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Geometry, Slip distribution and Segmentation of the 11/08/1931 Fuyun Earthquake (Ms 7.9), Xinjiang, China, from satellite image analyses and field observations.

Marie Etchebes (1), Yann Klinger (1), Paul Tapponnier (2), Xiwei Xu (3), Jérôme Van Der Woerd (4), Clément Narteau (1), and Neta Wechsler (1)

(1) Tectonics, Institut de Physique du Globe de Paris, Sorbone Paris Cité, CNRS, France (etchebes@ipgp.fr ; klinger@ipgp.fr), (2) Earth Observatory of Singapore, Singapore, (3) Institut of Geology, China Earthquake Administration, Beijing, China, (4) Ecole et Observatoire des Sciences de la Terre, Institut de Physique du Globe de Strasbourg, France

To understand how earthquake slip repeats along fault segments, it is necessary to document for each earthquake rupture, both the geometry and the slip distribution. Up to now, there are barely more than 20 historical strike-slip earthquakes for which accurate surface rupture maps are available. Displacement patterns for successive earthquakes on the same fault are even more rare. Hence, it remains difficult to assess which, if any, proposed earthquake recurrence models might work better in general, or on any given fault in particular.

Using geo-referenced high-resolution Quickbird images (pixel 70 cm) along with field observations, we analysed the well-preserved 11 August 1931 Fuyun strike-slip rupture (Ms 7.9), China. This event counts among one of the major continental strike-slip earthquakes of the last hundred years. These images allowed us to constrain the length and the geometry of the rupture zone. We could also define the coseismic horizontal slip distribution associated with the 1931 event.

The 1931 Fuyun earthquake broke along a 180-km-long surface rupture. This rupture, striking NNW, is extending from the Kayirti River in the North to the Ulungur River in the South. Right-lateral displacement is dominant with a normal component in the North and a reverse component in the South. Epicenter, although not very well constrained, seems to be located under the Karaxingar Mountain, near to the central part of the rupture. This mountain presents a peculiar setting with thrust at the western front of the range and a pull-apart geometry located at the top of the ridge. Both structures were activated during the last event. This peculiar geometry could be due to a mis-alignment of the schistosity with the main fault direction, forcing a component of reverse motion in addition to the regular extension due to the local pull-apart basin.

The rupture went bilateral through a series of jogs, both extensional and compressional, with dimensions varying from few hundred meters to about 2km-wide. In the South, however, the rupture ended at the Almant Mountain, a 10-km-wide compressional jog. According to major changes in rupture geometry (jogs, fault branches and bends), the 1931 surface rupture can be divided into five main geometric segments. Each of these first order segments could be further split into higher order segments, linked by geometric complexities of smaller scales.

Numerous geomorphological markers offsets have been measured along the rupture by best retro-fitting such markers into their initial geometry, using satellite images. The 1931 earthquake slip distribution, defined by 290 offsets, shows an average slip of 6.3 m. The slip distribution is unusually flat over its entire length. Co-located larger offsets, interpreted as cumulative offsets, allow us to define 4 more events in addition to the most recent. The slip distribution of each event seems to follow a similar flat pattern, supporting a characteristic earthquake model interpretation for the 5 last events.

If we consider the end of the last glaciation to be $\sim$ 9000 years BP and the cumulative slip for the last 5 events ($\sim$30 m), we obtain a slip rate of 3 mm/yr for the Fuyun fault, which is consistent with the geodetic estimates. A characteristic slip of 6 m and a slip rate of 3 mm/yr lead us to an earthquake recurrence time of 3000 years, which is of the same order of return time found along Mongolian faults. Further dating of offset geomorphic features is in progress to supplement these initial estimates and better constrain the Fuyun fault seismic cycle.