



Holocene slip rate and evidences of surface ruptures along the Main Frontal Thrust in Bhutan

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On the long term, the Himalayas absorb about 20 mm/yr of the convergence between the India and Eurasia plates. Morphotectonics studies East of Bhutan yielded an Holocene slip rate of 23 ± 6.2 mm/yr consistent with the 21 ± 1.5 mm/yr estimated in Nepal. In the past 1000 years, most of this crustal shortening is accommodated along the Main Frontal Thrust (MFT) by major $M \geq 8$ earthquakes. Recent paleoseismic investigations between the meizoseismal areas of the 1934 Bihar-Nepal and 1950 Assam earthquakes west and east of the Bhutan suggest that a great earthquake may have ruptured a 700 to 800 km long section of the MFT during a single event around AD 1100. However, between 89°E and 92°E where the MFT runs along the southern border of the Kingdom of Bhutan, no major earthquakes has been recorded so far.

In December 2012, we carried out a morphotectonic and paleoseismologic study within two sites along the MFT in central Bhutan. We identified several sequences of abandoned fluvial terraces that have been uplifted along the fault. From a kinematic GPS survey, we estimated that the oldest terrace sequence (T2) displays a cumulative offset of ~ 60 m. A younger sequence (T1) showed an offset of ~ 4 m on the lower terrace (T1a) and ~ 9 m on the upper one (T1b). We interpret this 4 m uplift as the vertical component of the last seismic event while the 9 m may be the cumulative offset of the two last earthquakes. These preliminary observations may suggest that the latest seismic event as well as the penultimate event correspond to two major $M > 8$ events.

Samples for ^{14}C , OSL and ^{10}Be dating (charcoals, fine sands and quartz rich cobbles, respectively) have been collected in excavations within the different uplifted alluvial surfaces in order to determine the ages of these two last seismic events as well as the Holocene uplift and shortening rates. Compiled with the morphotectonic and paleoseismological data published in the literature, these new results will allow discussing the issue of seismic cycle along this portion of the Himalayan belt.