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Reconstruction of glacier fluctuations in the Mont-Blanc massif, western Alps: a multi--method approach

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Providing tight spatial and temporal constraints on Late Pleistocene glacier fluctuations remains an important challenge for understanding glacier and glacial erosion responses to climatic change. Paleo-glacier reconstructions are often scarce, discrete and spatially-limited during the Lateglacial and Holocene times, which makes their use as a paleoclimate proxy sometimes challenging.

Here we focus on the Mer de Glace glacier (Mont-Blanc massif, France) where glacier reconstructions over the Little Ice Age (LIA, Vincent et al. 2014) and since the Mid Holocene (Le Roy et al., 2015) reveal important glacier fluctuations and ice thickness variations. LGM trimline mapping (Coutterand et al., 2006) and cosmogenic 10Be exposure dating on the Italian side of the massif (Wirsig et al., 2016) give important indications on the maximum ice thickness at the LGM and the timing of ice surface lowering in this area. However, continuous records of the Mer de Glace fluctuations have to precisely constrained to provide valuable record of local climate and erosion with time. Therefore, we collected samples of granitic polished bedrock surfaces between the LGM ice surface (∼2505 m a.s.l, Coutterand et al., 2006) and the present-day glacier (1920 m a.s.l) covering ∼600 m of elevation for the ice surface fluctuations.

We first used cosmogenic 10Be dating on quartz (Gosse and Phillips, 2001) to constrain ice surface fluctuations during the Lateglacial and Holocene. Given that cosmic rays exposure produces 10Be over the first ∼3 m below the rock surface, multiple exposure history from complex glacier fluctuations would be difficult to quantify using this chronometer. To improve the temporal resolution for such complex exposure history, we combined cosmogenic 10Be dating on quartz with OSL surface exposure dating (Sohbati et al., 2011). OSL surface exposure dating is sensitive to light, based on the progressive bleaching of the OSL signal in a rock sample that depends on its exposure time, mineralogical properties and environmental conditions. Premilary OSL results from rock slices show increasing exposure age (i.e. deeper bleaching of the OSL signal) with sample elevation. Moreover, our results reveal that the bleaching of the OSL signal is occuring within the first 1-3 cm below the rock surface, potentially offering high resolution to date the latest exposure following short-lived glacier fluctuations.

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