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# Upper mantle viscosity and lithospheric thickness under Iceland determined from a microphysical modelling approach of mantle rheology

A. Barnhoorn (1), W. van der Wal (2), and M.R. Drury (3)

(1) Delft University of Technology, Department of Geotechnology, Delft, The Netherlands (auke.barnhoorn@tudelft.nl), (2) Delft University of Technology, Faculty of Aerospace Engineering, Delft, The Netherlands (w.vanderwal@tudelft.nl), (3) Utrecht University, Faculty of Geosciences, Utrecht, The Netherlands (m.r.drury@uu.nl)

The Vatnajökull glacier, located in the south-east of Iceland is the largest ice cap of Iceland having a mean radius of ∼50 km covering an area of ∼8100 km2. The Vatnajökull glacier is situated directly on top of the spreading axis in the eastern volcanic zone (EVZ) of the Icelandic mid-ocean ridge and near the inferred center of the Icelandic hotspot. Due to the vicinity of the glacier to the active tectonic area, the response of the solid earth to melting of the ice cap is strongly controlled by the properties of the hot newly formed upper mantle underneath the mid-ocean ridge. The relatively high temperatures in the mantle during rifting result in relatively low upper mantle viscosities and fast relaxation times in comparison with tectonically inactive glaciated areas such as in. In this study, estimates for lithospheric thickness and upper mantle viscosity under Iceland are produced by a microphysical modelling approach using the theoretical temperature distribution under mid-ocean ridges combined with olivine diffusion and dislocation creep flow laws. Large lateral variations in upper mantle viscosity and especially lithospheric thickness are expected for Iceland perpendicular to the ridge axis due to the large changes in temperatures away from the ridge axis.
The lithospheric thickness (27–40 km) and upper mantle viscosity (2 × 1018–1019 Pa s) outcomes for the recent glaciation are consistent with previous reports of viscosity and lithospheric thickness from glacial isostatic adjustment studies. A combination of a 40 km thick elastic lithosphere and an average upper mantle viscosity of 5 × 1018 Pa s would suggest that the upper mantle under Iceland is most likely dry. Also, the results indicate that the presence of a plume under Iceland cannot explain the recent low viscosity values reported for Iceland. Using a larger extent and larger thickness of the Icelandic icecap during the Weichselian glaciation event (∼10,000 BP) this study predicts that during the Weichselian glaciation a slightly larger upper mantle viscosity ∼1019 Pa s and a lithospheric thickness of ∼100 km was present.