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A SHIPBOARD SYSTEM FOR EXTRACTING INTERSTITIAL WATER FROM DEEP OCEAN SEDIMENTS

P. S. RIDOUT

REPORT NO. 121

1981

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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ABSTRACT

A system is described which is used to extract large volumes of interstitial waters, on board ship, with procedures to minimise the effects of temperature, oxidation and contamination.

INTRODUCTION

Knowledge of the composition of interstitial water is important to the understanding of the chemistry of deep ocean sediments. The analytical requirements include chlorinity, alkalinity, nutrients, dissolved gases, organics, major and trace elements. Shipboard sediment squeezing can provide interstitial water samples for most of these requirements, providing one is aware of errors which may arise from improper sampling, storage and handling of the material. Studies have shown that warming of marine sediments prior to pore water extraction can give rise to enrichments in potassium[1,2] and silica[3] and depletion in magnesium and calcium[2]. To overcome this 'temperature of squeezing' effect, sediment must be treated at '*in situ*' temperatures. Additionally, some components of anoxic sediments are very sensitive to oxygen, especially phosphate[4] and iron[5]. It is essential, also, to minimise the storage time of the core prior to squeezing[6].

Various systems have been developed for pore water extraction. They include leaching,[7,8,9] centrifugation,[10,11] liquid/gas displacement,[12,13,14] low and medium pressure gas/mechanical[15-19] and high pressure hydraulic/mechanical squeezers.[20-25] Leaching is little used as it is generally slow, difficult to control and would have limited use on board ship. The displacement systems, although giving good results with coarse grained sandy sediments, are inefficient when applied to fine grained or clay sediments. Low pressure systems have been used in many situations on a range of sediments. They produce good pore water samples but are generally slow in operation and do not produce large volumes of samples. Gas systems can use large volumes of inert gas which may not be generally available on board ship. High pressure, hydraulic systems are much quicker and can provide large volume samples for analysis, but may be heavy and unsuitable for trace metal studies due to their metal construction.

The aim of the system must be to provide a sample for analysis which is chemically representative of '*in situ*' pore waters. Therefore, provision must be made for control of temperature, and for preventing contact with oxygen and contamination, whilst maintaining a system which is sufficiently transportable, reliable and uncomplicated for use on research vessels.

The system described utilises a mechanical, hydraulic system with pressures up to 4000 psi exerted on the sediment.

THE SQUEEZING UNITS

A scale drawing of the unit is shown in Fig. 1. A full, detailed components list is provided in Table 1. The sediment is contained within the PVC unit which comprises a base (1), cylinder (2), securing ring (3), and a piston (4). Nitex nylon gauze (5) and a filter paper (6) located on the base, are held in position by the 'O' ring (7). The cylinder is fixed in place and the securing ring is tightened down using the wing nuts (8), on the stainless steel studs (9). The piston presses into the barrel, sealing on its two 'O' rings.(10) A syringe (60 ml) is inserted at the outlet port (11) of the base. The complete PVC assembly is positioned, on the hydraulic jack (12), inside the steel frame (13), so that the support plate (14) locates in a recess in the PVC base. The thrust pad (15) is placed on top of the piston. The pressure in the system is measured by a gauge (16) connected to the base of the jack with copper pipe (17,18).

The PVC construction allows no metal contact with either the sediment or the pore water. All mild steel parts are epoxy coated before use. Nitex gauze facilitates lateral flow to the outlet port which has a minimal deal volume. The filter papers used (Whatman 542) have good retention and wet strength properties. The cylinders should be no more than 3/4 filled with sediment for efficient squeezing.

The steel frames are mounted, on a wooden support, in a domestic chest freezer (13.7 cu.ft) modified to run between -5°C and 10°C, with a circulation fan in the lid. The inner walls of the freezer are sprayed with vinyl to prevent corrosion. The hydraulic units can be operated from above without much disturbance of the cool air in the cabinet. (Plate 2)

This system was used on Discovery Cruises 108 and 110. The following general procedure was followed.

SAMPLE COLLECTION AND STORAGE

Core samples were collected by insertion of a precleaned, butyric core liner (4" dia.) near the centre of a box core (1 foot square cross section). The dead space at the top of the subcore was flushed with nitrogen before capping. These sub-cores were 'dug out' as soon as possible and transferred to the cool cabinet, for temporary storage before sectioning.

TRANSFER OF SUB-CORE TO SQUEEZERS

The sub-core was sealed into a large glove bag along with the squeezer units. The bag and its contents were thoroughly flushed with nitrogen, then the bag loosely inflated. A PVC piston, machined to fit the liner, was used to extrude the sub-core, which was sectioned into the PVC squeezer units using a plastic spatula. Each squeezer unit was sealed using its piston, then transferred to the frames, in the cooler, for squeezing. In order to reduce the storage time of the core, thereby reducing the risk of oxidation, the next set of sections to be squeezed can be prepared as above in a second set of PVC units and stored in the cool cabinet prior to squeezing.

SQUEEZING

After allowing time for the units to come to temperature, each one was pressurised to a reading in the range 2000-4000 psi (the reading is dependent on sediment type). The pressure gauges provide a good indication of squeezing efficiency and serve to warn the operator of over-pressure and leakage. The first few ml. of water were discarded to flush the dead volume and the filter assembly, before a plastic syringe (60 ml.) was inserted into the outlet port. The pressure was maintained by further pressurisation at approximately 5-minute intervals. The bulk of the sample (generally 100-2[illegible]) [illegible]as collected within half an hour. The syringes were capped and stored in t[illegible] Sub-samples were taken into glass vials for some analyses.

CONCLUSION

This system is easily operated and maintained and is r[illegible]ively inexpensive to build. Pore waters can be maintained at in situ temperatures and in an oxygen free environment. It was found that a large volume glove bag was essential for ease of operation and to prevent the bag splitting. However it may be of further benefit to inflate the bag in a perspex chamber in order to give it more structure. The diameter of the sub-core is also important. Initially, 2" diameter tubes were used, but these compressed the sediment so that an untypical vertical section was obtained. Increasing the surface area to wall thickness ratio by use of the 4" diameter tube, minimised this compression effect. The pressure exerted on the sediments (up to 400 psi) is not thought to affect the pore water chemistry,[23,26-28] but is sufficiently high to provide samples in a relatively short period of time. The PVC units avoid sediment/metal contact but this does not eliminate all possible contamination and careful cleaning is necessary between squeezing operations.[29] The system provides relatively large volumes of pore waters for analysis within the limitations of a shipboard collection system.

Acknowledgement

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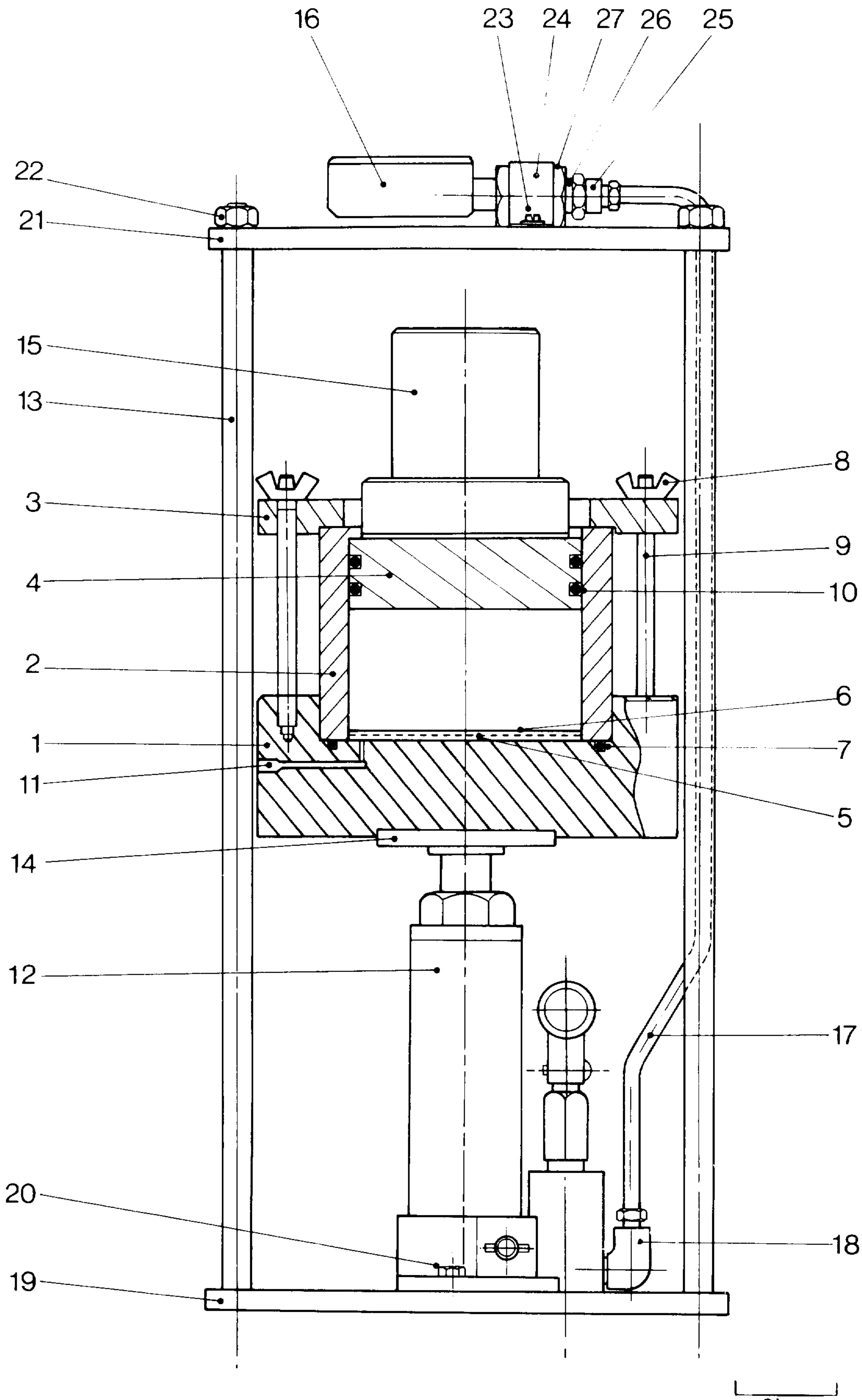

Fig.1 Scale Drawing of Sediment Squeezing Unit.

Table 1 - Components List (see Fig. 1)

No.	Description	Size	Material
1	Cylinder Base	O.D. 7"	Rigid PVC
2	Cylinder	O.D. 4.92" I.D. 3.940"	Rigid PVC
3	Retaining Collar	O.D. 7" I.D. 4.125"	Rigid PVC
4	Piston	O.D. 3.93"	Rigid PVC
5	Gauze	400µm mesh	Nylon (Nitex)
6	Filter	Whatman 542	Paper
7	'O' Ring	50-245 Imperial	Neoprene
8	Wing nut	1/4" BSW	St. steel
9	Studding	1/4" dia.	St. steel
10	'O' Rings	71-1000 metric	Neoprene
11	Outlet port	3/32" C' bored to 5/32"	-
12	Hydraulic jack	1 1/2 ton	-
13	Tie rod	3/8" dia.	Mild steel
14	Support plate	3" dia.	Mild steel
15	Thrust pad	3.5" dia. at piston	Rigid PVC
16	Pressure gauge	0-5000 psi 60 mm dia.	-
17	Hydraulic pipe	6 mm dia.	1/2 hard copper
18	Elbow	90°	Plain brass
19	Base plate	8.75" x 8.75" x 0.375"	Mild steel
20	Hexagon Head Screw	1/4" BSF x 1/2"	St. steel
21	Top Plate	8.75" x 8.75" x 0.375"	Mild steel
22	Hexagon nut	3/8" BSW	Mild steel
23	Ch. Hd. M/C screw & washer	2BA	Plain brass
24	Connector clamp	25 wg.	Plain brass
25	Male adaptor	Straight	Plain brass
26	Sealing Washer	For 1/8" BSP thread	Aluminium
27	Pressure gauge connector	1" A/F Hexagon	Plain brass

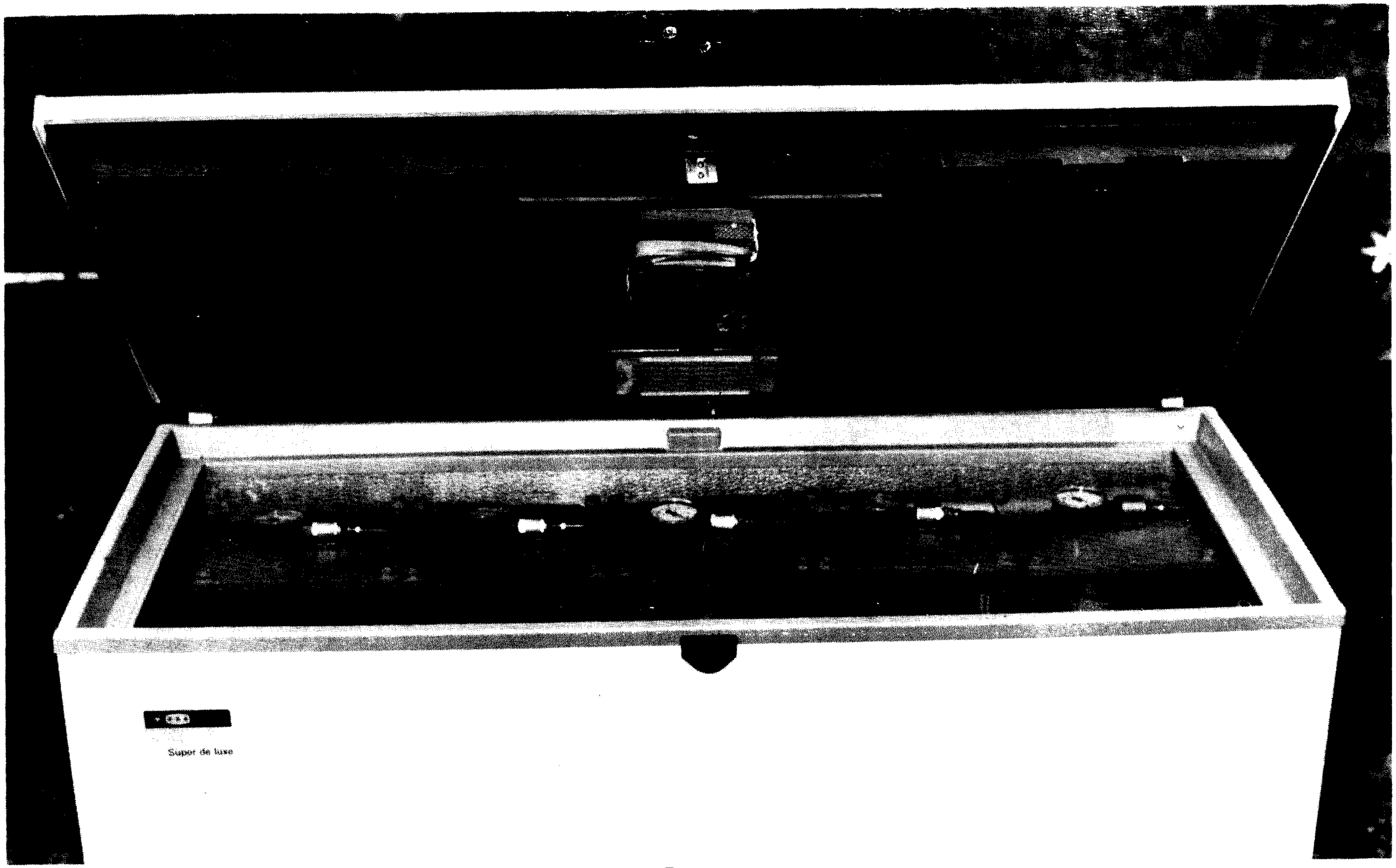

Plate 1

SQUEEZING UNITS FIXED IN COOLER CABINET

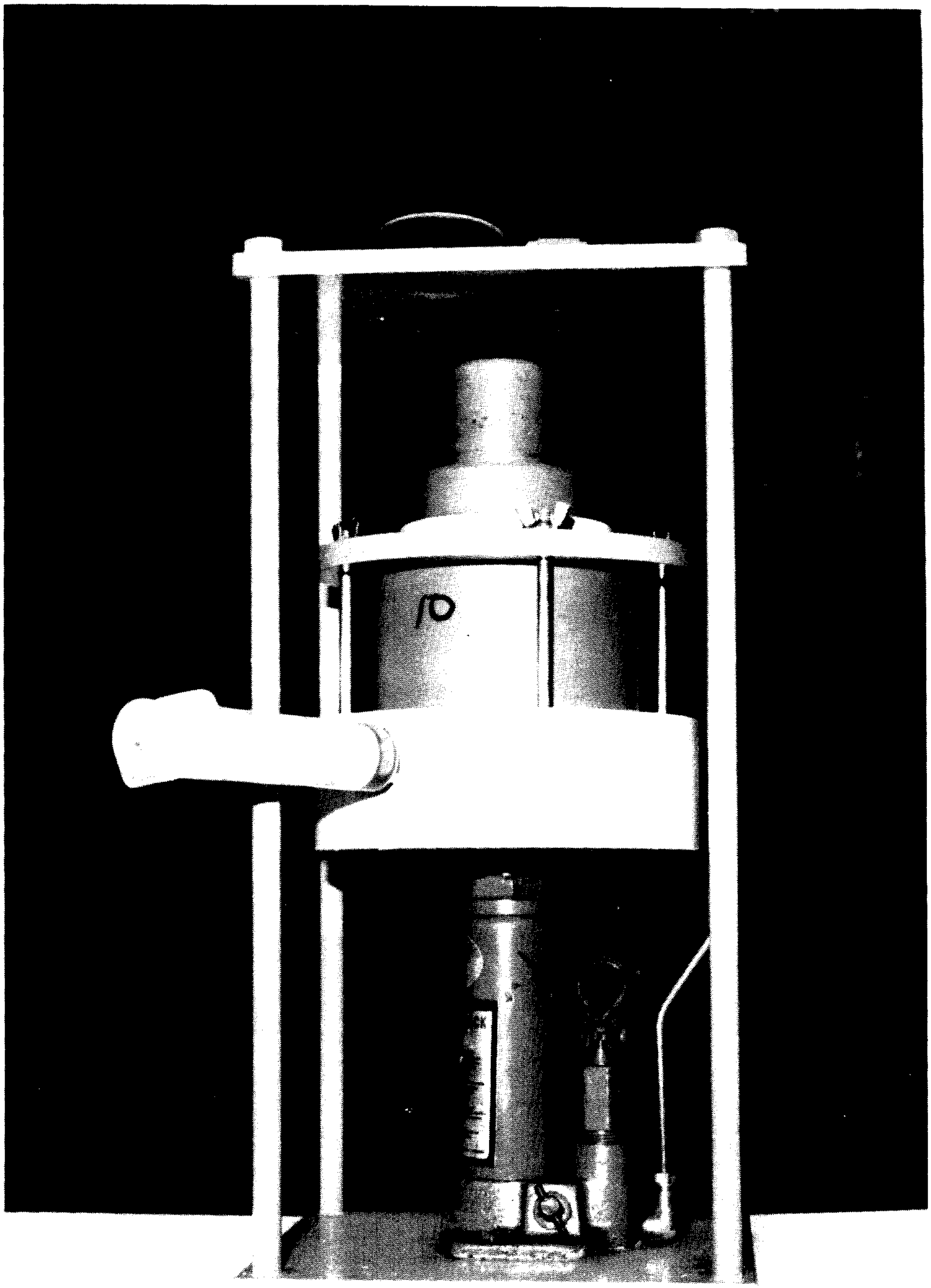

Plate 2

SEDIMENT SQUEEZING UNIT COMPLETE