Analogue modelling of southwest Taiwan thrust belt evolution

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Résumé

Southwest Taiwan is undergoing active orogeny and deformation, making it an ideal place to investigate mountain building with modern geodetic observations. The Taiwan mountain belt developed progressively from north to south due to the oblique collision between the Eurasian Plate and the Philippine Sea Plate. This led to the formation of a foreland basin system in the north, providing syntectonic sediments to the orogeny of southwest Taiwan. Previous studies also suggested that structural inheritance, including continental margin basement high (*e.g.,* Peikang High) and normal faults (*e.g.*, Yichu fault), and mechanical stratigraphy (*e.g.,* Gutingken mudstones), shape this region's morphology and dynamics. Today, southwest Taiwan is characterized with a sigmoid-shape thrust belt and counter-clockwise rotating surface motions.

To investigate the mechanisms of the deformation, we conducted analogue sandbox modelling. The experiments used a 60 × 90 cm sandbox mainly filled with dry sand to simulate brittle upper crustal behavior, scaled at _˜10-5 (1 cm = 1 km in nature). Each experiment involved 39 cm of total shortening. Basement high indentation, pre-existing weakness and surface processes (erosion and sedimentation) were tested in the experiments. Cross-sections of model results and surface motion during simulation were derived for further understanding of model evolution.

Our results demonstrate that lateral variations in basal friction can partially explain the sigmoid shape of the thrust system, but not the NNW-striking faults and surface motions. The presence of weak zone consistently localizes deformation, facilitates strain partitioning, triggers out-of-sequence thrusting, and leads to southwestward motion in surface displacements, aligning with GPS observations. A southward decrease in sedimentation contributes to fault strike deflection and further amplifies the surface rotation. With erosion in the northern part, the sigmoid shape of the thrust belts is also reinforced. Overall, our experiments show that none of an individual parameter sufficiently explains the observations in SW Taiwan. Instead, the combination of lateral basal and internal strength variations, and

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syntectonic surface processes leads to the sigmoid fault system and counterclockwise rotating surface motions. These findings underscore the importance of spatial heterogeneities and the interaction of multiple conditions in controlling thrust belt architecture and surface kinematics.

Mots-Clés: Fold and thrust belt, Analogue modelling, Surface processes, Taiwan