Collisional Orogeny in the Scandinavian Caledonides (COSC): From start to finish

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The Swedish Scientific Drilling Program was initiated in 2007 via a feasibility study grant form the Swedish Research Council (VR). The grant had two aims, first to investigate Swedish interest to join the International Continental Scientific Drilling Program (ICDP) and, secondly, develop a strategy for initializing scientific drilling projects in Sweden and abroad. As work progressed within SSDP it became clear that control of a national drilling rig capable of coring to 2.5 km would be beneficial for flexibly executing drilling objectives. In 2009 VR approved an application from SSDP for the procurement of such an infrastructure, known now as "Riksriggen". In parallel, approval was granted for Sweden to join ICDP and a number of applications were submitted for ICDP planning workshops. In 2010 the COSC ICDP planning workshop was held in Åre with the aim to define objectives for drilling two 2.5 km deep boreholes in the Åre-Järpen-Mörsil area (Gee et al. 2010, Lorenz et al. 2011). Further applications to ICDP (full proposals), the Swedish Research Council and other funding agencies resulted in the COSC-1 borehole being drilled to 2.5 km near Åre in 2014 (Lorenz et al. 2015) and the COSC-2 borehole to 2.28 km near Mörsil in 2020 (Lorenz et al. 2022). COSC-1 was drilled into the high grade Seve nappe with the top c. 1700 m consisting mostly of sub-horizontal and shallowly dipping intermittent layers of felsic calc-silicates/gneisses and amphibolite. First signs of increasing strain appear shortly below 1700 m in the form of narrow deformation bands and thin mylonites. Below c. 2100 m, mylonites dominate and garnets become common. A transition from gneiss into lower-grade metasedimentary rocks occurs between 2345 m and 2360 m. The lower part of the drill core is dominated by quartzites and metasandstones of unclear tectonostratigraphic position that are mylonitized to varying degree. The lowermost 800 m can be interpreted as a thick shear zone. COSC-2 started in Ordovician turbidites and penetrated a c. 80 m thick Alum shale at about 800 m, interpreted as the main detachment. Onwards to about 1200 m, rocks consist mainly of basal conglomerates and mixed siliciclastics covered by Cambrian coarse-grained sediment gravity flows grading into finer-grained turbidites. Magnetite rich Precambrian granitic rocks with dolerite intrusions were expected to be encountered below 1200 m. Instead, Precambrian porphyries are found, intruded by dolerites. These dolerite intrusions are interpreted to be responsible for the pronounced reflectivity observed in the area down to 15 km. One remaining geophysical enigma is the depth to the source rocks that generate the pronounced magnetic high that characterizes this part of the Caledonides. The COSC operational phase ended with the COSC-2 sampling party in summer 2022, about 15 years after the project was sketched out, and with much of the research still to be conducted.

References

Gee, D.G., Juhlin, C., Pascal, C. & Robinson, P., 2010: Collisional Orogeny in the Scandinavian Caledonides. *GFF 132*, 29-44.

Lorenz, H., Gee, D., and Juhlin, C., 2011: The Scandinavian Caledonides – Scientific Drilling at Mid-Crustal Level in a Palaeozoic Major Collisional Orogen. *Scientific Drilling 11*, 60–63.

Lorenz, H., Rosberg, J.-E., Juhlin, C., Bjelm, L., Almqvist, B.S.G., Berthet, T., Conze, R., Gee, D.G., Klonowska, I., Pascal, C., Pedersen, K., Roberts, N.M.W. & Tsang, C.-F., 2015: COSC-1 - drilling of a subduction-related allochthon in the Palaeozoic Caledonide orogen of Scandinavia. *Scientific Drilling 19*, 1-11.

Lorenz, H., Rosberg, J.-E., Juhlin, C., Klonowska, I., Lescoutre, R.,Westmeijer, G., Almqvist, B.S.G., Anderson, M., Bertilsson, S., Dopson, M., Kallmeyer, J., Kück, J., Lehnert, O., Menegon, L., Pascal, C., Rejkjær, S., & Roberts, N.N.W., 2022: COSC-2—Drilling the basal décollement and underlying margin of paleocontinent Baltica in the Paleozoic Caledonide Orogen of Scandinavia. *Scientific Drilling 30*, 43–57.