Geophysical joint inversion of the Gällivare mining area

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SUMMARY

Northern Sweden hosts a significant number of economic mineral deposits. Within the framework of the D-REx (Deposit to Regional scale Exploration) project, more than 400 MT sites were collected in a ~100x100 km^2 area of the Gällivare region. The project goal was to identify the deep mineral source regions and transport pathways/mechanisms within the upper mantle to the upper crust, for targeted exploration and characterization of the near surface zones of metal deposition and concentration.

An integrated study of MT, gravity, magnetic, and petrological data was carried out to characterize the subsurface distribution of geophysical properties such as conductivity, density, and susceptibility, and their correlations within a common model. The study was divided into two scales: full regional and deposit (40x40 km^2). The MT data were collected over geological units with high magnetic susceptibility compared to average cratonic surface rocks, due to a high magnetite content in significant parts of the study area. The high susceptibility zones are indicated by extreme aeromagnetic data anomalies. Therefore, we investigated the effects of highly elevated susceptibility on our primary impedance data. In such cases, magnetic permeability mat differ from free space values and the variation in permeability can be significant in comparison with the variation in bulk rock conductivity. When the relative permeability is higher than the commonly assumed value of one in modelling, it may lead to distorted impedance values and sounding curves corresponding to a resistivity other than the true value.

For the calculation, we use the jif3d package, which can invert available MT, gravity, and magnetic data individually and together in any combination in 3D. When applying the jif3d algorithm in this study, different binding strategies are selected to achieve the best resolution of the model and the greatest possible reduction of the interpretation ambiguity of the final model for the given geological structures and selected geophysical methods. In the code the cross-gradient and variation of information coupling approaches are implemented. We present individual geophysical 3D models and coupled inversions for both coupling approaches. The MT model exhibits the presence of a conductive anomaly approximately in the location of the main ore deposits, but high resolutions are limited due to the regional character of the collected MT data.

Keywords: MT model, magnetic permeability, joint inversion

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