# A NEW CORE SAMPLER AND ITS FIRST TEST.

**(Eine neue Lotröhre und ihre erste Erprobung)**

by OTTO PRATJE

(Extract from the *Deutsche Hydrographische Zeitschrift* - German Hydrographic Institute, Hamburg, May, 1950 - pages 100 to 107).

## SUMMARY.

Proceeding from approved principles, the author has devised an improved core sampler which has been manufactured for the German Hydrographic Institute by the Askania-Werke, Kiel. Its principal features are : inside diameter 4.5 cm., length about 2.50 m., weight 63 kilos. At the top of the instrument, the water can freely escape, the wall of the tube is as thin and smooth as possible and the cutting nose has a clack valve ("core-catcher"). When the device was tested in the North Sea and the Western Baltic, cores of serviceable length were obtained and it was found that, on an average, the length of the cores collected in a sea area is in inverse proportion to the sand contents of the bottom, and that from pure sand bottoms no cores can be obtained with this sampler. However, with the aid of the core catcher and the cutting nose, cores were brought up on board which would have been lost had they been extracted by an older type of sampler.

Another superior feature is the relatively small "compression" of the cores (only 35 per cent, as against 50 per cent and more with former devices).

***

On account of the war, German research on the D.A.E. (Deutsche Atlantische Expedition-*Meteor* 1927) and the Piggot (1) types of core samplers was suspended so that after the war it became necessary to devise new sounding instruments for the work of the German Hydrographic Institute. Previous experience gained in scientific experiments was to be applied to the new device.

The special task of the German Hydrographic Institute is to make researches on the quality of the sea bottom in the shelf seas of the North Sea and the Baltic. The sediments of the shelf sea are not as fine-grained as those of the deep sea and do not adhere so well to the sampler. In the before-mentioned areas the researches are made from small ships, and hence it is necessary that the dimensions of the core samplers, that is to say their length and weight, should be well in keeping with the size of the ship, while at the same time the economical aspect may not be neglected.

The design of the *tube* sounding instrument, the principle of which has been maintained, guarantees its success.

The Swedish piston instrument of the Kullenberg type does not always satisfactorily retain the complete contents of the upper layers of the sea bottom required for study after the material has been hauled up. Besides, the piston core sampler cannot always be used to its full length, as the sandy deposits embedded in the deeper layers prevent it from penetrating into the deeper regions. The compression, i. e. the diminution of the natural profile lengths, ought to be kept as far as possible within permissible limits and, consequently, the resistance offered by the penetrating tube should be reduced as much as possible.

As for the D.A.E. sounder, therefore, no glass tubes are used ; instead, there is a thin brass tube within the steel tube which renders it possible to keep the samples in faultless condition during transport. Besides, by increasing the diameter (to 4.5 cm instead of 2.- cm as in the former D.A.E. sampler) the friction is further reduced in proportion to the quantity of the core so that as a consequence thereof, the sounding tube now is able to hold a quantity five times greater than that of the previous type.

For the purpose of reducing the friction, the boring of the cutting nose has been made

(1) The German Atlantic *Meteor* Expedition. With this D. A. E. model the author obtained the first samples in 1925-27 in the South Atlantic. From then on, this model was used at several places and was put to regular use. As to the Piggot sampler, this is a large American type of sampler which is driven into the sea bottom by means of a powder charge.

somewhat narrower than the interior diameter of the brass tube so that the collected sediment core is somewhat smaller in diameter than the brass tube and is able to enter the latter with less difficulty. The projection of the cutting nose over the exterior wall of the sounding tube likewise facilitates the advance of the core as well as later on its removal, since the hole is larger than that of the sounding tube.

On the other hand, the loss in friction due to the increase of the diameter causes some inconvenience. Especially in the case of sand admixture, the samples are more apt to slip out because of their increased weight and their low cohesive faculty. Therefore, a valve (several different devices of it are already known) is required at the lower end of the tube. Lever closing systems put in action from the head of the sampler do not answer the purpose because they increase the friction. Kullenberg (Sweden) and Emery and Dietz (America) used more suitable valves and improved their capability of

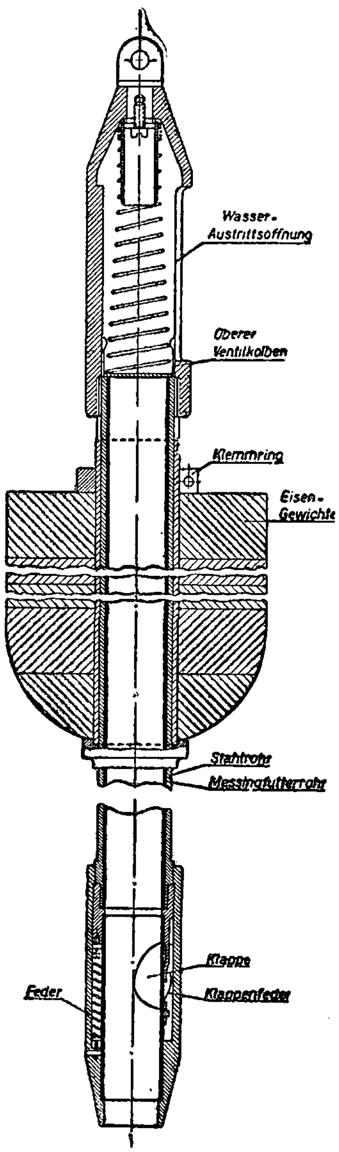


FIG. 1
The new core sampler, longitudinal section.

retaining the samples. The Kullenberg valve is fitted to the wall of the cutting nose and is automatically released the very moment the sounding tube is withdrawn from the sea bottom ; the valve then projects into the boring. In sliding towards the lower end of the tube, the sample turns the valve so that it adopts a transversal position and closes the nose. The American system makes use of a ring made of incurved celluloid sheets with rubber bands ; these slide in an upward direction when the sample advances into the tube, but close the tube before the sample is able to slip back. The author has adopted the Swedish principle.

When the valve is open, it lies closely to the interior wall of the nose, its hinges are fastened to the wall at its lower end and as soon as the closing system is released, a small spring presses the valve slightly into the tube. The sample that has entered the tube, but tends to slide towards the lower part of the instrument, presses the valve downwards and closes the tube and in so doing prevents the sample from sliding out.

The upper valve is no longer needed. In former models it caused a narrowness of the tube, and obstructed the advance of the sample into the tube. Piggot had already suppressed the upper valve and devised a streamlined form for the water outlet.

The total weight of the sounding apparatus is 63 kilos, of which 44 kilos fall to the set of weights and 19 kilos to the weight of the instrument itself. The valve head weighs 3 kilos, the nose 2.5 kilos, the receiving tube 4 kilos and the steel tube 9.5 kilos.

The instrument is supplied in a portable case which likewise contains the following accessories : a contrivance for the removal of the brass tubes, pliers for the rings and two keys.

The carefully constructed sampler behaved well during the trials. The brass tubes were always kept greased so that they could be easily withdrawn from the steel tube. Immediately after the tubes have been filled with the sediments they are removed and closed by a special type of rubber hood — a reliable closing appliance that keeps the samples perfectly moist ; oxidation and reduction cannot, however, be completely prevented. The cutting nose and the valve must of course be thoroughly cleaned to prevent the valve from being jammed by grains of sand. As the instrument has no movable or springy parts the greatest reliability in service is guaranteed.

The new core sampler which in itself does not represent a new principle, though in designing it the greatest efforts were made to ensure the maximum output, was tried out in September, 1949, during a twelve-day cruise — from the Elbe river to the Dogger Bank, then to the Fladengrund and the Montrose Bank and back through the Norwegian Channel, the Sound and the Great Belt. In this way, the behaviour of the core sampler with regard to the various qualities of sediments and in depths down to 500 m. could be studied.

The receiving tube (brass tube) consists of three parts each of which is 70 cm. long. On the one hand, this principle ensures a greater movability during removal of the tubes while on the other hand, if only parts of the samples are required, it is not necessary to preserve the full length of the cores. The receiving tubes are kept in place above by a system of rings, below by the cutting nose. A ring is welded outside the upper part of the steel tube, serving as resting-place for the set of weights. This set of weights is composed of 5 parts, viz. three cylindrical iron discs with a diameter of 20 cm placed on top of two iron hemispheres. Their total weight amounts to 44 kilos. By splitting up the total weight in single parts, it is possible to apportion the weight as required. The discs are held together by a ring.

The valve head is made of red brass and has three long slits reaching over its whole length for the admission of the water. A light withdrawable valve piston slides up and down in its interior; by means of a weak spring, it is pressed downward on the screw connection of the steel tube. To the upper end of the valve head a steel eyelet is fixed for the suspension of the instrument.

The cutting nose (or "mouth piece") is made of tool steel and has a bore of 4.5 cm, which at its lower end narrows to 4.3 cm so as to facilitate the advance of the sample within the tube. The exterior diameter is 7. cm. i. e. 1.6 cm greater than that of the steel tube. There is a valve with a weak spring and a stopping device in the mouth piece ; the mouth piece itself consists of two telescopic parts connected to each other by springs. The outer part of this device can be moved in a downward direction and by releasing the stopping device actuates the lower valve. This occurs at the very moment when the sampler is withdrawn from the bottom, as the cutting nose is thicker than the steel tube.

In the new model, the tube's diameter is not reduced and the slits in the valve heads have been extended so that the water is able to flow out without hindrance and without accumulation, thus protecting the samples from being reduced in length.

The core samplers were to be suitable for use in small vessels and for this reason, they could be neither too unwieldy nor too heavy. A useful length of 2 metres to a total length of about 2.5 m. is acceptable and in the majority of cases will suffice for the more or less sandy samples from the shelf sea. The total weight of the instrument amounts to 63 kilos, which means that, if necessary, it can be hauled in by hand. Besides, this weight allows the use of piano wire for the sounding operations.

On the author's direction, the *Askania Werke*, Kiel, have constructed a core sampler of the following dimensions : length of tube without valve-head and cutting nose: 2.10 m. ; length of valve-head : 29 cm ; and of the cutting nose : 19 cm ; length overall : 2.53 m; outside diameter of steel tube : 54 mm, inside diameter : 48.5 mm — hence, thickness of the tube 2.75 mm. Three closely fitting brass tubes of the following dimensions : length 70 cm ; outside diameter : 48 mm ; inside diameter : 45 mm ; thickness of the tube : 1.5 mm, are inserted in this steel tube. Hence, the total thickness of the wall amounts to 4.25 mm for which sediments are to be displaced.

This type of core sampler is still unsuitable for fast sand grounds. This instrument is not able to penetrate into the ground to any significant extent but tilts without releasing the lower clack of the valve so that the sand will not be retained. For this type of bottom a *van Veen* sampler would better suit the purpose. With the aid of the new type of the sounding tube it is, however, possible to obtain profiles which would have escaped from the previous type. Owing to the comparatively frequent occurrence of sand sediments in the North Sea, there have either been extracted no cores at all or very short profiles only, until now. The new core sampler, however, proved to be able to extract and retain even sediments with a high percentage of sand. Thus, in the Belt, the author obtained a core 90 cm long containing 86 % of fine and of coarser sand (> 0.1 mm) and in another case a core 55 cm long with an admixture of sand of 61 %. In the Outer Silver Pit in the North Sea a core was extracted containing 78 % of sand, size >0.1 mm, of which 9 % was sand of a grain > 0.5 mm.

As a result of the cruise, a total of 15 cores have been obtained by the new core sampler. Their lengths vary from 20 cm to 150 cm with an average length of 90 cm, which latter is a very suitable length, both considering the origin of the core — i. e. the shelf sea — and its handy weight. Three-quarters of the total number of cores were 90 cm long and even longer than this. As long as the weight of the core sampler remains constant and the instrument penetrates into the bottom at a uniform speed, the length of the core will depend on the consistence of the bottom. The speed of penetration mainly depends on the paying-out rate of the wire, the effect of which is, however, subject to variations according to the ship's drift and can be seen from the angle of the payed-out wire. During the cruise the best paying-out speed was aimed at, but owing to the differences in sea and swell, no guarantee can be made as to the achievement of perfect uniformity. Nevertheless, in making allowance for this possible source of error, it may be permitted to relate the length of the cores to the consistence of the bottom.

The consistence of a sediment depends, to a great extent, on its granular composition and on its physical condition and it may be suggested that the weaker the current dominating within the area of sedimentation, the finer - grained the granulation of a sediment and the looser its physical condition. Besides, organic matter, having a very low specific gravity, will be able to fall to the bottom as well and so loosen the sediment The fine minerals of clay swollen up in the water change their consistence as compared to sediments of quartz dust.

If, therefore, there exists a relation between the length of the cores and the consistence of the bottom it may be suggested that in a uniform sea area there may also exist relations to the depth, the granular composition and the quantity of organic matter.

The author supplied several tables in which he arranged the profiles obtained : 1) in the Norwegian channel — 2) in the Outer Silver Pit and the Devil's Hole — both in the North Sea — 3) in the Great Belt, the Sound and the Kattegat — in the Baltic — according to their length, to the depths they have been taken from and to their granulation ; he likewise stated the percentage of particles coarser than 0.5 mm, of particles between 0.5 mm and 0.1 mm, between 0.1 mm and 0.01 mm and smaller than 0.01 mm. Besides, he analyzed their contents in organic matter and derived mean values. Although the distinct groups differ from each other as to their constitution, which depends on various conditions not identical in all parts of the ocean, these tables show that the length of the cores provides a basis for the estimation of the sand admixture of the core and of the quantity of organic matter. On the other hand, it follows that the greater the sand content, the shorter he core, and that, hence, as a necessity, the core sampler will not be able to work in pure sand. Even the heaviest weights will not achieve any success as demonstrated by the pre-war trials of the Piggot sampler. Though the ballast weight of the American sounder amounts to almost 200 kilos and its total weight is estimated to be about 250 kilos, from sandy and muddy bottoms, it produced no cores of any longer length (on an average about 90 cm in both cases) and no cores at all from pure sand bottoms, whether the sounding tube was operated with or without a powder charge.

The research cruise also revealed the braking effect of sand layers ; the 90 cm sample taken from the Devil's Hole was not any longer because the cutting nose met with a layer with a high admixture of sand and, thus, was stopped by it.

In designing the new core sampler, it was aimed at reducing the compression. Because of the frictional resistance the core has to overcome in advancing into the tube, the material accumulates at the lower end of the instrument and pushes parts of the lower sediments aside so that, as an inevitable result, the extracted layers are more or less incomplete and thus the profiles are reduced as compared to the natural length of the layers in the bottom. A compression will only be avoided when the pressure above the core is correspondingly reduced, as is the case in the Swedish system. For the time being, however, the upper layers are intermixed with the lower ones so that this method is not suitable for our purposes.

The reduction of the core will be determined by measuring the trace left by the sediment on the outside of the sounding tube in penetrating into the bottom. The author measured the reduction of the cores taken on the German 1925-26 South Atlantic Expedition, with the Piggot sampler in the Baltic in 1938-39 and with the new sounding tube in 1949. In addition to this, in their first trials, Emery and Dietz made similar observations.

To obtain comparable results, the experiments were limited to sediments influenced by terrigenous substances, hence to mud and sandy mud, part of which was superimposed on clay layers ; they include the deposits of the shelf sea as well as the coloured semi-pelagian mud.

a) *Meteor Expedition 1925-27 : Coloured Mud.*
2 cm tube ; weight 35 kilos ; 10 soundings.
Length of core : depth of penetration (per cent) : 48.5.

b) *Research in the Baltic, 1938-39 : Soft mud to sandy mud, also glacial clay and boulder clay :*
5 cm Piggot tube ; weight 250 kilos, 35 soundings with and without powder charge.
Length of core : penetration depth (per cent) : 48.5
12 soundings (with the exclusion of soundings in soft mud).
Length of the core : penetration depth (per cent) : 56.

c) *Emery and Dietz : Green mud.*
Various tubes from 4 to 6 cm in diameter ;
Weight : 70 to 270 kilos.
Number of soundings are shown in brackets.
Length of cores : penetration depth (per cent)
for 270 kilos : 51 (29)
for 115 kilos : 62 (22)
for 70 kilos : 48 (17).

d) *Emery and Dietz : Sandy mud and mud intermixed with shell deposits.*
Length of sample : penetration depth (per cent) :
for 270 kilos : 41 (27)
for 115 kilos : 53 ( 6).

e) *Researches in the North Sea and the Baltic, 1949 :*
Clayey mud, sandy mud.
4.5 cm tube ; weight 63 kilos, 11 soundings.
Length of core : penetration depth (per cent) : 64.
( = 46 — 81 %).

From the preceding discussion it is evident that, with the exception of the *Meteor* sampler, the new core sampler is lighter than other instruments of its kind and that, likewise, with the exception of the *Meteor* sampler and the 70 kilos *Ekman* apparatus of Emery, its diameter, too, is smaller than that of other instruments. In spite of all that, the cores taken with the new instrument are considerably less reduced than are those of the other types of instruments. Their mean value of reduction is about 50 % i. e. the cores are half as long as the layers penetrated into, or, on some occasions, they are even reduced to 2/5ths of their natural length. The lengths of the cores from the new instrument, however, amount to 3/4 of the natural length. This is a considerable improvement, especially as the result is obtained with a ballast weighing only half of or one quarter less than the ballast used in previous types.

By a number of trials in different muddy bottoms of the shelf sea, the new core sampler of the German Hydrographic Institute has proved that it is well suited for the extraction of profiles and that, though issuing from old principles, it surpasses the instruments in use heretofore in so far as it is able to retain even sediments of sandy mud. In addition to this advantage the profiles are less compressed. Another advantage is its handy weight. For use in softer bottoms, the steel tube can easily be elongated to 2.80 m. or 3.50 m. by fitting to it a fourth and a fifth brass tube.