Collisional Orogeny in the Scandinavian Caledonides (COSC): Seismic imaging of a "fossilized" orogen

C. Juhlin[1], H. Lorenz[1], P. Hedin[2] and B. Almqvist[1]

[1]Uppsala University
[2]Geological Survey of Sweden

The Scandinavian Caledonides provide a particularly well-exposed example of a Paleozoic mountain belt, formed by the collision between the Baltica and Laurentia continents. The Caledonides are often compared to the present-day Himalayan continental collision zone where understanding of the on-going India-Asia collision at depth primarily depends on indirect observations on the surface. In contrast, in the Caledonides, it is possible to directly observe and sample the "fossilized" Paleozoic collisional processes that occurred in the middle and lower crust. The geometry of the collisional structures, both of the thrust sheets and the underlying basement, can be constrained by combining surface geological data with geophysical data. This allows addressing several unknowns regarding the collisional process: the structure and physical conditions of the deformation and metamorphism during nappe emplacement, the effects of the orogeny on the basement of the underriding plate in the foreland of the mountain belt, and the mechanism that allows lateral transport of nappes over distances of several hundreds of kilometers. The COSC project is investigating these unknowns with two fully cored 2-2.5 km deep boreholes that will provide a unique c. 5 km deep composite section through some of the overriding thrust sheets, the main detachment and into the basement of the underriding plate. COSC-1 (drilled in 2014) aimed at providing a continuous section downwards from within the high-grade metamorphic Lower Seve Nappe into the underlying lower-grade Särv nappe. The second borehole, COSC-2 (drilling to start in April 2020), will investigate the main Caledonian detachment that separates the Caledonian allochthons from the autochthonous basement of the Fennoscandian Shield. Basement structures at the planned site are of particular interest and are within reach of the drilling. Scientific targets of the COSC-2 borehole include better understanding of the geometry of the main detachment and associated fault systems in the foreland and to determine the relationship between the basement deformation and the thrust tectonics in the nappes above. The location of the COSC-2 borehole is based on results from high resolution seismic profiling. Migrated and depth converted results show generally transparent rock down to about 700 m at the planned drillsite. Between 700 m and 1200 m the reflectivity is strong, but rather discontinuous, while below 1200 m distinct laterally continuous reflections are present. MT data acquired along the seismic profile detected a strong conductor with a resistivity of less than 1 Ωm at a depth of about 700 m at the planned drillsite. This conductivity boundary is interpreted to represent the uppermost Cambrian Alum shale. Below this depth, the resistivity structure is difficult to resolve. However, the total magnetic field data indicate magnetic Precambrian basement at about 1200 m depth. Combined, the geophysical and geological data indicate that the upper 700 m of Silurian and Ordovician strata will be dominated by greywacke with subordinate quartzite, limestone and shale. Between 700 m and 1200 m an imbricate system of shales, limestones and turbidites are expected. Below about 1200 m, Precambrian rocks, including magnetic granites with dolerite sills, are anticipated.