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3-D imaging of the Central Lapland Greenstone Belt using magnetotelluric and seismic data

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New broadband magnetotelluric (MT) data were acquired in the Central Lapland Greenstone Belt (CLGB) area, northern Finland, during the field campaigns in 2009 and 2010. The measurements belong to an ongoing project at the Geological Survey of Finland. The project intends to create the target- and regional scale 3-D models of the CLGB area using potential field, seismic and electromagnetic data.

The survey area is located in the western and northern parts of the CLGB that is one of the largest Proterozoic greenstone belts in the world. In the north and west, the survey area is bordered by Proterozoic granitic rocks and intrusions. The CLGB consists of a Palaeoproterozoic (2.5 – 1.97 Ga) volcanic and sedimentary cover that was deposited on the Archaean (> 2.5 Ga) basement. The Kittilä Group greenstones, which form the core of the CLGB, are suggested representing an allochtonous unit, is bound by tectonic contacts with older units surrounding it (Hanski, 1997).

The collected MT dataset consists of the data from 80 sites with the frequency range of 300 – 0.002 Hz and the site spacing of 500 m - 4 km. At the first stage, the MT data were analyzed along a number of crossing 2-D lines. MT parameters were also examined as maps, because the central part of the survey area forms a magnetotelluric array. A regional electrical dimensionality and strike were studied with invariants and various decomposition techniques. Regional electrical dimensionality proved to be mainly 2-D and 3-D except for some northern MT sites in resistive granite-hosted regions, which fulfilled criteria for 1-D interpretation. Smooth 2-D conductivity models were obtained by inverting the determinant of the impedance tensor (Siripunvaraporn & Egbert, 2000; Pedersen & Engels, 2005) and TE- and TM- data jointly using the nonlinear conjugate gradient algorithm of Rodi & Mackie (2001).

Model resistivities range from 0.1 Ohm-m to greater than 20 000 Ohm-m in the survey area. The highest conductivities are related to N-S elongated graphite- and sulfide-bearing schists of the CLGB, which are visible also in the airborne electromagnetic data of the study area. Results show that these conductors have the deep roots of about 5 - 10 km. The highest resistivities emerge from granite intrusions that are located in the northern part of the study area. In the west, the resistivity of the CLGB is much higher with no indications of high-conductivity anomalies in the uppermost 40 km. However, in the westernmost part of the study area, a conductivity contrast is observed at the depth of about 10 km possibly indicating the contact zone of the two cratons of the Fennoscandian Shield, i.e. the Karelian and the Norbotten cratons (Lahtinen et al., 2005). 2-D inversion models are presented together with seismic data from the Finnish Reflection Experiment (FIRE) along the CMP-lines 4A and B. In the eastern and central parts of the study area, conductivity anomalies are usually associated with dipping reflectors, whereas such a relationship is not evident in the western part of the study area.

References:

Hanski, E. 1997. The Nuttio serpentinite belt, Central Lapland: An example of Paleoproterozoic ophiolite mantle rocks in Finland. Ofioliti 22 (1), 35–46.

Lahtinen, R.; Korja, A.; Nironen, M. 2005. Paleoproterozoic tectonic evolution. In: Precambrian geology of Finland : key to the evolution of the Fennoscandian Shield. Developments in Precambrian geology 14. Amsterdam: Elsevier, 481-531.

Pedersen, L.B. and Engels, M., 2005. Routine 2-D inversion of magnetotelluric data using the determinant of the impedance tensor. Geophysics, 70, G33-G41.

Rodi, W. L., & Mackie, R. L. 2001. Nonlinear conjugate gradient algorithm for 2-D magnetotelluric inversion. Geophysics, 66, 174-187.

Siripunvaraporn, W. & Egbert, G., 2000. An efficient data-subspace inversion method for 2-D magnetotelluric data, Geophysics, 65, 791-803.