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Electrical conductivity variations in Earth‘s mantle transition zone, based on ground observatory data

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We present initial results from application of a 3D spherical Earth non-linear conjugate gradients inversion code to existing catalogues of geomagnetic observatory response functions with periods in the range 5 – 107 days. Inverting several different subsets of these data, with varying regularization assumptions and model parametrizations, results in consistent large scale variations in conductivity of roughly an order of magnitude in and below the transition zone. The spatial pattern of high conductivity anomalies correlates well with the inferred locations of slow oceanic lithosphere that has subducted into or through the transition zone.
Because these areas of more conductive mantle are seismically fast and hence cold, temperature is not a viable explanation for the observed heterogeneity. Rather, the most likely explanation is that subducting lithosphere transports water into these areas of the transition zone, which is otherwise relatively dry. Based on recent laboratory measurements of the effect of water on the conductivity of transition zone minerals we infer water contents of up to 0.5 – 1.0 wt%.

Making use of a significantly expanded data set (wider frequency range, higher latitude and equatorial observatories, using satellite data) will be crucial to confirm and refine our initial estimates of deep mantle conductivity variations. This will require relaxing traditional source approximations, and developing more realistic models for the external fields. We briefly discuss our progress and future plans in this direction.