THE IMPACT Project: Sedimentological Studies of the Paleoclimate Record From El'gygytgyn Crater Lake

Celeste Cosby, Julie Brigham-Grette and Pierre Francus
Department of Geosciences and the Climate System Research Center, University of Massachusetts, Amherst, MA 01003 USA; ccosby@geo.umass.edu; brigham-grette@geo.umass.edu; francus@geo.umass.edu

413-545-4840; 413-545-0659

Knowledge of the full range of climate variability across the Arctic during the past is important for understanding the sensitivity of the Arctic system to future change. El'gygytgyn Lake with over 200 m of sediment fill may offer the longest and most complete Late Cenozoic lacustrine paleoclimate records available from the entire Arctic. This lake located in central Chukotka, NE Russia, lies in an impact crater ~18 km in diameter dated to ~ 3.6 Ma. In 1998 a multinational team collected a series of overlapping cores yielding a total depth of 13.5 m extending nearly 400 ka. THE IMPACT Project (Terrestrial History of El'gygytgyn Lake-International Multidisciplinary PaleoClimaTe project) includes collaborators from the Alfred Wegener Institute (AWI) Germany, Northeastern Interdisciplinary Science Research Institute (NEISRI), Magadan Russia, University of Alaska Fairbanks, and University of Massachusetts, Amherst (UMass) USA.

Sedimentological studies of the cores are being carried out at the UMass for comparison with other paleoclimate proxies. A macro overview of the full core was investigated for grain-size and clay mineralogy, with a more focused study on the upper 2 m. In the upper 2 m, which includes the LGM, overlapping thin-sections were taken for microstratigraphic investigation via Scanning Electron Microscope (SEM) and petrography.

Grain-size analyses were conducted on a Coulter Ls 200 laser analyzer. Grain-size, which rarely exceeds 40 microns shows a distinct bi- and tri-modal pattern in the clay and silt sized fractions. This suggests multiple transport modes into the deepest parts of the lake. A graph of selected grain-size analyses shows a pattern that suggests more event-based biasing of clastic deposition and little correlation to magnetic susceptibility or other measured proxies completed to date for this lake system.

Clay analyses were studied using standard XRD patterns of the separated clay fraction at 2 cm increments. Three clay species are present including illite, chlorite and smectite with illite the most dominant. Smectite occurs in distinct intervals along with illite throughout the core. This indicates a switch in source material and or weathering due to climatic changes at this depth in the core.

In general the cores consist of laminated and non-laminated lacustrine mud sequences. In the laminated sequences, bleb structures occur within individual laminae, revealing an almost boudinage pattern. These laminated sequences generally correspond with cool or cold glacial conditions when anoxic conditions prevailed beneath perennial ice. SEM investigation indicates that the bleb material is coarser in grain-size and encloses comparatively large clasts. A microprobe analysis of both the sediment laminae and bleb materials found little difference in the chemical composition of these two distinct forms. These bleb structures may indicate a distal component of debris flows off the steep slopes

of this impact crater or may be the product of flocculated mud through a perennial lake ice cover during cold periods.
Petrographic analysis of the non-laminated sequences reveals some evidence of bioturbation, while other sequences indicate a settling of preferentially oriented clay grains offering evidence for warmer conditions during their formation. Proxy data supporting this hypothesis include magnetic susceptibility and TOC where the non-laminated sequences show correlation to periods of warmer conditions.