Apatite fission track thermochronometry from central Alberta: implications for the thermal history of the western Canada sedimentary basin

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Apatite separated from 47 Cretaceous and Tertiary drill core and surface samples from the foreland basin strata of the Western Canada Sedimentary Basin (WCSB) have been analyzed for their apatite fission track (AFT) age and confined track length distribution. Thermal histories of the fission track data were then estimated using a constrained random search inversion technique based on the Durango apatite annealing model. Most importantly, this technique provides an estimate of the peak post-depositional temperature experienced by each sample with error bounds determined by the precision of the fission track data. Most apatite samples retain at least some tracks that formed prior to the time of maximum Cenozoic burial, assumed to be coincident with maximum temperature.

Seven apatite samples from near the deformation front were fully annealed (at $T \geq 120°C$) during or following the Laramide Orogeny, and provide a minimum age of 42 Ma for heating. In contrast, stratigraphically equivalent Lower Cretaceous samples at the northeastern end of the transect near the Cold Lake heavy oil and tar sand deposits did not exceed 80°C. Paleogeothermal gradients calculated using bounded estimates of the peak temperatures experienced by the samples, together with maximum burial estimates from coal moisture studies, range from ca. 20°C/km near the deformation front to as high as 60°C/km near the cratonic edge of the basin. This variation has greater contrast but the same trend across the basin as present geothermal gradients. The results are consistent with the concept of heat transport by basinal scale fluid flow.