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Initiation age and incision rates of inner gorges: Do they record multiple glacial-interglacial cycles?

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Inner gorges represent some of the most conspicuous landforms in the European Alps. They form narrow and deep active-channel incisions that link hanging tributaries with trunk valleys in glacially-conditioned environments. Despite abundant research carried out on these objects, both their origin and evolution have remained unclear. In particular, the age of initiation, the rate of incision, and the respective contribution of fluvial and subglacial processes in the evolution of inner gorges have still been a matter of scientific debate. Indeed, answering these questions has been complicated by the lack of appropriate quantitative methods and/or suitable sampling strategies for studying inner gorges. Here, we report ^{10}Be concentrations measured in alluvial sediments that have been collected along the main stream of a $\sim$20-km^2-catchment in the Swiss foreland (Central European Alps). This catchment hosts a ca. 100-m-deep and 2-km-long inner gorge that has been cut mainly in glacial till. Catchment wide denudation rates inferred from ^{10}Be analyses (n = 15) vary from $\sim$120 to 650 mm/ka and show a general downstream increasing trend. Additional field observations and GIS analyses reveal that the denudation rates within the catchment increase from the headwaters, characterized by relict glacial/periglacial landscapes, to the downstream end of the basin where the inner gorge has been formed. Using a ^{10}Be-based sediment budget approach and the delineation of topographic domains from a 2-m-resolution LIDAR, we provide an estimate of erosion rates within the gorge that are higher than 2.5 m/ka and can reach up to $\sim$ 7 m/ka. Combining these estimated erosion rates with the reconstruction of eroded volumes within the gorge, we obtain a rough initiation age in the early Holocene, in general agreement with previous studies reporting a postglacial origin for the inner gorges. Our results therefore appear contradictory with recent findings arguing for a gradual formation of inner gorges over multiple interglacial cycles and a relative preservation of Alpine landscapes during glacial periods.