A newly discovered first-order cross-orogen transtensional shear zone: The Western Nepal Fault System

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The Himalayan orogen is viewed as a compressional wedge with the distribution of great earthquakes (Mw>8) and highest seismic risk along the range front. New field and numerical modeling results indicate that this view is incomplete owing to the curvature of the orogen. Plate convergence becomes increasingly oblique away from the central axis and highest peaks, and the strain mechanisms vary as obliquity changes along strike. We hypothesize that strain becomes partitioned such that the western parts move northwestwards with respect to the central Himalaya. A previously unrecognized first-order system of northwest- striking transtensional faults, which we refer to as the Western Nepal Faults System (WNFS), can be traced more than 265 km, extending from the normal-convergent Main Frontal Thrust to the range-parallel Karakoram strike slip fault at the rear of the orogen.

The kinematics of the WNFS varies along strike. Multiple dextral strike slip segments are connected with extentional stepovers. A measured minimum rupture length of 63 km in the central WNFS has an average displacement of 5 m, maximum vertical displacement of >10 m, and maximum width of 500 m. Radiocarbon dates, including buried yak dung in a deformed terrace and macro-fossils in a sagpond buried under a colluvial wedge indicate that this last rupture occurred between 1145 and 1400 AD. This event, which approaches Mw~8 if the full 265 km ruptured, draws attention to a new seismic risk north of the range front, and may be a source of coeval seismicity that led to devastation in Nepal at 1255 and 1505 AD.

The dynamics of a geometrically-similar 3D segmented obliquely convergent orogen with a critical wedge thrust belt and plateau are demonstrated with the creeping flow program DOUAR. The model predicts a dominantly dextral strike slip shear zone traversing the western portion of the orogenic wedge, which mimics the WNFS. While the Karakoram and Main Frontal Thrust faults may be analogous to previously recognized strain portioning along the Sumatra Fault and Java Trench, the WNFS adds an additional cross-orogen transtensional shear requirement where convergence obliquity changes along strike.

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