Locating fault tips to aid fault length identification: an example from the Gulf of Corinth rift

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Crustal-scale active normal faults dominate seismic hazard in some regions and have been intensely studied. However, the lateral tips of these structures have received relatively little attention in the literature so their geometries are poorly known. This is an important omission because locating the tips of normal faults is vital in order to define fault lengths and calculate maximum expected earthquake magnitudes. Identifying tips will be challenging if their geometries, kinematics and rates of deformation are poorly known. Consequently, incorrectly identified tips and hence fault lengths may contribute to uncertainty in Probabilistic Seismic Hazard Assessment.

We investigate the geometry, rates and kinematics of active normal faulting in the western tip zone of the South Alkyonides Fault System (SAFS) (Gulf of Corinth, Greece) by detailed fault mapping and fault offset dating using a combination of new \(^{234}\)U/\(^{230}\)Th coral ages and in situ \(^{36}\)Cl cosmogenic exposure ages on wave-cut platforms deformed by faults.

Our results reveal that there is no clear singular fault tip and that distributed deformation in the tip zone of the SAFS occurs across as many as eight faults arranged within ~700 m across strike, each of which deforms deposits and landforms associated with the 125 ka marine terrace of Marine Isotope Stage 5e. Summed throw-rates across strike achieve values as high as 1.6 mm/yr, values that approach those close to the centre of the crustal-scale fault of 2-3 mm/yr from Holocene palaeoseismology and 3-4 mm/yr from GPS geodesy. Considering the uncertainty in the location of the western tip induced by distributed faulting, the SAFS fault length is uncertain by up to ± 6%, which equates to a total maximum magnitude uncertainty of Mw 0.1.

The calculated tip displacement gradient summed across parallel faults since 125 ka for the western tip zone of the SAFS is within the upper range compared to data from other normal crustal-scale faults. We discuss stress interaction between the SAFS and a neighbouring along-
strike crustal-scale fault as a potential cause of the observed fault complexity and anomalously high throw and investigate this by undertaking Coulomb stress transfer modelling. The results from the study are discussed within the context of fault-based seismic hazard assessment.

We conclude that identifying the locations of fault tips is challenging. While the results of this study may or may not be typical of other tip zones owing to the interaction, there is a need for further studies that explore the geometry of both non-interacting and interacting fault tip zones.