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Combining long- and short-term observations to understand the spatial and temporal evolution of mountain belts

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To study the evolution of active mountain belts we can use a wide range of methods that observe the tectonic and surface processes over time scales varying from days to millions of years. Thermochronometry is commonly used to study rock exhumation and erosion processes that are acting over millions of years. The various thermochronometric methods, which differ in their thermal sensitivity, allow detecting a range of surface and tectonic processes that influence various crustal depths. Additionally, we can combine these thermochronometers with various sampling strategies. Bedrock analysis provides a high spatial resolution and allows a multi-method analysis on a single sample providing an entire cooling path over >300° to 50°C at a specific location. In contrast, the analysis of sediments (detrital samples) provides less spatial resolution, but has the ability to indirectly sample regions that are otherwise inaccessible, and thus allows data collection with a large coverage of a region. Detrital thermochronometry can also be combined with geochronometry on single grains, which allows detecting the provenance area, and thus counteract the loss of spatial resolution.

Various sampling strategies and thermochronometric methods have been applied in the St. Elias orogen in southeast Alaska to understand the spatial and temporal patterns of deformation and rock exhumation over the past ca. 20 million years. These long-term observations are additionally combined with short-term observations from glacial hydrology, seismicity, and GPS velocities measurements, and provide new insights about glacial dynamics in general and the evolution of the heavily glaciated St. Elias orogen. Because most active mountain ranges on Earth have been covered by ice throughout the Quaternary, but show today mostly relic landforms of former glaciations, the St. Elias Range is a perfect natural example to study the processes that are actively going on in a tectonic active mountain belt that is heavily glaciated.