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The upper crust of the Scandinavian Caledonides as seen by Magnetotellurics

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As part of the Collisional Orogeny in the Scandinavian Caledonides (COSC) project, broadband magnetotelluric (MT) data were acquired along a 60 km long profile following recent seismic reflection surveys. In total, 78 MT sites were installed with an inter-site spacing varying between 600 and 1000 m. The aims of this study are to provide resistivity information on the upper crust of the mountain belt and, together with other geophysical investigations, to better delineate the structures of the orogen and the processes that shaped it. Additionally, the MT data are expected to help determine the location of a future borehole, COSC-2. COSC-2 is planned to drill through the décollement zone associated to the graphitic rich alum shales. Since these shales are highly conductive, they are an excellent target for the MT method. Besides the long MT profile, one short profile with 5 stations was acquired nearby the already existing COSC-1 drill site to increase areal coverage and better constrain 3D resistivity structures. The new 3D information improves the existing 3D geological model around the borehole, that has been interpreted from seismic reflection and potential field data.
The impedance functions were calculated using a robust statistical procedure and the remote reference technique. MT data from Norway recorded at the same time in a field campaign by Oulu University were used for remote referencing. The data quality of the obtained transfer functions varies along the profile, being very good in remote areas, but quite noisy close to cities. Thus, a careful selection of the data set was necessary prior to analysis and modelling. 2D resistivity models of the 60 km long profile were estimated through inversion using the determinant of the impedance tensor, the TE mode, the TM mode, and the combination of TE and TM modes. The main features shared by the models are a resistor lying beneath COSC-1 extending down to about 2 km depth, a shallow resistor further to the east, and a very strong conductor at about 1 km depth below the upper shallow resistive layer. Using resistivity data from the geophysical logging of COSC-1 and the results from the co-located seismic reflection survey, it is possible to attribute these resistivity features to geological formations of the orogeny. Through this study, the 3D geological model around COSC-1 was improved and the near surface structures in the central part of the Scandinavian Caledonides were well imaged. In general, the MT findings correlate well with most previous interpretations but also allow refinement of these interpretations.