Geophysical Research Abstracts,
Vol. 11, EGU2009-7469-1, 2009
EGU General Assembly 2009

Joint Inversion of Magnetotelluric and Surface Wave Data in an Anisotropic Earth

E. Roux (1), M. Moorkamp (2), and A.-G. Jones (3)

(1) Dublin Institute for Advanced Studies, School of Cosmic Physics, 5 Merrion Square, Dublin 2, Ireland (estelle@cp.dias.ie), (2) IFM Geomar, Wischhofstrasse 1-3, 24148 Kiel, Germany (mmoorkamp@ifm-geomar.de), (3) Dublin Institute for Advanced Studies, School of Cosmic Physics, 5 Merrion Square, Dublin 2, Ireland (alan@cp.dias.ie)

Joint inversion of different kind of geophysical datasets can improve model resolution and has been commonly undertaken with datasets sensitive to the same physical parameter. Our work involves inverting simultaneously for different physical parameters and is built upon a joint inversion method originally applied to teleseismic receiver functions and long-period magnetotelluric data. This is a challenging problem since the two datasets are sensitive to different physical parameters (respectively, shear wave velocity and electrical resistivity). A joint inversion using this approach has been applied successfully to recover one-dimensional isotropic structure with both synthetic and real datasets from the Slave Craton (Moorkamp et al., 2007). We decided to expand this work to jointly invert surface waves dispersion curves and magnetotelluric data for anisotropic one-dimensional media.

Anisotropy can be related to present and past strain in the lithosphere and is a powerful tool for understanding the formation of a geological environment. At lithospheric and sub-lithospheric depths, seismic anisotropy is often explained in terms of aligned crystals of olivine, which is the most abundant mineral in the upper mantle. This preferential alignment below continental lithosphere can be formed by relative motion between plates and the upper asthenospheric mantle or be a frozen-in crystal alignment created at the time of lithosphere formation. The origin of electrical anisotropy is more controversial.

An approximate agreement between geoelectric strike and seismic fast axis direction in continental lithosphere has been found in various regions such as the Great Slave Lake shear zone (Eaton et al., 2004), across the Grenville Orogen (Ji et al., 1996) and the Sao Francisco Craton (Padilha et al., 2006). This suggests a common origin is plausible in some situations for both seismic and electrical anisotropy. These observations motivate our attempt to jointly invert seismic and electrical anisotropic parameters.

We invert simultaneously magnetotelluric data and Rayleigh waves dispersion curves, which both provide a good depth resolution. Assuming that seismic and electrical anisotropy have a common origin, we can thus expect superior resolution of azimuthal anisotropy for lithospheric and sub-lithospheric depths combining these two techniques.

We have examined the capabilities and limitations of this new approach with synthetic datasets and obtained encouraging results. We will apply this new joint inversion of anisotropic parameters to real datasets. The Slave Craton in Northern Canada is of particular interest but other regions will be investigated.