Crustal formation and magma genesis beneath Iceland: Magnetotelluric constraints

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ABSTRACT
Two different models of the Icelandic crust and upper mantle have recently competed. The thin-crust model involves a crust ~10–15 km thick beneath the axial rift zones, thickening to ~25 km beneath older Tertiary areas. At the base of the crust is a thin layer containing 5–10% partial melt at temperatures around 1100 °C and with high electrical conductivity. Below the crust is an anomalous ultramafic mantle or an intermediate layer of mantle and crustal material containing 1–5% melt. According to the thick-crust model, the crust is ~20–30 km thick close to the coast and thickens toward the center of the island to as much as 40 km. A large amount of magnetotelluric data were reevaluated and a map constructed, which shows that the conducting layer is continuous beneath whole of Iceland except along the south coast. Joint interpretation of electrical, seismic, and temperature data provides many more constraints and more reliable results than does the use of one method only. There is a good correlation between the depth to the highly conductive layer, temperature gradient, and maximal focal depths. The uppermost 10–15 km of the crust are mainly formed by dike intrusions, lava eruptions, and continuous subsidence and mixing of magma in the rift zones. The lower crust is created by upflow of magma in layer 4, intrusions and underplating causing thickening of the crust with age. The thin-crust model explains the major features of crustal and mantle structure better than does the thick-crust model.