Seismogenic Structures Derived from Finite Fault Process of the 1999 Chi-Chi, Taiwan Earthquake Sequence

Wu-Cheng Chi
Institute of Earth Sciences, Academia Sinica

The 1999 Chi-Chi, Taiwan earthquake has inflicted huge damage to Taiwan, but at the same time, the earthquake sequence generated possibly the best-recorded strong motion dataset in the 20th century. We inverted the strong motion waveforms for the finite source parameters of the 1999 Chi-Chi, Taiwan earthquake and its 6 large aftershocks. For each event, we derived a preferred model by doing grid-search on different focal mechanisms, hypocenters, rupture velocities, and dislocation rise times, as well as different combinations of stations. By testing a wide range of parameters we were able to derive more reliable slip models -- actually one of our slip models coincides with the fault imaged by a published seismic profile. We used the derived slip models to interpret the seismogenic structures near the Chi-Chi earthquake region and found some surprising results: (1) The mainshock slip is constrained in a triangular region bounded by the towns Shanyi, Puli, and Chusan, where the topography is low. (2) For the thrust aftershocks, they were all initiated near the east-dipping decollement where large strains occurred during the mainshock. However, the aftershocks ruptured not only updip on the decollement, but also updip on a backthrust, or downdip on a basement fault. As a result, the seismogenic structures derived from this study differ dramatically from previous studies. (3) The decollement is not a total stress barrier. A strike-slip aftershock has initiated in the basement, then ruptured across the decollement before releasing most of the seismic energy above the decollement. All of these results have implications for rupture process studies and can help interpreting the seismogenic structures of Taiwan mountain belt.