RIDGETOP SPLITTING, SPREADING, AND SHATTERING RELATED TO EARTHQUAKES IN SOUTHERN CALIFORNIA

Program Element II: Evaluate Urban Hazard and Risk.

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1. ABSTRACT

In the winter and spring of 1997-98 we examined aerial photographs of the entire San Gabriel Mountains and the eastern Santa Susana Mountains (and hills to the north) to locate anomalous ridgetop landforms that might be the result of earthquake-induced lateral spreading. In 25 of the 33 7.5' quadrangles mapped we found such ridgetop landforms. These landforms were subdivided for the purpose of mapping into 10 landform types: cd, closed depression; tr, trough; shb, sidehill bench; bfs, back-facing scarp; fr, failed ridge; g, graben; sw, swale; dr, anomalous drainage pattern; sc, downhill-facing scarp; vl, vegetation lineament. In addition, at each site where we deemed the landforms significant, we classified the site into one of four landslide-association classes. This classification was based on the proximity of definite or suspected landslides to the ridgetop landforms. At each significant site we tabulated landform type, landslide association, ridge relief, distance to nearest Late Quaternary fault, and bedrock type. No particular landform type was exclusively associated with any landslide-association class, although graben tended to occur more frequently at the non-landslide-associated sites, and closed depressions and back-facing scarps more frequently at the landslide-associated sites. During 2 weeks in the summer of 1998 we field checked the more easily accessible sites.

In the crystalline rock terrain of the San Gabriel Mountains we mapped 143 significant sites of anomalous ridgetop landforms. Of these, 37% were definitely not associated with landslides, 14% were probably not associated, 23% were probably associated, and 26% were definitely associated with landslides. The relief of the ridges containing these landforms, and their distances from Late Quaternary faults, did not vary significantly among the landslide-association classes. Thus, it appears that ridgetop landforms resulting from gravitational spreading are responding to similar controls as shallower landslides.

In the weaker late Tertiary sedimentary rocks of the eastern Santa Susana Mountains and the hills to the north, we mapped 24 sites of significant anomalous ridgetop landforms. Of these, 16% were definitely not associated with landslides, 21% probably not associated, 25% probably associated, and 38% definitely associated with landslides. This higher proportion of landslide-association reflects the weaker nature of the rocks, as exemplified by the widespread landsliding during the 1994 Northridge earthquake. As in the San Gabriel Mountains, anomalous landforms not associated with landslides tended to occur in locations similar to landforms intimately associated with landslides. This result suggests that deep-seated gravitational spreading is merely an end-member of a continuum of gravitational failures, the opposite end of which is represented by "normal" translational and rotational landslides. Between these end members is a continuum of slope failures that grade from diffuse lateral spreading and its attendant incipient ridge fracturing, to progressively more severe ridge collapse and more discrete ridge flank failure masses, which eventually become recognizable enough to call landslides.