Paleoearthquakes-induced liquefaction along the western segment of the strike-slip Kunlun fault, northern Tibet

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The Mw 7.8 Kunlun (MS 8.1) earthquake occurred on November 14, 2001, which produced a 450-km-long surface rupture with a large strike-slip up to 16 m along the western segment of the strike-slip Kunlun fault (Lin et al., 2002, 2003, Lin and Nishikawa, 2006). Although this earthquake displaced the Qinghai-Tibet railway which was in construction in 2001 and also caused liquefactions and avalanches of snow and glacial ice, there are no reports of casualties or great damages because the earthquake occurred on a sparse population region in the remote high mountains, northern Tibet. Two large historical earthquakes of M (larger than) 7.5 prior to the 2001 Kunlun earthquake in the last century occurred in both the eastern and western fault segments bounded with the 2001 rupture segment of the Kunlun fault (e.g. Jia et al., 1988; Peltzer et al., 1999; Guo et al., 2006b). Recently, based on the trench and field investigations, an average strike-slip rate of 16.4 mm/yr. and an average recurrence interval of 300-400 years for large earthquakes have been estimated in the fault segment associated with the 2001 earthquake (Lin et al., 2006). However, there are no historic and instrumental records of large earthquakes in the 450-km-long fault segment due to the remote sparsely populated mountain region. The absence of historical and instrumental records of large earthquakes hinders further assessment of past long-term seismic behavior of large intracontinental strike-slip faults in the Tibet plateau.

Here, we report at least two large pre-historic earthquakes revealed by liquefaction-related structures found in the 2001 rupture segment and discuss the late Holocene activity of the strike-slip Kunlun fault by field investigations and interpretations of satellite images. Field investigations of liquefactions and radiocarbon dating results reveal that there are at least three large earthquakes including the 2001 earthquake occurred in the western segment of the Kunlun fault during the past 7-9 centuries. Liquefactions formed in alluvial deposits composed of sand-gravel yielding 14C ages of 679-901 yr BP. are observed on the current stream channel which is sinistrally offset 75-82 m including 3-6 m displacement produced by the 2001 event. On the basis of the field investigations and 14C dating results, we conclude that the liquefactions and subsequent faulting events were caused by at least two large earthquakes of M (larger than) 7 prior to the 2001 earthquake and an average recurrence interval of large earthquakes is estimated to be about 400 years in the late Holocene. The study on earthquake-induced liquefaction would help us evaluate palaeoseismicity and seismic hazard for possible engineering damage associated with future large earthquakes on intracontinental active faults.