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Increasing slip-rates within a rapidly localising fault network from the Corinth Rift

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The young (<5 Ma) and active Corinth Rift, Greece, is one of the fastest extending rift zones in the world with present day extension rates of up to ~15 mm/yr. High extension rates combined with high sedimentation rates make the rift a perfect laboratory for investigating early rift development and processes of fault evolution within rifts. The offshore syn-rift sediments of the rift have recently been drilled during the International Ocean Discovery Program (IODP) Expedition 381, which importantly provides details and constraints on the nature and age framework of the basin infill for the first time. Combing results from IODP Expedition 381 with a refined rift fault network and stratigraphic framework for the entire rift, we examine fault activity throughout the Corinth Rift determining the time-scales and slip-rate variation during strain localisation and the establishment of a border fault system.

Results from IODP Expedition 381 confirm 10s-100s of kyr cyclic variations in basin paleoenvironment, alternating between marine and isolated/semi-isolated intervals as eustatic sea level fluctuated with respect to basin sills. Correlation of paleomagnetic data and palaeontological assemblages with relative sea-level curves provides key age constraints and timing of marine intervals over the last ca. 800 kyr. A dense network of marine seismic reflection profiles allow these age constraints to be extrapolated and applied to horizons throughout the entire rift, for which detailed displacement data have been collected for the rift fault network.

Along strike cumulative displacement profiles of faulting within the Gulf of Corinth indicate that overall basement deformation has been equally distributed between major S-dipping and N-dipping faults over the last ca. 2-2.5 Myr. This shows two peaks in cumulative displacement that coincide with the early development of two depocentres offshore Akrata and Kiato before ca. 800 ka. However, since this time the distribution of displacement has been proportionally increasing on N-dipping faults within the rift. Fault maps show that this is related to a decrease in activity on major S-dipping faults between ca. 800-340 ka, namely the Galaxidi fault and is accommodated by numerous small faults that form within the syn-rift deposits at this time. This process is reflected in isochore maps of the syn-rift sediments, which show that the central Gulf of Corinth experienced a switch in rift polarity from a dominant N-thickening depocentre to a dominant S-thickening depocentre.

Since ca. 800 ka the rift has experienced an increase in activity on numerous N-dipping faults along the southern margin, which form the present basin bounding border fault system. Fault slip-rate patterns for these faults show an evolution towards a coherent bell-curve distribution in activity by ca. 130 ka, indicating a linked fault system at depth. As these faults have become kinematically and geometrically linked, slip-rates across the fault system have continued to significantly increase up to ca. 5 mm/yr by ca. 130 ka. Thus the majority of the basins deformation has rapidly localised onto the border fault system during its establishment.