Aspects of Foreland Belt Thermal and Geological History in the Southern Canadian Cordillera from Fission-Track and Organic Maturity Data

K.G. Osadetz
Geological Survey of Canada
Calgary, Alberta, Canada

B.P. Kohn
University of Melbourne
Victoria, Australia

S. Feinstein
Ben Gurion University of the Negev
Israel

R.A. Price
Queen's University
Kingston, Ontario, Canada

ABSTRACT

Apatite fission-track (FT) data from the Lewis thrust sheet and environs exhibit systematic variations with elevation. Current elevation serves as a proxy for deformed structural position. Apatite FT ages decrease from ~70 Ma, at the highest elevations in the Lewis thrust sheet east of the Flathead Fault (> +2000 m), to ~30 Ma below the Lewis Thrust (~ -1000 m). In this profile mean horizontal confined fission-track lengths (HCTL) exhibit a "dog-leg," or piece-wise linear variation with elevation. Mean HCTL is >13 microns at the highest elevations and decreases to ~12 microns at ~ +1400 m. At about +800 m mean HCTL is again about 13 microns, indicating the top of the second segment of the profile. At lower elevations mean HCTL decreases progressively to ~11.5 microns at < -500 m. Lewis thrust sheet samples from the hanging wall of the Flathead Fault yield apatite FT data of comparable age and comparable, or longer, mean HCTL than that of the highest samples in the footwall of the Flathead Fault. This suggests a higher position in the orogenic wedge, consistent with the reconstruction of the Tertiary Flathead Normal Fault. Rudaceous clasts of Lewis thrust sheet in the Lower Oligocene Kishenehn Formation show apatite FT data similar to that in the highest portions of the profile east of the Flathead Fault. Everywhere in the Lewis thrust sheet zircon FT ages are older than both the youngest strata and the time of maximum Phanerozoic temperatures.

Apatite and zircon FT data along with measurements of thermal maturity of coal and organic-rich rocks show that the Lewis thrust sheet reached maximum Phanerozoic temperatures prior to motion on the Lewis Thrust. This maximum heating was attained in response to burial by a succession >7 km thick, deposited during the mid-Campanian to Maastrichtian, which is no longer preserved. The Lewis thrust sheet geothermal gradient at the time of peak temperature was significantly lower than that observed currently (17°C/km). In late Campanian-Maastrichtian time (~75 Ma), the Lewis thrust sheet exhibited a profound cooling and additional lowering of its geothermal gradient. This cooling indicates motion on the Lewis Thrust Fault. We infer that the peak temperature and coalification rank of rocks below the Lewis Thrust were achieved by tectonic burial below the cooling and eroding overthrusting sheet. The "dog-leg" in the HCTL and high vitrinite reflectance further substantiate this inference. Considering the short time interval for burial and the moderate thermal gradient indicated by the low coalification gradient, the maximum temperature below the Lewis thrust sheet inferred from both the apatite FT profile and the %Ro implies deep burial (i.e. a relatively thick overriding Lewis thrust sheet). In mid-Eocene time a second cooling affected the region east of the Flathead Fault. This indicates displacement on Flathead Fault and links thermal histories derived from apatite FT parameters with the formation of Flathead Basin and the epeirogenic uplift of the craton.