The Aftershock Sequence of the 2011 Mineral, Virginia, Earthquake: Locations, Focal Mechanisms, Regional Stress and the Role of Coulomb Stress Transfer

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The aftershock sequence of the M_w 5.8, August 23, 2011 Mineral, Virginia earthquake was well-recorded by 36 temporary stations installed by several institutions. The detailed investigation of thousands of aftershocks resolves spatial details of the aftershock hypocenter distribution. And focal mechanisms of 393 aftershocks and stress inversion results exhibit substantial variability.

Aftershocks near the mainshock define a previously recognized tabular cluster with orientation similar to a mainshock nodal plane; other aftershocks occurred 10-20 kilometers to the northeast. A large percentage of the aftershocks occurred in regions of positive Coulomb static stress change and approximately 80% of the focal mechanism nodal planes were brought closer to failure. Moreover, the aftershock distribution near the mainshock appears to have been influenced strongly by rupture directivity. Aftershocks at depths less than 4 km exhibit reverse mechanisms with N-NW trending nodal planes. Most focal mechanisms at depths greater than 6 km are similar to the mainshock, with N-NE trending nodal planes. A concentration of aftershocks in the 4-6 km depth range near the mainshock are mostly of reverse type, but display a 90-degree range of nodal plane trend. Those events appear to outline the periphery of mainshock rupture, where positive Coulomb stress transfer is largest. The focal mechanisms of aftershocks at depths less than 4 km and those at depths greater than 6, along with the mainshock, point to the possibility of a depth-dependent stress field prior to the occurrence of the mainshock. Presumably, the aftershock process of this event is representative of other moderate to large shocks that have occurred and will occur in central and eastern North America, and a better understanding of the aftershocks of this event could shed more light on the state of stress in intraplate North America. The dataset and some of the preliminary results are available to public at the webpage of Virginia Tech Seismological Observatory (VTSO, www.magma.geos.vt.edu/vtso/).