D-Rex project in Fennoscandia, mapping large scale mineral systems

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SUMMARY

The formation and concentration of metals into economically viable mineral deposits require a combination of processes operating at various scales. Mineral deposits are a small component of a much larger geological framework known as the mineral system. This system encompasses a deeply seated source for fluids, a region rich in metals, an energy source that drives hydrothermal circulation, pathways for the migration of enriched fluids, and a depositional mechanism responsible for the formation of deposits and fluid outflow. The primary objective of the D-REx project is to enhance the identification of previously unrecognized endowed regions. Traditionally, the study of mineralized systems has concentrated on the near-surface identification and evaluation of individual resource bodies using shallow imaging techniques.

We have collected regional magnetotelluric datasets at three prospective areas in Sweden, Norway and Finland to generate the regional and deposit scale conductivity models needed to identify the deeper footprints of metal concentration. Here we focus on the results obtained in Northern Sweden. The Norrbotten region in northern Sweden is one of the most active mining areas in Europe and the hub of Europe's iron production. The northern Norrbotten ore district hosts a rather unique cluster of iron oxide-apatite (IOA) deposits, including the Kiruna and Malmberget iron mines as the most prominent examples. Genetic models for Kiruna-type IOA deposits are controversial and range from a magmatic origin to a purely hydrothermal origin.

About 400 MT sites in the area of 100x100 $km^{2.}$ were inverted to obtain a full 3D conductivity model of the entire crust. The 3D conductivity model contains extensive enhanced conductivity structure in the upper, middle crust at the depth range from about 10 to 30 km. The resolution of the 3D model is sufficient to map pipe-like deep feeders partly reaching the surface in the close vicinity of known IOA deposits. Enhanced conductivities in the crust can be explained by the presence of sulphides (grain boundary sulphides), iron oxides (magnetite), graphite or iron-rich ultramafic rocks. Based on a combination of MT 3D model with field observations and potential field 3D models, we suggest that the crustal conductor under northern Norrbotten represents a large volume of ultramafic rocks emplaced by underplating during the back-arc extension.

Keywords: Magnetotellurics, 3D inversion, Fennoscandia, mineral systems, mineral exploration