Geophysical Research Abstracts
Vol. 15, EGU2013-5067, 2013
EGU General Assembly 2013

Stress rotation and recovery in conjunction with the 1999 Izmit M7.4 earthquake in the Marmara Region, NW Turkey

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Local rotations of the stress field may serve as an indicator to characterize the physical status of individual fault segments during the seismic cycle. In this study we focus on the pre-, aftershock-, and post-seismic phase of the 1999 Mw7.4 Izmit earthquake in northwestern Turkey. Using a compilation of focal mechanism data we applied a stress tensor inversion. By systematically considering error bounds of the resolved stress field orientation we find distinct temporal variations of the principal stress directions and of the relative stress magnitude along individual segments of the Izmit rupture that correlate with the local tectonic setting and along-strike variations of coseismic slip during the mainshock. The regional stress field prior to Izmit and following the three-month aftershock sequence reflects a well-resolved strike-slip regime with a $\sim$N130E$^\circ$ trending subhorizontal maximum principal stress and is thus in accordance with the dextral EW-trending North Anatolian Fault Zone. In contrast, the early post-seismic period is dominated by NE-SW extensional normal faulting regime below the Akyazi pull-apart basin hosting a slip deficit of $\sim$3m. A remarkable change is observed after $\sim$11 days when the aftershock rate that generally shows an Omori-decay increased at the eastern part of the rupture. There, the stress field at the Karadere fault turned back to strike-slip while below the Düzce Basin that later hosted the nucleation point of the Düzce earthquake it turned into an EW-extensional normal faulting regime. Interestingly, we could observe a significant change from strike-slip to normal-faulting and backwards propagating eastwards with an individual time delay within the segments.
Our results show that spatiotemporal stress field rotations are a useful indicator for variations of the loading status of individual fault segments during the seismic cycle and in particular during recovery from lateral variations of co-seismic slip during a M7.4 strike-slip earthquake.