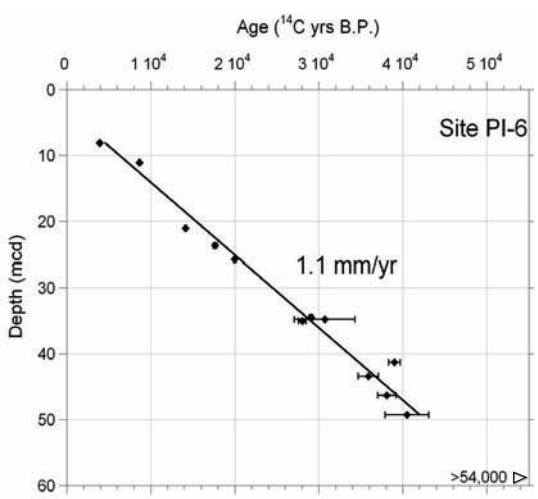
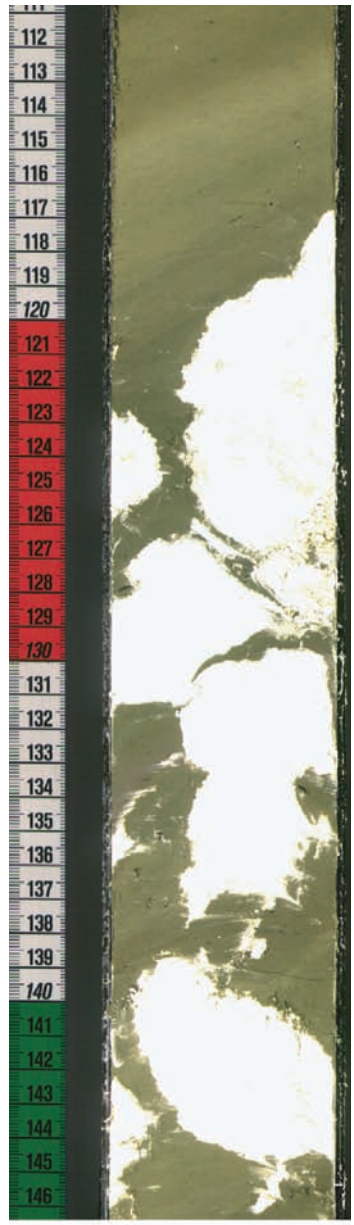
Preliminary Results of the Lake Peten Itza Scientific Drilling Project

In February and March 2006, DOSECC collected 1327 m of sediment from seven sites in Lake Peten Itza, northern Guatemala using the GLAD800. Cores were not split in the field, and descriptions were limited to information gleaned from sections while still in their plastic liners (density, p-wave velocity, magnetic susceptibility) using a Geotek Multi-Sensor Core Logger (MSCL), and from smear slide analysis of core catcher samples. In June 2006, the Peten Itza Scientific Drilling Project (PISDP) team held their first reunion at the National Lacustrine Core Repository (LacCore), University of Minnesota (Twin Cities) to split, describe, and sample cores (*photo above*). Cores that were split during the two-week sampling party revealed details of their lithologic variability and sediment structure.

Our initial efforts focused on cores from Site PI-6, taken in a water depth of 71 m, where three holes were drilled to a maximum depth of 75.9 meters below lake floor (mblf). At the LacCore facility, all cores from Site PI-6 were logged at 0.5-cm resolution with a GEOTEK MSCL, split lengthwise, and digitally imaged. We collected any obvious wood fragments from split cores for AMS radiocarbon dating. The first set of radiocarbon dates from Site PI-6, measured at Lawrence Livermore National Laboratory by Dr. Thomas Guilderson, display a nearly linear increase in age with depth (*graph below*), and indicate a mean sedimentation rate of ~1.1 mm/yr for the upper 50 meters of composite core depth (mcd). These preliminary results suggest a sustained high rate of sediment accumulation at Site PI-6 and indicate that most of the section is within the range of radiocarbon dating.

The top 10.8 mcd at Site PI-6 were deposited during the Holocene and consist primarily of gray carbonate clay with abundant charcoal. The Pleistocene/Holocene boundary is marked by a transition from interbedded dense gypsum sand and clay deposited during the Late Glacial period, from ~17 to 9.3 kyrs, to overlying Holocene clay (*photo page 6*). This transition represents a switch from generally arid conditions during the Late Glacial to moist climate during the early Holocene. One surprising finding was that gray carbonate clay deposited during the Last Glacial Maximum (LGM) from 23 to 17 kyrs, appears very similar to Holocene sediments, suggesting high detrital input and high lake level in the LGM. This contradicts previous suggestions that the LGM was dry in the Maya lowlands. We speculate that a cold, wet LGM may have been caused by increased winter precipitation when the Laurentide Ice Sheet was at its southernmost extent. Pollen and stable isotope analyses on Site PI-6 cores will test the paleoclimatic inference based on lithologic changes. Clays deposited in Lake Peten Itza during the LGM are underlain by interbedded gypsum and gray carbonate clay deposited before ~23 kyrs, during Marine Isotope Stage 3, that indicate alternating wet-dry conditions.

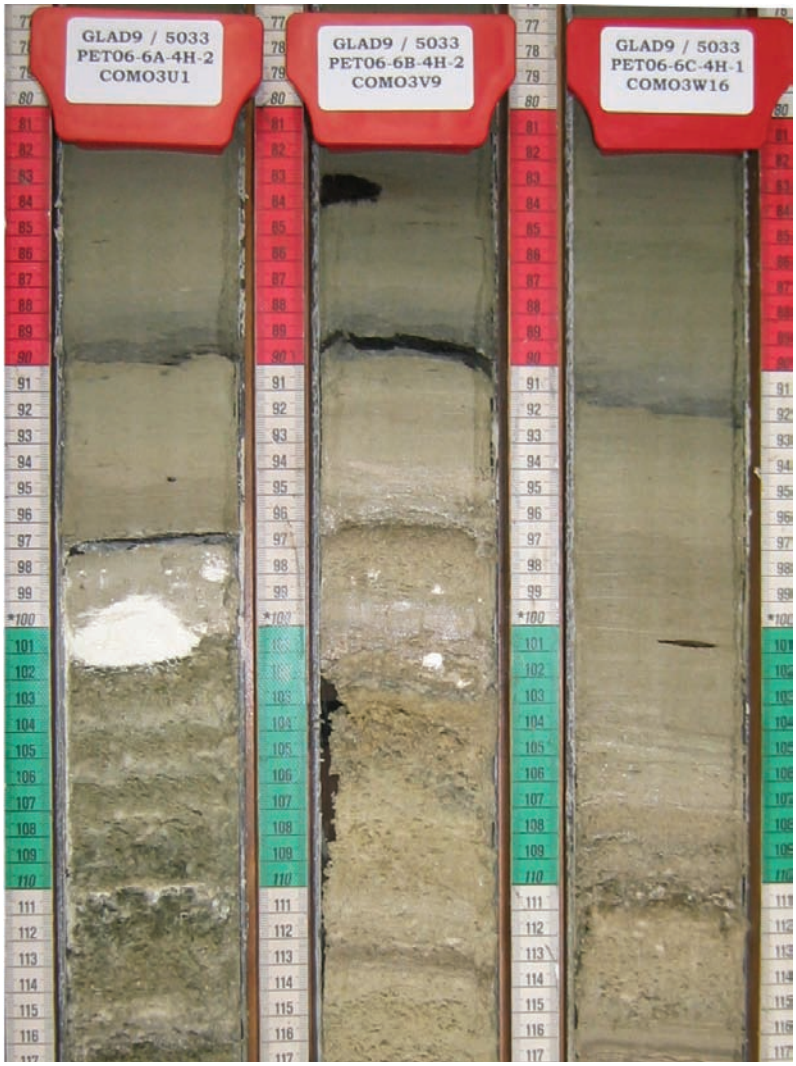




Above: Yellow elemental sulfur nodules seen in core PI 3A-11H. The nodules crosscut bedding within the gray-brown clay indicating that they formed post-depositionally, likely in association with microbial activity.

Upper Left: Graduate students Andy Mueller (ETH-Zurich) and Jennifer Mays (Univ. of Florida) examine PISDP cores at the LacCore facility in June.

Left: Initial radiocarbon ages of wood samples taken from sediment cores at Site PI-6. Fitting the age-depth points with a linear regression equation yields a mean sedimentation rate of ~1.1 mm/yr for the upper 50 mcd. A sample at 58.9 mcd gave an age beyond the range of radiocarbon dating (>54 kyrs).



Pleistocene-Holocene transition in Holes 6A, 6B, and 6C showing a change near 100 cm from gray Holocene clay to late Pleistocene deposits consisting of interbedded gypsum sand and clay. A large sulfur nodule occurs at the transition in Hole 6A. The black layer at ~90-91 cm is an ash layer.

A remarkable sedimentologic feature observed in the cores from Sites PI-6 and PI-3 (taken in 100 m of water) is the presence of large elemental sulfur nodules (*photos above and page 5*). These nodules often occur near the contact of lithologic units, between gypsum-rich and clay-rich facies (*above*). They crosscut the bedding (*photo page 5*), indicating post-depositional formation, probably associated with microbial activity. Microorganisms involved in the sulfur cycle probably played an important role in both sulfate reduction and sulfide oxidation. Dr. Crisogono Vasconcelos (ETH-Zurich) collected geomicrobiological samples from the freshly split core surfaces to investigate the possibility of microbial involvement in the formation of the sulfur nodules. Preliminary results of culture experiments show an active microbial community associated with the sulfur nodules. Some strains grown in the enrichment cultures are precipitating elemental sulfur through metabolic sulfide oxidation. These experimental results attest to microbial involvement in the formation of the sulfur nodules and contribute to our understanding of the formation of elemental sulfur in the geologic record.

Although we have processed only about one-third (450 m) of the total 1327 m of sediment cores recovered from Lake Peten Itza, the split sections have already provided new insights into both the paleoclimate of the region and biogeochemical processes within the lake sediments. Our preliminary results will be presented in December 2006 at the Annual Fall AGU meeting in San Francisco.

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Photos courtesy of David Hodell and PISDP.

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