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The impact of Glaciation on mountain topography and erosion

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Climate through erosion affected the shape and dynamics of mountain belts during the Cenozoic. However, in spite of many studies, whether the Plio-Pleistocene Glaciation, which is marked by warm interludes between dominant ice ages, has influenced denudation rates in mountain ranges by continuously switching the mode of erosion between fluvial and glacial processes remains unclear. This is, first, because previous inferences heavily relied on an apparent increase in sediment accumulation rates, which has been questioned to reflect an observational bias in the sedimentary record, and, second, because it is difficult to isolate the respective roles of tectonics and climate on setting erosion rates. Here we quantify exhumation rates at a global scale during the late Cenozoic, including the recent Plio-Pleistocene Glaciation, using low temperature thermochronology of the sediment source rocks. To this end, we compiled about 20,000 published bedrock fission-track and (U-Th)/He ages in apatite and zircon around the globe and use a novel formal inversion procedure to quantify how exhumation rates have varied both in space and time. Our results confirm exhumation rates to be highest in tectonically active mountain ranges. This leads us to conclude that tectonics has a strong control on mountain erosion, only under suitable climatic conditions, whereas climate has strong control mountain shape and height. Furthermore, and more importantly, we observe a robust increase of exhumation rate that is related to the onset of Plio-Pleistocene Glaciation in several glaciated mountain ranges around the globe. These findings are important because they suggest that total flux of sediments delivered from mountain ranges to the oceans has increased during the Plio-Quaternary.