FAULTING PARAMETERS OF THE SEPTEMBER 25, 1998 PYMATUNING, PENNSYLVANIA EARTHQUAKE

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Digest

Earthquakes in midplate regions have been considered enigmatic since they cannot be easily associated with major plate boundary deformations. In North America, small magnitude midplate seismicity is common in the central and eastern United States and Canada. On September 25, 1998 a moderate-size earthquake occurred in northwestern Pennsylvania, near the border of Ohio and Pennsylvania.

Rapid analyses of seismic waveforms generated by the m_{bLg} 5.2 Pennsylvania -Ohio border region earthquake suggested an unusual, non double-couple component to the faulting mechanism. The existence of a substantial non double-couple component to the faulting mechanism has important implications for the cause of the earthquake (hydrologically induced shallow faulting or "typical" eastern North America basement faulting?). Preliminary checks of the near real-time solutions suggested the non double-couple component may have been an artifact caused by the available data.

One of the goals of this study was to investigate the size of the non double-couple faulting component in the Pymatuning earthquake the other was to improve mechanism and depth estimates for the event. To investigate the detailed nature of this event I used the observed seismograms (from the United States National Seismic Network, USNSN, and from the Canada National Seismic Network, CNSN) to constrain faulting parameters including the source depth, fault strike, dip, and slip, and to explore the reason(s) why early estimates contained large non double-couple

source components. I performed moment tensor inversions with L2 and L1 norms for the closest stations (epicentral distance less than 1000 km), and the results agree with the previous near-real time studies. To test the significance of the non double-couple component I sought a solution constrained to be a pure double couple by checking the match to the observations for all values of strike, dip, and rake (grid search) for depths between 2.5 and 25 km.

The final results show that the Pymatuning earthquake can be explained with a pure double couple faulting mechanism, corresponding to a near-vertical, mostly strike-slip fault with planes striking 110°and 13°, with dips of 70°and 71°, and rakes of 20° and 159°. The estimated moment for this inversion is 5.6×10^{22} dyne-cm, which corresponds to a moment magnitude of 4.5. All three inversions (L2, L1 moment tensor and L1 Grid Search) match the observed seismograms well for a source depth less than 7.5 km. The best "formal" fit is for a 2.5 km deep source, but the 5.0 km depth fits the regional waveforms well. A short period teleseismic P-waveform from northwest Russia is more consistent with a very shallow 2-4 km source.

Although either solution (L2, L1, grid search) fits the regional waveforms well, the preferred solution is the pure double couple, with a depth shallower than 5 km. The Pymatuning earthquake was a small earthquake and most likely a simple rupture. The roughly east-west or north-south striking vertical strike slip mechanism agrees well with existing estimates of the stress field, and is similar to the 1986 Ohio earthquake mechanism (65 km northwest of the Pymatuning event).