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Reflection seismic characterization of the Grängesberg iron deposit and its mining-induced structures, central Sweden

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Reflection seismic investigation has been conducted on the Grängesberg apatite iron deposit where over 150 Mt of iron ore were produced until the mine closed in 1989. The mine infrastructure with shafts and tunnels extend down to ca. 650 m below the surface. Both natural and mine induced fracture and fault systems are today water-filled (some of them extending to the surface). The disputed ore genesis of the apatite-iron ores and its exploration potential due to large remaining quantities once again attracts both scientific and commercial interests. A good understanding of the geometry of mineral deposits and their hostrock structures at depth is essential for optimizing their exploration and exploitation. In addition, deep understanding of the fracture system is vital if mining activity is resumed as these may impact the terrain stability and seismicity, which may put at risk new populated and industrial areas.

To address some of these challenging issues related to the past mining and also to obtain information about the depth continuation of the existing deposit, two E-W oriented reflection lines with a total length of 3.5 km were acquired in May 2013 by Uppsala University. A weight drop mounted on an hydraulic bobcat truck (traditionally used for concrete breaking in demolition sector) was used to generate seismic signal. In order to increase the signal-to-noise ratio, several impacts were generated at each shot point and stacked together. The seismic lines intersect at high angle the Grängesberg ore body and open pit, as well as several mining-induced faults. A combination of cabled and wireless receivers placed at every 10 m was used for the data recording. Use of wireless receivers was necessary as deploying cabled sensors was not possible due to city infrastructures, roads and houses.

A careful analysis of the data suggested that several field-related issues such as (1) the crooked geometry of the lines (due to the available path and road network), (2) electric and vibration noise due to populated areas and roads, as well as a rock crusher working close to the line, (3) significant static variations (due to the variable nature of the terrain: forest, roads, open pit filled with 10s of meters of unconsolidated materials...), make this dataset similar to a city-kind dataset.

Preprocessing of the data first required the cable- and wireless- recorded sub-datasets to be merged using GPS time stamps (nanoseconds accuracy) registered in the active data. Vertical shift and stack was then carried out to stack all data available at each shot point.
Preliminary results from brute stacks exhibit evidences of reflections or diffractions. It is anticipated that further processing, involving especially appropriate static corrections and velocity analysis, would help interpreting such seismic events in relation to the ore body and its surrounding structures. Possible along-profile compartmentalization is also detected; further processing is however necessary before interpreting such features in terms of recent faulting.

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