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Magnetotelluric measurements in the Atna area, Southern Norway

Maxim Yu. Smirnov (1), Sofie Gradman (2), and Odleiv Olesen (2)
(1) Luleå University of Technology, Sweden, (2) Geological Survey of Norway

New magnetotelluric (MT) data were acquired in part of the Scandinavian Mountains to study the crustal structure of the Atnsjö tectonic window where Precambrian basement is exposed. The study focuses on the investigation of the structure of the upper crust in the area and its relation to the magmatic intrusion of the Western Gneiss Region exposed to the east of the Caledonian nappes.

Magnetotelluric array consisting of 33 sites was measured in September 2017. The signal to noise ratio was relatively high especially at long period range, due to significant geomagnetic activity occurring at the time of the measurements. This resulted in good quality of the measured time series, especially in the so-called dead-band between 0.1 and 10 s, where geomagnetic activity is usually low. Consequently, the quality of the final estimates of magnetotelluric transfer functions is high.

We estimated MT transfer functions in the period range from 0.003 to 1000 s. Dimensionality and strike analyses using the phase tensor approach generally indicate 2D behaviour of the data with substantial 3D effects in the period band 0.1 -10 s. The phase tensor diagrams suggest the preferred strike direction to be N30E at periods longer then 0.1s. However, due to strong variability of the strike angles we choose to invert the determinant of the impedance tensor in order to mitigate 3D effects in the data on our 2D models.

Three crustal-scale 2D models are selected and analysed. We have chosen to invert data in two substantially different strike directions orthogonal to each other due to the 90o ambiguity in the strike determination. The 2D inversion models are consistent between all the profiles. Furthermore, we have inverted the full impedance tensor using the 3D inversion code ModEM. It resulted in an acceptable data fit and and the improved model is compatible with the 2D results. Hence, we base our interpretation on the results of both 2D and 3D inversions.

Resistive rocks, extending to the surface, represent the Precambrian basement comparable to that of the allochthonous Western Gneiss Region.. A previous study in the adjacent area, however, mapped near-surface conductors, located between the resistive Caledonian nappes and deeper Precambrian basement. The absence of the conducting alum shales and the deeper conductor in our study area lets us conclude that a Faltungsgraben shear complex to the west represents a crustal scale boundary between the Western Gneiss Region in the west and the Southwest Scandinavian Domain in the east.