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Increase in localized exhumation with the onset of Pleistocene glaciation, Olympic Mountains (USA): New insights from thermochronometer data and numerical modeling.

Lorenz Michel, Todd A. Ehlers, Christoph Glotzbach, and Byron A. Adams
Department of Geosciences, University of Tübingen, Germany

Localized exhumation is well documented in orogen syntaxes like in the St. Elias Mountains (Alaska), Namche Barwa in the eastern Himalaya, and the Olympic Mountains (NW USA). These areas have also been used to study the influences of tectonics and climate on the development of mountain ranges. Likewise, an increase in denudation rates and changes in topography with the onset of Pleistocene glaciation is debated in many active mountain ranges and is a matter of active research. Here, we explore the exhumation history of the Olympic Mountains (Washington, USA) with an emphasis on the transient rates that occur after Pleistocene glaciation. At the Cascadia subduction zone the Juan de Fuca Plate subducts beneath North America. The Olympic Mountains form the aerially exposed part of the accretionary wedge and form a topographic high (reaching a maximum elevation of 2400 m). Uplift and exhumation of the mountain range started in the Miocene and its present topography shows significant glacial influence.
We complement previously published thermochronometry data with 29 new apatite (U-Th)/He (AHe) and zircon (U-Th)/He (ZHe) ages of sedimentary bedrock samples collected at an equal elevation of 400 m along two transects across the orogen. A total of 26 samples have reset AHe ages (15 – 1.5 Ma). Thirteen samples have reset ZHe ages (14.3 – 4.8 Ma), which are all located in the center of the mountain range. In general, profiles parallel and perpendicular to the range divide show AHe and ZHe ages that decrease towards the core of the range. However, AHe <2.5 Ma (postdating the onset of glaciation) are also present across the entire mountain range. We present a comparison of our new AHe and ZHe data as well as previously published AHe and apatite/zircon fission track data (AFT/ZFT) with cooling age predictions from a thermo-kinematic and erosion model. ZHe, AFT, and ZFT ages are best explained by an elliptical exhumation pattern active since 18 Ma, where rates are highest in the center of the mountain range ($\sim$0.9 mm/yr) and decrease outward. We interpret this exhumation pattern to be the result of the bending of the subducting Juan de Fuca Plate beneath the orogen syntaxis. However, to explain the <2.5 Ma AHe ages across the range an increase in exhumation rates is required, coincident with the onset of Pleistocene glaciation at $\sim$2 Ma. This effect is strongest on the western, coastal side of the range, where an increase of up to 100% in exhumation rates is required to match the observed AHe cooling ages. Taken together, these results suggest a strong transient disturbance to long-term exhumation rates and increased denudation rates induced by the onset of Pleistocene glaciation.