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Role of backstop indenter shape on the evolution of curved thrust traces in contractional orogens: An experimental investigation

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The map view pattern of an emerging thrust-traces show a conspicuous cuspate-lobate pattern comprising 'salients' and 'recesses' in many orogenic belts. Macedo and Marshak [1] experimentally showed that the curvature of a fold-and-thrust belt is essentially influenced by geological parameters like thickness of basin fill, geometry of the hinterland indenter and strength of the basal detachment. However, curved thrust traces at a scale much smaller than the orogen-length like the 'Nahan salient' and 'Kangra recess' in the Himalayas are well known in literature. Some of these 'less-than-orogen-scale' salient-recess type curvatures of Himalayan thrusts have been interpreted as a result of 3D curvature of the thrust planes, Ray [2]. Although the 3D curvature is responsible for the curved thrust fronts, the indenter shape modifies the curvature and the overall wedge geometry. The Indian-Asian collision is the most widely recognized example of indentation. Despite of lot of works done on indentation tectonics, the extent to which the indenter shape controls the curvature of thrusts and the wedge geometry still remains unresolved.

Therefore, the present study investigates the influence of backstop indenter shape on the emerging fault-line, overall thrust pattern and wedge taper and its morphology through scaled model analog experiments. Different shapes of indenters (flat, sinusoidally curved from one end to the other, convex upwards and convex downwards) were used and it was observed that the wedge behaviour changes with respect to shortening by virtue of indenter shape. Flat indenters models were the basic setup of experiments which produced sinuous fault lines with a number of forelandward convex salients and concave recesses in map view where salient formed in front of a recess. Back-thrusting and pop-up structures were more conspicuous and significant. The wedge taper was also very gentle i.e. 9º. In case of sinusoidal indenters, the indenter was sinuous in shape in Horizontal or strike direction to see the backstop influence mainly in the map pattern of emerging thrust traces. The fault lines closely followed the indenter shape and the overall curvature was enhanced. Convex downwards and convex upwards indenter at the hinterland, were mainly designed to see the influence of backstop on thrust propagation and wedge geometry in vertical dimension or cross-section.the fault lines were observed to be discontinuous i.e. developing in one half of the sand-box intersected by the next consecutive fault line developing in the other half resulting in criss-cross arrangement of segmented fault lines at the center of the wedge, due to their intersection. The fore-thrusts were closely spaced and had undergone relatively less displacements. The shape of wedge was entirely different and was developed like an antiformal structure. The wedge taper was relatively high 14º - 16º.
The experimental study confirms that Indenter shape in 3D has important bearing not only on the curvature of the thrust lines but also on the overall wedge geometry.

References:

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