Electrical conductivity of the Scandinavian Caledonides and the underlying lithosphere, Jämtland, Sweden

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We use five component magnetotelluric data from 60 sites along a 175 km long profile across the Caledonian orogen to explore electrical conductivity beneath the Central Scandinavian Caledonides in Jämtland, north-central Sweden. Data were collected in two phases. First phase provided AMT-MT data from 0.001 s to 100/1000 s and the second phase long period data reaching periods up to 10000 s. Combined data, covering period range from 0.001 s to 10000 s, yield information from near-surface to upper mantle. Our study focuses on determining the electrical conductivity of the (near-surface) accretionary wedge of the Caledonian orogen as well as the underlying autochthonous/parautochthonous carbonaceous alum shales. We investigate also the electrical conductivity of the Precambrian crust beneath the Caledonides and the deep margin of the Fennoscandian lithosphere.

The resulting model reveals remarkable subsurface resistivity variations ranging from less than 0.1 Ωm to over 100000 Ωm in the accretionary wedge and in underlying Precambrian basement. Main features of the model are:

(1) an electrically highly conducting layer beneath the Caledonides that images alum shales, the autochthonous Cambrian carbon-bearing black shales on top of the Precambrian basement,

(2) to the east of the Caledonian front, the autochthonous Precambrian basement is highly resistive with resistivities exceeding 100000 Ωm. The resistive unit extends far to the west beneath the Caledonides suggesting the presence of resistive basement granites under the Caledonides,

(3) a region of enhanced conductivity is detected at the depth of c. 150 km under the Caledonides in the western border of the Fennoscandian Shield yet the conductor is absent beneath the eastern part of the profile in the Fennoscandian Shield, proper.

Surface and groundwater quality in the Aijala and Hitura sulphide mines – AMD versus NMD

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Chemical quality of surface and groundwaters in the surroundings of the Hitura Ni mine and the abandoned Aijala Cu-Zn-Pb-Ag mine were compared. In Aijala, tailings have been dammed in a topographic depression. The upper part of the mine waste is oxidized which results in elevated metal and sulphate concentrations in tailings waters and groundwaters close to the facility, reflecting a rather typical AMD (Acid Mine Drainage). Surface waters discharging from the facility area are slightly acid and contain less sulphate and metals than the tailings waters due to precipitation in brooks. In Hitura, the wastewater and tailings are pumped as a slurry into an impoundment located near the mill. Groundwater contamination with sulphate, nickel and chloride close to the tailings facility has been reported (Heikkinen et al. 2002). Surface and groundwaters discharging from the tailings area represent NMD (Neutral Mine Drainage) influence (pH near neutral).

In both sites the main anion-cation relationships show that the impact of the mine can be detected in water chemistry even in low concentrations. Waters discharging from the tailings areas are of Mg-SO_4 – type, and in the surroundings, contamination is seen as a change from Ca-HCO_3- type water towards Ca-Mg – HCO_3-SO_4 –type water. This study shows that in environmental studies of mine areas, it is essential to understand the general chemical composition of the surrounding waters, affected by the ore type and the milling process.

Heikkinen, P.M., Korkka-Niemi, K., Lahti, M. & Salonen V-P. (2002). Environmental Geology 42, 313–329.