## 1.3.P05

# Variations in argon retention of metamorphic amphiboles from the Adirondack Lowlands, NY (USA)

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Argon retention properties of hornblende have been studied using diverse metamorphic lithologies in the Adirondack Lowlands, using mass spectrometry, microprobe, and X-ray diffraction. Incremental-heating of hornblendes and biotites constrain ~1100-900 Ma uplift, exhumation, and cooling in the Lowlands following the ~1270-1170 Ma Elzevirian orogeny. Ages of both hornblendes and biotites define parallel, northwest-to-southeast, younging trends of ~3 m.y./km across the ~45 km between the St. Lawrence River and the Carthage-Colton shear zone, which separates the Lowlands from the Adirondack Highlands domain. These trends are attributable to post-900 Ma tilting of the Lowlands domain by ~9 degrees [1].

Hornblende $^{40}Ar/^{39}Ar$ spectra indicate ages ranging from ~1100 to ~1000 Ma across the Lowlands. Age-distance regression of these indicates that ~67% of the age variance is attributable to the regional pattern (i.e., tilting) alone. The remaining ~33% apparently reflects various factors that may govern intrinsic Ar retention in hornblende, in particular, crystal chemistry and microtexture.

The overall age-distance trend for hornblende can be resolved into three subparallel compositional trends: magnesio-hastingsitic (oldest); pargasitic-tschermakitic; and edenitic (youngest), in order of decreasing Ar retention and increasing ionic porosity. The apparent age spread for a given locality is ~40 m.y., which, coupled with a known cooling rate of ~1.5 K/m.y., translates into a nominal ~60 K range in hornblende Ar closure temperature.

Multiple linear regressions of $^{40}Ar/^{39}Ar$ age (dependent variable) versus distance and various combinations of ~35 compositional and structural parameters (independent variables) have been performed. The most robust regression, statistically, relates age to a combination of distance, Mg number, Na content (A-site), Si content (T-site), and the beta angle. This regression accounts for ~90% of the $^{40}Ar/^{39}Ar$ age variance observed among Lowlands hornblendes, and appears to show that Ar retention reflects crystal chemistry.

### Reference

[1] Dahl P.S., Pomfrey M.E., and Foland K.A. (2004) *GSA Mem.* **197,** Ch. 14.

## 1.3.P06

# Thermal history of the Hadean Earth inferred from trace-element diffusion within ≥4 Ga zircons

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SHRIMP U-Pb systematics within ≥4 Ga zircons from the Narryer Complex of Western Australia indicate complex histories of radiogenic-Pb redistribution that may reflect high-grade thermal events between ca. 4404 and 3945 Ma. Trace-element diffusion distances, diffusion coefficients and ion-microprobe U-Pb isotopic analysis may enable constraints to be placed on the timing and intensity of these Hadean thermal events. In an attempt to decipher the thermal histories recorded within these ancient zircons, a detailed examination of their microstructures using back-scattered electron and cathodoluminescence (CL) imaging, combined with trace element and ion microprobe isotopic microanalytical methods, is in progress. Theoretical modelling indicates that the thermal conditions necessary to account for the radiogenic-Pb redistribution should be evident in electron microprobe trace-element traverses. A major hurdle concerns precise measurement of the diffusion distances of the trace elements for which diffusion coefficients in zircon are adequately known. Trace-element traverses using a Cameca SX-50 electron microprobe have highlighted some benefits and pitfalls of this technique. Using a 35kV and 450nA electron beam and 100s integration times, adequate spatial resolution (excitation volume ≤10 microns$^3$) and analytical precision could be attained for Pb, Y, Yb, Zr and Hf, whereas Sm, U, Ce, Dy, Th, La, Eu, Nd and Tb were near or below detection limits. Reducing the beam current to 100nA increases the spatial resolution (excitation volume ≤4 microns$^3$) and reduces damage to the grain but Y and Yb drop below detection limits. Initial results suggest that CL intensity is correlated with Y and Yb concentrations. Although currently limited by the lack of precise diffusion coefficient data for many elements in zircon, this approach might ultimately enable determination of T-time paths for any zircon-bearing metamorphic rock.