3-D electrical conductivity structure beneath the Hekla volcano in South Iceland

D. Kiyan[1], C.J. Bean[1], M.T. Gudmundsson[2], C. Castro[1], K. Árnason[3], Á. Benediktsdóttir[3,4], G.P. Hersir[3,5] and C. Hogg[1]
[1]Dublin Institute for Advanced Studies, Geophysics Section, Dublin, Ireland, duygu@cp.dias.ie
[2]University of Iceland, Faculty of Earth Sciences, Reykjavík, Iceland
[3]Iceland GeoSurvey, Reykjavík, Iceland
[4](now at) Reykjavík Energy, Iceland
[5](now at) Independent Geophysical Consultant, Iceland

SUMMARY

Volcanoes and volcanic eruptions are among the most spectacular and dangerous manifestations of Earth dynamics. Iceland hosts some of the most active and highest risk volcanic areas in the world. Volcanic systems are very complex, extending kilometres from deep regions of magma storage to shallow reservoirs providing volatiles and heat to subsurface geothermal circulation. Hekla volcano is located at the Mid-Atlantic plate boundary, at the junction of its transform segment, the South Iceland Seismic Zone and its rift segment, the Eastern volcanic zone. The volcanic system consists of a central volcano and a fissure swarm with an ENE trend. The volcano itself is a ridge-shaped stratovolcano where eruptions occur repeatedly on the same fissure. Hekla is the third most active volcano in Iceland, behind Grímsvötn and Katla, having had 18 summit eruptions in the last 1,100 years, with the most recent eruption in 2000.

Our pilot project MTHEK (MagnetoTelluric Assessment of the HEKla Volcano) aims at identifying low-resistivity zones at depth, which may be a proxy for melt accumulation and migration pathways, and may constrain the location of the proposed magma reservoir at the depths of 10 -20 km beneath Hekla. The initial 3-D inversion results of the impedance tensor and induction vector data from 20 stations yielded N-S oriented conductive anomalies within the upper two kilometres beneath and at the southeast part of the volcano. At greater depths (6-24 km), a striking NW-SE oriented conductive structure beneath the volcano is modelled. This anomaly/structure is perpendicular to the orientation of the Hekla fissure swarm. Our preliminary interpretation of the inversion model is that these shallow conductive structures may result from N-S oriented groundwater-filled fractures, which are characteristic of the South Iceland Seismic Zone, while the deeper, conductive NW-SE structure represents the magma reservoir region beneath Hekla.

Keywords: magnetotellurics, electrical conductivity, magma domain, Hekla, Iceland