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Large-scale interseismic deformation along the Altyn Tagh Fault determined from Sentinel-1 InSAR

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The 1600 km-long Altyn Tagh Fault (ATF) is a major intra-continental strike-slip fault along the Northern Tibetan Plateau, the slip rate of which has significant implications for our understanding of the present-day tectonic processes of the Tibetan Plateau region. We present an interseismic velocity field along ~1500 km length of the fault, derived from Sentinel-1 interferograms spanning the period between late 2014 and 2019. It is the first time such a large-scale analysis has been carried out for this fault with Interferometric Synthetic Aperture Radar (InSAR).

Using a modified elastic half-space model, we find significant strain accumulation along the 1500 km length of the ATF, at a relatively fast rate of ~10 mm/yr and quite localised along the fault. The results indicate an eastward decrease of the slip rate along the fault from 11.6 ± 1.0 mm/yr to 7.5 ± 1.2 mm/yr over the western portion to the central portion, whereas it increases again to 11.1 ± 1.1 mm/yr over the eastern portion. Furthermore, the results suggest that no significant creeping occurs along the fault.

We find a high slip rate of 11.5 ± 1.0 mm/yr along the south-western segment of the ATF, a region not typically covered by previous studies, is transferred to the structurally linked left-lateral strike-slip Longmu-Gozha Co Fault. It demonstrates that the generation of the NS-trending normal faulting events in this region, such as the 2008 Mw 7.2 Yutian earthquake, is ascribed to the EW-trending extensional stress at the Ashikule step-over zone between the two left-lateral faults. We also find a high surface shear strain rate greater than 0.4 μstrain/yr in this region, which could be caused by the stress loading effects of the recent seismic activities.

To investigate the pattern of strain localisation along the ATF, we fit a shear zone model to the derived long-term InSAR velocity field. Inverting for shear zone width reveals two broad shear zones along the ATF, where the strain is distributed over multiple strands rather than concentrated on a single narrow strand. The broad shear zones explain the high estimates of the locking depth found when using the elastic half-space model and also off-fault seismic activity on the strands away from the ATF in these areas. The results also show a relatively wider shear zone from the central portion eastward, where the ATF breaks into three parallel strands.

This study suggests that a slip deficit of around 1 m has been accumulated along the ATF over the last century, and indicates that the fault is capable of rupturing with the potential for a magnitude

7.5 or larger earthquake.