STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES

Alaska Geologic Materials Center

Data Report #426

Benowitz, J.A. and Layer, P.W., 2014, 40Ar/ 39Ar step heat analysis of core from the N. Kalikpik Test Well #1

Spread sheet available for download
Received May 2014

$^{40}Ar/^{39}Ar$ step heat analysis of core from the N. Kalikpik Test Well #1

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May 15, 2014

Summary of the Analysis

For ^{40}Ar/^{39}Ar analysis, two “tephra” samples was submitted to the Geochronology laboratory at UAF where it was crushed, sieved, washed and hand-picked for “glass” mineral phases. The monitor mineral MMhb-1 (Samson and Alexander, 1987) with an age of 523.5 Ma (Renne et al., 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 8b of the uranium enriched research reactor of McMaster University in Hamilton, Ontario, Canada for 150 megawatt-hours.

Upon their return from the reactor, the sample and monitors were loaded into 2 mm diameter holes in a copper tray that was then loaded in a 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 et al. (1981), Layer et al. (1987) and Layer (2000). Argon purification was achieved using a liquid nitrogen cold trap and a SAES Zr-Al getter at 400C. The samples were analyzed in a VG-3600 mass spectrometer at the Geophysical Institute, University of Alaska Fairbanks. 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 40Ar, 3 × 10218 mol 39Ar, 9×10^{-18} mol 38Ar and 2×10^{-18} mol 36Ar, which are 10–50 times smaller than the sample/standard volume fractions. Correction factors for nucleogenic interferences during irradiation were determined from irradiated CaF2 and K2SO4 as follows: (39Ar/37Ar)Ca = 7.06×10^{-4}, (36Ar/37Ar)Ca = 2.79×10^{-4} and (40Ar/39Ar)K = 0.0297. Mass discrimination was monitored by running calibrated air shots. The mass discrimination during these experiments was 0.8% per mass unit. While doing our experiments, calibration measurements were made on a weekly– monthly basis to check for changes in mass discrimination with no significant variation seen during these intervals.

A summary of all the ^{40}Ar/^{39}Ar results is given in Table 1, with all ages quoted to the ± 1 sigma level and calculated using the constants of Renne et al. (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% of the total gas release and are within two standard deviations of each other (Mean Square Weighted Deviation less than 2.5).

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Table 1 Interpretive Details

Sample (ft.)	Min.	Integrated Age (Ma)	Weighted Average Age (Ma)	Plateau Information	Isochron Age (Ma)	Isochron or other Information
7039.0-1	GL?	383.8 ± 3.0	**421.1 ± 4.6***	4 of 12 fractions 24.8 % ^{39}Ar release MSWD = 1.78	—	—
7039.3-2	GL?	295.0 ± 3.2	**323.6 ± 5.1**	3 of 13 fractions 44.3 % ^{39}Ar release MSWD = 1.92	—	—

Samples analyzed with standard MMhb-1 an age of 523.5 Ma.
Most robust age in **bold**.
*Does not meet the criteria of a plateau age. Weighted average age reported.

Overall Discussion:

Two tephra samples from the Pebble Shale (recovered from drill cores) were submitted to the University of Alaska Fairbanks geochronology facility for $^{40}Ar/^{39}Ar$ dating analysis. Both samples had Ca/K ratios (<1) that are more commonly associated with muscovite than glass. The glass in these tephras has likely been fully vitrified leaving behind fine-grained detrital muscovite. This explanation fits the age determinations, which are not in line with the stratigraphic age for the Pebble Shale (lower Cretaceous). The ages for these Pebble Shale mineral separates are similar to both detrital and primary regional Brooks Range muscovite ages obtained from bedrock outcrop samples (~332 Ma, Toro et al., 1998; ~420 Ma Toro personal comm.).

70390-1 Glass (GL)

A glass (?) separate from sample **70390-1** was analyzed. The analysis produced a stepping up age spectrum, which are associated with loss/alteration. The criteria for a plateau age determination were not met; hence a weighted average age determination is reported. The integrated age (383.8 ± 3.0 Ma) is not within error of the weighted average age (421.1 ± 4.6 Ma). We prefer the weighted average age of **421.1 ± 4.6 Ma** because of the documented loss. No isochron age determination was possible due to the generally homogenous radiogenic content of the steps used for the weighted average age determination.

70390-1 Glass (GL)

A glass (?) separate from sample **7039.3-2** was analyzed. The analysis produced a humped shaped age spectrum, which are associated with loss/alteration. The criteria for a plateau age determination were not met, hence a weighted average age determination is reported. The integrated age (295.0 ± 3.2 Ma) is not within error of the weighted average age (323.6 ± 5.1 Ma). We prefer the weighted average age of **323.6 ± 5.1 Ma** because of the documented loss. No isochron age determination was possible due to the generally homogenous radiogenic content of the steps used for the weighted average age determination.

Main Table

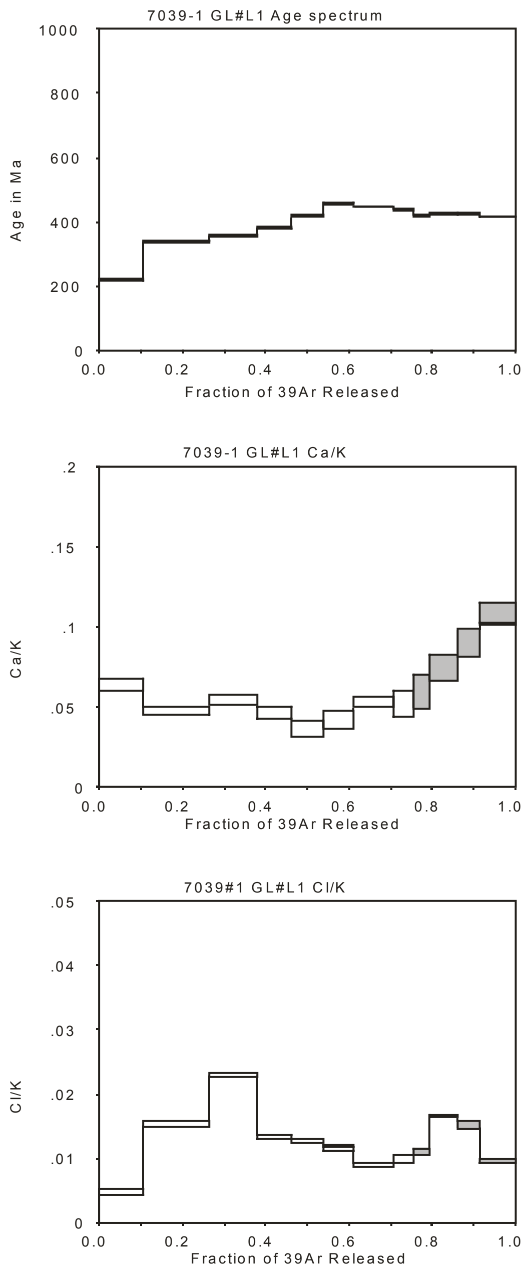
Table 1: $^{40}Ar/^{39}Ar$ step heating results.

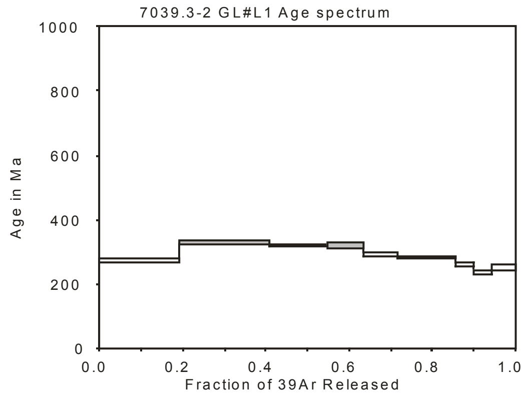
Main Figure

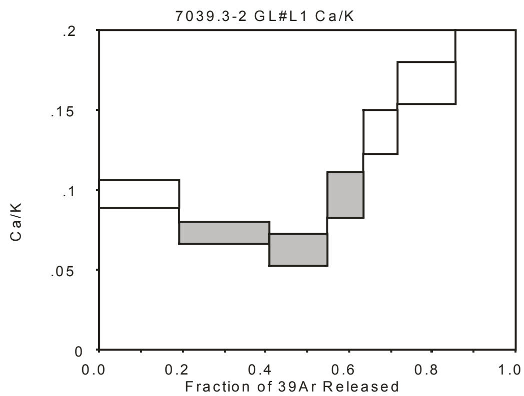
Figs: $^{40}Ar/^{39}Ar$ age spectra, Ca/K and Cl/K ratios for the samples from the Pebble Shale. Steps filled in grey were used for plateau age determinations. Steps filled in red were used for isochron determinations.

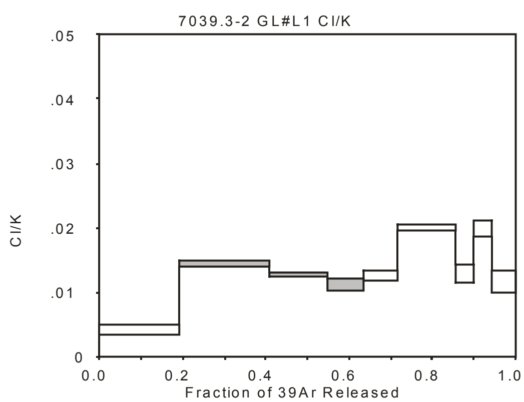
Supplemental Tables

Table A1: $^{40}Ar/^{39}Ar$ laser step heat data.


7039-1 GL#L1 Age spectrum
Age in Ma
1000
800
600
400
200
0
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released
7039-1 GL#L1 Ca/K
Ca/K
.2
.15
.1
.05
0
Fraction of 39Ar Released
7039#1 GL#L1 Cl/K
Cl/K
.05
.04
.03
.02
.01
0
Fraction of 39Ar Released


7039.3-2 GL#L1 Age spectrum
Age in Ma
1000
800
600
400
200
0
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released


7039.3-2 GL#L1 Ca/K
Ca/K
.2
.15
.1
.05
0
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of 39Ar Released


7039.3-2 GL#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