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Palaeo-earthquake magnitudes on the Dzhungarian fault, N. Tien shan, and implications for the rupture processes of intraplate strike-slip faults

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Long-term and present-day crustal deformation in the northern Tien Shan is poorly known, but is a key to understanding the mode of lithospheric deformation deep within the continental interiors, as well as the hazards posed by the slow-moving intraplate faults. Driven by the India-Asia collision, the NW-SE strike-slip faults and the E-W range-front thrust faults in the interior of Tien Shan together accommodate about 15-20 mm/yr of shortening. Here we focus on the NW-SE striking Dzhungarian fault (DZF) and the E-W striking Lepsy fault (LPF), which are large oblique strike-slip faults bounding the Dzhungarian Alatau, northern Tien Shan. Two large historical earthquakes in ~1716 and 1812 (Mw 8) were recorded in this region, and clear fault traces as well as scarps are visible from satellite images along some of the main faults. However, their geometries, slip rates, mode of deformation, expected earthquake magnitudes and recurrence interval have not been studied in details. A previous study suggested that the LPF ruptured in a seismic event around 400 yrBP that might be the 1716 earthquake known from historical records. Offsets of over 15 m were found over a fault length of 120 km, indicating a magnitude in the range Mw 7.5-8.2. The slip to length ratio for the LPF is unusually high, suggesting either that faults in this region are capable of generating very large earthquakes for a given fault length, or that the rupture length is underestimated.

Using a combination of high-resolution digital elevation models (DEMs) and orthophotos from High Mountain Asia (NASA), Pleiades optical imagery (CNES), drone photos and multi-temporal interferometric synthetic-aperture radar (InSAR) from the Sentinel-1 satellites, we identify the geomorphic signatures and quantify the long-term and short-term strain accumulation along the faults. The ~400 km DZF shows evidence for relatively 'fresh' rupturing along much of its length. We calculate an average lateral slip per event of 9.9 m from offset stacking analysis, which underlines the potential future large earthquakes on this fault. The proximity of the DZF and LPF ruptures and equivalent level of preservation opens the possibility that they were formed in a

single earthquake event, with a moment-magnitude greater than 8. We also present estimates of long-term and short-term rates of slip across the DZF in order to estimate average recurrence intervals and to build a kinematic model of the faulting in the Northern Tien Shan.