THE FOUR-METRE SOUNDING TUBE
OF THE "SNELLIUS" EXPEDITION

(From an article by Dr. PH. H. KUENEN,
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During the Netherlands oceanographical expedition of the *Willebrord Snellius* in 1929-30, to the East Indian Archipelago, an exceptionally long percussion tube was successfully used for obtaining samples of the bottom.

Details of this device, which may be used advantageously in the domain of oceanographical geology, are as follows :—

The outfit for taking samples of the bottom was based mainly on that carried by the *Meteor* during her Atlantic Expedition. SIGSBEE sounding tubes were employed for depths exceeding 6000 metres (3281 fms.). On account of the weight of the sounding wire, it appeared advisable to dispense with the weights when sounding in great depths. In all other cases, the improved V. W. EKMAN (1) and O. PRATJE (2) type of the old F. L. EKMAN sounding tube was used.

For obtaining samples of the bottom at great depths, Dr. KUENEN (3) constructed a percussion tube 4 metres (13 ft. 1 ½ ins.) long, the weight of which was 160 kgs. (352 ½ lbs.). On account of this excessive weight, it had to be suspended to the 4 m/m wire, for making serial oceanographical observations, on the windlass.

DESCRIPTION OF THE INSTRUMENT.

The 4 metre tube was constructed on the same principles as the O. PRATJE tube. Originally it was intended to fit it with an inner glass tube, but after the first tests, this idea was given up, as it was evident that the inner tube would reduce the diameter of the sounding tube too much. Another percussion tube of equal length, but of smaller diameter was not even tried, as it was manifestly too narrow.

The percussion tube was composed of a steel tube, 4 metres in length, with an interior diameter of 45 m/m (1.77 ins.), the exterior diameter being 60 m/m (2.36 ins.). At the lower end was a screwed on ferrule with a bevelled edge. The maximum diameter of this ferrule was 75 m/m (2.95 ins.), thus being wider than the percussion tube by 15 m/m (0.59 ins.). The ferrule which, primarily, was to serve for an entirely different purpose, (*i.e.* to receive the non-return valves) showed itself to be of capital importance. It was found that the small tubes without ferrules required three times the normal tractive effort to pull them out of the mud of the bottom ; instead of 20 to 30 kgs. (44 to 66 lbs.) of tractive force, about 80 (176 lbs.) were necessary (without taking into account the resistance due to the cable and the tube themselves), to draw the sounding tube out of the bottom. After several successful tests, the sounding wire finally broke under the strain. To pull the large tube out of the bottom, it was frequently necessary to use an extra tractive force of 200 kgs. (440 lbs.). Without the greater diameter of the ferrule, the tube would have been so firmly held in the mud at the bottom that it would have hardly been possible to pull it out. By using a ferrule of greater diameter, at equal risks of breaking the sounding wire, it was possible to employ a sounding tube of twice the weight. By this method, a greater penetration into the mud is ensured than by using a percussion tube of equal length but without a ferrule.

At the upper end of the tube, lead weights may be added to a total weight of 160 kgs. (350 lbs.). Thus it was found a 4 m/m steel wire which, at the beginning, often bore a strain of 1500 kgs. (3300 lbs.), easily bore, at the end of the expedition (on a length of several thousand metres) a strain of 600 to 700 kgs. (1320 to 1540 lbs.). This is the maximum strain required to raise the percussion tube and the wire at a depth of

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(1) An apparatus for the collection of bottom samples, *Intern. Counc. Publ. de Circons.* 27 (1905).

(2) Geolog. Tiefseeforschungen a. d. D. Atl. Exp., *Zeitschr. d. D. Geol. Ges., Vol.* 70 (1927), *p.* 194 *and fol.*

(3) C. W. CORRENS : Mineral.-geolog. Arbeiten d. D. Atl. Exp., *Supplement III to the Zeitschr. d. G. f. Erdk., Berlin,* 1928, *p.* 121 *and fol.*

5000 m. (2755 fms.). For depths less than this, the weight of the tube could easily have been increased to 250 kgs. (550 lbs.) without fear of breaking the wire. At the upper end, the tube was closed by a flap valve, similarly to that of the PRATJE apparatus.

This device was the most complicated and the most costly part of the whole instrument; but in the case of sounding tubes of great weight, it is almost superfluous to add valves to the tubes in order to prevent the sample of the bottom from falling out; the sediment is always so firmly packed in the tube that, generally, it is difficult to remove. Furthermore, it is very rarely that the sample of the bottom is of such composition that it would fall out.

Every expedition which expects to make frequent use of a heavy sounding tube should be careful to fit gear for hauling the tube in without great difficulty, or at least to get it into such a position that it is easy to remove the weights therefrom.

The removal of the samples from the tube is both a tedious and difficult operation. In order to keep the samples in good condition and to allow their stratification to be examined, they must be transferred to a glass tube. The glass tubes used were 150 c/m (5 ft.) long by 3 c/m (1.2 ins.) interior diameter (they were actually tubes forming part of the larger PRATJE sounding tubes). Once the sample is in the glass tube it is a little longer than it was originally as the glass tube, in penetrating the sediment, takes up a certain space.

One metre of sample, after transfer, has a length of 120 to 130 c/m (3.9 ft. to 4.3 ft.). Finally, the glass tube is completely withdrawn and closed at both extremities with paraffin and rubber plugs. A second glass tube is similarly treated and, if necessary, a third.

In measuring the thickness of the strata, the lengthening of the sample must be taken into consideration. It was found that, by this method of extraction, the stratification is hardly disturbed and is easily examined in the glass tubes.

For reasons which will be set out later, it would be as well for expeditions which expect to use sounding tubes of such dimensions to increase their weight (if the windlass and the cable will stand it) by using even larger and longer ones.

RESULTS.

The results obtained with the sounding tube described above were very satisfactory. By its use, valuable time was saved at oceanographical stations, seeing that there was no necessity to run out wire soundings at the beginning of each station, and that the deepest serial temperatures and the taking of water samples could be carried out at the same time as the sounding. Further it was unnecessary to fix the lower bottle for taking a water sample at more than 15 to 30 m. (8 to 16 fms.) above the sounding tube. It has one disadvantage that if, during the sounding, the depth should vary, the serial positions of the bottles vary in like proportion. Naturally, this variation is seldom more than 100 to 200 m. (55 to 110 fms.). Even when the difference is so great that the oceanographical observations have to be repeated, not much more time will have been lost than would have been necessary in ordinary wire sounding.

Experience has shown that by running the wire of the sounding tube out at a speed of 3 m. (10 ft.) per second (braking slightly), the drum stops automatically as soon as the bottom has been reached. The deepest sounding was made in a depth of more than 5000 m. (2755 fms.). It is advisable to run the wire over a dynamometer. The maximum strain necessary to drag the tubes out of the bottom was 650 kgs. (1433 lbs.); on several occasions it was necessary to wait some minutes for the tube to detach itself under this strain.

The large sounding tubes buried themselves in soft deposit as far as the weights. This fact and the remarks made above led to the idea that longer samples could be obtained if the tubes were larger (for example, 55 m/m (2.166 ins.) inner diameter), longer (5 or 6 m. (16 ½ or 20 ft.) for use when soft mud is expected) and heavier (for depths exceeding 4 to 5000 m. (2200 to 2755 fms.), taking the force of the wind into consideration).

From a geological point of view, the advantages obtained by the use of large sounding tubes are the following:

1. The quantity of sediment is greater per centimetre of total length.
2. The tube, owing to its added weight, can penetrate the bottom, even when it encounters hard material.

This last advantage is of particular interest in volcanic areas.

3. Were the sediment is uniformly soft, the large tube collects sediment specimens 2 or 3 times longer than the small tube.

The principal result of the experiment made with the large sounding tube is the following :

A *stratification* of sediments in the eastern area of the waters of the East Indian Archipelago is far more widespread than the results obtained with the small sounding tube would lead one to suppose.