Preliminary Apatite Fission Track Data and Their Significance for the Phanerozoic Thermal History of the Precambrian Crystalline Basement Below and Marginal to Canadian Williston Basin

S. Feinstein
Department of Geology and Mineralogy, Ben Gurion University of the Negev, Beer Sheva, Israel

B. P. Kohn,
Victorian Institute of Earth and Planetary Science, School of Earth Science, La Trobe University, Bundoora, Victoria, Australia

K.G. Osadetz
Institute of Sedimentary and Petroleum Geology, Calgary, AB, Canada

R. K. Bezys
Manitoba Energy and Mines, Winnipeg, MN, Canada

Preliminary apatite fission track data from 17 Precambrian crystalline basement samples from Manitoba and Saskatchewan fall into three groups. One group has older ages between 473-402 Ma. Another group has young ages between 111-5.9 Ma. A third group has intermediate ages between the other two groups. All samples are characterized by markedly shortened horizontal confined track lengths, generally < 12 microns. This indicates that the observed ages have been considerably affected by partial annealing. Apparently, basement cooled to a temperature below that of complete track annealing (about 120 degrees C), whereas temperatures under which track shortening evolved should have prevailed at later times than the observed ages. The older group of ages is consistent with, although perhaps younger than ages determined by other investigators, and probably represents a partial resetting of ages originally established by Late Proterozoic-Early Cambrian erosion of the Canadian Shield. Age and HCTL data within this group show no geographic trend or relation to present depth. This suggests that much of the Williston Basin never achieved temperatures of 90 degrees C, at any time during Phanerozoic. Furthermore, these samples appear similar to others lying beyond the current limits of the Williston Basin. This suggests that the initial late Precambrian-Early Cambrian epeirogenic event may not have been specifically related to any mechanism that subsequently controlled the Phanerozoic subsidence of the Williston Basin. The mechanism for the late Precambrian-Early Cambrian epeirogeny is enigmatic.

Young samples come from a relatively great depth and are concentrated in the southern and western parts of the study area. This group of ages reflects nearly complete annealing in response to maximum burial during the Tertiary. Although the achievement of maximum temperatures in these samples is a young event, the thermal environment responsible for this annealing does not persist to the present. Samples with intermediate ages appear to have been less affected by Tertiary burial.

This work suggests that thermal history analysis of the Williston Basin and the underlying basement can provide constraints on both the thermal history, which is important for hydrocarbon potential, and the tectonic causes of basin subsidence.