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Rockfall dating (10Be exposure age) in the permafrost-affected rockwalls of the Mont Blanc massif (European Alps)

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The characterization of the evolution of rockfalls (> 100 m3) in high mountain areas is a prerequisite to any risk management.
In previous studies, we compared photographs from the end of the Little Ice Age to today of two areas of the Mont Blanc massif to collect and analyse data on past rockfalls in order to investigate the possible correlation between periods of warming and rockfall and, beyond, between permafrost degradation and rockfall. This method, combined with field geomorphological data, allowed the identification of more than 50 collapses during this period, involving rock volumes ranging from 500 to 265 000 m3. In most cases, these rockfalls occurred during the hottest periods, either from the end of the LIA (the last two decades) or during one year (hot summer episodes) suggesting that rockfalls mainly result from permafrost degradation in relation to global warming.
To overcome the methodological blocking which limited us to the last century and a half, we carried out surface exposure dating on 20 samples of granite from 6 rockwalls of the massif located between 3310 to 3860 m a.s.l. by the determination of 10Be-concentrations in their surface. The surface ages found vary between 37 $\pm$ 14 to 62 000 $\pm$ 7000 years.
These results provide evidence of periods of occurrence of rockfalls whose volume is between 10,000 and 250,000 m3. Those volumes have been estimated from the rockfall scars whose extension was recognized from the topography and the homogeneity of their surface colour. These dates are not sufficient to verify the possible relationship between rockfall occurrence and warm periods characterized by permafrost degradation. In order to improve this chronology, we started to develop a protocol combining geomorphology, surface exposure dating, and spectrometry to date past rockfalls at the massif-scale, based on the correlation between rockwall surface ages and the corresponding spectral signature – the redder a rock surface, the higher its age.