Geophysical Research Abstracts
Vol. 19, EGU2017-15936, 2017
EGU General Assembly 2017
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The 2015 M7.2 Sarez, Central Pamir, Earthquake And The Importance Of Strike-Slip Faulting In The Pamir Interior: Insights From Geodesy And Field Observations

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The Pamir mountain range, located in the Northwest of the India-Asia collision zone, accommodates approximately one third of the northward advance of the Indian continent at this longitude (i. e. ∼34 mm/yr) mostly by shortening at its northern thrust system. Geodetic and seismic data sets reveal here a narrow zone of high deformation and M7+ earthquakes of mostly thrust type with some dextral strike-slip faulting observed, too. The Pamir interior shows sinistral strike-slip and normal faulting indicating north-south compression and east-west extension. In this tectonic setting the two largest instrumentally recorded earthquakes, the M7+ 1911 and 2015 earthquake events in the central Pamir occurred with left-lateral shear along a NE-SW rupture plane.

We present the co-seismic deformation field of the 2015 earthquake observed by radar satellite interferometry (InSAR), SAR amplitude pixel offsets and high-rate Global Positioning System (GPS). The InSAR and pixel offset results suggest a 50+ km long rupture with sinistral fault offsets at the surface of more than 2 m on a yet unmapped fault trace of the Sarez Karakul Fault System (SKFS). A distributed slip model with a data-driven slip patch resolution yields a sub-vertical fault plane with a strike of N39.5 degrees and a rupture area of ∼80 x 40 km with a maximum slip of 2 m in the upper 10 km of the crust near the surface rupture.

Field observations collected some nine months after the earthquake confirm the rupture mechanism, surface trace location and fault offset measurements as constrained by geodetic data. Diffuse deformation was observed across a 1-2 km wide zone, hosting primary fractures sub-parallel to the rupture strike with offsets of 2 m and secondary, en echelon fractures including Riedel shears and hybrid fractures often related to gravitational mass movements.

The 1911 and 2015 earthquakes demonstrate the importance of sinistral strike-slip faulting on the SKFS, contributing both to shear between the western and eastern Pamir and westward extrusion of critically thickened Pamir crust into the Tajik depression. Shear may also be transferred from below, where the tip of the Indian indenter is thought to have underthrusted the Pamir.