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The COSC-1 drill core – a geological sample through a hot allochthon and the underlying thrust zone

Henning Lorenz, Bjarne Almqvist, Théo Berthet, and Iwona Klonowska
Uppsala University, Department of Earth Sciences, Uppsala, Sweden (henning.lorenz@geo.uu.se)

The ICDP (International Continental Scientific Drilling Program) supported Collisional Orogeny in the Scandinavian Caledonides (COSC) scientific drilling project has the aim to study mountain building processes in a major Paleozoic orogen. COSC-1, drilled in 2014 near Åre (Sweden), was planned to sample a section from the hot allochthon of the Lower Seve Nappe through the thrust zone and into the underlying less metamorphic rocks of the Särv and/or Jämtlandian nappes. Diamond core drilling operations resulted in 2396.0 m of drill core with only about 2.5 m documented core loss (technical failure of the core catcher).

Down to about 1800 m, the COSC-1 drill hole penetrated a succession that is dominated by gneisses of varying compositions (felsic, amphibole, calc-silicate gneisses, and more), often garnet and diopside bearing. Meta-gabbros and amphibolites are common and apparently correlate well with seismic reflectors between 500 and 1000 m depth. Also marbles, pegmatite dykes and minor mylonites occur. These rocks are highly strained. Small scale structures (e.g. isoclinal folding) are occasionally discernible in the narrow section provided by the drill cores. (Young) Fractures are sparse. Only a set of very steep fractures results in fluid conduction zones at several levels throughout the drill hole. At 175 m and between 1200 and 1300 m, this results in the dissolution of calcite-rich bands in the gneisses to form “micro-karst”.

First signs of the thrust zone below the Seve Nappe appear just below 1700 m in form of narrow deformation bands and thin mylonites. The mylonites increase in thickness and reach a thickness of around 1 m between 1900 and 2000 m. Below c. 2100 m, mylonites are dominating and garnets become common (but are not present in all mylonites). The deepest rock of mafic origin (possibly amphibolite in the Seve Nappe) was identified at 2314 m, a transition from gneiss into lower grade metasedimentary rocks occurs between 2345 and 2360 m. The lower part of the drill core to TD is dominated by quartzites and meta-arkoses (field name) of unclear tectonostratigraphic position that are mylonitised to varying degree. The drill hole does not penetrate the base of the thrust zone. The rocks sampled in the lowermost part of the drill core are the thickest mylonites encountered, tens of metres thick and (again) rich in garnet.

Geological conclusions with relevance to mountain building have to wait for detailed analysis of the drill core. However, direct observations are:

- The gneisses of the Lower Seve Nappe are much more homogenous than expected.

- Thick (hundreds of metres) mafic bodies (Arnbom 1980, and unpublished geological maps) are absent. The maximum thickness in the drill core is about 30 m.

- The thrust zone below the Seve Nappe is much thicker than expected. After more than 500 m the lower boundary was not encountered.

- The drill hole seems to leave the Seve Nappe and enter lower grade metamorphic rocks. However, the mylonites at the bottom of the drill hole contain many and large garnets (up to cm size).