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Collisional Orogeny in the Scandinavian Caledonides (COSC): Some preliminary results from drilling of the 2.276 km deep COSC-2 borehole, central Sweden

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COSC investigations and drilling activities are focused in the Åre-Mörsil area (Sweden) of central Scandinavia. COSC-2 was drilled with nearly 100% core recovery in 2020 to 2.276 km depth with drilling ongoing from mid-April to early August. Drilling targets for COSC-2 included (1) the highly conductive Alum shale, (2) the Caledonian décollement, the major detachment that separates the Caledonian allochthons from the autochthonous basement of the Fennoscandian Shield, and (3) the strong seismic reflectors in the Precambrian basement.

Combined seismic, magnetotelluric (MT) and magnetic data were used to site the COSC-2 borehole about 20 km east-southeast of COSC-1. Based on these data it was predicted that the uppermost, tectonic occurrence of Cambrian Alum shale would be penetrated at about 800 m, the main décollement in Alum shale at its stratigraphic level at about 1200 m and the uppermost high amplitude basement reflector at about 1600 m. Paleozoic turbidites and greywackes were expected to be drilled down to 800 m depth. Below this depth, Ordovician limestone and shale with imbricates of Alum shale were interpreted to be present. Directly below the main décollement, magnetite rich Precambrian basement was expected to be encountered with a composition similar to that of magnetic granitic rocks found east of the Caledonian Front. The actual depths of the main contacts turned out to agree very well with the predictions based on the geophysical data. However, the geology below the uppermost occurrence of Alum shale is quite different from the expected model. Alum shale was only clearly encountered as a highly deformed, about 30 m thick unit, starting at about 790 m. Between about 820 and 1200 m, preliminary interpretations are that the rocks mainly consist of Neo-Proterozoic to Early Cambrian tuffs.

Further below, Precambrian porphyries are present. The high amplitude reflections within the Precambrian sequence appear to be generated by dolerite sheets with the uppermost top penetrated at about 1600 m. Several deformed sheets of dolerite may be present down to about 1930 m. Below this depth the rocks are again porphyries.

A preliminary conclusion concerning the tectonic model is that the main décollement is at about 800 m and not at 1200 m. Also the thickness of the lowermost Cambrian/uppermost Neoproterozoic sediments on top of the basement is much greater than expected (hundreds of meters instead of tens of meters) and likely to have been thickened tectonically. Detailed studies are required to assess the actual importance of the “main décollement” and the degree, type and age of deformation in its footwall. We can also conclude that the Precambrian basement is very similar to the Dala porphyries succession that are typically present farther south.

An extensive set of downhole logging data was acquired directly after drilling. Borehole seismic measurements in 2021 will help to define and correlate seismic boundaries with lithology and structures in the core. Unfortunately, work for describing the geology of the drill core in detail is still on hold due to Covid-19.