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Twisting of post-glacial Fennoscandian shorelines requires a low-viscosity asthenosphere

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The Fennoscandian uplift has been intensely studied and discussed since the 18th century and it is now widely accepted to be an isostatic response to the recent deglaciation. Our knowledge of the ?uid properties of the Earth comes largely from its uplift response to load redistributions that occurred over the last ice age. The elevation of past shorelines and the present rate of land uplift constrain the ?uid properties of the mantle and the elastic rigidity of the lithosphere.

The post-glacial uplift in Fennoscandia has been mapped by the following means:

1. Shorelevel displacement curves, showing the vertical displacement at a certain location,
2. Shoreline diagrams, showing the displacement and tilting of palaeo shorelines,
3. Present-day uplift monitored by tide gauge, old water marks, GPS observations and by satellite missions.

The Earth rheology is best constrained by the peripheral response of the former glaciated area. The Norwegian west coast has experienced significant transgression in Younger Dryas (YD). Both north of this area and south of this area the relative sea level fell during YD. In the area of transgression the 60 m YD isobase crosses the 60 m Allerød isobase. This twisting of the shorelines happens between Bergen and Stavanger. There has been no change in the shoreline tilts between Allerød and Younger Dryas in this area. The same section of the coast that was transgressed during the YD also experienced a major YD ice-sheet re-advance. In part of this area the ice sheet re-advanced by at least 40 km. It seems likely that there is a causal connection between the ice-advance and the shoreline transgression.

The Earth's response to glaciers and sediments has been modeled by using a layered viscous model overlain by an elastic lithosphere. In the calculations we have used the lack of tilting of the palaeo shorelines and twisting of shorelines as to constrain the Earth rheology. We will show that this data is very sensitive to the mantle viscosity and lithosphere rigidity.

Best fit with the observed twisting of shorelines was achieved with a low-viscosity asthenosphere of thickness less than 150 km and viscosity less than 7.0x10**19 Pa s above a mantle of viscosity 10**21Pa s, and an effective elastic lithosphere thickness of 30-40 km (flexural rigidity 10**24 Nm).