INSTRUMENTS AND METHODS

A METHOD FOR BOTTOM SEDIMENT SAMPLING IN GLACIAL LAKES

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Arctic Institute of North America
Report No. 1, Project ONR-86

Reprinted from Journal of Glaciology, Volume 2, Number 14, November 1953, pages 287–90

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In recent preliminary investigations of the character of bottom sediments of Twin Glacier Lake, Alaska, a light-weight, piston-type coring device has been successfully employed. The equipment is manually operated from a raft and represents modification of a larger, power-hoisted coring instrument developed for obtaining deep ocean cores.[1] Because of the potential value of this method in further studies of the nature and recent sedimentary history of the bottom of modern glacial lakes, an outline of the principles involved in the instrumentation and some special considerations for its use are reviewed.

DESCRIPTION OF EQUIPMENT EMPLOYED

The coring instrument is comprised of ten sections which are, for the most part, detachable to permit manual operation and ease in transport. As noted below, there are also six accessory units requisite to the field operations.

I. *Essential Components of Piston-corer*

(1) Tail fin assembly
(2) Body cylinder
(3) Piston assembly with fiege fitting and bumper washer
(4) Driving weights, 40–240 lb. (18–109 kg.)
(5) Coring tube, $1\frac{1}{2}$ in. (38 mm.) I.D.
(6) Penetration cutter and core catcher
(7) Trigger weight, 15 lb. (6·8 kg.)
(8) Trigger wire
(9) Trigger arm and tripping socket
(10) Automatic release shackle and cable clamp

II. *Accessory Units*

(1) $1\frac{1}{2}$–3 ton winch (manual) with safety ratchet and brake
(2) Hauling and lowering cable, $\frac{3}{16}$ in. or $\frac{3}{32}$ in. (4·8 or 2·4 mm.) diameter
(3) Tripod
(4) Suitable raft, with double anchor lines and anchors
(5) Deep sounding line
(6) Outboard motor, for maneuvering raft

The body of the instrument consists of a tubular center section, $1\frac{1}{2}$ in. I.D. and 3 ft. long (38 mm. × 0·9 m.) with four elongated tail fins welded to it at 90 degree angles from each other (Fig. 1, p. 289). At the lower end of the center section is placed the driving weight, composed of from one to six 40 lb. (18 kg.) lead discs. The fin section can be unscrewed to facilitate changing the number of lead discs. Although a total weight of 240 lb. (109 kg.) is possible, 200 lb. (90 kg.) is about the limit for efficient manual operation from a raft.

Into the base coupling of the body assembly, the coring tube is threaded, either in 5 ft. (1·5 m.) or 10 ft. (3·0 m.) lengths (Fig. 2, p. 289). This tube can be made from ordinary galvanized wrought-iron water pipe. A replaceable hardened steel striking bit and sediment cutter is attached at the bottom of the core barrel. Combined with the bit is a core-catching assembly—a pronged set of flexible brass claws which, while permitting the sediment sample to enter, prevent it from falling out during the recovery operation.

Field Procedure and Mechanics of Operation

The apparatus is lowered into the lake, by block and winch, from a wooden tripod built onto a raft. In the Twin Glacier Lake program, the raft was 16 ft. (4·9 m.) square and floated on six water-tight, 55 gallon (250 liter) fuel drums filled with air. The hole, through which the equipment was lowered, was slightly off-center to allow for working space during core removal operations.

To make the instrument ready for use, its suspension cable is attached to the piston assembly by a fiege fitting. The piston, together with bumper washer, is then placed in position at the bottom of the core barrel with the cable passing upward through the center of the body tube.

Before attaching the cable clamp, a suitable loop is taken in the cable. The apparatus is hoisted from the raft deck and hung in a vertical position. Then the safety bolt is removed from the trigger arm and the corer lowered slowly until the trigger weight touches the lake floor (Fig. 2). Settling of this 15 lb. weight causes the suspension cable to become limp and downward pressure to be released from the trigger arm. The weight of the instrument then forces the locking shackle cross-pin (Fig. 1) to slide out of its socket with a consequent sudden rise of the trigger arm. This detaches the cable clamp and precipitates the plunge of the corer.

Under the force of gravity, the corer falls to the distance pre-determined by the length of the trigger wire. The length of cable loop is so adjusted that just as the cutting edge touches bottom this loop is used up. The corer continues to fall while the cable holds the piston level with the bottom. If the sediment friction on the inner wall of the tube builds up to a significant quantity, the sediment in the tube is pulled away from the piston, creating a vacuum in the space above the core. The hydrostatic pressure then operates to push the core back against the piston, allowing more room at the cutting end to take in more core. The tail fins serve as a guide during the free fall so that the tube is lined up vertically when it strikes bottom. The free fall feature was used previously on the light-weight Phleger-type sampler which has been employed for shallow sampling of Pleistocene sediments in other glacial lakes,[2] and also extensively in oceanographic coring.[3]

By varying the length of the trigger wire, the cable loop and the number of lead weights, adequate driving force is usually provided for the core barrel to penetrate into bottom sediments of different consistencies and hardnesses. (Note: Fig. 2 illustrates conditions for a free fall of 10 ft. (3·0 m.). The trigger wire is 10 ft. longer than the distance from the core cutter to the trigger arm. One additional foot is added to allow for trigger arm movement before release.)

Other Considerations

A raft of the dimensions described is adequate for use with the 6 ft. core barrel. If the 10 ft. core barrel (Fig. 2) is to be used efficiently a correspondingly larger raft and higher tripod are necessary. The apparatus might also be employed from the frozen surface of a glacial lake during the spring when operating temperatures are mild enough to keep the moving parts of the equipment from freezing up. Sufficiently thick lake ice would provide quite a stable platform for careful work. Sediment samples could be taken by lowering the apparatus through holes cut into the ice at selected points.

For the collection and preservation of samples, a removable brass, zinc or plastic liner inside of the core tube may be desirable. In this way, specimens could be stored and studied at leisure. It is not always feasible, however, to use liners, since they may collapse from the great pressure temporarily exerted on them at the deeper levels and when the heaviest plunge weight is used. The sediment is, therefore, usually taken directly into the coring tube and later placed in a cellophane wrapper or pushed into a plastic tube held at the base of the pipe. Care must be taken, particularly if it is necessary to use a wooden plunger for the extrusion of the core, since there is danger of contamination from smearing and the possibility of loss of lamination due to compression or slumping.

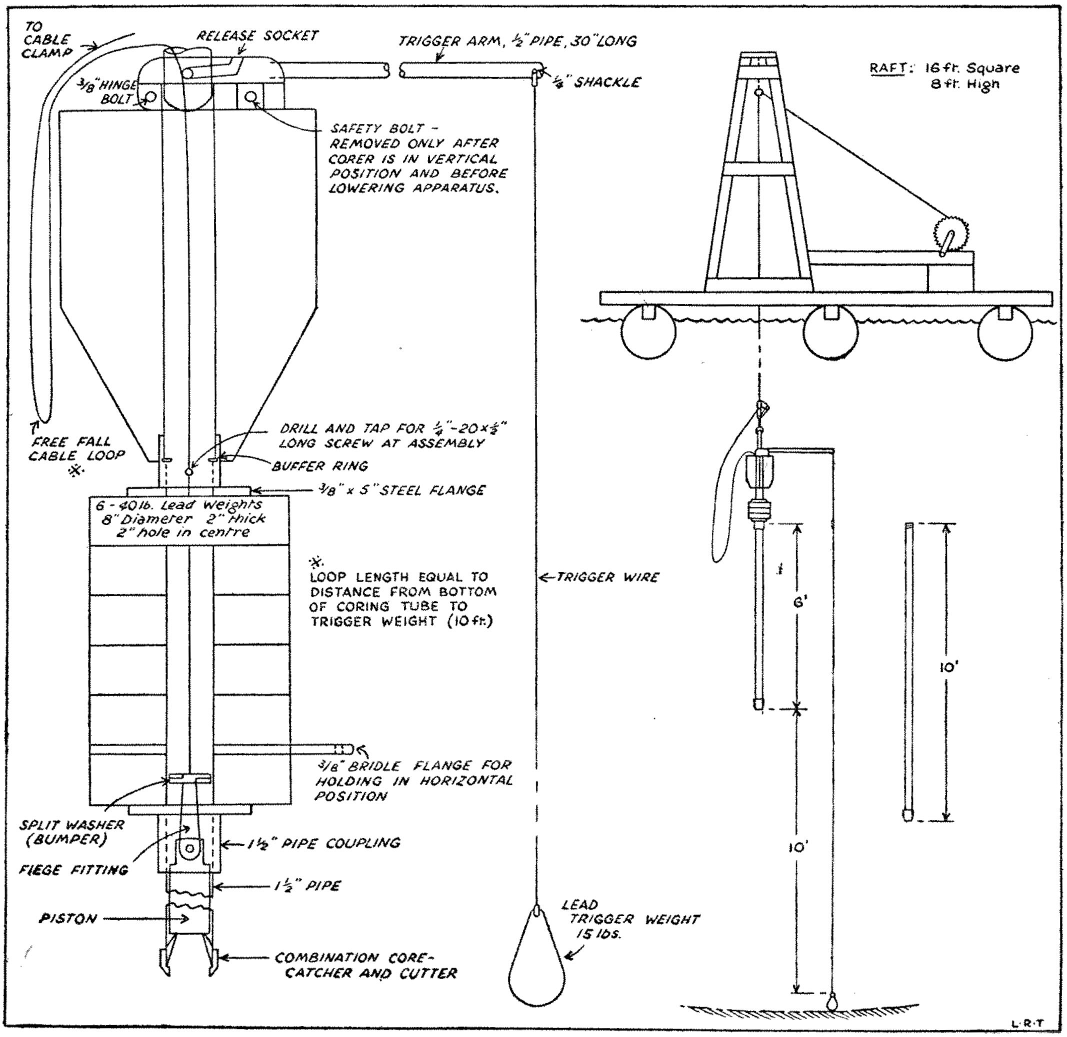

Fig. 1 (left). Detailed sketch of the instrumentation embodied in the piston-corer used for bottom sediment sampling of glacial lakes

Fig. 2 (right). Diagrammatic sketch of the raft and accessory units, showing the field relationship of the cable loop and the tripping mechanism. Also note comparison of different lengths of core pipe

Prior to each sampling, it is advisable to sound the water where one is operating. In the Twin Glacier Lake work, a standard Navy Hydrographic Office sounding reel, manually operated, was used. Before each sampling, the raft was moored securely with one or two anchors at each end to prevent drift. An outboard motor, attached to the raft, facilitated moving it from one coring site to the next.

With the equipment here described, cores have been obtained where the glacier lake has been several hundreds of feet deep and in sediments ranging from glacial silt to fine sand. It is interesting to consider conditions and possibilities for the use of this method in other lakes for the study of varved samples and for the collection of bottom material for pollen and radio-carbon analyzes.[4] For investigations in larger glacial lakes, where logistical requirements do not preclude the use of heavier equipment and power-driven hoisting gear, the application of related techniques which have given satisfactory results to the oceanographers may well be reviewed.[5, 6, 7]

ACKNOWLEDGEMENTS

The instrument described above was used in 1951–52 in investigations supported by the Juneau Ice Field Research Project of the American Geographical Society. Funds were also provided to the writer by a grant from the Arctic Institute of North America, under contractual arrangements with the Office of Naval Research, U.S. Navy. The equipment was constructed by the Geology Department of Columbia University for this study. Special acknowledgement is extended to Professors Maurice Ewing and J. Lamar Worzel for advice and technical assistance on the initial planning and instrumentation and to Mr. Angelo Ludas for the construction of this equipment. Mr. Carlyle Hayes, Senior Technician of the Woods Hole Oceanographic Institution, and Mr. David Dudley, field engineer for the Alaska Native Service, also provided useful practical suggestions for application of this technique to glacial lakes.

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13 *December* 1952

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REFERENCES

1. Kullenberg, B. The piston core sampler. *Svenska Hydrografisk-biologiska Kommissionens Skrifter*, Tredje Serien: Hydrografi, Bd. 1, Ht. 2, 1947, p. 1–46.
2. Ludington, Syl, *jr.* Preliminary analysis of the Pleistocene sediments on the bottom of Lake Geneva, Wisconsin. *Transactions of the Wisconsin Academy of Sciences, Arts, and Letters*, Vol. 41, 1952, p. 229–38.
3. Phleger, Fred. B. Ecology of Foraminifera, northwest Gulf of Mexico. *Geological Society of America, Memoir* 46, 1951, p. 3–4.
4. Piggot, C. S. Factors involved in submarine core sampling. *Bulletin of the Geological Society of America*, Vol. 52, 1941, p. 1513–24.
5. Hough, Jack L. Bottom sampling apparatus. (*In* Trask, P. D., *ed. Recent marine sediments.* Tulsa, Oklahoma, American Association of Petroleum Geologists, 1939, p. 631–64.)
6. Hvorslev, M. J., *and* Stetson, H. G. Free-fall coring tube; a new type of gravity bottom sampler. *Bulletin of the Geological Society of America*, Vol. 57, 1946, p. 935–50.
7. Piggot, C. S. Apparatus to secure core samples from the ocean-bottom. *Bulletin of the Geological Society of America*, Vol. 47, 1936, p. 675–84.