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# Modelling rock fragmentation of Extremely Energetic Rockfalls

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Extremely energetic rockfalls (EER) are phenomena for which the combination of a large volume (at least some thousands of m ) and a free fall height of hundreds of metres, results in a large released energy. We fix a threshold value of around 1/50 of kilotons to define such a type of events. Documented examples include several events with dif-ferent size in the Alps (Dru, 2005, 2011, 265,000, 59,200 m3; val Fiscalina – Cima Una, 2007, 40,000 m3; Thurwieser 2004, ca 2 Mm3; Cengalo, 2011, 1.5*105 m3 in 2016, in Switzerland; Civetta, 2013, ca 50,000 m3;), in the Apennines (Gran Sasso, 2006, 30,000 m3), Rocky Mountains (Yosemite, Happy Isles, 38,000 m3), and Himalaya. EERs may become more frequent on steep and sharp mountain peaks as a consequence of permafrost thawing at higher altitudes.
In contrast to low energy rockfalls where block disintegration is limited, in EERs the impact after free fall causes an immediate and efficient release of energy much like an explosion. The severe disintegration of the rock and the corresponding air blast are capable of snapping trees many hundreds of metres ahead of the fall area. Pulverized rock at high speed can abrade tree logs, and the resulting suspension flow may travel much further the impact zone, blanketing vast surrounding areas.
Using both published accounts of some of these events and collecting direct data for some of them, we present some basic models to describe the involved processes based on analogies with explosions and explosive fragmentation. Of the initial energy, one part is used up in the rock disintegration, and the rest is shared between the shock wave and air blast. The fragmentation energy is calculated based on the fitting of the dust size spectrum by using different proba-bilistic distribution laws and the definition of a surface energy and by considering the involved strain rate. We find the fragmentation is around one third of the initial boulder energy.
Finally, we evaluate the velocity of the corresponding cloud generated by the powder suspension and compare with the information available in literature.

keywords: EER, Rockfalls, Disintegration number, Omographic distribution