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Geometry of half-grabens with shallow interlayered décollement: insights from sandbox experiments

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The geometry of the sedimentary filling of extensional basins is conditioned by: (1) the geometry of the normal faults; (2) the amount of extension and (3) the rheological profile. In this work we explore by means of analogue models the influence of the geometry of listric normal faults and the thickness of detachment levels interlayered within the pre-rift sequence. The experimental device used consists of a rigid wooden basement in the footwall with two geometries of listric normal faults, dipping at surface 30º and 60º, respectively. The hangingwall of normal faults consists of a layered sequence of dry eolian sand. Silicone (PDMS) layers with thickness of 0.5, 1 and 1.5 cm were used in different experiments overlain by a 1 cm thick pre-rift sand layer. Extension was achieved by pulling a mylar sheet underlying the sandpack in the hangingwall. During extension syn-tectonic layers were deposited by sieving fresh sand at constant intervals.

The differences in the sedimentary basin related to variable listric normal dips only affect the geometry of the deposits near the fault surface, steeper as the fault surface displays higher angle. However, the results obtained indicate a strong constrast between models with and without detachment level. In models without detachment level the geometry of the extensional basin is a half-graben with a roll-over anticline in the hangingwall. In models with detachment level, the areas located near the main basement fault show a wide normal drag, and the hangingwall basin shows a wide syncline geometry, with dips in the fault side progressively shallowing from bottom to top. Near the fault a secondary roll-over structure appears in some of the models. Other remarkable structures are: (1) nearly vertical reverse faults dipping towards the main fault, (2) antithetic faults in the footwall, appearing only in models with the 30º

dipping fault and silicone level thicknesses of 1 and 1.5 cm, and (3) listric normal faults at the end of the model opposite to the main fault. These faults are linked to the termination of the detachment level and show listric geometries, with sginificant thickness changes in the syn-tectonic units.

The analogue models presented demonstrate that the presence of a detachment level is a first-order factor in the geometry of extensional sedimentary basins and that syncline (steer's head) basin geometries are possible associated to an only main basement fault.