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Reactivation of slow-moving landslides by earthquakes, kinematics measurements and mechanical implications

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Major earthquakes in mountainous areas often trigger landslides. The impact of earthquakes on slow-moving landslides is however not well constrained due to few co-seismic measurements of landslide motion.
We document the first time-series of a landslide reactivation by an earthquake (Mw6.0, distance 20 km), using continuous GPS measurements over the Maca landslide (Peru). Our survey shows a coseismic response of the landslide of about 2 cm, followed by a relaxation period of 5 weeks during which postseismic slip is three times greater than the coseismic displacement itself. Our results confirm the coseismic activation of landslides and provide the first observation of a post seismic displacement.
Finally, a multi-temporal survey using images from the very high resolution Pléiades optical satellite, allowed us to detect 9 active slow-moving landslides over the whole valley. Their pattern of motion show they have been reactivated by the same earthquake. We analyze this small but comprehensive database of landslides reactivated by the earthquake. We find that the landslide motion due to the earthquake is function of the shaking intensity, suggesting a friction at the basal interface dependent on the earthquake solicitation.
These various observations are consistent with a mechanical model where slip on the landslide basal interface is governed by rate and state friction, analogous to the mechanics of creeping tectonic faults.