EGU21-5075, updated on 25 Jan 2022
https://doi.org/10.5194/egusphere-egu21-5075
EGU General Assembly 2021

Spatially varying ductile structures in fold-and-thrust belts: insights from laboratory experiments

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Fold and thrust belts (FTBs), formed by the collision of two continental plates, accommodate tectonic convergence through folding and faulting of crustal rocks. The effects of distributed deformation although ubiquitous in all fold-and-thrust belts, regionally occurring ductile structures are often interpreted as an outcome of localized deformation. Our study presents 3D laboratory-scale models using a viscous thin sheet as crustal layer to investigate the evolution of distributed ductile strain in FTBs. Here, we tested the role of mechanical coupling at the basal decollement (i.e., weak versus strong) on the nature of ductile strain variations within a deforming tectonic wedge. Convergence velocity has been kept constant in all experiments to avoid the influence of rate-dependence on viscous rheology. Our results reveal that the mode of wedge growth with changing basal coupling is crucial for varying strain pattern towards the hinterland. Weak decollement models yield a zone of constriction towards the central part of the hinterland, explaining the occurrence of isolated patches of L-tectonites and cross-folds in FTBs; while strong decollement condition allows the gravity-driven flow to be dominant over horizontal shortening, leading to rotation of earlier structures and formation of orogen-parallel recumbent folds, particularly towards the hinterland. The deformation towards the frontal part of the tectonic wedge, irrespective of coupling strength in both models is similar, forming a characteristic pattern of pervasive, hinterland dipping ductile fabrics. We correlate our findings to infer that spatio-temporal variations in basal coupling are responsible for the development of variably occurring ductile structures in FTBs.