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Sanjeev Gupta[1], Deirdre Commins[2], William M Phillips[3], Joseph A Cartwright[4] (1) Imperial College, London, United Kingdom (2) Imperial College, London, England (3) Dept. of Geography, Univ. of Edinburgh, Edinburgh, United Kingdom (4) Dept. of Earth Sciences, Univ. of Cardiff, Cardiff, United Kingdom

Constraining Rates of Normal Fault Growth Using In Situ Cosmogenic Surface Exposure Dating of Relict Fluvial Landforms, Canyonlands Graben, Utah

Understanding how faults grow and interact within fault populations is central to elucidate spatial and temporal patterns of landscape evolution in zones of active extension. We use cosmogenic surface exposure dating of relict geomorphic features to reconstruct the growth of fault systems in the Canyonlands Graben, Utah. We studied a 4.5km-long multi-segment fault array to determine the sequence and chronology of fault activity. The presence of a series of wind gaps in the footwall crest suggests that the drainage system has been progressively defeated and diverted by propagation and linkage of the fault segments. The rate of stream diversion is thus a proxy for the rate of fault array development. Wind gap ages were determined by 10Be surface exposure dating of quartz-rich sandstone bedrock surfaces on the floors of the windgaps. These data yield a clear pattern of decreasing age with decreasing tectonic offset. The oldest age (74.8 ± 2.8ka) is located at the crest of the central fault segment, and the youngest age (17.2 ± 3.7ka at an adjacent fault overlap zone. We hypothesize that lateral propagation of the tip caused the stream to be systematically diverted in a southerly direction, until finally it flowed in a topographic low between two interacting segments. Our study quantifies the changes in fault displacement rates as a response to segment interaction. We find anomalously high displacement rates (2.3 ±0.1mmyr-1) at the overlap zone, which we propose is due to mechanical interaction of the overlapping segments.

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