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Late-Post-Glacial Tilt of the Lake Ladoga – Gulf of Finland Region and Rheology Models

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Numerous Earth rheology models attempt to explain features of late- and post-glacial isostatic adjustment of Fennoscandia. An area of specific interest is the peripheral areas to the former ice sheet. We used geological-geomorphological observations of relevant elements of the Lake Ladoga - Eastern Gulf of Finland for verification of our modeling studies. New revised glaciation- deglaciation were tested together with thin ice model scenario, with only ~10-11 000 years total last ice-age duration on largest highs. On this basis we expect an uplift pattern which differ from what is generally usually assumed, with more distinct northern trend eastward from the Ladoga basin, and subsidence in the Lake Onega region.

Hydro-isostasy (HI) was a very noticeable factor in the post-glacial adjustment, both in local and regional scale. The local one is connected with water load changes of the Baltic-Ladoga system. Its details are extremely important for the verification of Earth rheology parameters. Gulf of Finland and Ladoga regions have probably experienced several dramatic water level changes, and expected HI pattern was sophisticated. In the modeling we have incorporated drops of large local ice lakes. Another one due to ice sheet retreat in Sweden probably happened ~13000 cal. BP, with smaller influence due to posterior readvance and Baltic Ice Lake water rise untill the final drop at ~11600 cal. BP. The minimum water level in the region from the model culminated 10800 cal. BP, with expected extensive dry land areas in south-eastern parts of the basin. Ancyllus Lake transgression could have two peaks, with another deep level fall in both separated basins at culmination of Baltic Ancyllus Lake regression ~8700-8900 cal. BP. This could be synchronous with the known most pronounced largest sea level fall in Great Lakes of North America, being also caused by global climatic changes. Final dramatic changes influenced south-eastern Ladoga, with transgression and final drop took place ~3200 cal. BP, caused by drainage changes. Very short-term bifurcation stage seems to be happen around this time.

Our results show that an isostatic channel flow model (with a thick elastic lithosphere and a high viscosity lower mantle) gives larger mismatch to the observations, especially related to the prediction of outlines of paleo-basins along the retreated glacial margin. On the other hand, an isostatic model with thin elastic lithosphere and a low-viscosity asthenosphere gives mismatch to the expected forebulge. Model modification with the locally reduced asthenosphere is discussed. Geological features illustrate possible modification of elastic thickness of the lithosphere (Te) from ~7 km during Mesoproterozoic formation of Early Riphean (Jotnian) basins as a result of implacement of huge Sub-Jotnian magmatic plutons to 35 – 50 at present, likely lowest in the central parts of syneclises.