The 1992 Landers earthquake: effect of crustal heterogeneity on earthquake generation

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In order to understand the relationship between earthquake occurrence and crustal heterogeneities, we used 107,401 P- and 19,624 S-wave high-quality arrival times from Landers aftershocks and local earthquakes which were recorded by both permanent and temporary stations in Southern California to determine a detailed three-dimensional P- and S-wave velocity and Poisson's ratio structures beneath the Landers earthquake area. Our results show a correlation between the seismic rupture zones and crustal heterogeneities. The distribution of the Landers aftershocks is cluster-like and separated or terminated in the area where low-velocity anomalies exist. Most of the large earthquakes with magnitudes bigger than 4 occur in or around areas with high P-wave velocity. The possibility is that high-velocity areas are probably brittle and strong parts which can sustain seismogenic stress, and so can generate earthquakes. In contrast, low-velocity areas may have either higher degree of fracture, high fluid pressure, or higher temperatures where deformation is more likely to be aseismic. In addition, we infer that fluids exist in the Landers earthquake areas from the distribution of P- and S-wave velocity and Poisson's ratio. The existence of fluids may weaken the surrounding crustal rocks, then trigger strong earthquakes.