From surface processes modelling to high-resolution drilling record: resolving key controls on sediment production and stratigraphic development in the Corinth Rift, Greece

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The Corinth Rift, Greece, is a young (~5 Ma) sea-level controlled rift and one of the most rapidly extending areas on Earth. The unique combination of high strain and sedimentation rate with a closed drainage system and the well preserved syn-rift sedimentary record makes the Corinth Rift an ideal laboratory for understanding interactions between surface processes and tectonics and their implications for syn-rift stratigraphy.

The Corinth Rift has exceptional onshore and offshore field data coverage and as such it represents one of the best natural examples for model calibration. To this end, offshore sediment packages mapped from seismic reflection data were used to validate the surface process model pyBadlands, by comparing the total real and modeled sediment volumes and deposition patterns over the past 130 kyr. Our results shed light on the impact of tectonic forcing on sediment fluxes by showing that sediment supply to the rift is not primarily controlled by relief development, but instead by tectonically-driven tilting of the landscape. This is the first time that this has been demonstrated for a natural system and challenges the view that relief is a key control on catchment averaged erosion rates.

Moreover, recent drilling data from IODP Expedition 381 in the Corinth Rift generated a complete record of the syn-rift sequence offshore and provided the first age constraints to enable us to resolve sediment accumulation rates with high temporal resolution. The new cores record climate-driven cyclic variations in the basin paleoenvironment, alternating between glacial/isolated and interglacial/marine periods. A key finding is that sedimentation rates are markedly increased during glacial/isolated periods. Furthermore, bed frequency and bed thicknesses show significant stratigraphic variability and highlight the dominance of gravity flow sedimentation which represents > 60% of the total sedimentation during the last glacial-interglacial cycle.

This extraordinary offshore drilling data when combined with surface processes modelling will provide an unprecedented opportunity to address the challenge of resolving tectonic versus climatic controls on sediment production and stratigraphic development within rift basins.