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Impact of glacial erosion on synthetic (U-Th)/He detrital thermochronological age distributions: a new approach integrating glacial landscape modelling and thermal history inversion.

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Landscapes in Greenland have been deeply impacted by glacial erosion since the major cooling event at the Eocene-Oligocene boundary and the initiation of the Greenland ice sheet between 5 and 30 Ma. Glacial erosion created deep and wide fjords including the largest in the world, the Scoresby Sund fjord, with a width greater than 40 km. As fjords are unequivocally associated to glacial erosion, they represent a unique archive to assess the co-evolution of ice dynamics and landscapes during the Cenozoic. More specifically, the thermal history of rocks assessed from low-temperature thermochronology offer valuable insights to infer the long-term erosion history of Greenland landscapes and the spatial distribution of ice over time. In the last decade, detrital thermochronology has been used to deduce spatial patterns of erosion within a catchment by considering just age probability distributions functions (PDF). Recently, we have developed a new inverse approach to infer thermal histories directly from detrital age distributions, without the need for in situ or vertical profile bedrock data.
As this approach has shown promising results, we built the concept into the 3D landscape evolution model iSOSIA. Within the model we track sediment-particles resulting from erosion through multiple glaciation events, leading to the formation of a major fjord comparable to those observed in Greenland. Each particle has an associated thermochronological age, reflecting both the age distribution on the pre-glacial landscape and any modifications in response to glacial erosion. This information allows us to predict age distributions in a detrital sample anywhere in the catchment. From these distributions we are then able to infer thermal histories, and to model the pattern of erosion using an inverse approach. We present results of this modelling approach in a case study simulating fjord development in East Greenland. The results highlight the importance of the strategy of detrital sampling for constraining erosion history of fjords and the impact of Cenozoic glaciations on landscape evolution.