Geophysical Research Abstracts
Vol. 16, EGU2014-6157, 2014
EGU General Assembly 2014

Tectonics and surface processes interactions in exhumation history of South Alaska: insights from the thermochronological record

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The southern Alaska range presents an ideal setting to study complex interactions between tectonics, climate and surface processes in landscape evolution. It exhibits active tectonics with the ongoing of subduction/collision between Pacific and North America, and major active seismogenic reverse and strike-slip faults. The alpine landscape, rugged topography and the important present-day ice-coverage reveal a strong glacial imprint associated with high erosion and sediment transport rates. Therefore, the relative importance of glacial erosion and tectonics for the observed late-exhumation history appears to be quite complex to decipher. This problem partly arises from the fact that most studies have been focused on the southern coast of Alaska where both glacial erosion and tectonic processes are both very active and act together in driving high exhumation rates.

Here, we first perform a formal inversion of an extensive bedrock thermochronological dataset collected in southern Alaska over the last decades to quantify the large-scale 20-Myr exhumation history. Our results confirm high exhumation rates in the St Elias "syntaxis" and frontal fold and thrust belts for the last 0-2 Myr, where major ice fields and high precipitation rates likely promoted high erosion rates. It also highlights localized exhumation in the last 4-6 Myr along major tectonic features such like the Fairweather and Border Ranges faults. Large-scale inverse modeling therefore suggests that the late-stage exhumation history of South Alaska has mainly been driven by tectonic processes; the impact of late Cenozoic glaciations impact being less visible there than in less active mountain ranges such as the European Alps, British Columbia or Patagonia.

To overcome this potential bias in resolving the glacial impact on erosion history, we studied to the Granite Range (Wrangell-St Elias National Park, Alaska), an area presenting a strong glacial imprint but minor tectonic activity with only localized brittle deformation. We sampled four elevation profiles over an East-West transect for low-temperature thermochrometry. Apatite (U-Th-Sm)/He dating provides ages between $\sim$10 and 30 Ma, in agreement with published data, and shows apparent low long-term exhumation rates ($\sim$0.05-0.1 km/Myr). 4He/3He thermochronometry on a subset of samples reveals a more complex exhumation history, with a significant increase in exhumation/erosion since $\sim$6-5 Ma that we relate to the early onset of glaciations and glacial erosion processes. Our results thus confirm early glacial activity and associated topographic response in Alaska, well before the onset of Pliocene-Pleistocene Northern Hemisphere glaciations.