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A Comparison of Electrical Anisotropy at the Lithosphere- Asthenosphere Boundary under Continents and Ocean

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Long-period magnetotellurics (MT) utilzing periods above 20.000 s at which the electromagnetic field penetrates through the asthenosphere provides its conductance and its depth. With this technique and in particular the MT strike analysis, mantle conductivity under the continental lithosphere has been found to be anisotropic in many target areas in Europe and Australia. In contrast, seafloor magnetotelluric data show only low degrees of anisotropy.

It has been suggested that the electrical anisotropy is a consequence of the anisotropy of hydrogene diffusity in olivine cristals which are aligned due to lattice-preferred orientation (LPO) But the high conductivity anisotropy found for central Europe can not be explained with LPO alone because the degree of alignment is not 100%, the diffusion anisotropy factor does not readily translate to an conductivity anisotropy. Small anisotropy factors, however, can be explained with LPO.

He we propose an additional conduction mechanism at the base of the continental lithosphere: Random resistor network studies have shown that strong anisotropy is created if the interface between the conductive and the resistive structure has a fractal geometry. In addition, the ratio between the conductivities of the resistive and the conductive phase has to be large. Carbonatite melt is a possible candidate for the conductive phase, while the eroded base of the continental lithosphere could be the resistive phase. Absence of this ractal two-phase structure at the base of the young oceanic lithosphere would explain the low degree of anisotropy there.