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Spatial and temporal patterns in the dynamics of analogue accretionary wedges

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Analogue models of accretionary wedges have been studied for decades to understand the processes underlying the complexity of orogenic belts. Especially spatial and temporal varying deformation behaviour in wedge dynamics is an ongoing study. In this study we give an overview of recent experiments intended to simulate spatiotemporal deformation pattern at various time scales. We conducted experiments of two different set-ups of analogue sand models, representing the brittle upper crust.

From the first set of experiments we obtain a cross section of wedge deformation in particular 1) deformation time series characterized by first order new thrusts formation and second order thrust reactivation and 2) time series of the evolution of the wedge geometry. Analysis of the data consisted of characterizing the temporal fault behaviour in relation to the growing wedge geometry. Therefore also characterizing the wedge into zones of active and inactive segments.

A second set-up provided the surface expression of deformation correlated with high resolution recording of the push exerted by the growing wedge. The well correlated surface deformation and force data show varying patterns of deformation at different time scales e.g. 1) localization of strain at each thrust event, 2) between two accretionary cycle and 3) smaller scale stick – slip events.

Together the two experimental approaches provide a compilation of data that aids in unravelling the transient internal deformation style of the accretionary wedge. Our study uses the Critical taper theory as the bases for understanding wedge evolution through parameters that govern the force balance. Results show that strain localization, duration of a thrust event (related to the forces applied on the fault plane) and inactivity of the thrust are feedback interactions with the geometry and load of the wedge. Force balancing of the parameters as they change in time delineates that the mechanics are controlled by processes that employ least gravitational or frictional work. Therefore changing the role and activation of first order (new fault) and second order structures (reactivation of faults). Overall, it is observed that complexity in processes of the wedge are not primarily inherit but develop due to the interaction of varying styles of deformations.