Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

SSS021-07 Room: 302 Time: May 27 15:30-15:45

Weakness of the intracontinental strike-slip Kunlun Fault

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Fault strength is an important factor in understanding rupture mechanisms of large earthquakes and rheology property of seismogenic faults. Geological and geophysical evidence suggests that some crustal faults are weak compared to laboratory measurements of frictional strength (e.g., Brune et al., 1969; Zoback et al., 1987; Lin, 2008). In particular, the strength of San Andreas Fault (SAF) has been the subject of debate for decades, with majority of the studies show ample evidence that the SAF is weak (e.g., Mount and Suppe, 1987; Zoback et al., 1987; Townend and Zoback, 2004), although others argue otherwise (e.g., Scholz, 2000; Hardebeck and Michael, 200 4). Despite these advances, studies on the topics of fault strength to date are almost limited to the SAF, a lack of geological and geophysical data for intracontinental active faults on which large earthquakes repeatedly occurred means that it remains disputed; therefore, more cases and more evidence besides the SAF are needed in order to deepen the understanding of this fundamental but still controversial problem.
In this study, we focus on the Kunlun Fault, one of the major intracontinental active faults in the Tibetan Plateau. By examining the fault-related fold structures developed on the late Pleistocene-Holocene alluvial fans around the fault, together with the stress analysis of the in-situ measurement data obtained right before and after the 2001 Mw 7.8 Kunlun earthquake, and combining the focal mechanisms of large earthquakes, here we document on the fault strength of the intracontinental strike-slip Kunlun Fault and discuss its implications for the collisional tectonics in the Tibetan Plateau.
Fault-related fold structures and focal mechanisms of large earthquakes show that the maximum horizontal stress is nearly perpendicular to the strike slip Kunlun Fault which triggered the 1997 Mw7.6 Manyi and 2001 Mw 7.8 Kunlun earthquakes in the northern Tibetan Plateau. On the basis of seismic inversion results and in-situ measurements of stress carried out right before and after the 2001 Mw 7.8 Kunlun earthquake, a low shear stress of <1MPa on the Kunlun Fault, is estimated, which is one order less than that of shear strength obtained from laboratory measurements, compatible with that of the San Andreas Fault. Geological and geophysical evidence confirms that the intracontinental strike-slip Kunlun Fault is rheologically weak, which plays an important role in the eastward extrusion of the Tibetan Plateau caused by the ongoing continental collision between the Indian and Eurasian plates.

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Keywords: intracontinental fault, Kunlun fault, Fault strength, stress, weak core zone, Tibetan Plateau