How variable normal fault geometry affects fault interaction and stress transfer: Examples from central Apennines, Italy

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Coulomb stress is routinely calculated following earthquakes in many different tectonic settings around the world to determine the transfer of stress into the surrounding crust and neighboring faults. In many of these studies, the faults modeled are of a planar geometry given by the focal mechanism of the earthquake. The coulomb stress transferred is resolved onto optimally orientated planes or planes of a defined orientation. However this is generally an inaccurate representation of active faults. Numerous observations of the surface expressions of active faults and coseismic surface ruptures from earthquakes show that they do not follow a single straight line at the surface and instead show a variable geometry (strike, dip and magnitude of offsets). It is also well established in the literature that the geometry of receiver faults greatly affects the magnitude of transferred coulomb stress. Hence the coulomb stress generated during an earthquake may be an inaccurate representation if the full variability of the fault geometry is not included. Preliminary results indicate that by including the variable geometry of the source and receiver faults, the coulomb stress pattern transferred to the receiver faults is more complex than calculated by a planar approach (Figure 1). This hypothesis is tested using the central Italian Apennines, an actively extending intra-plate region with a closely spaced, soft-linked array of faults. Holocene (15±3kyr) fault scarps are well exposed at the surface due to the carbonate bedrock lithology and low erosion rate. These fault scarps show variable geometry on a range of scales, from metre to kilometre scale corrugations and variations in the Holocene throw and slip direction along the fault length. These variations are well known due to extensive fieldwork conducted in the region and good visibility of fault scarps in satellite imagery. The Italian Apennines also has an extensive historical record which is complete for magnitude >5.5 earthquakes since 1349. These earthquakes can be assigned to faults with varying degrees of certainty, based on the distribution and magnitude of shaking. The effects of including variable normal fault geometry into coulomb stress calculations will be analysed using this structural and earthquake database. In particular, an earthquake sequence in 1703 where ruptures propagated from north-west to south-east is investigated, to see if the inclusion of the variable geometry can explain the sequence. Aftershocks following the 2009 L'Aquila earthquake will also be investigated to see if their distribution can be better explained by utilising variable fault geometries compared to planar faults.

Keywords: normal faulting, fault geometry, coulomb stress transfer

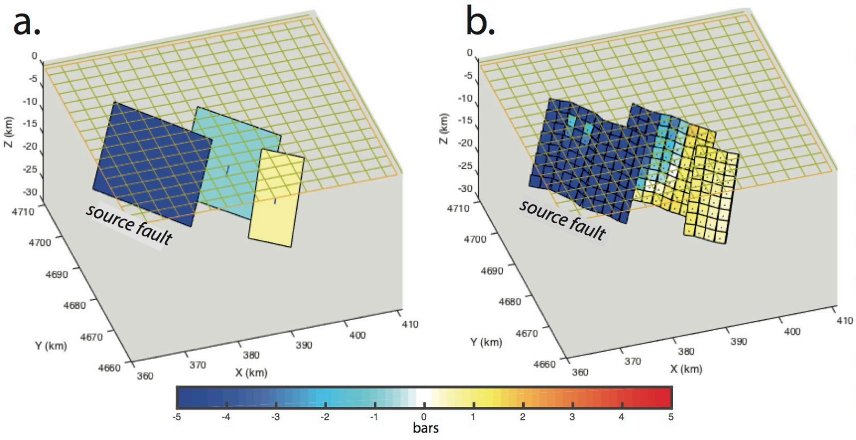

Figure 1- a.) standard *Coulomb* calculation for three planar faults. Blue indicates a coulomb stress decrease, red indicates a coulomb stress increase. b.) *Coulomb* calculation for three faults with variable geometry (strike variable). Colours as (a.). Note the complexity of the stress pattern generated for a variable geometry fault versus a planar fault.