Slip rate of the Chaman fault: estimates based on ^{10}Be exposure dating for offset geomorphic surfaces in Afghanistan

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Afghanistan is located in a tectonically active part of the world near the collision boundary between the Eurasian and Indian plates. The Chaman fault traverses the eastern part of the country and is a major left-lateral strike-slip fault that accommodates much of the differential movement between the Indian and Eurasian plates. The fault starts from Makaran coast and extends to northeast through the Chaman City, Pakistan. Then it extends to north-northeast into Afghanistan and runs in west of Kabul and finally merges with the Pamir faults system. It is ~1000 km long and strikes from N10˚E to N35˚E. High slip-rates of the fault are known by previous works in the Pakistan side. In Afghanistan no research has been done, therefore we prepared a detailed fault map based on visual images interpretation and previous literatures. The fault offset older and younger alluvial fans and stream deposits of late Pleistocene and Holocene age. Along the fault, relative ages of geomorphic surfaces are known but their absolute ages are unknown. In the absence of absolute ages for faulted deposits, it is not possible to determine the fault slip-rate. Therefore we have conducted cosmogenic dating as was done in Pakistan side to provide age controls for fluvial deposits in the study area. Terrestrial Cosmogenic Nuclide (TCN) uses the interactions between cosmic rays and nuclides in transported boulders, and therefore is an excellent method to directly date alluvial deposits. TCN is particularly useful in Afghanistan due to lack of terrestrial organic materials for radiocarbon dating. Our study focuses on three different areas located at Wardak Province. One of the sites is Ghat Bandakul south of Kabul where the distal part of alluvial fan deposited at the mouth of a stream channel is offset left-laterally. The fan slopes 3-5˚ westward for ~1 km from the foot of the Syah-Tapa Mountain. The deposits are composed of clay, sandstone and granitic clasts originating from bedrocks. Analysis of ALOS images and field work indicate that younger and older terrace risers are displaced left-laterally along the fault for 165 m and 235 m respectively. We collected 6 samples from the top 1-3 cm of each desired sandstone boulders that were >1m in diameter and well-embedded in surface to ensure their long-term stability. The sandstone has large amounts of quartz mineral, which yields ^{10}Be TCN nuclide ideal for dating deposits over Quaternary timescale. Samples were processed at the laboratories of DPRI, Kyoto University and MALT, University of Tokyo.
Based on ~165 m displaced alluvial fan with a ^{10}Be exposure age of ~46 kyr, we obtained the first geomorphologically determined slip-rate of 3.5 mm/yr along the Chaman fault. This slip-rate is considerably smaller than the geologically and geomorphologically defined slip-rates of 19–24 mm/yr and 33 mm/yr along the fault in the border region of Afghanistan and Pakistan. Along the southern section at Ghazni and Zabul Provinces, we mapped east-dipping thrust faults as well as the multiple fault splays indicating a complex interplay between left-lateral faulting and northwest compression, which may cause slower slip-rate at the northern end of the fault. We plan to date two other alluvial surfaces in the southern part of the study area to determine exact slip-rate of the fault in Afghanistan.

Keywords: Chaman fault, 10Be exposure dating, offset geomorphic surface , Afghansitan

