



## **Ground motions at the outermost limits of seismically triggered landslides**

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Over the last few decades, we and our colleagues have conducted field investigations in which we mapped the outermost limits of triggered landslides in four earthquakes: 1987 Whittier Narrows, California (M 5.9), 1987 Superstition Hills, California (M 6.5), 1994 Northridge, California (M 6.7), and 2011 Mineral, Virginia (M 5.8). In an additional two earthquakes, 1976 Guatemala (M 7.5) and 1983 Coalinga, California (M 6.5), we determined limits using high-resolution aerial photographic interpretation in conjunction with more limited ground investigation. Limits in these earthquakes were defined by the locations of the very smallest failures ( $< 1 \text{ m}^3$ ) from the most susceptible slopes that can be identified positively as having been triggered by earthquake shaking. Because we and our colleagues conducted all of these investigations, consistent methodology and criteria were used in determining limits. In the six earthquakes examined, we correlated the outermost landslide limits with peak ground accelerations (PGA) from ShakeMap models of each earthquake. For the four earthquakes studied by field investigation, the minimum PGA values associated with farthest landslide limits ranged from 0.02-0.08 g. The range for the two earthquakes investigated using aerial photographic interpretations was 0.05-0.11 g. Although PGA values at landslide limits depend on several factors—including material strength, topographic amplification, and hydrologic conditions—these values provide an empirically useful lower limiting range of PGA needed to trigger the smallest failures on very susceptible slopes. In a well-recorded earthquake, this PGA range can be used to identify an outer boundary within which we might expect to find landsliding; in earthquakes that are not well recorded, mapping the outermost landslide limits provides a useful clue about ground-motion levels at the mapped limits.