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Post-glacial rebound of Iceland during the Holocene

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The geodynamic context of Iceland provides the rare opportunity to analyse the combined effect of ridge and hot spot on the deformation processes. The ground deformation results from rifting, magmatic (hot spot and volcanism) and ice loading/unloading. We present in this study a quantitative synthesis of vertical crustal motions of Iceland during the Holocene time with a focus on the postglacial isostatic rebound around the whole island after the retreat of the Weichselian ice cap.

Quantitative information, amounts and rates, of the postglacial rebound are obtained from sea levels deduced from elevated beach terraces, marine cliffs and deposits. From digital elevation models, field study, and a synthesis of previous works, we determined two ancient marine limits, one above and one below the present sea level, estimated at 10 ka $\pm$300 and 8150 $\pm$350 yrs BP respectively. The amplitude and the rate of vertical motions undergone by the Icelandic lithosphere were calculated from these marine levels, once their elevations were corrected with sea level changes.

We calculated an uplift phase of 40 to 170 m with a rate of 2.1 to 9.2 cm/yr between 10 ka $\pm$300 and 8150 $\pm$350 yrs BP. This stage corresponds to the postglacial rebound of Iceland following the Weichselian deglaciation. The analysis of variability of the uplift does not reveal a strong correlation with geodynamic structures (rift, thermal anomalies, and eruptive centres). Spatial variations of the postglacial rebound are mainly related to the local glacial dynamics (ice load and deglaciation history) rather than the geodynamic context. However, the relaxation time deduced from uplift data is 4167 years in west Iceland and 2000 years in south-southwest Iceland. We estimated viscosity from relaxation time, ranging from $2.1.10^{19}$Pa.s to $3.2.10^{19}$ Pa.s. The significant difference in the relaxation time is due to local variation of the lithospheric thickness due to the rift rather than to a variation of the viscosity.