Division of Geological & Geophysical Surveys

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^{40}AR/^{39}AR DATA FROM ROCKS COLLECTED IN 2013 IN THE WRANGELLIA MINERAL ASSESSMENT AREA, GULKANA, HEALY, MOUNT HAYES, AND TALKEETNA MOUNTAINS QUADRANGLES, ALASKA

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CONTENTS

Note: This report (including all analytical data and tables) is available in digital format from the DGGS website (www.dggs.alaska.gov) at no charge.

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Jeff A. Benowitz[1], Paul W. Layer[1], and Evan Twelker[2]

ABSTRACT

This DGGS Raw Data File presents ^{40}Ar/^{39}Ar age dating results from selected mafic to intermediate intrusions encountered during a geological and geochemical resource assessment project in the Gulkana, Healy, Mount Hayes, and Talkeetna Mountains quadrangles. Three intrusions returned mid-Cretaceous crystallization ages, while one olivine gabbro returned a Late Triassic crystallization age. Two altered or metamorphosed samples yielded Late Jurassic and Early Cretaceous ages. Analyses were performed by the University of Alaska Fairbanks Geochronology Laboratory, and results were reported by Paul Layer and Jeff Benowitz. Products included in this data release are: a summary of sample collection methods, the laboratory report, analytical data tables and associated metadata, and 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:10.14509/29119 at no charge.

INTRODUCTION

Mineral-resources geologists from the Alaska Division of Geological & Geophysical Surveys (DGGS) carried out a helicopter-supported geological and geochemical resource assessment project in the Gulkana, Healy, Mount Hayes, and Talkeetna Mountains quadrangles from July 29 through August 16, 2013. The objectives of this assessment were to improve the publicly-available geological, geophysical, and geochemical data in the area of known mineral occurrences in the Mount Hayes Quadrangle, and to extend this coverage and any gained insight westward into the less-explored extension of the Wrangellia terrane. This program of stream-sediment, pan-concentrate, and rock sampling was conducted as part of the State's *Strategic Minerals Assessment* project, an initiative designed to evaluate Alaska's potential for rare-earth elements, PGEs, and other similarly-supply-challenged resources.

SAMPLE COLLECTION TECHNIQUES

Field geologists collected rock samples from surface outcrops. Care was taken to collect fresh, unweathered samples displaying sufficiently large grains for the mineral separate samples when possible. Location coordinates (WGS84 datum) were collected using handheld GPS units, with a typical reported accuracy of about 10 m. Prior to processing, thin sections of the samples were petrographically inspected to ensure that mineral specimens selected for dating were free of alteration.

ANALYTICAL METHODS

For ^{40}Ar/^{39}Ar analysis, rock samples were submitted to the Geochronology Laboratory at the University of Alaska Fairbanks (UAF) where they were crushed, sieved, washed, and hand-picked for hornblende and biotite mineral phases. 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 2.5 cm in diameter and 6 cm in 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.

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Upon their return from the reactor, the sample and monitoring standards were loaded into 2 mm diameter holes in a copper tray, which was then loaded in 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 Layer (2000). 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, weekly to monthly calibration measurements were made to check for changes in mass discrimination, with no significant variation seen during these intervals.

DISCUSSION

A summary of all the $^{40}Ar/^{39}Ar$ analyses is included the accompanying data distribution file set, 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] <2.5). Below, we provide additional discussion of the results of each age analysis and note our preferred age determination.

13ET270: Biotite (BI)

A biotite separate from sample **13ET270** was analyzed. The analysis produced an upward-stair-stepping age spectra associated with loss/alteration. The integrated age (122.9 ± 0.5 Ma) is within broad error of the plateau age (124.6 ± 0.5 Ma). No isochron age determination was possible because of the documented loss (~5%). We prefer the plateau age of **124.6 ± 0.5 Ma** because of the documented loss.

We interpret this age as the approximate magmatic crystallization age of this biotite quartz monzonite intrusion.

13LF253A: Hornblende (HO)

A hornblende separate from sample **13RN253A** was analyzed. The analysis produced a slightly jig-saw-edge spectra associated with both alteration and heterogeneous mineral composition.

The integrated age (132.4 ± 0.6 Ma) is within broad error of the weighted average age (MSWD >2.5; <50% of the ^{39}Ar release; 131.1 ± 1.2 Ma). No isochron age determination was possible because of the homogenous radiogenic content of the step releases used for the weighted average age determination. We prefer the weighted average age of **131.1 ± 1.2 Ma** as an approximation of the geological age of this mineral phase because the first few heating steps showed anomalous younger and older ages and high atmospheric content, which are both associated with alteration.

This analysis apparently reflects the approximate age of retrograde alteration or metamorphism of an older hornblende-bearing gabbroic intrusion.

13RN428A: Biotite (BI)

A biotite separate from sample **13RN428A** was analyzed. The analysis produced a slightly jig-saw-edge spectra associated with both alteration and heterogeneous mineral composition. The integrated age (227.8 ± 1.0 Ma) is within broad error of the plateau age (225.8 ± 1.1 Ma). No isochron age determination was possible because of the homogenous radiogenic content of the step releases used for the plateau age determination. We prefer the plateau age of **225.8 ± 1.1Ma** because the first few heating steps showed anomalous younger and older ages and high atmospheric content, which are both associated with alteration.

We interpret this analysis to represent the approximate magmatic crystallization age of this olivine gabbro.

13RN474A: Hornblende (HO)

A hornblende separate from sample **13RN474A** was analyzed. The integrated age (110.6 ± 0.4 Ma) is within error of the plateau age (111.3 ± 0.4 Ma). No isochron age determination was possible because of the homogenous radiogenic content of the step releases used for the plateau age determination. We prefer the plateau age of **111.3 ± 0.4 Ma** because the first few heating steps showed anomalous younger ages and high atmospheric content, which are both associated with alteration.

We interpret this analysis as the approximate magmatic crystallization age of this hornblende gabbro dike.

13RN490B: Hornblende (HO)

A hornblende separate from sample **13RN490B** was analyzed. The integrated age (107.4 ± 0.5 Ma) is within broad error of the plateau age (105.8 ± 0.4 Ma). No isochron age determination was possible because of the homogenous radiogenic content of the step releases used for the plateau age determination. We prefer the plateau age of **105.8 ± 0.4 Ma** because the first few heating steps showed anomalous younger ages and high atmospheric content, which are both associated with alteration.

We interpret this analysis as the approximate magmatic crystallization age of this hornblende gabbro dike.

13RN503A: Hornblende (HO)

A hornblende separate from sample **13RN503A** was analyzed. The analysis produced a slightly jig-saw-edge spectra associated with both alteration and heterogeneous mineral composition.

The integrated age (162.2 ± 1.0 Ma) is within broad error of the weighted average age (MSWD >2.5; 165.2 ± 2.1 Ma). No isochron age determination was possible because of the homogenous radiogenic content of the step releases used for the weighted average age determination. We prefer the weighted average age of **165.2 ± 2.1 Ma** as an approximation of the geological age of this mineral phase because the first few heating steps showed anomalous younger and older ages and high atmospheric content, which are both associated with alteration.

We interpret this analysis as the approximate age of alteration of sedimentary rocks by an immediately adjacent intrusive complex, including an immediately adjacent gabbroic body and a >10 km^2 granodiorite pluton.

ACKNOWLEDGMENTS

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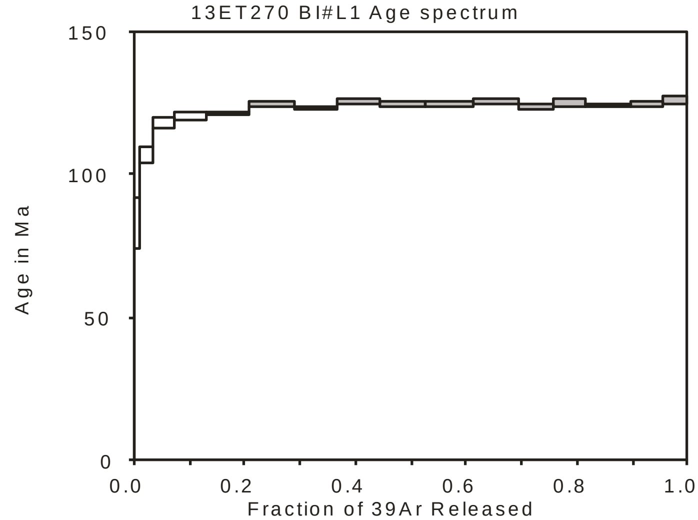
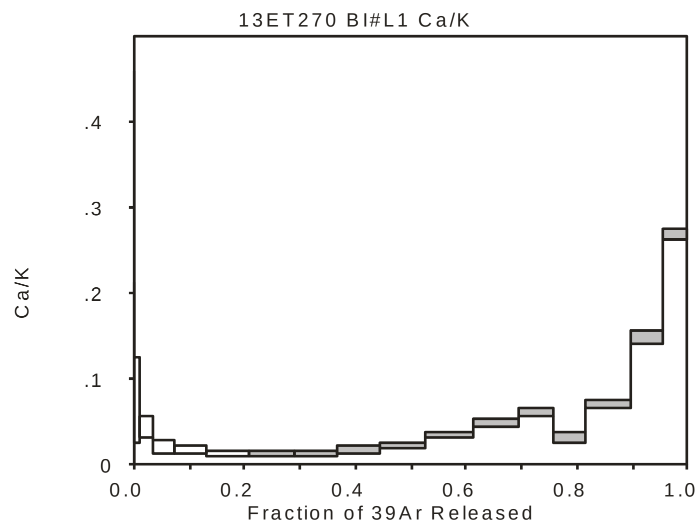
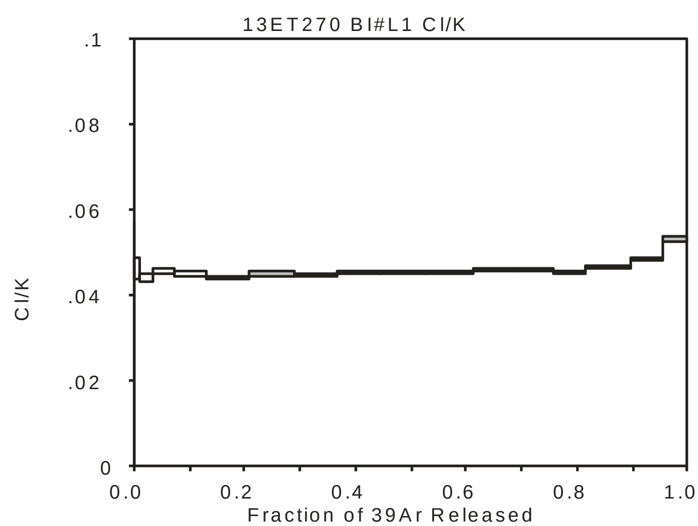
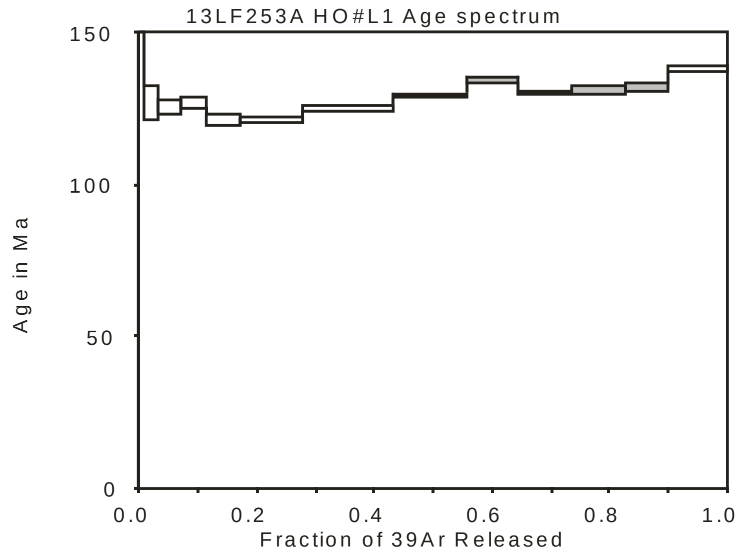
APPENDIX: ^{40}AR/^{39}AR AGE, Ca/K, AND Cl/K SPECTRA PLOTS

Steps filled in gray were used for plateau age determinations.





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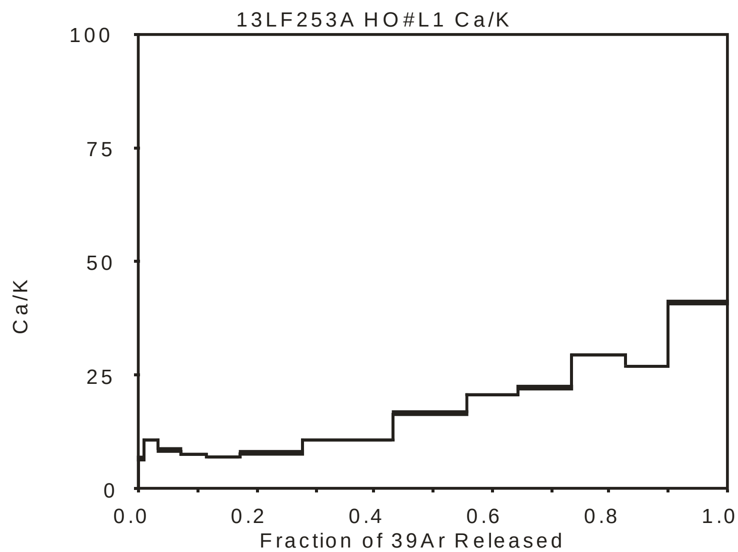
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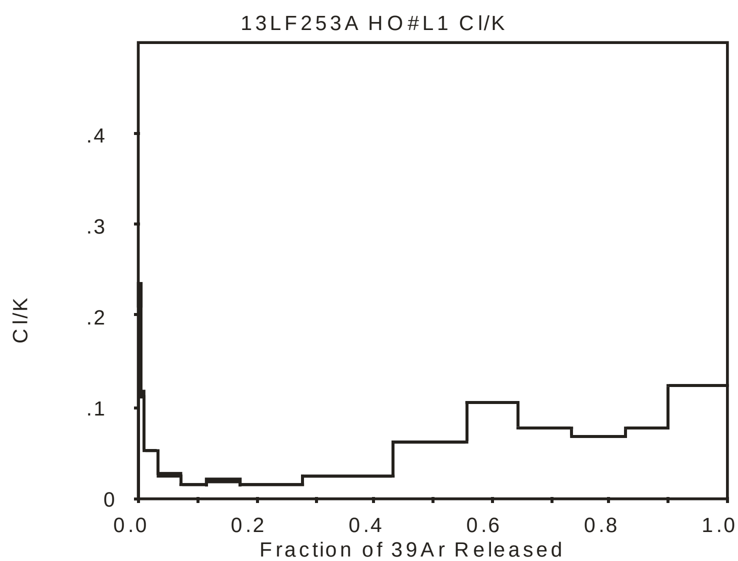
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Cl/K
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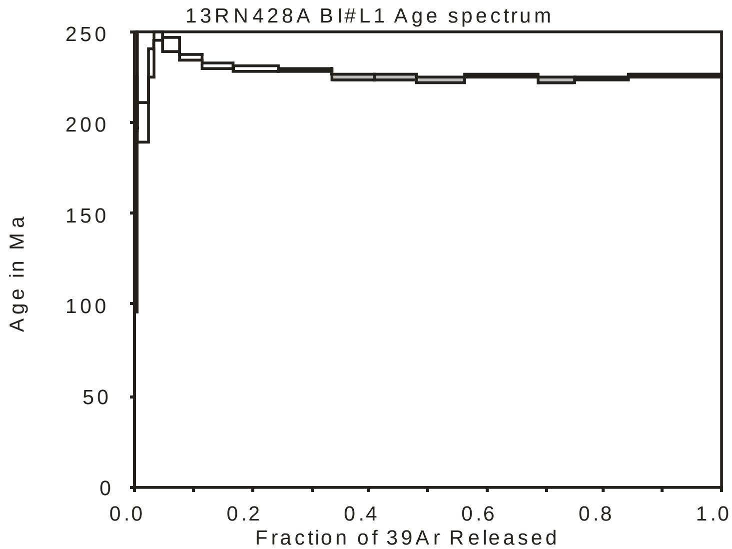
1.0
Fraction of 39Ar Released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Age in Ma
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150
100
50
0
0.0
0.2
0.4
0.6
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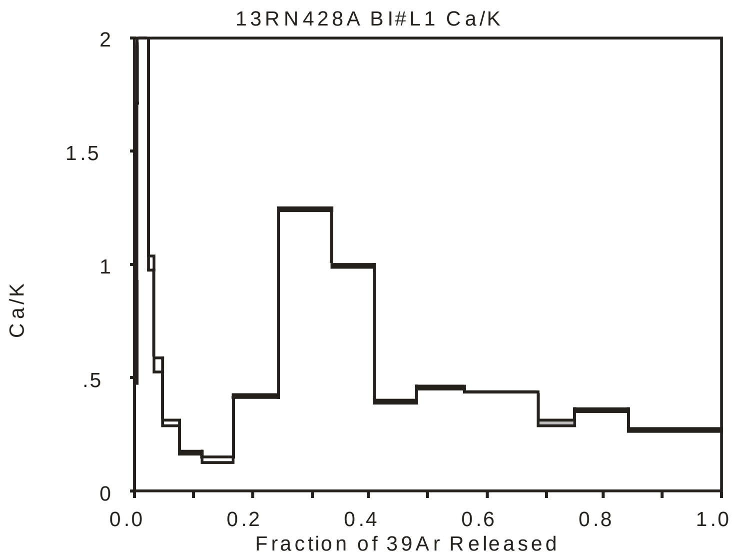
1.0
Fraction of 39Ar Released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Ca/K
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1
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0
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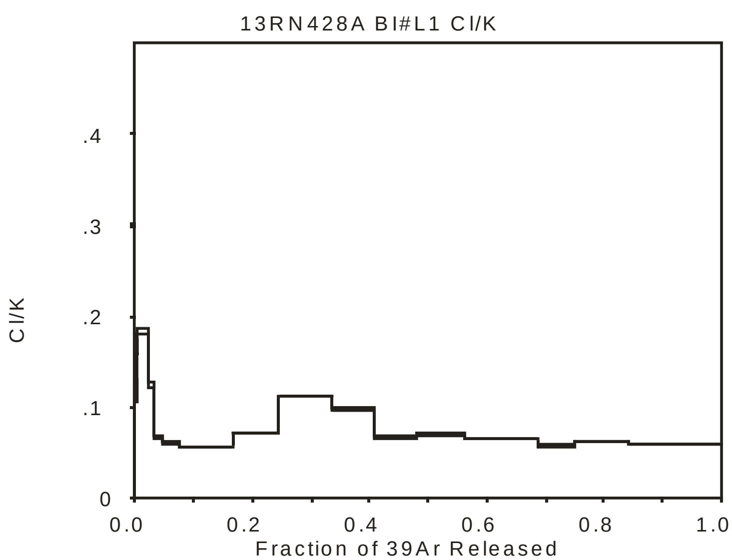
1.0
Fraction of 39Ar Released


13RN428A BI#L1 Cl/K
Cl/K
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.2
.1
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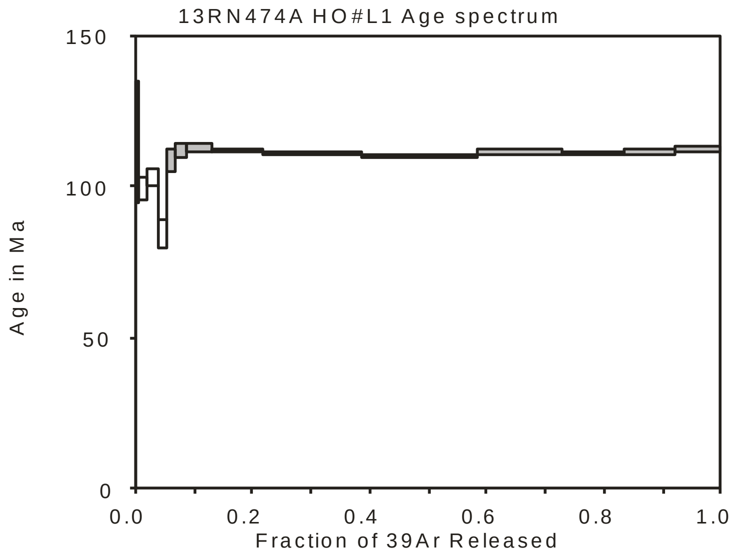
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released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Age in Ma
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0.2
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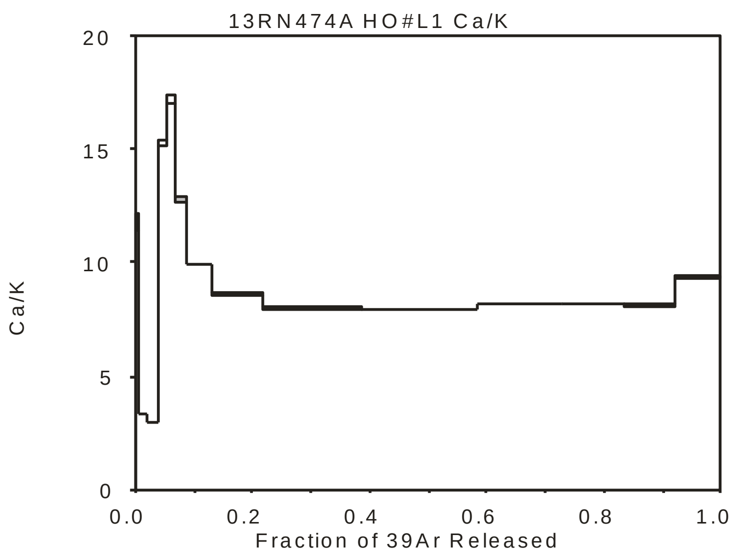
0.6
0.8
1.0
Fraction of 39Ar Released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5
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Ca/K
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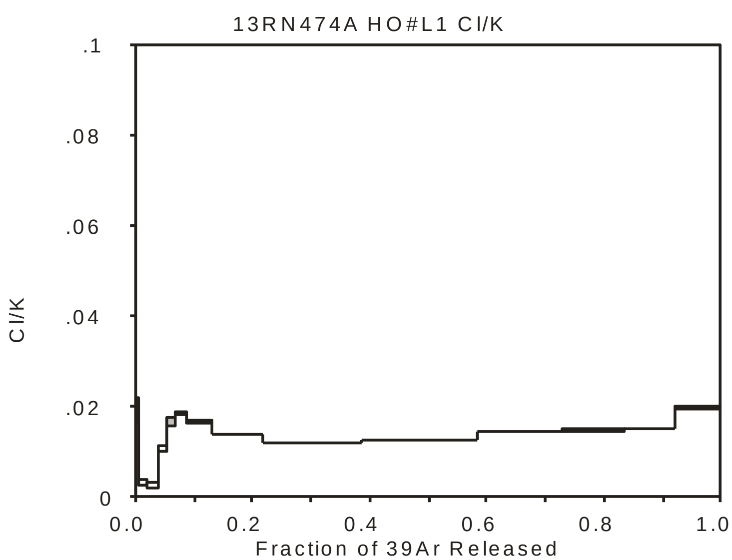
Fraction of 39Ar Released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.06
.04
.02
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Cl/K
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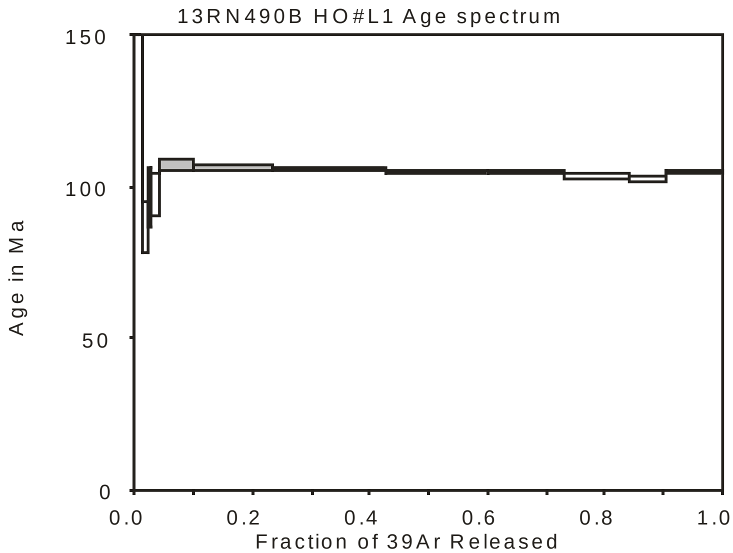
Fraction of 39Ar Released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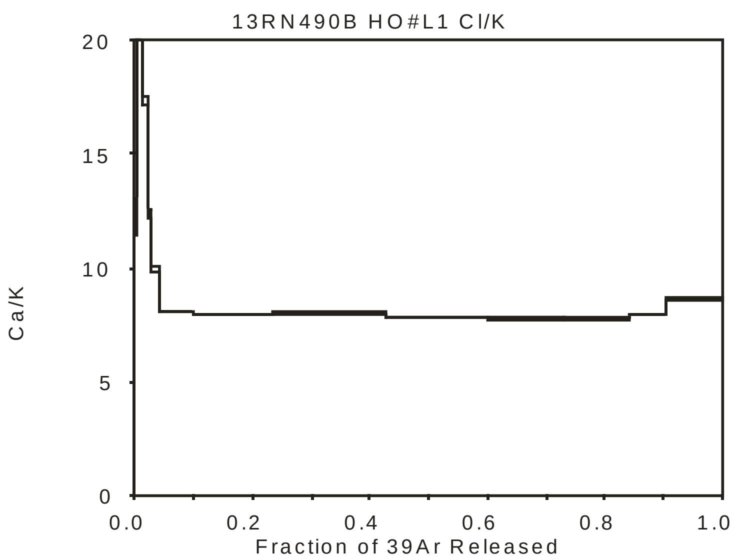
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Ca/K
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10
5
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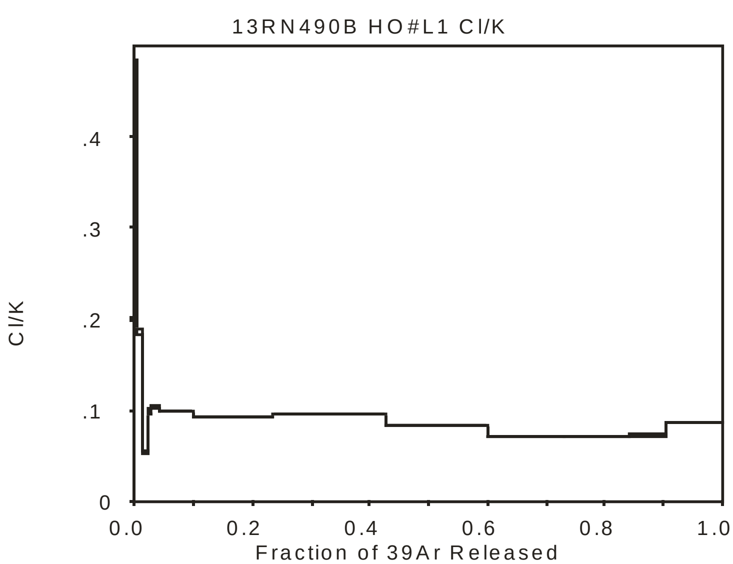
1.0
Fraction of 39Ar Released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Cl/K
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.3
.2
.1
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0.2
0.4
0.6
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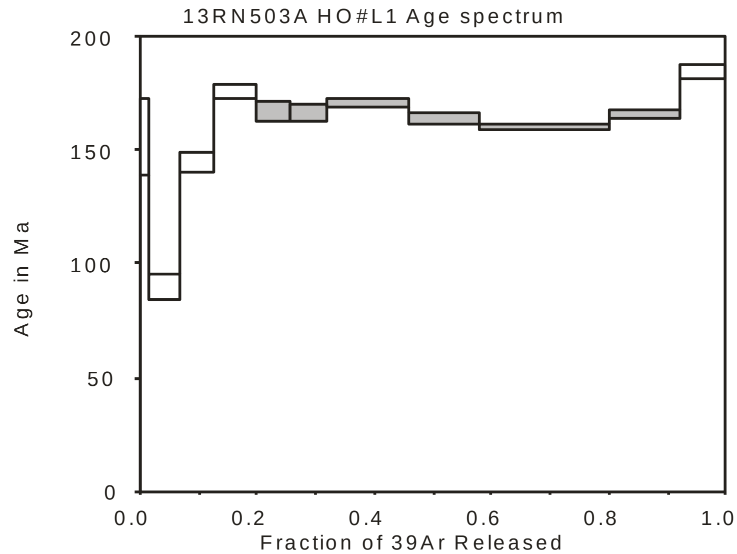
1.0
Fraction of 39Ar Released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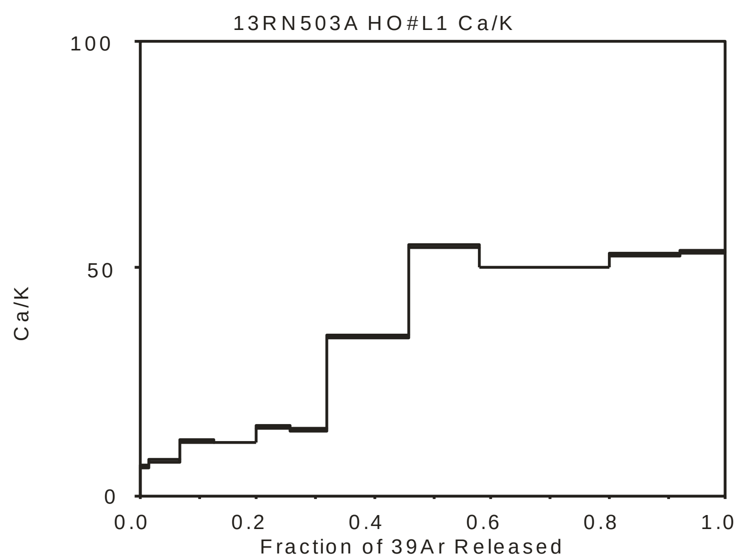
13RN503A HO#L1 Ca/K
Ca/K
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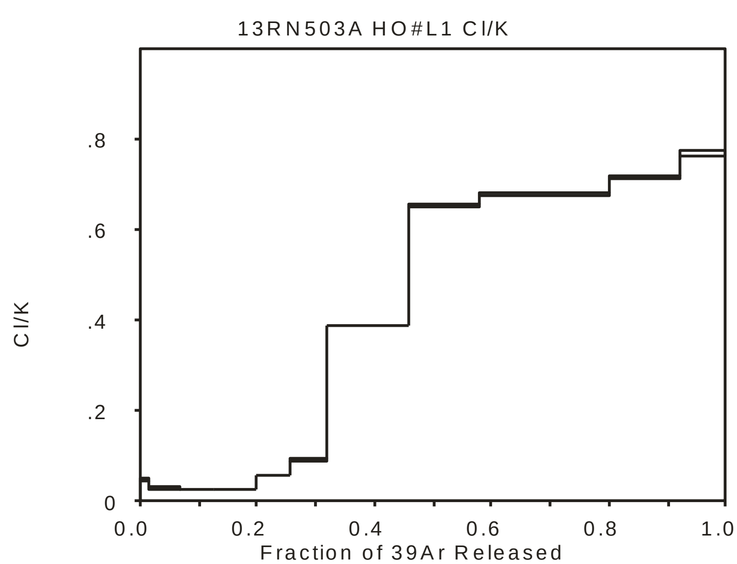
13RN503A HO#L1 Cl/K
Cl/K
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.6
.4
.2
0
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released