Control of frost-induced processes on catchment denudation rates: Insight from *in situ* produced ^{10}Be concentrations in stream sediments (Ecrins-Pelvoux massif, French Western Alps)

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The morphology of the Ecrins-Pelvoux massif (French Western Alps) has been strongly rejuvenated by Quaternary glaciations, providing a suitable area to study the efficiency of erosion processes in relief evolution on post-glacial timescales. We have quantified denudation rates at catchment scales using *in situ* produced cosmogenic nuclides (^{10}Be) in stream sediments. Stream sediments were sampled in twelve outlets of variously sized watersheds with average altitudes ranging from 1700 to 2800 m. Spatially averaged denudation rates vary from 0.30 ± 0.03 mm/yr to 1.10 ± 0.09 mm/yr.

Our results exhibit a correlation (R^2 = 0.55) between denudation rate and mean catchment altitude, in the absence of significant correlation with any other morphometric parameters (relief, slope, catchment size, etc). We interpret the increasing denudation rate with elevation as the effect of frost-controlled processes, which are more efficient at high elevations. We use a one-dimensional heat flow model to correlate the variability in denudation rates with the mean time spent within the Frost Cracking Window for each catchment. The results imply that the efficiency of frost cracking constitutes a major control on catchment-wide denudation rates in the study area.

We have also quantified in-situ produced ^{10}Be concentrations of different exposed morphological features within a single catchment. These data have been input into a provenance model allowing to evaluate the origin of sediments that carry the ^{10}Be concentrations measured at the catchment outlet.

Our study suggests that present-day denudation of the studied mountain belt is controlled by a climatically driven factor, provides better constraints on high-altitude stream sediment routing systems and establishes the role of frost-controlled processes in alpine landscape development.

Hydrogen diffusion in grain boundaries: An experimental approach

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Hydrogen can be stored in the lattice of Nominally Anhydrous Minerals (NAMs) as point defects, and this impurity substantially modifies many physical properties of NAMs in Earth's mantle. However, Earth's deep interior is not made of a unique and 'giant' single crystal and, to date, little is known on the storage, speciation, mobility and possible remobilization of hydrogen within grain boundaries. Recently, Hiraga *et al.* [1] have performed experiments demonstrating the capability of grain boundaries to store incompatible elements. The same trend is expected to occur for a volatile element such as hydrogen. We report here an experimental investigation of hydrogen diffusion through grain boundaries in synthetic polycrystalline aggregates. Synthesis of hot-press material and diffusion experiments were performed using a gas-medium pressure vessel at a confining pressure of 300 MPa over a temperature range of 1000 to 1250°C. The diffusion assembly consisted of a hot-press polycrystalline cylinder of aluminous spinel + olivine coupled with a talc cylinder (providing 20-40 μL of water above 800°C). Each diffusion assembly was placed in a Ni canister, which buffers the oxygen fugacity at Ni-NiO. Experiment duration varied from 5 to 300 minutes. The presence of hydrogen in the sample was confirmed using Fourier-transform infrared spectroscopy. No modification in major element composition was observed using electron microprobe between the post-mortem samples and the starting material. The estimation of the characteristic distances and then diffusion coefficients were calculated based on the absence or presence of hydrogen recorded by olivine 'water sensor' within the aluminous spinel aggregate. Our results indicate that hydrogen diffusivity in grain boundaries is similar to hydrogen diffusion in olivine lattice and significantly slower than previously though. The slow diffusivity of hydrogen in grain boundaries will then insure conservation of water-rich zone in the deep Earth, as in mantle wedge or in the vicinity of subducted plates.

[1] Hiraga *et al.* (2004) *Nature* **427**, 699-703.