AAPG Search and Discovery Article #90172 © CSPG/CSEG/CWLS GeoConvention 2010, Calgary, Alberta, Canada, May 10-14, 2010

Low temperature thermochronology from the Athabasca river valley, Rocky Mts., Alberta

Keith D'Arcy[1], David Baque[1], Dale Issler[2], Bernard Guest[1], Daniel Stockli[3], Michael McDonough[4]
1 - University of Calgary; 2 - Geological Survey of Canada; 3 – University of Kansas; 4 – Statoil Canada Ltd.

We utilized six samples that were collected from the Neoproterozoic Miette Gp., Mississippian Banff Fm. (bentonite unit), Jurassic - L. Cretaceous Nikanassin Fm. and the U. Cretaceous Brazeau Fm. at exposures along the Miette and Athabasca river valleys. These samples were collected for fission track thermochronometry during the 1990s and were reutilized to conduct an exploratory (U-Th)/He low temperature thermochronology study. The basic aim of this study is to evaluate the Tertiary thermal evolution of a portion of the Rocky Mts. and Foothills.

We obtained 16 cooling ages from six of the samples. Samples J91-2 and J91-5 are from the middle Miette Gp. J91-2 produced three (U-Th)/He ages; 22.1 Ma, 32.6 Ma, 20.5 Ma. Sample J91-5 had one (U-Th)/He age of 2.5 Ma. Sample J91-4 is from the lower Miette Gp. The sample produced one (U-Th)/He age of 10.7 Ma. Sample J91-1 from the Banff Fm. produced five (U-Th)/He ages of 137.0 Ma, 132.1 Ma, 80.5 Ma, 61.7 Ma and 77.3 Ma. Sample J91-9 (Nikanassin Fm.) returned one age of 118.3 Ma. Sample J91-18 (Brazeau Fm.) returned five ages of 43.0, 36.2, 45.9, 47.9, and 34.1 Ma. Additional fission track data are available for four Foothills samples from Upper Cretaceous (J91-17 (65.8±7.0 Ma), J91-16 (72.8±7.2 Ma), J91-14 (65.0±6.1 Ma) and Lower Cretaceous (J91-8 (62.8±12.2 Ma) rocks.

The young ages from J91-5 and J91-4 may be misleading due to small sample populations; with more ages it is possible that these samples would give an average age that falls in the early Miocene (e.g. J91-2). This would be consistent with final erosional cooling in the lower to mid Miocene in the Main Ranges. We tentatively interpret the ages from sample J91-1 to indicate that this sample spent a long time in the He partial retention zone resulting in partial resetting and leading to a large cooling age range. For example, it has been shown that apatites with significant radiation damage are more retentive of He (higher closure temperature) than apatites with minimal radiation damage. In this case the sample apatite population may include a mix of metamict and undamaged apatites; a long residence time in the partial retention zone would result in the undamaged apatite being reset while the metamict, (more retentive) apatites would remain un-reset. For the Foothills samples we combine the (U-Th)/He data from J91-18 with the fission track data from that sample as well as additional fission track data from samples J91-17, J91-16 and J91-14. We tentatively interpret these ages to record erosional cooling in the Foothills during Late Cretaceous-Paleocene time (62.8 to 72.8 Ma).

J91-9 with an age of 118.3 ± 7.1 Ma comes from the Lower Nikanassin Fm. (125-146 Ma). We suspect that this sample also experienced a long residence time in the partial retention zone (as we have interpreted for J91-1). This is because a nearby fission track age for sample (J91-8) from the Cadomin Formation (up-section from the Nikanassin) is 62.8±12 Ma, which is inconsistent with normal top down cooling (the structurally and stratigraphically higher sample should be older not younger). This suggests that this single analysis does not represent the full distribution of cooling ages for the sample and further analyses will reveal a broader spread in ages.

These preliminary data suggest that shortening related uplift and exhumation in the Front Ranges was under way prior to the Early Cretaceous, and that cooling was slow throughout the Cretaceous. During the latest Cretaceous to early Tertiary, final erosional exhumation took place in the Foothills. In contrast, in the Main Ranges final cooling was much later (Oligo-Miocene), possibly reflecting regional extension to the west at this time.