

## What caused the Main Himalayan Thrust (MHT) to ramp? Insights from analogue and numerical models

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Occurrence of any conspicuous ramp on the low angle basal detachment causes hindrance on the overall wedge progression and behaves as an asperity by localizing stress in the inter-seismic gaps. The mid-crustal ramp on the Main Himalayan Thrust (MHT) results in strain partitioning by focusing seismicity, including 2015 magnitude 7.8 Gorkha earthquake in the central Nepal Himalaya. However, the ramp structure is laterally discontinuous; even absent in some parts of the Himalaya (e.g. western Bhutan). Interestingly, it has been widely shown that the geometry of the basal detachment (in terms of presence or absence or geographic location of the ramp) provides first order control on the along strike variations in the structure, topography, low-temperature thermochronological ages, precipitation, exhumation and erosion patterns. Motivated by the absence of any mechanical explanation for these peculiar observations, we compare physical and numerical experiments with the geology of the frontal eastern Himalaya to show how the mechanically weak coal bearing Gondwana horizon controls the position of the basal detachment in space and time. Our modelling results confirm that the initial spatial distribution of the Gondwana horizon strongly influences the position of the mid-crustal ramp at different geographic location which resulted in segmented MHT structure (Fig. 1). The numerical modelling largely validates the physical experiments and explains the rock uplift and river incision pattern recorded in the Nepal Himalaya.

Keywords: mid-crustal ramp, Main Himalayan megathrust, seismicity asperity, Basal friction, Analog sandbox, Numerical model Underground



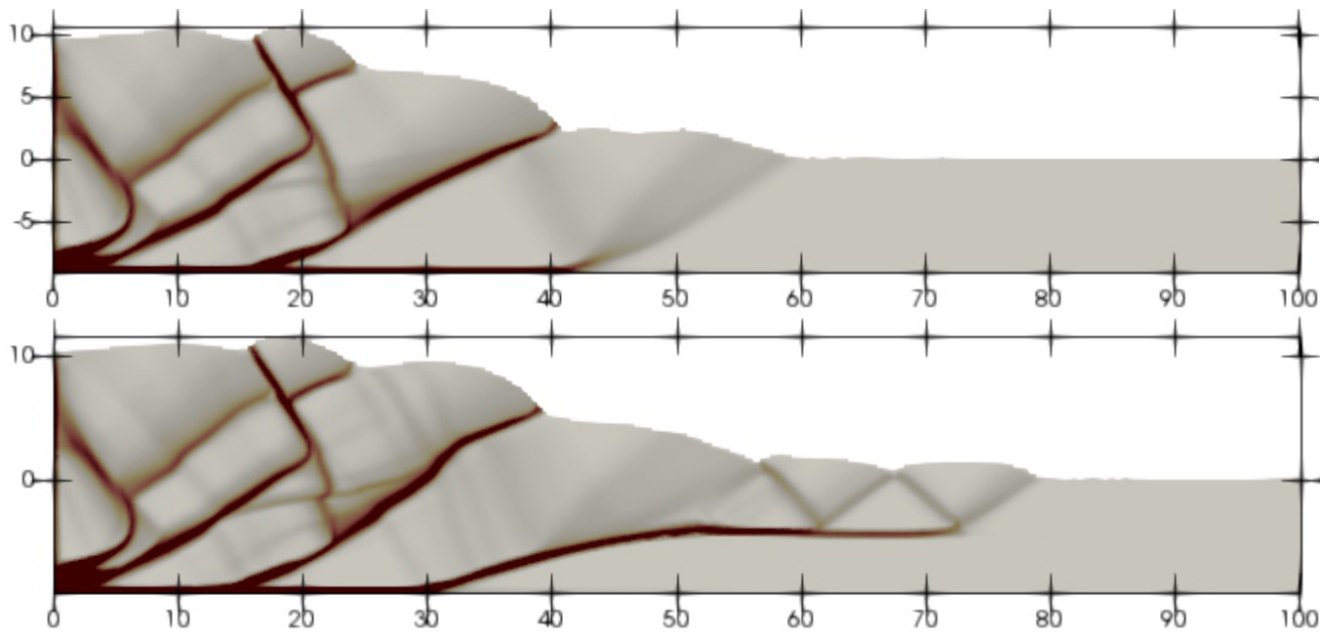


Fig. 1 Numerical sandbox simulation with visco-plastic rheology. Sequential thrust progression in a model containing a weak zone ( $\Phi_w = 10^\circ$ ). The weak zone shifted the thrust progression to a shallower depth. Plastic strain mapping clearly marks the location of ramping of the basal detachment.