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Two critical tapers in a single wedge

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Thrust involving a ductile décollement (e.g. salt, over-pressured shales) like Zagros, Jura, Pakistan Salt Ranges, Cascades and Makran have in common a small cross-sectional taper, attributed to large thrust spacing and fast frontward propagation above the ductile décollement. Such a low cross-sectional taper has been analytically explained by approximating the ductile layer as a horizon with negligible shear strength.

We tested the development of thrust wedges involving a ductile basal décollement of uniform shear strength by means of laboratory experiments. The model consists of a sand layer with initial wedge geometry and a basal ductile décollement of constant thickness and shear strength made of silicone putty. 30% of bulk shortening is applied to the wedge at constant velocity. Thrusting starts in the middle of the wedge, followed by in-sequence frontward propagation. The back part of the wedge, between backstop and the closest thrust, remains undeformed; it passively advances over the base without internal deformation.

It appears that both domains have different critical tapers. The inner domain is in a critical state from the onset of shortening (i.e. the initial wedge is already critical), while the frontal domain steadily acquires a state of critical taper by thrusting. This result is at variance with the classical assumption that shortening of a wedge made of homogeneous layers creates a single critical taper. The experimental thrust wedges do show other features characteristic for weak décollement wedges like narrow cross-sectional taper, large thrust spacing and variety in thrust geometries. Application of the results to natural thrust wedges like the Jura Mountains could shed new light on their development and geometry at depth.