



Zero-Offset VSP in the COSC-1 borehole

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As support for the COSC drilling project (Collisional Orogeny in the Scandinavian Caledonides), an extensive seismic survey took place during September and October 2014 in and around the newly drilled borehole COSC-1. The main aim of the COSC project is to better understand orogenic processes in past and recently active mountain belts. For this an approx. 2.5 km deep borehole, with nearly 100% core recovery, was drilled in the Scandinavian Caledonides, close to the town of Åre in western Jämtland/Sweden.

The seismic survey consisted of a high resolution zero-offset VSP (vertical seismic profiling) and a multi-azimuthal walkaway VSP experiment with receivers at the surface and in the borehole. For the zero-offset VSP (ZVSP) a hydraulic hammer source (VIBSIST 3000) was used and activated over a period of 20 seconds as a sequence of impacts with increasing hit frequency. For each source point, 25 seconds of data were recorded. The wavefield was recorded in the borehole by 15 three-component receivers using a Sercel Slimwave geophone chain with an inter-tool spacing of 10 meters. The ZVSP was designed to result in a geophone spacing of 2 meters over the whole borehole length. The source was about 30 meters away from the borehole and thus, provides a poor geometry to rotate 3C-data in greater depths. For this reason, a check shot position was defined in about 1.9 km distance to the borehole. With this offset shots, it is possible to rotate the components of the 3C receivers and to concentrate the S-wave energy on one component and thus, increase the signal-to-noise ratio of S-wave events. This offset source point was activated periodically for certain depth positions of the geophone chain. The stacked ZVSP-data show a high signal-to-noise ratio and good data quality. Frequencies up to 150 Hz were recorded. On the vertical component, clear direct P-wave arrivals are visible. Several P-wave reflections occur below 1600 meters depth.

After rotating the components, further processing steps will be applied to sharpen the signal shape by signal deconvolution and to separate the upgoing and downgoing wavefields by f-k-filtering. P- and S-wave velocities as well as reflection events will be compared to available information from logging and geological interpretation of the drilled cores.