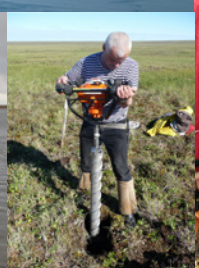
20 Years of Terrestrial Research in the Siberian Arctic

The History of the LENA Expeditions



20 Years of Terrestrial Research in the Siberian Arctic

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4i Holocene Lakes Around the Lena Delta

Palaeolimnological studies of lakes around the Lena Delta were undertaken during the Lena expeditions in 1998, 1999, 2009, 2010, and 2017 (Figure 1). Since 2003, these studies also included various lake systems all over eastern Siberia. The limnogeological work was funded by the Russian-German partner institutions and by several third-party grants under the umbrella of the SibLake programme.

The study area extends far into the forested hinterland of Yakutia, the Verkhoyansk Mountains, and as far as Kamchatka at the Pacific Ocean. Our research seeks to provide broad spatial coverage to capture the spatial-temporal dimension of palaeoenvironmental changes in Siberia. In this sense, it is comparable to the weather forecast, which is based on a wide network of meteorological sta-

Figure 1: Palaeolimnological study sites in the northern Lena River region: Lake Nikolay (1998/1999), nameless lakes referred to as Tik sites (2009), lakes Kyutyunda and El'gene Kyuelle (2010), lakes Golzovoye and Northern Polar Vox near the town of Tiksi (2017).
Figure 2: Field camp and tripod raft for sediment coring at Lake Kyutyunda (Photo: B. Diekmann).

tions. We are particularly interested in the period since the last ice age and the Holocene. This time span includes the natural climate variability of approximately the last 50,000 years until the current era of human-made climate change.

The research approach in the field is devoted to the recovery of lacustrine sediment records. In order to infer the palaeolimnological changes, the samples are subsequently analysed in the laboratory using radiocarbon dating as well as sedimentological, geochemical, and micropalaeontological methods.

As an example of how adventurous limnogeological fieldwork in the Arctic periglacial wilderness can be, we highlight the experiences in a late summer season during a sub-campaign of the Russian-German expedition "Lena 2010".

September 3, 2010: A final flight over the sprawling tundra of northeastern Siberia. We finally spot the first houses on the horizon. We land and unload almost two tons of expedition equipment from the packed helicopter – one last time. We're back home in Tiksi, the polar outpost of Russian civilization at the Arctic Ocean. Behind us lie three weeks of field work, carried out on two lakes in the hinterland of the Lena Delta.

The first voyage took us 300 km south of Tiksi to Lake Kyutyunda (3 x 3 km, 5 m water depth), situated in the forest-tundra. Swarms of mosquitoes and biting flies greeted us, though the first night frosts soon replaced them as autumn approached. We set up our camp on a soft beach made up of reworked peat debris (Figure 2). We enjoyed unforgettable sunsets at midnight, which announced the fading of the 24-hour polar days. The fieldwork had been quite successful: We retrieved several up to 8 m long sediment cores, which would later document the Holocene history of the lake's development and Siberian climate over the last 11,000 years.

Ten days later, the helicopter picked us up again and dropped us off at Lake El'gene Kyuele, some 200 km to the north. Here we were faced with the harsh sides of the tundra. The days were mostly rainy and windy, the nights were wet and cold, and became noticeably longer. Walking on the soft, lumpy, and damp underground became a permanent challenge which our chilly rubber boots narrated with continuous smacking sounds. Such conditions, however, could in no way curb our enthusiasm for the upcoming field work at this exciting study site.

The lake is located in a 20 m deep and 3 x 5 km wide alas depression, which is widely occupied by silted-up areas (Figure 3). Today, the lake has an area of 3 x 3.5 km and is limited to the western part of the basin. Spectacular bluffs of the Pleistocene ice complex (Yedoma) with mighty ice wedges often border the lake's edges. The Yedoma formation shows signs of thermal erosion with typical retrogressive thaw slumps and remnants of frozen loess-like sediment pillars between lost ice wedges, thus forming a characteristic "egg-carton landscape".

A steep ridge up to three meters high borders the eastern shore of the lake. The ridge merges into an old lakeside terrace, where we set up camp. Young peat deposits cover the terrace. Fossil subaquatic sediments lie underneath it, with abundant wood remains and fossil logs from warmer times of the early Holocene. Our fieldwork started with a bathymetric survey of the lake. It revealed quite an uneven underwater relief, with numerous irregular subaquatic holes that reached a depth of 10 m.

Sediment cores up to five meters long were recovered from different water depths at four representative sites across the lake (Figure 4). We also took

Figure 3: Northward view across the thermokarst setting of Lake El'gene Kyuele (Photo: B. Diekmann). The left lake margin shows small deltas resulting from sediment redeposition by onshore thaw slumps.

samples from fossil lake sediments, peats of the old lakeside terrace, Yedoma sediment, and ground ice. Later studies on the sediment records showed that climate-related thermokarst subsidence and lake level changes mainly controlled the lake history, as well as shore erosion and migration during the Holocene.

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Figure 4: Part of a sediment core section from Lake El'gene Kyuele, showing light event layers of sediment redeposition from shore erosion, embedded in dark, organic-rich lake gyttya (Photo: D. Subetto).