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Late-Quaternary exhumation rates constrained by OSL thermochronometry at the Franz Josef Glacier, New Zealand

Arnaud Duverger (1), Georgina King (2), Pierre Valla (3), Simon Cox (4), and Frederic Herman (3)

(1) Département des Géosciences, Ecole Normale Supérieure, Paris, France (arnaud.duverger@ens.fr), (2) Institute of Geography, University of Cologne, Cologne, Germany, (3) Institute of Earth Surface Dynamics, University of Lausanne, Lausanne, Switzerland, (4) GNS Science - Te Pu Ao, Dunedin, New Zealand

The Southern Alps of New Zealand are often cited as the primary example of a mountain range that has reached exhumation and topographic steady state, especially on the West Coast where exhumation rates reach up to about 10 mm/yr. However, cyclic climatic changes, throughout the Quaternary period have meant that the Alps cycled between being completely glaciated and ice free. The impact that such glacial cycles may have had on the spatial variability of erosion rates remains poorly constrained.

Here we use Optically Stimulated Luminescence (OSL) as a very low temperature thermochronometer to constrain rock cooling histories at 10-100 kyr timescales on samples collected near the Franz Josef glacier. OSL-thermochronometry is based on the amount of electrons accumulated in the lattice defects of natural minerals such as quartz or feldspar, due to the competing effects of charge trapping due to the natural radioactivity within the rock and charge detrapping due to thermal loss during rock exhumation towards the surface.

We collected 9 samples along the Waiho valley (crossing the Alpine Fault) and the Franz Josef glacier to quantify late-Quaternary exhumation rates and their potential spatial variations. Bedrock samples have been crushed to extract the light-safe rock interiors which have then been processed to isolate potassium-rich feldspars (K-feldspars). We used the Infra-Red Stimulated Luminescence at 50°C (IRSL50) protocol, including the measurement of the natural IRSL50 trapped charge population and the laboratory characterization of sample-specific thermal and athermal kinetic parameters. Once measured, the luminescence signal can be inverted into cooling histories. We also explored the potential of the recently developed multi-OSL-thermochronometer (King et al., accepted) to better constrain the cooling path.

Our first OSL measurements show that samples are not in saturation and thus contain useful thermochronometric information over the last ∼100 kyr. Inverse modeling reveals large variations in exhumations rates, with faster rates recorded in the valley bottom than in the ice-accumulation area. These results suggest that late-Quaternary exhumation at the Franz Josef glacier has been controlled by spatially-variable erosion processes, even in this part of the Southern Alps where active tectonics has been regarded as the primary driver of exhumation and topographic steady state is thought to have been achieved.

Reference:
King, G.E., F. Herman, R. Lambert, P.G. Valla, B. Guralnik (accepted). Multi-OSL-thermochronometry of feldspar. Quaternary Geochronology.