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# High-angle faults control the geometry and morphology of the Corinth Rift

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The Corinth Rift is one of the most actively extending basins on Earth, with modern-day GPS extension rates of up to 15 mm/yr. The structure of the onshore and offshore parts of the rift has been intensely studied, however controversy remains as to the geometry of faults at depth. The rift has long been described as experiencing low-angle (< 30°) active faulting. The presence of an active low-angle detachment has been proposed from an interpreted cloud of microseismicity dipping at 12-20° at depths of 8-11 km. In contrast, others suggest that this microseismicity marks the brittle-ductile transition or that any detachment is incipient, and that low-angle faulting is not required to explain extension across the rift. This has led to an alternative interpretation where faults remain dipping at angles of 45-60°, as observed onshore, to the brittle-ductile transition depth. Other interpretations from seismic reflection data suggest that faults may be non-planar, being high angle at shallow depths (< ∼3 km) and then shallowing in dip to 25-45° at greater depths. One observation that the various fault models must be able to honour is the long-term vertical deformation pattern and geomorphology across the Corinth Rift such as: high uplift rates along the southern margin (1-2 mm/yr); offshore basement descending to depths of 3 km; and a northern margin that is generally stable or subsiding.

We compute the surface uplift and subsidence for faults of different geometries to assess which deep fault geometries can best recreate the first-order vertical deformation characteristics of the Corinth Rift. Slip rates appropriate for southern margin faults have been applied to model the deformation field over timescales of 1 Ma. We use PyLith, an open-source finite-element code for quasi-static viscoelastic simulations of crustal deformation. We model the uplift and subsidence fields associated with the following fault geometries: i) planar faults with dips of 45-60° that sole onto a 10° detachment at a depth of 8 km, ii) 45-60° faults, which change to a dip angle of 25-45° at a depth of 3 km and continue to a brittle-ductile transition at 10 km and iii) planar faults which dip 45-60° to the brittle-ductile transition at a depth of 10 km.

We find that models (i) including a 10° N-dipping low-angle detachment produce very limited uplift of the southern coastline and predict uplift along the northern margin. These uplift patterns do not match the key observation that the northern margin is stable or subsiding. Non-planar fault models (ii) also produce limited footwall uplift. Planar fault models (iii) create significant uplift of the southern margin and subsidence of the northern coastline, in line with observations. Therefore, we conclude that low-angle detachment faulting cannot play a major role in controlling the long-term geometry of the basin and that the Corinth Rift should no longer be considered an example of a rift dominated by low-angle (<30°) faulting. Planar faulting within the brittle crust is consistent with the total extension across the basin and also the vertical deformation patterns across the rift.