Gravity Driven Deformation on Passive Margins – Is Analogue Modeling the Ultimate Tool?

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Gravity driven deformation leads to a large variety of growth structures. The typical structural zonation consists of (i) an extensional upslope domain with tilted blocks, turtle-back anticlines and growth faults with associated rollovers, (ii) a downslope compressional domain, with squeezed diapirs, inverted graben, reverse faults growth synclines and polyharmonic folds.

Ductile flow of the basal décollement layer is accommodated by a combination of pure shear and simple shear. This affects the thickness of the weak layers through time. Meanwhile, sedimentation/erosion on the margin changes the thickness of the brittle cover. The resulting mechanical coupling between brittle and ductile layers therefore varies through time. We present here series of laboratory experiments on small-scale models used to study this coupling which is directly related to (i) the basal slope angle and (ii) the sedimentation rate. Models are composed of two layer slabs, with Newtonian silicone putty at the base and dry sand on top. Synkinematic sedimentation layers are deposited during the experiment.

Synthetic and antithetic growth normal faults can occur in the upslope part of the extensional domain, while synthetic growth normal faults characterize the down slope part. We demonstrate how the coupling between brittle overburden and ductile decollement control (i) the width of the deformation domains, (ii) the location of faulting in the overburden, (iii) the amount of rotation in the Growth fault/rollovers systems.

The downslope initial zone of compression propagates principally upslope in the formerly extensional domain. Through time, the shortening increases and is then characterized by folds, thrusts and squeezed diapirs. Where the folds are pinched-out, synclines can become detached pod-like structures encapsulated within the underlying ductile layer, and anticlines can isolate blobs of ductile material forming compressional diapirs that can extrude up to the surface. Unfolded layers develop into pop-up-type anticlines flanked by growth synclines.