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Deglaciation effects on earthquakes and volcanism at a divergent plate boundary: Welcome to Iceland!

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In Iceland, ice caps have been generally retreating since the 1890's, when the current general warming trend started. Deglaciation causes widespread uplift in central Iceland, as recorded by countrywide GPS campaigns in 1993 and 2004 which showed vertical velocities of up to 25 mm/yr. We model the uplift using a 3D finite element model and ice loss estimates from the largest ice caps between 1890 and 2004. Our best fit 1D Earth model has a 10 km elastic layer on top of a 30 km viscoelastic layer with viscosity 1e20 Pa s, overlying a viscoelastic half-space with viscosity 1e19 Pa s. The inferred viscosity is higher than found by some previous studies that considered more spatiallylimited data sets.

We explore how 3D structures such as laterally varying lithosphere thickness, inclusion of a low-viscosity ridge system and lateral viscosity variation, all present in the complex structure of Iceland, affect the resulting uplift. Preliminary results indicate that data coverage near the glacial rims, or even better on nunataks, are essential to resolve such structures.

We use the modeled stress field to investigate the effect of deglaciation on fault stability and increased melt production beneath Iceland. Although the stresses can be readily used to calculate increasing or decreasing fault stability using e.g. the Coulomb Failure Stress (CFS) criterion, we show that such inferences need to take the background stress field into account. Using only the stresses induced by deglaciation, a mainly reverse stress state, the models predict a widespread decrease in fault stability. Including a general tectonic normal faulting stress field, and the flexural effect of the weight of the ice caps, we show that the deglaciation generally does not cause fault instability. Our models provide the pressure decrease at depth due to the melting ice caps and we revisit the decompression melting relationship by Jull and McKenzie (1996) to estimate the likely increase in melt production along the ridge and in the vicinity of the mantle plume. Using a triangular melting region below the rift zone, we estimate a significant increase of 0.04-0.06 km3/yr in melt production. This applies for the entire length of the rift zone, including volcanic centers in the Northern Volcanic Zone, Vatnajökull and the Eastern Volcanic Zone.