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10Be dynamics of fine sediments: impact of mixing, grain size and annual variability in the Alps.

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Cosmogenic nuclides such as ^{10}Be have been widely used to assess present denudation rates at the catchment scale. A growing number of studies also use this tool to analyze mainly continental sedimentary archives and reconstruct past denudation on large integrated area. Because of recent analytical improvements, this tool is now also amenable in low concentrated and fine-grained marine sediments, providing the opportunity to study numerous well dated archives throughout the world. However, the use of ^{10}Be on such fine grained sediments relies on several assumptions: i) the sediments have to be well mixed to be representative of the whole basin, ii) the impact of the grain size of sediments on the ^{10}Be concentration is either negligible or can be linked to geomorphological processes, such as landslides, and iii) the ^{10}Be signal is stable from one year to the next, meaning that the catchment is at steady state.

Here, we analyze the evolution of the in situ ^{10}Be cosmogenic concentration in a catchment of the Southern French Alps (drainage area of 2 800 km^2, mean elevation of 1 250 m, max elevation of 3 200m and mean slope of 23°) with a short transfer zone and a high variability of geomorphic, climatic and geological parameters; thus providing a good setting to test those assumptions.

Eleven sediment samples have been collected in November 2016 from active riverbeds of the Var River and its main tributaries (Tinée, Vésubie, Estéron and Coulomp) and four key locations have been re-sampled in November 2017.

In order to test the impact of grain size on ^{10}Be concentration on fine sediments, samples have been sieved in two fractions: 50-100 μm and 100-250 μm and their respective quartz contents isolated. Only two samples points, located in the upper catchments, yield ^{10}Be concentrations that are not in agreement within uncertainties. On the other hand, grain size has no impact in downstream sediments, notably at the Var's outlet, ranging from 4.02±0.78 x 10^4 atoms/g$_{quartz}$to 4.40±0.64 x 10^4 atoms/g$_{quartz}$.

We check the mixing of sediments at three majors river junctions by comparing the ^{10}Be concentration measured downstream of the junction to the sedimentary flux weighted by ^{10}Be concentration measured for each tributary upstream of the junction. For all three junctions, the expected ^{10}Be concentrations are in agreement with the measured ^{10}Be concentrations. We consequently assume complete sediment mixing for the three major river junctions in the Var catchment (Var-Tinée, Var-Vésubie and Var-Estéron).

We checked the annual variability of the ^{10}Be signal for four key locations comparing November 2016 - when high precipitations events induced high discharge value at the Var's outlet ($<$ 200 m^3/s) - with November 2017 - when low precipitation events induced a much lower discharge value at the Var's outlet (around 10 m^3/s). We find that despite the high variability of discharge, the denudation rates of the whole watershed calculated in 2016 and in 2017 are mostly in agreement. Only the upper Var catchment shows significant differences, with higher erosion rates during the "dry" 2017.