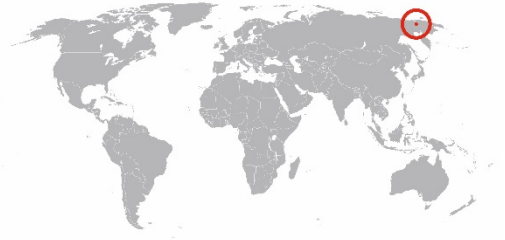




Lake El'gygytyn Drilling Project

Russia, Northeast Siberia



Goal & Scientific Objective

The main goals of the Lake El'gygytyn Drilling Project are to obtain, from analyses of the drill cores, new information the formation of the impact crater, as well as to derive a climate history of the Arctic. That includes assessing the environmental dynamics recorded at El'gygytyn against other arctic and lower latitude paleoenvironmental records and placing them in the context of existing knowledge concerning the impacts and responses of different regions to past and future change. El'gygytyn has the only currently known impact structure formed in siliceous volcanics, including tuffs. The impact melt rocks and target rocks provide a unique opportunity on Earth to study shock metamorphism of volcanic rocks.

Operational Achievements

On two sites were drilled four boreholes, one into permafrost deposits on lakeside (5011-3) and three into the lake sediments (5011-1 A – C). 5011-3 reached a depth of 141.5 m with 91 % core recovery. 5011-1 completed three holes in the centre of the frozen lake:

Hole 1 A (146.58 m depth, 92% core recovery)

Hole 1 B (111.92 m depth, 98% core recovery)

Hole 1 C (517.3 m TD, 63% core recovery)

Downhole logging of hole 1 C was carried out by the ICDP Operational Support Group in the upper sedimentary section. On-site multi-sensor core logging was of the cores from 5011-1.



Web & Media Resources

www.geo.umass.edu/lake_e/index.html

www.elgygytyn.uni-koeln.de/

<http://lithosphere.univie.ac.at/impactresearch/elgygytyn-crater/>

<http://elgygytyn.icdp-online.org/>

www.youtube.com/playlist?list=PLA32489E0A3B3358A

<https://www.polartrec.com/expeditions/geologic-climate-research-in-siberia>

Timeline

2005 ICDP proposal submission

2008 (October – December) permafrost drilling

2009 (January – May) lake and impact rock drilling

Principal Investigators

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Data & Sample Access

Permafrost cores are stored at the Marum core repository at Bremerhaven, lake sediments in the National Lacustrine Core Facility at the University of Minnesota and impact rocks are stored at the Core Repository for Scientific Drilling at the Federal Institute for Geosciences and Natural Resources in Berlin.

Core, downhole and drill data available on the ICDP website (public).

Scientific Findings

The remarkable coherence of interglacial warmth across the western Arctic with repeated deglaciation events in West Antarctica supports the notion of strong long distance connections between the polar regions over the last 2.8 Ma.

Evidence from Lake El'gygytyn shows that 3.6-3.4 Ma ago, summer temperatures were $\sim 8^{\circ}\text{C}$ warmer than today when atmospheric CO_2 concentration are comparable to those of today.

Multiproxy evidence suggests extreme warmth and polar amplification during the middle Pliocene, sudden stepped cooling events during the Pliocene-Pleistocene transition, and warmer than present Arctic summers until ~ 2.2 Ma, after the onset of Northern Hemispheric glaciation.

The drill core penetrated through postimpact sediments, impactites, and the fractured igneous basement. The impactite portion of the core was recovered from 316.08 to 517.30 m in depth below the lake bottom. A comparison between the similar sized Bosumtwi and El'gygytyn impact craters shows that initial expectations of large amounts of impact melt within either of those craters were not confirmed.

Key Publications

Melles, M.; Brigham-Grette, J.; Minyuk, P.S.; Koeberl, C.; Andreev, A.; Cook, T.; Fedorov, G.; Gebhardt, A.C.; Haltia-Hovi, E.M.; Kukkonen, M.; Nowaczyk, N.R.; Schwamborn, G.; Wennrich, V.; the El'gygytyn Scientific Party (2011): The Lake El'gygytyn Scientific Drilling Project - Conquering Arctic Challenges through Continental Drilling. *Scientific Drilling* 11 15-40. doi: 10.2204/iodp.sd.11.03.2011

Melles, M.; Brigham-Grette, J.; Minyuk, P.; Nowaczyk, N. R.; Wennrich, V.; DeConto, R.M.; Anderson, P.M.; Andreev, A.A.; Coletti, A.; Cook, T.M.; Haltia-Hovi, E.; Kukkonen, M.; Lozhkin, A.V.; Rosen, P.; Tarasov, P.; Vogel, H.; Wagner, B. (2012): 2.8 Million Years of Arctic Climate Change from Lake El'gygytyn, NE Russia. *Science* 337 315-320. doi: 10.1126/science.1222135

Brigham-Grette, J.; Melles, M.; Minyuk, P.; Wagner, B.; Cook, T.; Rousseau, D.D. (eds.) (2012): Initial results from lake El'gygytyn, western Beringia: first time-continuous Pliocene-Pleistocene terrestrial record from the Arctic. *Climate of the Past*, Special Issue 8.

Koeberl, C.; Pittarello, L.; Reimold, W.U.; Raschke, U.; Brigham-Grette, J.; Melles, M.; Minyuk, P.S. (eds.) (2013): The 2009 ICDP drilling project at the El'gygytyn impact structure in Arctic Russia. *Meteoritics and Planetary Science* 48, Special Issue 7. doi: 10.1111/maps.12146

Brigham-Grette, J.; Melles, M.; Minyuk, P.; Andreev, A.; Tarasov, P.; DeConto, R.; Koenig, S.; Nowaczyk, N.; Wennrich, V.; Rosen, P.; Haltia-Hovi, E.; Cook, T.; Gebhardt, T.; Meyer-Jacob, C.; Snyder, J.; Herzsuh, U. (2013): Pliocene Warmth, Polar Amplification, and Stepped Pleistocene Cooling Recorded in NE Arctic Russia. *Science* 340 1421-1427. doi: 10.1126/science.1233137



Laminated section within the Pliocene