

Lake Sediments and Climate Change

Concerns over future global change have increased interest in understanding past changes in climate and their effects on the environment—including vegetation, fire regimes, landforms, and soils—as well as human society. Some aspects of past climate can be studied by investigating meteorological records or historic documents. For example, information on the beginning and ending of grain or wine harvests in Europe during the Middle Ages (about AD 450–1450) provides clues about past climate, because harvest dates are strongly influenced by climate conditions. However, much of the information about climate change over time has not been written down by people and is not available for study as historical archives. Instead, researchers must investigate various *natural archives of climate change*—sources of evidence preserved by nature, not humans. Records of past climate can be developed from tree rings and from sediments that accumulate in lakes and ocean basins. Corals, peat bogs, ancient packrat middens, glacial ice, and stalagmites in caves also contain paleoclimate information!

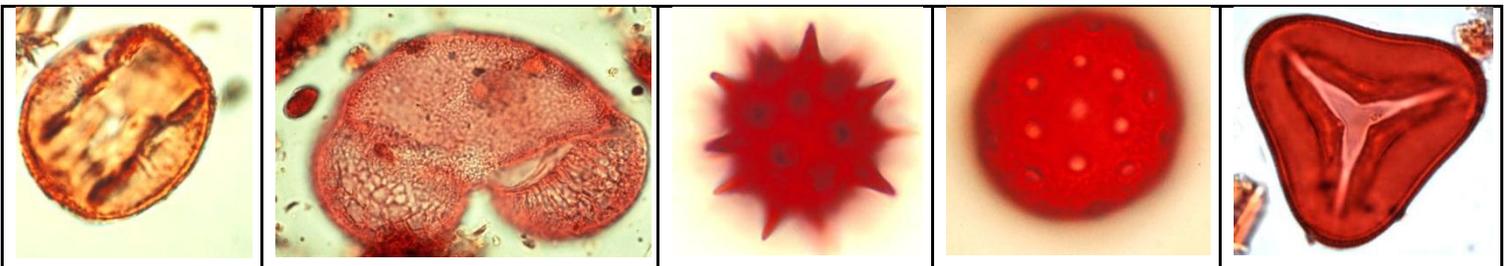
The sediments that accumulate year by year in natural lakes are a key source of information on changes in climate over the past two to twenty thousand years, and sometimes longer. Lake sediments can be recovered using piston corers operated from anchored floating platforms, as shown to the right.

Once recovered, lake sediment cores are taken to the lab where they are described in terms of color and texture, and photographed. Cores are sometimes X-rayed to reveal differences in sediment density. Next, pieces of charcoal, wood, leaves, or other organic materials are removed from the cores for radiocarbon dating to provide a chronology for the sediment record. Sediments are sometimes dated using other techniques, such as the analysis of Pb-210 profiles, or through the identification of marker horizons, such as volcanic tephra of known age.



Sediment coring at Crystal Lake in Knoxville

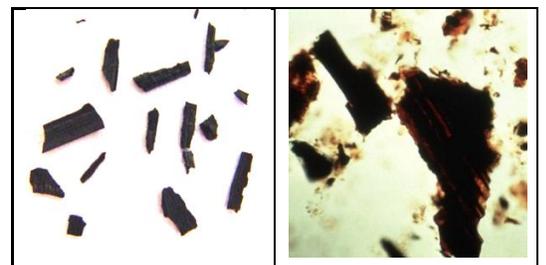
The nature of sediments deposited in lakes can be an important indicator of past conditions, for example, whether they have high or low carbonate content, contain particular minerals, or have organic matter fractions with isotopic signatures suggestive of C_4 vegetation. Lake sediments also contain a variety of microfossils that provide information about past climate, such as pollen grains, fern spores, charcoal fragments, and diatoms. Pollen grains are microscopic structures carrying the male gametes of seed plants, which are shed from the anthers of flowering plants, or from pollen cones of gymnosperms. They are produced in great abundance by many plants, and the “extras” that don’t pollinate another plant often end up in lakes, where they may be preserved in sediments for thousands of years. Pollen and microspores from ferns can be extracted from lake-core samples, and identified based on distinctive morphologies (as in the photographs below). Changes over time in the proportions of different types of pollen grains and fern spores deposited in lake sediments can indicate changes in vegetation that may be related to climate change, or to other factors, including human impacts.



From left to right: pollen grains of *Quercus*, *Pinus*, Asteraceae, and Amaranthaceae, and a trilete fern spore.

In contrast to pollen grains, which come from plants mainly growing outside of the lake, diatoms live within lakes. They are single-celled algae that have cell walls made of silica. They are very important indicators of conditions within lakes, which can be influenced by climate as well as other natural and human phenomena. Charcoal fragments in lake sediments indicate past fires, set naturally by lightning or volcanism, or by people. Past fires also shed light on climate conditions, as fires require suitable fuels to burn, and climate is an important control on the production and condition of fuels.

At the University of Tennessee, faculty and students interested in lake sediments and other natural archives of climate and environmental change have formed a research group known as the *Initiative for Quaternary Paleoclimate Research*. For more information, see <http://web.utk.edu/~cqpr/>. Natural archives of climate change are the focus of several courses at UT. Two that include hands-on study of lake sediments are *Geography 430: Global Environments of the Quaternary*, and *Geography 581: Pollen Grains and Other Microfossils in Quaternary Research*. Taught by Dr. Sally Horn, these courses are open to both graduate and undergraduate students.



Charcoal fragments in lake sediments from Costa Rica.