Geophysical Research Abstracts
Vol. 19, EGU2017-1599, 2017
EGU General Assembly 2017

Dynamic Source Inversion of Intermediate Depth Earthquakes in Mexico

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The source mechanisms of earthquakes at intermediate depth (50-300 km) are still under debate. Due to the high confining pressure at depths below 50 km, rocks ought to deform by ductile flow rather than brittle failure, which is the mechanism originating most earthquakes. Several source mechanisms have been proposed, but for neither of them conclusive evidence has been found. One of two viable mechanisms is Dehydration Embrittlement, where liberation of water lowers the effective pressure and enables brittle fracture. The other is Thermal Runaway, a highly localized ductile deformation (Prieto et. al., Tecto., 2012). In the Mexican subduction zone, intermediate depth earthquakes represent a real hazard in central Mexico due to their proximity to highly populated areas and the large accelerations induced on ground motion (Iglesias et. al., BSSA, 2002).

To improve our understanding of these rupture processes, we use a recently introduced inversion method (Diaz-Mojica et. al., JGR, 2014) to analyze several intermediate depth earthquakes in Mexico. The method inverts strong motion seismograms to determine the dynamic source parameters based on a genetic algorithm. It has been successfully used for the M6.5 Zumpango earthquake that occurred at a depth of 62 km in the state of Guerrero, Mexico. For this event, high radiated energy, low radiation efficiency and low rupture velocity were determined. This indicates a highly dissipative rupture process, suggesting that Thermal Runaway could probably be the dominant source process.

In this work we improved the inversion method by introducing a theoretical consideration for the nucleation process that minimizes the effects of rupture initiation and guarantees self-sustained rupture propagation (Galis et. al., GJInt., 2014). Preliminary results indicate that intermediate depth earthquakes in central Mexico may vary in their rupture process. For instance, for a M5.9 normal-faulting earthquake at 55 km depth that produced very high accelerations in Mexico City we found a moderate radiation efficiency and a typical rupture velocity (i.e. $\sim$70% of the shear velocity). Differences and similarities between the earthquakes studied here will help to better elucidate the physical processes originating intermediate depth earthquakes.