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On the validity of 2D critical taper theory in 3D wedges: defining a lateral deformation length scale

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For 2D critical taper theory to be applicable to 3D natural cases, cylindric deformation is a requirement. The assumption of cylindricity is violated in case of localized perturbations (subducting seamount, localized sedimentation) or due to a lateral change in decollement strength or depth.

In natural accretionary wedges and fold-and-thrust belts, along strike changes may occur in a variety of ways: geometrical (due to a protruding indenter or a change in decollement depth), through a lateral change in basal friction (leading to laterally different tapers), or through a change in surface slope (by strongly localized fan sedimentation on accretionary wedges). Recent numerical modelling results (Ruh et al., 2013) have shown that lateral coupling preferentially occurs for relatively small perturbations, i.e. the horizontal shear stress caused by the perturbation is supported by the system. Lateral linking of the wedge in front of a protruding indenter to the wedge in front of the trailing edge of the back stop leads to curved thrust fronts and importantly it has been noted that even outside the curved zone, where the wedge front is again parallel to the direction of tectonic transport, the lateral effect is still evident: both tapers are different from the analytical prediction.

We present results from a 3D analogue modelling parameter study to investigate this behavior more quantitatively, with the objective of empirically finding a lateral length scale of deformation in brittle contractional wedges. For a given wedge strength (angle of internal friction), we infer this to be a function of the size (width) of the perturbation and its magnitude (difference in basal friction). To this end we run different series of models in which we systematically vary the width and/or magnitude of a local perturbation. In the first series, the width of a zone of high basal friction is varied, in the second series we vary the width of an indenter and in the third series, sedimentation rate from a point source.

Ruh, J. B., T. Gerya, and J. P. Burg (2013), High-resolution 3D numerical modeling of thrust wedges: Influence of décollement strength on transfer zones, Geochemistry, Geophysics, Geosystems, 14(4), 1131-1155.