Geophysical Research Abstracts,
Vol. 11, EGU2009-2888-1, 2009
EGU General Assembly 2009

Geomagnetic, magnetotelluric and other geophysical signatures of a hypothetical Hopkinson peak in the crust

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We discuss geomagnetic and magnetotelluric consequences of hypothetically high Hopkinson peaks in the Earth's crust (a sudden enhancement of magnetic permeability at the ferromagnetic-paramagnetic transition, in a few degree wide temperature range around the Curie temperature). Some geomagnetic anomalies of unknown origin (widely assumed to be due to commonly magnetized, huge rock bodies down to the Curie depth) can equally well explained by very thin (a few hundred meters thick), highly-magnetized layers at Curie depth, in state of second-order magnetic phase transition. The magnetotelluric effect of the Hopkinson peak is also observable on the surface. Since the magnetic permeability is usually neglected in magnetotellurics, inversions lead to very high-resistivity and very thick pseudolayers at midcrustal depths. We have already found a few field sounding curves, supporting this hypothesis. In multidimensional environment the magnetotelluric response is very complex. Observable two- and three-dimensional magnetotelluric anomalies require an extremely large (at least 100 times) enhancement of the ferro(i)magnetic permeability value. Whether it is realistic to assume such a high Hopkinson peak in the crust? Theoretically, and according to solid state physics experiments it does have reality, and at midcrustal depths the temperature stability and homogeneity would be able to maintain such a phenomenon. At the same time, the disordered nature of realistic earth materials and also the rock physics experimental results (where the Hopkinson peak has not been found higher than 3-4 times the ferromagnetic value) make this phenomenon questionable. Anyway, the results of Hopkinson peak measurements in rock physics laboratories cannot be accepted as a clinching argument, since neither the usual sampling rate on the temperature scale, nor the homogeneity of the temperature distribution within the sample (that is a heating or cooling rate), nor the external magnetic field have not been satisfactory to detect such a delicate phenomenon. The abnormal behaviour of the specific heat and of some elastic constants (and perhaps the electrical conductivity itself) at the Hopkinson peak temperature might lead to a new interpretation approach of some midcrustal structures and processes. Acknowledgement: Hungarian Scientific Research Fund, T68475