NORWAY'S POTENTIAL IN REE – MODELLING THE FEN CARBONATITE COMPLEX

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The Fen Complex is a carbonatite and alkaline complex, emplaced around 580 million years ago in Mesoproterozoic orthogneisses in Southern Norway. It is located about 110 km southwest of Oslo at lake Norsjø in the Telemark County. With a circular shape of about 4-5 km2 it most likely represents the roots of an eroded volcano.

Carbonatite and alkaline intrusive rocks are the primary source of Rare Earth Elements (REE). These are metals of fundamental importance for hi-tech applications and the production and storage of renewable energies. Worldwide only a handful of REE deposits are in production while none of the few European deposits is among them. Consequently, Europe is entirely dependent on the import of raw materials that are critical for industry and society. Preliminary estimates suggest that the Fen Complex may contain at least 50 million tons of REE-oxides, and if validated and exploitable this deposit would have international importance (Dahlgren 2019).

Due to a prominent density contrast between the intrusion and its surrounding rocks, gravity data is an important asset to study the Fen Complex. Based on 2D and 2.5D modelling, two different models were previously proposed. One suggests a cylindrical, vertical, downward extension of the complex, where the carbonatites constitute only the uppermost 0.5-1 km with denser, cumulate rocks below. A second model suggests a south-westward-dipping pipe of carbonatites with a core of denser rock.

Because of increased interest and the possible importance of the deposit, investigations in the Fen area have been intensified over recent years. Geophysical data were collected during several campaigns to aid in mapping and modelling. The data include district-scale airborne magnetic and radiometric data, as well as ground gravity data. The new gravity data include in addition two high resolution profiles crossing the centre of the intrusion. Two vertical boreholes were drilled at the gravity high, revealing that the REE-bearing carbonatites continue at least 1 km downward. Petrophysical analysis was carried out on drill core and field samples to further aid prospect-scale modelling.

The new data compilation, together with bedrock maps and field observations, builds the basis for the 3D modelling that was now used to gain a better understanding of the intrusion complex. Geophysical and geological modelling was combined in an integrated approach. Geophysical modelling on a district-scale took the lead, as the depth extent of the intrusion was a main target of the investigations. It was supplemented and refined in a geological modelling environment. Combining both disciplines adds constraints and geological meaning to the geophysics, making the model less abstract. On the other hand, the geological model benefits from depth information and surface patterns revealed by geophysics. The final model satisfies data and observations from both disciplines and gives a holistic representation of the subsurface.