Geophysical Research Abstracts
Vol. 18, EGU2016-13532-1, 2016
EGU General Assembly 2016

Glaciation and erosion of Eastern Greenland at the Eocene-Oligocene transition: Insights from low-temperature thermochronology

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Climate cooling through the Late Cenozoic was important in the evolution of glaciated mountain ranges. While the onset of accelerated Cenozoic exhumation is generally associated with the Quaternary at mid-latitudes, coincident with the local onset of glaciation, some high-latitude passive margins may have experienced earlier glaciation starting at 30-38 Ma or even 45 Ma. To address this issue, we use a set of new AFT data from 16 sub-vertical profiles sampled along the fjords of the central Eastern Greenland margin between 68˚ and 76˚N, combined with new apatite (U-Th-Sm)/He (AHe) data from selected profiles. To infer thermal histories and exhumation from these profiles, we use the software QTQt. The modeling results show a major phase of exhumation in the East Greenland margin between 68˚ and 76˚N starting at 30±5 Ma. The spatial distribution of the exhumation shows that normal faulting on East Greenland margin had no resolvable influence on exhumation related to the cooling phase. However, the timing is coincident with the dramatic worldwide fall of surface temperature at the Eocene-Oligocene transition. We therefore suggest that a transition from an Eocene fluvial to an Oligocene glacial-dominated landscape triggered a period of enhanced erosion. We infer from the thermal histories that around 2.7±1.9 km of erosion occurred close to the coast since the Eocene-Oligocene transition. This amount of erosion is consistent with the incision of the fjords and with the effective removal of 2.3±1.5 km of basalt thickness, deduced by the thermal modeling of a heating phase at 55±5 Ma. This phase of erosion is most strongly evidenced near the coast, suggesting either that continental ice extent was limited to the coastal areas or that erosion was less efficient outside these areas, leading to no obvious signal in thermochronometric data further north. Overall, this study provides the first onshore evidence of the onset of continental ice in East Greenland margin at the Eocene-Oligocene transition (∼34 Ma), contemporary with the onset of Antarctica glaciation and erosion. Our interpretation is consistent with that based on of the oldest ice-rafted debris found in the sedimentary records offshore the Eastern Greenland and implies East Greenland exhibits the oldest onshore record of Cenozoic glacial erosion on Earth.