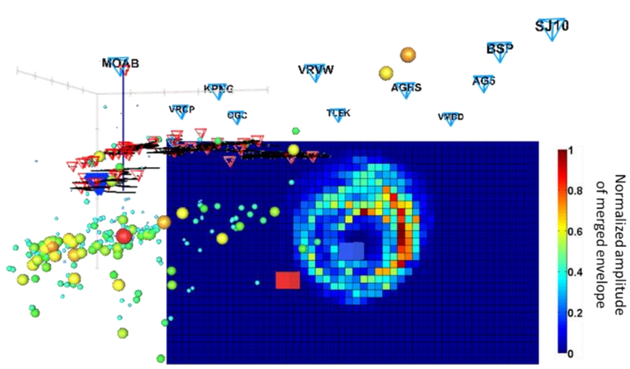
Paper Number: 3937

The 2014 Orkney M5.5: location of initial and main rupture origins and high energy sources

Hiroyuki Ogasawara[1], Hiroshi Ogasawara[1], Makoto Okubo[2], Artur Cichowicz[3], Denver Birch[3], Shigeki Horiuchi[4], Taka Utiura[1], Akimasa Ishida[1], SATREPS
[1]Ritsumeikan University, Japan
[2]Kochi University, Japan
[3]CGS, South Africa
[4]HomeSeismo Inc., Japan

In August 2014, the largest seismic event (M5.5) in a South African gold mining district took place near Orkney. The M5.5 and aftershocks were recorded by strainmeters installed at 3km depth hundreds of meters above the M5.5 fault, in-mine 46 4.5Hz geophone stations at depths of 2 - 3km within a radius of 2 - 3 km, and surface 17 strong motion stations (South African Seismograph Network; SANSN) within a radius of 25 km. Aftershocks were distributed on a nearly vertical plane striking NNW-SSE. The upper edge of this fault was hundreds of meters below the deepest level of the mine. This event allows us to collect fault material and fractures and to measure stress in detail because we can drill into the hypocenter. This drilling also reveals why the M5.5 (left-lateral strike slip) was different from induced earthquakes on mining horizons (normal faulting). Thus, it is important for not only seismology but also South African gold mine to investigate M5.5.

Velocity structure and station correction have not been calibrated, because SANSN of CGS was enhanced in 2010. The 4.5 Hz geophones saturated during the M5.5 before the S-arrivals making it difficult to pick the onsets accurately and locate the hypocenter. The geophone network didn't cover the northern part of the aftershock area. Therefore, firstly I analyzed SANSN strong motion data to locate origins of initial and main ruptures. I analyzed 19 aftershocks within a radius of 2~3 km from M5.5 hypocenter that were recorded both the SANSN and the in-mine geophones. As the hypocenters of aftershocks are better located by the in-mine underground 46 geophones, we calculated the SANSN station corrections based on the geophone's hypocentral locations. The original SANSN hypocenters are 1km deeper than those relocated using the station correction. The relocated SANSN hypocentres were no farther than 100m from the in-mine geophone hypocentres. The depths of the initial and main rupture origins thus relocated were 5.2km and 4.7km, respectively. Both were deeper from deepest level of the gold mine (3.0km). The differences in onset times of P wave between initial and main phases were dependent on azimuth, suggesting the rupture propagated from initial rupture origin in a direction of N20~30W and triggered the main rupture 0.6 seconds later.



Moreover, I located strong motion generation areas by the Isochrones back projection Method (IBM; [1]). Strong motion envelopes were back-projected on isochrones on a grid plane 6 x 10 km across with a 200m grid interval. IBM showed that the strong motion was generated in northern area near the mainshock origin, outside the active gold mine. At IGC I will report on the follow-up.

Figure 1. IBM image of Orkney M5.5. Red and blue and red squares origins of an initial and a main ruptures. Blue triangles: SANSN. Red triangles geophones. Spheres: aftershocks located by in-mine geophones.

References:

[1] N. Pulido, S. Aoi and H Fjiwara, 2006, Rupture process of the 2005 Fukuoka-ken Seiho Oki Earthquake by using an Isochrones Back-projection Method, *Earth Planets Space, **60**, 1-6*.