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Late Paleozoic Thermochronology of Northern Yukon: Implications for Phanerozoic Basin Evolution in Northern Canada

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Summary

The identification of a significant Carboniferous thermal event related to Ellesmerian foredeep deposition implies that late Paleozoic hydrocarbon generation may have been locally significant in the region.

Introduction

Apatite fission track (AFT) thermochronological analysis of stratigraphic successions across northern Yukon yields a predominance of latest Cretaceous to Paleogene thermally reset AFT ages related to uplift and cooling in the northern foreland of the Cordilleran Orogen (e.g., O'Sullivan and Lane, 1997; Lane and Issler, 2011). One small window within the southern Richardson Mountains preserves older AFT ages, ca. 200 Ma, related to pre-Cretaceous thermal resetting followed by partial annealing of fission tracks. In this local area, latest Cretaceous-Paleogene burial and heating were insufficient to completely anneal older tracks. The preserved age and track length data provide important insights into the area's Paleozoic time-temperature evolution. Similar ca. 200 Ma cooling ages were recovered from samples in the southern Mackenzie Delta area. This suggests that insights into the regional Paleozoic thermal evolution may be applicable beyond the extent of Cordilleran deformation.

Method

AFT age and track length data, together with U, Th, Pb and major element chemistry, were collected from a Late Devonian sandstone (Frasnian, ca. 372-382 Ma) where the apatite grains belong to at least three statistical AFT populations with different thermal annealing kinetics. Annealing kinetic parameters are defined using the r_{mr0} parameter (Carlson *et al*., 1999; Ketcham *et al*., 1999) which is based on apatite elemental data. We have used multi-kinetic thermal modelling (Issler *et al*., 2005) in tandem with local vitrinite reflectance data and the exposed stratigraphic relationships to extract time-temperature histories from AFT samples.

Conclusions

In order to produce the AFT results together with the local vitrinite data (Ro = 1.38%) and the known geological history, the sampling area had to undergo rapid burial and heating in Early Carboniferous time, followed by exhumation, Cretaceous reburial and finally latest Cretaceous-Paleogene exhumation/cooling (see Figure 1). At the Richardson Mountains locality, the young thermal peak is less than 100°C, whereas elsewhere in the region it is more intense (based on AFT resetting). Conversely, the Carboniferous thermal event is severe within the core of the Richardson Mountains, but is less intense outward from the core (based on vitrinite reflectances). The Carboniferous thermal event is interpreted as a consequence of Ellesmerian foredeep sedimentation, whereas the latest Cretaceous-Paleogene event is attributed to

Cordilleran deformation. Characterization of two substantial, but areally variable, thermal events in the northern Cordillera, together with the correlation of the older event into the adjacent lower Mackenzie Valley, significantly modifies our understanding of the hydrocarbon maturation and expulsion history of basins in this area. Specifically, the late Paleozoic Ellesmerian foredeep-related thermal event was sufficient to induce an early episode of hydrocarbon generation in Paleozoic source rock successions.

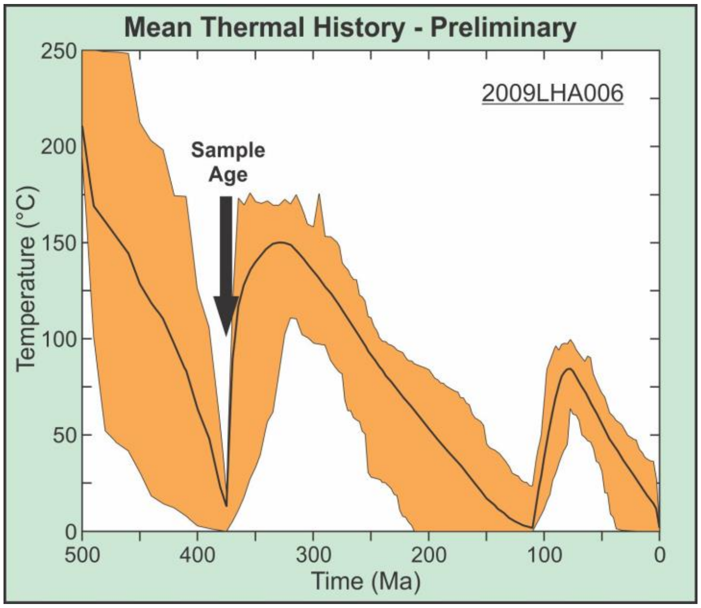

Figure 1. Preliminary mean thermal history model for Late Devonian sample 2009LHA006. At this locality, the Carboniferous thermal peak exceeds the latest Cretaceous-Paleogene peak.

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