Scaling Relation of Segmented Strike-slip Surface Ruptures

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Most of long surface ruptures composed of more than one segment and many of large earthquakes are multiple-rupture events. To understand and model the static earthquake source parameter, 16 strike-slip surface ruptures with lengths of 13-180km and maximum displacement up to 11.5m were segmented based mainly on geometry of fault strand and slip distribution, and supplementary on paleoseismicity and seismic rupture process. Then, the scaling relation of sizes of segmented surface rupture is analyzed. A surface rupture is composed of one to five segments with length of several to 48 km, and the number of segments (Ns) is lineally proportional with the total rupture length (Lt). A segment consists of a straight main section where displacement is large and continuous, and tail sections at both ends where displacement suddenly decreases and dies out. The size of tail section is proportional to the length of the segment. A segment is further divided into smaller segments by indistinct jogs and changes in slip distribution. These geometric similarity and nested array of smaller segments suggest the hierarchical self-similarity of fault structure. The maximum displacement of a segment (Dsm) is lineally proportional to the length of the segment (Ls), and the scaling relations is Dsm (m) = 0.17 Ls (km). This relation suggests that the stress drop on individual segment is almost constant. In addition, the equation estimates that the world largest displacements of strike-slip surface rupture; ca.12-13 m occurred on a segment shorter than about 100 km. These scaling relations of segment can depicts the relations among Mo, Lt and W (fault width). The linear proportions between Dsm and Ls, and number of segments and Lt are consistent with the well-known scaling relations; Mo is proportional to L∗∗2 for long ruptures, and L for very long ruptures. The saturation of fault displacement in case of very-long surface rupture can be explained by the upper limit of segment size, which is probably governed by the thickness of seismogenic layer of the crust.