American Mineralogist, Volume 93, pages 1215–1229, 2008

Concentric slow cooling of a low-*P*–high-*T* terrane: Evidence from 1600–1300 Ma mica dates in the 1780–1700 Ma Black Hills Orogen, South Dakota, U.S.A.

PETER S. DAHL[1,*] AND KENNETH A. FOLAND[2]

[1]Department of Geology, Kent State University, Kent, Ohio 44242, U.S.A.
[2]School of Earth Sciences, Ohio State University, Columbus, Ohio 43210, U.S.A.

ABSTRACT

The crystalline core of the southern Black Hills, South Dakota, exposes an extensive, low-*P*–high-*T* aureole of garnet- to second-sillimanite-zone schists centered on the plutonic core of the 1715 Ma Harney Peak Granite (HPG). This paper demonstrates regional patterns of apparent ages observed for 52 $^{40}Ar/^{39}Ar$ dates of muscovite and biotite in diverse rocks from across the ~1000 km^2 metamorphic aureole and its plutonic center. About 20 biotite dates, sampled mostly near faults, are influenced by excess ^{40}Ar and obscure the regional trends. The remaining mica dates reveal radial patterns of apparent younging from outer aureole toward inner granite, with previously unrecognized, elliptical age zones centered on the main HPG pluton and its outliers. The regional pattern of $^{40}Ar/^{39}Ar$ cooling ages indicates non-uniform slow cooling of the mid-crust between ~1600–1250 Ma. This scenario of delayed slow cooling from aureole to pluton is consistent with published cooling ages for muscovite (Rb/Sr) and apatite (U/Pb), which range from 1690 to 1550 Ma and from 1700 to ~1500 Ma, respectively. To explain these results, it is likely that ambient pre-granite temperatures of the country rocks were ≥350 °C at the ~10–14 km depth of granite emplacement, as previously proposed, and that the entire complex resided at this depth and cooled slowly from aureole to granite for hundreds of millions of years. Alternatively, or in addition, the HPG and inner aureole were not uplifted until ~1480–1330 Ma, whereupon they finally cooled through ~300–350 °C.

Keywords: Geochronology, micas, high-temperature studies, argon retentivity of micas (field-based), radiogenic isotopes, argon, strontium, and lead, major and minor elements, pegmatites