Assessing past environmental conditions in Northern Eurasian Lakes by the means of high-resolution, multichannel seismic reflection data: Key observations from lakes Ladoga (NW Russia) and Levinson-Lessing (Taymyr Peninsula)

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Lake systems have been targets of extensive research over the past decades, since they contain in their sedimentary infills important records of the origin, development and evolution of lake basins, and of changes in the depositional processes over time. In the framework of the Russian-German project 'PLOT - Paleolimnological Transect', extensive fieldwork, including seismic surveys, coring, and hydrological investigations, was carried out on five lakes (Ladoga, Bolshoye-Shuchye, Emanda Levinson-Lessing and Taymyr). The project aims at recovering lacustrine sediments along a >6000-km-long longitudinal transect across the Russian Arctic to investigate the Late Quaternary climatic and environmental history, with a special emphasis on recovering preglacial sediments. In this contribution, we focus on understanding of the origin and the formation of the geomorphological features observed on the seismic data on lakes Ladoga and Levinson-Lessing, with respect to the glacial history of each lake.

In 2013, ∼1500 km of seismic reflection profiles have been acquired on Lake Ladoga (NW Russia). The high-resolution of the data allows us to document in detail the sedimentary processes that occurred in the lake during the preglacial and postglacial history. The seismic stratigraphic architecture of the lake shows, from top to bottom, acoustically well-stratified Holocene muds overlaying rather transparent postglacial varves. The nature of the material composing the uppermost units have been tied to coring information from core Co1309, which was retrieved during the same survey. Of particular interest, are the single to composite, giant (kilometer-scale) mounds directly overlying a hard reflector. Internal architecture of the mounds reveals a complex formation history, with mound types showing significant structural deformation of different degrees. A strong reflector marks the top of the giant mounds and corresponds to an un/disconformity. Our age-depth model indicates a hiatus between this strong reflector and the overlying unit of ca. 65 ka. The deepest seismic unit underlying the mounds is characterized by well-bedded, tilted reflectors in the southeastern part of the lake, while clear synclines are identified in the northwestern part of the lake. An erosional truncation separates the deepest unit from the overlying ones.

During the campaign carried out on Lake Levinson-Lessing (Taymyr Peninsula) in 2016, ∼70 km of seismic profiles were acquired, allowing us to capture the complete lacustrine sedimentary infill (∼135 m) down to the basement. Five main seismic units have been recognized and interpreted as glacial (Unit V), subglacial and proglacial (Unit IV), marine (Unit III), fluvial-lacustrine (Unit II) and lacustrine (Unit I) sediments. Of particular significance are imbricated, south-oriented structures present in the southernmost part of the lake basin within Unit V and a large topographic ridge recognized in front of those structures. We interpret these structures as push-moraines and an end moraine, respectively, left by the glacier after its retreat. The depositional pattern of the units above the moraines document past lake-level fluctuations. The study at Lake Levinson-Lessing shows that deep tectonic lake basins affected by several glaciations can preserve important palaeoenvironmental records, which contributes significantly to improve our understanding of palaeoenvironmental changes in the Taymyr Peninsula.