Near-field Observations and Slip Distribution for the 2014 Orkney, South Africa Earthquake

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We examined the near-field records for the 2014 Orkney earthquake, Mw5.5, to infer source properties for this moderate-sized earthquake. The event was the largest recent earthquake associated with the deep gold mines of the region. Different from usual normal-faulting events that are induced on known structures of the mines, the M5 earthquake took place significantly below the mining horizon with a strike-slip mechanism on an unknown geologic structure. Seismic activity close to the Moab Khotsong and Great Noligwa mines is very well monitored by instruments installed on the surface and in the mine tunnels. The high sample-rate, 6 khz, geophones installed in the mine at depths of 1 to 3 km provide high-quality recordings of the mainshock and aftershocks.
The waveforms show that there is a small foreshock,about M1.8, located 1.6 km south of the mainshock hypocenter and at 0.6 sec before the mainshock. There is no evidence of any unusual character of the foreshock, or any significant deformation between the foreshock and mainshock.
Using lower frequency data, lower than 2.0 hz, the nearfield waveforms can be modeled using a finite fault slip inversion. The results show a slip distribution with two main patches of larger slip. One is located slightly shallower than the hypocenter to the north and another located slightly deeper than the hypocenter to the south. The area of the fault plane is relatively large for a M5 earthquake and this gives a rather small static stress drop.