A mantle flow model for the North Atlantic and its relation to seismic anisotropy and geochemical signature

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A temperature and flow mantle model for the North Atlantic, based on a section of the tomography model by Bijwaard and Spakman (1999), was derived under the demand of a maximum fit to the observed medium wavelength gravity field. The resulting an upper mantle temperature field reveals two distinct temperature anomalies, one beneath Iceland and the westerly adjacent regions with an excess temperature of 200°C, which is connected to a deep mantle root and, and a second anomaly, starting at a depth of 300 km beneath the Kolbeinsey Ridge, for which we estimated excess temperature of 120°C. The related flow pattern is essentially radial south of Iceland with ridge parallel flow along Reykjanes Ridge and divergent flow at the Kolbeinsey Ridge north of Iceland. This flow model well explains an influence of a possible Iceland plume on the Reykjanes Ridge, which is well established both in the occurence of rare earth elements and He-ratios of Mid-Atlantic Ridge Lavas, and predicts a deep and hot melt zone beneath Kolbeinsey creating a thick thick crust but without plume tracers which is in agreement with geochemical observations. For this flow model we also determined the longest axis of the finite strain ellipsoid (FSE) as well as the direction of the fast axis in multi-aggregate olivine (based on the formulation of Kaminski, 2002), including lattice preferred orientation (LPO) and dynamic recrystalization. The long direction of FSE and LPO are in good agreement and mainly reflect a large scale upwelling, some stronger deviations are observed in regions of a strong vertical flow component. Comparison of regional scale seismic anisotropy models based on Rayleigh waves (Levshin et al. 2001) show partly argeement to our fast directions of olivine derived from the flow model mainly south of Iceland. For the Greenland shield, however, we found a shift of 90° between the seismic anisotropy and the olivine fast direction.