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Cenozoic denudation history of northern Ellesmere Island: Eurekan tectonics or Eocene glaciation?

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The tectonic history of the Canadian Arctic is mainly influenced by the opening of the Arctic ocean during the Mesozoic, and by northward movements of Greenland resulting from spreading of the North Atlantic and Baffin Bay during the Cretaceous to Eocene (Eurekan orogeny). Its detailed evolution, however, is still poorly constrained. For this study we collected samples from the Pearya terrane for apatite fission track (AFT) and (U-Th-Sm)/He (AHe) analysis. Peary is situated at the northern rim of Ellesmere Island (Canadian Arctic) and thus forms the northern margin of the American continent. AFT and AHe thermochronology records cooling of rocks through the upper ∼5 to 1 km of the continental crust and is thus capable of monitoring vertical movements related to erosion and exhumation, subsidence, and fault activities. The goal of our study is (i) reconstructing the erosion history of Pearya in response to tectonic and / or climatic processes, and (ii) understanding the relation between structural evolution and long-term geomorphic evolution. First AFT ages cluster exclusively around 40 Ma, regardless whether they are derived from crystalline exposures or from modern sand samples taken from glacial outlets. All AHe ages measured so far cluster around 30 Ma. These ages are in marked contrast to the mainly Jurassic to Cretaceous AFT and AHe ages of NW-Svalbard, although NW Svalbard is assumed to have formed the eastern continuation of Pearya during the Eocene. However, Eocene AFT ages are also reported from central Ellesmere Island and Axel Heiberg Island (e.g., Arne et al., 2002, Zentilli et al., 2008). Here, these ages are clearly related to structural lineaments and associated vertical movements during the Eurekan Orogeny. In Pearya, by contrast, brittle tectonic activity mainly involves dextral strike-slip movements with no indications for significant vertical offset. An alternative, non-tectonic explanation for the AFT and AHe age pattern of Pearya would be erosion due to glacial activity. It was long assumed that northern hemisphere glaciation only started during the middle Miocene. However, a recent publication by Tripati et al. (2008) reports the occurrence of ice rafted debris in Eocene sediments from the Greenland Sea, suggesting glaciation since at least 44 Ma. The two maxima of drop stone occurrences in these sediments are at ∼40 and 30 Ma, in agreement with the AFT and AHe age clusters from Pearya. Furthermore, AFT ages from East Greenland are also similar to those from Pearya, but only in the vicinity of large geomorphic features such as fiord systems (Hansen et al., 2001). If our hypothesis is correct and the ages from Pearya reflect glacial erosion rather than Eurekan tectonics, then this would mean that northern Ellesmere Island and probably parts of North and East Greenland would have experienced glaciation already during the Eocene, whereas the northern margin of Svalbard would have remained largely unglaciated.

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