2001 年 M_w 7.8 昆崙地震により生じた地表地震断層のフラクタル分布形態とその地震テクトニック意義

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Fractal geometry of co-seismic surface ruptures produced by the 2001 M_w 7.8 Kunlun earthquake along the strike-slip Kunlun fault, northern Tibet Plateau

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The spatial and geometric distributions of faults generally are influential in the mechanical behavior of faults (Okubo and Aki, 1987), which affects the nucleation and rupture propagation of earthquakes (e.g., Sibson, 1986; Scholz, 2002). Despite faults are often mapped as continuous strands, it has been noted that faults are generally composed of multiple discontinuous strands on all scales, and that the fault strand length distribution often shows a fractal geometry following a power law (e.g., Scholz, 2002). Similar structural features of fault geometry have also been reported on the co-seismic surface ruptures produced by the strike-slip Dasht-Bayez (Iran) earthquake, and recognized in shear box experiments (e.g., Tchalenko, 1970). Studying on the geometric structure of co-seismic ruptures, thus, provides important information for accessing the rupturing behaviors and mechanical property of seismogenic faults.

This study presents a case study of detailed analysis and interpretation of co-seismic surface rupture strand-length produced by the 2001 M_w 7.8 (M_S 8.1) Kunlun earthquake along the strike-slip Kunlun fault, northern Tibet Plateau, using 1m-resolution IKONOS and 0.61-resolution QuickBird images. The Kunlun fault strikes E-W to WNW-ESE over ~1200 km, and is considered as one of the major strike-slip faults along which strike-slip partitioning occurs in accommodating both the northeastward shortening and eastward extrusion of Tibet (e.g. Tapponnier and Molnar, 1977; Meyer et al., 1998; Wang et al., 2001). The M_w 7.8 Kunlun 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, 2007; Lin, 2008). We measured 19,455 co-seismic surface rupture strands ranging from 1 m to 200 m in length, which are concentrated in a zone of 3-500 m in width along the 450-km-long Kunlun co-seismic surface rupture zone. The analytical results show that that the co-seismic surface rupture strands have a fractal geometry distribution feature with a fractal dimension of 3.0052-3.5979 between cumulative numbers and surface rupture strand lengths in four segments, a total fractal dimension of 3.5708 for the 450-km-long co-seismic surface rupture zone. The fractal dimension *D* may be a useful factor for accessing the complexity of co-seismic ruptures produced by a large earthquake in different geological conditions.

Our results indicate that co-seismic surface rupturing occurred on the strike-slip Kunlun fault is a self-similar process, and strand lengths of surface ruptures obey a power law distribution. The fractal distribution feature of the co-seismic surface ruptures may reflect a fractal faulting property of strike-slip faults during a large intracontinental earthquake.