Imperial College London

Natural Environment Research Council

2024_89_Phy_FS: Probabilistic Joint Inversion of Geophysical and Physicochemical Data from Iceland

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Sitting astride the mid-Atlantic ridge, where the North American and Eurasian tectonic plates diverge at a rate of 18-20 mm/year and being hypothesised to be centred over a mantle plume, Iceland is a unique geophysical laboratory for studying geodynamic processes possibly extending from the Earth's crust to the core-mantle boundary (CMB). Whereas the rift zones in Iceland are visible at the surface, evidence for a mantle plume – including a topographic high, excess crustal thickness and geochemical signatures – is subtle and although an ultra-low seismic velocity zone at the CMB has been cited as evidence for a deep-seated plume, others opine that magmatic upwelling is confined to the uppermost 400 km of the mantle, with little consensus on its lateral and vertical dimensions due to conflicting tomographic models that appear to diverge from the classical description of a vertically-ascending mantle plume and show greater complexity. Magnetotellurics (MT) is a complementary geophysical technique to seismic tomography that uses the physical principle of electromagnetic induction to quantify Earth's 3D electrical conductivity structure. The different sensitivities of seismology and MT to composition, physical state and temperature make them complementary techniques for characterising deep-seated fluids and partial melts associated with regions of active rifting and volcanism. However, whilst the seismic structure of Iceland's crust and mantle has been extensively studied, much less is known about Iceland's deep electrical conductivity structure.

In this PhD project, we will a) acquire MT data from an array of sites in Iceland and b) investigate the Iceland hotspot by developing and applying probabilistic joint inversion of multiple complementary datasets: MT data collected in Iceland as part of this work and existing seismological, petrophysical and thermochemical databases. This will result in a quantitative self-consistent 3D model and its uncertainties for the physicochemical state of the mantle below the Iceland hotspot and environs.

Requirements: Bachelor and Masters degrees in Physics, Geophysics, Data Science or similar; demonstrable programming skills in Fortran, MatLab, Python or C; willingness to participate in MT fieldwork in Iceland and to present research at international conferences; familiarity with Bayesian inverse theory, numerical modelling, seismology and/or electromagnetic induction is highly desirable; strong organisation skills; potential to become a future leader in multidisciplinary geophysics; willingness to participate in outreach activities.

If you wish to discuss any details of the project informally, please contact Dr Fiona Simpson (email: f.simpson@ic.ac.uk)