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Structural and lithological control on anomalous high strain rate in fold-and-thrust belt in Southwestern Taiwan

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The interseismic deformation pattern in the fold-and-thrust belt of Southwestern Taiwan exhibits an extremely high and localized strain rate. Several models have been proposed to explain the geodetic observations in SW Taiwan; however, complicated structures and realistic conditions there were unconsidered in the previously proposed models and made it challenging to comprehensively understand the role of each factor and potential mechanisms.
In this study, we incorporate the observations from SAR Interferometry and simulations by finite element method (FEM), considering local geological conditions, to probe the mechanisms responsible for the deformation patterns in SW Taiwan.
To get a comprehensive observation, we first process the time series of InSAR images from both ascending and descending tracks of Sentinel-1 during 2016-2023 by small baselines and persistent scatterer methods, which are then benchmarked with GNSS ones. The InSAR result shows a localized deformation zone along the Lungchuang fault (LCF) with an vertical slip rate of up to ~20 mm/yr and unproportionally low horizontal slip rate. The highly uplifted region is not aligned with the present topography, suggests that the uplift might be transient.
Subsequently, we employ the DynEarthSol program to simulate the observed deformation pattern. Initial configuration of the model is constructed according to regional tectonic structures, various lithological properties, and fluid pressure conditions. We assess the deformation pattern caused by mud diarism, mud-cored anticline, duplex, ramp, back thrust, high-angle thrust, and specific material properties. The results indicate that the deformation pattern in SW Taiwan is dominated by duplex at depth and the high-angle west-dipping fault west of the LCF. Additionally, elevated fluid pressure within the mudstone layer (Gutingkeng Formation), supported by bore-hole measurements, formulates a weak and prone-to-creep fault zone, facilitating aseismic and triggered slip events.

Keywords: Fold-and-thrust belt; FEM; InSAR