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Using a multi-mineral multi-chronometer approach to unravel the evolution of the Northern Canadian Cordillera

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Foreland basins are of great interest because they record the tectonic and erosional evolution of the orogenic hinterland. In the Northeastern Canadian Cordillera, however, most of the foreland basin strata are erased. What is left are Cretaceous clastic strata that unconformably overlay pre-Cordilleran Devonian deposits. Hence, reconstructing the orogenic evolution and foreland basin development is challenging.

We present new integrated geo- and thermochronological data from Upper Devonian Imperial Formation and Lower Cretaceous Martin House Formation in the Mackenzie Plain (Northwest Territories). The Imperial Formation consists of turbiditic sandstones and shales that are part of the clastic wedge of the Late Devonian to Early Carboniferous Ellesmerian orogeny. These strata were incorporated in the fold-and-thrust-belt during Late Mesozoic to Cenozoic Cordilleran deformation. In the Mackenzie Plain, Cretaceous strata of the Cordilleran foreland basin unconformable overlay the Devonian. Previous thermochronological studies on the Imperial Formation suggest two phases of heating and subsequent cooling with different maximum temperatures in the 80–200 °C range in the late Paleozoic and in the Late Cretaceous to Cenozoic.

To unravel the complexity of this thermal history, we integrated different geo- and thermochronological methods on detrital apatite and zircon from twelve samples of the Devonian Imperial and three samples from the Cretaceous Martin House Formation: apatite U/Pb, fission-track and (U-Th)/He data and zircon U/Pb and combined U/Pb-(U-Th)/He-Raman data. Our geochronological results suggest that the Lower Cretaceous strata contain zircon grains from the Devonian to Proterozoic sedimentary rocks in the Mackenzie Mountains instead of only receiving detritus from the Canadian Shield and derived strata east of the Mackenzie Plain. We use the thermochronological results to model and compare the post-depositional thermal histories of both formations. We compare the thermal histories from samples collected along the strike of the Mackenzie Mountains and into the Mackenzie Plain to investigate the spatial pattern of fold-thrust belt evolution.