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$^{40}Ar/^{39}Ar$ AGES OF ROCKS COLLECTED FROM THE PASSAGE CANAL AREA, SEWARD D-7 QUADRANGLE, ALASKA

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Jeffrey A. Benowitz[1], Paul W. Layer[1], Alicja Wypych[2], and Lawrence K. Freeman[3]

INTRODUCTION

In 2016, geologists from the Alaska Division of Geological & Geophysical Surveys (DGGS) lead two field trips in the Turnagain Arm and Passage Canal area hosted as part of the Association of American State Geologists annual meeting in Girdwood, Alaska. To illustrate features associated with south-central Alaska's Mesozoic accretionary complex and Paleogene near-trench intrusions and associated orogenic gold deposits, the field trip toured pertinent road-accessible outcrops identified in published field trip guides (Clark, 1981; Winkler and others, 1984; Bradley and others, 1997; Bradley and others, 2000, Bradley and Miller, 2006; Karl and others, 2011; Karl and others, 2015). The samples collected for this report are from a single outcrop of a mineralized near-trench intrusion exposed in a road cut near Whittier, Alaska. The outcrop is the best road-accessible occurrence of a Tertiary near-trench pluton in the region and is commonly visited by field trips, yet no prior geochronological data from this outcrop have been published.

The $^{40}Ar/^{39}Ar$ step-heating geochronology results presented herein improve our understanding of the geology and structural history of intrusive rocks in the Turnagain Arm and Passage Canal area. Two chronologically distinct intrusive bodies, the Paleogene Sanak–Baranof belt and the Eshamy-suite, are documented in the upper Cook Inlet area. The Paleogene Sanak–Baranof belt of intrusive rocks was recognized and named by Hudson and others (1979) and is regarded as marking the site of a trench-ridge-trench triple junction, which migrated from west to east (Bradley and others, 2003). The forearc setting of gold occurrences in the Paleogene Sanak–Baranof belt is unusual, $^{40}Ar/^{39}Ar$ dating of sericite from a number of gold lodes has shown that mineralization took place between 57 and 49 Ma (Haeussler and others, 1995); essentially coeval, and by implication, cogenetic with the near-trench magmatism. Eshamy-suite plutons comprise a distinct suite of near-trench intrusions in western Prince William Sound (Nelson and others, 1985; Madsen and others, 2006, Johnson, 2012). Eshamy suite plutons have yielded U/Pb ages of 37.6 ± 0.5 to 39.9 ± 0.9 Ma (Gillis, DGGS unpublished data; Johnson, 2012) and K/Ar ages of 34.3 ± 1.7 to 37.6 ± 1.0 Ma (Wilson and others, 2015; Lanphere, 1966; Nelson and others, 1985). Geochronological analysis of the two samples in this report confirms that the Whittier road-cut intrusion and veins are coeval (53.0 ± 0.3 Ma and 50.9 ± 0.2 Ma, respectively) with the Sanak–Baranof suite and not the younger, Eshamy plutonic suite.

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The analytical data tables associated with this report are available in digital format as comma-separated value (CSV) files. See accompanying metadata file for additional details about the organization of the digital files. All files can be downloaded from the DGGS website (http://doi.org/10.14509/29721).

Samples collected during this project, as well as laboratory sample rejects and pulps, will be stored at DGGS for the duration of the project and will be available for public viewing upon request. Once the project concludes, the samples and pulps will be stored at the Alaska Geological Materials Center in Anchorage in late 2017.

DOCUMENTATION OF METHODS

SAMPLE COLLECTION

Fresh, unweathered rock samples were collected from surface outcrops; samples were selected based on the presence of sufficiently large crystals. Before processing, the samples were examined under a binocular microscope, or thin sections were prepared and scrutinized, to avoid analyzing altered mineral phases.

Location data were collected using a Nexus 5x smartphone operating the Avenza Maps 2.0 Application (AvenzaMaps.com). Data were merged into an ArcGIS geodatabase. Location error for this process is undocumented. However, locations were visually checked and corrected using USGS and multiple imagery files in ArcGIS, and errors are estimated to be within 20 meters. Latitude and longitude are reported in the WGS84 datum.

SAMPLE PREPARATION

Samples were submitted to the geochronology laboratory at the University of Alaska Fairbanks (UAF) for $^{40}Ar/^{39}Ar$ analysis. Laboratory staff crushed, sieved, washed, and hand-picked pure sericite mineral phase separates. 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.

ANALYTICAL METHODS

Upon return from the reactor, the samples and neutron flux monitors were loaded into 2-mm-diameter holes in a copper tray that 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) and Layer and others (1987). 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 Geophysical Institute, UAF. 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-minute, 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. While doing experiments, calibration measurements were made on a weekly to monthly basis to check for changes in mass discrimination, with no significant variation seen during these intervals.

DISCUSSION

16LF002A

Felsite dike: white on fresh surface, tan weathering; fine-grained, equigranular. Mineralogy includes: 55 percent, 1-mm-diameter anhedral feldspar; 20 percent subhedral white mica; 10 percent euhedral amphibole(?); 10 percent, 2- to 5-mm-diameter, subhedral feldspar; and about 5 percent, cubic-shaped vugs formed from weathered-out pyrite(?).

A homogeneous white mica separate from sample 16LF002A was analyzed. The integrated age (52.8 ± 0.3 Ma) and the plateau age (53.0 ± 0.3 Ma) are within error. We prefer the plateau age of 53.0 ± 0.3 Ma for sample 16LF002A because of the high atmospheric content of the lower temperature step-heat release. No isochron age determination was possible because of the homogenous radiogenic content of the release.

The white mica selected from this sample comprises 1 mm books and flakes that appear to be modal white mica rather than alteration sericite and thus would indicate the cooling age of the dike.

16LF002B

Comb-textured quartz vein up to 20 cm wide with foliated white mica on margin; locally pyrite seam is present on vein margin.

A homogeneous sericite separate from sample 16LF002B was analyzed. The age-stepping-up nature of the gas release is indicative of a sample that experienced loss (modeled to be ~13 percent), with the higher-temperature/more-retentive gas release more accurately reflecting the true age of the mineral phase. The integrated age (49.2 ± 0.1 Ma) and the plateau age (50.9 ± 0.2 Ma) are not within error. We prefer the plateau age of 50.9 ± 0.2 Ma for sample 16LF002B because of the documented loss. No isochron age determination was possible because of the documented loss.

The sericite selected from this sample comprises 1 mm flakes occurring interstitial to comb-textured quartz in a hydrothermal vein. The age represents a hydrothermal age for the vein and indicates that alteration post-dated crystallization of the enclosing granite by approximately 2 million years.

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To comply with Alaska Railroad Corporation regulations and safely collect these samples, DGGS staff and field trip participants obtained written permission from the Alaska Railroad Corporation to cross the Right of Way. The sample collection and analyses were paid for with State of Alaska general funds. Sue Karl of the U.S. Geological Survey, Peter Oswald of the University of Alaska Anchorage, and Joe

Kurtak provided outcrop-location information, discussion of geologic context, and assistance with the field trip.

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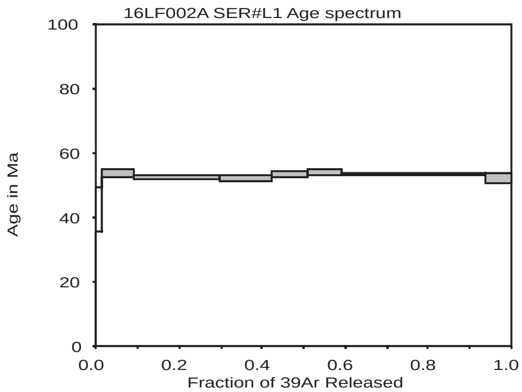
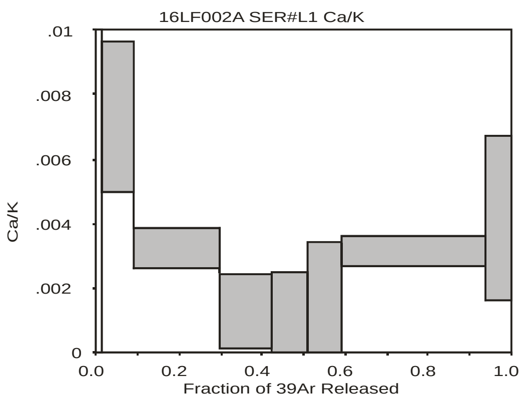
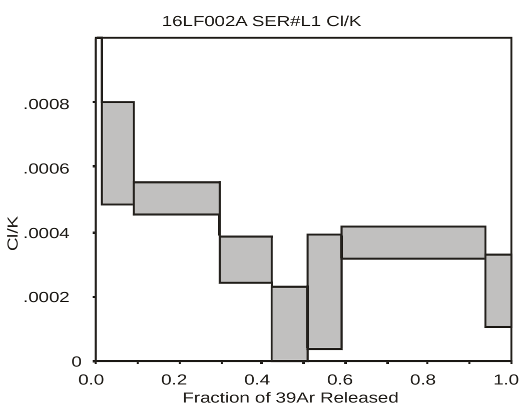
APPENDIX: PLOTS OF $^{40}Ar/^{39}Ar$ AGE SPECTRA AND Ca/K AND Cl/K RATIOS

Gray-shaded steps were used for plateau age determinations.

16LF002A







16LF002B