Initial Core Description (ICD): Overview

Since the early 1990s the LRC and its Core Laboratory have focused on the improvement of instrumentation and protocols for lake sediment analysis, especially for what is termed *Initial Core Description* (ICD; Schnurrenberger et al., 2001), the portion of core analysis that takes place prior to subsampling. ICD comprises:

- Whole-core multisensor logging
- Core splitting into working and archive halves
- Core surface preparation
- Digital whole-core imaging
- ICD sheet production
- Split core multisensor logging
- Macroscopic sediment description
- Microscopic sediment description (smear slides and coarse fractions)
- Cold storage in D-tubes
- Data archiving and curation

Detailed procedures for each of these steps are available on the ICD page of the Core Facility website (http://lrc.geo.umn.edu/corefac-icd.htm) or in the lab itself. Training and support are provided to the visiting researcher free of charge, and expendible supplies (D-tubes, microslides, etc.) are kept on hand and billed to the researcher at cost. The visitor, with help from three or four assistants (lab staff, the researcher's grad and undergrad students, etc.) can expect to complete ICD at a rate of at least five to ten meters of core per day, depending on the complexity of the sediments to be described.

The availability of a low-cost open ICD laboratory and curation facility makes it possible for researchers at all types and sizes of institutions to use the best techniques available in processing their cores. Few large research institutions can justify the purchase of expensive equipment such as digital line scanners and core loggers; scientists in small research groups and at teaching colleges and museums have even less chance to use high-end instrumentation. In addition, expertise and experience in visual core description, logger data interpretation, and image analysis is not widespread.

The LacCore Facility serves as a locus for training students and researchers in all aspects of initial core description and providing access to instrumentation, the high-quality data from which forms the basis of all further analytical studies. Taken together, the centralization of instrumentation and the distributed products of LacCore Facility staff can significantly stretch the analytical dollar at the same time as it increases the quality of the research.

The Importance of Initial Core Description

ICD provides crucial components of any lake sediment study, but if the ICD process is not convenient, it can easily be overlooked in the rush to subsample. ICD includes written and photographic documentation of cores, whole- and split-core logger data, and detailed visual description of sedimentology and sedimentary structures, mineralogy, and biological components. These data together can provide a remarkable amount of information about the changes in depositional environment even before the first sample is taken, and ICD always helps to guide sampling strategy. Lab visitors leave with these data in hand, providing a context for all analytical data that come out of the core in the ensuing studies.

Whole-core logging on the Geotek Multisensor Core Logger (MSCL) track is the first step in Core Facility ICD. The automated track features sensors that non-destructively measure sediment density, acoustic wave velocity, electrical resistivity, and loop-sensor magnetic susceptibility at any resolution (typically 1 cm).

Core liners (if used) are then grooved using a pair of vibrating medical cast saws mounted over a sliding core cradle. Utility knives complete the cuts through the liners, and guillotines, fishing line, or filet knives (depending on the texture and consolidation of core material) are used to split the sediment into working and archive halves.

Glass microscope slides with rounded corners are used to clean the sediment surface and prepare it for imaging and description.

A digital line scanner produces a ~50 MB single image per 1.5 m core section at a resolution of 10 pixels per millimeter (~300 dpi). Polarizers on the light source and the camera lens completely eliminate glare from the core and allow fine details to be seen. A color card in each file allows for color correction after the fact, and the D-tube endcap for the core is included in the picture for identification. 10 pixels/mm is sufficient for almost all cores; however, in special cases such as microlaminated cores, another camera, mounted on the Geotek MSCL track, collects images at a resolution of 20 pixels/mm.

The newest piece of equipment in the Facility is the Geotek XYZ core scanner, which is used primarily for measurement of high-resolution point-sensor magnetic susceptibility on split cores. This analysis is slow relative to other steps (~2.5 hours per 1.5 m section), but the XYZ can be loaded with up to nine core sections at a time and left to run unattended, even overnight. When each section finishes, it can be replaced with another section for non-stop continuous logging. Typically the archive half of the core is placed on the XYZ, and the working half is imaged and then placed in a core cradle for visual description.

Sediment description (Valero-Garcés and Kelts, 1995, Schnurrenberger et al., 2003) begins without genetic attribution (i.e., without interpretation of the depositional environment), but with the goal of ultimately building a facies model for the basin. Lake sediments are highly variable between basins and over time within a given basin, so the level of detail of description is dictated by the nature of the sediments themselves (i.e., laminated, massive, etc.). It is important to recognize structures such as turbidites and slumps so that these are not included in the age-depth model for the core. Correlation between cores in a basin (facilitated by the use of the digital whole-core images, which are easier to manipulate than cores themselves) is helpful in identifying hiatuses and changes in deposition.

Smear slides taken at regular intervals and in anomalous layers are used to identify minerals and organic components that make up the sediment, to make an initial estimate of relative abundance of each sedimentary component, and to estimate grain size distribution. Smear slide compositional information is combined with macroscopic structural description to classify and name sedimentary units (Schnurrenberger et al., 2003). The practice of naming sediments in a way that includes compositional information and according to uniform guidelines enables comparison of sediment descriptions between researchers and provides information supplementary to the core image that can be made available through the LRCVault database.

We have accumulated a smear slide reference collection covering most of the common minerals, crystal forms, and biological components in lake sediments, and have a small subset of these in a parallel web-based reference collection. We intend to further develop the web collection in the next phase of Facility operations. Smear slide analysis is a powerful, low-cost, low-tech procedure (requiring only a hotplate, optical cement, and a UV light source, along with a petrographic microscope that can be found in most geology departments), and if more researchers were comfortable with identifying smear slide components, this could become a much more widespread technique.

Facility staff have also developed the semiautomated production of ICD sheets (also called “barrel sheets”) to facilitate sediment description. Logger data (typically magnetic susceptibility) and the core image are placed on an electronic standard core description sheet that is printed within minutes of the completion of the digital scan. The core descriptions and notes made on this sheet can then refer to the logger and image data, and point to, rather than simply describe, particular features. After descriptions are made on paper, the text and lithological symbols are entered using Adobe Illustrator to generate a PDF version of the electronic ICD sheet that is made available through the database. In the future we plan to further automate this procedure for fully electronic core descriptions with real-time database connectivity.

References

Schnurrenberger, D.W., K.R. Kelts, T.C. Johnson, L.C.K. Shane, and E. Ito, 2001. National lacustrine core repository (LacCore). Journal of Paleolimnology 25: 123-127.

Schnurrenberger, D., J. Russell, and K. Kelts, 2003. Classification of lacustrine sediments based on sedimentary components. Journal of Paleolimnology 29: 141-154.

Valero-Garcés, B.L. and K. Kelts, 1995. A sedimentary facies model for perennial and meromictic saline lakes: Holocene Medicine Lake Basin, South Dakota, USA. Journal of Paleolimnology 14: 123-149