



The status of on-going drilling into seismogenic zones of M2.0 – M5.5 earthquakes from deep South African gold mines (DSeis)

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It is extremely difficult to investigate the seismogenic zones of large earthquakes directly as they are often several kilometres deep and suitable drilling sites are rarely available. Consequently, there are many questions related to earthquake nucleation and rupture that remain unanswered. Some of the most important scientific questions are listed in the ICDP Scientific Plan (2014-2019), which include:

- Physical properties that control rupture evolution and termination.
- Variation with time in physical properties in seismogenic zones and surroundings between larger events?
- Structural and physical differences for different size earthquakes
- Fluid and chemical properties of faulting that influence microbiological communities

We also address a local, but important question:

- How to explain the M5.5 Orkney earthquake that took place on unknown geological structure below mining horizon with different mechanism than usual mining induced earthquake?

In 2017 we commenced an ICDP-funded project (DSeis) to drill into the source zones of M2.0-M5.5 earthquakes located 1 - 4 km below the surface in four deep South African gold mines. The drilling targets were previously characterised by a Japanese - South African collaborative research project (2009-2015). Cores with a total length of about 1.9 km with minimal drilling-induced damage have already been recovered. We expect to complete the last ICDP-funded hole in March 2018. It will intersect the aftershock zone of a M5.5 earthquake beneath Moab Khotsoong mine. A Kinetically Activated Subsurface Microbial Sampler (KASMS, funded by the US NSF) will then automatically sample water and gas in order to investigate whether deep microbial life is associated with seismic activity in any way.

The DSeis cores are being logged, imaged, and catalogued using the ICDP DIS system. Stress is measured by analyzing elastic anisotropic deformation of cores following drilling. Borehole geophysical logging and surface seismic reflection data are also available. Using these datasets, a Source Inversion Validation (SIV) workshop, funded by the Southern California Earthquake Centre, will be held in Spring (northern-hemisphere) 2018 to determine the best rupture model of the M5.5 earthquake.

The depletion of gold reserves has led to changes in mine ownership and mine closures. Sibanye Gold has already closed Cooke 4 shaft, site of a hole into the source zone of a M2 earthquake. AngloGold Ashanti Ltd is finalising the sale of Moab Khotsoong mine, site of the hole intersecting the M5.5 seismogenic zone, to Harmony Gold Ltd in the first quarter of 2018.

In addition to the above, this talk also overviews DSeis drilling and related activity, which are much more detailed in other talk or posters in this EGU meeting.