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AMT survey in the Outokumpu ore Belt, Eastern Finland

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The Outokumpu ore belt comprises Paleoroterozoic turbiditic deep-water sediments enclosing fault-bound ophiolitic slices composed dominantly of serpentinites derived from oceanic upper mantle peridotites. These together form the allochthonous Outokumpu suite that was emplaced onto the Karelian Craton margin during the early stages of the Svecofennian Orogeny. The area which has been over 100 years among the most important mining regions in Finland is still supporting active mining and exploration. The main prospectivity is for polymetallic (Cu-Co-Zn-Ni-Ag-Au) sulfide ores that are hosted by carbonate, calc-silicate and quartz rocks fringing serpentinite bodies embedded in extensive formations of electrically conductive iron sulfide and graphite-bearing black schists that are showing no geochemical vectors to the ores (e.g. Peltonen et al., 2008). The presence of conductive schists makes also electromagnetic exploration of the sulfide ores challenging. However, the detection of the black schists at depth would be useful in locating new environments with potential for the serpentinites and prospective Outokumpu rock assemblage.
Audiomagnetotelluric (AMT) data has been recently collected to image subsurface conductivity structure of the belt. These data were acquired along five profiles transecting several key-features, including the Miihkali serpentinite, Archean Sotkuma gneiss window and the area SE from the Outokumpu mine. Altogether 91 sites were measured with the site spacing of 300 m – 2 km. AMT data (f = 1 - 10 000 Hz) were acquired during daytime whereas night-recordings enabled to obtain data at the frequency range of 0.01 – 10 000 Hz. Measurements were done using two Metronix 24bit ADU-07e broadband electromagnetic acquisition systems. Robust remote reference processing yielded mostly good data quality, particularly for data recorded during night-time.
The survey area is favorable for 2-D modeling as it is characterized by thin, laterally extensive conductors indicated by airborne electromagnetic data and regional strike analysis of acquired impedance tensor data. Two-dimensional inversion was done jointly for TE, TM- and Tipper data using the inversion code by Rodi and Mackie (2001). Results are visualized as sounding curves, sections of electrical conductivity and induction vectors. Results show dipping and sub-horizontal conductors southeast of the Outokumpu town. One c. 1 km deep sub-horizontal conductor is verified by a drill hole located approximately 8 km from the town. Gently eastwards dipping conductor was detected in the Miihkali serpentinite area. Conductors are absent in the uppermost $\sim$ 7 km below the Sotkuma gneisses, which consequently represent rather a uplifted fault block than a thrust sheet of the Archaean basement rocks, thus resolving an old debate concerning the crustal structure at Sotkuma.
In addition to AMT, high resolution seismic and airborne ZTEM surveys have been recently carried out in the study area providing a good opportunity to compare results from different deep penetrating geophysical methods.

References

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