Absolute Stress Fields in the Source Region of the 1992 Landers Earthquake

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Earthquake focal mechanisms are often used to invert for spatial fields of the deviatoric stress tensor. Because shear stress equals frictional strength of the fault at the time of the earthquake, we can obtain the six components of the corresponding absolute stress tensors from focal mechanisms by combining such deviatoric stress fields with the Coulomb failure criterion. For a dataset of focal mechanisms determined for southern California earthquakes including the 1992 Landers earthquake sequence, we calculated the absolute stress tensors at their hypocenters with a fixed intrinsic friction coefficient (0.6) under three representative pore pressure conditions. The pore pressure condition is defined as the reference pore pressure which is the minimum pore pressure at the optimally oriented faults to the stress field. When applying each dataset of absolute stress tensors to an inversion scheme based on the Bayesian statistical inference and Akaike’ s Bayesian Information criterion (ABIC), we obtained three absolute stress fields in southern California just before the Landers mainshock. Each component of the absolute stress field was obtained as a continuous function (with estimation errors) governed by the reference pore pressure. We also calculated the coseismic stress field caused by the Landers mainshock, and added it to each absolute stress field to obtain the absolute stress fields just after the mainshock. We directly evaluated the temporal changes in the deviatoric stress fields due to the mainshock, and related variations of temporal stress changes relative to the reference pore pressure. Comparing this relationship with temporal stress changes observed through stress inversion, we determined the plausible reference pore pressure and absolute stress field in the source region of the mainshock. The optimum absolute stress magnitudes just before the mainshock were on average 44±13 and 74±16 MPa at depths of 5 and 10 km under the reference pore pressure of hydrostatic. We conclude that the faults that ruptured in the Landers mainshock were responding to Anderson-Byerlee stress conditions.

