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Measuring ^{10}Be and ^{26}Al concentrations in stream sediments from the Vosges Mountains (NE France) to explore the respective role of lithologic, topographic and climatic control on massif-wide denudation

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Located in northeastern France, the Vosges Mountains (VM) belongs to these Hercynian ranges strewn across the European alpine foreland. Peaking at ~1425 m of elevation, it presents four contrasting primary characteristics. Firstly, the geological basement allows a bipartite N-S subdivision: the Palaeozoic southern part (crystalline Vosges) composed of various igneous, metamorphic and sedimentary rocks contrasts with the much more homogeneous Triassic cover in the northern part (sandstone Vosges). Secondly, a clear E-W topographic gradient is reflected by steep hillslopes on the eastern side (Alsace) and gently-sloping hillslopes on the western side (Lorraine). Thirdly, a sharp W-E precipitation gradient (>1000mm/yr) is recorded between the windward and the leeward side. Finally, the imprint left by Quaternary climatic fluctuations yields a N-S gradient: whereas the crystalline Vosges hosted abundant valley glaciers, the sandstone Vosges were void of ice cover.

Owing to these advantageous characteristics, this contribution aims to present the first data of catchment-wide denudation at the massif scale and to explore the long-term interactions between denudation, lithological control, morphometry and climatic forcing. Modern stream sediments from 21 river catchments draining the whole massif were sampled for *in situ* ^{10}Be and ^{26}Al concentration measurements at the outlet of their mountainous reach. The mean Channel Steepness Index (k_{sn}) was computed as a morphometric "predictor" of denudation rates. Groups of lithologically uniform catchments were statistically identified based on their lithological surficial proportions.

Catchment-wide denudation rates inferred from cosmogenic ^{10}Be and ^{26}Al concentrations range from 33 to 83 mm/ka and 38 to 337 mm/ka, respectively. The [^{26}Al]/[^{10}Be] ratio range from 1.43 to 7.96, highlighting a complex exposure history for the glaciated catchments. At the massif scale, results show (i) no relation between denudation and steepness, (ii) a strong positive relation

between denudation and precipitations when lithological groups are considered and (iii) a negative relation between the surficial proportion of fluvio-glacial deposits in the catchment and the [^{26}Al]/[^{10}Be] ratio.

To our knowledge, this contribution is the first massif-scale attempt to quantify denudation in an European low- to medium-altitude mountain range. This is especially relevant as long-term landscape evolution in the Variscan belt, by contrast to the numerous works focusing on denudation in high-mountains ranges (e.g. the Alps), has been regularly disregarded in recent geomorphological studies. Importantly, whereas a vast majority of studies measuring denudation rates rely on ^{10}Be concentrations only, this study highlights the need of using a pair of cosmogenic nuclides (i.e. ^{26}Al/^{10}Be) to check whether stream sediments in formerly glaciated catchments have experienced complex exposure history.