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Co-seismic and cumulative slip along the Kokoxili Mw 7.9 earthquake rupture (Kunlun Fault, northeastern Tibet)

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Co-seismic slip values along a strike-slip rupture are found to be very irregular with variations up to one order of magnitude. Data usually scattered and sparse, are more dense and continuous with slip functions derived from InSAR or image correlations. Whether the fast variations in slip along strike reveals long-lived structures of the fault plane at depth, only incomplete slip at the surface or inelastic accommodation of slip remains debated. In addition, how these slip disparities are accommodated with time is unclear. The surface breaks of the Kokoxili Mw 7.9 event sytematically follow the geomorphic trace of the fault, which bears evidence for cumulative displacements. In the epicentral area, the rupture steps along the highest ice-capped summit of the region, the Buka Daban Feng. Evidence for normal fault breaks, left-lateral ruptures and steep triangular facets indicate that the Buka Daban Feng, a 40 km-long range reaching about 6800 m a.s.l. formed as a result of continuous oblique left-normal faulting. Normal faulting is attested by hanging glaciers, a steep southeastern flank and hot springs along coseismic and cumulative surface ruptures. Left-lateral movement along the main oblique normal fault has displaced the distal frontal moraines of almost all glacial valleys. West of the Buka Daban Feng, the western most ruptured strand is continuous between Kushiwan and Tayang lakes (about 60 km long) with coseismic left-lateral offsets reaching 4-5 m. To the east, at one site, the rupture splays into 4 main, N90°E-striking strands across a 1200x300m pull-apart. Three strands show right-stepping scarps with maximum throws of 1 m. The northern strand shows 3 m of purely normal throw. On NS profiles, the coseismic subsidence of the pull-apart floor was about 2 m, 1/10th of its 20 m depth, consistent with the repetition of 10 comparable earthquakes. East of the pull-apart 5 +/- 0.2 m sinistral slip are measured on the single stranded rupture. A similar coseismic sinistral slip value (4.8 +/- 0.4 m), with a thrust throw of 0.75 m, is found across two lake shorelines (1 and 2.3 meters above lake level), about 1.5 km farther east. At one river channel site, 15 km farther east, we measured a larger coseismic sinistral offset. The lowest terrace riser, between the active river bed and the lowest terrace is offset by about 10 m. Two older terrace risers show cumulative offsets twice as large (about 20 m). The largest cumulative offset measured reaches 50 m. Thirty kilometers yet farther east, near a glacial outlet at the foot of the Yuxi Shan, 4 distinct rills are offset by 3.5 m along the main surface break while smaller offsets (1-1.5 m) characterize a secondary break 250 m southwards. We have investigated in more detail the co-seismic and paleo-seismic slip near the central part of the rupture, where a set of about 10 inset terraces is used to infer the slip history of the fault. The particularly low co-seismic slip value at the site, about 2.4 +/- 0.6 m, lower than the value derived from Spot image correlation or from Insar, follows a maximum slip value of about 8 m only a few kilometres to the west. Site interpretation from field data, total station measurements and high resolution Ikonos images allow to reconstruct the different riser offsets across the damaged rupture zone. 10Be cosmogenic nuclide exposure ages of cobbles from the surface of the terraces allow to constrain the age the terraces and to infer an average slip-rate of 10-15 mm/yr in good agreement with previous results along the fault. When a characteristic slip model is considered, and depending of the measurement method or location of coseismic slip, the recurrence time for events comparable to the Mw 7.9 Kokoxili event may vary from 200 to 800 years.