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Kinematic and 3D geometric evolution of a normal fault network, Corinth rift, Greece

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The Gulf of Corinth is one of the most active rifts in the world, with maximum N-S extension rates of up to 1.6 cm/yr in the western Gulf. The early rift (Plio-Pleistocene) is now uplifted along the southern coast of the Gulf recording consistent N-S extension since initiation of rifting (5 Ma). Syn-rift stratigraphy records a northward migration of fault activity, and a stepwise acceleration of extension rate accommodated on fewer, larger faults. Active faults (<1Ma) are concentrated along the south coast of, and below, the subsiding gulf, which is characterised in its western part by intense and ongoing micro-seismicity

The 3D geometry and kinematics of the normal fault system in the western Gulf is analysed in order to (a) understand the kinematic and geometric evolution of the fault system and to (b) assess and model seismic hazard. Data available are field data (traces, orientation and fault dip data) and geological maps, DEM, seismic reflexion lines (R/V Alkyon 2012, M/V Vasilios 2003, R/V Maurice Ewing 2001), bathymetric data (R/V AEGAEO 2001-2004), seismicity data (earthquake focal mechanisms, micro-seismicity, multiplets), geophysical data (inSAR, AIG10 borehole). Major uncertainty surrounds (1) the geometry of faults (planar or listric); (2) the nature of the zone(s) of micro-seismicity (detachment, brittle-ductile transition, zone of high fluid pressure or inherited structure); (3) the relationship between normal faults, micro-seismicity and major strong earthquakes.

The fault network is oriented WNW-ESE. Fault blocks have a length of approximately 15 km and lie in both onshore and offshore domains with an average trend of 110°EN. The southern margin is defined by en echelon fault systems dipping north (40-65°) whereas faults, in the offshore part and northern margin, are antithetic and dip dominantly to the south (30-60°). Of the 60 to 70 faults identified in the western part of the rift, only 20 normal faults are selected following specific criteria (accommodate earthquakes M>5.5, size range, active in the last 1M yrs, slip rate > 0.5 mm/a). The 3D modeller gOcad allows the integration of this different kind of data associated with different levels of uncertainties. Using appropriate upscaling to detailed fault traces and assumptions related to 3D geometries, two viable models of the active fault network have been constructed. The first model is defined by planar faults. The zone of micro-seismicity acts as a diffuse shear zone transferring deformation from main north dipping faults to blind faults at 5-6 km depth. The second model uses listric geometries and north-dipping faults root onto the layer of micro-seismicity.

These models are examined in terms of their coherence with available data and with faulting models (connectivity, distribution of displacement, cross cutting relations), and their implications for the relationship between the micro-seismicity, major faults and the distribution of active deformation in the upper crust. From a methodological point of view, this work is important for data integration in 3D structural modeling. This is an excellent data set to test new geomodeling algorithms and opens the way to reducing the gap between processing and interpretation of geophysical data.