Geophysical Research Abstracts
Vol. 19, EGU2017-12219, 2017
EGU General Assembly 2017

Imaging the state of the rock mass in the Kiirunavaara iron ore mine, Sweden, using local event tomography

Björn Lund (1), Karin Berglund (1), Ari Tryggvason (1), Savka Dineva (2), and Linda Jonsson (3)

(1) Uppsala University, Dept. of Earth Sciences, Uppsala, Sweden (bjorn.lund@geo.uu.se), (2) Luleå Technical University, Luleå, Sweden, (3) LKAB, Kiruna, Sweden

Induced seismic events in a mining environment are a potential hazard, but they can be used to gain information about the rock mass in the mine which otherwise would be very difficult to obtain. In this study we use approximately 1.2 million mining induced seismic events in the Kiirunavaara iron ore mine in northernmost Sweden to image the rock mass using local event travel-time tomography. In addition, relocation of the events significantly improves the possibility to infer structural information and rock damage. The Kiirunavaara mine is one of the largest underground iron ore mines in the world. The ore body is a magnetite sheet of 4 km length, with an average thickness of 80 m, which dips approximately 55° to the east. Mining production is now at a depth of 785 – 855 m. During 2015 the seismic system in the mine recorded on average approximately 1,000 local seismic events per day. The events are of various origins such as shear slip on fractures, non-shear events and blasts, with magnitudes of up to 2.5. We use manually picked P- and S-waves in the tomography and we require that both phases are present as we found that events from the routine processing need screening for anomalous P- versus S-travel times, indicating occasional erroneous phase associations. For the tomography we use the 3D local earthquake tomography code PStomo_eq (Tryggvason et al., 2002), which we adjusted to the mining scale. The study volume is 1.2 x 1.8 x 1.8 km and the velocity model grid size is 10x10x10 meter.

The tomographic images show clearly defined regions of high and low velocities. Low velocity zones are associated with mapped clay zones and areas of mined out ore, and also with the near-ore tunnel infrastructure in the foot-wall. We also see how the low S-velocity anomaly continues to depth below the current mining levels, following the inferred direction of the ore. The tomography shows higher P- and S-velocities in the foot-wall away from the areas of mine infrastructure. We relocate all 1.2 million events in the new 3D velocity model. The relocation significantly enhances the clarity of the event distribution in space and we can much more easily identify seismically active structures. One example of this is the clarity with which deformation of the ore-passes is correlated with the intensity and distribution of relocated seismic events. The relocations also show more structures in areas of the mine where rock stability is a significant problem. The large number of events makes it possible to do detailed studies of the temporal evolution of stability in the mine. We present preliminary results of time-lapse tomography in an area where a few events of magnitude 2+ occurred in September 2015.