



20

Years of Terrestrial Research  
in the Siberian Arctic  
The History of the LENA  
Expeditions





Excerpt from:

## 20 Years of Terrestrial Research in the Siberian Arctic

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## Deep Insights into the Past: Terrestrial Permafrost Drilling Campaigns

Permafrost thaw is associated with impacts on climate, land surface and coastal and river bank structures. Thermokarst and thermoerosion, for example, are thaw processes that lead to ground subsidence. Two main factors of surface subsidence vulnerability are the sedimentological composition, including ground ice content, and the temperature state of permafrost. This surface destabilization is getting relevant because of a potential positive feedback of deep thaw to the global climate system through the release of greenhouse gases trapped beneath or in the permafrost (see pages 68-70), as well as through the release of so far freeze-locked old carbon by microbial decomposition (see pages 117-119). With these facts in mind the overarching aims of our drilling campaigns were to retrieve deep (> 50m) frozen and unfrozen sediment cores including sediments, ice, and organic components. We analysed the cores for understanding the geology and cryostratigraphy of the Lena Delta and adjacent regions, the deep carbon characteristics and amounts, sediment thicknesses, permafrost conditions, as well as fluvial and deltaic environmental history of these regions (Figure 1). We used deep permafrost as a window into the past, which is needed to understand the conditions today, and to assess the changes in a warming future. Several scientific disciplines have been involved in the research based on these coring

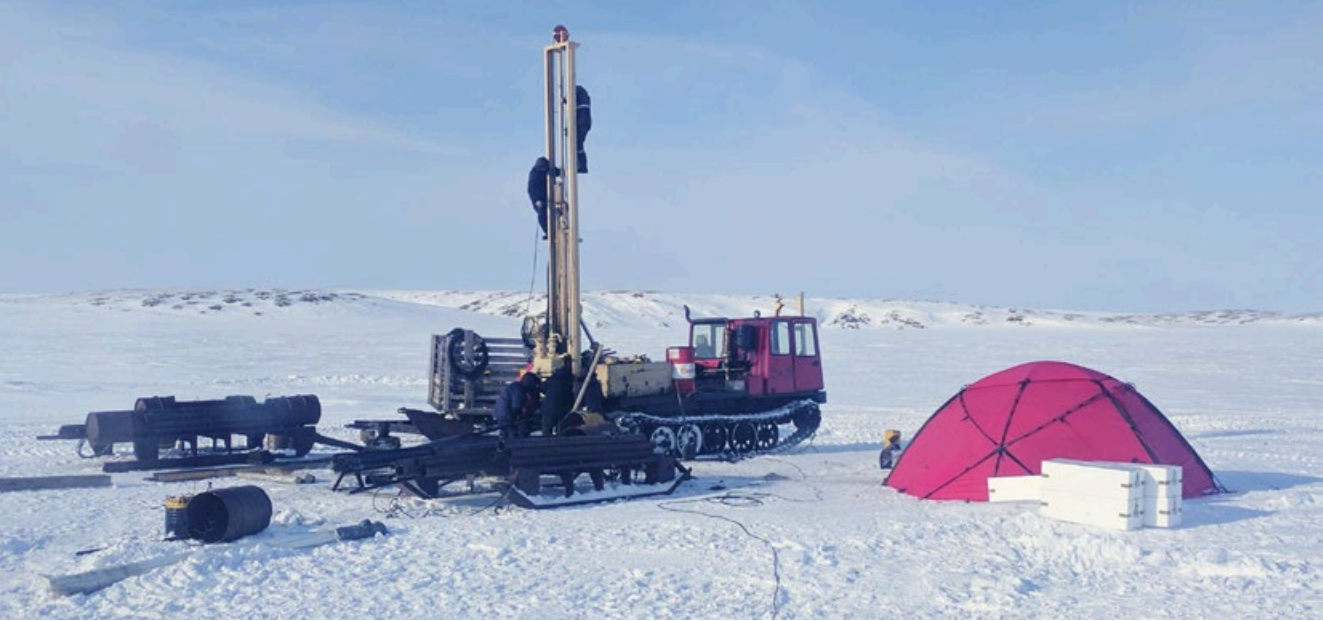


Figure 1: Sites where we drilled deep into the permafrost and unfrozen deposits to get deep insights into the past. Included sites are Bols'hoj Lyakhovskiy (Island (2014 N73.33, E141.32), Buor Khaya Peninsula (2012, N71.4203, E132.111), Bykovskiy Peninsula (2017, N71.7452, E129.3022), Kurungnakh Island (2015, N72.2903, E126.1843), Mamontovy Klyk (2005, N73.60597, E117.17736), Samoylov Island (2005 and 2018, N72.3766, E126.4816), Sardakh Island (1998, 2009 N72.571544, E127.241499), and Turakh Island (2005, N72.9740, E123.7986). Map compiled by S. Laboor.



campaigns including geocryology, sedimentology, paleoecology, geophysics, and geochemistry. Deep drilling expeditions are mostly carried out during Arctic spring time, when the large and heavy drilling equipment can be easier transported over the frozen tundra and water bodies and when cores remain frozen while retrieved from the coring equipment. Field life and work under conditions of  $-20^{\circ}\text{C}$ , and a potential risk of snowstorms and polar bears, are challenging. However, good logistical preparation and longstanding experience for such work on both the Russian and German expedition organizers and leaders make such

Figure 2: Defying the harsh Arctic temperatures during a Russian-German spring drilling expedition in North Siberia: A small temporary settlement on sledges with a canteen, a generator sledge, two two-storey houses, and the drilling rig (from left to right).



expeditions possible. Within the very good logistical framework of the Lena expeditions, those field camps often resemble a small temporary settlement on sledges that may be able to relocate to new drilling adventures as needed based on scientific questions (Figure 2).

Another important piece of field logistics is of course the drilling device itself. The technical options within the Lena expedition framework are outstanding: Various types of drills are available to the joint expeditions to retrieve cores in different landscape settings, down to different depths, and in different ground materials. In most cases an URB2-4T drilling rig was used for permafrost (Figure 3), because it is suitable and well-tested for drilling deeper than 20 m into frozen sediments. Another often used system is the KMB drill for cores up to 20 m depth which is smaller but able to be transported with a helicopter like an MI-8 and an all-terrain vehicle (vezdekhod).

One of the deepest holes was drilled very recently on Samoylov Island in April 2018. In the future, this borehole will provide us with the unique opportunity for long-term deep permafrost temperature observations revealing the influence of Arctic warming to deep permafrost sediments, and will give us an idea for how long the permafrost-legacy of the last ice age will last.

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Figure 3: Drilling rig in action: Starting the URB2-4T drilling rig for deep drilling on Bykovsky Peninsula, April 2017. (Photo: J. Strauss)



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