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Reconstruction of the rock fall frequency in the Mont Blanc massif since the Last Glacial Maximum using TCN dating and laboratory reflectance spectroscopy. A complete dataset of 72 samples.

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Rockfalls and rock avalanches are active processes, including hazards for infrastructures and outdoor activities. Present rockfalls are well surveyed and documented in the Mont Blanc massif thanks to a network of observers set up in 2007, and composed of hut keepers, mountain guides, alpinists and infrastructure workers. Frequency over the past 150 years of massif rockfall, studied by comparison of historical photographs, has strongly increased during the last 30 years, especially during very hot summer (2003 and 2015), likely due to permafrost degradation driven by the climate change.

In order to understand at a longer timescale the relationship between rockfall frequency and climate dynamics in the Mont Blanc massif, we use Terrestrial Cosmogenic Nuclide (TCN) dating to obtain the exposure ages of Lateglacial and Holocene rockfall scars and old rockwall surfaces, and glacial and climate proxies to verify the hypothesis that rockfalls were more frequent in warm periods.

55 samples have been collected at 9 sites of the Glacier du Géant basin, at elevation in the range 3300-3800 m a.s.l. These new exposure ages were completed by the 25 others TCN ages sampled during two previous campaigns and recalculated using the newest input parameters. A total of 72 ages were obtained, between 0.04 $\pm$ 0.02 and 100.50 $\pm$ 8.50 ka.

We found four age clusters. Two clusters are related to the Holocene Warm Period ($\sim$ 6.1-7.4 ka) and Roman Warm Period ($\sim$ 1.6-2.3 ka); a cluster of LIA-post-LIA ages is mainly composed by smaller rockfalls, considered as the 'normal' erosion. A forth cluster have been recognized at $\sim$ 4.2-5.0 ka.

Data suggest a relationship between the reflectance spectral data of the scar surfaces and exposure ages, mainly in the E-SE-S aspects. Fresh rock surfaces of recent rockfall scars are light grey, whereas long-time exposed weathered rock surfaces range from light orange to dark red. This confirms the initial hypothesis: the redder a rock surface, the older its age. Reflectance spectroscopy is used to quantify the granite surface colour and allow the establishment of a robust relationship between scar exposure ages and colour of the rockwalls in the Mont Blanc massif.