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Why does a landslide accelerate? - Estimation of dynamic friction process associated with the sliding -

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Assessing and managing the risks posed by deep-seated catastrophic landslides requires a quantitative understanding of the dynamics of sliding rock masses. Previously, landslide motion has been inferred qualitatively from topographic changes caused by the event, and occasionally from eyewitness reports. However, these conventional approaches are unable to evaluate source processes and dynamic parameters.

In this study, we apply a different approach for reconstructing the dynamic landslide processes using ground shaking data recorded away from the landslide. The deep-seated catastrophic landslide sequence induced by heavy rainfall in 2011 in the Kii Peninsula, Japan, was the first instance in which 1) seismic signals radiated by landslides were recorded by densely distributed near-source seismometers, and 2) the precise volume of the landslide material was able to be measured by comparing pre- and post-landslide topographic data obtained using airborne laser scanning. We performed a source inversion with the long-period seismic records of one of the largest events, and from this obtained a force history of the landslide.

Here we reveal the dynamic processes of the landslide: smooth initiation of sliding, acceleration accompanied by a substantial decrease in frictional force, and deceleration due to collision. Of particular importance is the determination of the dynamic friction during the landslide. The coefficient of friction is estimated to be 0.56 at the beginning of the event and drops to 0.38 for most of the sliding. The change in the frictional level on the sliding surface may be due to liquefaction or breaking of rough patches, and contributes to the extended propagation of the large landslide. The approach demonstrated here offers an innovative method for understanding the sliding processes associated with catastrophic landslides, enabling us to simulate the motion of such events.

Figure caption: Dynamic process of the Akatani landslide. (a) Estimated single-force source time functions for the two horizontal components (sliding direction and its perpendicular direction) and the vertical component. (b) Schematic diagram of the mass sliding model. The numbers correspond to the three stages indicated in (a).

Keywords: landslide, deep-seated landslide, seismic data, coefficient of dynamic friction