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Mechanical and Structural Control on Aftershock Rupture Planes and Implications for Crustal Strength

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We observe that aftershocks for two well-documented seismic sequences occurring in extensional and compressional environments, the 1997 M_w=6.0 Colfiorito sequence (Central Italy) and the 1999 M_w= 7.5 Chi-Chi sequence (Taiwan), respectively, nucleate on planes favourably oriented for frictional fault reactivation. In particular, 89% of 329 and 81% of 121 events for the Colfiorito and Chi-Chi sequences respectively, are the result of fault reactivation processes on geological structures that represent well oriented planes within the regional stress field.

The nucleation of the aftershock ruptures on well-oriented planes for fault reactivation in the regional stress field, suggests that aftershock ruptures are mainly loaded to failure by tectonic stresses and the main shock induced stress perturbations, e.g. static stress changes or increase in fluid pressure, would trigger aftershocks on planes already close to failure.

In addition, the positive correlation of the orientation of the aftershock ruptures with the regional stress field for the two studied sequences suggests that the static stress drop induced by the main shocks -usually in the range of 1-10 MPa- is not enough to totally release the tectonic stress level. Therefore, following a major event, the orientation of the aftershock rupture planes is still governed by the regional stress field. In other words the stress level of the seismogenic volumes activated during the two intracontinental seismic sequences, was well above the stress changes induced by the main shocks.