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

Benjamin Lehmann[a], Pierre G. Valla[a], Georgina E. King[b], Susan Ivy-Ochs[c], Marcus Christl[c] and Frédéric Herman[a]

[a] Institute of Earth Surface Dynamics, Faculty of Geosciences and Environment, University of Lausanne, CH-1012 Lausanne (benjamin.lehmann@unil.ch)
[b] Institute of Geography, University of Cologne, D-50923 Cologne, Germany
[c] Laboratory of Ion Beam Physics, ETH Zurich, 8093 Zurich, Switzerland

Providing tight spatial and temporal constraints on Late Pleistocene glacier fluctuations remains an important challenge for understanding glacier response to climatic change. In the Alps, paleo-glacier reconstructions are often scarce, non-continuous and spatially-limited during the Lateglacial and Holocene times, which makes their use as a paleoclimate proxy sometimes problematic.

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 (~350 m over the last 4 ka). LGM trimline mapping (Coutterand et al., 2006) and cosmogenic $^{10}$Be 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 since the LGM are not precisely constrained. In order to better understand this complex deglaction history, we collected seven 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 $^{10}$Be dating on quartz (Gosse and Phillips, 2001) to constrain ice surface fluctuations during the Lateglacial and Holocene. Given that cosmic rays exposure produces $^{10}$Be 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 our temporal resolution for such complex exposure history, we combined cosmogenic $^{10}$Be 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 folowing short-lived glacier fluctuations.

REFERENCES

Coutterand S., Buoncristani J-.-F. (2006), Pal.og.ographie du dernier maximum glaciaire du Pléistocene récent de la région du Massif du Mont Blanc, France, Quaternaire, 17, (1), 2006, p. 35-.-4.

Gosse, J.C, and F.M. Phillips (2001). Terrestrial in situ cosmogenic nuclides: theory and application. Quaternary Science Reviews, 20, 1475-1560.

Le Roy, M., Nicolussi, K., Deline, P.,Astrade, L., Edouard, J-L., Miramont, C., Arnaud, F. (2015), Calendar dated glacier variations in the western European Alps during the Neoglacial: the Mer de Glace record, Mont Blanc massif, Quaternary Science Review 108 (2015) 1-22, doi:10.1016.

Sohbati, R., Murray A., Jain M., Buylaert J.-P., and Thomsen K. (2011), Investigating the resetting of OSL signals in rock surfaces, Geochronometria, 38 (3), 249_258, doi:10.2478/s13386-011-0029-2.

Vincent, C., Harter M., Gilbert A., Berthier D., Six D., (2014). Future fluctuations of Mer de Glace, French Alps, assessed using a parameterized model calibrated with past thickness changes. Annals of Glaciology, 55, 15-24.

Wirsig C., Zasadni J., Christl M., Akçar N., Ivy-Ochs S. (2016), Dating the onset of LGM ice surface lowering in the High Alps. Quaternary Science Reviews 143 37-50.