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ICDP drilling in the Scandinavian Caledonides: Preliminary results from COSC-1

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The Collisional Orogeny in the Scandinavian Caledonides (COSC) project is a multidisciplinary investigation of the Scandian mountain belt. Cenozoic uplift of the Scandes has exposed a lower- to middle-crustal level section through this Himalaya-type orogen, providing unique opportunities to better understand not only the Caledonides, but also on-going orogeny and the earthquake-prone environments of modern mountains belts. COSC will also contribute to our knowledge of mountain belt hydrology, provide new data on deep thermal gradients for paleoclimate modeling and potential geothermal energy resources of the area, contribute new information about the deep biosphere, and improve our understanding of the geophysical response of the sub-surface. Two 2.5 km deep fully cored holes will help achieve these goals with the first one, COSC-1, completed in late August 2014. COSC-1 targeted the high-grade metamorphic complex of the Seve Nappes (SNC) and the contact with the underlying allochthon. Drilling was performed using an Atlas Copco CT20 diamond core-drilling rig, operated by Lund University, that resulted in nearly 100% core recovery to 2.5 km depth. A crew of 6 on-site researchers examined the core as it came up and performed on-site documentation of it; including photography, optical core scanning, physical property measurements and biological sampling. A number of geophysical logging suites were run during and after completion of drilling, including sonic, density, electric, temperature and acoustic televiewer logs. A near four week long seismic acquisition program followed in the Fall of 2014 with combined surface and borehole surveys in the vicinity of COSC-1. On-site core analysis indicates that the SNC is about 2 km thick (the lower boundary is not well defined), consisting mainly of gneisses and amphibolites. A zone of extensive shearing is found in the lowermost 500 m of the borehole. Metamorphosed sandstones intercalated with garnetiferous mylonites in this lower part of the drillcore suggest that underlying thrust sheets of the Middle Allochthon have been penetrated, but not the low greenschist facies turbidites and other metasediments of the Lower Allochthon. Logging-while-pumping tests show that there are 8 significant hydraulically conductive zones in an otherwise tight rock down to 2.5 km. Pore waters appear to be relatively fresh throughout the borehole. Bottom hole temperatures are expected to reach 60ºC after equilibration, giving a geothermal gradient of over 20ºC/km. The observed high seismic reflectivity of the SNC is due to the large contrast in density and velocity between the gneiss and amphibolite. In general, the geophysical response on the surface is consistent with observations in the borehole.