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Electromagnetic mini arrays (EMMA project). 3D modeling/inversion for mantle conductivity in the Archaean of the Fennoscandian Shield

M.Yu. Smirnov (1), T. Korja (1), and L.B. Pedersen (2)

(1) University of Oulu, Department of Physical Sciences, Geophysics, Oulu, Finland, (2) Uppsala University, Department of Earth Sciences, Uppsala, Sweden

Two electromagnetic arrays are used in the EMMA project to study conductivity structure of the Archaean lithosphere in the Fennoscandian Shield. The first array was operated during almost one year, while the second one was running only during the summer time. Twelve 5-components magnetotelluric instruments with fluxgate magnetometers recorded simultaneously time variations of Earth's natural electromagnetic field at the sites separated by c. 30 km.

To better control the source field and to obtain galvanic distortion free responses we have applied horizontal spatial gradient (HSG) technique to the data. The study area is highly inhomogeneous, thus classical HSG might give erroneous results. The method was extended to include anomalous field effects by implementing multivariate analysis. The HSG transfer functions were then used to control static shift distortions of apparent resistivities.

During the BEAR experiment 1997-2002, the conductance map of entire Fennoscandia was assembled and finally converted into 3D volume resistivity model. We have used the model, refined it to get denser grid around measurement area and calculated MT transfer functions after 3D modeling. We have used trial-and-error method in order to further improve the model.

The data set was also inverted using 3D code of Siripunvaraporn (2005). In the first stage we have used homogeneous halfspace as starting model for the inversion. In the next step we have used final 3D forward model as apriori model. The usage of apriori information significantly stabilizes the inverse solution, especially in case of a limited amount of data available.

The results show that in the Archaean Domain a conductive layer is found in the upper/middle crust on contrary to previous results from other regions of the Archaean crust in the Fennoscandian Shield. Data also suggest enhanced conductivity at the depth of c. 100 km. Conductivity below the depth of 200-250 km is lower than that of the laboratory based estimates of dry olivine. The last finding suggests that the base of lithosphere is very deep beneath the central part of the cratonic Fennoscandia.