An Experiment in Glacio-Isostasy near Vatnajökull, Iceland, 1991

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Abstract *– Several lines of evidence suggest low subcrustal viscosity beneath Iceland. Values of the order of 10^{19} Pa s are compatible with high rates of crustal uplift at the end of the last glacial period, and post-rifting stress relaxation measured after the Krafla rifting episode. Present-day changes in glacial loading of the crust are expected to lead to rapid isostatic adjustments that should be easily detectable by geodetic methods. The volume of the Vatnajökull ice cap has decreased by 180 km^3 in this century. Model calculations indicate that this decrease should lead to crustal uplift in the area around the glacier at a rate of 5-15 mm per year at the present time and tilt away from the glacier. An experiment to measure this uplift was initiated in 1991-1992. A geodetic network of 10 points was installed in the area SE of the glacier and measured by GPS geodesy. The network contains points near the glacier edge as well as a point at a distance of 50 km, i.e. outside the affected area. Uncertainties in relative positioning are estimated to be about 1 cm in the horizontal components and 2 cm in the vertical. Gravity was also measured at the geodetic points as well as several older gravity points in the area. Indications of gravity changes were found, consistent with uplift of several mm per year.*

INTRODUCTION

It is well known that the crust and upper mantle respond to changes in surface loads and seek isostatic equilibrium. In some areas such as Fennoscandia and Canada the crust is still uplifting in response to the deglaciation at the end of the last glacial period. The rate of movement depends on the thickness of the lithosphere, the load distribution in space and time, and the viscosity of the underlying asthenosphere. Similar movements took place in Iceland at the end of the ice age, but they appear to have been completed in less than 1000 years. This has been used to infer that the viscosity of the asthenosphere beneath Iceland is at least an order of magnitude lower than that beneath the continental areas (Einarsson, 1966). This problem