

## **Coring Systems and Platforms Available for Rent from LacCore, the National Lacustrine Core Facility**

By Anders Noren, updated 2/10/10

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### **Overview of Coring Systems**

LacCore maintains an array of field equipment for sampling water and sediment in most environmental settings. The coring devices range from simple, lightweight dredges and samplers designed to recover only the uppermost sequences to a marine coring system adapted for portability and deployment in lakes. Complementing these sampling systems are a suite of vessels and platforms designed for use in a variety of situations. All of the systems described below are presently in the LacCore equipment pool and are available for rental by any qualified researcher.

#### *Surface Corers*

These devices are used for recovering the sediment-water interface and materials immediately below the surface. They are all single-drive corers – they cannot be used to take a second, deeper core at a location already sampled. All but the Griffith corer can be operated by a single person.

#### *Freeze corer*

LacCore freeze corers consist of a steel wedge 1.5m tall, ~15cm wide, and ~8cm deep at the top. The wedge is filled with a mixture of dry ice and alcohol, and lowered into the sediment via rope or standard Livingstone drive rods. The corer remains in this position for ~10 minutes while sediment freezes to the outside of the wedge, then returned to the surface. The dry-ice alcohol slurry is poured into a bucket, and the frozen slabs of sediment on the outside of the corer are removed and preserved in a cooler with dry ice. Freeze corers produce exceptional samples of near-surface sediments, which can be difficult to recover without disturbing the fragile sedimentary structures. Corer length determines the maximum depth of recovery.

#### *Ekman dredges*

Ekman dredges (Ekman, 1911) are essentially metal cubes with side length ~15cm, and a pair of spring-gate doors that are held open during deployment and closed during recovery. The box is lowered into the sediment via rope. The operator slides a messenger down the rope, which closes the doors, and the sample is returned to the surface. Recovered sediments are assumed to be mixed.

#### *Gravity corers*

Gravity corers are single-drive corers deployed on a rope, and lowered into the sediment under their own weight to recover an undisturbed sample of the near-surface sediments. The LacCore gravity corer uses standard polycarbonate tube (70mm outer diameter, 2mm wall thickness; LacCore stocks thousands of meters and sells to the community) of any length. Penetration depth is determined by the amount of weight on the core head, which can range

from 5 to 30kg, and core recovery is typically in the range of 1m. A valve in the core head closes when the deployment rope becomes slack, and provides suction during recovery.

#### *Hongve corer*

The Hongve corer (Hongve, 1972) is a lightweight, mini gravity corer, easily carried by hand and deployed in remote field locations for recovering an undisturbed sample of the uppermost sediments. Its core barrel is ~2cm wide and 15cm long, and is stored inside the core head during transport. The corer is deployed with a rope, and lowered into the sediment under its own weight, or if more weight is needed, pebbles or other materials found at the field site can be placed in the core head. A one-way ball valve at the top of the core barrel provides the suction needed for recovering cores.

#### *Griffith corer*

The single-drive Griffith corer consists of a simple but robust core head that connects standard polycarbonate tube to Livingstone drive rods. Cores are pushed into the sediment with the rods, and a piston provides the suction needed for recovery. The length of tube and the character of the sediments limit core length, and operation becomes difficult in water deeper than 30m or with core tubes longer than ~3m.

### ***Long Corers***

These devices are used to reach the maximum sediment depth possible, given the particular constraints (water depth, sediment character, tube length) of each device. Unconsolidated materials near the sediment-water interface are typically disturbed, if recovered at all with these corers. With the exception of the Livingstone-type devices, these corers are all single-drive corers: they cannot be used for repeat-drive coring in the same hole. They can reach sediment depths only as long as their core tube. Resistant deposits such as desiccation/soil surfaces, coarse-grained materials (sand, gravel, tephra) thicker than ~10cm, and hardpans formed through precipitation of (e.g.) silica, iron oxides, or calcium carbonate effectively stop downward progress with these corers wherever they occur in the stratigraphy, except as noted.

#### *Nesje corers*

The Nesje corer (Nesje, 1992) is a single-drive, cable-deployed percussion coring system with a piston, and is operable by two people – although three to four are preferable, particularly as core lengths increase. The core head consists of a steel cylinder to which the core tube is bolted; a rod extending from the top of the head guides a weight (another steel cylinder of ~20kg) as the operator repeatedly lifts the weight a short distance and allows it to drop onto the core head. This system is relatively effective at penetrating clastic and/or coarse-grained sediments. However, plastic core tubes attenuate the percussive strikes, thus limiting its effectiveness at increasing sediment depths. As with all single-drive corers, the length of the tube limits the potential coring depth. Most tubing is available in lengths only up to 6m. If longer lengths are desired, multiple tubes can be coupled together by using a larger diameter plastic coupling over the joint between two lengths of tube. However, such longer tubes pose challenges for handling and for tube stability during the coring process. Like all percussion corers, the Nesje can cause disturbance to the recovered sediment, particularly in sediments of continuously alternating density or grain size (e.g. clastic varves).

#### *Livingstone-type repeat-drive corers*

The Livingstone-type drive rod piston corer (Livingstone, 1955; Wright, 1967) can be used in water up to about 30m deep to collect successive one-meter drives of soft to consolidated lake sediment, which are extruded between drives into split tubes or other containers for storage. Two people at a minimum (and preferably four or five) are required to operate the coring device, as repeatedly pushing the corer into the sediment and pulling it back to the surface are more efficient and effective with additional hands.

A modification to the Livingstone, called the Bolivia corer, replaces the Livingstone's 2-inch (5 cm) steel barrel with standard polycarbonate tube, eliminating the need to extrude cores and providing superior retention of upper watery sediments. When a depth is reached at which sediments are too tough for the polycarbonate tube (usually at least several meters below lake floor, depending on sediment characteristics), it only takes a few minutes to switch to the steel barrel and continue coring in the same hole. The Bolivia can also be deployed with a square rod long enough to take 1.5-meter drives, increasing efficiency in both coring time and polycarbonate tubing utilization. Maximum depths attainable with the steel barrel depend on sediment character but are typically ~15-20m in fine-grained organic sediments. Casing pipe facilitates coring at greater water depths, and is important for re-entering holes for successive drives. Resistant sedimentary units (of the types described above) are typically impenetrable with this system.

To overcome obstacles posed by coarse-grained layers, Livingstone corers can be used with the LacCore vibracoring system that attaches to the drive rods at the surface. This allows coring through thicker coarse-grained units (sands/gravels, tephra), which are notoriously difficult to push through without vibration or percussion. Other Livingstone corers are specially modified for coring through fibrous material such as peat.

#### *Mackereth corer*

The Mackereth corer (Mackereth, 1958; Smith, 1959) is a pneumatic device that consists of a cylindrical aluminum chamber ~1.2m long and 0.5m in diameter. A pair of 6m core barrel tubes, one of smaller diameter and nested inside the other, is inserted into one end of the chamber and protrudes from its top during deployment. The apparatus is lowered to the lake floor on a rope, and air hoses connect the chamber to the vessel at the water surface. Compressed air is used to pump the water out of the chamber and then to force the inner core barrel downward through the chamber and into the sediment. The chamber then fills with compressed air, which increases its buoyancy and lifts the device out of the sediment and back to the water surface. The system is relatively portable and lightweight compared with other deep-water coring systems. The Mackereth can be deployed in water depths to ~100m.

#### *Kullenberg corer*

The Kullenberg corer (Kullenberg, 1947; Kelts et al., 1986) is a single-drive, cable-deployed piston corer that is dropped into the sediment from a short distance (typically 0 to 3m), propelled by the momentum of the heavy (~1000 pounds/450 kg) lead weights on the core head. Cores are recovered in steel barrels lined with plastic tubes (standard polycarbonate for the LacCore system). The corer drop is triggered when a gravity corer, suspended on a second cable to the side of the Kullenberg corer, enters the sediment and ceases downward travel—thus most Kullenberg cores have an accompanying gravity core that captures the upper sediments that are disturbed by the long corer. Deployed from a cable, the range of water depths is limited only by the length of cable on the winch. However, the immense weight of the system requires a substantial secondary apparatus to handle the corer. A

heavy-duty winch and hydraulic system or power supply must be employed to raise and lower the corer, and if long core barrels are used to increase the depth of recovery, a tower or A-frame must be available for deployment and recovery. The weight and bulk of the system can also create hazardous conditions in any deployment circumstances, but particularly if waves cause the vessel to roll and pitch. Thus, a minimum of two experienced crew plus three additional hands is required for safe operation.

### ***Platforms***

#### *Innertube (R/V Mark Griffith)*

The LacCore R/V Mark Griffith was developed specifically for use in remote locations where equipment weight and volume considerations are paramount. It consists of six tire inner tubes inflated on site, lashed together, and topped with small pieces of thin plastic. It provides the bare minimum of buoyancy for recovery of Livingstone cores at ~10m sediment depth.

#### *Cataraft*

The LacCore cataraft, an off-the-shelf model manufactured by Aire, is comprised of two 4.5m inflatable pontoons, a rigid metal frame, and two standard sheets of plywood or their equivalents. It is a small platform that can be easily transported or shipped to distant locales and assembled on site.

#### *Canoe*

LacCore owns several canoes that can be used independently by one or two people, or two canoes side-by-side can be joined in the middle with a plywood platform for increased stability during core recovery operations. It can be assembled more quickly than the cataraft but is more difficult to transport (and cannot be shipped easily).

#### *Motorboat*

The LacCore motorboat is a typical ~14-foot (4m) aluminum boat that is easily towed behind a vehicle and rapidly launched at a boat access point. It can be used for water sampling and surface coring with cable-deployed devices.

#### *Pontoon (R/V Happy)*

The LacCore R/V Happy is a basic 20-foot (6m) pontoon boat with a moonpool cut in the floor. It provides a stable platform for most types of open-water coring at locations with a boat launch. It must be towed to its destination – it cannot be shipped.

#### *Kullenberg (R/V KRKII)*

The LacCore R/V KRKII is a large platform consisting of two 19-foot (5.5m), 950-pound skiff boats bolted together with aluminum deck plates and beams. It can be disassembled and towed behind a heavy-duty truck or shipped in a standard 20-foot shipping container. It was engineered and custom-built for Kullenberg coring, for which it provides a large, stable work surface, a 6.5m quad-leg tower, and 5m long moonpool. At 6m long and 5.5m wide, it is larger and heavier than is necessary for most other types of coring operations, and it is more difficult to ship and requires more time to assemble than more appropriately-sized platforms.