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

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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 synthetic datasets. A joint inversion of real data from the Slave Craton has shown that the main boundaries are sensed by both magnetotelluric and seismic measurements (Moorkamp et al., 2007).

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 expand the previous work to jointly invert seismic and magnetotelluric data for anisotropic one-dimensional media.

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.

The capabilities and limitations of this new approach have been examined with synthetics datasets and have given promising results. As a first try with real dataset, we apply this new joint inversion method to coincident magnetotelluric and seismic measurements from Central Germany. We aim to constrain the depth of the lithosphere asthenosphere boundary as well as anisotropic parameters at lithospheric and asthenospheric depths. This work is still in progress but results consistent with previous studies have been obtained so far.