have centred on how we should view these early assemblages with bifaces, broadly classified under the name Developed Oldowan, in terms of their relationship to the Oldowan and Acheulean industries. Should they be seen as signifying technological developments by the emergent hominin species *Homo erectus* (Leakey 1971), as transitional industries foreshadowing the later development of the Acheulean or as evidence for pushing back the appearance of the Acheulean itself (Stiles 1991; Klein *et al.* 1999)? The debate focuses inevitably on definition (Gowlett 1986). There is a broad division between those who view the appearance of bifaces as a technological/cognitive rubicon separating the Oldowan from the Acheulean (Clark 1987; Klein *et al.* 1999; Stiles 1991) and more pragmatic views that prefer to see the Acheulean as being defined by more than the presence/absence of a single tool type (Leakey 1971; Kleindienst 1961; Davis 1980).

The inadequacies of both viewpoints are readily apparent. By reducing the definition of the Acheulean to the presence of bifaces alone, many other defining and potentially significant differences between the Late and Middle Pleistocene assemblages are overlooked. It also leaves a hostage to fortune as bifacial tool-forms may be found as isolated, idiosyncratic examples amongst Pliocene assemblages that could never be classified as Acheulean in any meaningful sense. Yet the alternative, of following strict prescriptive definitions for the Acheulean such as requirement that at least 40% of tool forms in an assemblage are bifaces (Kleindienst's 1967), creates similar problems. Middle Pleistocene assemblage variability, as we have seen both at Boxgrove and in examples given in Chapter 2, is highly heterogeneous and many assemblages contain very low bifacial tool counts despite the presence of characteristic debitage firmly demonstrating biface production. GTP17 and Q2/D at Boxgrove are perfect examples of assemblages that would not be classified as Acheulean under Kleindienst's definition.

The arena in which these definitions are tested and developed has been named, with broad acceptance, as the Developed Oldowan. At Olduvai, the term Developed Oldowan was used to characterise a range of assemblages from Beds II and IV that contained small numbers of bifacial tools within otherwise Oldowan industries which were found alongside 'Acheulean' assemblages meeting the >40% definition (Leakey 1971). Leakey further suggested that the two industries represented co-occupation of the lake margin environments by two hominin species with *Homo habilis* producing Developed Oldowan assemblages and *Homo ergaster/erectus* being responsible for the Acheulean assemblages. While this theory remains unproven, lacking clear contextual associations with hominin remains, a firmer contextual basis was determined by Hay who showed that Acheulean assemblages in Bed II had a more 'inland' distribution, while Developed Oldowan assemblages were consistently proximal to the lake edge (Hay 1976). In a recent review of this evidence, Potts *et al.* (1999) phrase this association in terms of biface-rich and biface-poor sites dispensing with the Developed Oldowan-Acheulean dichotomy altogether. Like Hay it would seem that they would also prefer to view all the Bed II assemblages as being part of a single system of land use. I also see this as being the simplest explanation for assemblage variability in Bed II. This pattern, which is of crucial importance in explaining assemblage variability in the Middle Pleistocene (see below), can be traced back towards trends for widening ecological expansion and differential discard of tool types seen previously at the site (Blumenschine and Masao 1991). Also the association of biface-rich sites with inland fluvial contexts and biface-poor sites with open flood-plain situations foreshadows similar patterns established both at Boxgrove (Chapter 6) and within other Middle Pleistocene landscapes. The importance of Hay's work was in shifting the emphasis away from technological and typological definitions and towards the significance of assemblage variability for land use and ecology (Gowlett 1986).

Another apparently defining aspect of the differences between the contemporary Developed Oldowan and early Acheulean bifaces in Olduvai Bed II was the form of bifaces themselves. Developed Oldowan bifaces were characterised as being both smaller and cruder than those from Acheulean assemblages. While this was taken by Leakey as further evidence to suggest two competing hominin populations with different levels of technical skill, Gowlett's (1988) metrical study of bifaces from Kilombe showed a similar bimodal dichotomy between crude and 'classic' Acheulean bifaces within a single assemblage. Given the high degree of regularity in basic proportions previously established for the Kilombe bifaces (Gowlett 1982a) the data suggested that two distinct mental 'templates' for biface manufacture existed. At Olduvai these two types were separated on the basis of ecological difference between environments of the lake shore and those of 'inland' margins. At Kilombe however, Gowlett suggests that environmental changes over time at the site could have provoked different behavioural responses leading to a mixed assemblage.

"It is possible that activities occurring separately at Olduvai were permitted to occur together at Kilombe because of the sustained occupation. Thus aspects of the lake margin and inland sites could well have been combined here." (Gowlett 1988, 23).

The analysis of the small, apparently crude bifaces from Developed Oldowan assemblages at Olduvai was to further undermine Leakey's suggestion that different species manufactured these tools. Jones (1994) studied the smaller bifaces and interpreted their smaller and more intensively retouched morphology as reflecting worked out tools with obtuse edges and failed flake detachments. As with GTP17, it might be that the only bifaces being discarded at Developed Oldowan sites are worked out, failed or non-classic biface forms. According to this theory, more classic, symmetrical and larger forms were transported off-site and subsequently were more likely to be discarded at locales routinely embedded in land use patterns.

At Gadeb, in Ethiopia, assemblages characterised by Clark (1987) are found from 1.5 Ma. Clark isolated a similar distinction amongst the assemblages of Gadeb to that identified by Hay at Olduvai. Here, assemblages were recovered from streamside contexts which exhibited multi-occupation, multi-episode signatures and in which bifaces comprised >25% of all tools. This contrasted with single episode butchery sites with assemblages containing much lower proportions of bifaces. Clark did not resort to any elaborate explanations invoking competing technological traditions or species. Instead he viewed the variation as stemming from different aspects of land use by a single population using the environment and tools in new, more organised ways.

"The two kinds of activity can be seen as complementary and suggest a more structured pattern of behaviour." (Clark 1987, 809).

The Gadeb evidence would seem to mirror the established pattern of assemblage variability at Boxgrove in showing a direct link between biface discard patterns and land use. It is therefore entirely possible to invoke an explanation based on the Boxgrove data for Gadeb and propose that the relative absence of bifaces at Gadeb single-episode butchery sites was due to the off-site transport and suppressed discard of these tools. It is plausible then that the biface-using hominins at Gadeb were beginning to develop structured patterns of land use and tool transport/discard remarkably similar to those of the inhabitants of Northern Europe one million years later. At Gadeb, evidence for widening patterns of land use is also provided by four obsidian bifaces that indicate tool transport distances of up to 100km.

The evidence from Olduvai and Gadeb, mirrored also in the Middle Awash (Clark 1987; Chapter 2) and at Melka Kunture (Chevaillon *et al.* 1979) would seem to suggest that structured patterns of land use emerged quite rapidly during the Early Pleistocene. The picture is a confusing one only if a clear transition from one technological regime to another is expected. The real picture in fact shows a gradual and long-term expansion of habitat exploitation throughout the Late Pliocene and Early Pleistocene, combined with an increasingly large range of assemblage components. When bifaces do appear, the discard of these tools seems contextually tied from the start. Small bifaces are discarded at different locations to larger, more classic forms and a clear dichotomy between biface-rich and biface-poor sites is so marked that it suggests to some the overlapping of species or competing technological traditions. Structured biface discard, which I would argue had a strong role in the formation of all biface-rich sites, is therefore a fundamental and defining part of the hominin land use patterns that gave rise to the Developed Oldowan assemblages. The evidence for the Developed Oldowan and early Acheulean sites discussed here matches the Boxgrove data extremely well and provides clear evidence that increasingly structured land use patterns were inseparable from technological development during the Early Pleistocene.

7.4 Unity and stasis?: Defining assemblage variability through the Early and Middle Pleistocene.

The patterns of assemblage variability within the Late Pliocene and very Early Pleistocene become easy to understand once broad frameworks of ecology, raw material distribution and behavioural transport/discard processes are modelled (Potts 1988, 1994; Hay 1976). Yet these patterns are generally defined for closed sedimentary basins within well-defined spatial/temporal contexts. However, in pursuing the nature of this variation into the succeeding periods of the Early and Middle Pleistocene, it becomes apparent that variation increases to continental spatial scales and to temporal spans that encompass more extreme, punctuated climatic shifts. Most of the 'classic' Acheulean sites date from this period and appear to coincide with major population radiations out of Africa into the Near East, Asia and Europe. Acheulean sites from this very broad temporal/spatial area are, as we have seen in Chapter 2, remarkably similar both in terms of ecological associations (butchery of large mammals within open environments) and in terms of assemblage composition. Not only are the bifaces from this period remarkably standardised, the sites at which they are found also have similar configurations across their range (Gamble 1999; Gowlett 1988). Where identified, a large degree of morphological variation in biface form is attributable either to local raw material (Ashton and McNabb 1994; White 1998a) or degree of reduction (McPherron 1994; Jones 1994) and not to technological progression (Cole and Kleindienst 1974; Leakey 1971; McBrearty 2001). Yet despite their widespread distribution and their compositional, contextual and morphological uniformity, classic Acheulean assemblages exist in tandem with a wide variety of contemporary assemblages which either completely lack bifaces or contain only very small numbers of non-classic bifacial tools. These assemblages, which were broadly summarised and discussed in Chapter 2 stand in stark contrast to the more striking examples of classic Acheulean biface-rich sites.

While results of the Boxgrove data analysis presented in this thesis have proved useful in interpreting the ecological/technological differences between Developed Oldowan and early Acheulean assemblages, interpreting wider patterns of variation presented by other non-biface 'industries' such as the Clactonian, Buda, and Hope Fountain, requires a much broader application. The approach of this thesis has been to work step-wise from smaller to larger scales of analysis and in widening out the application of the Boxgrove data. This approach will be retained. Thus in addressing this question, evidence for variation within a comparable sedimentary basin to Boxgrove will first be considered before patterns at wider continental scales across Middle Pleistocene Africa and Europe are examined.

7.5 Olorgesailie and explaining bimodality within sedimentary basins.

A brief introduction to the patterns of assemblages variation at Olorgesailie has already been given in Chapter 2. Through the work of, successively, Glynn Isaac (1967, 1977) and Rick Potts (1989, 1994, 1999) Olorgesailie has become one of the most intensively studied and best understood Middle Pleistocene landscapes. The archaeological record of Olorgesailie provides an excellent comparative dataset for the application of the land use/discard model derived from the Boxgrove data. In terms of preservational environment, a mix of both high-resolution and coarser, fluvial context signatures and the detailed reconstruction of palaeoecology both sites are broadly comparable. Olorgesailie differs from Boxgrove in that it provides a much longer and more complex stratigraphic sequence that allows the analysis of ecological and behavioural change over a much wider chronological time frame, between 1.1 and 0.4 Ma (Isaac 1977; Potts 1999).

Isaac first drew attention to the main features of inter-assemblage variation through the application of Principle Components analysis. The main axis of variation was provided by a strong, inverse correlation of scrapers and bifaces (Figure 7.2).

“if one is present in large or even moderate numbers the other tends to be scarce”. (Isaac 1977, 209)

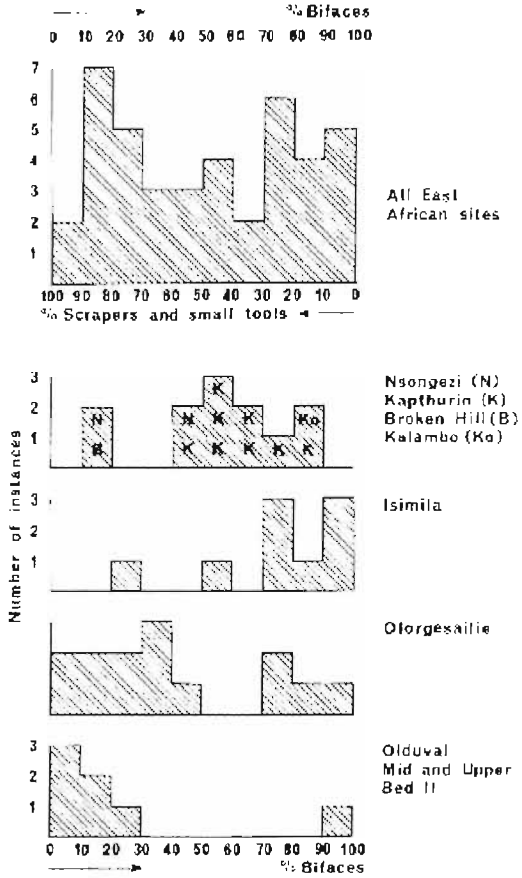


Figure 7.2: Scraper dominated vs. biface dominated assemblages from East African Acheulean sites. (From Isaac 1977, fig 69, page 210. Reproduced with the kind permission of Barbara Isaac)

The bimodality of scraper dominated *vs.* biface dominated assemblages, shown in Figure 7.2, was contextually underpinned by a clear association of biface-rich assemblages with sandy channel areas. While Isaac was inclined to believe that hydraulic activity was implicated in the formation of biface-rich assemblages, the case was not proven. Isaac envisaged that such biface-rich assemblages were fluvial concentrations of material 'harvested' from areas adjacent to channels due to a kinematic wave effect documented in sandy-bottomed channels (Leopold *et al.* 1966). One of the main archaeological research aims of Potts' excavations was to further investigate the formation of the biface-rich assemblages and to test Isaac's model of assemblage formation. Potts focused on localities in Member 7 which had produced dense concentrations of Acheulean handaxe and cleaver forms; these included sites DE/89, H9, Mid and Meng (Potts *et al.* 1999). The investigations revealed that the bifaces were almost exclusively limited to the sandy channels, but no direct evidence could be found to suggest that these assemblages were the product of hydraulic action. The edges of concentrations were sharp, no scouring features were identified and fragments of transported lava fragments from local outcrops were completely absent, all of which suggested low-energy flow. The evidence showed that 'flow was not competent to move the handaxes' yet the general arrangement of the assemblages suggested that 'patches of artifacts and bones were subsequently rearranged and clumped within these patches by fluvial flow' (Potts *et al.* 1999). This assessment exactly matches my assessment of site formation at Q1/B showing that while small-scale spatial relationships and micro-stratigraphy is unlikely to be preserved within such depositional environments, the assemblages are essentially complete, in primary context and are formed by behavioural, not natural agencies.

Having both reassessed pessimistic fluvial aggregation explanations for the formation of biface-rich sites (Isaac 1977; Schick 1987a), Binford's assessment of the value of such assemblages begins to look less convincing (Binford 1977a). With caution and with appropriate taphonomic control, the apparent bimodality between biface-rich and flake tool assemblages should be re-examined. The Boxgrove evidence would suggest that there is a strong likelihood that behaviour underpins some of this variability and that understanding the environmental context/ecology of each assemblage type may help to unravel what the precise nature of these behavioural adaptations might have been.

The archaeological record at Olorgesailie provides a clear example of the kinds of ecological relationships that can be teased out of well-researched Middle Pleistocene records. Potts' research at the site has established a clear association between sandy channels, lava outcrops and bifaces. This kind of relationship between contexts and assemblage type mirrors the established pattern at Boxgrove between wet areas close to the raw material-rich cliff and biface discard. The analysis of palaeosol isotopes near to the dense I3 concentration at Olorgesailie also indicated increased levels of shade (Sikes *et al.* 1999). Potts (*et al.* 1999) suggested that these large biface-rich assemblages formed at the junction between the higher plateau with its abundant lava outcrops and food-rich lake basin environments. The sandy channels formed route ways between the two areas. Bifaces were discarded at these sites because they were carried around as useful sources of raw material, even as flake dispensers (Potts 1989a) in the lower areas, and then discarded as hominins re-entered areas where they could easily reprovision with stone tools. Thus, Potts' model relies only on the simple economic limitations of raw material provisioning to explain the apparent asymmetry between biface-rich assemblages and those dominated by flake tools in lake-margin areas. At Boxgrove we could easily invoke the same mechanism, as was suggested in Chapter 6, by explaining the increased discard of bifaces close to the cliff as being assemblages formed by hominins returning to territories on the wooded downs after hunting/foraging trips on the open grassland. However if this model were to be followed, the very rapid fall in biface discard within only two hundred metres of the cliff would indicate an unreasonably high and implausible degree of resource tethering. The plain at Boxgrove would have extended many kilometres away from the cliff as seas levels fell making it hard to make an economic case for large differences in discard over the nearest 200m. Furthermore, there is no direct suggestion that the Q1/B locality was backed by clear access ways to the wooded chalk plateau. Thus, while the artifact distribution patterns at Olorgesailie and Boxgrove are extremely similar, the scale of patterning at the latter site demonstrated earlier in this thesis is so small as to negate arguments viewing transport costs as being the prime factor behind the pattern.

Yet the model derived from the Boxgrove data, based on differences in artifact discard at single episode butchery sites *vs.* multi-occupation, biface-rich sites can be invoked to explain the Olorgesailie evidence. The strong correlation of bone and stone tool density at the site, was explained by Potts as arising from hominins exploiting and accumulating animal carcasses; the same kind of behaviour that it is suggested formed the Q1/B assemblages. In stark contrast, Potts also identified assemblages that appeared to relate to single episodes of butchery and lacked even moderate quantities of bifaces. At Site I5 the skeleton of a single *elephas recki* was discovered alongside 2322 artifacts. Some parts of the carcass were still anatomically joined and exhibited cuts marks marking this out as a butchery site and, given the lack of primary carnivore gnawing, a possible kill site. The nature of the site exactly parallels the GTP17 Unit 4b horse butchery locality with the artifact assemblage and fauna assemblage tightly confined to 64m^2 (c.70m^2 at GTP17) occurring in an area of low artifact density, suggesting that this was not a revisited locale. The assemblage, while comprising 2322 artifacts (1795 at GTP17) contained only two bifaces (two non-classic bifacial tools at GTP17). The greater time depth at Olorgesailie showed that some particular environments seemed to favour the formation of I5/GTP17–type assemblage. The UMP1 palaeosol for example was dominated by assemblages with low biface counts and represented a relatively undifferentiated grassland environment (Potts *et al.* 1999). At Boxgrove low biface counts were similarly observed for sites on grassland areas away from the wet cliff base within Unit 4c and for the rapidly deposited lagoon edge Unit 4b.

Thus, the Olorgesailie data provides clear confirmation that the patterns of assemblage variability demonstrated at Boxgrove were part of a wider shared set of behaviours that shaped hominin land use in the Middle Pleistocene. The model of differential discard of bifaces associated with patterns of site reuse, developed from the Boxgrove data, can be applied to explain the bimodality of assemblage composition noted by both Isaac and Potts at Olorgesailie. That the model may have a wider validity beyond the specific context of the Boxgrove palaeolandscape, strengthens the idea that biface-rich assemblages are primarily behavioural phenomena.

7.6 The Acheulean and non-biface industries in the Middle Pleistocene.

The evolutionary perspective presented thus far suggests that assemblage variability within sedimentary contexts can be linked to behavioural responses associated with, in the Oldowan, the exploitation of wider ranges and heterogeneous environments and eventually more complex patterns of land use. The bimodality between biface and non-biface assemblages within sedimentary contexts, it is suggested, reflects from the Developed Oldowan onwards, a definable distinction between modes of behaviour at single episode activity areas as opposed to routinely revisited locales. With the strong patterns for the differential discard of bifacial tools at such sites, this model does not need to invoke competing technological traditions or species to account for assemblage variability within a given context. The mechanism isolated at Q1/B can be used to explain the dense concentrations of bifaces at classic 'Acheulean' sites, while it has been shown that biface discard could be entirely suppressed at single-episode butchery sites.

If the Middle Pleistocene archaeological record could be equated with the Acheulean, this would be the end of the discussion. Yet the Acheulean, despite its wide geographical and temporal distribution has its limits, and the behavioural package that gave rise to the structured distribution of bifaces with landscapes might be widespread but is by no means universal. In Europe, industries labelled as the Tayacian (Bordes and Bourgon 1951; Rolland 1986), Buda (Svoboda 1987; Bosinski 1995) and Clactonian (McNabb 1992; White 2000) have already been discussed (Chapter 2) as clear examples of well defined groups of non-Acheulean assemblages. Early assemblages within Europe (pre-0.7 Ma) are almost totally lacking in bifaces (Gamble 1999) while some regional sequences, including that for Britain (Westbury, Pakefield), currently appear to be initiated by flake assemblages. In Africa, similar groups of assemblages can be identified, such as the Hope Fountain 'industry' (Clark 1950), although here it is accepted that such industries form part of a wider Acheulean tradition and do not, as has been argued for the European variants, reflect separate hominin species (McBrearty 2001). Thus it would appear that the bimodalities identified within given sedimentary basins and discussed above, were present at larger scales which some have suggested reflect separate regional technological traditions. There are however, a number of reasons for accepting that such assemblages should not be considered technologically separate from the Acheulean.

- These assemblages do invariably contain bifaces albeit in small numbers. These bifaces tend to be small, non-classic forms (Ashton and McNabb 1994; McBrearty 1981). Such bifaces form a regular component of biface assemblages in classic Acheulean sites such as Kilombe (Gowlett 1988) and Boxgrove (Roberts *et al. in prep*).
- Technologically there is little to distinguish the core and flake technologies from biface-rich and biface-free assemblages (Isaac 1977; Gowlett 1986; White 2000).
- Many non-biface assemblages are known from indisputable Acheulean contexts such as Boxgrove and Olorgesailie. Isaac states that bifaces make up between 0-94% of assemblages at the latter site (Isaac 1977).

Yet the significance of non-biface assemblages comes not from technological or compositional comparisons but rather from the discrete spatial temporal contexts in which they are found. This is most apparent in Europe where both the Clactonian (Early OIS 11) and the Buda (Eastern Europe OIS 11-9) appear as distinctive entities. The Buda forms part of an even more pronounced pattern in which Acheulean assemblages become increasingly rare the further east one looks in Europe (McBurney 1950; Gamble 1993a). The distribution of classic Acheulean assemblages in Europe is also temporally limited appearing in great numbers only Europe after 0.6

Ma. The earliest settlement of Europe and its adjoining areas in Northern Africa and Eurasia, would thus appear to have been accomplished with assemblages dominated by core and flake tools. Such patterns indicate behavioural differences that go beyond the scope of differential discard within given landscapes, and as such they fall outside the scope of variation studied in the course of the Boxgrove analysis. These distribution patterns do however show that while hominins with bifacial technology appear to have colonised the wide areas of the Old World, the behavioural patterns that gave rise the contextual discard of classic bifacial forms were actually much more limited and context specific. Understanding the constraints that inhibited the spread of Acheulean behaviour into parts of Northern and Eastern Europe, or into Europe as a whole prior to 0.6 Ma, is therefore critical to a deeper understanding of both the origin and significance of biface-rich assemblage.

7.7 Summary.

This brief examination of assemblage variability across the Lower Palaeolithic has shown support for the results of the Boxgrove analysis, demonstrating that increases in assemblage variability relate directly to widening exploitation of landscapes. The emergence of structured discard patterns can be seen in Olduvai Bed II prior to the appearance of Developed Oldowan assemblages. The Developed Oldowan/Acheulean assemblages of the Early Pleistocene are likely to have formed part of a single unified system of land use that was to find full expression much later in the highly structured patterns of discard of classic Middle Pleistocene Acheulean sites like Olorgesailie and Boxgrove. In the next and concluding chapter, the wider social context of these patterns of land use behaviour will be explored in an attempt to explain both the wider significance of biface-rich sites, and why such sites failed to appear in particular spatial/temporal contexts.

Chapter 8: Some conclusions on the social, palaeoecological and technological significance of structured discard.

8.1 Introduction.

The evolutionary perspective taken in Chapter 7 placed the patterns of artifact discard identified at Boxgrove within the wider context of assemblage variability at other Middle Pleistocene localities. Moreover, the discussion showed that structured patterns of tool discard and land use can be traced back to changes in the tool-use behaviour of early *Homo*. Increases in both the diversity of tool kits and incipient patterns of structured artifact discard appeared alongside a widening in the range of habitats exploited by *Homo*. These changes broadly coincided with the start of a period characterised by more punctuated climatic change at the beginning of the Pleistocene. Thus, in evolutionary context, the Acheulean can been seen as emerging at the end of a long period of behavioural development during which structured artifact discard patterns became increasingly complex, giving rise to the observed bimodal division between biface-rich and flake tool dominated assemblages. I have suggested, on the basis of evidence from Boxgrove and other Pleistocene sites, that biface-rich assemblages relate to the reoccupation of favoured locales while assemblages with low counts or a complete absence of bifaces relate to a single short-term butchery episode.

In this final, concluding chapter, the possible wider significance of structured discard behaviour for understanding the nature of hominin society in the Middle Pleistocene will be explored. The evidence has shown that artifact distribution patterns, assemblage composition and the distribution of resources within an environment are closely linked variables. My aim in this chapter is now to go beyond the analysis of relationships between quantitative variables and to discuss the wider implications of these relationships on the evolutionary development of hominin society. Thus, having established, with appropriate taphonomic controls, that real and distinctive patterns of hominin behaviour lie behind biface-rich assemblages, in this chapter the conditions under which such behaviour patterns either appeared or were absent will be examined in further detail. By considering the wider demographic and ecological context of structured discard, this discussion will identify the social significance of the phenomenon and potentially fertile avenues for further research.

8.2 Behavioural basis of assemblage bimodalities.

The archaeological localities of Aridos, Spain provide examples of assemblages with distinctive GTP17 type signatures. Aridos 1 and 2 (Villa 1990) both provide evidence for the butchery of a single elephant carcass. They are associated with stone tool assemblages which relate to the manufacture and off-site transport of finished bifaces and the on-site resharpening of existent tools. As at GTP17, finished tool forms at Aridos were often selectively transported off-site. The similarity also extends to the overall taphonomic condition of the faunal and lithic assemblages at the sites, each suggesting single short episodes of occupation during which hominins gained primary access to a carcass and then systematically butchered it.

There are numerous other examples of Lower Palaeolithic assemblages exclusively preserving the remains of a single butchered carcass, and almost all are associated with stone tool assemblages either dominated by flake tools or completely lacking bifaces. The *Elephas recki* site at Olorgesailie (Potts 1994;1999), the Mwamganda elephant butchery site (Clark and Haynes 1970), the Hippo carcass at Isimilia, Gadeb 8F (Clark 1987) and the Lehringen elephant site all produced this behavioural association. With the exception, of Lehringen, all are demonstrably part of spatial/temporal contexts with a broadly Acheulean technological character.

The repeated association between obvious single-episode butchery sites and low biface counts has led some researchers to conclude that bifaces were not used in animal processing activities. Binford (1972) proposed that 'light artifact arrays' were the signature butchery kit of Early and Middle Pleistocene hominins, with scrapers and flake tools used to assist in the marginal scavenging of carcass elements. Similarly Clark and Haynes (1970, 409) suggested that bifaces were not used in butchery on the reasonable assumption that if they had been, "it would be expected that they would occur in large numbers on the sites..."

Yet this assumption only remains reasonable as long as one accepts a direct relationship between tools used at a given locale and the artifacts discarded at that place; the evidence would suggest that, in most cases, such simple relationships are rare in the Lower Palaeolithic record. This fact, coupled with the clear evidence for meat and hide use-wear from some European bifaces (Mitchell 1997; Keeley 1993), weakens the case for disassociation between bifaces and butchery. Binford's arguments that flake tool assemblages would have adequately met the demands of marginal scavenging seem reasonable. However, the evidence from Aridos, Boxgrove, Schöningen (Thieme 1997) and Olorgesailie all provide direct evidence for either primary carcass access or hunting, which some researchers now generally accept was a regular feature of Middle Pleistocene behaviour (Mellars 1995; O'Connell 1997; Klein 2000). It is true that hominins effectively butchered large mammals without the use of bifaces (eg. within non-biface contexts of Europe and Asia) and that bifaces were used in a variety of other processing tasks (Keeley 1993; Binneman and Beaumont 1992; McBrearty 2001). However, where evidence survives, multi-kill/butchery sites are marked within Acheulean contexts as much by the presence of bifaces as they are by large faunal assemblages.

The repeated association of bifaces with butchered animal remains at biface-rich sites strengthens the evidence for their involvement in carcass processing. While I would maintain that such assemblages are primarily behavioural products, their almost universal association with routinely revisited channel contexts means that such assemblages are usually winnowed and transformed. Because of this, direct relationships between stone tool assemblages and butchered faunal remains are often difficult to prove (Binford 1977a; Schick 1986; McBrearty 2001). Yet, where preservation allows, large quantities of butchered faunal remains, often from many individuals are found at such sites alongside large quantities of bifaces and a wide range of other flake tools. Clear associations between large tools and faunal assemblages have been documented at many sites including activity areas from Olduvai Beds II-IV, Ternifine (Arambourg 1963), Torralba, Ambrona (Villa 1990), Olorgesailie I3 (Isaac 1977), Peninj (Isaac 1967a) and the Cave of Hearths (Mason 1962b). Such sites, which Clark took to represent classic Acheulean 'multiple kill or occupation sites', could be cautiously invoked to explain similar large biface accumulations where faunal elements were not preserved (Clark and Haynes 1970,409). While a 'multi-kill/occupation' classification is adequate in a descriptive sense for such signatures, it does little to help our understanding of how hominins operated behaviourally at such sites when compared to their rhythms of action at a single kill site.

We can however be sure that there were some operational differences between the two types of activity. If large accumulations were simply overprinted, compounded signatures of the same behaviour exhibited at single kill sites, we would have been left with an archaeological record differentiated only in terms of the spatial distribution and size of assemblages. Instead, faunal and lithic assemblages throughout the Pleistocene are characterised by qualitative as well as quantitative variability. As such, definitions should be sought that explain assemblage variability in terms of context-specific behaviour and accept that it was possible for assemblage composition to change over time. These definitions should therefore recognise that assemblages had mutable, evolving characteristics that were controlled in part by selective transport and discard. The data, from Boxgrove and other Acheulean localities, shows that classic Acheulean sites are more clearly defined by contextual relationships rather than by quantitative measures of assemblage composition and tool morphology alone. In this light we might be able to understand the Acheulean in terms of the social dynamics, ecology and land use patterns of hominin groups rather than as simply a technological phenomenon.

8.2.1 Biface-rich assemblages in social context

In attempting to model the relationship between biface-rich assemblages and those lacking bifaces, I have invoked Ashton's useful distinction between 'fixed' and 'mobile' resource sites (see Chapter 6). In reviewing the wider archaeological record of the Pleistocene it appears that this relationship is robust, being demonstrated repeatedly across the Lower Palaeolithic record. GTP17-type assemblages are apparently associated with the exploitation of single animals in largely open, undifferentiated grassland habitats. Q1/B-type assemblages are repeatedly associated with particular locales, usually channel contexts which provided combinations of fresh water, game concentrations, raw materials, vegetable resources and access routes between or through habitats. Bifaces appear to have been used alongside a wide array of flake tools for butchery activities at both site-types with the selective discard of bifaces alone producing the apparent assemblage bimodality in Acheulean palaeolandscapes. This pattern suggests that structured artifact discard is directly related to patterns of land use involving contextually dependant patterns of behaviour.

What might help to explain differing parameters of behaviour in the exploitation of mobile vs. static resource sites is group social dynamics. Evidence that the exploitation of mobile resources (i.e. hunting) became a more regular part of Middle Pleistocene food provisioning comes, with varying degrees of confidence, from sites such as Schöningen (Thieme 1997), Aridos (Villa 1990), Boxgrove (Roberts and Parfitt 1999) Cotte de St Brelade (Callow 1981; Scott 1980) and Lehringen (Clark 1970). Increasing reliance on game may have necessitated a shift in land use and social behaviour (O'Connell 1997). While 'fixed' areas where game might be intercepted can be remembered and incorporated into fundamental patterns of routed land use, the hunted animal, once intercepted, becomes a 'mobile' and unpredictable resource. We have already seen that patterns of social behaviour along the lake margins of Olduvai Bed II and East Turkana led to the formation of archaeological signatures characterised by differential 'scatters and patches' configurations (Isaac 1981) as well as incipient patterns of structured discard (Potts 1988). I would argue that changes in land use, partly brought about by the spatial scale, unpredictability and danger of game pursuits, spatially stretched patterns of land use even further in the Middle Pleistocene. Although in competitive scavenging situations large group aggregations are advantageous, in order to drive off competitors and prevent the requisition of carcasses by other carnivores, whole family groups (which would have included nursing mothers, infants and the elderly) could not have participated in long-distance hunting pursuits.

Reliance on mobile resources increased throughout the Lower Palaeolithic. However, this can also be viewed a general evolutionary trend for the widening territories throughout the Plio-Pleistocene and even perhaps in the development of our close primate relatives. Chimpanzee groups have wide territories compared to those of gorillas and orangutans (Foley and Lee 1989; Wrangham 1979; Gowlett 1996). At Gombe, male chimpanzees were observed to routinely exploit the entirety of 10 km^2 territories while females and infants restricted themselves to more limited core areas (Wrangham 1979). On the basis of this evidence we might begin to consider that widening patterns of differential land use indicated at Olduvai Bed II (Hay 1976) and East Turkana would have involved the increasing routine fragmentation of social groups during foraging. As chimpanzee groups recombine at favoured sleeping sites (Anderson 1984) within preferred woodland groves (Sept 1992) we might suggest that, from an early stage in the evolution of *Homo*, favoured places were central to the maintenance of group cohesion as exploited territories widened.

The importance of such favoured locales has received much attention through the discussion of Isaac's 'central place foraging' model which developed out of his original 'home-base' hypothesis during the 1970's (Isaac 1984, see also Schick 1991, Potts 1994; Chapter 2; Gowlett 1996). If the degree to which a social group routinely divided and recombined significantly increased throughout the Pleistocene, then we should expect to see increasingly marked divisions in the archaeological record between multi-occupation/favoured/central places and areas of one-off resource exploitation. 'Central place foraging' would therefore be marked by more structured archaeological records. The Acheulean and its associated structured signatures are, I believe, one such manifestation; a product of the adaptive behavioural responses required to maintain group cohesion as increasingly wider resources and areas of landscape were exploited. Acheulean 'central places' were by no means areas of settlement or 'home bases' but rather areas of group aggregation and possibly food redistribution. Their location, often within stream channels, contrasts with the general location of modern hunter-gatherer settlements that tend to be situated 10-15 minutes from water (O'Connell 1997). Such sites fit a pattern, seen also at some Oldowan localities such as FXJj50 and FLK 22 Zinj, as areas where game was intercepted and where butchery and redistribution activity often took place within a 'near-kill' context. However, in contrast to the Oldowan sites, Acheulean central places appear to have wider catchments being located within much larger areas of undifferentiated scatter signatures or at ecotonal junctions (Potts 1989a, 1994). How stone tool discard may have helped to stretch the spatial and temporal effectiveness of social relations will be discussed further below. First we need to consider the possible social significance of non-biface industries.

8.3 Non-biface assemblages: social fragmentation and pioneer occupation.

While it has been shown that non-biface assemblages form a regular component of the Acheulean, it was demonstrated in Chapter 7 that there were certain spatial/temporal contexts in the Pleistocene world where classic Acheulean signatures failed to appear. Given that the general evolutionary thrust of tool using behaviour during the Early Pleistocene was towards increasingly complex assemblage arrays and the standardisation of biface form, such occurrences require explanation.

The clearest evidence for discrete non-biface industries, which contain no classic bifaces and only small amounts on non-classic biface forms, come from Europe. In Africa such assemblages occur as more or less isolated instances within otherwise Acheulean contexts (McBrearty 2001) and can generally be explained in terms of the patterns of structured discard outlined above. In Europe however we have three reasonably well-defined Pleistocene contexts in which biface-rich assemblages are either inconspicuous or fail to appear:

1. No classic Acheulean assemblages date to before 0.7 Ma in Europe despite occupation from at least 1.1 Ma onwards. Such assemblages only become common in Europe after 0.5 Ma.
2. Biface-rich industries are virtually unknown in Europe east of the Rhine (McBurney 1950;Gamble 1994c) and are common only in river-valley contexts of north-western Europe and the Atlantic seaboard.
3. Biface-rich assemblages are largely absent from Early OIS11 in the British Isles. Here Clactonian assemblages, containing only a few non-standardised bifacial tool forms are limited to the opening and final stages of OIS11 and perhaps to the start of OIS9 (Wenban-Smith 1998; White 2000).

As patterns of social land use appear to have partly underpinned the formation of Acheulean assemblages, I believe the explanations behind non-biface industries will similarly be related to group dynamics under particular environmental and demographic conditions. The particular context of non-biface industries in Europe helps to show how such factors may have affected technological behaviour in relation to land use.

8.3.1 The Clactonian

A social explanation for the Clactonian has previously been forwarded by Mithen (1994b;1996). Mithen suggested that industries demonstrating a high degree of technical skill, refinement and standardisation of form could only be maintained within relatively large and stable social groups. Mithen proposed that in the relatively open conditions that characterised much of Pleistocene East African environments and those of early/late glacial phases in Europe, large group sizes could be maintained and led to high levels of social learning. Conversely, during full interglacial conditions,

"Palaeoenvironments were thickly wooded and we should expect hominins to have formed relatively small social groups and social learning to have been weakly present" (Mithen 1996, 222).

The Clactonian was therefore viewed as the product of hominin groups that had become fragmented in developing interglacial wooded environments, cutting them off from the wider Acheulean population. The Clactonian, when viewed in terms of Mithen's model can only be viewed as a relatively degenerate industry involving 'limited technical skill' and lacking the 'artifacts with imposed form' of a more sophisticated Acheulean culture (Mithen 1996, 223).

Mithen's social learning model has been criticised on two main fronts. The first being to question the idea that such a strong distinction can be made between the technologies of the Clactonian and Acheulean. The presence of non-classic (Ashton and McNabb 1994) or proto- (Wymer 1968) bifaces in Clactonian assemblages reduces the distinction between the two industries to one of refinement, which can be argued on the basis of access to raw materials (Wenban-Smith 1998) or even rarer resources such as antler. Conversely, it has been demonstrated that non-classic forms form a regular and significant component of Acheulean assemblages as at Kilombe

(Gowlett 1984) and Boxgrove, further strengthening Ashton and McNabb's suggestion that the Clactonian forms part of a spectrum of assemblage variability within the wider Acheulean (McNabb and Ashton 1992). Wenban-Smith (1998) has also argued against Mithen's model on environmental grounds, showing that the Clactonian is in fact associated with open landscapes of both early OIS11 (Swanscombe, Clacton) and early OIS10 (Little Thurrock). Here the mechanism of group fragmentation in wooded environments envisaged by Mithen could not have pertained. Instead Wenban-Smith suggests that the Clactonian relates to the *ad hoc* exploitation of poor quality fluviatile gravel.

The arguments against Mithen are compelling and yet I believe that they should not lead to a complete dismissal of the broad social framework of his model. Mithen proposes that assemblage variability should be viewed as an aspect of group dynamics and social behaviour in relation to environmental context. Replace the wooded, supposedly "challenging" environments of full interglacials with the equally challenging open and cold landscape of Southern Britain in early OIS11 and an convincing argument for small fragmented populations can be made. In such a context the Clactonian can be viewed as a 'pioneer' industry associated with the recolonisation of Northern Europe after the severe and protracted OIS12 glacial (White 2000). During such conditions we might expect recolonisation to begin first from isolated, refugia populations of archaic *Homo sapiens*. Under such conditions Mithen's model still remains valid; small population may well have become isolated from a broader cultural pool of Acheulean technological tradition and developed less standardised but still complex and efficient tool kits.

Mithen's model can be more fruitfully pursued as long as consideration is given to the possible adaptive significance of the Acheulean. In this way discussion of the Clactonian may help to throw light on the conditions under which Acheulean signatures developed. We might also begin to conceive of what deeper, adaptive significance non-biface industries had, instead of continuing to define them in relation to the absence of particular, refined tool types. Social learning may well be one aspect through which the Acheulean developed into such a widespread and standardised industry. Yet taken alone it cannot explain what particular roles structured discard played in hominin life nor how behaviour differed in populations which happened not to produce classic Acheulean signatures during the Middle Pleistocene. Mithen's model is important because it indicates a relationship between demographics and social learning. Taking the argument further will involve examining the adaptive significance of socially maintained behaviour.

I have suggested that structured land use patterns, as implicated in the formation of classic Acheulean signatures, relate to a particular pattern of land use involving large population groups habitually fragmenting and recombining to exploit a wide resource base, including large mammals, within increasingly extensive territories. From this perspective, the Clactonian may represent different patterns of land use with smaller, pioneer groups only marginally established in newly occupied environments. Under such conditions the evidence might imply that hominin groups would have been less fragmented on a daily basis and would have foraged over much smaller spatial scales. There are modern analogies for stress-provoked reductions in group size amongst the Hadza.

> "During periods of modestly reduced availability, there is a tendency for the camp to disperse into smaller units foraging for smaller patches of food and smaller game" (Ingold 1980, 54).

Invoking an ethnographic analogy, the Netsilik Inuit will congregate in large groups of up to 150 individuals during the winter to hunt seals in open coastal environments. During the summer these aggregations fragment into small groups of one to three families to exploit fish and other scattered resources (Hames 2001; Hawkes 2001). Group cohesion of Clactonian groups, in the absence of structured discard patterns, could only have been maintained through direct sight and vocalisation.

At Boxgrove the signatures that were most Clactonian in character were those from Q2/D and GTP17. These assemblages had relatively high quantities of flake tools, no classic bifaces, large proportions of cores and primary, hard hammer debitage. While, in contrast to Clactonian industries, these assemblages also contained quantities of biface manufacturing debitage, they have been shown to contextually relate to the activities of small task-groups. I would therefore argue that the similarity in assemblage type could mean that relatively small social groups also formed Clactonian assemblages. The crucial difference being that Clactonian populations comprised only isolated, dispersed populations whereas Acheulean task-groups regularly recombined within larger population units.

The assemblages from Barnham demonstrate the potential complexity of the relationship between Clactonian and Acheulean signatures, which could have formed component parts of single land use systems (Ashton *et al.* 1999). If the same hominin groups were responsible for both assemblage types then it would indicate a pattern of structured land use even more extreme than indicated at Boxgrove. The direct contemporaneity of these assemblages is by no means proven at Barnham (Wenban-Smith 1998), and each could be the product of overlapping transitional groups.

These examples clearly illustrate that, while non-biface industries can be shown to have existed in certain spatial/temporal contexts, such industries cannot be demonstrated on the basis of isolated assemblages alone. Wider assemblage variability within the palaeolandscape needs to be examined before a clear non-Acheulean signature can be firmly demonstrated.

8.3.2 Pioneer occupation in pre-OIS13 Europe and East of the Rhine.

Non-biface assemblages were the first to appear in Europe, despite Acheulean technology being common in contemporary areas of Africa. This evidence may also indicate that pioneer populations did not exhibit the same patterns of structured land use and discard as established ones. In Europe east of the Rhine, true wooded environments may have created just the conditions Mithen erroneously envisaged for the development of the British Clactonian and here assemblages are, as he predicted, non-standardised and lacking refined bifacial forms. Such non-biface industries should not be taken, however, to indicate marginal populations subsisting with impoverished technologies. That the colonisation of Europe, now thought to have been begun over 1.0 Ma, occurred so early, with only flake/pebble tool industries and penetrated difficult interglacial environments (Gamble 1986, 1999; Turner1992; Roebroeks *et al.* 1992) shows that such populations were meeting environmental challenges head on during the Early-Middle Pleistocene. Evidence for hunting of large mammals (Schöningen, Lehringen, Clacton), established mutli-occupation areas (Bilzingsleben) also indicate a broad overlap in the range of behaviours I suggest lie behind structured Acheulean land use.

The signature of early European populations is also shared by all early 'pioneer' industries outside Europe with, flake tool industries being the first to appear in the Near East (Ubeidiyah, Yiron) and Asia (Dmanisi, Riwat, Kuldara) from 1.8 Ma onwards (Gamble 1999). As contemporary 'source' populations in Africa were operating structured land use patterns with bifacial technologies, these pioneer populations could be seen in the context of less structured and less complex group dynamics. Structured discard signatures could not apparently be transplanted like a culture or a language. Instead they had to grow and develop *in situ*. As behaviours were modified to suit local environmental conditions, population increases would have inevitably led to more routinely fragmented and wide ranging land use patterns. Thus, only when populations became sufficiently stable and operated in conditions which allowed the development of large groups sizes would more structured land use begin. Under Mithen's model, we could see such regional population booms reconnecting previously isolated groups into a wider Acheulean social/cultural framework, leading to increasing refinement and standardisation in tool form. In Western Europe we have clear evidence for this beginning from about 0.6 Ma with the appearance of Acheulean industries, with stable, structured patterns of land use developing in the interglacials of the Middle Pleistocene. The absence of such signatures from Eastern Europe and some early post-glacial British contexts sets out possible limits on the adaptive range of structured Acheulean land use.

8.4 Group size.

Discussions of group size in the Lower Palaeolithic are limited on two fronts. Firstly, for much of the Pleistocene we have few indicators of group population (e.g. hearths, huts, formal settlements). Even where weak indicators are present (site size, knapping scatters, butchery practise), it remains impossible to determine whether estimates of group size from such data equate with 'total' group-size or represents a component (e.g. hunting party, foraging group) of a population (Isaac 1977; Dunbar 1993; Steele 1996). The study of group-size is also impeded on an interpretational level, as there is much variation and overlap between modern ethnographic and primates examples depending on environmental or even seasonal factors (Hames 2001). Thus even where estimates of group size can be made, the interpretation significance of such figures is hard to ascertain.

Changes in land use patterns and hominin morphology do however suggest that group size and dynamics underwent a significant degree of transformation during the Pleistocene, prior to the more rapid social/cognitive developments associated with the development of modern *Homo sapiens*. The significance, for example, of encephalisation on hominin society has been shown by the established positive correlation between relative neo-cortex volume and group-size in primates (Dunbar 1992; Aiello and Dunbar 1993; Steele 1996). Despite the possible evolutionary advantages of maintaining larger groups, this could have only been achieved through the development of increasingly complex systems of social grooming. Dunbar (1992) suggests that the development of increasingly complex vocal communication (i.e. language), would have allowed the social 'grooming' of more than one individual at a time, allowing for maintenance of larger groups sizes. This non-archaeological data has allowed empirical estimates of hominin groups size to be made on the basis of relative neo-cortex size and suggested that Middle Pleistocene hominins were capable of maintaining groups with in excess of 100 individuals. While this figure exceeds the more usual estimates for hominin groups and modern hunter-gatherer examples (Martins 1993), it establishes a potential maximum limit for the number of individual within a Middle Pleistocene social group. However, recent analysis of possible range areas for hominin groups in Middle Pleistocene Europe has indicated that primate data may provide inappropriate analogies for the modeling of archaic *Homo sapien* populations. Gamble and Steele have suggested that the ranges of raw material transport documented in Europe were more comparable with carnivore, as opposed to primate, scales of land use and ranging (Gamble and Steele 1999; Gamble 1999). Thus, estimates based on ranging patterns for the sites of Arago and La Grotte Vaufrey indicate total group sizes of between 30 and 69 individuals, a figure which is broadly comparable with modern observations of hunter-gatherers (Steele 1996; Gamble and Steele 1999; Hassan 1981).

However, these studies provide us only with bench marks with which to interpret the archaeological data. Small family groups, following the carnivore model, could have successfully exploited large territories and mammalian game quite effectively. Non-biface industries, where repeatedly shown in a consistent spatial/temporal context, could be the archaeological signature of such hominin 'packs' as groups with a social framework geared towards mobility, cohesion and looser, perhaps more innovative, patterns of social learning. Such groups can be seen at the evolutionary edge, exploiting new environmental niches and developing non-bifacial/non-lithic technologies and new frameworks of social behaviour. Research could now be directed to look at the relationship between such industries and the development of Middle Palaeolithic/MSA technology. Links have been drawn between the development of Levallois technology and modern cognitive abilities (Foley and Lahr 1997). The structured discard model would suggest that such developments were more likely to have occurred within the context of smaller pioneer populations.

The Acheulean, I believe, should also be viewed as a social phenomenon; one in which ecological conditions allowed the maintenance of relatively large populations for prolonged periods of time giving rise to more structured patterns of land use. Under optimal environmental conditions group size could have reached the limits set by encephalisation. In such contexts, Acheulean patterns of structured land use would have begun to develop with groups fragmenting daily over wide areas and the possibility of hunting groups being limited to healthy, non-nursing adults.

Acheulean social groupings might then represent a highly successful social adaptation to the exploitation of large open territories, increased metabolic reliance on meat procurement (hunting) and the maintenance of large but routinely fragmented populations. While the development of Acheulean social structures would have been dependant on stable and favourable environmental conditions, once established, complex and organised patterns of social behaviour would have rapidly developed. The similarity of Acheulean tool forms and site structure across the Lower Palaeolithic world (Gamble 1999; Gowlett 1988) can be explained by the similar and apparently limited trajectories these new behaviours followed. The effect of entrenched patterns of structured land use on social learning may have been somewhat akin to hormonal stygmergy in insect populations. It would have allowed complex and highly organised social behaviours to develop at the expense of flexibility and innovation. I would also argue that the effect of cultural inertia in these populations would make it more likely that more modern behaviour patterns emerged and evolved at the spatial/temporal limits of Acheulean.

Future research, directed towards hominin population at edge of the Acheulean world, could help to test the validity of this model. Certainly the evidence shows that non-biface populations represent more than mere back-waters areas of behavioural evolution where social and cultural complexity could not be maintained. Instead research should be directed towards teasing out the behavioural adaptations that were required for hominins, with cultural trajectories adapted to open, heterogeneous environments, to occupy temperate woodland. It is not unreasonable to assume that the occupation of new and initially marginal ecologies may well have provoked behavioural changes that re-routed the cultural trajectories of the Acheulean into the new behavioural rhythms of the Middle Palaeolithic and subsequent 'modern' aspects of behaviour.

8.5 Conclusions: The temporal limits of the Acheulean, structured discard and the release from proximity.

The ways in which hominins used space has undergone enormous changes during the past three million years of evolution. While shifts in the scale of land use behaviour can be documented in the archaeological record of specific sedimentary basins, the bigger picture of global colonisation in the more recent past points to enormous changes in the spatial context of human social life. Gamble (1996a) sees a fundamental shift in the nature of social land use occurring during the past 100,000 years or less. The development of a true Social Landscape involved a rapid increase in the scale and complexity of territorial/social networks across both space and time, coupled with an increase in use of symbolic behaviour to manipulate social relations. The development of new modern patterns of behaviour can be seen in the Middle Pleistocene (McBrearty 2001). The shift from biface/flake tool assemblages of the Acheulean to MSA technologies utilising Levallois technique, blades and, hafted points is rapid considering the relative degree of technological stasis which preceded it.

Through such developments in the MSA, Social Landscapes replaced earlier more routinised and habitual patterns of land use combined with uncomplicated patterns of social behaviour, characterised by Gamble as the Local Hominin Network (Gamble 1993d). These concepts are useful in isolating, in terms of scale and complexity, the differences between the social context of modern hunter-gatherer life and that of earlier *Homo* species. While the Social Landscape grew out of the LHN, the relationship between the two is not simply evolutionary, the LHN in itself was a highly successful and self-contained behavioural package. The concepts are provocative in that they challenge Lower Palaeolithic archaeology to tease out measurable vectors of complexity and to isolate those behavioural aspects of the LHN which engendered the new modes of modern social land use during the MSA/Middle Palaeolithic.

8.5.1 Structured land use and group cohesion.

Structured patterns of land use may have provided one of the mechanisms by which more complicated patterns of social land use developed. Large, stable populations engaging in active predation would have had to disperse on a daily basis at scales which would have rendered primate mechanisms for group cohesion, sight-lines and sound attenuation (Wrangham 1979), obsolete. Structured artifact discard would have marked areas of regular re-aggregation with large accumulations of bifacial tools. Just as these areas signal specific patterns of group behaviour to the archaeologist, even basic associative reinforcement would have marked such sites as socially significant to hominin groups. Without the presence of structured discard, set within a 'scatters and patches' distribution framework, hominins would have inhabited undifferentiated social landscapes characterised by simple, repetitive and dispersed signatures. Structured discard would mark out not only ecological affordances but also would have helped to maintain group cohesion, marking areas of demonstrated aggregation from other identical stretches of landscape. Such landscapes, which would have developed over time under favourable conditions, would have been unconsciously, although actively, formed by hominins following routine and contextually reinforced patterns of social behaviour.

8.5.2 The 'release from proximity' in pre-language societies.

As such, structured landscapes may have provided a type of social land use that stretched some of the limitations of the LHN and fulfilled the function of symbolic manipulation in modern social landscapes.

"If the structure of the LHN can be understood as stemming from habit and complex negotiation then the SL is based upon habit-plus and complicated negotiations. I argue here that habit-plus refers to concepts of time and the symbolic use of objects" (Gamble 1996, 267)

I would suggest that structured discard provides a mechanism whereby the routinised behaviour patterns of hominins foreshadows Gamble's concept of habit-plus. Archaic *Homo sapiens* may not have been consciously manipulating symbolic environments in the modern sense, but the very presence of structured cultural landscapes would have fed-back into the complexity of social land use. Through such habitual rhythms, hominin discard patterns would have created an Acheulean landscape rich with valuable and usefully contextualised ecological and social information. Once set in motion, evolutionary processes would have started to select for structured discard and the necessary symbolic, abstract and inferential thought processes required to make use of the information stored within such signatures. Such processes would have been a necessary precondition to establishing the first true social landscapes and symbolic systems by anatomically modern humans.

The model of structured land use forwarded here suggests how modern human land use and cultural environments may have developed during the course of the Pleistocene. In structured landscapes, artifacts stand as proxies for the hominins themselves, providing a mechanism through which groups could go beyond the limitation of direct perception to effect a 'release from proximity' (Rodseth *et al.* 1991, 240). The way in which group cohesion could have been maintained within structured landscapes has been outlined above. Yet the durability of stone tools would have allowed the contextual triggers implicit in such distribution patterns to be made available across far wider temporal scales than those of day to day foraging. With wide territories and seasonal movement patterns, the persistence of structured landscape, especially with large concentrations of highly visible tools, would have provided, in effect, a trigger for groups to recommence the successful land use patterns of an earlier season. The presence of such signatures would also have allowed a hominin group entering an area for the first time, to track on previously successful patterns of earlier, group land use. Where environmental conditions remained stable, biface-rich signatures would have marked optimal locales for resource exploitation, allowing detailed palaeoecological information to be transmitted across time and space without either the use of language or deliberate symbolic behaviour.

Structured landscapes are thus undoubtedly cultural ones. Once *Homo* began to litter the landscape with a durable record of behaviour an inevitable process of enculturation was set in train. The associative value of such residues, for maintaining group cohesion and transmitting social/ecological information may provide a possible adaptive mechanism by which modern social behaviour, so heavily dependant upon the verbal and symbolic exchange of information, was engendered.

Appendix 1: System for debitage analysis

The system for debitage analysis used in this thesis was developed directly from the standard scheme for the Boxgrove Project. This was developed over the course of the project by a number of different researchers including Mark Roberts, Francis Wenban-Smith, Dimitri De Loecker and myself. Details of flake attributes recorded for this thesis are listed below.

Attribute	Measured	Description
Maximum Length	In mm	Longest axis.
Maximum Width	In mm	Length of axis 90° to above
Maximum Width	In mm	Maximum distance from ventral to dorsal face.
Weight	In gm	Weight of artifact
Percentage Cortex	By %	Percentage of dorsal face retaining cortex.
Dorsal Scar Count	Integer	Number of flake scars on dorsal surface.
Flake Class	1. Platform present. 2. Platform absent.	Gives minimum flake counts.
Break	1= Whole 2= Proximal only 3= Medial only	Degree of flake completeness.

Attribute	Measured	Description
Platform Type	Natural	Flake struck from natural break surface.
	Cortical	Flake struck from cortical surface.
	Plain	Flake struck from platform comprising single scar.
	Retouched	Platform has been retouched or formed tool edge.
	Dihedral	Platform comprises two flake scars.
	Polyhedral	Platform comprises three or more flake scars.
	Punctiform	Small, localised platform from marginal and generally softhammer flaking.

Abbreviations

Flk	Flake or flake fragment not subsequently utilised.
Ft	Flake tool. Retouched or demonstrably utilised flake.
Tr	Tranchet Flake. Sharpening flakes removed from biface tip.
Bf	Biface. Handaxes and cleavers.
Cr	Flake production cores and biface rough-outs.

Appendix 2: Quantifying 'scatters and patches'. A suggested methodology and its application to the Boxgrove data.

A2.1 Introduction.

Through the analysis of assemblage formation at key Boxgrove localities in Chapters 4 and 5, two distinct modes of tool using behaviour were isolated as having been operated by hominins at the site. The multi-episode assemblages from Q1/B indicated that bifacial tools were discarded in large numbers along with a full range of flake tools, percussors and anvils. These discard events formed a series of superimposed tool-rich assemblages throughout the local sedimentary sequence. The pattern of prolific tool use and discard at Q1/B contrasted markedly with indicated activities at the single episode butchery site GTP17. The assemblage here consisted almost entirely of biface manufacturing debitage but the tools themselves were largely absent.

In Chapter 6, variations in patterns of discard and artifact movement with the Boxgrove palaeolandscape are considered. A discussion of patterning in the gross distribution of artifacts forms a key component of this analysis. In this Appendix a provisional methodology for the objective description of landscape artifact distribution patterns is introduced. The methodology is aimed at isolating potentially significant levels of artifact density, for example by identifying atypically dense artifact accumulations or characterising the background level of density. A move towards the analysis of variation in discard patterning was initially proposed by Glynn Isaac with 'scatters and patches' analysis (see Chapter 2). In this section an attempt will be made to utilise his methodological framework in order to identify the wider patterns of hominin land use underpinning assemblage variation at Boxgrove. As the foregoing studies have suggested that large, multi-episode site have distinctive 'tool rich' signatures, the 'scatters and patches' approach will be utilised to test this possibility. In order achieve this, a methodology is developed that allows the quantification of variation in artifact densities within a given landscape. It will be shown that the simple application of box and whisker analysis allows the gross numerical distribution of artifact densities within a sample to be effectively categorised. As a standardised system of classification, the method also allows the direct comparison of signatures in different palaeolandscapes or between different ecological/environmental contexts within a single landscape. The approach is aimed at providing clearly defined, standardised and repeatable limits for Isaac's hierarchical divisions.

Thus, this section aim to demonstrate how such a standardised classification scheme could be developed and shows that, when applied to the Boxgrove data, a link between artifact density and technological composition can be identified. In Chapter 6 this work is built upon, to further isolate patterning in the distribution of these assemblage characteristics and to model the behaviours underpinning these patterns.

A2.2 The target horizon: the Unit 4c Palaeosol.

The target horizon for this part of the study is Unit 4c. The unit has been intensively studied and results of environmental and structural analysis have been presented in a number of earlier publications (Roberts *et al.* 1986; Roberts *et al.* 1997; Roberts and Parfitt 1992). The bulk of this work involved the detailed study of sediment micromorphology from a number of Unit 4c localities. In addition to this, surveying and mapping of Unit 4c and temporally equivalent sediments provide, for limited areas at least, a picture of drainage patterns and topography. This body of evidence also provides a basis from which to develop a reasonably detailed picture of the palaeoenvironment of the Unit 4c landscape, crucial to any degree of developing an understanding of hominin land use at the site.

Unit 4c is not strictly a definable, separate geological unit, instead it has been described as 'the weathered and partly homogenised upper part of the Slindon Silts' (Macphail in Roberts *et al.* 1997, 320). It appears to differ from Unit 4b mainly in the degree of decalcification, which is particularly high in Unit 4c and may have led to variations in its observed thickness across its mapped extent. The modification apparent in the structure of Unit 4c appears to be related to a combination of prolonged exposure and biological modification. Macphail has identified rooting features and pedological structure formation. He has suggested that a good sedimentary analogy for Unit 4c can be found in soils that develop subsequent to the draining of Dutch polders. Bal's studies of sediment development and vegetation colonisation of the Ijsselmeer polder in Holland documented that biological homogenisation to a depth of 40cm occurred very rapidly and that scrub woodland was established across the site over a twenty-year period (Bal 1982). At Boxgrove the superficial nature of the rooting structures and extremely shallow depth of homogenisation indicate that the period of soil development was rather limited. Macphail has suggested that grazing by ungulates could have arrested the development of shrub and woodland communities across the landsurface. However, the small degree of soil homogenisation indicates that, even without grazing, the soil horizon would not have been in existence for long enough allow the colonisation of shrub woodland species (Macphail in Roberts *et al.* 1997).

Spatial and temporal variation in drainage is indicated by the ferruginisation of soil structures within Unit 4c. These appear to show that the palaeosol was subject to large fluctuations in the water table and may have become seasonally waterlogged. Macphail has been able to demonstrate that particular locales within the landscape were, to a relative degree, perennially dry (Macphail in Roberts *et al.* 1997). The great depth of biological homogenisation and decalcification at three locations, Q2/A, EQPTPC and GTP17, indicate that these were better-drained locations. At TPC infilled surface cracks attested to the complete and presumably seasonal drying out of the surface. In contrast some locations, such as B/TPQ, showed evidence for the partial development of a peaty soil indicating poor drainage and extended waterlogging. Indications of more dramatic variations in drainage for the Unit 4c landscape come from two Quarry 1 localities with atypical geological sequences. At Q1/B, Q1/A and EQ1/TP1, fresh water deposits shown to both postdate the deposition of Unit 4b and predate the formation of Unit 5a have been recorded. The local sedimentary sequences indicate that, during the formation of the Unit 4c palaeosol, spring-fed freshwater channels dissected the grassland. At the Q1/B locality, one such spring appears to have fed a standing freshwater body. These water locales appear to be fringed by more typical areas of Unit 4c grassland, clearly demonstrable at EQ1/TP7 and EQ1/TP6 and appear to indicate a broad NW-SE axis of drainage through the centre of Quarry 1.

Another habitat within the Unit 4c landscape would have been the cliff line and its associated talus slopes that formed the northern boundary of the grassland area. On the basis of derived chalk fossils, it would appear that the cliff would have had a maximum height of approximately 80m, although dry valleys would have presumably dissected the chalk plateau and led to a degree of variability in this height. If the present distribution of dry valleys can be used as a guide to that of the Middle Pleistocene, it could be inferred that the cliff attained a maximum height at a point now situated between the two quarries and fell away to the east and west of this point. The regressional deposits underlying Unit 4c attest to the fact that high energy marine action had no influence on the cliff for tens of years proceeding the formation of Unit 4c. As such, it is possible to suggest that the cliff had already begun to degrade and that extensive talus slopes had formed at the foot of the Chalk. The existence of talus slopes is shown in the cliff-section GTP25 where chalk rubble, underlying solifluction gravel, can be identified up to 25m from the cliff base. The extent of these slopes would have been variable but appear not to have been extensive enough to suggest more than a superficial collapse or reduction in height of the chalk cliff, which would have still been a formidable topographic feature. Pollen evidence indicates that the Chalks Downlands above the cliff were forested with pine and birch. The possibility of over-hanging trees may have allowed the colonisation of the talus margins by shrub communities, explaining the presence of shade loving mollusc species despite the absence of rooting structures from the palaeosol itself (Roberts *et al. In prep.*).

Thus, we can envisage the environment of the Unit 4c landscape: to the north a collapsing, but still imposing chalk cliff and at its foot, were a series of talus slopes and recently collapsed blocks of chalk with a small pioneer community of shrub vegetation. Fringing the talus slopes would have been marly out-wash deposits from the chalk which gave way to a broad, seasonally wet area of grassland. This grassland extended for a least 5 km east and west of the site and an unknown distance to the south, where it blended with intertidal, regressional environments fringing the retreating ocean. Crossing the grassland were a series of narrow sandy bottomed channels with a seasonal flow related to variation in the output of springs at the cliff base. These springs were either directly drained by the channels or occasionally fed shallow ponds. Towards the end of the formation of the Unit 4c palaeosol evidence from sites Q1/B and Q1/A indicate that tufa-like sediments were beginning to form where spring water was seeping and pooling over the grassland surface.

In geological terms, the 10-100 year formation period of the palaeosol represents an exceptionally well-defined time bracket allowing the deposit to be considered as an isochronous landsurface. While in relative, geological terms this degree of time-bracketing can be considered exceptionally tight, we still have to accept that in term of hominin behaviour we have a time averaged context representing, at the very least, a single generation. Thus, despite the good evidence for *in situ* archaeology, the Unit 4c palaeosol represents a time-averaged, palimpsest context. It therefore has to be accepted that individual find spots do not necessarily relate to a single 'contemporary' or continuous period of occupation. Considering the degree of time-averaging, it would be wrong to consider this record 'high-resolution' despite the presence of *in situ*, refitting artifacts. The palaeosol record represents a more complicated record with less control over site formation processes and integrity of the intra-site spatial distribution. The extent of time averaging becomes apparent when one compares the archaeology of the Unit 4c palaeosol to that excavated from the intra-Unit 4b horizon of the Slindon Silts. The archaeology of these units, described in Chapter 2, is of an entirely different character. Artifact spreads are associated with fine laminations within the silts that appear to represent very short term, low-energy depositional events. In these contexts, the archaeology appears to relate to very short time periods, with perfectly preserved knapping clusters from 15 minute episodes of tool manufacture to butchery episodes lasting a few hours at most. Through taphonomic analysis the integrity of artifacts and faunal assemblages has been clearly demonstrated (Chapters 3-6; *Roberts et al. in prep*; Austin 1994; Austin in Roberts and Parfitt 1999). These studies have shown that there has been no significant movement or realignment of artifacts within the assemblages and that flake breakage levels are consistent either that from experimental debitage samples suggesting that there had been little post depositional disturbance by large mammals. The picture these studies have provided is of a rapidly accreting, low-energy deposition sealing artifact spreads very rapidly. As a result the archaeology of the intra-Unit 4b horizons appears to represent exactly the type of the short term, *in situ* signatures characterised by Derek Roe as 'precise moments in remote time' (Roe 1981).

Taphonomic studies of assemblages from the Unit 4c palaeosol have not indicated a similar degree of preservation. Instead they have suggested that the material from individual occupation sites, while compositionally intact, may not always be strictly *in situ*. Refitting was carried out for assemblages from Unit 4c at both Q1/A and Q2/A (Bergman and Roberts 1988; Austin in Roberts and Parfitt 1999). This programme failed to establish tight refitting clusters of a character similar to both GTP17 (Unit 4b) and the scatter at Q1/A (Unit 4b). A refitting programme carried out for site Q2/D, where long distance refits were established across the excavation area, (Lankstead 1991) matched these results. Analysis of refit orientations failed to show a clear preferred orientation at Q1/A suggesting that the dispersal mechanism was not fluvial. Instead, Austin suggested that a combination of hominin activity, in the form of short knapping episodes, and trampling might have led to the dispersed nature of archaeology at the site. A similar pattern was observed at Q2/A where apparent clusters of debitage, observed during excavation, were not upheld as intact knapping clusters by the refit distribution analysis. These clusters had a large diameter (>3m^2) and refits commonly crossed between the clusters. Instead of representing intact knapping episodes, the clusters resolve as more general accumulations of material resulting from a number of short-term knapping events occurring in the same location. Kris Wilhelmsen carried out a very detailed microartifact study in order to assess the degree of post depositional modification at a very fine level. His results suggested that there was no detectable winnowing of smaller size classes of debitage and that the assemblage appears to have been 'effectively held in place by sediment before they could be affected' (Wilhelmsen in Roberts and Parfitt 1999, 372). Analysis of vertical artifact distribution indicates that bioturbation has effectively homogenised any previous vertical separation between material discarded during the formation of the Unit 4c palaeosol,

As a preservational context, the Unit 4c palaeosol has allowed the recovery of relatively undisturbed assemblages resulting from a series of hominin occupation episodes over a 10-100 year period. Assemblages appear to be compositionally intact, complete with micro-artifacts, but there does appear to have been a high degree of vertical homogenisation and horizontal dispersal of artifacts. The latter most likely occurred through a mixture of bioturbation, trampling, hominin activity and with a localised influence from 'sheet-wash' drainage. The archaeological resolution from this context is not fine enough to establish associations of artifacts except where directly demonstrated through refitting. However, it is possible to consider each assemblage compositionally intact and spatially associated with the locality from which it was recovered, i.e. in primary context. While in specific demonstrable cases, *in situ* refitting clusters can be isolated through refitting.

Time averaged signatures, like Unit 4c, present real challenges to the reconstruction of hominin behaviour from the archaeological record. Yet the palaeosol, in relative terms, is still an exceptional one both in terms of its lateral extent and degree of archaeological preservation. Certainly the interpretational limitations of the palaeosol are not quite as starkly formidable and exaggerated as Stern's (1994) assessment of palimpsest signatures at Koobi Fora which she argues could represent periods of up 70,000 years. Stern argues that behavioural processes that occur on human time scales such as the interaction between an individual and their environment cannot be teased out from such time-averaged signatures. The argument is a potentially serious one, especially as the whole methodological basis for 'scatters and patches' analysis rests on the assumption that palimpsests could provided contexts through which the interaction between hominin and environments can be studied (Isaac 1984). In this analysis, it is hoped to demonstrate that time-averaging can be negotiated in order to take full advantage of the access such signatures provide to the kind of long term, routinised behaviour which stands beyond the of detailed analysis of high-resolution evidence.

A2.3 The sample.

The Unit 4c palaeosol has been identified at 70 excavation localities within the two northerly quarries of Amey's Eartham Pit as well as at the Valdoe Gravel quarry, 4km to the west of the Boxgrove site. For the purpose of the present study only the exposures at AEP will be considered. these comprise some 23 section exposures, 111 archaeological test pits, and 6 large excavation areas (position shown in Figure A2.1). Included in the sample are localities which lacked any artifactual material, these provide valuable negative evidence by indicating parts of the landscape that were never utilised by hominins in a way that left survivable traces. While it was important to try and include as many Unit 4c sample points as possible, some exposures of the horizon had to be excluded despite the documented presence of archaeology. These excavation areas were usually made by machine, with artifacts being recovered from sections or spoil heaps. Such uncontrolled excavation conditions could not provide a reliable, quantitative assessment of actual assemblage composition, being biased towards larger, non-debitage artifacts. Having excluded these sites, some 66 excavation localities remained that provide directly comparable, hand excavated samples of the palaeosol. These sample points range from small excavations of the edge of machine cut trenches, 12m^2 test pits to large area excavations covering up to 1000m^2. The sites were dug over a 15 year period during the course of the major fieldwork projects outlined below.

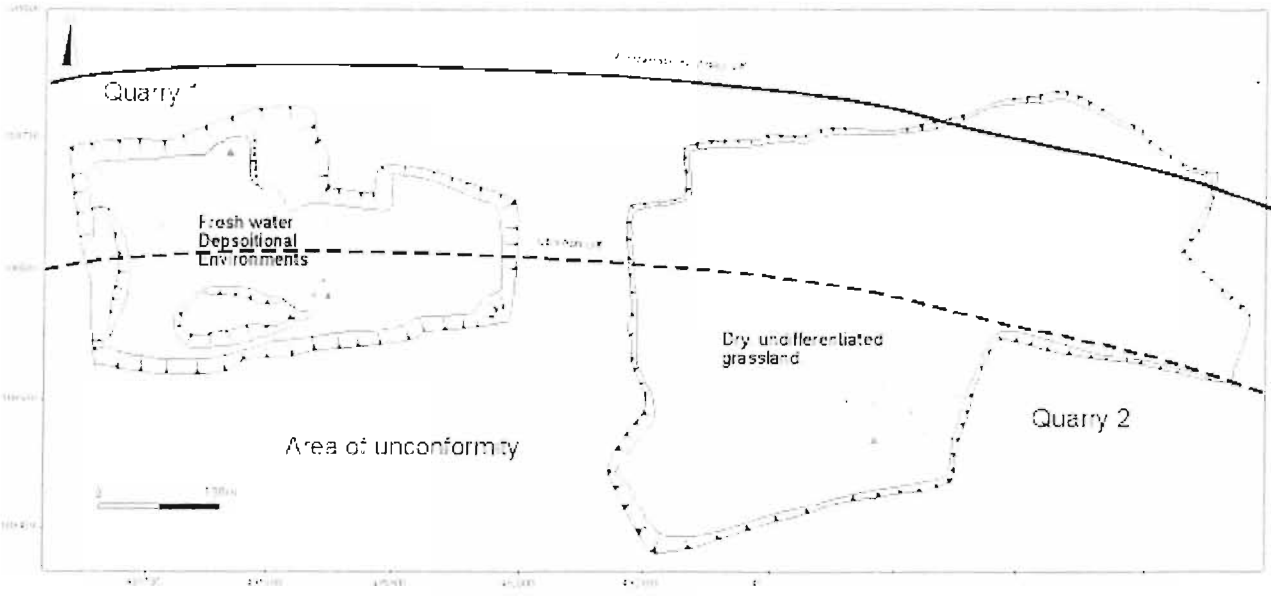


Figure A2.1: Map showing the position of Unit 4c sample points at Boxgrove.

A2.3.1 Project A Test Pits

Project A included three types of excavation locality: the original test pits dug in Quarry Two by Mark Roberts in the early 1980's (ATP's 1-5), machine cut geological sections and hand dug test pits (GTP's 1- 40). However, while the bulk of these pits relate to the early years of the project, test pits continued to be given GTP designation right up until the close of the 1996 excavation season. In some cases, a machine cut trench would be expanded into a hand-excavated area when archaeology was encountered. In other cases a machine-cut trench would be widened, by the careful hand excavation of a half metre or metre wide strip along the entire section face. The latter exercises opened up sometimes considerable, linear areas of the Unit 4c palaeosol.

A2.3.2 Project B Test Pits

The Project B test pits relate to a limited survey area in the eastern edge of the main sand extraction area from Quarry 2. The test pit survey formed the first phase of a rescue project aimed at recovering archaeology from a 12,000m^2 area immediately prior to sand extraction. 17 test pits designated BTP A- Q were located in a series of east–west transects across the survey area. Each test pit was 6m^2 in extent and while five square metres were excavated by hand, a sixth was bulk sieved in order to both provide microartifact information and to act as a check on the success of hand excavation. The Project B survey was a more formal sampling exercise due to the focused 'rescue' brief behind its implementation. As a result, the regular, close placement of these test pits, the standard size and methodology distinguish the Project B test pits as a controlled sub-sample of the palaeosol within a defined area of Quarry 2.

A2.3.3 Project C (Eartham Quarry Project) Test Pits

The Eartham Quarry project was conceived primarily as a geological investigation of an apparent geological unconformity that lay between the two quarries. A series of test pits were located in order to determine the limit of the conformable sequence in both quarries and investigate the boundaries with the unconformity. Worked into the project was time allocated to the careful hand excavation of units with archaeology. The test pits were designated EQP Quarry 1/ 1-18 and EQP Quarry 2/ 1-22 (shortened to e.g. EQP/2/15). In the course of the excavation, a series of freshwater deposits were located in Quarry 1. These have been stratigraphically equated with the deposition of Unit 4c (Roberts *et al. In prep*). These deposits were also hand excavated and the recovered archaeology has been included as part of the Unit 4c sample.

A2.3.4 Main excavation areas

In addition to the test pits, six large main excavation areas were excavated in order to sample large areas of the Unit 4c palaeosol or temporally equivalent horizons. These have been designated according to the quarry in which they were located and in alphabetic order (e.g. site Q2/A was the first main area excavation in Quarry two). These have all been excavated to a similar standard with x,y,z recording for all artifacts >20mm and collection by spit and square for smaller material. The excavation areas range in size from 25m^2 at Q1/TP1 to 276m at Q1/B.

Given the longevity of the project and varied excavation conditions, it is important that the sample is collated in such a way so as to ensure that as many variables and potential sampling biases are taken into account and controlled for. In order to achieve this, Simon Parfitt and the author undertook a review of all Boxgrove excavation localities in order to establish: a) the presence of Unit 4c (or stratigraphic equivalent), b) the overall area of Unit 4c excavated by hand under controlled conditions and c) the quantity of finds from each of the localities. In 65 cases it was possible to demonstrate careful excavation of the Unit 4c horizon and ascertain the quantity of material recovered. Having established the quantity of material recovered the author then embarked on the analysis of lithic material from all the excavation localities to a single standard recording method. All material <20mm was excluded from the analysis. This was done for two reasons: firstly artifacts smaller than 20mm were recorded only by metre square while the larger material was given x,y,z provenances to the nearest mm. In addition, earlier artifact analysis showed wide variations in the recovery of smaller artifacts, while bulk sieving controls implemented in Boxgrove Project B suggested that total recovery of material >20mm was achievable by most excavators. Artifacts >20mm were recorded to a standard system devised by Francis Wenban-Smith and the author for Boxgrove Project D (see Appendix A).

In almost every case, gravel and sand extraction dictated where test pits were located, either due to accidental exposures through quarry working or directly as rescue projects. The main area excavations were, however, sited at localities where test pits had indicated a locally dense or otherwise interesting archaeological area. As such they cannot be considered random samples of typical area of the Pleistocene landsurface, having been sited only in places of especially dense artifacts concentrations. To ameliorate this bias, where a large excavation area was either sited close to, or over, a test pit that produced a dense artifact accumulation, the assemblages have been lumped together. This step has prevented the phenomena of a single dense archaeology 'patch' being represented twice in our sample. From the above it can be seen that there were some inherent problems in integrating data from each of the 80 Unit 4c sample sites in our original sample. However, by the application of a 20mm artifact size cut off, a consistent universal recording scheme for individual artifacts and the elimination of assemblages with incomplete documentary evidence, a sample of 66 sites and 41 stone tool assemblages remains available for direct comparative analysis. These sites provide a small sample of a relatively small spatial area of the originally extensive grassland environment once in existence at Boxgrove. The assemblages thus inevitably represent the accumulated residues of numerous occupation episodes over a 10-100 year period, but also represent largely unmodified assemblages, in primary context and time bracketed to a fine degree. With these considerations in mind, the sample can be utilised to assess patterns of hominin land use within the palaeolandscape of the study area.

A2.4 Developing a 'scatters and patches' analysis.

A2.4.1 Aims and approaches

In order to account for assemblage variability, previous research has shown that it is first essential to understand the nature of the overall distribution of artifacts within a landscape. For the reasons outlined in Chapter 2, the adoption of Isaac's 'scatters and patches' approach offers a useful framework through which to study assemblage variability at a landscape scale. At the heart of the 'scatters and patches' approach is the recognition that the distribution of artifacts within a given landscape is uneven, but that this unevenness is itself highly significant and provides the key to understanding wider patterns of variation in hominin technology, resource exploitation and social context. In this study I hope to demonstrate that the inherent 'patchiness' of the archaeological record in effect provides the quantitative structure through which qualitative variation in assemblage composition can best be understood. In order to achieve this it was necessary to look at ways in which Isaac's approach could lend itself to the development of a more formal methodology through which artifact distribution patterns could be quantified and compared. In this section such a methodology is suggested and developed to provide an example of one way in which the 'scatters and patches' approach could be developed into 'scatters and patches' analysis. The method will be applied to the archaeology of the Unit 4c palaeosol at Boxgrove. Individual assemblages will be classified in terms of their relative position in the statistical/numeric distribution of observed artifact densities.

A2.4.2 Defining 'scatters and patches': establishing a system of classification

While the 'scatters and patches' approach is often characterised as the analysis of spatial distribution patterns, beginning with the idea that the analysis will result in any kind of meaningful 'map' of hominin land use is wrong. Rather Isaac began to develop the approach as a response to the virtual impossibility of developing distribution maps of land use, as a method directed at characterising the range of variation in artifact density within the palaeolandscape (Isaac 1982b). With this in mind, the starting point for developing an suitable analytical framework was abandoning any attempt at dealing with data in spatial terms at the outset. Previous attempts to model data at Boxgrove spatially were in part successful (Roberts *et al.* 1997) but relied on the study of small patches of the Palaeolandscape for which there was even, regularly spaced sample coverage. Instead, the starting point for this methodology was a recognition that 'scatters and patches', at its simplest level, refers to the numeric distribution of observed variation in artifact density. Only once assemblages have been classified through the application of the box and whisker technique, could there be an attempt to examine variation in a spatial framework.

The problem can be illustrated in Figure A2.2a, which represents Isaac's observations of artifact densities in the Okote member at Koobi Fora. Isaac suggested that it is 'convenient' to recognise three levels of artifact density in the archaeological record of the site: 'background' density (<1 per m^2), 'intermediate' levels (<20 per m^2) and 'peak' levels . (>20 per m^2). It is just about possible to discern Isaac's tripartite hierarchy in the distribution pattern at Koobi Fora shown in Figure A2.2a, with only two assemblages returning 'peak' levels of greater than twenty artifacts per m^2. However, it is difficult to make any clear distinction between 'background' and 'intermediate' levels and the data would tend to uphold Isaac's labelling of the hierarchical division as "convenient" rather than a real feature of the Koobi Fora data (Isaac 1981b; Isaac 1997). Similarly, when one examines the distributions of observed artifact densities at the two other palaeolandscapes in Figure A2.2 (Olorgesailie, Upper Member 1; Olduvai, surface of Marker Tuff IF), no obvious tripartite hierarchies emerge from any of the distributions. While the objective existence of a tripartite hierarchy appears to be unsubstantiated, visual inspection of the three distributions shows some apparent relative differences between the three samples. Thus, Isaac's hierarchical scheme remains useful as a descriptive tool, allowing different components of the dataset to be identified and compared. For example, visual inspection of the three graphs in Figure A2.2 shows an apparent similarity between the two distributions from Olduvai and Koobi Fora, as distinct from that of Olorgesailie. At the two former locales, clear 'peak' level densities can be seen to stand out clearly against a relatively dispersed 'scatter'. At Olduvai the 'scatter' is more constant (few zero observation) than at Koobi Fora, but both have a distinctive 'peak' assemblage exhibiting an artifact density almost double that of the next densest observation. The distribution from Olorgesailie has a different pattern. Low-density assemblages still make up the majority of observations, the distributions increase gradually towards the higher observations with no obvious 'peak' levels. While the intermediate group is not clearly demonstrated in any of the curves, it is

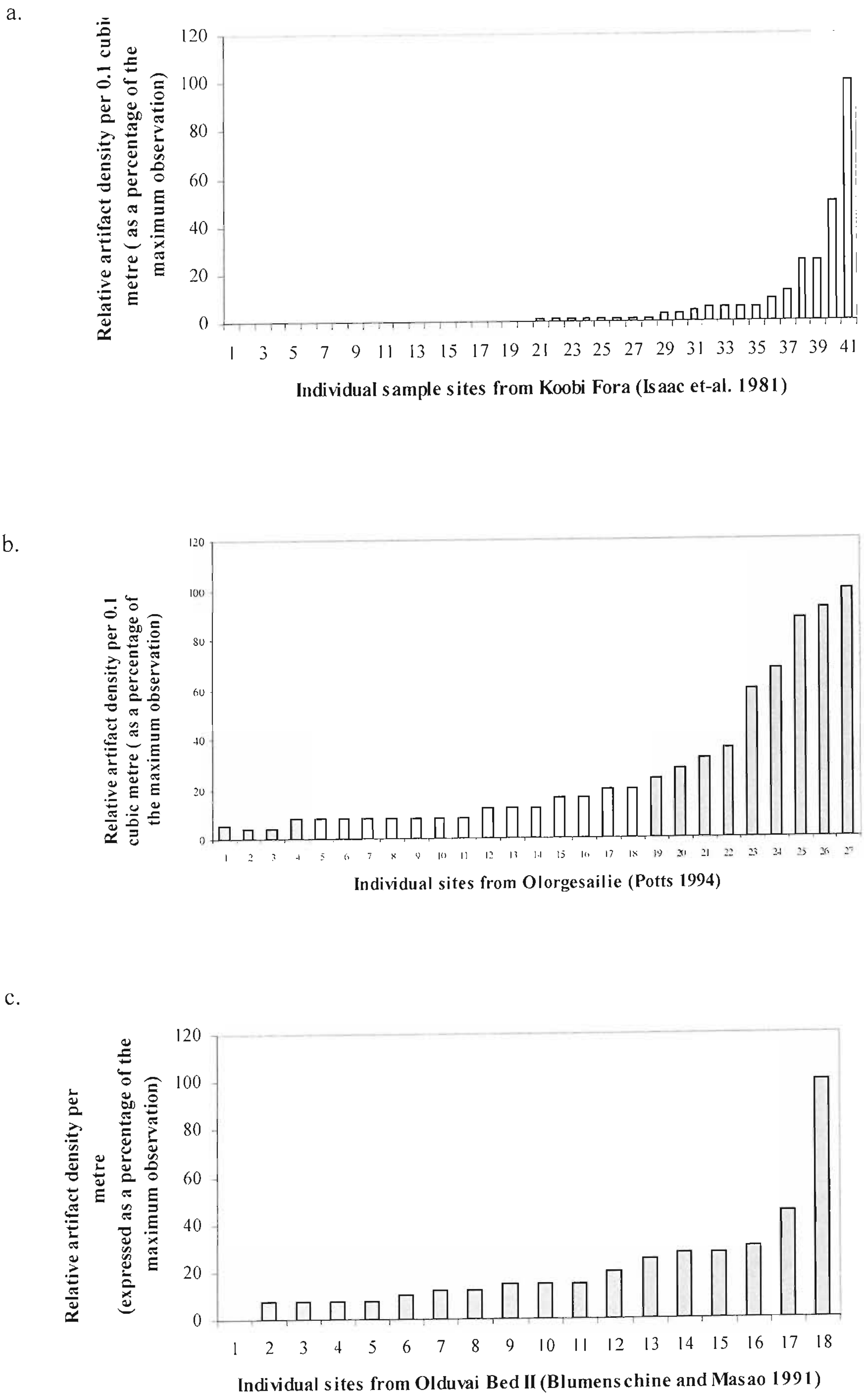


Figure A2.2: Observed artifact densities from three palaeolandscapes apparent that the degree of asymmetry between the 'peak' levels assemblages and the 'background' scatter largely defined by the presence or absence of sites with densities values bridging these extremes. These observations are purely subjective, but without reference to the flexible three-level scheme suggested by Isaac such differences would be difficult to convey. For this reason it is indeed 'convenient' to retain Isaac's tripartite hierarchy.

Moving from the recognition of variation to the development of a formal standardisation of Isaac's hierarchy requires an objective means of comparing distribution patterns. Defining the hierarchy in quantitative terms will allow the overall configuration of assemblage-types, in terms of distribution shape, possible asymmetries and bi-polarities, to be examined, classified and compared in a systematic, objective fashion. Such a step would be the first stage towards transforming the 'scatters and patches' approach into a real analytical framework. As a suggestion for how one might go about this task I will apply an existing analytical tool directly suited to summarising observed artifact densities and allowing direct comparison between different samples. The box and whisker plot provides a simple visual summary of distribution data and is comprised of components that can be translated from standardised, statistical criteria into an assemblage-type hierarchy as conceived by Isaac. The box and whisker plot is comprised of four major components: a box, whisker, median point and outlier markers. The upper and lower limits of the 'box' mark the limits of those 50% of observations in a distribution that are found around the median, 25% below the median and 25% above. Outside of the box a further 50% of observations can be found, 25% of observations are found below the box and 25% of observations are found above the box. The distance between the top and the bottom of the box is known as the inter-quartile range and the extending whiskers show this distance outside the box. Observations within the whiskers can be thought of as normally distributed around the median while observations that fall outside of the whiskers can be considered atypical, extreme values (Shennan 1988). The features of the distribution identified as important in the box and whisker plot have potential analogies in Isaac's hierarchy. Using this standardised approach enables the identification and comparison of 'peak' levels even when the relative distributions vary in terms of the actual densities. Thus, by defining 'peak' level assemblages in terms of their mathematical relationship (i.e. as statistical outliers) to the overall distribution of observations, we no longer have to set limits in terms of actual densities per square metre. Instead a standardised approach can be applied to any sample and from it 'peak' levels appropriate to that distribution can be isolated.

While 'peak' levels are easy to equate with statistical outliers, finding quantifiable equivalents for Isaac's other two components, the 'intermediate' and 'background' levels, is more complicated. The lower limit of the 'background' component is already set by the minimum observation, likewise the upper limit of the 'intermediate' component is set by the extent of the upper inter-quartile range 'Whisker'. As Isaac defined the background scatter as comprising those assemblages with <1 artifacts per m^2 that characterised 'vast areas up to several kilometres diameter'' while the 'intermediate' levels were more restricted areas with higher densities (Isaac 1981,261). On this basis, it was thought best to set the upper limit of the background range at the third quartile thus defining the background' scatter in statistical terms as comprising the lowest 75% of observations in a sample. By default the 'intermediate' assemblages comprise the Upper 25% of the distribution, minus those assemblages that fall outside the upper inter-quartile range, these being the 'peak' or outlier observations.

In a classic 'scatters and patches' configuration the minimum, median and midspread of the distribution should be skewed to the lower part of the distribution while the intermediate and 'peak' levels should appear to occupy and asymmetrical spread of higher values. In descriptive terms the lowspread (distance between the minimum and median) should be less than the highspread (distance between the median and max). However, by setting these relativistic limits it has to be accepted that artifact configurations will occur with highly variable 'background' scatters which include a range of values from zero observations to within 75% or more of the observed maximum. If such cases were to arise and we found ourselves dealing with distributions skewed towards higher values, the whole notion of the 'scatters and patches' configuration as a universal distribution pattern would be questioned. But by equating the hierarchy with predefined elements of the numerical distribution we have the means to objectively demonstrate in what ways an atypical configuration differs from the classic 'scatters and patches' model. The application of the box and whisker plot to the three African datasets described earlier shows that all do conform to a 'scatters and patches' configuration. In Figure A2.3a the box and whisker plot shows artifact densities as actual counts, Figure A2.3b shows relative differences in the shape of each distribution by presenting the data as a percentage of the maximum observation in each sample. The raw data and values for each of the box and whisker components are presented below in Table A2.1 and comparison of these features enable the 'scatters and patches' configurations from each of the three palaeolandscapes to be characterised and directly compared. Examples of how potentially significant differences between landscape distribution patterns can be identified are shown below.

1. Zero Values and minimum observations.

The Koobi Fora sample stands out due to the fact that at 47% of the recorded sites no artifactual material was recovered. This compares to a single site (2.5%) in the Olduvai samples and no sites from the Olorgesailie sample having zero values. These figures indicate a more constant spread of artifacts within the latter Palaeolandscapes while at Koobi Fora there was a more discontinuous spread.

	Koobi Fora		Olorgesailie		Olduvai	
	(n)	%	n	%	n	%
Zero values (quantity)	19.00	47.50	0.00	0.00	1.00	2.50
Min	0.00	0.00	1.00	1.00	0.00	0.00
Median	1.00	1.50	2.00	12.00	6.00	15.00
75th percentile (Background Limit)	6.00	5.47	5.50	32.00	11.00	27.50
Non-outlier Max (Intermediate Limit)	8.00	9.38	6.20	36.00	18.00	45.00
Intermediate-First outlier distance	8.00	9.38	4.20	23.33	22.00	55.00
Max (Maximum Outlier)	64.00	100.00	17.00	100.00	40.00	100.00
Outliers (quantity)	4.00	10.00	6.00	22.22	1.00	5.56
Outlier average (clustering)	32.00	50.00	12.90	74.04	40.00	100.00
Asym Index (Non-outlier average)	1.22	1.90	2.42	13.90	6.71	16.76

Table A2.1: Variation in artifact density from three palaeolandscapes

2. Median.

The median artifact density in the Koobi Fora sample was 1, which in relative terms was 1.5% of the observed maximum observation. This compares with relative median values in the Olduvai and Olorgesailie samples of 12% and 15% respectively. The difference is almost certainly a product of the higher proportion of zero values at Koobi Fora which has effectively skewed the sample towards the lower limit of the range. The median positions of the other two samples similarly show a skew but not to the same degree, with Olorgesailie being the less skewed of the three configurations. Comparison of the median values indicates a more even distribution of artifacts across the Olorgesailie palaeosol than across that at Koobi Fora.

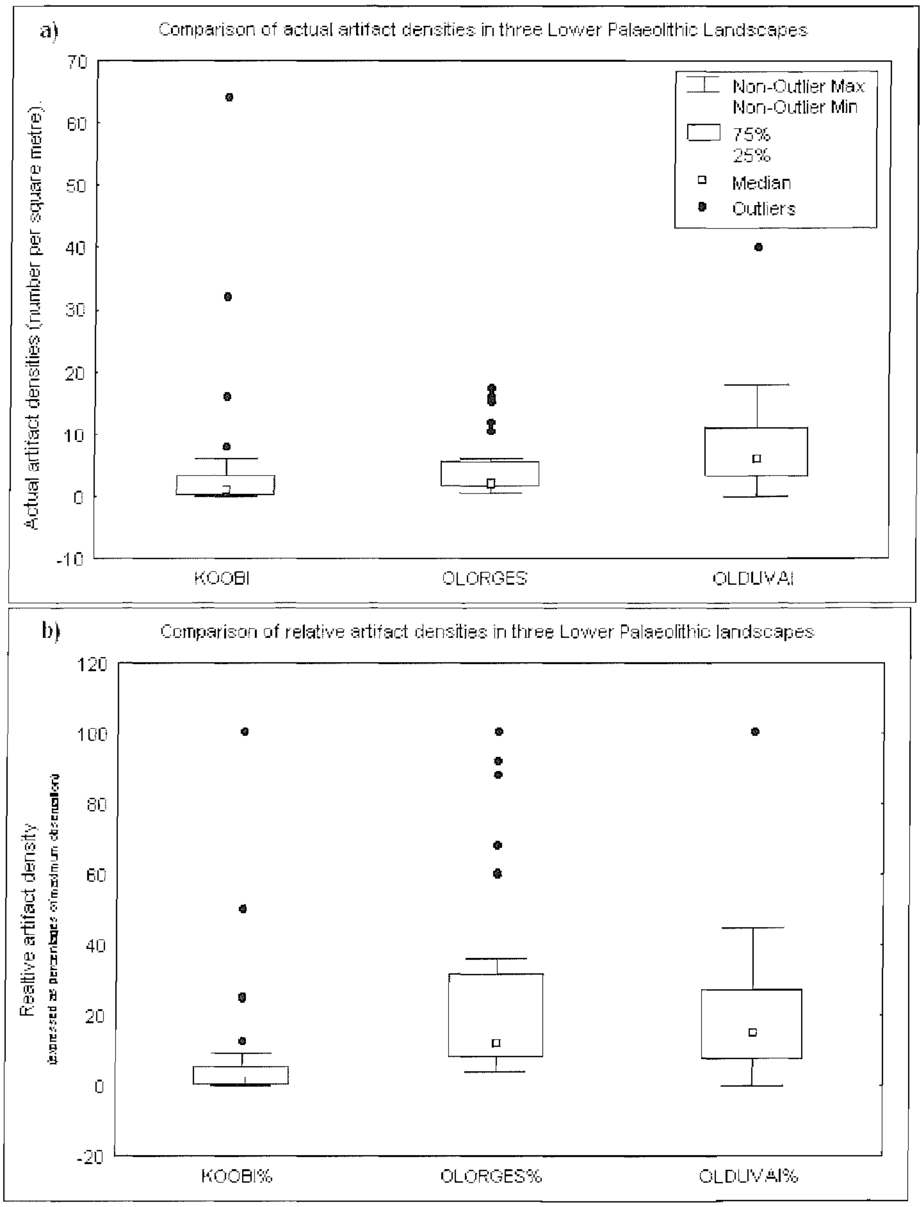


Figure A2.3: Box and whisker comparing variation in artifact densities for three palaeolandscapes.

3. 75th Percentile ('Background' Limit).

The relative differences in the position of the 75th percentile match those in seen in the median. At Koobi Fora the 75th percentile is at 6, which translates into only

5.5% of the observed maximum. At Olduvai and Olorgesailie however the relative positions of the 75th percentile are at 27.5% and 32%. In descriptive terms we can show that the 'background' scatter at Koobi Fora is heavily skewed to the low end of the distribution, with 75% of observation not exceeding values of 6% of the maximum observed density. At the other two assemblages the 'background' level has a broader numerical range, but in each case three-quarters of the observations occupy less that 35% of the overall range of observed data. In all cases equating the 'background' limit with the 75th percentile has led to observations consistent with the classic 'scatters and patches' model.

4. Non-Outlier Max ('Intermediate' limit).

   'Intermediate' level values also show a relative degree of differential skewing with the Koobi Fora limits being at only 8% of the observed max while at 36% and 45% at Olorgesailie respectively. In isolation, the upper limit of the 'intermediate' level means very little, but by quantifying the relative differences between the highest value within the 'intermediate' group and the lowest outlier we can gauge the degree of separation between this group and the outlying 'peak' level assemblages. In this way we can determine whether there is a relative graduation or punctuation between the two classes. At Koobi Fora the highest 'intermediate' is separated from the lowest 'peak' value by 9.4%, at Olorgesailie this distance is 23.3% while at Olduvai this distance is 55%. These differences are large and indicate a very high degree of separation between 'peak' levels at Olduvai and a more gradual gradation at Koobi Fora.

5. Outliers (Number and clustering).

The three samples differ in the number of 'peak' level assemblages. At Koobi Fora, four assemblages (10%) emerged as statistical outliers, while at Olorgesailie 6 assemblages (22%) had atypically high densities while only one emerges from the Olduvai sample. In order to determine whether there is a large degree of separation in the size of these outliers the average of their relative values (expressed as a percentage) can be compared to the max observation (100%). The higher the average of the 'peak' values the more distinctive the levels are as a separate group. Hence at Koobi Fora a score of 50% reflects that the outliers are spread across a wide range of values, while at Olorgesailie a score of 75% indicates a relatively clustered configuration. At Olduvai the single 'peak' observation, of course, returned a 100% score. In this case examining the separation of the 'peak' value from the non-outliers max is a more useful gauge of how distinct the outliers are.

6. Asymmetry

Finally, the overall asymmetry of the distribution can be broadly quantified by determining the overall mean of all non-outlying observations defined as a percentage of maximum observation (100%). This index works because it is measure of the degree of the spread of observations normally distributed around the mean (i.e. within the interquartile range). Where a low on-site/off-site asymmetry exists a wide range of 'intermediate' observations will effectively raise the non-outlier average score. Where a high on-site/off-site asymmetry exists, the majority of observations will be low. This method has been used in preference to establishing skewdness thorough the difference between the median and mean observations (Shennan 1988) because of the effect more than one 'peak' level observation has on the mean of the all observations. It is useful because it is very sensitive to the range and quantity of 'intermediate' observations, the role of which is pivotal in the degree to which a strong 'scatters and patches' configuration can be identified. Olorgesailie and Olduvai returned broadly similar asymmetry indexes (13.9% and 16.8% respectively), with Olduvai having a wider spread of 'intermediate' density assemblages, reducing the overall asymmetry. Despite the quantity and range of 'peak' observations at Koobi Fora, the tightly clustered and low 'background' and 'intermediate' scores present a distinctive 'background' scatter, indicated in the asymmetry index by a score of only 1.9%.

While these examples usefully illustrate the methodology, there are far too many differences in excavation method, data set quality and sedimentary context to proceed any further with the comparison of the three samples. It is hoped however that the foregoing gives an example of how the application of a 'scatters and patches' analysis offers a range of new descriptive and comparative tools to help explain variations in both the pattern and overall volume of artifact distributions. In the following section the distribution of observed artifact densities from Boxgrove will be catergorised according to the box and whisker method in order to define assemblage in terms of the overall 'scatters and patches' configuration of the palaeolandscape.

A2.5 Applications to the Boxgrove Unit 4c sites.

Artifact densities for the Boxgrove sites have been quantified in terms of the number of humanly modified flint and demonstrable nodular manuports with a maximum dimension equal to or greater than >20mm per metre square. Where there are intra-site variations in artifact density across a single artifact spread, an average density score has been given for the whole area in order to provide directly comparable figures. Artifact densities for the sample of 65 sites from the Unit 4c palaeosol are shown in Figure A2.4 of the investigated test pits and area excavations produced no archaeology, indicating unoccupied areas of the palaeosol. In contrast, three sites with recorded densities exceeding fifteen artifacts >20mm per m^2 stand out as possible 'peak' level assemblages for the Boxgrove landscape. However, the 35 other sites, with artifact densities ranging between 0.1 and 9 artifacts per m^2, present a relatively even rising curve with only minor inflections. From visual inspection of this distribution alone, no obvious case can be made for any division between 'background' and 'intermediate' level assemblages at Boxgrove. While this observation matches those made for the three African examples illustrated above, it has been shown that these divisions are useful to retain from a conceptual point of view and that this can be achieved through the application of the box and whisker approach outlined above.

In Figure A2.5 a box and whisker plot showing actual densities for the Unit 4c assemblages is presented. The accompanying table highlights the main features of the distribution and the elements correlated to Isaac's tripartite hierarchy. The 'background' limit is set at 4.2 artifacts per m^2 which, in relative terms, means that three-quarters of observations fall below 22% of the maximum observed density.

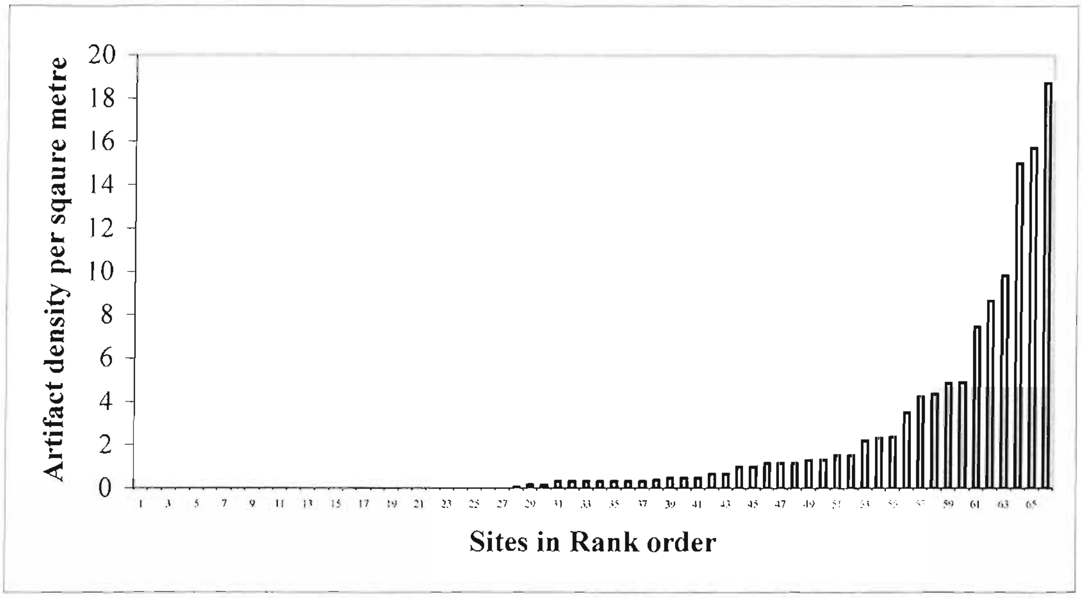


Figure A2.4: Observed artifact densities from Unit 4c at Boxgrove in rank order.

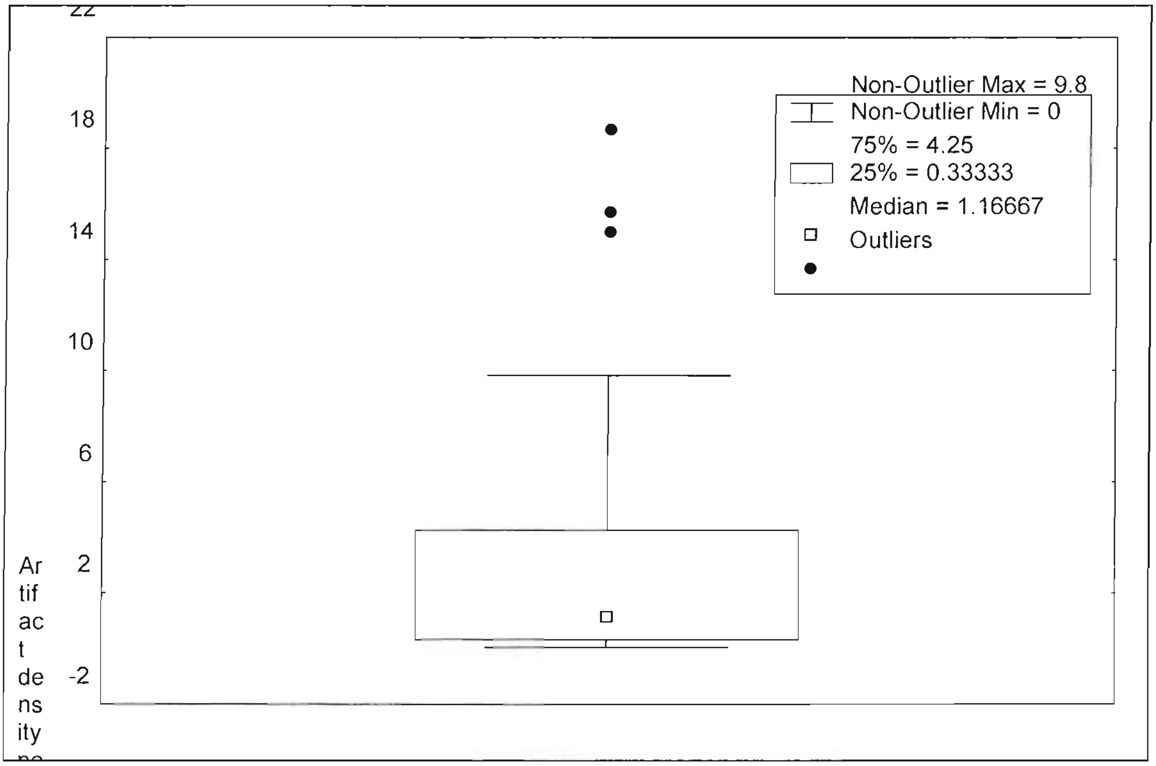


Figure A2.5: Box and whisker plot showing the distribution of observed artifact densities for the Boxgrove Unit 4c sites.

While this value indicates a far less skewed configuration than at Koobi Fora (5.5%) it falls below the observed limit of the 'background' level at Olorgesailie (32%) and Olduvai (27%). This suggests, in relative terms, that the Boxgrove configuration exhibits a moderate degree of skewing and exhibits a relatively well-defined 'background scatter'. A more accurate picture of the relative degree of skewing is illustrated by the Median figure of 1.2 (6.2% of max) for the Boxgrove sample.

The non-outlier max 'whisker' marks the upper limit of the 'intermediate' group. For the Boxgrove sample this limit is set at 9.8 artifacts per m^2 which equates to 52% of the maximum observed density. Comparison with the other samples shows that this is relatively high. The 'intermediate' level was set at 9.4% for Koobi Fora, 36% for Olorgesailie and at 45% for the Olduvai sample showing that Boxgrove has a more dispersed series of observations around the median and hence a broader inter-quartile range. In archaeological terms it indicates that 'background' and 'intermediate' densities are more evenly spread across the Boxgrove landscapes than at the other sites. While Boxgrove and Koobi Fora both appear to have a relatively skewed distribution weighted towards the 'background' scatter Boxgrove appears to differ markedly from Koobi Fora in having a more dispersed spread of 'intermediate' level assemblages.

As suggested by visual inspection of the rank-order curve in Figure A2.4, three assemblages were isolated by the box and whisker plot as representing 'peak' level outliers. These had artifact densities of 15.2, 15.7 and 18.5 per m^2. The three assemblages appeared to be quite separated from the 'intermediate' group and this separation was established in relative terms at 27% of the maximum observation. This compares with 9.4% at Koobi Fora, 22% at Olorgesailie and 55% at Olduvai suggesting a distinct but relatively unremarkable degree of separation. The three 'peak' level assemblages were quite tightly clustered with an average of 88.1%. This compares with 50% at Koobi Fora, 74% at Olorgesailie and 100% at Olduvai. Given that the Olduvai sample had only one outlier, the 100% score is misleading and suggests that the Boxgrove 'peak' assemblages should be considered as a relatively well defined group. The overall asymmetry of the Boxgrove configuration (separation between the max and mean) was 7.8%, which compares with 1.9% at Koobi Fora, 13.9% at Olorgesailie and 16.8% at Olduvai. This data again suggests that the degree of 'scatter and patch' symmetry at Boxgrove and Koobi Fora were comparable.

Application of the box and whisker plot technique has allowed us to classify the Boxgrove assemblages on the basis of a predetermined set of statistical criteria broadly correlated with the tripartite hierarchy proposed by Isaac. While previous discussions have talked in general terms of the 'scatter between the patches ' or the 'veil of stones' (Robroeks *et al.* 1992) the application of this technique allows the definition and comparison of palaeolandscape distributions. Having defined the three major elements of the Boxgrove distribution, it can now be determined whether any real differences in assemblage composition can be identified between the major groups. Subsequently (Chapter 6), the tripartite level hierarchy will help provide a quantitative framework through which spatial patterning can be identified in the distribution of the assemblage types or particular assemblage components. By utilising the tripartite hierarchy in this way it will be shown that the 'scatters and patches' approach goes beyond a simple description of the gross distribution of artifacts to provide a basis for the systematic analysis of spatial and compositional assemblage variability and ultimately patterns of hominin land use.

A2.6 Establishing assemblage variability.

In the first stage of the 'scatters and patches' analysis, assemblages from the Unit 4c palaeosol were grouped into three types based solely on relative artifact density. These types were each equated with a component of Isaac's tripartite 'scatters and patches' hierarchy. While based on a solid set of repeatable criteria allowing the direct comparison with other samples, defining assemblages in these terms is not the ultimate goal of 'scatters and patches' analysis. Instead, the approach is geared towards utilising isolated differences in artifact density as a context for understanding compositional differences in the assemblages themselves. To this end, having established the three groups on the basis of artifact density, it is necessary to establish whether any real qualitative differences in assemblage composition can be identified between these groups. Our three groups vary quite markedly in the number of assemblages they contain, this being a function of the numerical distribution of observed assemblage densities that are skewed towards lower values. The population of the 'background' assemblages contains 26 artifact assemblages and a further 27 localities with no recorded artifacts. Our 'intermediate' population contains 8 assemblages and the 'peak' population consists of only three assemblages. Conversely, the inevitable effect of having defined our groups on the basis of artifact density has resulted in a great variation in the overall number of artifacts >20mm in each of the groups. Hence the 'background' assemblages contain only 161 artifacts in total, the 'intermediate' assemblages contain 3046 artifacts while the three 'peak' assemblages contain 6471 artifacts. The extremely large differences in artifact density are demonstrated here by the inverse relationship between the number of assemblages in each of the three 'populations' and the number of artifacts.

A2.6.1 'Background' assemblages

28 assemblages were assigned in the first stage of the analysis to the 'background' population of assemblage, with artifacts having been recovered at densities of less than 4.2 artifacts per m^2. These assemblages are summarised in Table A2.2, which gives total counts of artifact types and average values for artifact morphology for each assemblage. Assemblage size varies, the assemblages from GTP5 comprising 27 artifacts >20mm. Only two other assemblages contained similarly sized assemblages: BTP/N (21 artifacts) and ATP2 (19 artifacts). All the other assemblages are extremely small, comprising less than 10 artifacts in total, while 17 of the assemblages contain less than 5 artifacts. The small assemblage size means that the average figures for particular assemblage components are going to be less meaningful. Hence, the average artifact maximum lengths of 70mm and 72mm recorded for the assemblages of BTP/P and EQPTP2 were based on populations of only one and three flakes respectively. These averages have the potential to be distorted by individual outliers more than those of the larger populations. The average flake size from GTP5 is 45mm, a figure which is relatively high in comparison with experimental observations and represents the mean of 27 flakes. This being said, the presence of single, relatively large flakes occurring in virtual isolation should not be dismissed because of the small sample size. The occurrence of low-density archaeology is a direct product of hominin behaviour and the presence of atypically large pieces within these assemblages may be significant. We might, for example suggest, that the 70mm flake was transported to the BTP/P because of its size and value as a flake tool.

The average percentage of cortex was relatively low for all the assemblages, with only the single large flake from BTP/P having more than 29% coverage. Artifact weight is relatively low for most of the assemblages, with the large flake from the small BTP/P and EQPTP2 assemblages giving the highest average scores. In general the low cortex, weight and size of the artifacts suggests that debitage from the primary stages of biface manufacture is largely absent from any of the assemblages. Apart from a single retouched flake from EQPTP4, no flake tools were recovered from the assemblages, there was also an absence of cores and manuports from all of the assemblages. Tranchet flakes were recovered from three assemblages, one from EQPTP14, two from BTP/K and three from BTP/I. At the latter site only seven flakes were found in total, the tranchet removals comprising a significant proportion of the complete assemblage. At none of these sites were bifaces found alongside tranchet flakes. The Bifaces themselves were restricted to three sites with single tools being found at GTP20, EQPTP5 and EQPTP10.

There is no evidence for extensive primary reduction of bifaces or cores at any of the sites. Instead the 'background' level assemblages comprise generally small flakes and flake fragments derived from the later stages of biface manufacture. The three tranchet flakes from BTP/I seems to confirm the modification/resharpening of existent tools and reinforces the idea that most of this relatively undifferentiated debitage relates to small episodes of late-stage modification as opposed to tool manufacture or even the extensive thinning and shaping of bifaces. This data confirms observations made in the Project B Survey, that across the Unit 4c palaeosol extensive areas are characterised by low density spreads of debitage resulting from biface modification (Roberts *et al.* 1997). Bifacial tools were apparently transported by hominins within the landscape, having been manufactured within more restricted, localised areas. While transporting these tools hominins appear to have been constantly modifying the bifaces during short episodes of flaking. The exact purpose and context of this flaking is impossible to determine from this level of analysis and should be addressed in future research. It is however clear that, despite being extensively transported and modified within the 'off-site' parts of the landscape, the discard of bifaces in association with low-density scatters was rare.

Site	Area	X	Y	Dist' from cliff	Artifacts	Density	Ml	Wt	F	Ds	Ft	Tr	Bf	Cr
GTP20	6.13	2396.4	8660.2	39.43	2	0.3	35	4	1	2	0	0	1	0
EQPTP14	6	2220.7	8655.8	66.29	2	0.3	29	2	0	4	0	1	0	0
GTP26	36	1653.7	8675.6	84.29	2	0.1	23	2	1	3	0	0	0	0
EQPTP13	6	2213.3	8617.5	104.29	2	0.3	30	3	0	3	0	0	0	0
EQP1TP6	6	2285.2	8612.6	108.29	2	0.3	25	2	0	2	0	0	0	0
GTP8	1.3	1707.6	8635.1	117.14	3	2.3	27	2	1	3	0	0	0	0
GTP22	5.06	1706.5	8632.1	118.57	2	0.4	27	2	2	2	0	0	0	
EQPTP4	6	2259.9	8601.2	120.29	7	1.2	40	22	2	2	1	0	0	0
BTP/Q	6	2321.2	8575.7	125.59	2	0.3	29	2	0	2	0	0	0	0
EQPTP7	6	1842.1	8635.6	125.71	2	0.3	25	2	0	2	0	0	0	0
EQPTP2	6	2330.2	8577.7	130.57	3	0.5	72	31	0	5	0	0	0	0
BTP/N	6	2354.4	8556.8	140.88	21	3.5	35	8	1	3	0	0	0	0
BTP/P	6	2314	8562.1	141.18	1	0.2	70	32	3	2	0	0	0	0
EQP2TP6	6	1840.9	8616.9	145.71	2	0.3	23	1	0	2	0	0	0	0
EQPTP5	21	1838.2	8594.5	155.00	27	1.3	45	14	2	3	0	0	1	0
EQPTP1	6	2188.2	8562	160.57	4	0.7	29	3	1	2	0	0	0	0
EQPTP10	6	1830.6	8584.2	166.00	8	1.3	45	20	1	2	0	0	1	0
BTP/M	6	2300.6	8533.3	175.59	9	1.5	28	2	0	2	0	0	0	0
BTP/H	6	2348.9	8512	188.53	3	0.5	26	4	2	2	0	0	0	0
BTP/I	6	2329.5	8514.8	189.12	7	1.2	44	17	1	4	0	3	0	0
BTP/K	6	2288.7	8519.4	190.00	9	1.5	41	5	0	4	0	2	0	0
ProjATP3	8	2282.8	8505.5	196.25	4	0.5	-	-	-	-	-	-	-	
BTP/F	6	2281.5	8505.5	205.88	7	1.2	29	3	0	3	0	0	0	0
BTP/D	6	2326.6	8499.3	206.76	4	0.7	25	1	0	2	0	0	0	0
ProjATP2	8	2282.8	8486	210.00	19	2.4	-	-	-	-	-	-	-	
BTP/A	6	2345.1	8482	220.59	1	0.2	27	1	0	3	0	0	0	0
BTP/B	6	2324.8	8484.8	220.88	6	1.0	34	3	0	2	0	0	0	0
Total					161	-	-	-	-	-	1	6	3	0
% of Total					100	-	-	-	-	-	0.6	3.7	1.9	0.0
Average						0.9	34.5	7.5	0.	2.6	-	-	-	-
Std Dev						0.8	12.8	9.2	0.	0.9	-	-	-	-

Table A2.2 : Assemblage composition for 'background' assemblages from Unit 4c (See Appendix 1 for guide to attributes and abbreviations).

A2.6.2 'Intermediate' assemblages

Eight assemblages were identified as having occurred at densities bridging the 'background' level and the limit of non-outlying observations. They occurred at densities between 4.2 and 9.9 artifacts per m^2. These assemblages vary in size but are generally larger than those of the 'background' scatter, containing between 17 and 1402 artifacts >20mm. As with the 'peak' assemblages, the larger assemblage size is due to excavation methodology whereby large excavation areas were opened up where artifact densities were highest. The large assemblage size does mean that the average scores shown in Table A2.3 are unlikely to be skewed by individual, anomalous artifacts. Average artifact size is similar to that of the 'background' assemblages at 35.1mm but given the skewing effects of the few large flakes in the 'background' population it can probably be assumed that in general larger artifacts are more abundant in the 'intermediate' assemblages. This is confirmed by a comparison of average artifact weight between the 'background' assemblages (7.5gm) and the 'intermediate' assemblages (20.5gm). The overall larger mass of artifacts may be due, in part, to the relative increase in abundance of debitage from the earlier stages of biface production. This is illustrated at sites Q2/C and Q2/D which have average cortex scores of 42% and 25%, suggesting that the actual production of bifaces is occurring at these sites (see Roberts *et al.* 1997). Flake tools are restricted to the large assemblages from Q2/C and Q2/D, these assemblages contain all but one of the 45 tranchet flakes recovered from the 'intermediate' assemblages. While biface-manufacturing debitage is present at all seven sites, actual bifaces were only recovered from three sites BTP/C, GTP17 (4c), Q1/A and Q2/C. While the BTP/C assemblage is too small to assess properly, the detailed analysis of the other assemblages suggests that the bifaces at these sites were transported in a finished state prior to discard (Austin 1994; Roberts *et al.* 1997; see Chapter 3). This evidence reflects the pattern of behaviour indicated by the 'background' assemblages, demonstrating biface transport. The 'intermediate' assemblages differ in that bifaces are discarded alongside more substantial concentrations of biface manufacturing debitage. In the case of Q2/C this appears to be debitage from all stages of the biface reduction sequence while primary material seems to be absent from the assemblage at BTP/C (Roberts and Parfitt 1999).

Site	Quarry	Area	X	Y	Distance	Artifacts	Density	Ml	Wt	Pc	Dsc	Ft	Tr	Bf
GTP17	2	64	2466.9	8617	62.86	252	4.2	30	2	1	2	0	0	4
GTP3	2	23.5	2362.2	8612.6	95.14	210	8.9	51	25	1	3	0	0	3
Q1/A (4c area)	1	65.2	1706	8645.2	107.14	317	4.9							5
BTP/O	2	6	2333.8	8560	141.00	59	9.8	33	53	1	2	0	0	0
Q2/C/TPl	2	196	2326.5	8535.5	172.00	1402	7.5	36	3	42	2	3	33	8
BTP/J	2	6	2313.8	8516.3	189.71	26	4.3	32	7	0	2	0	1	0
BTP/C	2	6	2310.4	8486.9	221.76	29	4.8	30	6	0	3	0	0	0
Q2/D	2	87	2309.2	8471.8	238.00	751	8.6	34	?	25	?	1	11	0
Total						3046	-	-	-	-	-	4	45	20
As % of Total						100	-	-	-	-	-	0.1	1.5	0.7
Average							6.6	35	15.9	10.0	2.3	-	-	-
Std Dev							2.2	6.6	18.2	15.4	0.4	-	-	-

Table A2.3: Assemblage composition of 'intermediate' assemblages (See Appendix 1 for guide to attributes and abbreviations)..

A2.6.3 'Peak' assemblages

Three assemblages were categorised as 'peak' level assemblages, having artifact densities that exceeded the upper inter-quartile range. These outliers can be considered atypically dense concentrations and a summary of their composition is shown in Table A2.1. The assemblages are all relatively large with 368 artifacts from EQPTP1, 1236 artifacts from Q2/A and 4867 artifacts from Unit 4u at Q1/B and occurred at relatively similar densities (between 14.7 and 18.7 artifact per m^2). Given the large population size, the average artifact size of 41.4mm and average artifact weight of 19.4gms this reliably suggest that larger elements from the early stages of biface manufacture are present. However, this is perhaps more apparent at site Q2/A which exhibits a higher cortex score than the other two sites. The average size and weight of the artifacts is also due in part to the relative abundance of core and manuports within these assemblages as compared to those from the 'intermediate' and 'peak' assemblages. Tranchet flakes were identified in all three assemblages and while flake tools were identified at Q1/B and EQPTP1 none were recovered from site Q2/A. The assemblage from Q1/B and EQP/TP1 appear far more similar in compositional terms than Q2/A. The absence of flake tools, low incidence of tranchet and cores, as well as the more dominant presence of cortical debitage within the assemblage, suggests that the assemblage from Q2/A contains more complete reduction sequences and less non-debitage elements than the other two assemblages. While all are characteristically large, dense accumulations of material, the differences between these assemblages require explanation.

Site designation	Quarry	Area	X	Y	Distance	Artifacts	Density	Ml	Wt	Pc	Dsc	Ft	Tr	Bf	Cr
EQPTP1	1	25	1841.9	8583.7	161.0	368	14.7	43	17	10	2	7	9	4	2
Q2/A	2	78.6	2282.8	8481	231.4	1236	15.7	40	19	42	4	0	3	4	1
Q1/B 4u	1	260	1762.7	8686.9	74.2	4867	18.7	41	22	10	4	85	60	74	76
Total						6471	-	-	-	-	-	92	72	85	79
As % of Total						100	-	-	-	-	-	1.42	1.11	1.31	1.2
Average							16.4	41.4	19.4	20.7	3.1	-	-	-	-
Std Dev							1.7	1.2	2.0	15.1	0.6	-	-	-	-

Table A2.4: Composition of 'peak' assemblages(See Appendix 1 for guide to attributes and abbreviations)..

A2.6.4 Summary

In Table A2.5 the overall compositional details of assemblages from the three groups are summarised. Dealing first with artifact types some important difference can be isolated in the relative abundance of non-debitage types. Flake tools account for very low proportions of either the 'background' or 'intermediate' assemblages forming 0.2% of both, while they comprise 1.4% of the 'peak' level assemblages. This indicates either that flake tools were manufactured to a greater extent in these contexts or that the discard of the tools was more likely. Tranchet flakes formed a relatively uniform component of the three assemblage types comprising between 1.1% and 1.7% of each. Tranchet flakes were least abundant in association with the 'peak' level assemblages, while most abundant in the 'intermediate' level assemblages. This evidence suggests that bifaces were resharpened throughout the landscape. The distribution of bifaces themselves does appear to be related in part to the density of overall artifact discard. Bifaces comprise only 0.6% of assemblages from the 'background' scatter despite the evidence that the debitage here almost entirely derives from the finishing of bifacial tools. While these tool were extensively transported throughout the landscape, it appears that their discard was suppressed outside of restricted contexts. Bifaces form a similar proportion of the 'intermediate' assemblages (0.7%) but at the sites of GTP17, Q1/A, Q2/C and GTP3 only twenty bifaces were recovered. The low percentages therefore appear to reflect an increase in the quantity of debitage at these sites rather than equally suppressed levels of biface discard at the 'background' sites.

Perhaps more significant is the higher biface percentages observed at the 'peak level' sites. Here they account for 1.3% of the combined assemblages, a figure broadly twice that for the assemblages from the other populations. Flakes tools, cores and

Assemblage	Type	Artifacts	Density	Ml	Wt	Pc	Dsc	Ft	Tr	Bf	Cr
Background	Total	161	-	-	-	-	-	1	6	3	0
Background	As % of Total	100	-	-	-	-	-	0.6	3.7	1.9	0.0
Intermediate	Total	3046	-	-	-	-	-	4	45	20	2
Intermediate	As % of Total	100	-	-	-	-	-	0.1	1.5	0.7	0.1
Peak	Total	6471	-	-	-	-	-	92	72	82	79
Peak	As % of Total	100	-	-	-	-	-	1.4	1.1	1.3	1.2
Background	Average		0.9	34.5	7.5	0.6	2.5	-	-	-	-
Background	Std Dev		0.8	12.8	9.2	0.8	0.9	-	-	-	-
Intermediate	Average		6.6	35.1	15.9	10.0	2.5	-	-	-	-
Intermediate	Std Dev		2.2	6.6	18.2	15.4	0.4	-	-	-	-
Peak	Average		16.4	41.4	19.4	20.7	3.1	-	-	-	-
Peak	Std Dev		1.7	1.2	2.0	15.1	0.6	-	-	-	-

Table A2.5: Comparison of assemblages from 'background', 'intermediate' and 'peak' groups.

tranchet flakes also account for higher proportion of the 'peak' assemblages, indicating that non-debitage components appear to be discarded at proportionally higher levels within these restricted areas. Yet crucially, the observed percentage of tranchet flakes is lower than that observed for the 'intermediate' and 'background' level assemblages. This is no doubt due in part to the higher proportions of debitage from the primary stages of biface production observed at 'peak' level sites, but the less extensive resharpening of bifaces may also be indicated at these locales.

Certainly the lack of sharpening and increased discard of bifaces within 'peak' level assemblages indicates that biface transport and reuse behaviour may have been contextually based at Boxgrove, a crucial possibility examined in Chapter 6.

From this comparison of assemblage composition across the three populations there would appear to be grounds to suggest that different approaches to tool use, reuse, transport and discard appear to account for the compositional differences between the assemblages. While this has been indicated by previous studies of individual sites, this exercise has managed to establish in quantitative terms that these differences are also an intrinsic part of the 'scatters and patches' configuration. The results indicate that some real compositional differences exist between the assemblages in each group. In addition, the Boxgrove sample shows that particular characteristics of the distribution support the validity of a tripartite hierarchy as a useful framework, one that can be justified on qualitative, not simply quantitative, terms. Isaac, in developing the 'scatters and patches' approach, hoped that,

> "These methods should allow us to address questions such as, was the morphology of the artifact sets in areas of high density (sites) the same as that of the set discarded as a dispersed scatter over the terrain?" (Isaac 1981b, 224).

The Boxgrove data would suggest that there were indeed differences between the composition of assemblages discarded at different densities, that a 'patch' at Boxgrove was not simply a more concentrated but otherwise undifferentiated concentration of the material forming the 'scatter'. The data from Boxgrove indicates that the 'scatters and patches' phenomenon does not simply result from the spatially differential overprinting of a single behavioural package. Rather 'scatters and patches' signatures appear to have formed over time through contextually sensitive differences in the nature of hominin tool discard and transport patterns. The methodology suggested here could, in the future be developed to isolate differences in the nature of this activity between different Pleistocene sedimentary basins.

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