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^{40}AR/^{39}AR DATA FROM THE TALKEETNA MOUNTAINS C-4 QUADRANGLE AND ADJOINING AREAS, CENTRAL ALASKA

by
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^{40}AR/^{39}AR DATA FROM THE TALKEETNA MOUNTAINS C-4 QUADRANGLE AND ADJOINING AREAS, CENTRAL ALASKA

by
Jeff Benowitz[1], Paul Layer[1], Alicja Wypych[2], and Evan Twelker[2]

ABSTRACT

This report presents ^{40}Ar/^{39}Ar step-heating geochronology results for igneous and metamorphic rocks from the Alaska Division of Geological & Geophysical Surveys' (DGGS) Talkeetna Mountains C-4 Quadrangle and Adjoining Areas geologic mapping project. The U.S. Geological Survey (USGS) National Cooperative Geologic Mapping Program partially funded work by DGGS to map approximately 450 mi^2 of the Talkeetna Mountains region of central Alaska at 1:50,000 scale. This area contains significant exposures of Late Triassic mafic volcanics and gabbro sills that have been the focus of region-wide exploration for the Strategic and Critical platinum-group elements (PGEs). The area also exposes numerous inactive and possibly active faults that project through the area of the proposed Susitna–Watana hydroelectric dam and reservoir. Because this area was poorly mapped at a reconnaissance scale of 1:250,000, a team of eight DGGS geologists spent 42 days in the field to produce a new geologic map and a greatly improved understanding of the geology, structural history, and mineral potential of the area.

Hornblende-bearing gabbro returned a Late Triassic crystallization age consistent with regional results for Nikolai Greenstone-related magmatism. We determined Early Jurassic metamorphic ages for hornblende and sericite from two samples of upper greenschist to amphibolite grade metavolcanic rocks. Our results indicate that a granodiorite pluton intruding Wrangellia in the study area has a Middle Jurassic age consistent with the Talkeetna Arc, indicating that the Wrangellia and Peninsular terranes were joined at that time. Cretaceous plutons and porphyry intrusions in the map area can be divided into two types: reduced granitic to felsic porphyry intrusions with latest Cretaceous ages, and an earlier, oxidized type with early Late Cretaceous ages. This observation corresponds to similar patterns in magmatism in the western Alaska Range, and may indicate geological potential for similar style intrusive-related gold, copper, and molybdenum mineralization in the study area. Finally, we obtained Eocene ages for andesite and rhyolite; these ages constrain the timing of displacement on some of the faults in the map area.

Analyses were performed by the University of Alaska Fairbanks (UAF) Geochronology Laboratory, and the results were reported by Jeff Benowitz and Paul Layer. Products included in this data release are a summary of sample collection methods, the laboratory report, analytical data tables and associated metadata, and the plots of the ^{40}Ar/^{39}Ar age spectra, Ca/K, and Cl/K ratios. All components of this data release are available on the DGGS website, doi:10.14509/29454

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INTRODUCTION

The mineral-resources group from the Alaska Division of Geological & Geophysical Surveys (DGGS) carried out a geologic mapping project in the Talkeetna Mountains C-4, C-3, and B-4 quadrangles from June 23 through August 3, 2014. This project is part of a multi-year effort focusing on improving the publicly-available geological and geochemical data and assessing the mineral potential of the less-explored extension of the western Wrangellia terrane. This program of geologic mapping and rock sampling was conducted as part of the U.S. Geological Survey National Cooperative Geologic Mapping Program (STATEMAP grant G14AC00167) and the State of Alaska's Strategic Minerals Assessment project.

The project focused on detailed mapping, identification, sampling, and characterization of a broad section of Wrangellia stratigraphy, including Late Triassic rocks of the Ni–Cu–Co–PGE- and Cu–Ag-mineralized Wrangellia large igneous province, as well as modern geochemical characterizations of skarn, vein, and basalt-hosted Cu mineralization.

METHODOLOGY

Sample Collection Techniques

Fresh, unweathered samples from surficial outcrops were collected by DGGS field geologists; samples were selected based on presence of sufficiently large crystals and/or fresh glassy matrix. Sample location coordinates (in WGS84 datum) were obtained using handheld Trimble Juno T5 GPS units, with typical reported accuracy of about 10 m. Before processing, samples were examined under binocular microscope, or thin sections were prepared and scrutinized to eliminate the possibility of analyzing altered mineral phases.

Analytical Methods

For $^{40}Ar/^{39}Ar$ analysis, nine rock samples were submitted to the UAF Geochronology Laboratory, where they were crushed, sieved, washed, and hand-picked for phenocryst-free rock chips (1,000–500 micron size fraction) and hornblende, biotite, feldspar, and sericite mineral phases (1,000–150 microns). The monitor mineral MMhb-1 (Samson and Alexander, 1987) with an age of 523.5 Ma (Renne and others, 1994) was used to monitor neutron flux (and calculate the irradiation parameter, J). The samples and standards were wrapped in aluminum foil and loaded into aluminum cans of 2.5 cm diameter and 6 cm height. The samples were irradiated in position 5c of the uranium-enriched research reactor of McMaster University in Hamilton, Ontario, Canada, for 20 megawatt-hours.

Upon their return from the reactor, the samples and monitors were loaded into 2-mm-diameter holes in a copper tray, which was then loaded into an ultra-high-vacuum extraction line. The monitors were fused, and samples heated, using a 6-watt argon-ion laser following the technique described in York and others (1981), Layer and others (1987), and Benowitz and others, (2014). Argon purification was achieved using a liquid nitrogen cold trap and an SAES Zr-Al getter at 400°C. The samples were analyzed in a VG-3600 mass spectrometer at the UAF Geophysical Institute. The argon isotopes measured were corrected for system blank and mass discrimination, as well as calcium, potassium, and chlorine interference reactions following procedures outlined in McDougall and Harrison (1999). Typical full-system 8 min laser blank values (in moles) were generally 2×10^{-16} mol ^{40}Ar, 3×10^{-18} mol ^{39}Ar, 9×10^{-18} mol ^{38}Ar and 2×10^{-18} mol ^{36}Ar, which are 10–50 times smaller than the sample/standard volume fractions. Correction factors for nucleogenic interferences during irradiation were determined from irradiated CaF_2 and K_2SO_4 as follows: $(^{39}Ar/^{37}Ar)_{Ca} = 7.06 \times 10^{-4}$, $(^{36}Ar/^{37}Ar)_{Ca} = 2.79 \times 10^{-4}$ and

$(^{40}Ar/^{39}Ar)K$ = 0.0297. Mass discrimination was monitored by running calibrated air shots. The mass discrimination during these experiments was 1.3 percent per mass unit. Throughout the data collection process, calibration measurements were made on a weekly–monthly basis to check for changes in mass discrimination, with no significant variation seen during these intervals.

DISCUSSION

A summary of all the $^{40}Ar/^{39}Ar$ results is provided in Table 1, with all ages quoted to the ± 1 sigma level and calculated using the constants of Renne and others (2010). The integrated age is the age given by the total gas measured and is equivalent to a potassium-argon (K-Ar) age. The spectrum provides a plateau age if three or more consecutive gas fractions represent at least 50 percent of the total gas release and are within two standard deviations of each other (Mean Square Weighted Deviation [MSWD] less than 2.5). Below we provide additional discussion of the results of each age analysis, noting our preferred age determination.

14RN694

Hornblende (HO)

A hornblende separate from sample 14RN694 was analyzed. No precise isochron regression was possible because of the homogenous radiogenic ^{40}Ar content of the steps chosen for the plateau age determinations. The integrated age (197.3 ± 1.9 Ma) is within error of the plateau age (195.0 ± 1.6 Ma). We prefer the plateau age of 195.0 ± 1.6 Ma because of the high atmospheric content of the initial low-temperature step-heat releases.

The hornblende analyzed in this rock is clearly recrystallized; we interpret its age to represent the approximate metamorphic age of the amphibolite.

14AW299

Phlogopite (PHLOG)

A phlogopite separate from sample 14AW299 was analyzed. The analysis produced an irregular age spectrum that stepped up in age, which is associated with loss/alteration. A plateau age determination was not possible because the age determinations did not meet all the criteria for a plateau age (having an MSWD <2.5; >50% of ^{39}Ar gas release), hence a weighted average age is presented. No isochron regression was possible because of the documented loss/alteration. The integrated age (61.4 ± 0.4 Ma) is not within error of the weighted average age (67.1 ± 0.9 Ma). We prefer the weighted average age of 67.1 ± 0.9 Ma because of the documented loss/alteration.

We interpret this age to be an approximate magmatic crystallization age of the porphyry dike.

14ET424

Whole Rock (WR)

A phenocryst-free whole-rock separate from sample 14ET424 was analyzed. The analysis produced an irregular age spectrum that stepped up in age, which is associated with loss/alteration. No isochron regression was possible because of the documented loss/alteration. The integrated age (48.9 ± 0.4 Ma) is not within error of the plateau age (54.0 ± 0.8 Ma). We prefer the plateau age of 54.0 ± 0.8 Ma because of the documented loss/alteration.

This date is obtained from glassy matrix in an andesite porphyry; we interpret this age as the approximate magma quenching age.

14ET231

Whole rock (WR)

A phenocryst-free whole-rock separate from sample 14ET231 was analyzed. Based on the isochron regression to initial $^{40}Ar/^{36}Ar$, there is no evidence this sample had any significant inherited ^{40}Ar. The integrated age (36.0 ± 0.2 Ma) is within error of both the plateau age (37.6 ± 0.2 Ma) and the isochron age (37.2 ± 1.8 Ma). We prefer the plateau age of 37.6 ± 0.2 Ma because of the larger error on the isochron age determination.

The analysis was done on fresh glass from rhyolite; we interpret this age as the minimum extrusive age.

14ET158

Hornblende (HO)

A hornblende separate from sample 14ET158 was analyzed. No precise isochron regression was possible because of the homogenous radiogenic ^{40}Ar content of the steps chosen for the plateau age determinations. The integrated age (231.4 ± 4.8 Ma) is within broad error of the plateau age (223.0 ± 4.0 Ma). We prefer the plateau age of 223.0 ± 4.0 Ma because of the high atmospheric content of the initial low-temperature step-heat releases.

This age was obtained from hornblende in a gabbro; we interpret this age to represent the approximate magmatic crystallization of the gabbro.

14RN301

Sericite (SER)

A sericite separate from sample 14RN301 was analyzed. No precise isochron regression was possible because of the homogenous radiogenic ^{40}Ar content of the steps chosen for the plateau age determinations. The integrated age (186.3 ± 0.8 Ma) is within error of the plateau age (186.3 ± 0.8 Ma). We prefer the plateau age of 186.3 ± 0.8 Ma because of the high atmospheric content of the initial low-temperature step-heat releases.

The sericite from the Paleozoic volcanics is clearly a secondary mineral; we interpret the age obtained on this mineral as representing a metasomatic event.

14DR003B

Biotite (BI)

A biotite separate from sample 14DR003B was analyzed. No precise isochron regression was possible because of the homogenous radiogenic ^{40}Ar content of the steps chosen for the plateau age determinations. The integrated age (74.8 ± 0.3 Ma) is within error of the plateau age (76.9 ± 0.5 Ma). We prefer the plateau age of 76.9 ± 0.5 Ma because of the high atmospheric content of the initial low-temperature step-heat releases.

This age is obtained on a hornblende gabbro pluton; we interpret this result as the approximate magma crystallization age.

14LL220

Hornblende (HO)

A hornblende separate from sample 14LL220 was analyzed. The analysis produced an irregular age spectrum that stepped up in age, which is associated with loss/alteration. A plateau age determination was not possible because the age determinations did not meet all the criteria for a plateau age (more than two fractions used), hence a weighted average age is presented. No isochron regression was possible because of the documented loss/alteration. The integrated age (165.2 ± 0.7 Ma) is within broad error of the weighted average age (168.0 ± 0.7 Ma). We prefer the weighted average age of 168.0 ± 0.7 Ma because of the documented loss/alteration.

This age is from an intrusive granodiorite, the hornblende appears unaltered in thin section, and the age obtained agrees with unpublished $^{40}Ar/^{39}Ar$ hornblende age data for a nearby pluton of similar composition. We interpret this age as the approximate magmatic crystallization age of this body.

14LL220

Biotite (BI)

A biotite separate from sample 14LL220 was analyzed. The analysis produced an irregular age spectrum that stepped up in age, which is associated with loss/alteration. No isochron regression was possible because of the documented loss/alteration. The integrated age (180.5 ± 0.7 Ma) is within broad error of the plateau age (183.8 ± 0.9 Ma). We prefer the plateau age of 183.8 ± 0.9 Ma because of the documented loss/alteration.

The biotite from this sample shows evidence of replacement by chlorite. Based on this alteration and the age of the hornblende obtained from the same sample, nearby unpublished data, and the susceptibility of biotite for gaining excess ^{40}Ar, we suspect this age could be incorrect.

14LL220

Feldspar (FS)

A feldspar separate from sample 14LL220 was analyzed. The separate was likely plagioclase based on the sample having a Ca/K ratio of 5/1. The analysis produced an irregular age spectrum that stepped up in age, which is associated with loss-prolonged cooling for feldspar $^{40}Ar/^{39}Ar$ release patterns. No isochron regression was possible because of the documented loss. No plateau age determination was possible, but the sample had a significant weighted average saddle age at 144.3 ± 0.6 Ma (29.4% of the release).

This is the same age as the lower saddle obtained from the hornblende analysis on sample 14LL220 (145.1 ± 2.8 Ma, 6%, six fractions, MSWD = 1.02) and the age of the lowest saddle from the biotite analysis on this sample (144.2 ± 0.8 Ma, 5%, one fraction). Clearly, sample 14LL220 experienced a loss event at ~145 Ma; the hornblende age of 165.2 ± 0.7 Ma likely most closely approximates the magmatic age for this sample.

14AW266

Hornblende (HO)

A hornblende separate from sample 14AW266 was analyzed. No precise isochron regression was possible because of the homogenous radiogenic ^{40}Ar content of the steps chosen for the plateau age determinations. The integrated age (69.5 ± 0.8 Ma) is within broad error of the plateau age (68.8 ± 0.6 Ma). We prefer the plateau age of 68.8 ± 0.6 Ma because of the high atmospheric content of the initial low-temperature step-heat releases.

This age obtained on fresh-looking hornblende most likely represents the magmatic crystallization age of the plutonic body.

14AW266

Biotite (BI)

A biotite separate from sample 14AW266 was analyzed. The analysis produced an age spectrum with high precision for individual steps. A plateau age determination was not possible because the age determinations did not meet all the criteria for a plateau age (having an MSWD <2.5), hence a weighted average age is presented. No isochron regression was possible because of the homogenous radiogenic ^{40}Ar content of the steps chosen for the weighted average age determinations. The integrated age (60.1 ± 0.2 Ma) is within error of the weighted average age (60.4 ± 0.3 Ma). We prefer the weighted average age of 60.4 ± 0.3 Ma because of the high atmospheric content of the initial low-temperature step-heat releases.

This mineral phase age is significantly younger than the hornblende age determination (68.8 ± 0.6 Ma) for this sample, implying reheating or later cooling through the biotite closure temperature isotherm. Given the ages of the surrounding volcanics (Eocene), we interpret this age to represent reheating of this pluton and resetting of the biotite.

ACKNOWLEDGMENTS

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REFERENCES CITED

Benowitz, J.A., Layer, P.W., and Vanlaningham, S., 2014, Persistent long-term (c. 24 Ma) exhumation in the eastern Alaska Range constrained by stacked thermochronology: London, Geological Society of London, Special Publication 378, no. 1, p. 225–243.

Layer, P.W., Hall, C.M., and York, Derek, 1987, The derivation of $^{40}Ar/^{39}Ar$ age spectra of single grains of hornblende and biotite by laser step-heating: Geophysical Research Letters, v. 14, no. 7, p. 757–760.

McDougall, Ian, and Harrison, T.M., 1999, Geochronology and thermochronology by the $^{40}Ar/^{39}Ar$ method, 2nd edition: New York, Oxford University Press, 269 p.

Renne, P.R., Mundil, Roland, Balco, Greg, Min, Kyoungwon, and Ludwig, K.R., 2010, Joint determination of ^{40}K decay constants and $^{40}Ar/^{40}K$ for the Fish Canyon sanidine standard, and improved accuracy for $^{40}Ar/^{39}Ar$ geochronology: Geochimica et Cosmochimica Acta, v. 74, no. 18, p. 5,349–5,367.

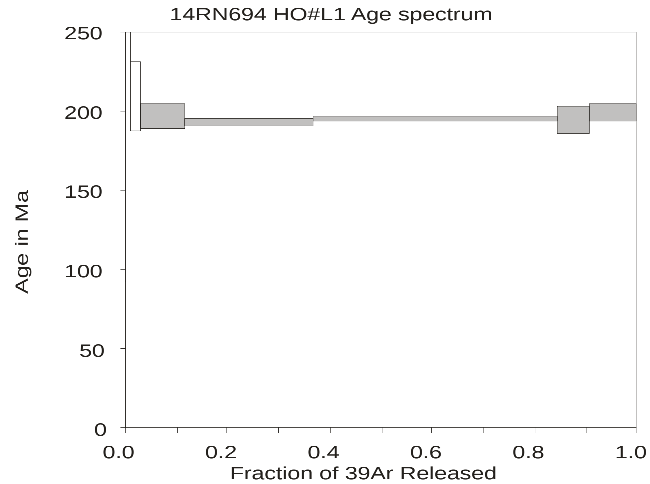
Renne, P.R., Deino, A.L., Walter, R.C., Turrin, B.D., Swisher, C.C., Becker, T.A., Curtis, G.H., Sharp, W.D., and Jaouni, A.R., 1994, Intercalibration of astronomical and radioisotopic time: Geology, v. 22, no. 9, p. 783–786. doi:10.1130/0091-7613(1994)022<0783:IOAART>2.3.CO;2

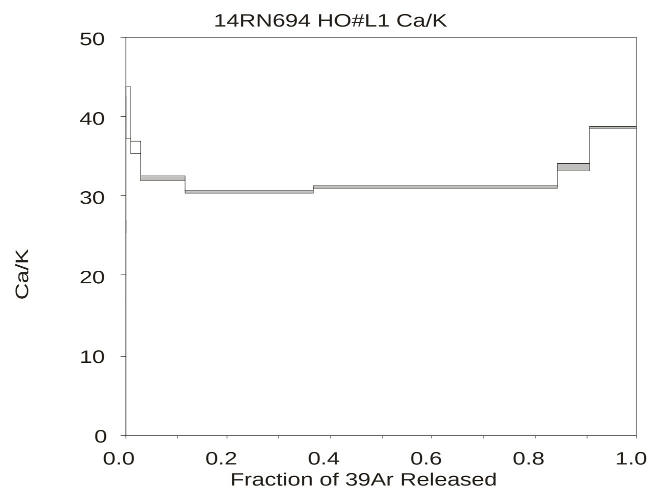
Samson, S.D., and Alexander, E.C., 1987, Calibration of the interlaboratory $^{40}Ar/^{39}Ar$ dating standard, MMhb-1: Chemical Geolology, Isotope Geoscience Section, v. 66, no. 1-2, p. 27–34.

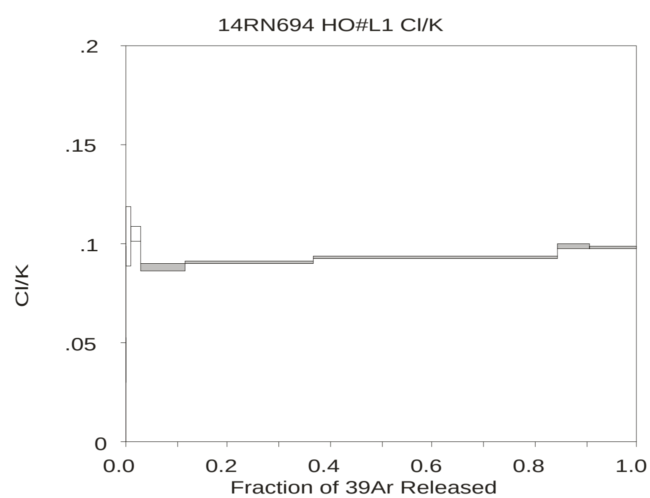
York, Derek, Hall, C.M., Yanase, Yotaro, Hanes, J.A., and Kenyon, W.J., 1981 $^{40}Ar/^{39}Ar$ dating of terrestrial minerals with a continuous laser: Geophysical Research Letters, v. 8, no. 11, p. 1,136–1,138.

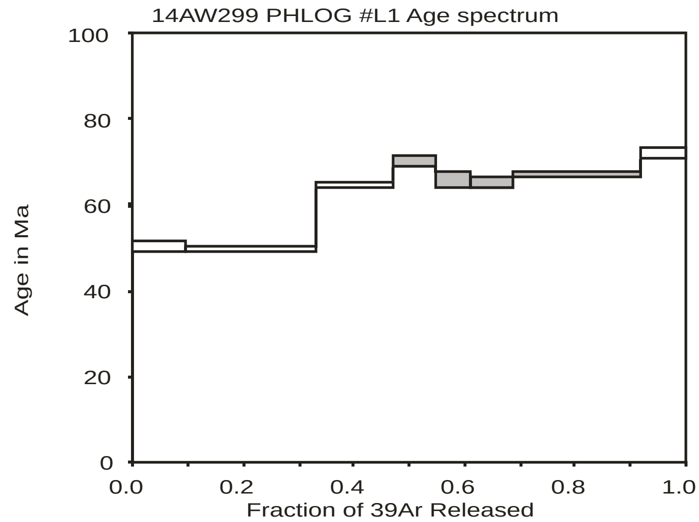
APPENDIX: $^{40}Ar/^{39}Ar$ age spectra, Ca/K and Cl/K ratios plots

Steps filled in grey were used for plateau age determinations.





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60
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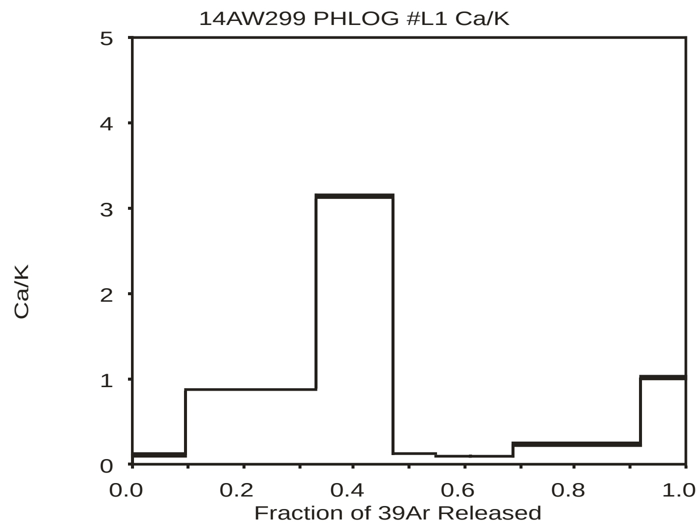
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released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Ca/K
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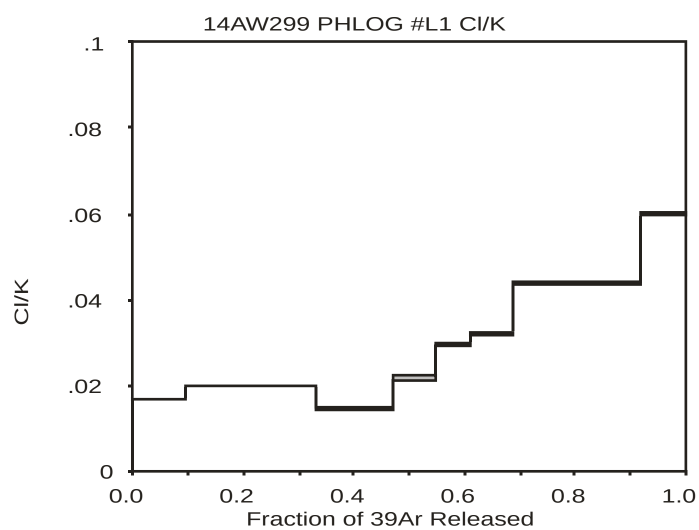
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Cl/K
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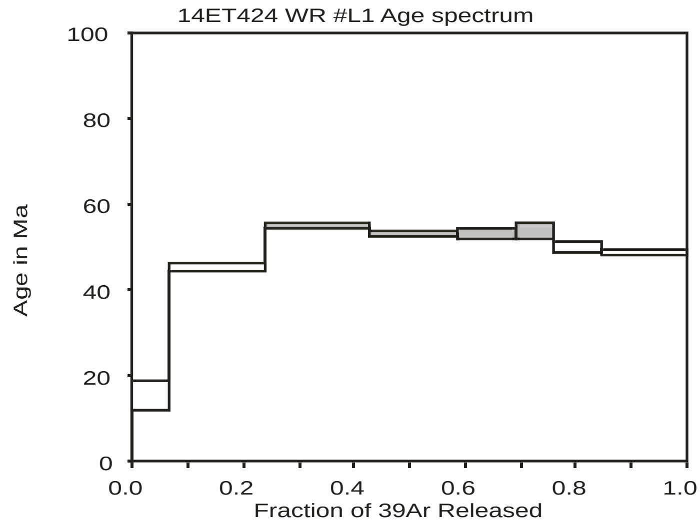
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60
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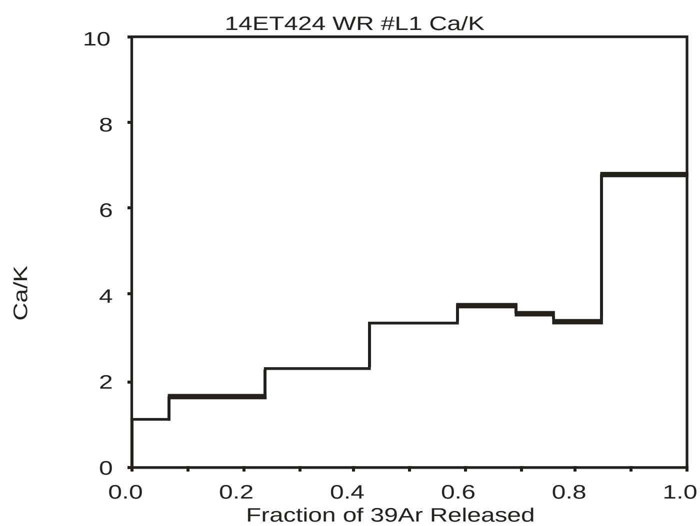
Fraction of 39Ar Released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Ca/K
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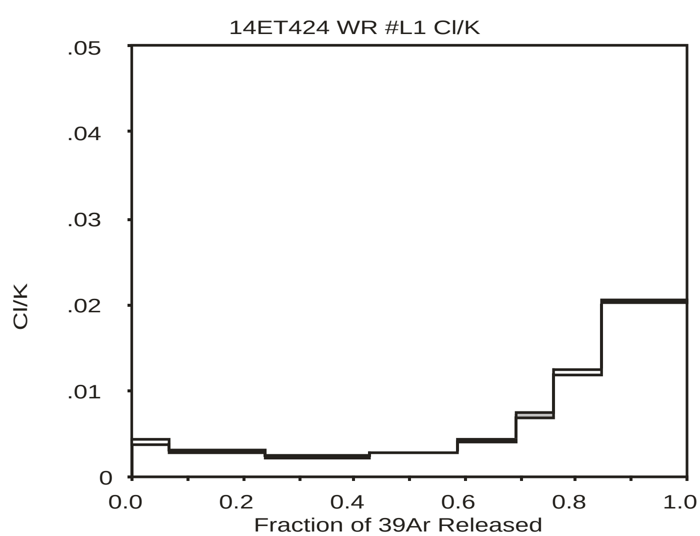
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Cl/K
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1.0
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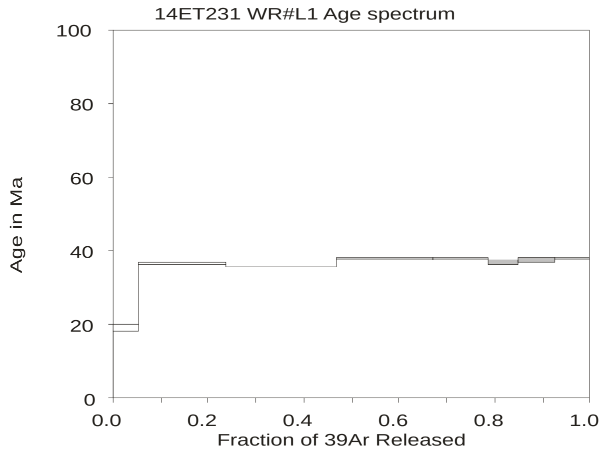
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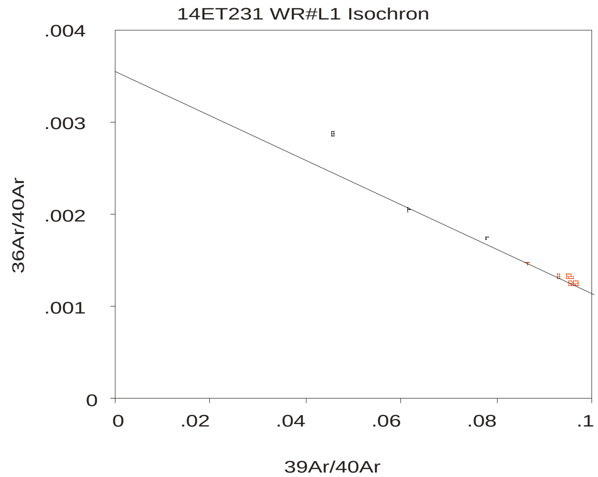
Age in Ma
Fraction of 39Ar Released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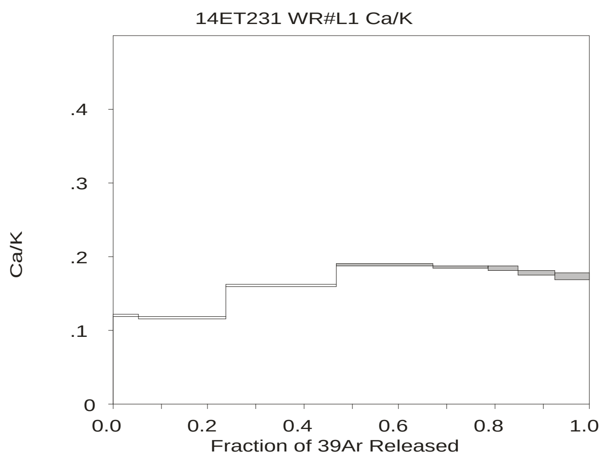
36Ar/40Ar
39Ar/40Ar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Ca/K
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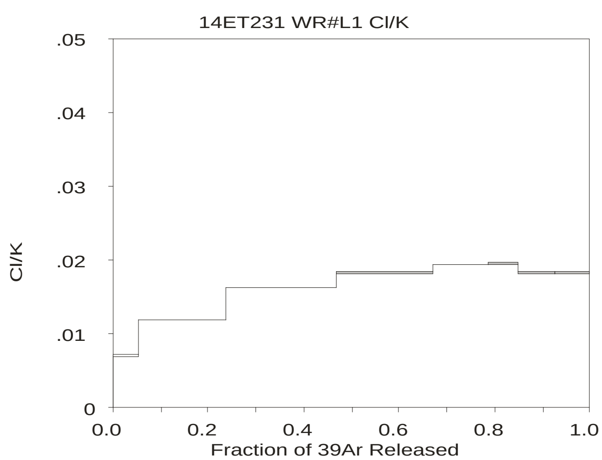
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Cl/K
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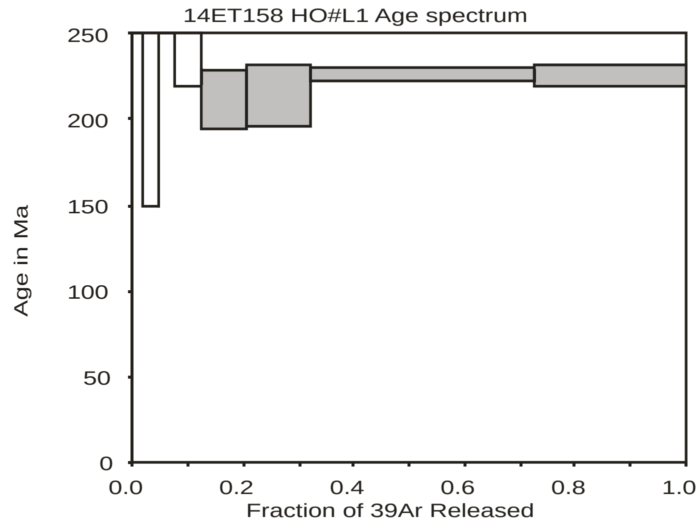
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250
200
150
100
50
0
Age in Ma
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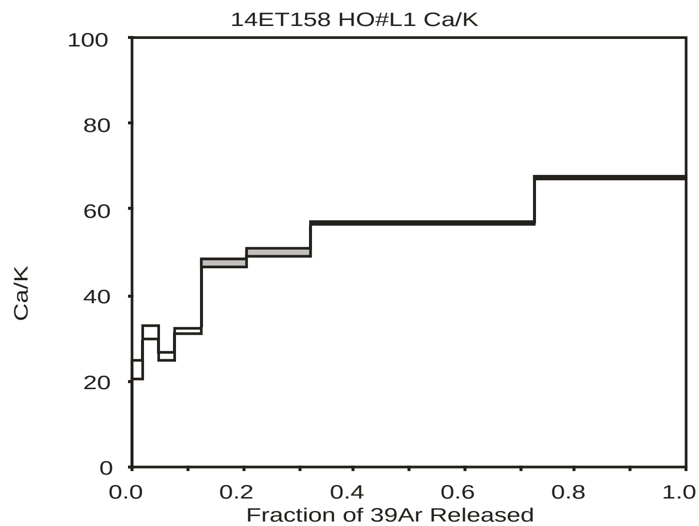
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released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80
60
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Ca/K
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0.6
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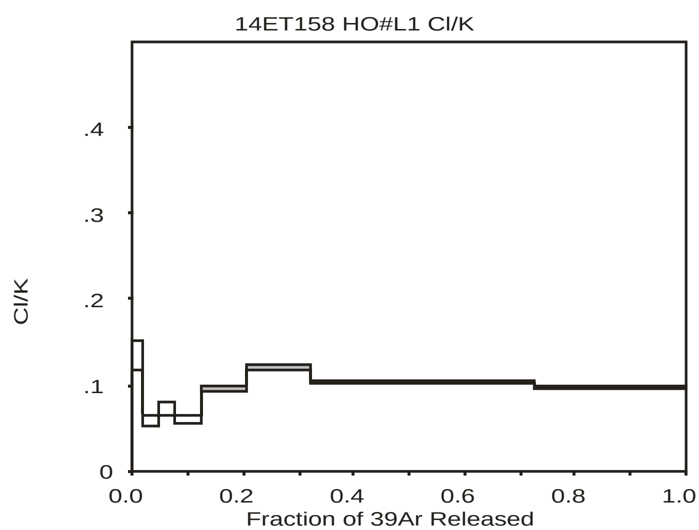
Fraction of 39Ar Released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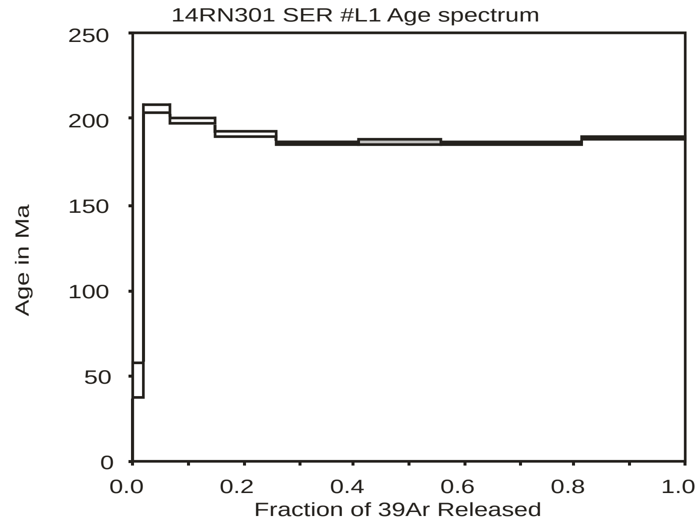
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1.0
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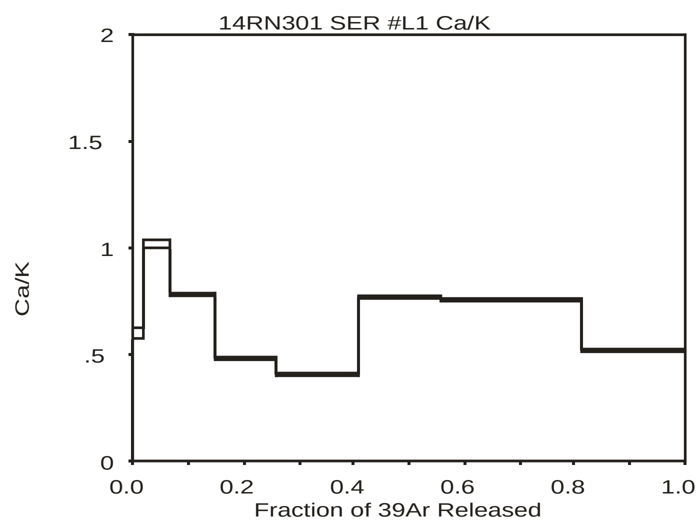
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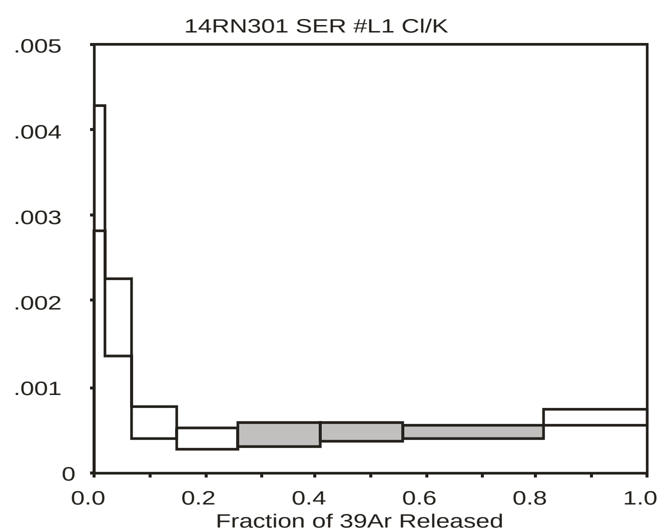
Fraction of 39Ar Released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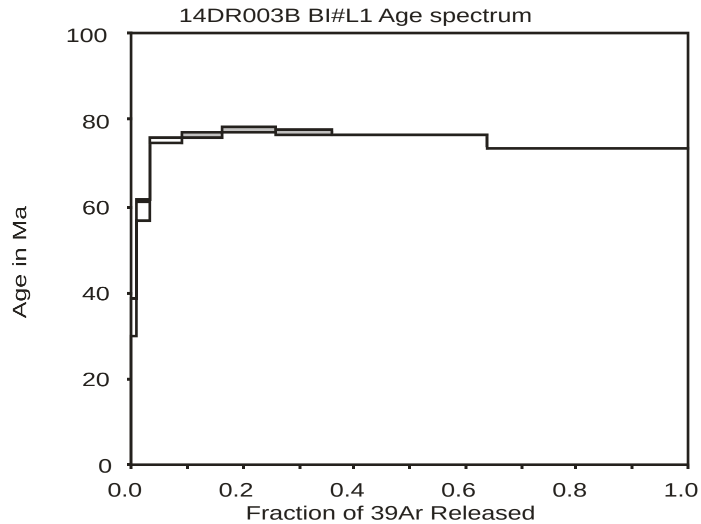
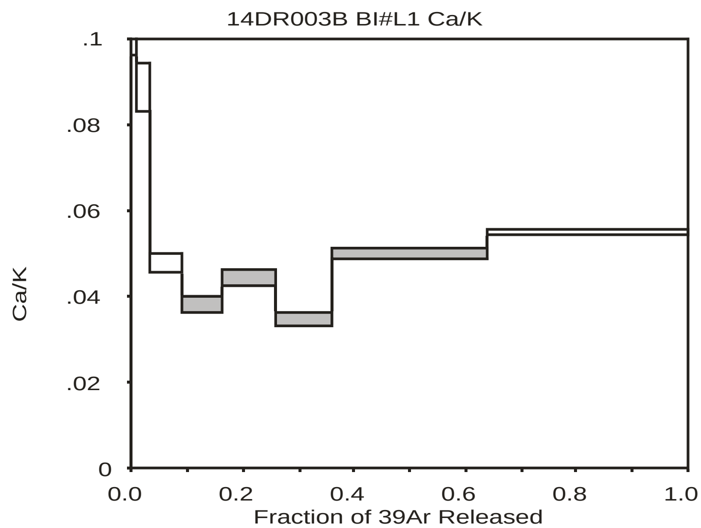
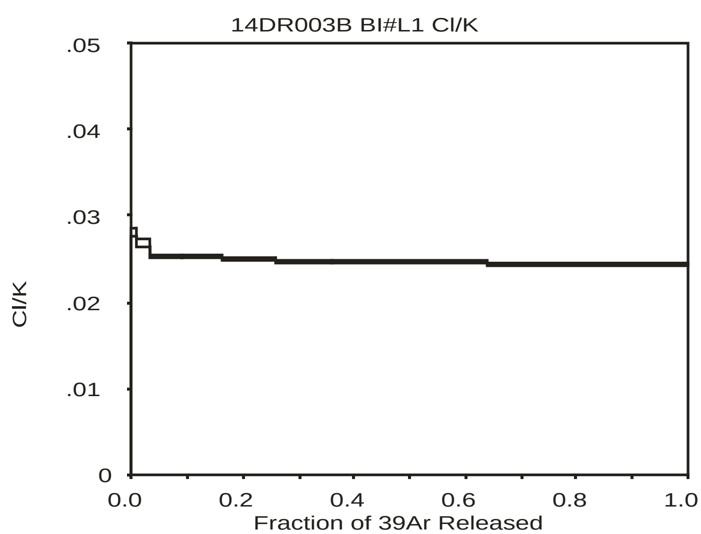
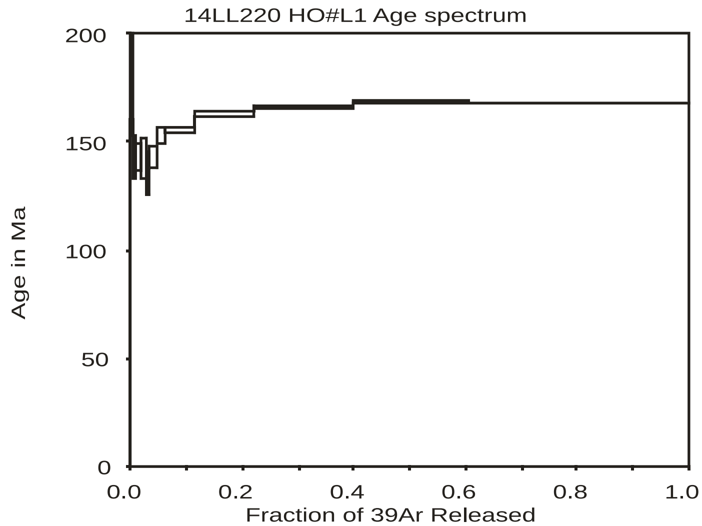
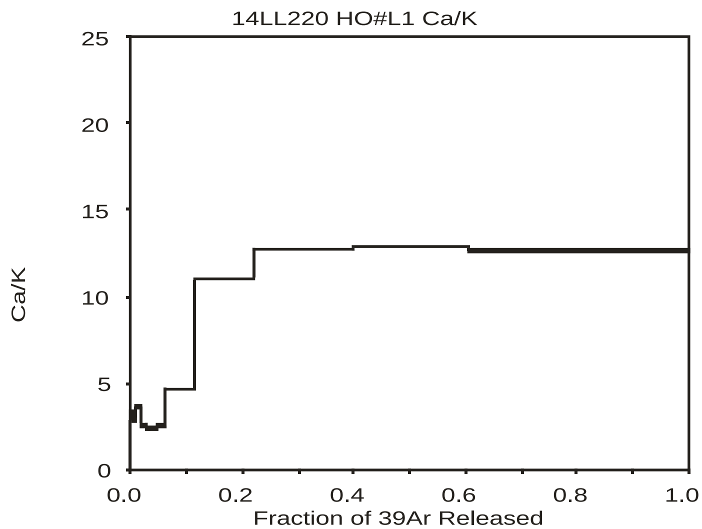
0.4
0.6
0.8
1.0
Fraction of 39Ar Released

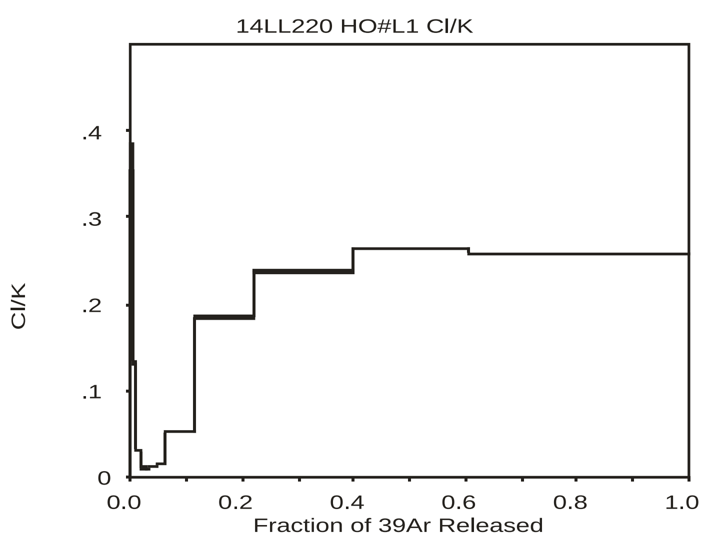

14DR003B BI#L1 Age spectrum
Age in Ma
100
80
60
40
20
0
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released

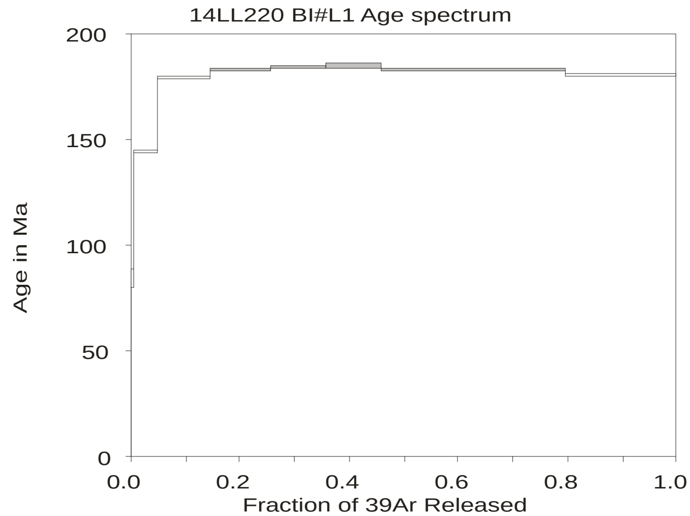

14DR003B BI#L1 Ca/K
Ca/K
.1
.08
.06
.04
.02
0
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released

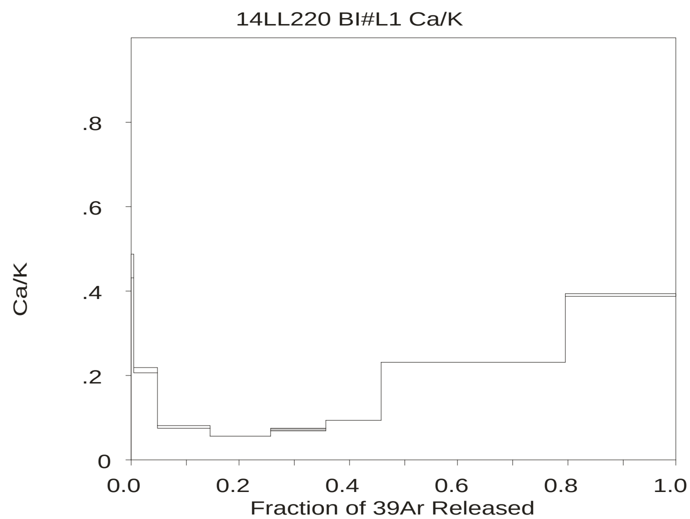

14DR003B BI#L1 Cl/K
Cl/K
.05
.04
.03
.02
.01
0
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released

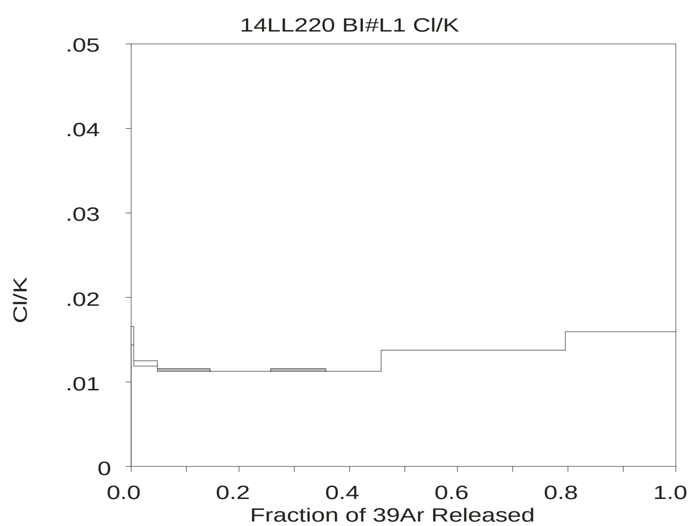

14LL220 HO#L1 Age spectrum
Age in Ma
200
150
100
50
0
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released

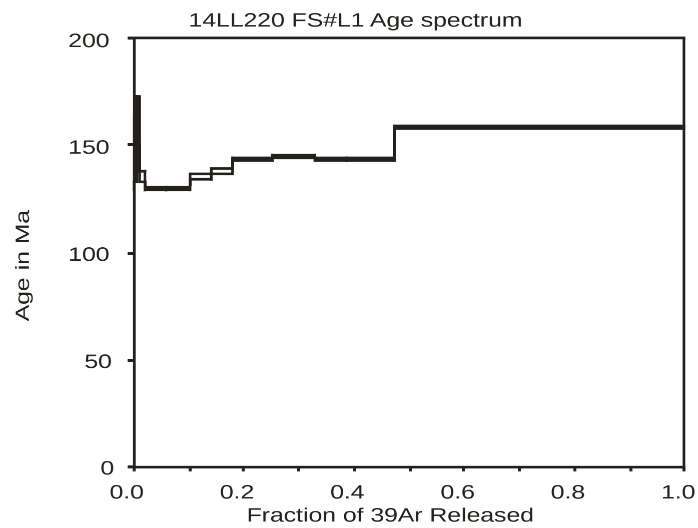

14LL220 HO#L1 Ca/K
Ca/K
25
20
15
10
5
0
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released

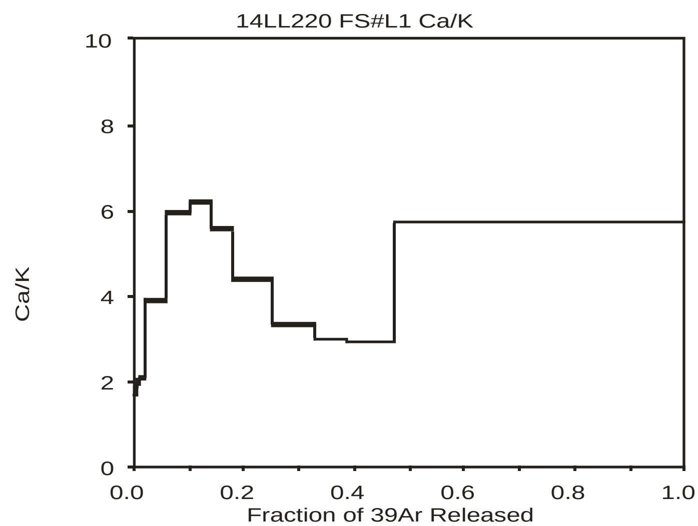

14LL220 HO#L1 Cl/K
Cl/K
.4
.3
.2
.1
0
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released

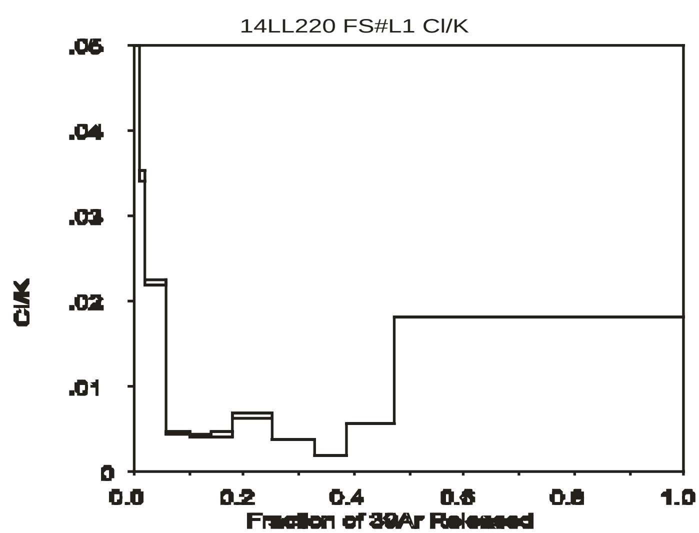

14LL220 BI#L1 Age spectrum
200
150
100
50
0
Age in Ma
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released

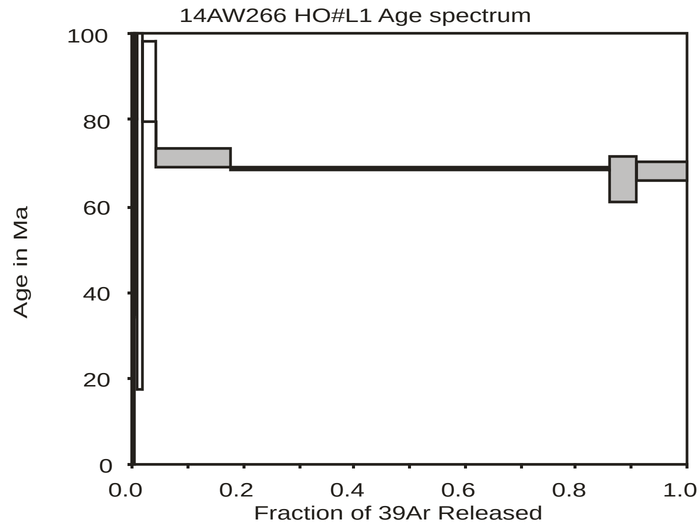

14LL220 BI#L1 Ca/K
.8
.6
.4
.2
0
Ca/K
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released

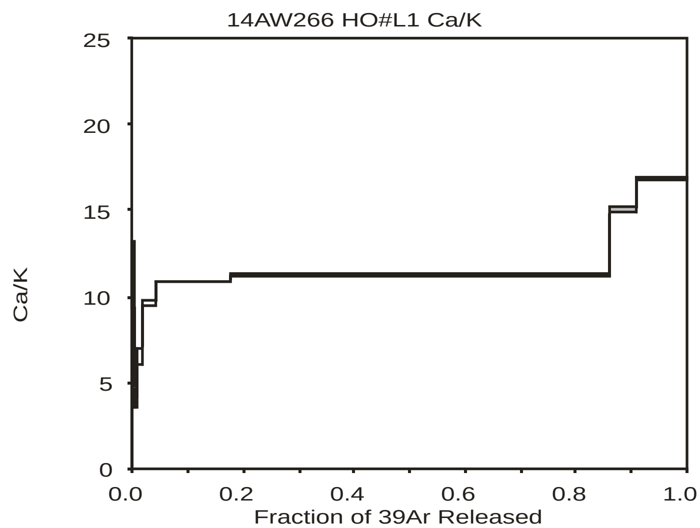

14LL220 BI#L1 Cl/K
.05
.04
.03
.02
.01
0
Cl/K
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released

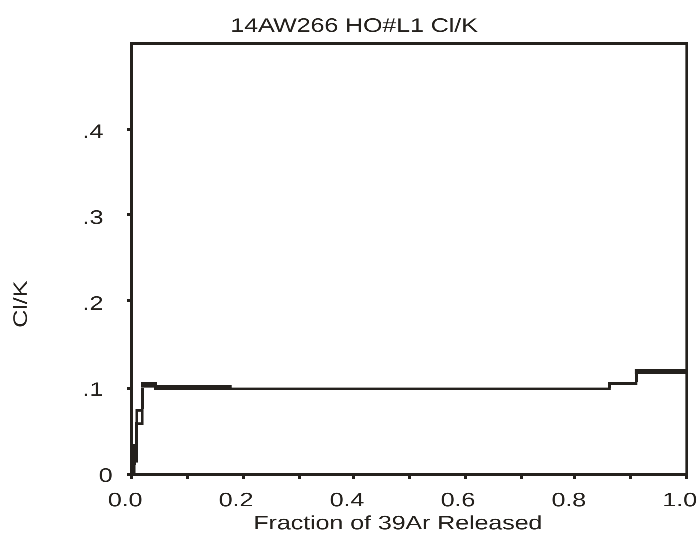

14LL220 FS#L1 Age spectrum
Age in Ma
200
150
100
50
0
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released

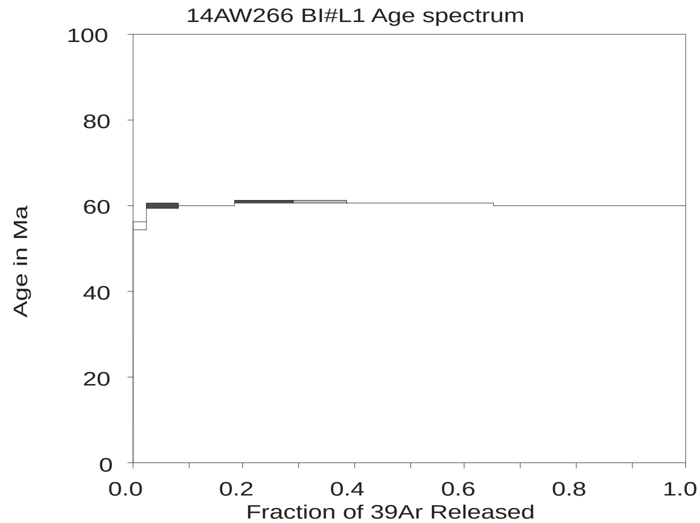

14LL220 FS#L1 Ca/K
Ca/K
10
8
6
4
2
0
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released

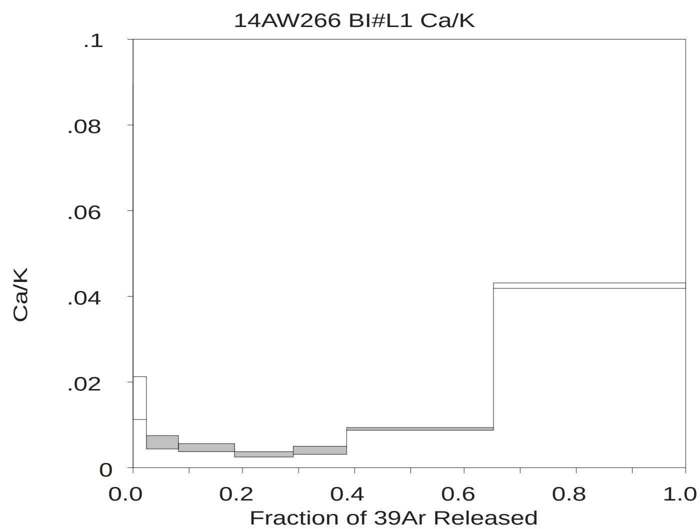

14LL220 FS#L1 Cl/K
Cl/K
.05
.04
.03
.02
.01
0
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released

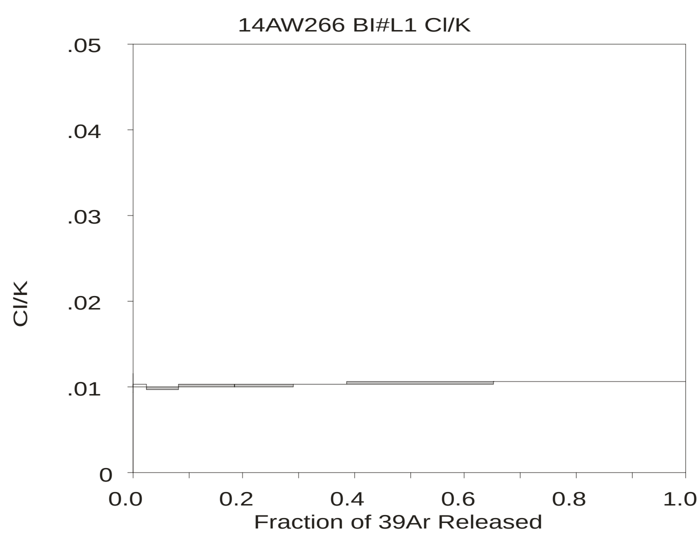

14AW266 HO#L1 Age spectrum
Age in Ma
100
80
60
40
20
0
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released


14AW266 HO#L1 Ca/K
Ca/K
25
20
15
10
5
0
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released


14AW266 HO#L1 Cl/K
Cl/K
.4
.3
.2
.1
0
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released


14AW266 BI#L1 Age spectrum
Age in Ma
100
80
60
40
20
0
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released


14AW266 BI#L1 Ca/K
Ca/K
.1
.08
.06
.04
.02
0
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released


14AW266 BI#L1 Cl/K
Cl/K
.05
.04
.03
.02
.01
0
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released