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Crustal structure in the Kiruna area, northern Sweden, based on seismic reflection profiling

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Northernmost Sweden is currently one of the most active mining areas in Europe. In order to better understand the regional three-dimensional crustal structure and to support deep ore exploration, we have acquired a 74 km long seismic reflection profile in the Kiruna area. The upper crust in this area is largely composed of various supracrustal units, which are dominated by metabasalts, acidic metavolcanics and clastic metasedimentary rocks, resting on an Archaean metagranitoid complex. All of these units have been intruded by plutonic rocks, and to variable degrees folded, sheared and metamorphosed, during the Svecokarelian orogeny. The profile crosses several steep ductile shear zones, some of which extend for hundreds of kilometres along strike. Many of the lithological contacts and deformation zones are expected to be seismically reflective. The profile is located only a few kilometres from the world's largest underground iron-ore mine in Kiruna, and closer to the profile there are several known ore bodies, some of which are active exploration targets.

For the seismic recording we used approximately 350 geophones in split-spread configuration, at a separation of 25 m. The main seismic source was the Vibsist system (an impact source), which normally was employed at every geophone station. We also fired explosive charges (8-16 kg) at a few locations distributed along the profile to image deeper structures, although at very low resolution. Wireless seismometers were placed along and to the side of the profile, mainly in order to achieve better velocity control and to study out-of-the-plane reflections. Some mining blasts in Kiruna were also recorded.

The upper crust in the area is quite reflective, most clearly demonstrated by the dynamite shot records. Some of the reflections appear to originate from steeply dipping structures. The dynamite shot records show a set of reflections at 3-4 s twt, corresponding to a depth of roughly 10 km, the explanation for which is unknown at present. Many of the dynamite shot records also show reflections from deeper in the crust.

The preliminary stacked sections based on the Vibsist data show reflections down to depths of at least 5 km, some of which have been tentatively interpreted to originate at the contacts between basalts and felsic metavolcanics. In the further data analysis, special focus is given to the processing of reflections from steeply dipping structures and to the integration of the low-fold dynamite and high-fold Vibsist data.