Stress Triggering Analysis of the November 2011 M5.7 Oklahoma earthquake sequence

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On 6 November 2011, a M5.7 earthquake ruptured a ~N55E-striking trend on the Wilzetta fault in Prague, Oklahoma. This earthquake was preceded by a M5.0 foreshock that occurred on 5 November 2011 and followed by a M5.0 aftershock that occurred on 8 November 2011. We deployed three broadband seismometers after the M5.0 foreshock, and an additional seven broadband, eight short-period, and five strong-motion sensors after the M5.7 mainshock, as part of a PASSCAL RAMP experiment. In addition, we deployed ten USGS stations in an approximately 100 km long linear array east of the mainshock epicenter. The temporary stations recorded approximately 700 events in the twelve hours leading up to the M5.7 mainshock, which was then followed by an active aftershock sequence of ~1000 earthquakes in the hours and days after the mainshock.

We pick polarities and examine the S/P amplitude ratio of ~200 events with the HASH algorithm [Hardebeck and Shearer, 2002; 2003] to obtain focal mechanism solutions. We then use the Coulomb 3.3 software [Toda et al., 2011] to investigate the local Coulomb stress changes on the aftershocks and focal mechanisms due to the M5.0 foreshock, M5.7 mainshock, and M4.7 aftershock. The foreshocks and aftershocks located within the first few hours surrounding the mainshock suggest very active faulting, with events defining three near-vertical fault planes. The planes defined by the seismicity of the foreshock and mainshock strike 34º and 55º, consistent with the range of strikes within the Wilzetta fault zone. The M5.0 aftershock appears to have occurred on a plane striking nearly 90º, clearly distinct from structures that were previously mapped. We first examine whether the stress change induced by the M5.0 foreshock increases the stress at the hypocentral location of the subsequent mainshock. Similarly, we determine the combined stress change from the foreshock and mainshock at the hypocentral location of the largest aftershock. Then, we compare the spatial distribution of earthquake activity after each of the three primary event to the Coulomb stress changes imposed on fault orientations inferred from the aftershock focal mechanisms. These results will improve our understanding of earthquake interaction and triggering in this intraplate region.