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Implication of fault interaction to seismic hazard assessment in Sichuan–Yunnan provinces of Southeastern China

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Strong seismicity in China and adjacent regions is distributed over specific zones that configure rigid lithospheric subplates often bounded by active faults. Sichuan and Yunnan provinces correspond to a so–called rhombic shaped subplate that experiences the strongest intraplate seismicity in the territory of China. The region exhibits a complicated tectonic regime that consists of various rupture zones and different faulting types with strike slip prevailing, consistent with the regional stress field and geological background.

During the 20th century, 35 devastating earthquakes with magnitude Ms$\geq$6.5 occurred nearby densely populated areas causing a majority of casualties and deaths. The fact that Sichuan and Yunnan provinces are densely populated and industrially developed urges the necessity for investigating the occurrence pattern of the region's stronger events through the stress evolutionary model and also identifying the structures that are apt to produce a potential strong seismic event in the future. The tectonic complexity reveals a real challenge for our investigation, since the interaction is sought among different faulting types. Stress transfer seems not to be restricted in a single however segmented fault but also expands over the adjacent faults or conjugate zones often bringing them toward rupture. The characteristic of the tectonic setting is that various long strike slip, normal and some thrust faults exist within the same area, interacting with each other. Such interaction of strong earthquakes has been proved by previous investigation concerning the Xianshuihe fault zone (Papadimitriou et al., 2004) and the stress evolution for the northeast Tibetan Plateau from 1920 till present for a viscoelastic model (Wan et al., 2007).

A feature characterizing long fault zones is that they are found segmented and distinct parts of faults rupture each time until they complete a seismic cycle. Although fault surfaces are irregular and ruptures are more complicated, meaning that slip is not uniform but varies along its segments, it is believed that the approximate models are sufficient for identifying the areas of stress change, when they are computed for distances far from the causative fault. A subsequent event can be triggered on the faults having proper orientation and being close to failure, even if the stress change is only a few bars. Stress increment does not declare subsequent epicentre location but corresponds to the segment sufficient to fail because it has reached high stress level, in accordance with Coulomb Failure Criterion. Stress transfer among adjacent faults or fault segments, or conjugate faults is confirmed to dominate in this area. It is evidenced in the present study that strong earthquakes in a long fault zone undoubtedly encourage a second event along strike. In most of the cases triggering is evidenced and many events are located in bright zones where static stress changes have relatively high positive values. Most of them are concentrated in the places around fault tips or on the sites where fault changes its strike since there is a high stress increase. Characteristic examples are demonstrated in the case of Xianshuihe fault zones in northern Sichuan and Lancang–Gengma fault zone in southern Yunnan, where almost all the segments of the fault have ruptured in the last century.

There are cases however, where epicentres are found in stress shadows before reloading. This behavior could be attributed to misfits in the stress computation due to the complexity and the existence of minor faults in this multi–segmented crust. The accumulated result of possible post seismic effects, such as viscoelastic relaxation beneath the brittle part of the crust and transient postseimic slip below the rupture zone are not incorporated in the evolutionary model. Stress diffusion in each case needs further study since there is a wide variation in the post seismic behaviour of rupture. As it is suggested (Jaume, 1994) the postseismic slip when exists, will reinforce

both regional stress and stress change caused by coseismic slip. None the less, the results of our study, revealing a correspondence between positive changes and earthquake occurrence, evidence that Coulomb stress changes certainly influence the location and timing of the following earthquakes and can serve as a fundamental tool in seismic hazard assessment.