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The 1946 Rawilhorn rock avalanche (Valais, Switzerland) – linking earthquake-induced rock mass damage to seismic amplification

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Earthquake-triggered landslides are among the most destructive secondary effects of strong seismicity in steep alpine regions. Recent studies have shown that compliant fractures in bedrock can generate significant seismic site effects (amplification and polarization of ground motion) on steep hillslopes, which influences the potential for co-seismic triggering. Here we demonstrate a mechanistic link between earthquake-induced rock fracturing and subsequent site effects through analysis of a case study in the southern Swiss Alps. The Rawilhorn rock avalanche was triggered by the second M $\sim$6 earthquake of a sequence in 1946. The failure released roughly 5 million cubic meters of sedimentary rock from a ridge 600 m high, and had a run out distance of roughly 1.5 km downstream and 0.7 km upstream. We simulate earthquake-induced damage and resulting site effects in a three-step numerical procedure: 1. Evaluate the dynamic response of the rock slope when all joints are assigned uniformly stiff values; 2. Apply a realistic earthquake input motion and model the distribution of joints that open in tension; 3.Reduce the shear and normal stiffness of these new open joints and again evaluate the dynamic response of the rock slope. Model results reveal amplified ground motion within the incipient failure area resulting from induced fracturing, with site-to-reference spectral ratios increasing by up to a factor of three from the first to the second earthquake. This outcome demonstrates how earthquake-induced slope fracturing, which acts to selectively open joints and reduce their stiffness, can create significant spectral amplification during subsequent seismic events.