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Bridging erosion rate measurements across timescales

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Understanding the processes shaping the Earth's topography requires detailed reconstructions of erosion, climate and tectonic histories on different spatial and temporal scales. In that context, and particularly for glacial landscapes, there is an ongoing debate on how erosion rate measurements can be compared across timescales (Ganti et al., 2016). Because of the stochastic nature of erosional processes, a timescale bias might cause apparent changes in erosion rates through time. However, this bias occurs primarily when erosion rates are acquired with independent methods and averaged over different timescales. Therefore, methods that enable to quantify time series of erosion rates, rather than erosion integrated over a single timescale are needed. Thermoluminescence thermochronology (TLT) offers this possibility. This method uses the signal emitted by the temperature-stimulated release of electrons previously ionized due to ambient radioactivity and trapped in different energy levels. It enables us to constrain the high-resolution temperature-time path of a rock sample during exhumation by using several closure temperatures ranging from about 80° to 30°C. TLT thus bridges the erosion rates constrained by apatite (U-Th)/He thermochronology and by denudation rates inferred from 10Be. In the Western Cordillera of the Central Andes, at 26°-35°S latitude, new and previously published low-temperature thermochronological data (AHe, AFT, ZHe, ZFT) show a Pleistocene increase in erosion rates at the latitude of 33.5°S latitude. TLT measurements confirm this increase in erosion, but show additionally a later decrease of the erosion rates towards present. Interestingly, the inferred erosion rates are similar to published erosion rates (0.28 mm/yr) derived from 10Be and sediment yield measurements. Our study implies that TLT offers the link between Ma- and ka-scale erosion rates by avoiding problematics posed by a possible timescale bias.