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Seismic Analysis of the August 2017 Landslide on Piz Cengalo (Switzerland)

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Landslides are still difficult to predict, often occur in inaccessible mountainous terrain and have a high destructive potential. Consequently, data-driven documentation of large events is difficult to come by and often relies on observations of pre and post event conditions, such as surface topography and deposition characteristics. Occasional co-event observations in form of time-lapse videos provide valuable information, however, they require some degree of event anticipation and only probe the Earth's surface.

Over recent years, seismological approaches have become a useful tool for landslide studies. Seismic observations allow remote monitoring of landslide-prone regions at unrivaled temporal resolution, give insights into the motion of landslide material and can constrain frictional properties during events. Nevertheless, our understanding of the seismic signatures of landslides is not yet complete and will benefit from detailed investigations of the relatively few events, which are documented with other observations as well, such as time-lapse videos and pre/post event elevation changes.

Here we present a seismic study of the landslide series on Piz Cengalo, a 3369 m high peak in Eastern Switzerland. The largest event occurred on 23 August 2017 and involved 3 million cubic meters. Permanent broadband stations in Switzerland and Italy provide high-quality seismic records and the seismic signature of the largest event contains pronounced low-frequency (<0.1 Hz) signals. We follow the approach of various previous authors to reconstruct the trajectory of the landslide's bulk mass from the low-frequency signals. This yields estimates of peak velocity and allows interpretation of the event's high-frequency signal, which can be used to study smaller Piz Cengalo events, whose low-frequency signal is missing or weak.

Our study shows that for a densely recorded landslide such as the 2017 Piz Cengalo event, seismology reconstructs dynamic details, including re-acceleration phases and sharp turns forced by topographical features. Moreover, stations within close vicinity (a few tens of km) may record static displacements, which could be used as additional constraints for inversions of the (dynamic) seismic waves. We discuss how these details can be used to force landslide models and determine rheological characteristics of large (order million cubic meters or more) events.