Geophysical Research Abstracts
Vol. 13, EGU2011-5031, 2011
EGU General Assembly 2011

Reflection seismic investigations and integration with geological and geophysical data in the Bergslagen Ore District, Sweden

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The Bergslagen Ore District is historically the most prosperous mining area of Sweden. In this study, regional scale land reflection seismic profiling has, for the first time, been used to study upper crustal structures, including a major deformation zone, in the region. Two nearly perpendicular seismic reflection profiles, each about 25 km long, were acquired in May/June 2010. Profile 1 strike in the N-S direction and lies to the east of an active iron ore mine, the Dannemora mine. Profile 2 starts about 2 km west of Profile 1, crosses the Dannemora mine and its lake, and continues nearly 10 km to the west. It also crosses a major deformation zone, the Österbybruk Deformation Zone and the Skyttorp-Vattholma Fault Zone east of the Dannemora mine. Profile 1 crosses several major shear zones that are clearly visible in the total field aeromagnetic map as well as in outcrops.

A SERCEL 408UL recording system was used for the acquisition with the capability of recording up to 400 channels. This capability allowed us to design an asymmetric split-spread geometry using 340 channels (100 tails in the down dip direction). Nominal source and receiver spacing was 40 m and 20 m, respectively. A reduced receiver and shot spacing (10 m) was used over the Dannemora mine in order to increase the resolution in this area, in particular to record high frequency signals related to the iron mineralization. A series of about 50 additional shot points west of the mine perpendicular to the Profile 2 were also acquired. The additional shot points may help constrain the 3D geometry of structures in the vicinity of the Dannemora mine.

Seismic data quality is good with clear reflections observed in a few shot gathers. Although the geology of the region is complex, the processing results reveal a series of steeply dipping reflectors, many of which can be traced to the surface and allowing correlation with surface geology. We implemented both post-stack and pre-stack migration algorithms in order to improve the image quality for the interpretation of Profile 2. The pre-stack migration was particularly useful for improving the image quality in the west where conflicting dipping events and a large gap in shooting occurs. Crossdip analysis was also performed to provide insight into the out-of-the-plane nature of some of the observed reflectors. This analysis revealed a reflector on the eastern end of the profile that was not clearly visible on the original seismic section because of the crooked nature of the line. This analysis also suggests that the Österbybruk deformation zone has a crossdip component of about 35 degrees to the south, which is consistent with the geometry of the zone from the geological map. Profile 2 images the Österbybruk deformation zone and/or the Skyttorp-Vattholma Fault Zone, the Dannemora main orebody and the Diamant 2 orebody, and a series of reflectors with varying dip in the western portion of the seismic profile. The seismic data suggest that the Dannemora main orebody may extend to a depth of at least 2.2 km. This work demonstrates the potential of reflection seismic methods to identify structures controlling faulting systems and mineralization in a complex and deformed crystalline environment. Processing of Profile 1 and 3D – shots across Profile 2 will continue in spring 2011.