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D. Regis and D.A. Kellett

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CONTENTS

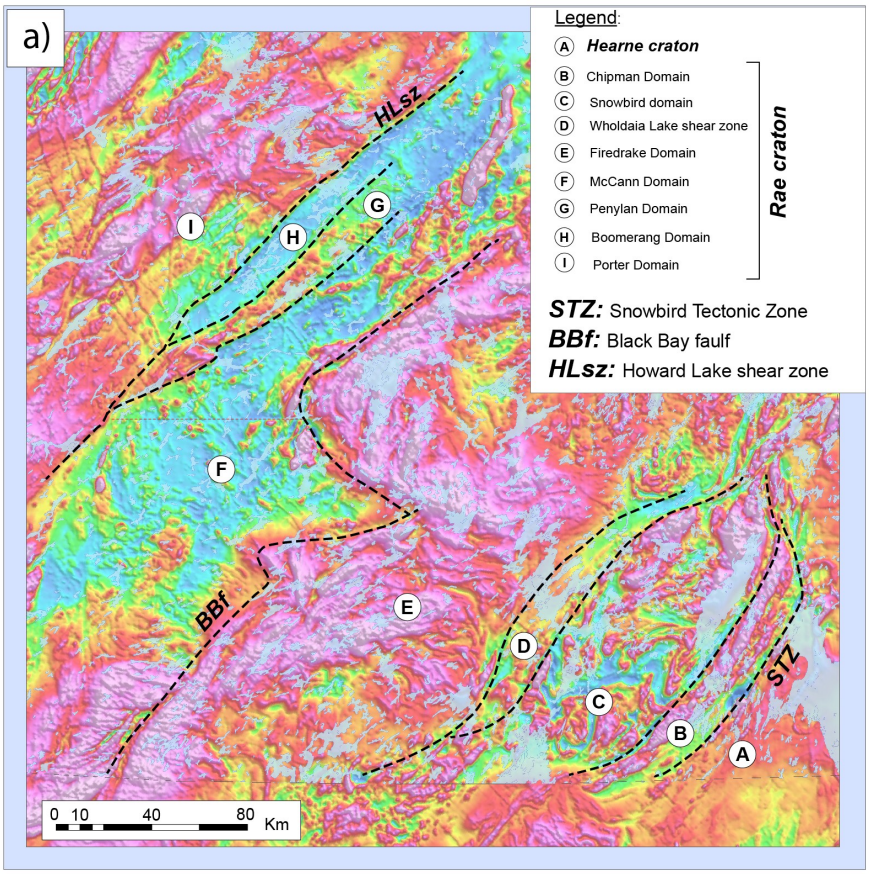
INTRODUCTION

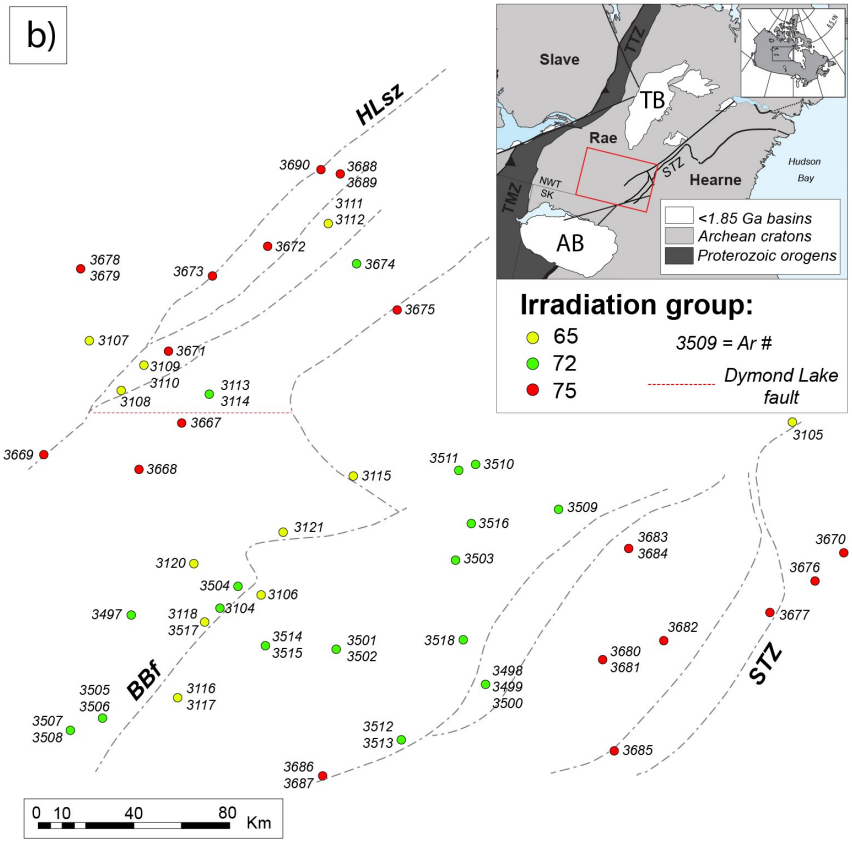
This Open File presents new $^{40}Ar/^{39}Ar$ hornblende and biotite analyses for forty-six plutonic and pelitic samples in the southern part of the Rae Craton, Northwest Territories (NWT). Detailed mapping and sampling for $^{40}Ar/^{39}Ar$ thermochronology was carried out as part of Natural Resources Canada's Geomapping for Energy and Minerals (GEM-II) South Rae project. Age determinations were carried out in the Geological Survey of Canada (GSC) Noble Gas Laboratory facility in Ottawa, Ontario. Samples have been collected from different tectono-metamorphic domains recognized in the South Rae (during three field seasons: 2012, 2015, and 2016) in order to (i) delineate domains of different cooling histories and (ii) improve our understanding of the age of regional metamorphism and exhumation of the South Rae Craton. These data will be used in the future to examine the role of major structures and shear zones in accommodating the exhumation of different blocks, as well as the role of major crustal shear zone as conduits for transporting mineralized fluids.

REGIONAL GEOLOGICAL FRAMEWORK

The Rae Craton (Fig. 1) consists of ca. 3.2-2.5 Ga granodiorite-tonalite gneiss and 2.9-2.63 Ga volcanic-sedimentary assemblages intruded by a variety of 2.68-2.58 Ga felsic plutons (e.g. Pehrsson et al., 2013). The southern Rae Craton is bound to the west by the 1.98-1.92 Ga Taltson Magmatic Zone (TMZ, Fig. 1). Bounding the eastern side of the south Rae is the Hearne Craton (Fig. 1), which consists predominantly of greenschist- to amphibolite-facies 2.71-2.67 Ga mafic to intermediate volcanic, volcanoclastic and related sedimentary rocks, as well as granites dated at ~2.68-2.66 Ga (Davis et al., 2004). Dividing the south Rae and Hearne is the Snowbird Tectonic Zone (STZ), first described as a suture (e.g. Hoffman, 1988) related to an early phase of the Trans Hudson Orogen (THO), and later called the Snowbird orogen at 1.90-1.86 Ga (Berman et al., 2007). Considerable debate exists regarding whether the STZ marks the site of a suture or an intracontinental shear zone (e.g. Mahan et al., 2008; Regan et al., 2014, Thiessen et al., 2018).

A subdivision of the south Rae crustal architecture has been recently proposed (Davis et al. 2014; Percival et al., 2016; Regis et al., 2017; Martel et al., 2018). The authors recognized 7 litho-tectonic domains in the south Rae based on new U-Pb geochronological transects in the southern NWT, the incorporation of work in Saskatchewan (e.g. Card, 2012) and analysis of regional geophysical magnetics (Fig. 1a). These domains are dominantly composed of reworked Neoarchean and Paleoproterozoic magmatic and sedimentary rocks, and each records a different P-T-t metamorphic evolution (e.g. Martel et al., 2008; Berman et al., 2013). Major north-east trending structures including (from east to west) the Chipman shear zone (Martel et al., 2008), the Black Bay fault zone (Bergeron, 2001), and the Howard Lake shear zone (Pehrsson et al., 2014), separate the litho-tectonic domains and are hypothesized to accommodate exhumation of these blocks. A detailed description of each domain can be found in Davis et al. (2014), Pehrsson et al. (2015), Percival et al. (2016), Regis et al. (2017) and Martel et al. (2018).


a)
Legend:
A Hearne craton
B Chipman Domain
C Snowbird domain
D Wholdaia Lake shear zone
E Firedrake Domain
F McCann Domain
G Penylan Domain
H Boomerang Domain
I Porter Domain
Rae craton
STZ: Snowbird Tectonic Zone
BBf: Black Bay faulf
HLsz: Howard Lake shear zone
HLSZ
BBf
STZ
0 10 40 80 Km


b)
Slave
TTZ
TB
Rae
STZ
Hearne
Hudson Bay
TMZ
NWT
SK
AB
<1.85 Ga basins
Archean cratons
Proterozoic orogens
Irradiation group:
65
72
75
3509 = Ar #
Dymond Lake fault
HLSZ
BBf
STZ
3690
3688
3689
3111
3112
3672
3678
3679
3673
3674
3675
3107
3671
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3687
3685
0 10 40 80 Km

Figure 1: (a) Total field magnetic map of the southern Rae area; (A) to (I) major structures and lithotectonic domains from Davis et al. (2014), Percival et al. (2016), Thiessen et al. (2017), and Regis et al. (2017). (b) Hornblende and biotite plutonic and pelitic rock thermochronology sites; circles with different colors indicate different irradiation groups. Numbers reported in the figure are Argon Lab # (see Appendix A and Table 1). In the inset: regional context for the southern Rae province. TB: Thelon Basin, AB: Athabasca Basin, STZ: Snowbird Tectonic Zone, BBf: Black Bay fault, HLsz: Howard Lake shear zone.

$^{40}Ar/^{39}Ar$ ANALYTICAL METHOD

Each sample was crushed using a ceramic mortar and pestle. The crushed material was washed with water and acetone and sieved to isolate the 250–500 µm fraction. The highest quality mineral grains were picked, avoiding fragments and grains with inclusions. The grains were packed into aluminum foil packets and arranged in 35 mm-long vertical tubes in an aluminum canister, and then irradiated in the research nuclear reactor at McMaster University in Hamilton (Canada) for 320 h in position 8D with a medium total flux of ~1.3×10^{13} neutrons/cm^2/s operating at a 3 MW power level (cadmium-shielded). Neutron flux was monitored using the PP-20 hornblende monitor (Hb3gr equivalent) with an apparent age of 1074 ± 5 Ma (1σ; Jourdan et al., 2006). At least four PP-20 monitors were interspersed among the ten samples in each vertical tube of the irradiation can.

The $^{40}Ar/^{39}Ar$ analyses were conducted at the Noble Gas Laboratory at the Geological Survey of Canada in Ottawa (Canada). Individual grains were loaded into 1.5 mm-diameter holes in a copper sample holder, which was placed into a CO_2 laser source chamber under ultrahigh vacuum. A Photon Machines, Inc. Fusions 10.6 55 W CO_2 laser equipped with a beam-homogenizing lens was used to heat each grain for at least 30 s per step, and laser power was increased incrementally for each subsequent step. Heating schedules ranged from 0.1 to 7 W and were adjusted with the aim of releasing near equal volumes of ^{39}Ar among heating steps.

The gas released during each incremental heating step was cleaned for 3–4 min using two SAES™ NP-10 getters held at ~400°C, and a room temperature getter containing HY-STOR® 201 calcium-nickel alloy pellets. The gas was then admitted to a Nu Instruments Limited Noblesse magnetic sector multicollector noble gas mass spectrometer. A Faraday cup was used to collect the ^{40}Ar signal while three ion-counting multipliers simultaneously collected ^{39}Ar, ^{37}Ar and ^{36}Ar using the MC-O multicollection method described in Kellett and Joyce (2014). Neutron flux gradients were evaluated by analyzing the PP-20 hornblende flux monitors and calculating J-factor values using linear interpolation between bracketing standards. Background values were measured in blank runs before and after each grain was analyzed and after every four incremental heating steps. All measured background values are presented with the analytical data in Appendix A together with the correction factors applied to account for reactor-induced interference reactions. Atmospheric $^{40}Ar/^{36}Ar$ measurements were conducted periodically during each analysis session using aliquots of air transferred to the extraction line. Using these air shot analyses, detector intercalibration corrections relative to a reference detector were applied to all sample gas analyses to correct for efficiency differences between detectors and for mass fractionation. Data collection, reduction, error propagation, age calculation and plotting were completed using the Mass Spec software (v. 7.93; Deino, 2001). Thorough descriptions of

laboratory procedures, instrument specifications, data collection and correction factors are provided in Kellett and Joyce (2014).

Ages presented here were calculated using an assumed $^{40}Ar/^{36}Ar$ ratio of 298.56 for atmospheric Ar (Lee et al., 2006) and a ^{40}K total decay constant of $5.543 \times 10^{-10}\ a^{-1}$ from Steiger and Jäger (1977).

RESULTS

Metamorphic hornblende and biotite were separated from metasedimentary rocks as well as felsic to mafic meta-igneous rocks to determine higher and lower temperature-time data to bracket the cooling history of metamorphic rocks across the study area. Results are presented on a sample by sample and mineral basis in this section, and are summarized in Table 1. The new Ar data are presented, divided by litho-tectonic domain roughly from SE (Hearne Craton) to NW (Porter domain, South Rae Craton, Fig. 1b). A graphical summary of the new ages is presented in two figures, one for hornblende cooling ages (Fig. 2), and one for biotite cooling ages (Fig. 3).

The single page reports presented here include the preferred age and age significance for each sample/mineral, the level of confidence in the interpretation, a short sample description, a description of the rationale behind the age interpretation, and a step heat plot showing all analyzed aliquots. The full data are included in Appendix A, organized according to irradiation group (65, 72 and 75, respectively). Note that inverse isochron diagrams are generally not considered in this report, as nearly all data are highly radiogenic, plotting on or near the radiogenic $^{39}Ar/^{40}Ar$ axis, and thus not particularly informative. However, ratios are included in Appendix A for the reader to easily construct their own plots.

In the following step-heating results, a plateau is defined as three or more consecutive heating steps yielding the same apparent age (within 1σ) that, together, comprise at least 50 % of the total ^{39}Ar released. The plateau ages were calculated by weighting each step by the inverse of the variance. In several cases, multiple aliquots were analyzed due to complexities in the age spectrum observed from the first step-heating analysis (aliquot 1). Regardless of whether a statistical plateau was obtained, the age interpretation made considers the apparent likelihood of Ar loss and/or excess Ar contributions to the apparent Ar step heat ages. In all cases, an interpretation is provided, and qualified with a confidence level – high, intermediate or poor. Ages with poor interpretation confidence should be treated with extreme caution in applying these data to geological interpretations of the region, particularly where they deviate from a regional pattern. Integrated (total gas) ages were calculated by weighting all the individual step ages and respective errors by the fraction of ^{39}Ar released. Note that in each step heat plot, the integrated age is reported. This age is reported as part of the characterization of the step heat spectra, but in almost every case, it does not coincide with the interpreted cooling age for the analyzed mineral. In all cases, the reported age interpretation should be preferred, regardless of integrated or plateau age calculations.

Results of the $^{40}Ar/^{39}Ar$ step-heating analyses commonly show patterns diagnostic of both Ar loss and excess Ar. Partial Ar loss, the removal of a component of daughter $^{40}Ar^{K}$ from the mineral, is represented in the majority of Ar release spectra for both biotite and hornblende as a climbing staircase pattern in the initial low temperature steps (McDougall & Harrison, 1999). Alternatively, descending staircase patterns in the initial low temperature steps (or throughout the entire age spectrum), and/or unrealistically old apparent Ar ages or biotite $^{40}Ar/^{39}Ar$ ages older than hornblende $^{40}Ar/^{39}Ar$ ages for the same sample, are considered to be diagnostic of excess Ar, or $^{40}Ar^{K}$ derived from outside the mineral of interest (Kelley, 2002). Interaction of these two phenomena can produce hump-shape apparent age spectra for both biotite and hornblende. In all cases, age interpretations below have focused on the portions of step heat spectra that are "flat" or generally homogeneous. There are few cases in which a statistical plateau was determined for a stair-cased segment of the step heat spectrum. In those cases, the statistical plateau is not used for interpretation of the mineral cooling age. In cases of evidence for significant Ar loss and significant inclusion of excess Ar, no age interpretation was made. In cases of multiple aliquots showing an excess Ar signature that approach a common apparent age in the final high temperature heating steps, this common apparent age is tentatively interpreted as a maximum cooling age for the analyzed mineral. These interpretations are usually and necessarily reported at a poor confidence level.

Note that nominal closure temperatures for ^{40}Ar in hornblende and biotite are 550 °C and 300 °C (e.g. McDougall and Harrison, 1999). However, closure temperature is dependent on the size of the diffusion domain (possibly the grain size), and the rate of cooling through the closure temperature, and therefore, in detail should be considered on a sample by sample basis.

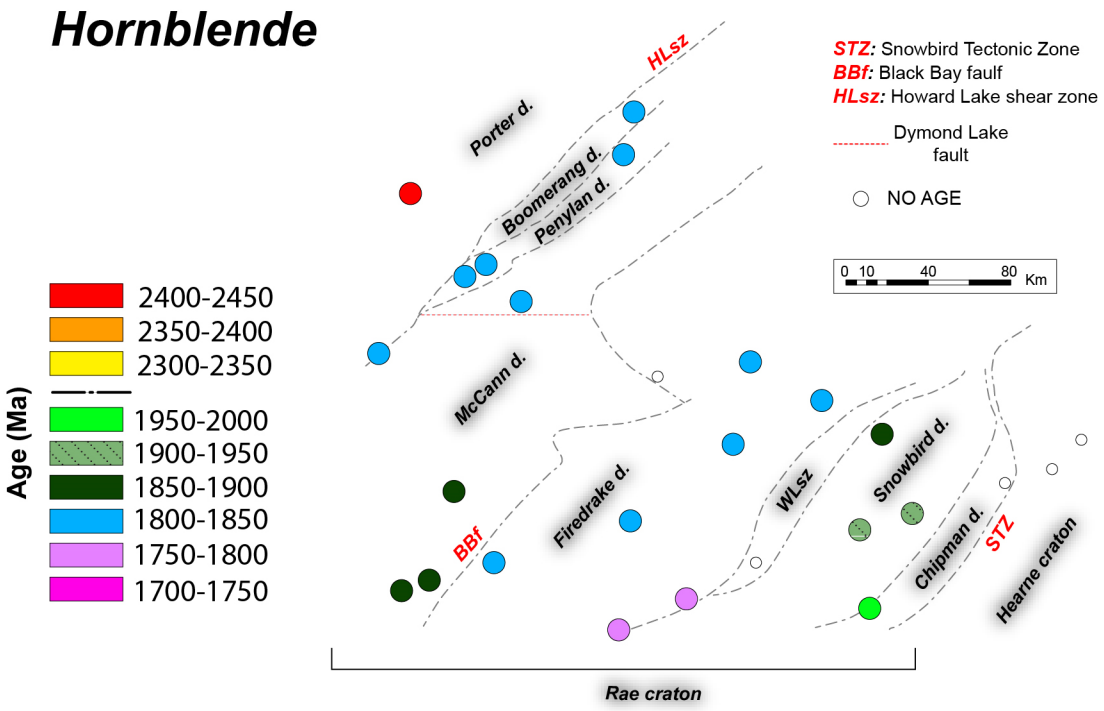

Figure 2: $^{40}Ar/^{39}Ar$ step-heating hornblende age map. Domains as in Figure 1. Undeformed Porter domain rocks preserve early Paleoproterozoic ages; samples in the McCann domain south of the Dymond Lake fault, as well as rocks in the Snowbird domain preserve hornblende cooling ages at ca. 1.85-1.95 Ga. Refer to Table 1 and Appendix A for the data.

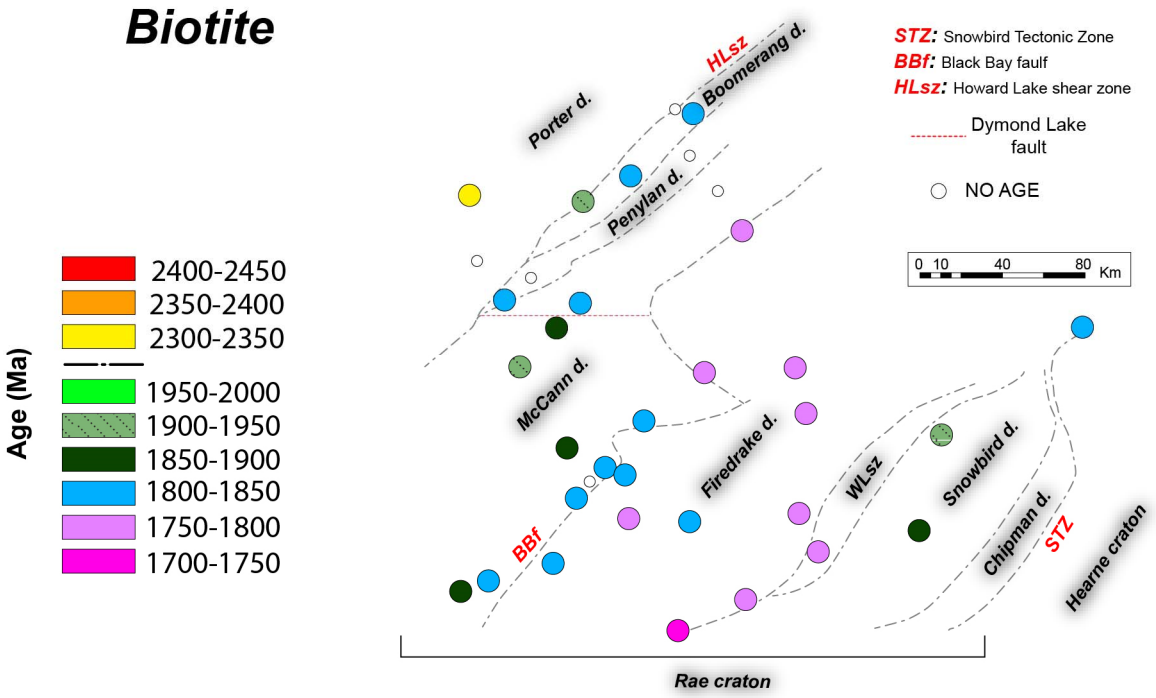

Figure 3: $^{40}Ar/^{39}Ar$ step-heating biotite age map. Domains as in Figure 1. Undeformed Porter domain rocks preserve early Paleoproterozoic ages; samples in the McCann domain south of the Dymond Lake fault, as well as rocks in the Snowbird domain preserve hornblende cooling ages at ca. 1.85-1.95 Ga. The Firedrake domain preserves the youngest cooling age at ca. 1.75-1.8 Ga. Refer to Table 1 and Appendix A for the data.

Hearne Craton

Sample Number: PQB67A
Lithology: Meta-basalt
Mineral analyzed: Hornblende
Age: NO AGE
Interpretation: NO AGE
Confidence: N/A

Geochronology Lab Number: 12006
Argon Number: 3670
Location: Hearne Craton
Lat: **Long**: 60.90017 -107.4040869, NTS sheet 75B
Geologist: Sally Pehrsson

Sample Description: massive, fine to medium-grained meta-basalt.

Results: Three hornblende aliquots from this sample show highly heterogeneous step heat spectra with very high and heterogeneous Ca/K ratios, suggesting degassing of non-hornblende phases. This heterogeneity prevents interpretation of a geological age.

Analytical details (Fig. 4):
Irradiation Batch: GSC #75

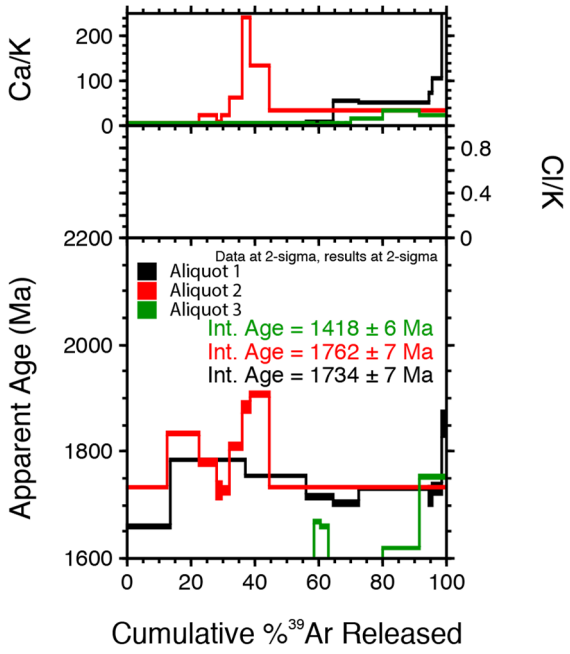

Figure 4: $^{40}Ar/^{39}Ar$ step-heating hornblende spectra, aliquots 1-3.

Sample Number: PQB65A
Lithology: Meta-gabbro
Mineral analyzed: Hornblende
Age: NO AGE
Interpretation: NO AGE
Confidence: N/A

Geochronology Lab Number: 12012
Argon Number: 3676
Location: Hearne Craton
Lat: **Long**: 60.81639 -107.93357; NTS sheet 75B
Geologist: Sally Pehrsson

Sample Description: Fine- to medium-grained metagabbro; rusty surface; 5% of quartz-rich veinlets.

Results: All three hornblende aliquots from this sample yielded highly heterogeneous age spectra that preclude geological interpretation. Note the elevated Ca/K ratios.

Analytical details (Fig. 5):
Irradiation Batch: GSC #75

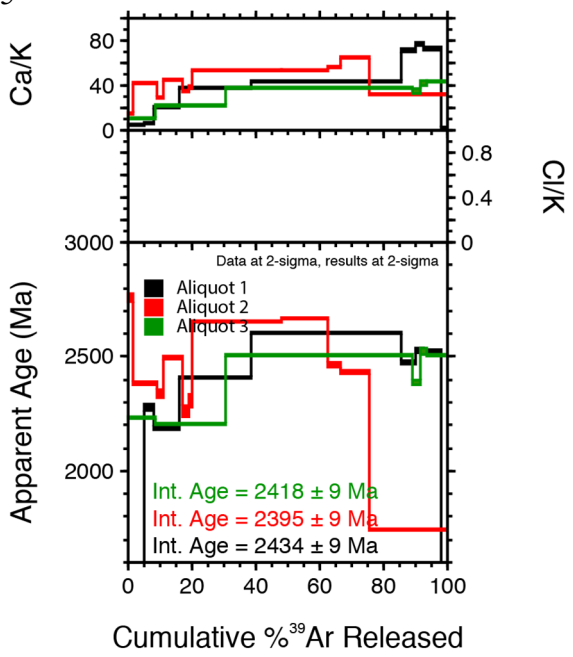

Figure 5: $^{40}Ar/^{39}Ar$ step-heating hornblende spectra, aliquots 1-3.

Chipman domain (Rae Craton)

Sample Number: PQB-22b-2012
Lithology: Lamprophyre
Mineral analyzed: Phlogopite
Age: 1830 ± 6 Ma
Interpretation: cooling age
Confidence: intermediate

Geochronology Lab Number: 10843
Argon Number: 3105
Location: Chipman domain
Lat: **Long**: 61.329864 -102.04646; NTS sheet 65E
Geologist: Sally Pehrsson

Sample Description: ca. 1 meter-thick, phlogopite-bearing lamprophyre dyke.

Results: The step heat spectrum for this sample yielded a plateau age of 1836 ± 6 Ma including 68.4% of ^{39}Ar released. However, the steps used to calculate the plateau show a down-stepping staircase pattern suggesting excess Ar. The flattest portion of the spectrum (indicated with red arrow) yields a pseudo-plateau age of 1830 ± 6 Ma, which is interpreted as the maximum cooling age for biotite. Final heating steps also show small spikes in Ca/K and Cl/K suggesting degassing of a non-biotite component.

Analytical details (Fig. 6):
Irradiation Batch: GSC #65

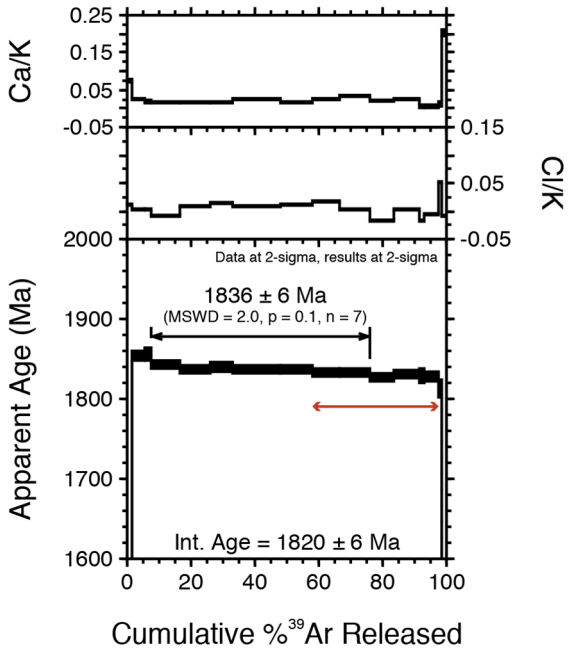

Figure 6: ^{40}Ar/^{39}Ar step-heating phlogopite spectrum, aliquot 1.

Sample Number: DR21A
Lithology: Amphibolite
Mineral analyzed: Hornblende
Age: NO AGE
Interpretation: NO AGE
Confidence: N/A

Geochronology Lab Number: 12013
Argon Number: 3677
Location: Chipman domain, NW of Kasba Lake.
Lat: **Long**: 60.56221 -102.54537; NTS sheet 65D
Geologist: Daniele Regis

Sample Description: Foliated garnet-bearing amphibolite with clinopyroxene + garnet ± plagioclase relic domains preserved within the foliation. Cm- to m-thick mafic dykes crosscutting the foliation.

Results: Two hornblende aliquots show large downward steps in apparent age for the majority of ^{39}Ar released, indicating a significant excess Ar component. The final, youngest heating steps approach ca. 1850 Ma. Note the elevated Ca/K ratios. No geological interpretation is made for this sample.

Analytical details (Fig. 7):
Irradiation Batch: GSC #75

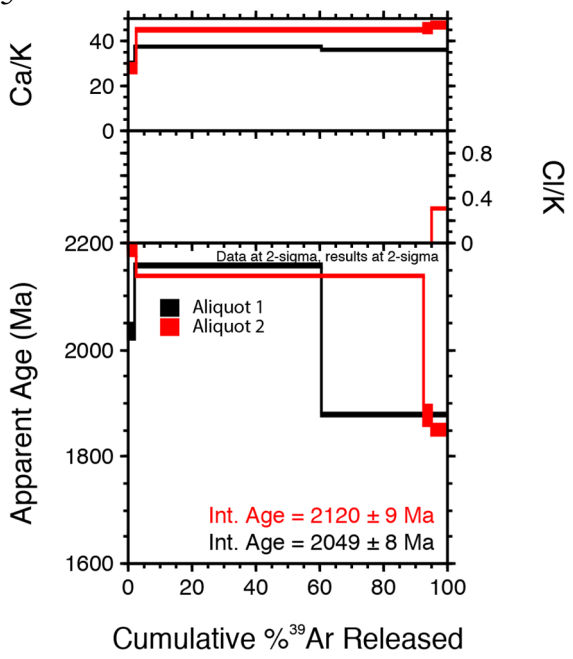

Figure 7 ^{40}Ar/^{39}Ar step-heating hornblende spectra, aliquots 1-2.

Snowbird domain (Rae Craton)

Sample Number: EM950A
Lithology: Amphibolite
Mineral analyzed: Hornblende
Age: ca. 2000 Ma
Interpretation: maximum cooling age
Confidence: low

Geochronology Lab Number: 12019
Argon Number: 3685
Location: Snowbird domain
Lat: **Long**: 60.15474 -103.55414; NTS sheet 65D
Geologist: Edith Martel

Sample Description: gneissic and strongly magnetic magnetite-clinopyroxene-garnet-hornblende amphibolite with melt-rich layers parallel to the gneissic foliation.

Results: Three hornblende aliquots show downward stepping apparent ages indicative of a significant excess Ar component. Aliquots 1 and 2 reach similar ages at the highest temperature heating steps of ca. 2000 Ga, which is tentatively interpreted as maximum hornblende cooling age for this sample

Analytical details (Fig. 8):
Irradiation Batch: GSC #75

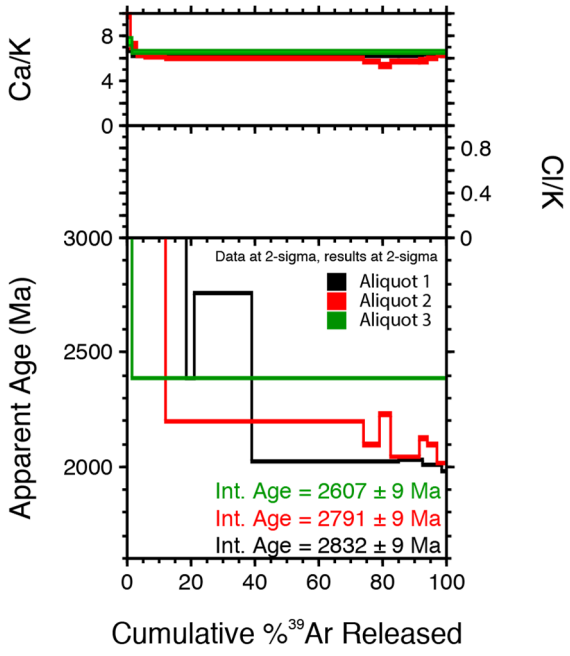

Figure 8: $^{40}Ar/^{39}Ar$ step-heating hornblende spectra, aliquots 1-3.

Sample Number: DW616A
Lithology: Amphibolite
Mineral analyzed: Biotite
Age: 1896 ± 7 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 12016
Argon Number: 3680
Location: Snowbird domain
Lat: **Long**: 60.46122 -103.72407; NTS sheet 65D
Geologist: Edith Martel

Sample Description: Coarse-grained biotite-clinopyroxene-orthopyroxene-hornblende amphibolite.

Results: Three biotite aliquots show similar, homogeneous step heat age spectra, with aliquot 1 yielding a plateau age of 1896 ± 7 Ma. This result is interpreted as the biotite cooling age for this sample.

Analytical details (Fig. 9):
Irradiation Batch: GSC #75

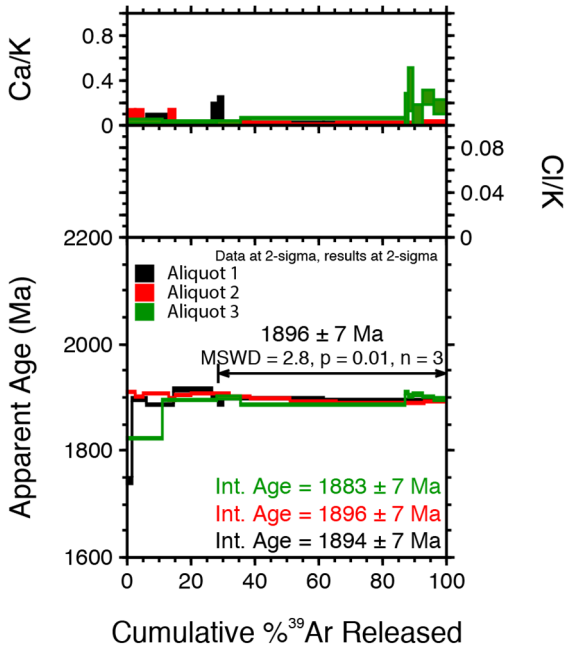

Figure 9: $^{40}Ar/^{39}Ar$ step-heating biotite spectra, aliquots 1-3.

Sample Number: DW616A
Lithology: Amphibolite
Mineral analyzed: Hornblende
Age: 1902 ± 7 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 12016
Argon Number: 3681
Location: Snowbird domain
Lat: **Long**: 60.46122 -103.72407; NTS sheet 65D
Geologist: Edith Martel

Sample Description: Coarse-grained biotite-clinopyroxene-orthopyroxene-hornblende amphibolite.

Results: Two hornblende aliquots both yielded identical plateau ages at 1902 ± 7 Ma and 1905 ± 7 Ma, respectively, for aliquots 1 and 2. Since aliquot 2 has a slight downward stepping age pattern, the plateau age from aliquot 1 is preferred as the interpreted hornblende cooling age for this sample.

Analytical details (Fig. 10):
Irradiation Batch: GSC #75

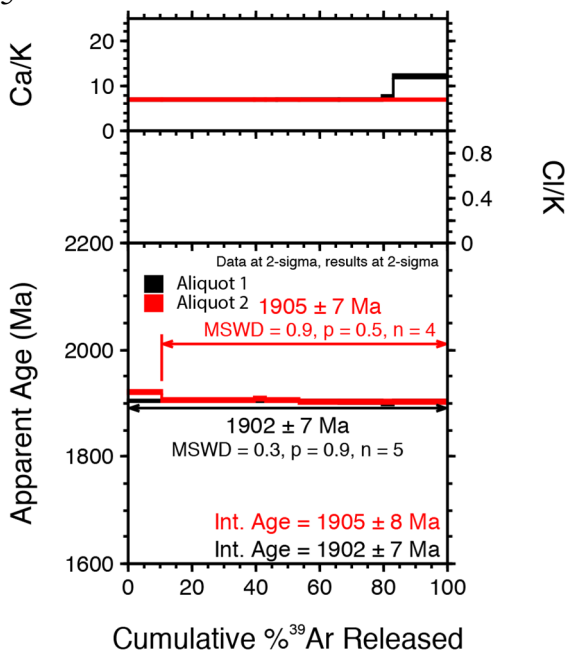

Figure 10: $^{40}Ar/^{39}Ar$ step-heating hornblende spectra, aliquots 1-2.

Sample Number: DW680A
Lithology: Granodiorite
Mineral analyzed: Hornblende
Age: 1913 ± 8 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 12017
Argon Number: 3682
Location: Snowbird domain
Lat: **Long**: 60.52687 -103.25429; NTS sheet 65D
Geologist: Edith Martel

Sample Description: hornblende-pyroxene-magnetite-bearing granodioritic gneiss injected by late light pink to white, massive granitic melts.

Results: Three hornblende aliquots show downward stepping apparent ages for the first 30-40% of ^{39}Ar released, followed by similar, and flat step heat ages. The initial apparent ages are indicative of an excess Ar component. The latter apparent ages are best defined by the plateau age from aliquot 3 of 1913 ± 8 Ma, interpreted as defining the hornblende cooling age for this sample.

Analytical details (Fig. 11):
Irradiation Batch: GSC #75

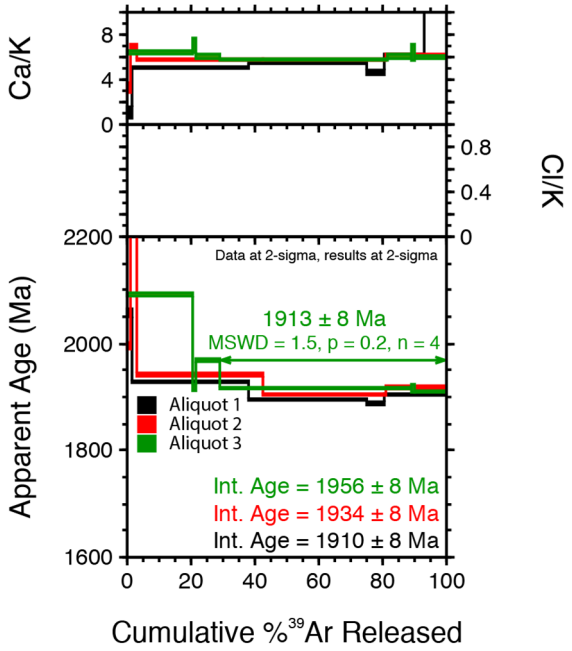

Figure 11: ^{40}Ar/^{39}Ar step-heating hornblende spectra, aliquots 1-3.

Sample Number: EM264A
Lithology: Quartz diorite
Mineral analyzed: Biotite
Age: 1911 ± 7 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 12018
Argon Number: 3683
Location: Snowbird domain
Lat: **Long**: 60.89809 -103.34229; NTS sheet 65D
Geologist: Edith Martel

Sample Description: Hornblende-rich quartz diorite with tonalitic veins and leuco-granodiorite injections.

Results: Two aliquots of biotite show similar apparent age spectra, although aliquot 1 is significantly more homogeneous in terms of apparent age. The plateau age for aliquot 1 is 1911 ± 7 Ma.

Analytical details (Fig. 12):
Irradiation Batch: GSC #75

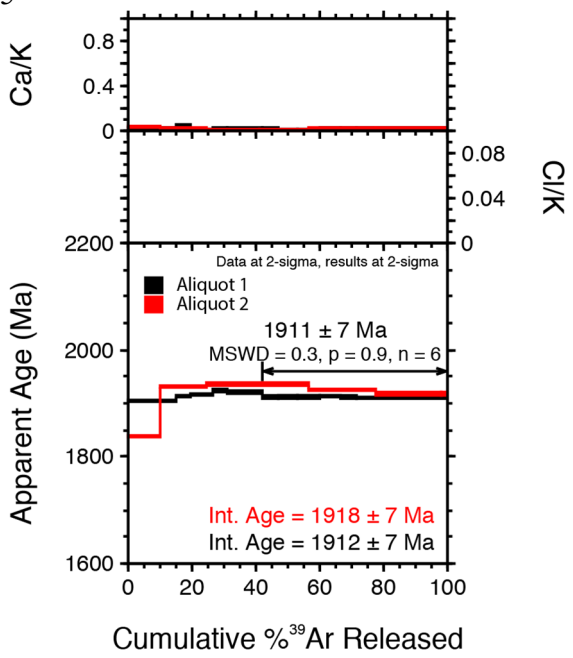

Figure 12: $^{40}Ar/^{39}Ar$ step-heating biotite spectra, aliquots 1-2.

Sample Number: EM264A
Lithology: Quartz diorite
Mineral analyzed: Hornblende
Age: 1891 ± 7 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 12018
Argon Number: 3684
Location: Snowbird domain
Lat: **Long**: 60.89809 -103.34229; NTS sheet 65D
Geologist: Edith Martel

Sample Description: Hornblende-rich quartz diorite with tonalitic veins and leuco-granodiorite injections.

Results: Two hornblende aliquots show downward stepping apparent ages, with aliquot 1 reaching a plateau age of 1891 ± 7 Ma, while aliquot 2 does not reach a stable age result.

Analytical details (Fig. 13):
Irradiation Batch: GSC #75

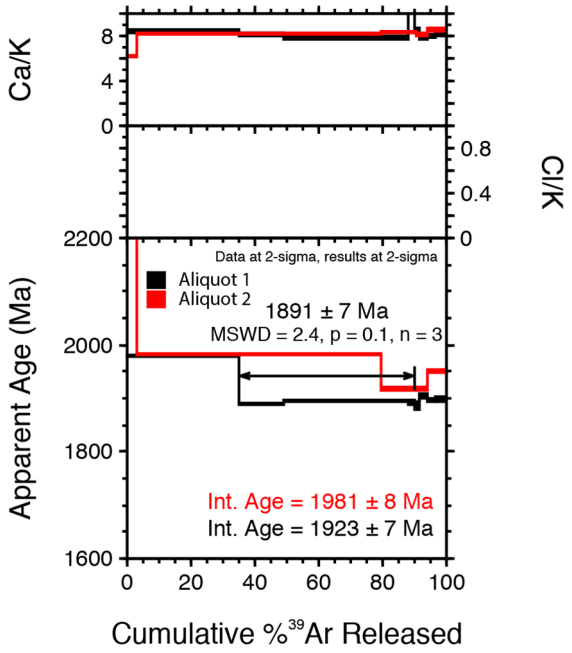

Figure 13: $^{40}Ar/^{39}Ar$ step-heating hornblende spectra, aliquots 1-2.

Wholdaia Lake shear zone (Rae Craton)

Sample Number: 15EM67A
Lithology: Gabbro
Mineral analyzed: Hornblende
Age: NO AGE
Interpretation: NO AGE
Confidence: N/A

Geochronology Lab Number: 11683
Argon Number: 3498
Location: Wholdaia Lake shear zone
Lat: **Long**: 60.39008 -104.63409; NTS sheet 75A
Geologist: Edith Martel

Sample Description: hornblende-garnet-clinopyroxene foliated mafic unit with compositional variations and garnet rich layers.

Results: All three aliquots analyzed showed highly heterogeneous and generally downward-stepping staircase step heat spectra. No age interpretation is possible.

Analytical details (Fig. 14):
Irradiation Batch: GSC #72

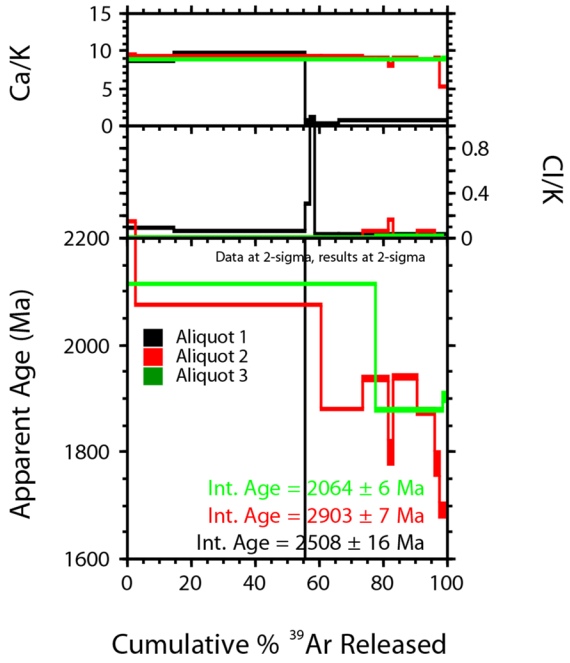

Figure 14: $^{40}Ar/^{39}Ar$ step-heating hornblende spectra, aliquots 1-3.

Sample Number: 15EM68A
Lithology: Tonalite
Mineral analyzed: Biotite
Age: ca. 1775 Ma
Interpretation: minimum cooling age
Confidence: low

Geochronology Lab Number: 11584
Argon Number: 3499
Location: Wholdaia Lake shear zone
Lat: **Long**: 60.39008 -104.63409; NTS sheet 75A
Geologist: Edith Martel

Sample Description: foliated fine to medium-grained garnet-hornblende-clinopyroxene tonalite.

Results: Both biotite aliquots for this sample show an upward staircase step heat spectrum indicating post-cooling Ar loss. The integrated age for the oldest heating steps from both analyses provide a minimum cooling age of ca. 1775 Ma.

Analytical details (Fig. 15):
Irradiation Batch: GSC #72

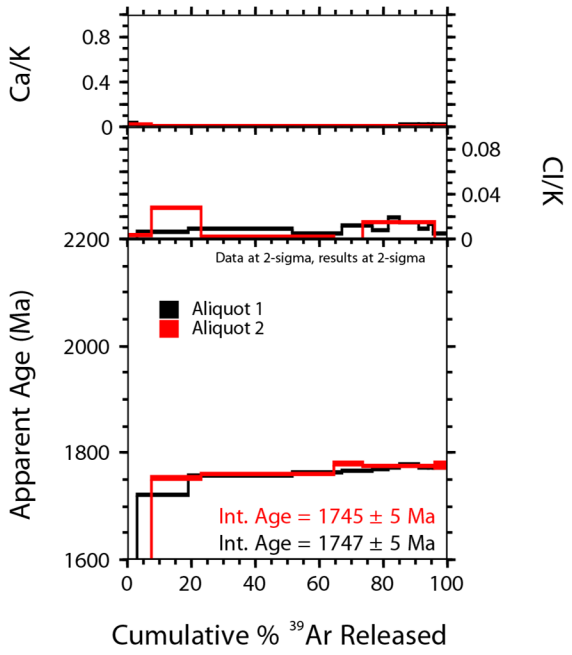

Figure 15: $^{40}Ar/^{39}Ar$ step-heating biotite spectra, aliquots 1-2.

Sample Number: 15EM68A
Lithology: Tonalite
Mineral analyzed: Hornblende
Age: ca. 1840 Ma
Interpretation: cooling age
Confidence: intermediate

Geochronology Lab Number: 11584
Argon Number: 3500
Location: Wholdaia Lake shear zone
Lat: **Long**: 60.39008 -104.63409; NTS sheet 75A
Geologist: Edith Martel

Sample Description: foliated fine to medium-grained garnet-hornblende-clinopyroxene tonalite.

Results: Hornblende aliquots 1 and 2 from this sample show excess Ar and Ar loss, respectively, for the initial 25% of ^{39}Ar released. However, the remaining heating steps, though heterogeneous, yield a ca. 1840 Ma age. Aliquot 3 appears to have been significantly more affected by Ar loss and is not used for age interpretation. The interpreted hornblende cooling age for this sample is 1840 Ma.

Analytical details (Fig. 16):
Irradiation Batch: GSC #72

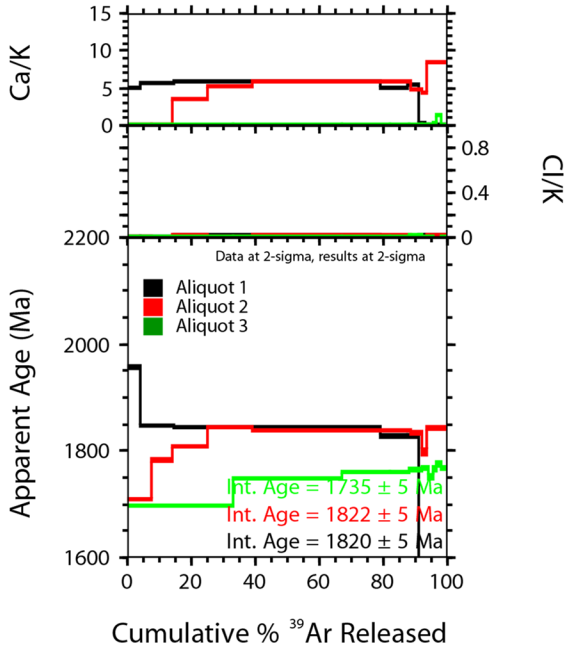

Figure 16: ^{40}Ar/^{39}Ar step-heating hornblende spectra, aliquots 1-3.

Firedrake domain (Rae Craton)

Sample Number: PQB-50d-2012
Lithology: Tonalite
Mineral analyzed: Biotite
Age: 1815 ± 6 Ma
Interpretation: cooling age
Confidence: intermediate

Geochronology Lab Number: 10844
Argon Number: 3106
Location: Firedrake domain
Lat: **Long**: 60.70231 -106.292417; NTS sheet 75B
Geologist: Sally Pehrsson

Sample Description: massive biotite-bearing tonalite orthogneiss; sampled close to the Black bay fault.

Results: The step heat spectrum for this sample is somewhat heterogeneous and does not produce a statistical plateau. However, the latter ~50% of ^{39}Ar released (indicated with the red arrow) yields steps with fairly consistent ca. 1815 Ma ages; 1815 Ma is, thus, considered a reasonable approximation of the cooling age for this sample.

Analytical details (Fig. 17):
Irradiation Batch: GSC #65

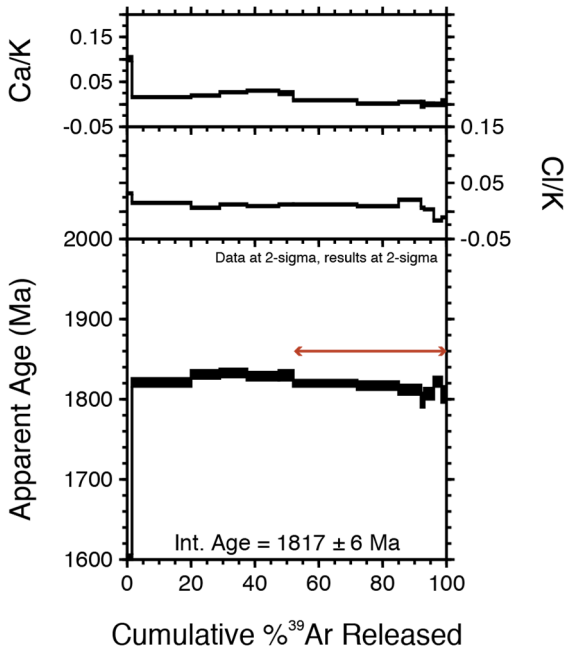

Figure 17: ^{40}Ar/^{39}Ar step-heating biotite spectrum, aliquot 1.

Sample Number: PQB-81b-2012
Lithology: Paragneiss
Mineral analyzed: Biotite
Age: 1795 ± 6 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 10850
Argon Number: 3115
Location: Firedrake domain
Lat: **Long**: 61.123773 -105.627229; NTS sheet 75H
Geologist: Sally Pehrsson

Sample Description: garnet, biotite, and minor sillimanite-bearing migmatitic paragneiss. Strongly magnetic.

Results: Aliquot 1 from this sample yielded a statistical plateau age of 1795 ± 6 Ma. It otherwise has a similar shape, but slightly younger step heat profile compared to the more heterogeneous step heat spectrum obtained from aliquot 2. Both aliquots show Ar loss in the initial ~25% of ^{39}Ar released. The plateau age is considered to represent the biotite cooling age for this sample.

Analytical details (Fig. 18):
Irradiation Batch: GSC #65

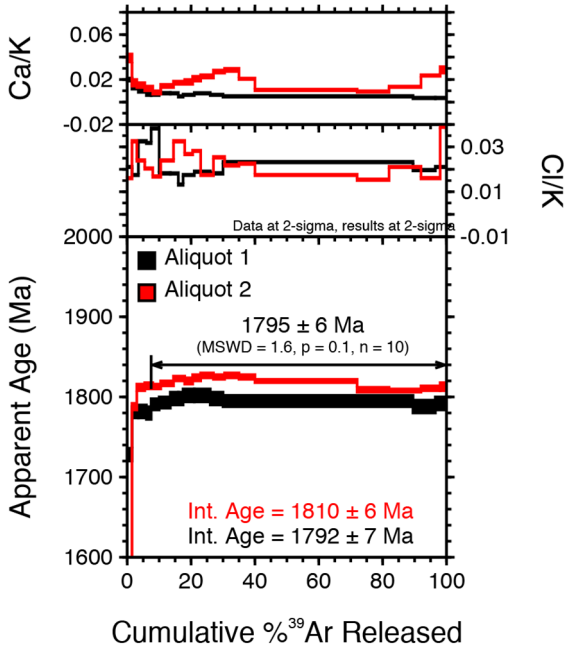

Figure 18: ^{40}Ar/^{39}Ar step-heating biotite spectra, aliquots 1-2.

Sample Number: PQB-84-2012
Lithology: Paragneiss
Mineral analyzed: Biotite
Age: 1806 ± 5 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 10851
Argon Number: 3116
Location: Firedrake domain
Lat: **Long**: 60.31397 -106.93577; NTS sheet 75B
Geologist: Sally Pehrsson

Sample Description: garnet-biotite quartzo-feldspathic schist layer in the migmatitic paragneiss. Sampled east of the Black Bay fault.

Results: The step heat spectrum for this sample indicates Ar loss in the initial 25% of ^{39}Ar released, followed by a statistical plateau of 1806 ± 5 Ma for the remaining 75%. This plateau age is considered to represent the biotite cooling age for this sample.

Analytical details (Fig. 19):
Irradiation Batch: GSC #65

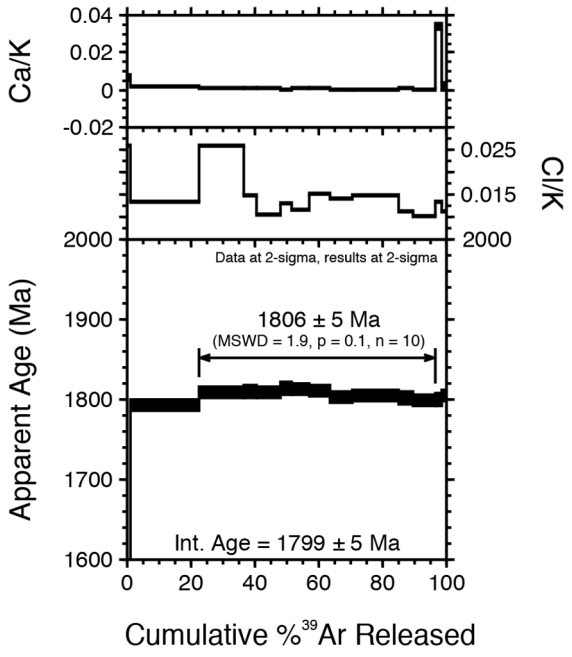

Figure 19: $^{40}Ar/^{39}Ar$ step-heating biotite spectrum, aliquot 1.

Sample Number: PQB-84-2012
Lithology: Paragneiss
Mineral analyzed: Hornblende
Age: 1820 ± 6 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 10851
Argon Number: 3117
Location: Firedrake domain
Lat: **Long**: 60.31397 -106.93577; NTS sheet 75B
Geologist: Sally Pehrsson

Sample Description: garnet-biotite quartzo-feldspathic schist layer in the migmatitic paragneiss. Sampled east of the Black Bay fault.

Results: The step heat spectra for hornblende from this sample are similarly homogeneous with Aliquot 2 yielding a statistical plateau of 1820 ± 6 Ma which is within error of the integrated ages for both aliquots. This plateau age is considered to represent the hornblende cooling age for this sample.

Analytical details (Fig. 20):
Irradiation Batch: GSC #65

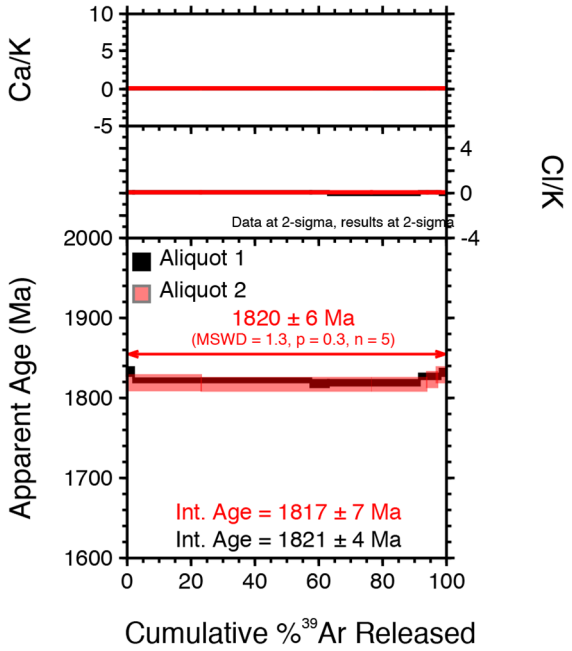

Figure 20: $^{40}Ar/^{39}Ar$ step-heating hornblende spectra, aliquots 1-2.

Sample Number: 15EM71B
Lithology: Granite
Mineral analyzed: Biotite
Age: 1839 ± 5 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 11588
Argon Number: 3501
Location: Firedrake domain
Lat: **Long**: 60.53435 -105.75241; NTS sheet 75A
Geologist: Edith Martel

Sample Description: foliated to gneissic biotite- and hornblende-bearing granite; Contains several xenoliths of mafic composition (hornblende-clinopyroxene-plagioclase).

Results: Both biotite aliquots from this sample show evidence of Ar loss in the initial 40% of ^{39}Ar released. Aliquot 1 yields a plateau age of 1839 ± 5 Ma comprising most of the remaining heating steps, while aliquot 2 yields similar but more heterogeneous step heat ages. The plateau age of aliquot 1 is interpreted as the biotite cooling age for this sample.

Analytical details (Fig. 21):
Irradiation Batch: GSC #72

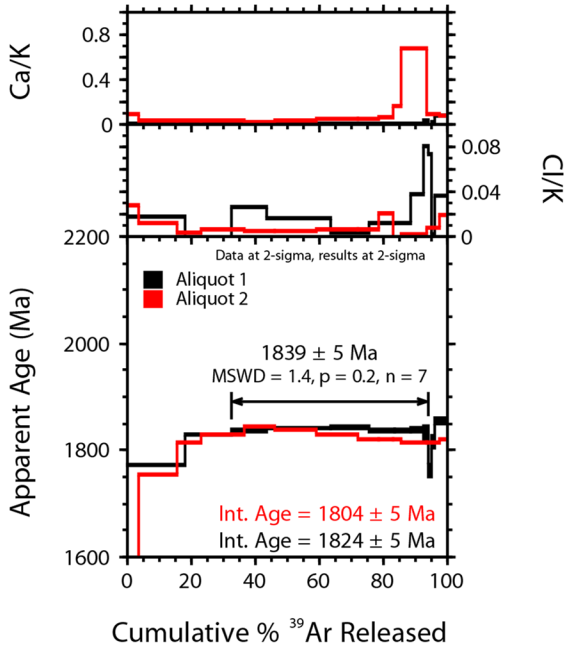

Figure 21: ^{40}Ar/^{39}Ar step-heating biotite spectra, aliquots 1-2.

Sample Number: 15EM71B
Lithology: Granite
Mineral analyzed: Hornblende
Age: ca. 1840 Ma
Interpretation: cooling age
Confidence: low

Geochronology Lab Number: 11588
Argon Number: 3502
Location: Firedrake domain
Lat: **Long**: 60.53435 -105.75241; NTS sheet 75A
Geologist: Edith Martel

Sample Description: foliated to gneissic biotite- and hornblende-bearing granite; Contains several xenoliths of mafic composition (hornblende-clinopyroxene-plagioclase).

Results: The hornblende aliquots from this sample both indicate excess Ar for the heating steps that comprise the initial 10% of ^{39}Ar released. The remaining heating steps are heterogeneous but together are in the range of ca. 1840 Ma, which is tentatively interpreted as the hornblende cooling age.

Analytical details (Fig. 22):
Irradiation Batch: GSC #72

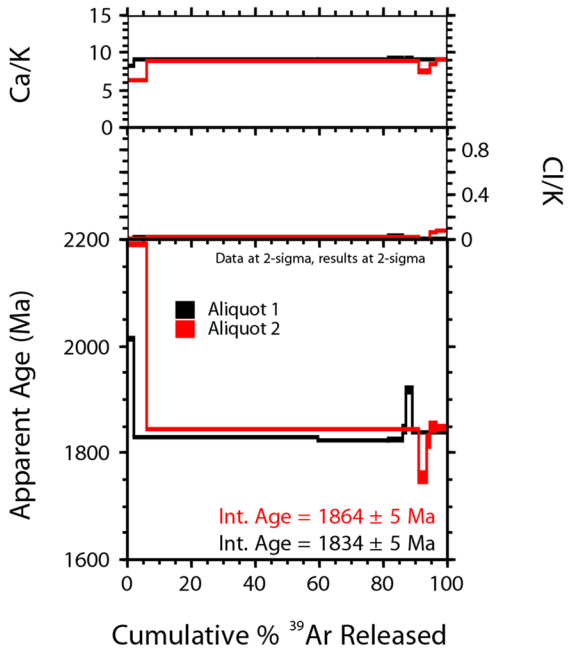

Figure 22: ^{40}Ar/^{39}Ar step-heating hornblende spectra, aliquots 1-2.

Sample Number: 15EM80C
Lithology: Granodiorite
Mineral analyzed: Hornblende
Age: ca. 1800 Ma
Interpretation: maximum cooling age
Confidence: low

Geochronology Lab Number: 11684
Argon Number: 3503
Location: Firedrake domain
Lat: **Long**: 60.86402 -104.86423; NTS sheet 75A
Geologist: Edith Martel

Sample Description: foliated granodiorite with granitic injections parallel to the foliation. Contains mafic xenolith, some with clinopyroxene rimmed by biotite with radial growth textures.

Results: The down-stepping staircase pattern exhibited by both hornblende aliquots from this sample indicate presence of excess Ar, such that the youngest age steps provide a poorly-defined maximum cooling age of ca. 1800 Ma, despite the statistical plateau age obtained from aliquot 1.

Analytical details (Fig. 23):
Irradiation Batch: GSC #72

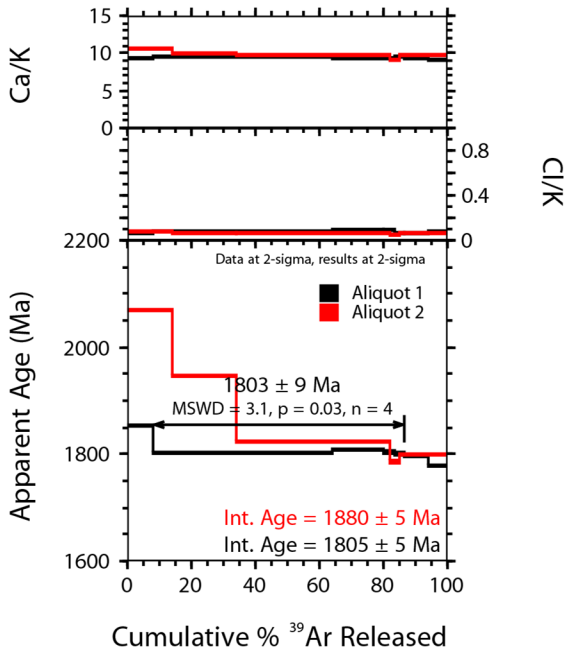

Figure 23: $^{40}Ar/^{39}Ar$ step-heating hornblende spectra, aliquots 1-2.

Sample Number: 15ET241A
Lithology: Meta-gabbro
Mineral analyzed: Hornblende
Age: ca. 1800 Ma
Interpretation: cooling age
Confidence: low

Geochronology Lab Number: 11593
Argon Number: 3509
Location: Firedrake domain
Lat: **Long**: 61.04571 -104.02965; NTS sheet 75H
Geologist: Eric Thiessen

Sample Description: Fine-grained, foliated metagabbro cutting tonalitic gneiss, which has intrafolial folds and injections defining the gneissic fabric.

Results: Aliquot 1 from this sample indicates a significant component of excess Ar for all heating steps, as well as elevated Cl/K and does not contain geological age information. Aliquots 2 and 3 yield highly heterogeneous age results. However, the high temperature heating steps from aliquot 3 are consistent with the majority heating step from aliquot 2 at ca. 1800 Ma. The high temperature heating steps of aliquot 2 yielding <1600 Ma apparent ages reflect degassing of a different phase with lower Ca/K and higher Cl/K, and thus are not considered to reflect the cooling age of the hornblende. Thus ca. 1800 Ma is tentatively interpreted as a cooling age for this sample.

Analytical details (Fig. 24):
Irradiation Batch: GSC #72

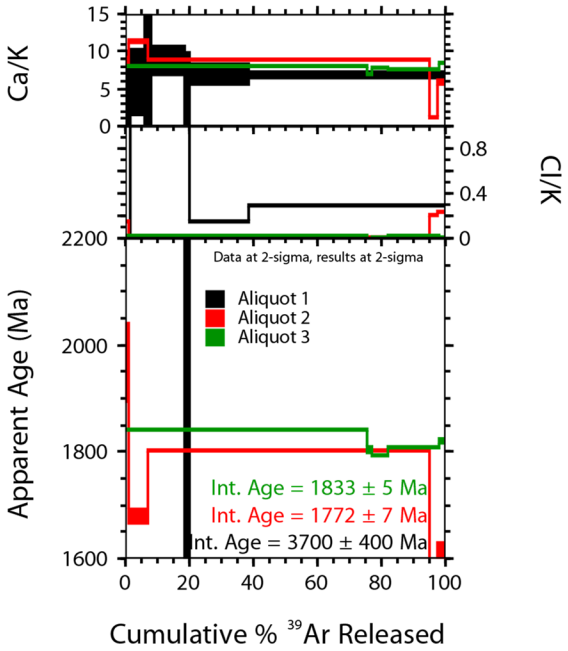

Figure 24: $^{40}Ar/^{39}Ar$ step-heating hornblende spectra, aliquots 1-3.

Sample Number: 12PQB39
Lithology: Tonalite
Mineral analyzed: Hornblende
Age: 1823 ± 6 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 11687
Argon Number: 3510
Location: Firedrake domain
Lat: **Long**: 61.15312 -104.69874; NTS sheet 75H
Geologist: Sally Pehrsson

Sample Description: Clinopyroxene-hornblende-rich tonalite to granodiorite; mafic layered enclaves observed at the outcrop scale.

Results: Aliquots 1 and 2 from this sample indicate excess Ar in the initial heating steps, but all three aliquots yield relatively homogeneous apparent ages for the remainder of the gas released. The plateau age yielded by aliquot 2 of 1823 ± 6 Ma is interpreted to reflect the hornblende cooling age for this sample.

Analytical details (Fig. 25):
Irradiation Batch: GSC #72

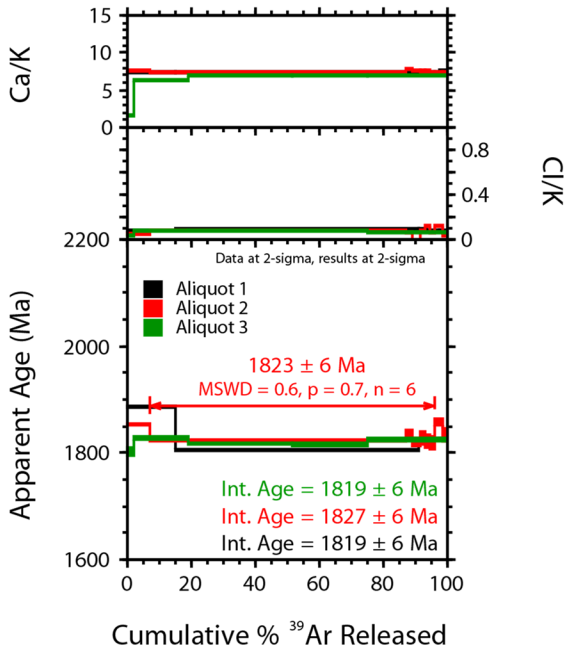

Figure 25: $^{40}Ar/^{39}Ar$ step-heating hornblende spectra, aliquots 1-3.

Sample Number: 12PQB40
Lithology: Semi-pelite
Mineral analyzed: Biotite
Age: ca. 1760 Ma
Interpretation: cooling age
Confidence: intermediate

Geochronology Lab Number: 11688
Argon Number: 3511
Location: Firedrake domain
Lat: **Long**: 61.13908 -104.78042; NTS sheet 75H
Geologist: Sally Pehrsson

Sample Description: biotite-garnet-sillimanite semi-pelite. Refolded foliation defined by biotite and sillimanite.

Results: Both aliquots from this sample yield similar step heat apparent age patterns, with Ar loss evident for the initial heating steps, reaching a generally flat age spectrum for the latter 50% of ^{39}Ar released. However, aliquot 2 is slightly more homogeneous, yielding an approximate cooling age of ca. 1760 Ma.

Analytical details (Fig. 26):
Irradiation Batch: GSC #72

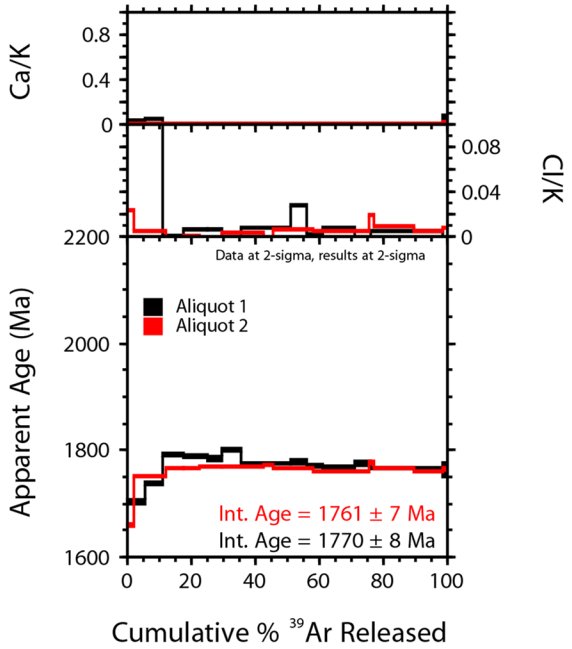

Figure 26: ^{40}Ar/^{39}Ar step-heating biotite spectra, aliquots 1-2.

Sample Number: 12PQB47
Lithology: Quartz diorite
Mineral analyzed: Biotite
Age: 1798 ± 7 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 11689
Argon Number: 3513
Location: Firedrake domain
Lat: **Long**: 60.18471 -105.25899; NTS sheet 75A
Geologist: Sally Pehrsson

Sample Description: biotite-hornblende quartz diorite with rare garnet (<5%); sampled at the boundary with the Snowbird domain.

Results: Five aliquots were analyzed for this sample, with all aliquots indicating a component of Ar loss in the initial 10-40% of ^{39}Ar released, and two aliquots (2 and 5) yielding plateau ages. Since the aliquot 2 indicates elevated Cl/K, the plateau age of aliquot 5 is considered to best reflect the biotite cooling age for this sample at 1798 ± 7 Ma.

Analytical details (Fig. 27):
Irradiation Batch: GSC #72

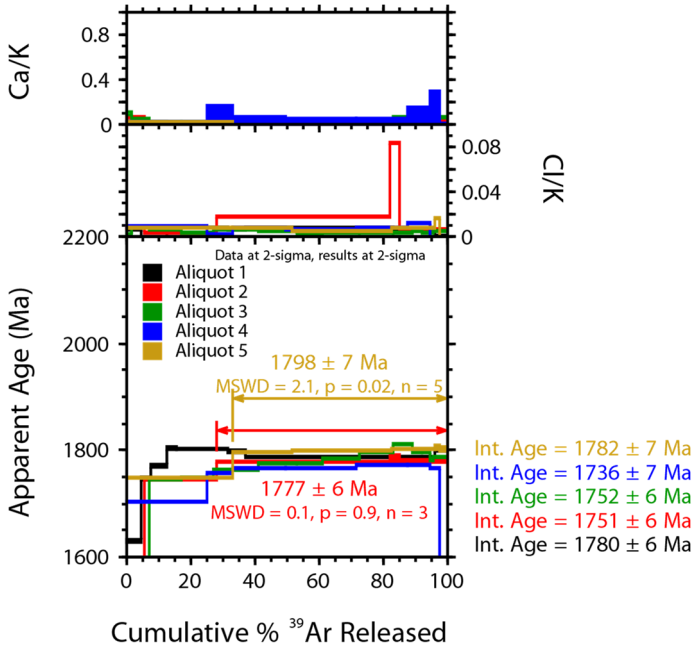

Figure 27: ^{40}Ar/^{39}Ar step-heating biotite spectra, aliquots 1-5.

Sample Number: 12PQB47
Lithology: Quartz diorite
Mineral analyzed: Hornblende
Age: 1798 ± 7 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 11689
Argon Number: 3512
Location: Firedrake domain
Lat: **Long**: 60.18471 -105.25899; NTS sheet 75A
Geologist: Sally Pehrsson

Sample Description: biotite-hornblende quartz diorite with rare garnet (<5%); sampled at the boundary with the Snowbird domain.

Results: Four hornblende aliquots from this sample yielded similar step heat apparent age spectra with initial steps showing a component of excess Ar, and latter steps yielding relatively homogeneous apparent ages. Aliquot 4 yielded a plateau age for these latter steps which is consistent with the other aliquots and provides a cooling age of 1798 ± 7 Ma.

Analytical details (Fig. 28):
Irradiation Batch: GSC #72

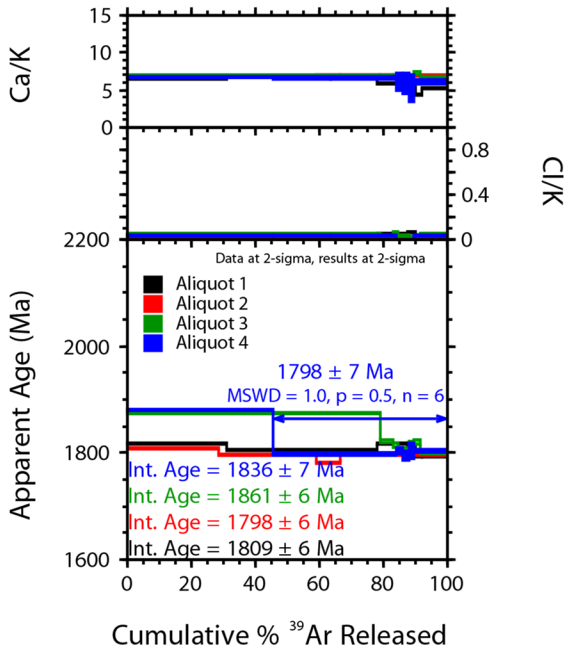

Figure 28: $^{40}Ar/^{39}Ar$ step-heating hornblende spectra, aliquots 1-4.

Sample Number: 12PQB91
Lithology: Tonalite
Mineral analyzed: Biotite
Age: 1796 ± 7 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 11690
Argon Number: 3514
Location: Firedrake domain
Lat: **Long**: 60.49656 -106.28057; NTS sheet 75B
Geologist: Sally Pehrsson

Sample Description: foliated biotite-hornblende-bearing tonalite.

Results: Three biotite aliquots from this sample yielded similar step heat apparent age spectra with initial steps showing Ar loss, and latter steps yielding relatively homogeneous apparent ages. Aliquot 3 yielded a plateau age for these latter steps, which is consistent with aliquot 1 and, provides a cooling age of 1796 ± 7 Ma. Aliquot 2 yielded overall younger step heat ages.

Analytical details (Fig. 29):
Irradiation Batch: GSC #72

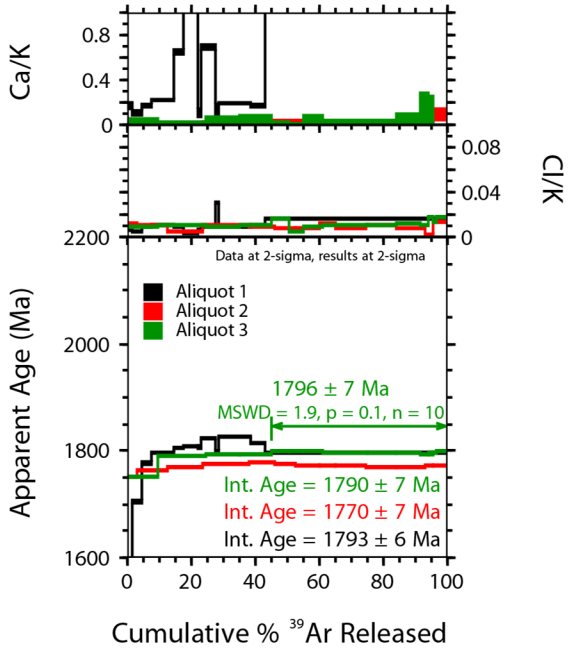

Figure 29: $^{40}Ar/^{39}Ar$ step-heating biotite spectra, aliquots 1-3.

Sample Number: 12PQB91
Lithology: Tonalite
Mineral analyzed: Hornblende
Age: NO AGE
Interpretation: NO AGE
Confidence: N/A

Geochronology Lab Number: 11690
Argon Number: 3514
Location: Firedrake domain
Lat: **Long**: 60.49656 -106.28057; NTS sheet 75B
Geologist: Sally Pehrsson

Sample Description: foliated biotite-hornblende-bearing tonalite.

Results: Hornblende aliquots 1 and 2 from this sample exhibit significant components of excess Ar that preclude determination of a geological cooling age.

Analytical details (Fig. 30):
Irradiation Batch: GSC #72

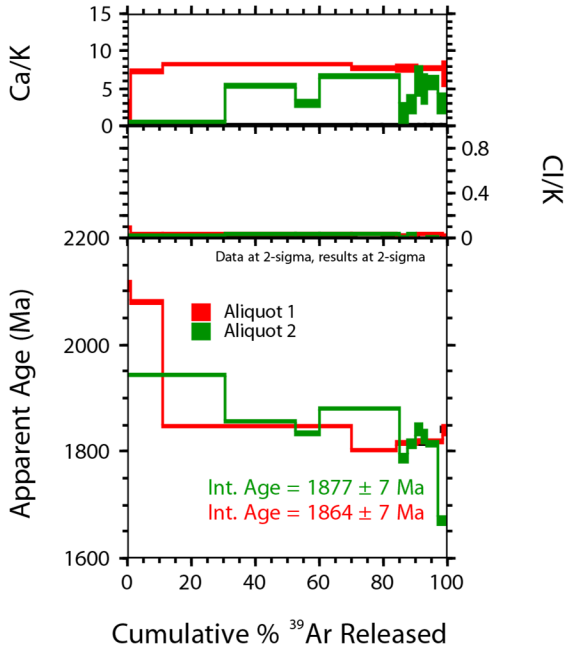

Figure 30: $^{40}Ar/^{39}Ar$ step-heating hornblende spectra, aliquots 1-2.

Sample Number: 12PQB41
Lithology: Granite
Mineral analyzed: Biotite
Age: ca. 1785 Ma
Interpretation: cooling age
Confidence: intermediate

Geochronology Lab Number: 11691
Argon Number: 3516
Location: Firedrake domain
Lat: **Long**: 60.98518 -104.95314; NTS sheet 75A
Geologist: Sally Pehrsson

Sample Description: Foliated biotite-bearing granite, with minor enclaves of biotite-bearing tonalite.

Results: Aliquots 1 and 2 from this sample show similar step heat age profiles with Ar loss in the first ~40% of ^{39}Ar released, and then several heterogeneous but broadly consistent age steps of ca. 1785 Ma. Aliquot 3 yields a significantly younger plateau age of 1741 ± 7 Ma dominated by one heating step comprising 45% of ^{39}Ar released. The more reproducible ca. 1785 Ma age from aliquots 1 and 2 is preferred as the cooling age for this sample.

Analytical details (Fig. 31):
Irradiation Batch: GSC #72

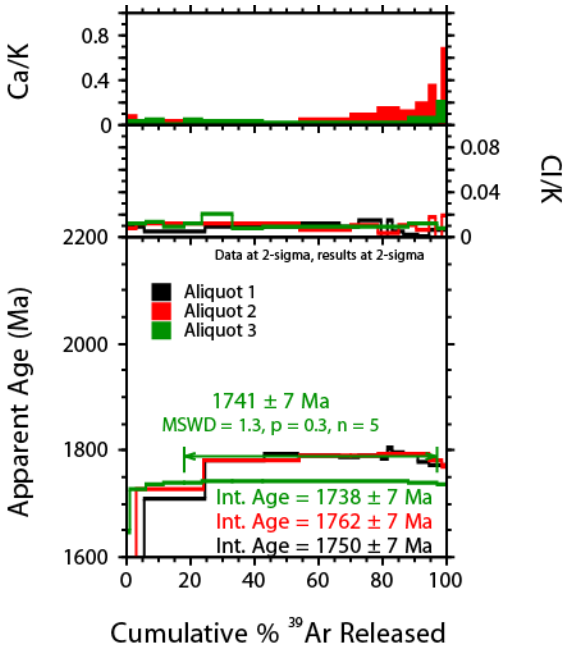

Figure 31: ^{40}Ar/^{39}Ar step-heating biotite spectra, aliquots 1-3.

Sample Number: 12PBA63
Lithology: tonalite
Mineral analyzed: Biotite
Age: 1785 ± 7 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 11692
Argon Number: 3518
Location: Firedrake domain
Lat: **Long**: 60.59805 -104.75682; NTS sheet 65D
Geologist: Sally Pehrsson

Sample Description: garnet-clinopyroxene-biotite and minor hornblende-bearing massive tonalite.

Results: All three biotite aliquots for this sample show similar Ar loss profiles for the initial ~30% of ^{39}Ar released and then relatively homogeneous step heat ages for the remainder of the step heat profile, with aliquot 3 best defining that age population with a plateau age of 1785 ± 7 Ma.

Analytical details (Fig. 32):
Irradiation Batch: GSC #72

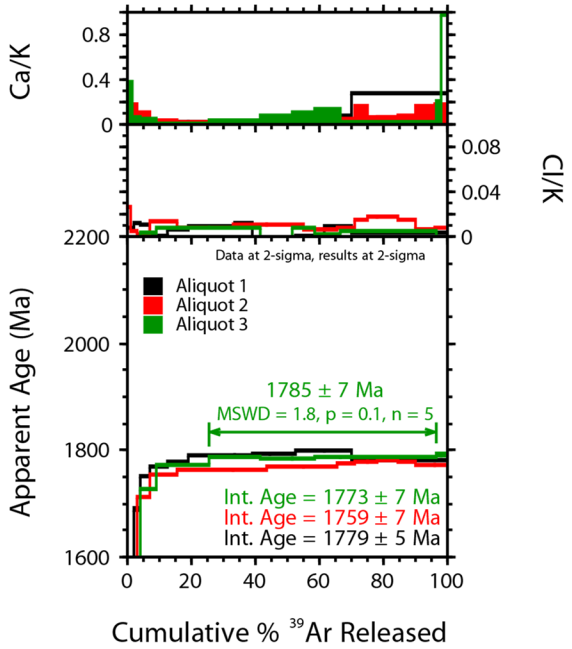

Figure 32: ^{40}Ar/^{39}Ar step-heating biotite spectra, aliquots 1-3.

Sample Number: DR1013A
Lithology: Tonalitic orthogneiss
Mineral analyzed: Biotite
Age: ca. 1800 Ma
Interpretation: cooling age
Confidence: intermediate

Geochronology Lab Number: 12011
Argon Number: 3675
Location: Firedrake domain
Lat: **Long**: 61.78757 -103.30954; NTS sheet 75H
Geologist: Daniele Regis

Sample Description: highly magnetic biotite-hornblende and minor orthopyroxene tonalitic orthogneiss; gneissic foliation cut by thick (1-3 m) pegmatite dykes.

Results: Three biotite aliquots yielded similar step heat spectra, with an upward staircase indicative of Ar loss in the initial 1-40% of ^{39}Ar released. The final ~80% of aliquots 2 and 3 show similar homogeneous step heat ages of ca. 1800 Ma, which is interpreted as the biotite cooling age for this sample.

Analytical details (Fig. 33):
Irradiation Batch: GSC #75

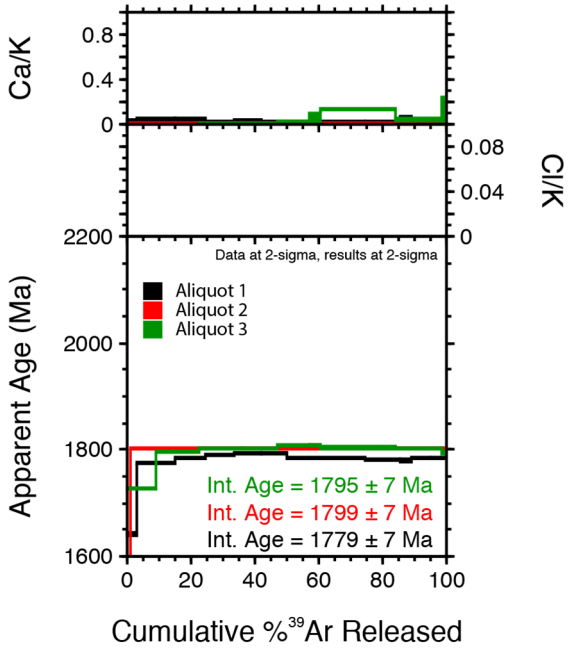

Figure 33: ^{40}Ar/^{39}Ar step-heating biotite spectra, aliquots 1-3.

Sample Number: ET265A
Lithology: Diorite
Mineral analyzed: Biotite
Age: 1745 ± 7 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 12021
Argon Number: 3686
Location: Firedrake domain
Lat: **Long**: 60.09587 -105.75462; NTS sheet 75A
Geologist: Eric Thiessen

Sample Description: medium to coarse-grained plagioclase-biotite-hornblende-clinopyroxene-bearing foliated diorite. Late thin gabbro veins and pegmatite cut the unit. Sampled at the boundary with the Snowbird domain.

Results: Three biotite aliquots show broadly similar and homogeneous apparent ages, although they are slightly discordant between aliquots. Aliquots 1 and 3 both yield plateau ages of 1745 ± 7 Ma and 1761 ± 7 Ma, respectively. Since aliquot 3 shows considerable homogeneity in Ca/K ratio, aliquot 1 is preferred as the interpreted biotite cooling age for this sample.

Analytical details (Fig. 34):
Irradiation Batch: GSC #75

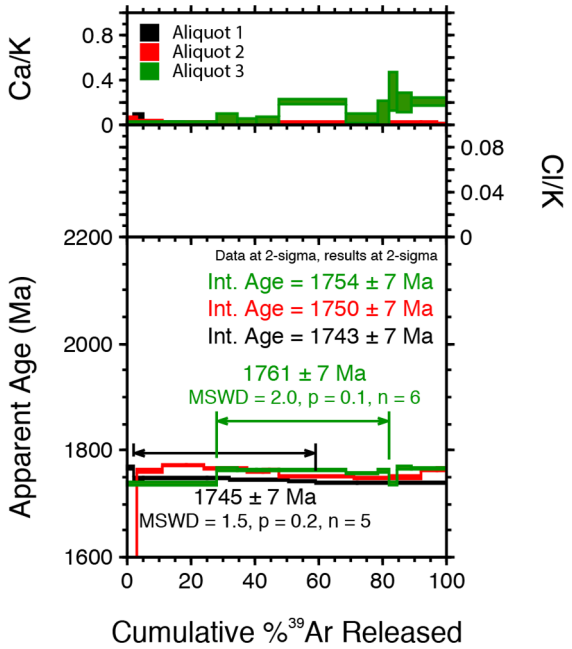

Figure 34: $^{40}Ar/^{39}Ar$ step-heating biotite spectra, aliquots 1-3.

Sample Number: ET265A
Lithology: Diorite
Mineral analyzed: Hornblende
Age: 1769 ± 7 Ma
Interpretation: cooling age
Confidence: intermediate

Geochronology Lab Number: 12021
Argon Number: 3687
Location: Firedrake domain
Lat: **Long**: 60.09587 -105.75462; NTS sheet 75A
Geologist: Eric Thiessen

Sample Description: medium to coarse-grained plagioclase-biotite-hornblende-clinopyroxene-bearing foliated diorite. Late thin gabbro veins and pegmatite cut the unit. Sampled at the boundary with the Snowbird domain.

Results: Three hornblende aliquots show downward stepping apparent ages indicative of a significant excess Ar component. Aliquots 1 and 3 both yield plateau ages. However, since the apparent ages for aliquot 3 continue to decrease in the final heating steps, the plateau age for aliquot 1, 1769 ± 7 Ma, is preferred as the interpreted hornblende cooling age for this sample.

Analytical details (Fig. 35):
Irradiation Batch: GSC #75

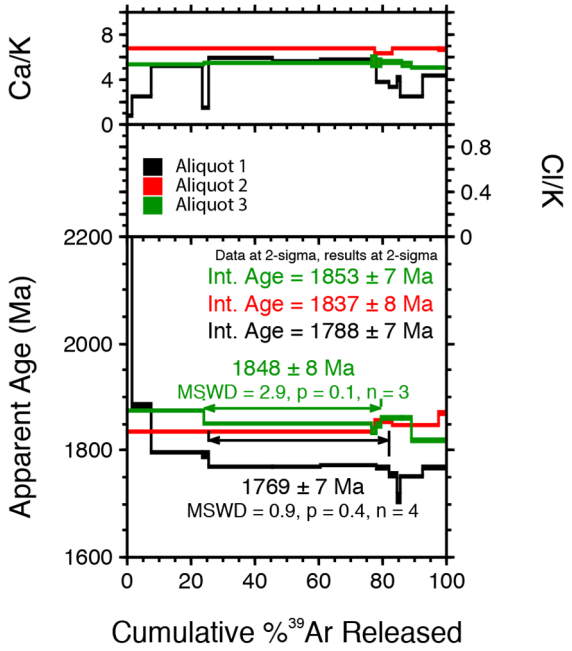

Figure 35: $^{40}Ar/^{39}Ar$ step-heating hornblende spectra, aliquots 1-3.

McCann domain (Rae Craton)

Sample Number: 15EM84A1
Lithology: Granodiorite
Mineral analyzed: Biotite
Age: 1828 ± 6 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 11685
Argon Number: 3505
Location: Ena-McCann domain
Lat: **Long**: 60.22967 -107.50796; NTS sheet 75B
Geologist: Edith Martel

Sample Description: Soupy-gneissic clinopyroxene-(replaced by hornblende) and biotite-bearing granodiorite. Highly magnetic. Gneissic foliation cut by pegmatitic dykes.

Results: Both aliquots show Ar loss in the initial heating steps, and yield similar plateau ages and step heat age patterns for portions of the remaining heating steps. Since the plateau age for the first aliquot is slightly hump-shaped and includes steps from the Ar loss staircase pattern, the plateau age of the second aliquot, 1828 ± 6 Ma, is favoured as the interpreted cooling age for biotite in this sample.

Analytical details (Fig. 36):
Irradiation Batch: GSC #72

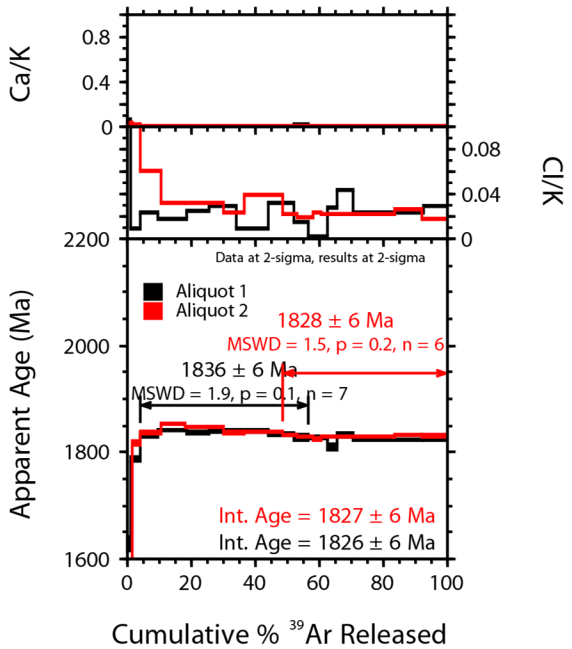

Figure 36: $^{40}Ar/^{39}Ar$ step-heating biotite spectra, aliquots 1-2.

Sample Number: 15EM84A1
Lithology: Granodiorite
Mineral analyzed: Hornblende
Age: ca. 1885 Ma
Interpretation: cooling age
Confidence: low

Geochronology Lab Number: 11685
Argon Number: 3506
Location: Ena-McCann domain
Lat: **Long**: 60.22967 -107.50796; NTS sheet 75B
Geologist: Edith Martel

Sample Description: Soupy-gneissic clinopyroxene-(replaced by hornblende) and biotite-bearing granodiorite. Highly magnetic. Gneissic foliation cut by pegmatitic dykes.

Results: Both aliquots show heterogeneous apparent $^{40}Ar/^{39}Ar$ ages, but are broadly consistent in the central 60% of ^{39}Ar released at ca. 1885 Ma, which is tentatively interpreted as the cooling age for hornblende in this sample.

Analytical details (Fig. 37):
Irradiation Batch: GSC #72

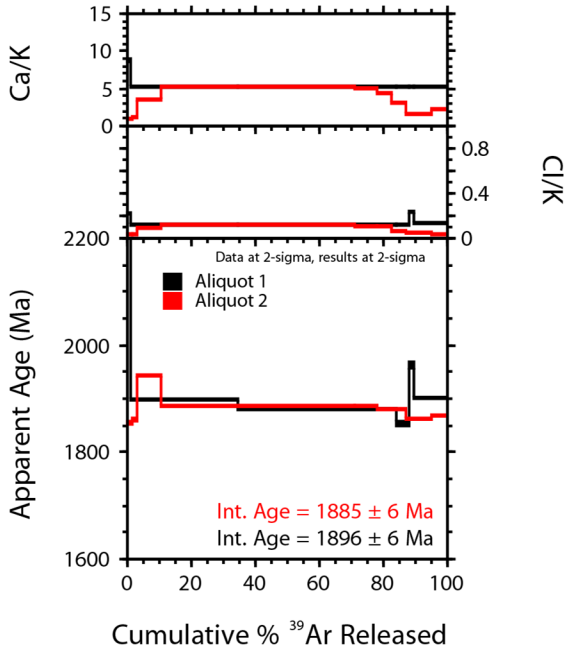

Figure 37: $^{40}Ar/^{39}Ar$ step-heating hornblende spectra, aliquots 1-2.

Sample Number: 15EM85A
Lithology: Psammite
Mineral analyzed: Biotite
Age: ca. 1860 Ma
Interpretation: cooling age
Confidence: intermediate

Geochronology Lab Number: 11686
Argon Number: 3507
Location: Ena-McCann domain
Lat: **Long**: 60.19593 -107.7043; NTS sheet 75B
Geologist: Edith Martel

Sample Description: Fine-grained, high-grade psammite (about 15% melt) with orthopyroxene-clinopyroxene-hornblende-biotite and magnetite.

Results: Both biotite aliquots from this sample show initial partial Ar loss, and then broadly stabilize at apparent ages of ca. 1860 Ma, which is interpreted as the cooling age.

Analytical details (Fig. 38):
Irradiation Batch: GSC #72

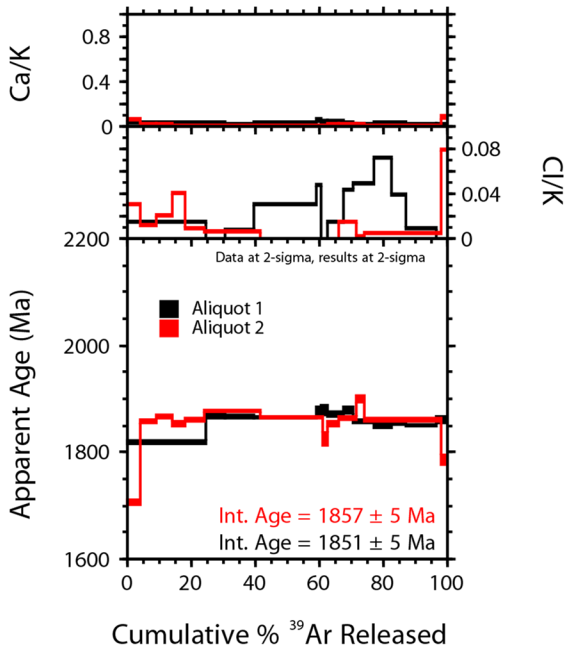

Figure 38: $^{40}Ar/^{39}Ar$ step-heating biotite spectra, aliquots 1-2.

Sample Number: 15EM85A
Lithology: Psammite
Mineral analyzed: Hornblende
Age: ca. 1880 Ma
Interpretation: cooling age
Confidence: low

Geochronology Lab Number: 11686
Argon Number: 3508
Location: Ena-McCann domain
Lat: **Long**: 60.19593 -107.7043; NTS sheet 75B
Geologist: Edith Martel

Sample Description: Fine-grained, high-grade psammite (about 15% melt) with orthopyroxene-clinopyroxene-hornblende-biotite and magnetite.

Results: Both aliquots show heterogeneous apparent $^{40}Ar/^{39}Ar$ ages, with excess Ar in initial heating steps. Aliquot 2 indicates a less significant excess Ar component and generally more consistent ages and Ca/K ratios, thus it is the preferred result for age interpretation, and indicates a ca. 1880 Ma which is tentatively interpreted as the cooling age for hornblende in this sample.

Analytical details (Fig. 39):
Irradiation Batch: GSC #72

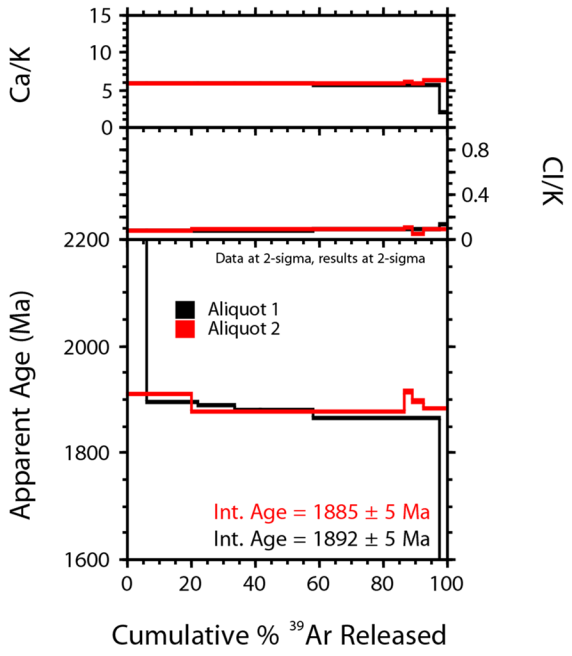

Figure 39: $^{40}Ar/^{39}Ar$ step-heating hornblende spectra, aliquots 1-2.

Sample Number: PQB-14b-2012
Lithology: Augen gneiss
Mineral analyzed: Biotite
Age: NO AGE
Interpretation: NO AGE
Confidence: N/A

Geochronology Lab Number: 10842
Argon Number: 3104
Location: McCann domain
Lat: **Long**: 60.66908 -106.61742; NTS sheet 75B
Geologist: Sally Pehrsson

Sample Description: The sample is a foliated hornblende-bearing augen gneiss with distinctive blue quartz. The sample location is from the southeast end of Labyrinth Lake, NWT, immediately southeast of the prominent magnetic low defining the Black Bay fault zone.

Results: Ar release spectra for both aliquots exhibits a hump-shaped pattern indicative of both post-cooling Ar loss in the initial 50% of ^{39}Ar released, and the ingress of excess Ar in the subsequent gas steps. The final heating steps are characterized by an elevated Ca/K ratio indicated contamination by either another mineral phase or fluid inclusions. The inhomogeneous step heat pattern prevents an age interpretation.

Analytical details (Fig. 40):
Irradiation Batch: GSC #65

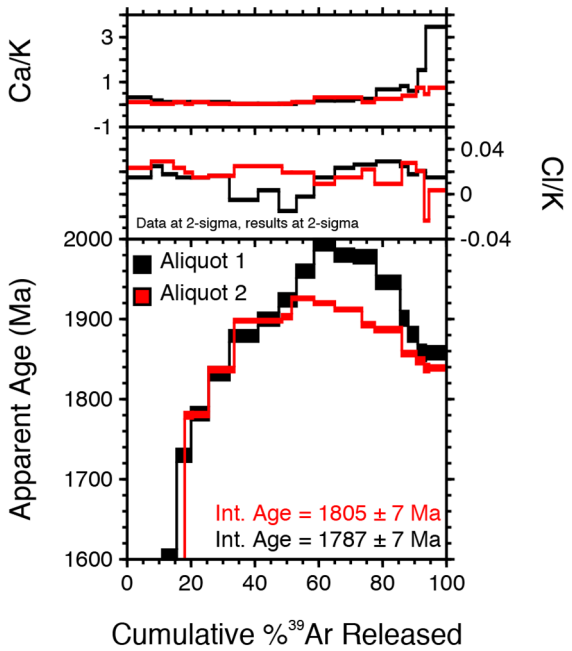

Figure 40: ^{40}Ar/^{39}Ar step-heating biotite spectra, aliquots 1-2.

Sample Number: PQB-56-2012
Lithology: Quartz diorite
Mineral analyzed: Biotite
Age: ca. 1825 Ma
Interpretation: maximum cooling age
Confidence: low

Geochronology Lab Number: 10854
Argon Number: 3121
Location: McCann domain
Lat: **Long**: 60.93128 -106.15462; NTS sheet 75B
Geologist: Sally Pehrsson

Sample Description: Foliated biotite-orthopyroxene-orthoamphibole quartz diorite. The sample location is from NW of the Black Bay fault.

Results: Three aliquots from this sample yielded hump-shaped step heat spectra suggestive of both Ar loss and excess Ar. Thus the final heating steps of Aliquot 2 are tentatively considered to yield a maximum cooling age for biotite in this sample. The plateau age for Aliquot 1 is not considered to have geological significance.

Analytical details (Fig. 41):
Irradiation Batch: GSC #65

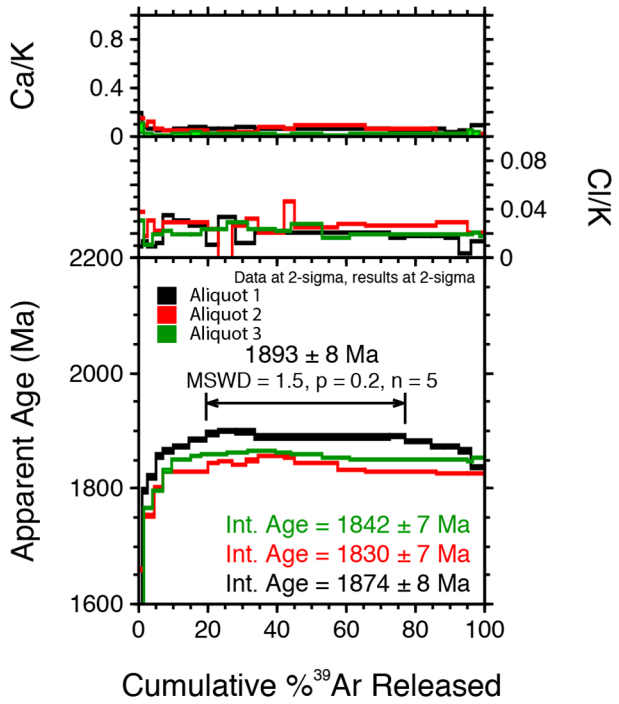

Figure 41: $^{40}Ar/^{39}Ar$ step-heating biotite spectra, aliquots 1-3.

Sample Number: PQB-78a-2012
Lithology: Granitic dyke
Mineral analyzed: Biotite
Age: ca. 1845 Ma
Interpretation: cooling age
Confidence: low

Geochronology Lab Number: 10849
Argon Number: 3113
Location: McCann domain
Lat: **Long**: 61.45888 -106.7461; NTS sheet 75G
Geologist: Sally Pehrsson

Sample Description: Fine-grained biotite-bearing granitic dyke cross-cutting coarse-grained, massive diatexite-charnockite with ca. 30% of blue quartz. Sampled north of the Dymond Lake fault.

Results: Both aliquots for this sample show Ar loss in the initial ~20% of ^{39}Ar released, and broadly heterogeneous Ar dates for the remaining 80%. However, both aliquots show broadly similar ca. 1845 Ma dates, which is tentatively interpreted as the biotite cooling age.

Analytical details (Fig. 42):
Irradiation Batch: GSC #65

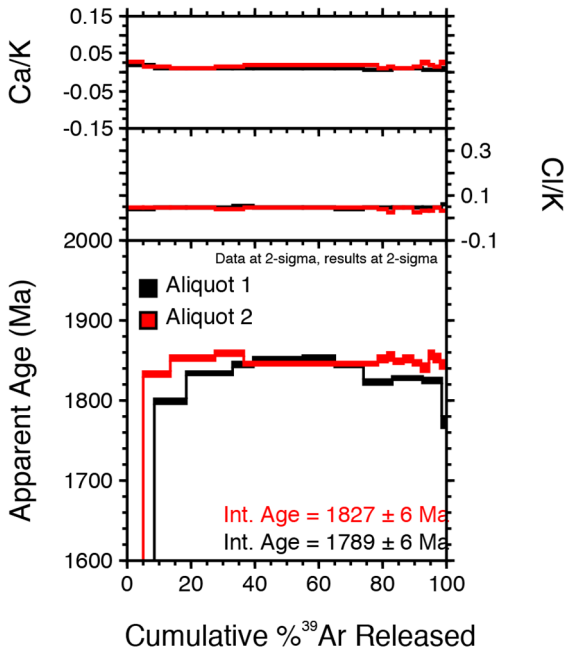

Figure 42: ^{40}Ar/^{39}Ar step-heating biotite spectra, aliquots 1-2.

Sample Number: PQB-78a-2012
Lithology: Granitic dyke
Mineral analyzed: Hornblende
Age: 1835 ± 6 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 10849
Argon Number: 3114
Location: McCann domain
Lat: **Long**: 61.45888 -106.7461; NTS sheet 75G
Geologist: Sally Pehrsson

Sample Description: Fine-grained biotite-bearing granitic dyke cross-cutting coarse-grained, massive diatexite-charnockite with ca. 30% of blue quartz. Sampled north of the Dymond Lake fault.

Results: Both aliquots for this sample yielded statistical plateau ages within error of each other at 1835 Ma, interpreted as the hornblende cooling age for this sample. The 2σ error for the individual plateau ages is considered representative for the interpreted cooling age.

Analytical details (Fig. 43):
Irradiation Batch: GSC #65

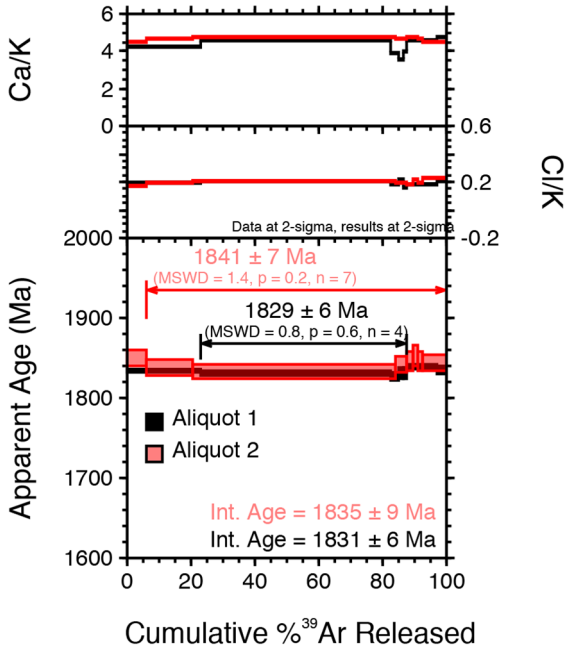

Figure 43: $^{40}Ar/^{39}Ar$ step-heating hornblende spectra, aliquots 1-2.

Sample Number: PQB-88b-2012
Lithology: Monzogranite
Mineral analyzed: Biotite
Age: 1820 ± 5 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 10852
Argon Number: 3118
Location: McCann domain
Lat: **Long**: 60.63876 -106.69844; NTS sheet 75B
Geologist: Sally Pehrsson

Sample Description: The sample is a biotite-bearing deformed augen monzogranite. The sample is from the linear magnetic low of the Black Bay fault, on the boundary between the Firedrake and McCann domains.

Results: Biotite from this sample yielded young initial steps indicative of Ar loss, followed by plateau ages for two aliquots that are within error of each other at 1820 Ma, which is considered to be the cooling age for biotite in this sample.

Analytical details (Fig. 44):
Irradiation Batch: GSC #65

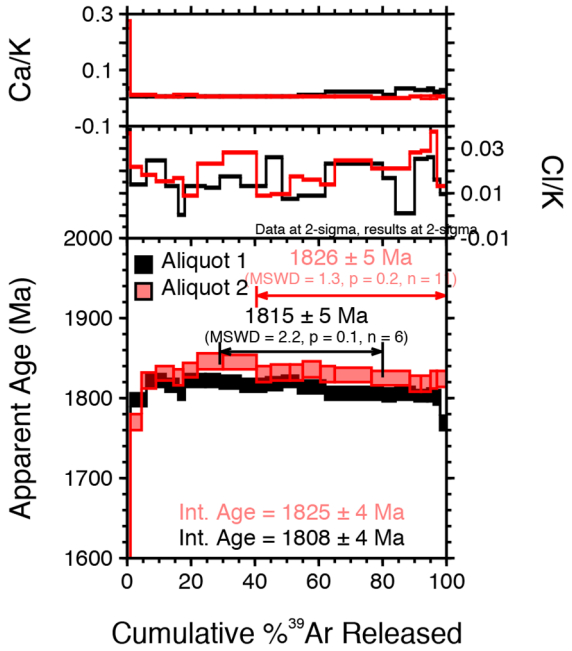

Figure 44: $^{40}Ar/^{39}Ar$ step-heating biotite spectra, aliquots 1-2.

Sample Number: PQB-200-2012
Lithology: Diatexite
Mineral analyzed: Biotite
Age: 1881 ± 8 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 10853
Argon Number: 3120
Location: McCann domain
Lat: **Long**: 60.78056 -106.77134; NTS sheet 75B
Geologist: Sally Pehrsson

Sample Description: Coarse-grained orthopyroxene-garnet-blue quartz-rutile diatexite.

Results: Two biotite aliquots from this sample produced plateau ages within error of one another, yielding a mean age of 1881 Ma, interpreted as the biotite cooling age for this sample. The error for each plateau age of 7-8 Ma is considered representative of the error in the mean age.

Analytical details (Fig. 45):
Irradiation Batch: GSC #65

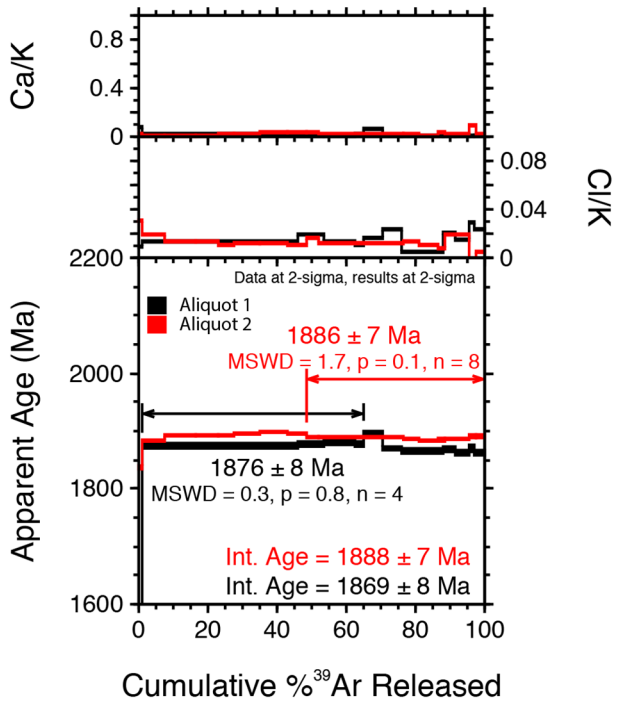

Figure 45: $^{40}Ar/^{39}Ar$ step-heating biotite spectra, aliquots 1-2.

Sample Number: 15EM55C
Lithology: Granite
Mineral analyzed: Hornblende
Age: ca. 1890 Ma
Interpretation: cooling age
Confidence: low

Geochronology Lab Number: 11583
Argon Number: 3497
Location: McCann domain
Lat: **Long**: 60.63680 -107.25898; NTS sheet 75B
Geologist: Edith Martel

Sample Description: Garnet-hornblende megacrystic granite, L>S tectonite, non magnetic. Contains rare xenoliths of fine-grained diorite and tonalite, cut by quartz-rich pegmatite veins which contains large crystals of hornblende, and bluish-grey feldspar.

Results: The first heating steps in all three aliquots of this sample indicate excess Ar, with aliquot 1 showing a staircase for the majority of ^{39}Ar released suggesting Ar loss as well. However, aliquots 2 and 3 aliquots show similar ages for the heating step which accounts for the majority of Ar released at ca. 1890 Ma. This is tentatively assigned as the cooling age.

Analytical details (Fig. 46):
Irradiation Batch: GSC #72

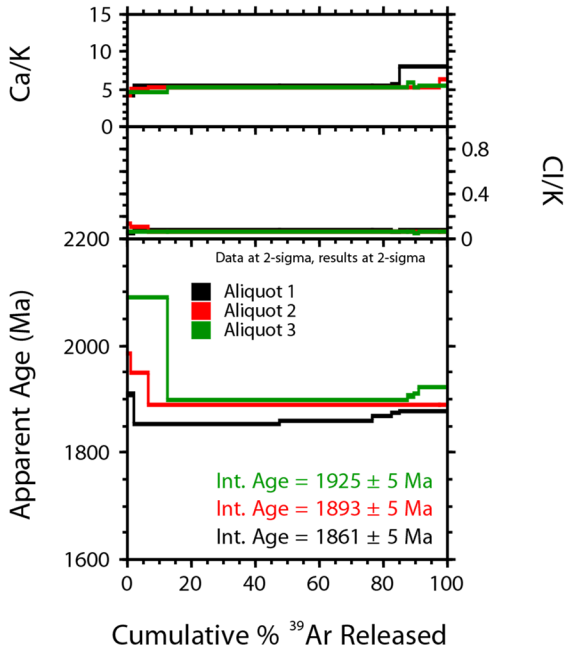

Figure 46: ^{40}Ar/^{39}Ar step-heating hornblende spectra, aliquots 1-3.

Sample Number: 15EM83A1
Lithology: Tonalite
Mineral analyzed: Biotite
Age: ca. 1820-1800 Ma
Interpretation: minimum cooling age
Confidence: low

Geochronology Lab Number: 11589
Argon Number: 3504
Location: McCann domain
Lat: **Long**: 60.73664 -106.47351; NTS sheet 75B
Geologist: Edith Martel

Sample Description: Clinopyroxene-orthopyroxene-minor garnet-bearing tonalite to quartz diorite. Sampled NW of the Black Bay fault.

Results: The upward-stepping staircase pattern exhibited by both aliquots from this sample indicate Ar loss, such that the oldest age steps provide a poorly-defined minimum cooling age of ca. 1820-1800 Ma.

Analytical details (Fig. 47):
Irradiation Batch: GSC #72

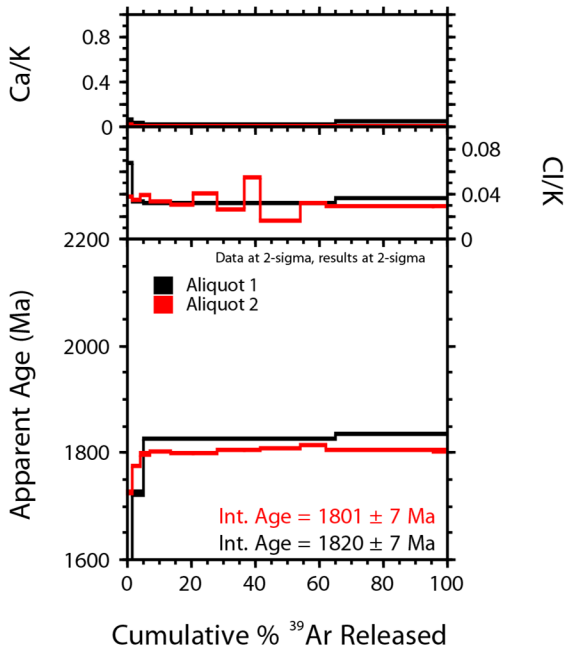

Figure 47: $^{40}Ar/^{39}Ar$ step-heating biotite spectra, aliquots 1-2.

Sample Number: PQB88C
Lithology: Granite
Mineral analyzed: Biotite
Age: ca. 1810 Ma
Interpretation: cooling age
Confidence: intermediate

Geochronology Lab Number: 11590
Argon Number: 3517
Location: McCann domain
Lat: **Long**: 60.63876 -106.69844; NTS sheet 75B
Geologist: Sally Pehrsson

Sample Description: Biotite-bearing granite, associated with sample PQB-88B-2012. Sampled on the boundary between the Firedrake and McCann domains (Black Bay fault zone).

Results: The step heat pattern for this biotite aliquot is an upwards staircase indicative of Ar loss. However, the final ~60% of ^{39}Ar released yields a relatively homogeneous age pattern at ca. 1810 Ma, though it does not yield a statistical plateau. This is interpreted to be the cooling age for biotite in this sample.

Analytical details (Fig. 48):
Irradiation Batch: GSC #72

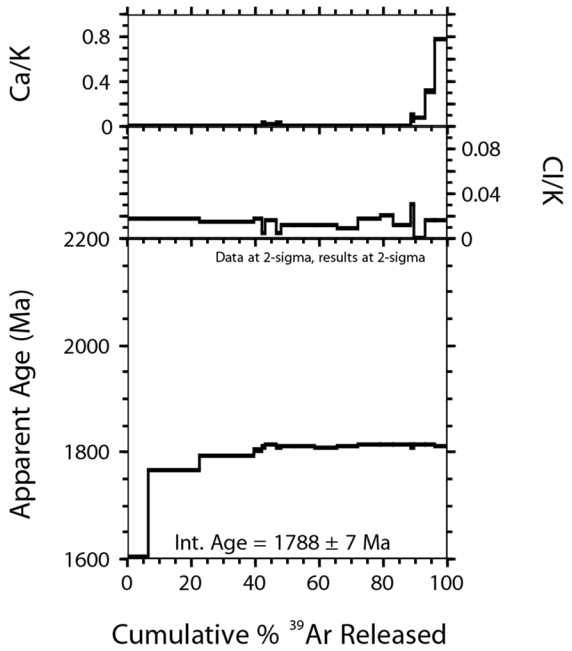

Figure 48: ^{40}Ar/^{39}Ar step-heating biotite spectrum, aliquot 1.

Sample Number: DR273A
Lithology: Granodiorite
Mineral analyzed: Biotite
Age: 1868 ± 8 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 12003
Argon Number: 3667
Location: McCann domain
Lat: **Long**: 61.35073 -106.97745; NTS sheet 75G
Geologist: Daniele Regis

Sample Description: Coarse-grained biotite-garnet-orthopyroxene-blue quartz-bearing granodiorite to tonalite. Sampled south of the Dymond Lake fault.

Results: Two biotite aliquots from this sample show evidence of Ar loss, with aliquot 1 showing a continuous upward staircase, and aliquot 2 reaching a statistical plateau of 1868 ± 8 Ma for >70% ^{39}Ar released. The plateau age is interpreted as the biotite cooling age for this sample.

Analytical details (Fig. 49):
Irradiation Batch: GSC #75

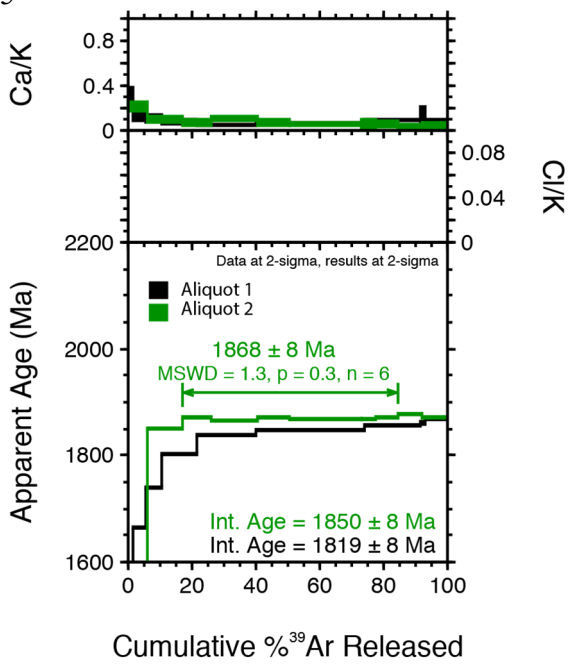

Figure 49: ^{40}Ar/^{39}Ar step-heating biotite spectra, aliquots 1-2.

Sample Number: DR270B
Lithology: Tonalite
Mineral analyzed: Biotite
Age: 1916 ± 12 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 12004
Argon Number: 3668
Location: McCann domain
Lat: **Long**: 61.19287 -107.32514; NTS sheet 75G
Geologist: Daniele Regis

Sample Description: Coarse-grained biotite-garnet-orthopyroxene-blue quartz-bearing tonalite. Sampled south of the Dymond Lake fault.

Results: Three biotite aliquots from this sample show similar, relatively homogeneous step heat spectra, with aliquot 2 providing a plateau age of 1916 ± 12 Ma for ~70% of ^{39}Ar released. This is interpreted as the biotite cooling age for this sample.

Analytical details (Fig. 50):
Irradiation Batch: GSC #75

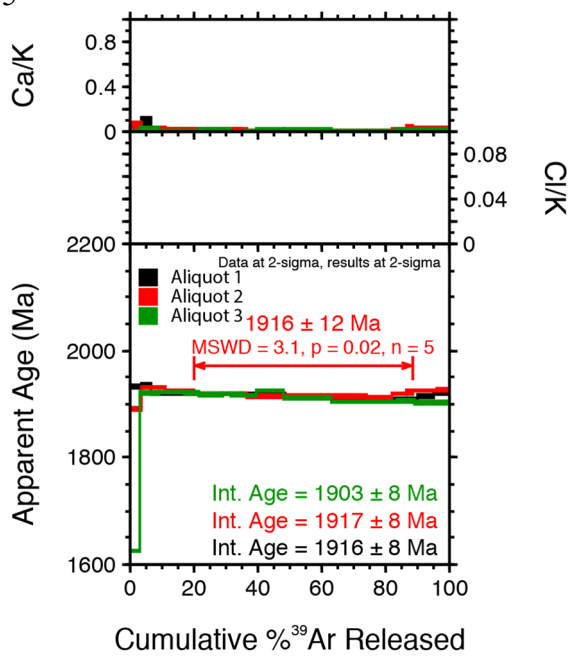

Figure 50: ^{40}Ar/^{39}Ar step-heating biotite spectra, aliquots 1-3.

Sample Number: DR292A
Lithology: Tonalite
Mineral analyzed: Biotite
Age: NO AGE
Interpretation: NO AGE
Confidence: N/A

Geochronology Lab Number: 12010
Argon Number: 3674
Location: McCann domain
Lat: **Long**: 61.94436 -105.65581; NTS sheet 75H
Geologist:Daniele Regis

Sample Description: Highly-magnetic, fine-grained, biotite-garnet-bearing tonalite.

Results: Three biotite aliquots yielded heterogeneous step heat spectra, with aliquot 3 also showing elevated Ca/K. The lack of reproducibility between aliquots and the internal heterogeneity within each aliquot prevents geological interpretation of these spectra.

Analytical details (Fig. 51):
Irradiation Batch: GSC #75

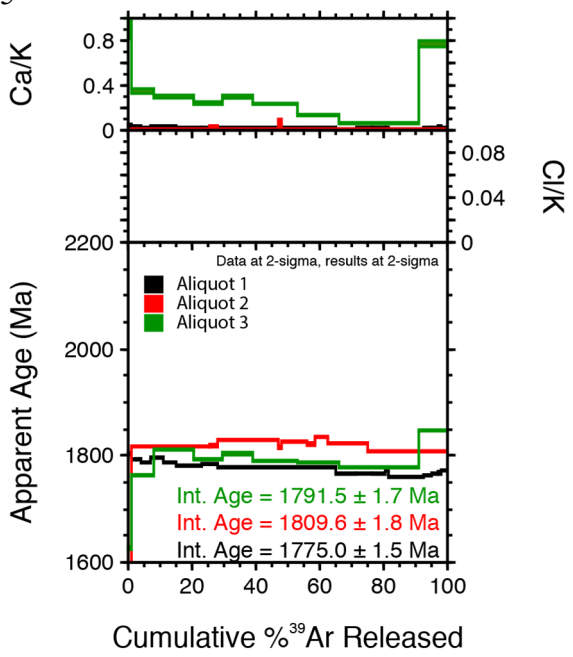

Figure 51: $^{40}Ar/^{39}Ar$ step-heating biotite spectra, aliquots 1-3.

Penylan domain (Rae Craton)

Sample Number: PQB-59G-2012
Lithology: Quartz diorite
Mineral analyzed: Biotite
Age: ca. 1825 Ma
Interpretation: maximum cooling age
Confidence: low

Geochronology Lab Number: 10846
Argon Number: 3108
Location: Penylan domain
Lat: **Long**: 61.513993 -107.280966; NTS sheet 75G
Geologist: Sally Pehrsson

Sample Description: Layered, strongly foliated quartz diorite-anorthosite unit (clinopyroxene-orthopyroxene-biotite-hornblende).

Results: The step heat spectra from two aliquots show similar hump-shaped patterns indicative of Ar loss from and excess Ar influx into the biotite grains. While the second aliquot is a continuous staircase, the first aliquot shows final heating steps of ca. 1830 Ma (excluding the fusion step) which may indicate a maximum cooling age for biotite.

Analytical details (Fig. 52):
Irradiation Batch: GSC #65

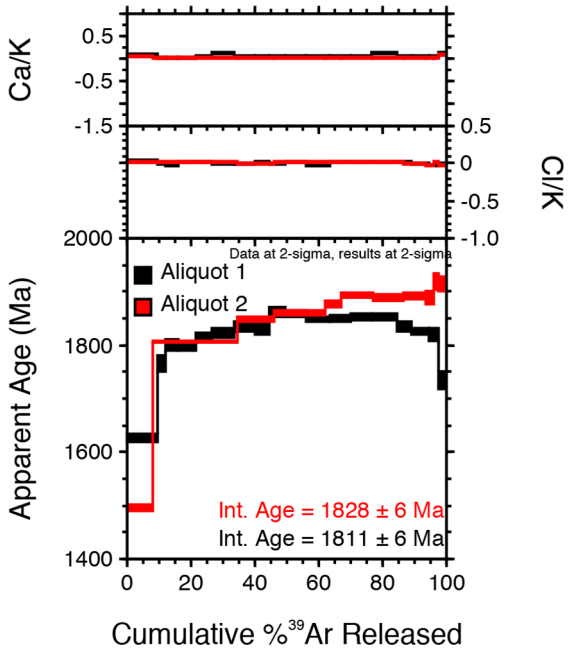

Figure 52: $^{40}Ar/^{39}Ar$ step-heating biotite spectra, aliquots 1-2.

Sample Number: PQB-60A-2012
Lithology: Tonalite
Mineral analyzed: Biotite
Age: NO AGE
Interpretation: NO AGE
Confidence: N/A

Geochronology Lab Number: 10847
Argon Number: 3109
Location: Penylan domain
Lat: **Long**: 61.60536 -107.15603; NTS sheet 75G
Geologist: Sally Pehrsson

Sample Description: Foliated biotite-hornblende (minor garnet?) tonalite.

Results: The step heat spectra from two aliquots show similar stair-case patterns indicative of Ar loss from the biotite grains. Significantly younger hornblende $^{40}Ar/^{39}Ar$ ages from the same sample also indicate significant excess Ar in this biotite, precluding age interpretation from these data.

Analytical details (Fig. 53):
Irradiation Batch: GSC #65

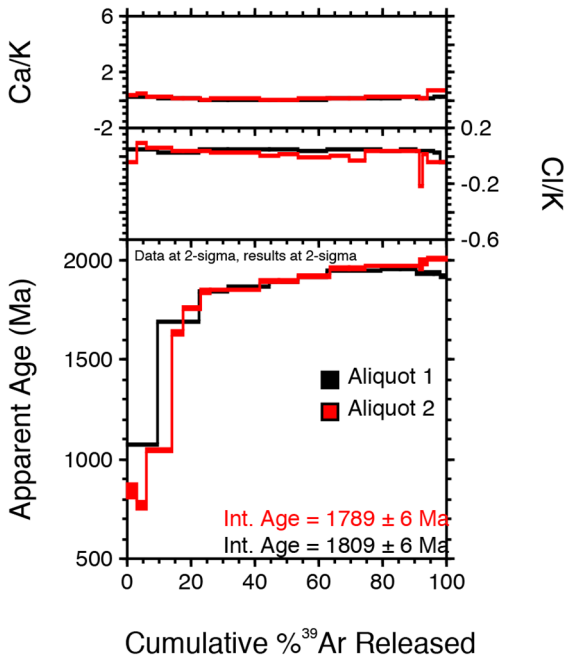

Figure 53: $^{40}Ar/^{39}Ar$ step-heating biotite spectra, aliquots 1-2.

Sample Number: PQB-60A-2012
Lithology: Tonalite
Mineral analyzed: Hornblende
Age: 1820 ± 9 Ma
Interpretation: cooling age
Confidence: intermediate

Geochronology Lab Number: 10847
Argon Number: 3110
Location: Penylan domain
Lat: **Long**: 61.60536 -107.15603; NTS sheet 75G
Geologist: Sally Pehrsson

Sample Description: Foliated biotite-hornblende (minor garnet?) tonalite.

Results: The step heat spectra from two aliquots are fairly homogeneous, although a majority of the Ar gas was released in a single heating step for both aliquots, and statistical plateaus were not obtained in either case. Aliquot 2 shows a young initial heating step, influencing the calculated integrated age. Thus the integrated age from Aliquot 1 is considered to represent the hornblende cooling age for this sample.

Analytical details (Fig. 54):
Irradiation Batch: GSC #65

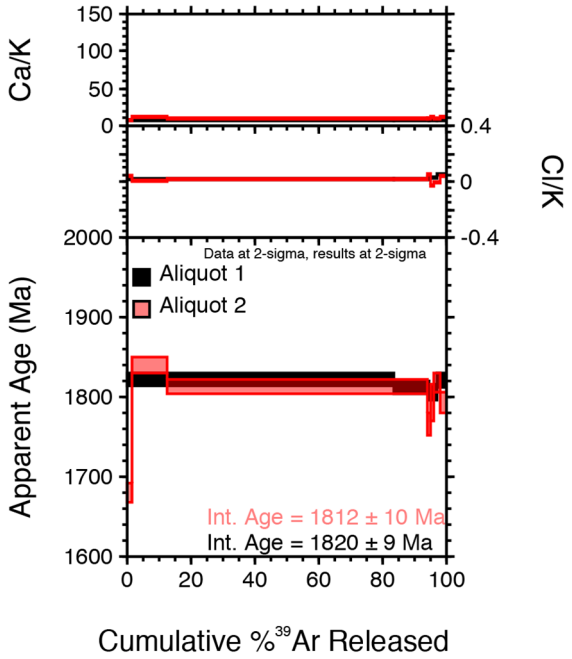

Figure 54: $^{40}Ar/^{39}Ar$ step-heating hornblende spectra, aliquots 1-2.

Sample Number: PQB-74-2012
Lithology: Monzogranite
Mineral analyzed: Biotite
Age: NO AGE
Interpretation: NO AGE
Confidence: N/A

Geochronology Lab Number: 10848
Argon Number: 3111
Location: Penylan domain
Lat: **Long**: 61.989073 -106.108252; NTS sheet 75G
Geologist: Sally Pehrsson

Sample Description: K-feldspar porphyritic monzogranite; red weathering surface.

Results: The step heat spectrum for this sample is heterogeneous and does not produce a statistical plateau. It also yields significantly older $^{40}Ar/^{39}Ar$ dates than hornblende dated from the same sample. Thus, the $^{40}Ar/^{39}Ar$ result is considered to reflect excess Ar, and formulation of a geological age is not possible from this data.

Analytical details (Fig. 55):
Irradiation Batch: GSC #65

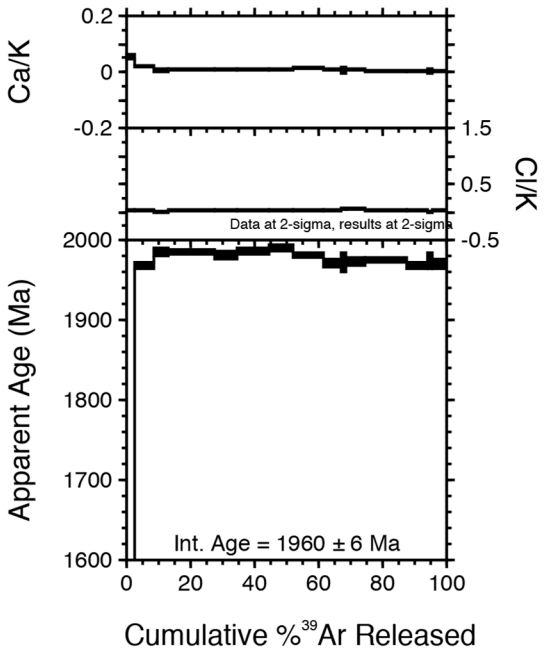

Figure 55: $^{40}Ar/^{39}Ar$ step-heating biotite spectrum, aliquot 1.

Sample Number: PQB-74-2012
Lithology: Monzogranite
Mineral analyzed: Hornblende
Age: 1837 ± 6 Ma
Interpretation: cooling age
Confidence: intermediate

Geochronology Lab Number: 10848
Argon Number: 3112
Location: Penylan domain
Lat: **Long**: 61.989073 -106.108252; NTS sheet 75G
Geologist: Sally Pehrsson

Sample Description: K-feldspar porphyritic monzogranite; red weathering surface.

Results: The step heat spectrum for this sample produced a statistical plateau age. Though overall the step heat spectrum forms a down-stepping staircase, the final heating steps yielding significantly younger apparent ages also show a lower Ca/K ratio, suggesting degassing of a different, Ca-poor phase. Thus, the plateau age is considered to represent the cooling age for this sample.

Analytical details (Fig. 56):
Irradiation Batch: GSC #65

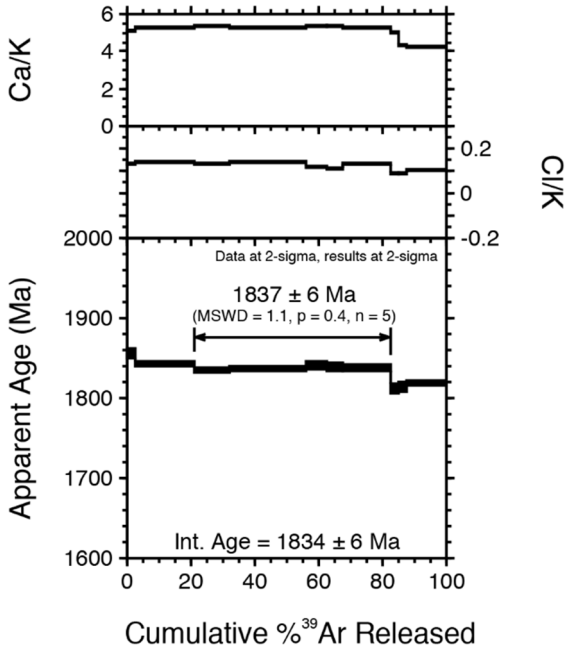

Figure 56: $^{40}Ar/^{39}Ar$ step-heating hornblende spectrum, aliquot 1.

Sample Number: DR205C
Lithology: Anorthosite
Mineral analyzed: Hornblende
Age: 1820 ± 8 Ma
Interpretation: cooling age
Confidence: intermediate

Geochronology Lab Number: 12007
Argon Number: 3671
Location: Penylan domain
Lat: **Long**: 61.62160 -106.98026; NTS sheet 75G
Geologist: Daniele Regis

Sample Description: Coarse-grained garnet-bearing anorthosite.

Results: Three hornblende aliquots from this sample show somewhat heterogeneous step heat spectra indicative of an excess Ar component. Aliquot 2 yielded a statistical plateau of 1820 ± 8 Ma which coincides with the final step heat ages for aliquot 3, and few steps from aliquot 1. Thus, it is tentatively interpreted to reflect the hornblende cooling age for this sample

Analytical details (Fig. 57):
Irradiation Batch: GSC #75

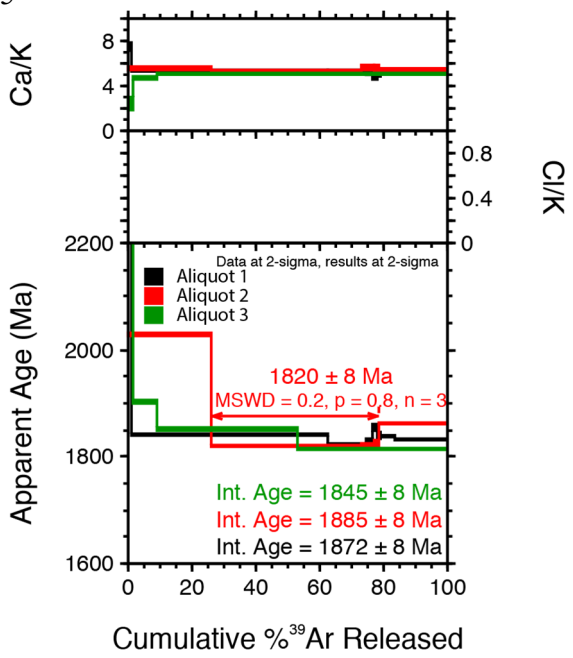

Figure 57: $^{40}Ar/^{39}Ar$ step-heating hornblende spectra, aliquots 1-3.

Boomerang domain (Rae Craton)

Sample Number: DR238A
Lithology: Granite
Mineral analyzed: Biotite
Age: ca. 1810 Ma
Interpretation: minimum cooling age
Confidence: low

Geochronology Lab Number: 12008
Argon Number: 3672
Location: Boomerang domain
Lat: **Long**: 61.98488 -106.43514; NTS sheet 75G
Geologist: Daniele Regis

Sample Description: Biotite-bearing megacrystic foliated granite with a late generation of plagioclase overgrowing the foliation.

Results: Two biotite aliquots show staircase patterns indicating significant post-cooling Ar loss. The final heating steps of both aliquots approach ca. 1810 Ma (excluding the fusion heating step of aliquot 2, which yielded 1860 Ma), which is tentatively interpreted to provide a minimum biotite cooling age for this sample.

Analytical details (Fig. 58):
Irradiation Batch: GSC #75

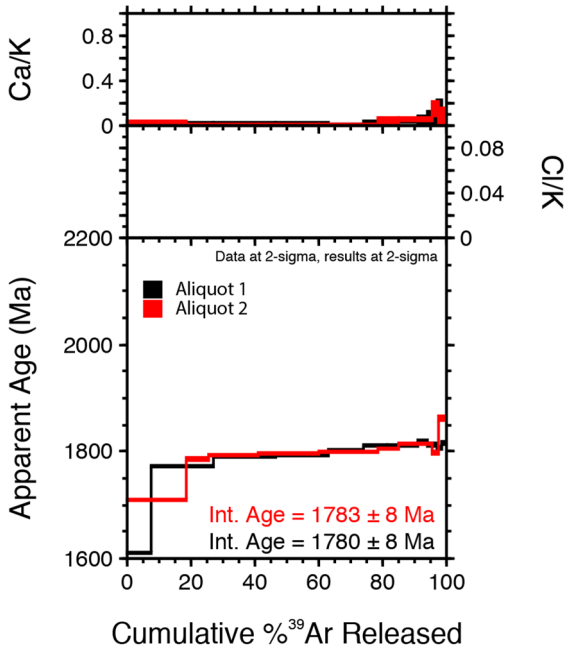

Figure 58: $^{40}Ar/^{39}Ar$ step-heating biotite spectra, aliquots 1-2.

Sample Number: ET60A
Lithology: Granitic gneiss
Mineral analyzed: Biotite
Age: 1811 ± 11 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 12022
Argon Number: 3688
Location: Boomerang domain
Lat: **Long**: 62.26800 -105.91476; NTS sheet 75I
Geologist: Eric Thiessen

Sample Description: Strongly foliated to gneissic k-feldspar clastic protomylonitic granitic gneiss.

Results: Three biotite aliquots show similar step heat spectra patterns with upward staircases for the initial ~25% ^{39}Ar released, and then relatively flat apparent age steps for the remainder of gas released. These flat portions of the age spectra are best defined by the plateau age calculated from aliquot 3 of 1811 ± 11 Ma, which is interpreted as the biotite cooling age for this sample.

Analytical details (Fig. 59):
Irradiation Batch: GSC #75

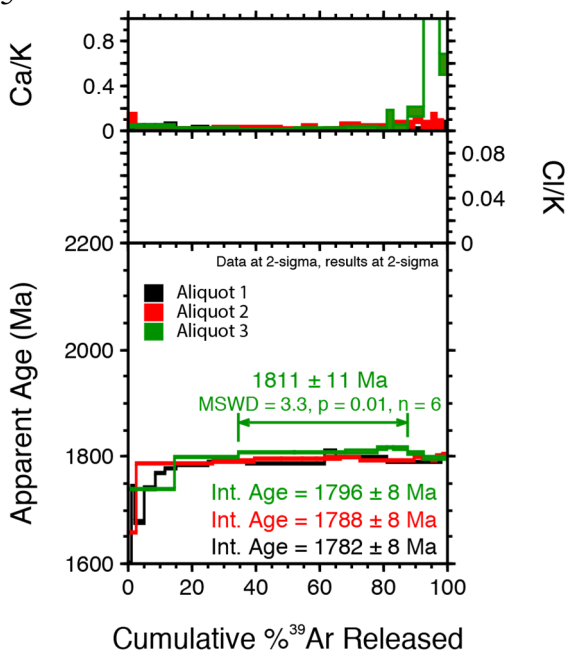

Figure 59: ^{40}Ar/^{39}Ar step-heating biotite spectra, aliquots 1-3.

Sample Number: ET60A
Lithology: Granitic gneiss
Mineral analyzed: Hornblende
Age: 1824 ± 10 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 12022
Argon Number: 3689
Location: Boomerang domain
Lat: **Long**: 62.26800 -105.91476; NTS sheet 75I
Geologist: Eric Thiessen

Sample Description: Strongly foliated to gneissic K-feldspar clastic protomylonitic granitic gneiss.

Results: Two hornblende aliquots show relatively flat step heat apparent age patterns, with concordant plateau ages at 1810 ± 20 Ma and 1824 ± 10 Ma for aliquots 1 and 2, respectively. The aliquot 2 plateau age is more precise and includes more of the total ^{39}Ar released for that aliquot, so it is the preferred hornblende cooling age for this sample.

Analytical details (Fig. 60):
Irradiation Batch: GSC #75

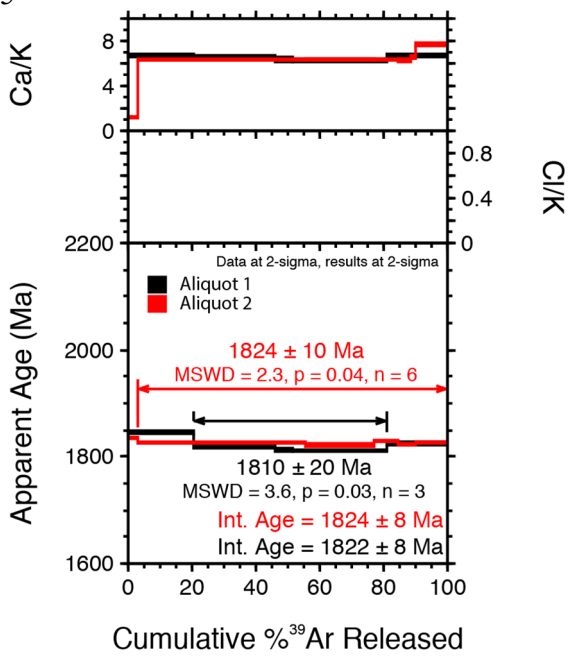

Figure 60: ^{40}Ar/^{39}Ar step-heating hornblende spectra, aliquots 1-2.

Sample Number: ET63A
Lithology: Granitic gneiss
Mineral analyzed: Biotite
Age: NO AGE
Interpretation: NO AGE
Confidence: N/A

Geochronology Lab Number: 12023
Argon Number: 3690
Location: Boomerang domain
Lat: **Long**: 62.26749 -106.00298; NTS sheet 75J
Geologist: Eric Thiessen

Sample Description: Granitic gneiss minor mafic material. Numerous ductile dextral kinematic indicators. A 10 m wide unit of metapelite occurs within the granitic gneiss. Sampled along the Howard Lake Shear Zone.

Results: Three biotite aliquots show highly heterogeneous, and broadly hump-shaped step heat age spectra. This is interpreted to reflect both significant Ar loss as well as excess Ar. In addition, Ca/K ratios show contamination of the biotite. Thus no geological age interpretation is possible

Analytical details (Fig. 61):
Irradiation Batch: GSC #75

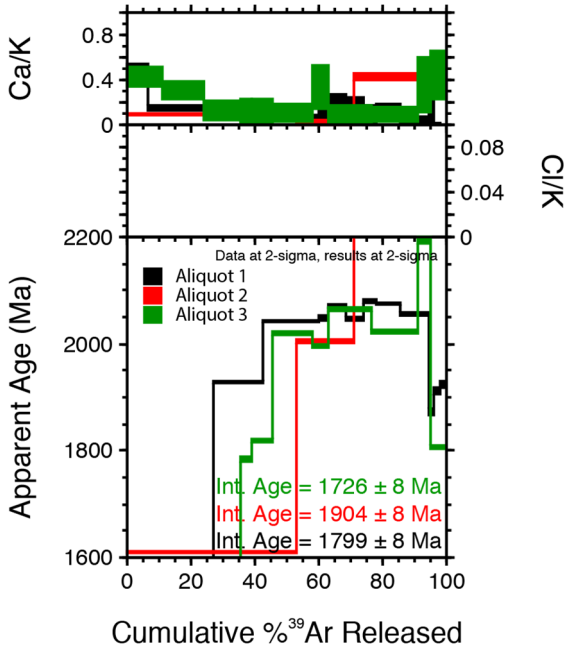

Figure 61: $^{40}Ar/^{39}Ar$ step-heating biotite spectra, aliquots 1-3.

Sample Number: DR239A
Lithology: Meta-andesite
Mineral analyzed: Biotite
Age: 1904 ± 8 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 12009
Argon Number: 3673
Location: Boomerang domain
Lat: **Long**: 61.89381 -106.77641; NTS sheet 75G
Geologist: Daniele Regis

Sample Description: Biotite, hornblende, plagioclase-phyric meta-andesite. Sampled along the Howard Lake shear zone.

Results: Two biotite aliquots yielded relatively homogeneous step heat spectra of indistinguishable age. Aliquot 2 provides a plateau age of 1904 ± 8 Ma, interpreted as the biotite cooling age.

Analytical details (Fig. 62):
Irradiation Batch: GSC #75

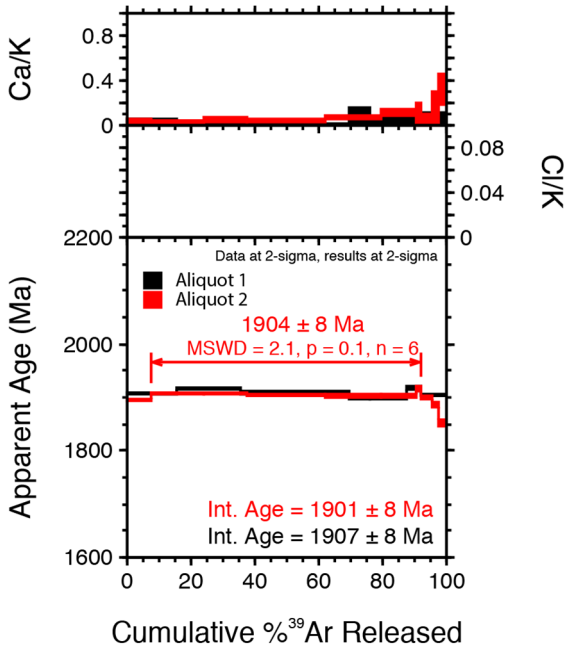

Figure 62: $^{40}Ar/^{39}Ar$ step-heating biotite spectra, aliquots 1-2.

Porter domain (Rae Craton)

Sample Number: PQB-58-2012
Lithology: Leucogranite
Mineral analyzed: Biotite
Age: NO AGE
Interpretation: NO AGE
Confidence: N/A

Geochronology Lab Number: 10845
Argon Number: 3107
Location: Porter domain
Lat: **Long**: 61.63051 -107.88013; NTS sheet 75G
Geologist: Sally Pehrsson

Sample Description: Sheared (locally mylonitic) biotite-bearing leucogranite. Sampled north of the Howard Lake shear zone.

Results: The step heat spectra from two aliquots show similar hump-shaped patterns indicative of Ar loss from and excess Ar influx into the biotite grains. This inhomogeneous step heat pattern prevents formulation of an age interpretation.

Analytical details (Fig. 63):
Irradiation Batch: GSC #65

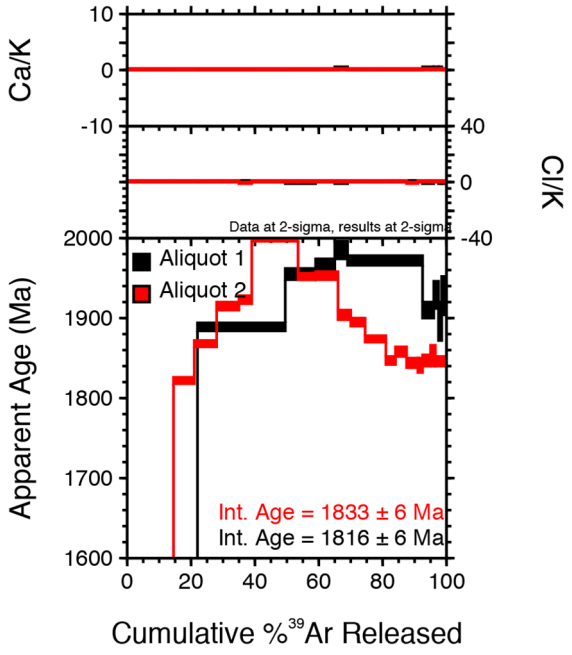

Figure 63: $^{40}Ar/^{39}Ar$ step-heating biotite spectra, aliquots 1-2.

Sample Number: EM691B
Lithology: Amphibolite
Mineral analyzed: Hornblende
Age: 1827 ± 7 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 12005
Argon Number: 3669
Location: Boomerang domain
Lat: **Long**: 61.28699 -107.90319; NTS sheet 75G
Geologist: Edith Martel

Sample Description: Strongly foliated, fine-grained amphibolite. Sampled along the Howard Lake shear zone.

Results: Two hornblende aliquots from this sample show contrasting step heat spectra, with aliquot 1 showing a downward-stepping age profile indicative of excess Ar, while aliquot 2 yielded a plateau age comprising ~100% of ^{39}Ar released. The plateau age of 1827 ± 7 Ma is considered to represent the hornblende cooling age for this sample. Note the elevated but homogeneous Ca/K ratio.

Analytical details (Fig. 64):
Irradiation Batch: GSC #75

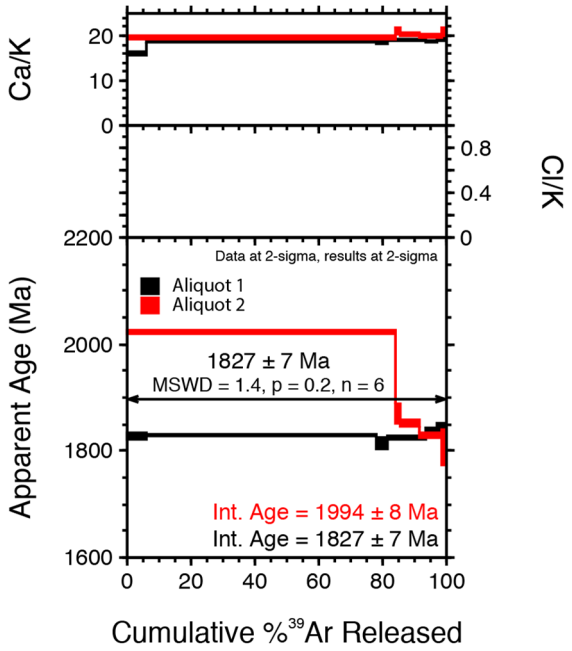

Figure 64: ^{40}Ar/^{39}Ar step-heating hornblende spectra, aliquots 1-2.

Sample Number: 16DR1000A
Lithology: Granodiorite
Mineral analyzed: Biotite
Age: 2323 ± 8 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 11845
Argon Number: 3678
Location: Porter domain
Lat: **Long**: 61.91585 -107.80749; NTS sheet 75G
Geologist: Daniele Regis

Sample Description: Strongly-magnetic orthopyroxene-clinopyroxene-hornblende-biotite bearing granodiorite; rich in mafic xenoliths.

Results: Three biotite aliquots from this sample show similar, and relatively homogeneous step heat age spectra, with aliquots 1 and 2 in particular producing similar age profiles, best defined by a plateau age for aliquot 2 at 2323 ± 8 Ma. This plateau age is interpreted as the biotite cooling age for this sample.

Analytical details (Fig. 65):
Irradiation Batch: GSC #75

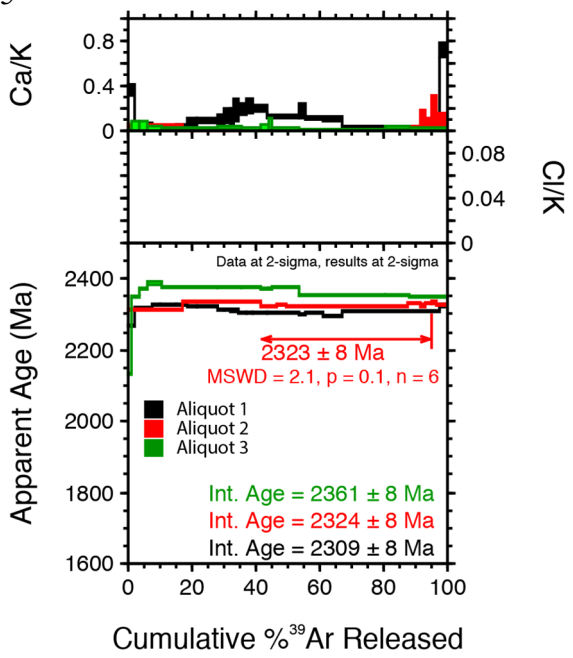

Figure 65: $^{40}Ar/^{39}Ar$ step-heating biotite spectra, aliquots 1-3.

Sample Number: 16DR1000A
Lithology: Granodiorite
Mineral analyzed: Hornblende
Age: 2409 ± 9 Ma
Interpretation: cooling age
Confidence: high

Geochronology Lab Number: 11845
Argon Number: 3679
Location: Porter domain
Lat: **Long**: 61.91585 -107.80749; NTS sheet 75G
Geologist: Daniele Regis

Sample Description: Strongly-magnetic orthopyroxene-clinopyroxene-hornblende-biotite bearing granodiorite; rich in mafic xenoliths.

Results: Three hornblende aliquots show similar step heat age spectra, with aliquots 1 and 3 in particular coinciding in apparent age for the majority of ^{39}Ar released. This corresponds to the plateau age of 2409 ± 9 Ma calculated from aliquot 3, interpreted as the hornblende cooling age for this sample.

Analytical details (Fig. 66):
Irradiation Batch: GSC #75

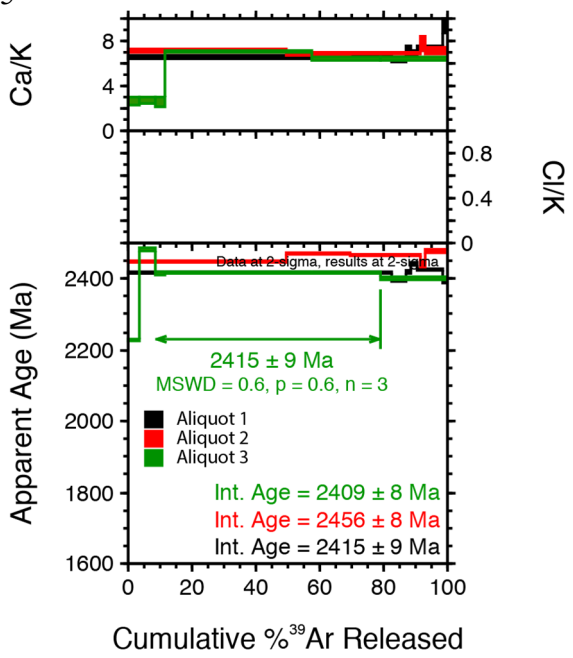

Figure 66: ^{40}Ar/^{39}Ar step-heating hornblende spectra, aliquots 1-3.

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