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Extensional deformation in a convergent margin: the Makran accretionary prism

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The offshore prolongation of the Makran accretionary prism can be observed in front of the Pakistani-Irani coastline as a network of ridges with a conspicuous expression on the sea bottom. The activity of north dipping-imbricate thrusts is responsible for this deformation. Regardless the lack of frequent seismic activity, the wedge front is active. Seismic lines acquired during the CHAMAK cruise in 2004 show recent sediment layers of the Oman abyssal plain being deformed by nascent thrusts. Between the coast and the continental platform, a series of normal faults can be identified on both outcrop inspections and seismic lines. This extensional deformation is thought to be the product of shear strain along a secondary detachment level stratigraphically higher than the root detachment below the accretionary prism. A series of analogue models have been carried out to understand the role of this second detachment level on the evolution of the uppermost part of the prism. A composite wedge formed by two layers of sand and one layer of silicone putty placed in between was pushed up along a tilted plane. The three layers thicken towards the backstop and the top of the wedged body is horizontal. The deformation is induced by a rigid-mobile backstop perpendicular to the base. Shortening is applied to the model from the thickest side towards the thinnest one. Several experiments were carried out varying the taper angle from 0.75° to 3° (defining the thickness) and the shortening velocity (strain rate), to observe the impact of these parameters on the deformation history and the final configuration of the wedge. Systematically, a thrust wedge was developed close to the backstop in the lower sand layer showing the classic configuration of fragile systems. Forward-verging thrusts being the dominant structures and backthrusts only developing as secondary features. Compression from the backstop was transferred to the upper sand layer through the silicone putty resulting in the development of several

thrusts. Depending on the applied parameters, these structures developed right above the inferior sand layer thrusts (high-low strain rates/low taper angle) or farther away towards the thin border of the model (low strain rates/high taper angle). In all the experiments the silicone layer and upper sand layers were upraised and tilted above the lower thrust wedge until a critical slope was reached. After this value was attained the silicone putty acted as a detachment on which normal faults, cutting the upper sand layer, where rooted. The intermediate silicone layer allows the decoupling between both the upper and lower sand layers. Thus, an offset can be observed between the two thrusts wedges with a gap of undeformed material in between. The extension processes developed in the upper sand layer must produce a difference in the shortening rates above and below the silicone layer.