Geophysical Research Abstracts
Vol. 21, EGU2019-7924, 2019
EGU General Assembly 2019

Rupture Imaging and Directivity of the 2014 M5.5 Earthquake Below a Gold Mine in Orkney, South Africa

Carsten Dinske (1), Marcel Müller (1), Maximilian Voigt (1), Jonas Folesky (1), Jörn Kummerow (1), Serge Shapiro (1), and Hiroshi Ogasawara (2)

(1) Freie Universität Berlin, FR Geophysik, Berlin, Germany (carsten@geophysik.fu-berlin.de), (2) Ritsumeikan University, College of Science and Engineering, Kusathu, Japan

We present a comprehensive study of seismicity from deep South African gold mines. Here, we find the unique situation that the seismicity consists of both mining-induced earthquakes and aftershocks triggered by the M5.5 Orkney earthquake which occurred in August 2014. We hypothesize that the finite size and geometry of the volume of stress perturbation, caused either by mining activities or by a large earthquake, controls the propagation of ruptures and influences the observed frequency-magnitude distribution. We use advanced approaches which involve both waveform-based and probabilistic methods. These methods include rupture propagation imaging and directivity analysis, and studies of the scaling of earthquakes magnitudes in finite perturbed rock volume. For the first time we apply these approaches to the observed seismicity in deep South African gold mines which also occurs in finite volume where the in-situ stress is perturbed. It contributes to a better understanding of seismogenic processes and, in particular, to an improved assessment of seismic hazard in an active mining environment. Our results indicate a unilateral rupture of the M5.5 main shock propagating nearly from North to South over a distance of about 5km. The images of back-projected seismic energy as well as the retrieved source time function reveal a highly complex rupture process of this earthquake which complements other results (Imanishi et al., 2016, Moyer et al., 2017). Furthermore, we see a clear spatial separation between the triggered aftershock cloud and the induced seismicity in the different mining horizons. The aftershock cloud is unilaterally situated in respect to main shock epicenter and aligned to the South which confirms the obtained rupture propagation image and directivity. The magnitude statistics of both aftershocks and induced earthquakes are noticeable affected by the finite size of the perturbed rock volume which inhibits the occurrence of larger magnitude events. The statistic of the event waiting times however differ for the two types of seismicity. The distribution of aftershocks in time shows clearly the typical Omori-Utsu behavior (i.e. a strict power-law decay) whereas earthquakes in the mines are observed at a rather constant level of activity emphasizing a Poissonian nature of acausal occurring events induced by mining operations.