Geophysical Research Abstracts
Vol. 20, EGU2018-5470-1, 2018
EGU General Assembly 2018

Re-processing seismic reflection data to calibrate the velocity field surrounding the Orkney M5.5 seismogenic zone to identify a capable fault

Hiroyuki Ogasawara (1), Musa Manzi (2), Raymond Durrheim (2), and Hiroshi Ogasawara (1)
(1) Ritsumeikan Univ., Kusatsu, Japan (ogasawar@se.ritsumei.ac.jp), (2) Univ. Witwatersrand, Johannesburg, South Africa

Several holes have been successfully drilled into seismogenic zones of M2.0 - M5.5 earthquakes in deep South African gold mines (ICDP DSeis), as reviewed by Ogasawara et al. (EGU2018-3624). The drilling targets include the seismogenic zone of the 2014 Orkney M5.5 earthquake. This event was the largest seismic event (M5.5) to occur in a South African gold mining district. The main and aftershocks were recorded by two strainmeters installed near the bottom of the mine at a depth of about 3 km, 46 in-mine 4.5Hz triaxial sensitive seismometer stations at depths of 2-3 km within a hypocentral radius of 2-3 km, and 17 surface strong motion stations within an epicentral radius of 25 km. The aftershocks are distributed on a nearly vertical plane striking NNW-SSE and are considered to define the “M5.5 fault zone”. The upper edge of this fault is located several hundreds of meters below the deepest level of the mine. The geological structure that hosted the M5.5 earthquake was unknown because the projection of the aftershock plane did not coincide with any capable fault or geological structure on the mining horizon.

In order to locate drilling targets more accurately and identify the responsible geological structure, we re-processed and reinterpreted 2D and 3D seismic reflection data acquired for gold exploration by the mining company in the 1990s and 2000s. A 2D seismic reflection line intersects the M5.5 fault, while the 3D seismic reflection cube is located adjacent to the M5.5 fault. We used the 2D reflection data to identify geological structures that might have hosted the M5.5 event; and the 3D reflection data, together with geological information from exploration boreholes drilled from surface or the mine workings, to calibrate the velocity field. A special effort was made to image geological formations and structures lying below the mining horizons. These structures had not been well-resolved during previous processing as they were not considered to be directly relevant to the assessment of the gold resource.

The first 817-m-long NQ DSeis hole was drilled from a chamber excavated at a depth of 2.9km below the surface, while the second 750-m-long hole is being drilled from the same site but in a slightly different direction (about 300-m-long as of 22 December 2017; Ziegler et al. EGU2018). We will integrate the borehole fullwave sonic data in the velocity calibration. These will also be presented at EGU 2018.

The calibrated velocity model, the reflection seismic image, and the interpreted geological structure will contribute significantly to our understanding the M5.5 Orkney earthquake and the modeling of the seismic rupture.