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QUADRANGLE, ALASKA**

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⁴⁰AR/³⁹AR DATA FROM THE NORTHERN FAIRBANKS MINING DISTRICT, CIRCLE QUADRANGLE, ALASKA

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INTRODUCTION

This report presents ⁴⁰Ar/³⁹Ar step-heating geochronology results for igneous and metamorphic rocks from the Alaska Division of Geological & Geophysical Surveys' (DGGS) geologic mapping project in the northern Fairbanks mining district, covering parts of the Circle A-4, A-5, B-4, and B-5 quadrangles, Alaska (Athey and others, 2022). Field samples were collected by the DGGS Mineral Resources Section during detailed a geologic mapping campaign in June 2007. In addition to analytical data compiled in the geologic map for this area (Athey and others, 2022), other DGGS publications supporting geologic mapping in the northern Fairbanks mining district include geophysical data (Burns and others, 2019), geochemical data (Athey and others, 2008), and a planned U-Pb detrital zircon age report. Data associated with this report is available at <https://doi.org/10.14509/31472>.

The northern Fairbanks mining district map area lies within the Yukon-Tanana Upland in rocks that we interpret to correlate with the Cambrian to Late Proterozoic Fairbanks schist (Newberry and others, 1996) and the Wickersham Grit unit (Foster and others, 1983; Weber and others, 1988; Weber and others, 1992). These rocks are intruded by several phases of plutonism, of which two occur in the map area: Tertiary and Cretaceous plugs, dikes, and sills with characteristic geochemical signatures (Athey and others, 2022). The Cretaceous intrusions are regionally associated with placer- and lode-gold mines and occurrences (Newberry and others, 1995). The age data in this report constrain the crystallization ages of igneous rocks, potential timing of mineralization, and the cooling histories of metamorphic rocks in the map area.

DOCUMENTATION OF METHODS

Sample Collection

Samples from surface outcrops were collected by DGGS field geologists and were selected for dating based on the priority of information needed, presence of sufficiently large crystals appropriate for dating, and minimal weathering. Sample location coordinates were obtained using recreational-grade GPS units, with a typical reported accuracy of about 10 meters. Coordinates are reported using the WGS84 datum. Hand samples and (or) thin sections were examined to select unaltered mineral phases before sample preparation.

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Sample Preparation

Five rock samples were submitted to the Geochronology Laboratory at the University of Alaska Fairbanks (UAF) for $^{40}\text{Ar}/^{39}\text{Ar}$ analysis. The samples were crushed, sieved to either 100–250- or 250–500-micron size fractions, and handpicked for biotite, hornblende, and sericite mineral phases. The monitor mineral MMhb-1 (Samson and Alexander, 1987) with an age of 513.9 Ma (Lanphere and Dalrymple, 2000) 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 at McMaster University in Hamilton, Ontario, Canada, for 20 megawatt-hours.

Analytical Methods

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 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 a SAES Zr-Al getter at 400°C. 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). System blanks generally were 2×10^{-16} mol ^{40}Ar and 2×10^{-18} mol ^{36}Ar , which are 10 to 50 times smaller than fraction volumes. Mass discrimination was monitored by running both calibrated air shots and a zero-age glass sample. These measurements were made on a weekly to monthly basis to check for changes in mass discrimination, with no significant variation observed during these intervals.

RESULTS AND SAMPLE DESCRIPTIONS

A summary of all the $^{40}\text{Ar}/^{39}\text{Ar}$ results is provided in the accompanying data tables, with all ages quoted to the ± 1 -sigma level and calculated using the constants of Steiger and Jaeger (1977). The integrated age is the age given by the total gas measured and is equivalent to a potassium-argon (K-Ar) age. Age spectra, Ca/K, and Cl/K plots are included in the appendix. 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 less than ~ 2.7). When a spectrum did not provide a plateau age under the above definition, a weighted mean age was calculated. Below we provide additional discussion of the results of each age analysis, noting our preferred age determination.

07MBW335A – Porphyritic syenogranite

A homogeneous **biotite** separate from sample 07MBW335A was analyzed. The integrated age (57.3 ± 0.2 Ma) and the plateau age (56.8 ± 0.2 Ma) are within uncertainty. We prefer the plateau age of **56.8 ± 0.2 Ma** for sample 07MBW335A because of the minor atmospheric content of the two lowest-temperature step releases. This age represents the cooling age of the intrusion.

Sample 07MBW335A is from a porphyritic intrusion interpreted geochemically as syenogranite. The sample is pinkish gray and contains biotite phenocrysts.

07JEA299A – Altered monzogranite

A homogeneous **sericite** separate from sample 07JEA299A was analyzed. The integrated age (72.4 ± 0.4 Ma) and the plateau age (72.1 ± 0.4 Ma) are within uncertainty. We prefer the plateau age of **72.1 ± 0.4 Ma** for sample 07JEA299A as most representative of the time of argon closure for this mineral phase. The last heating step (1.4 percent release) jumps up to 86 Ma, indicating that the sample lost argon after pluton emplacement. This argon loss was likely caused by a subsequent heating event rather than low-temperature alteration since the remaining argon releases during step heating meet the statistical criteria for a plateau. Pluton emplacement is therefore interpreted to be older than 86 Ma.

Sample 07JEA299A was collected from an altered dike. The sample was identified in the field as quartz monzonite and later identified as monzogranite through geochemical analysis. The sample is yellowish-white to pink and porphyritic, with feldspar and quartz phenocrysts in a sericite-altered matrix. Associated mineralization includes fine-grained sulfides (probably arsenopyrite).

07Z161A – Granodiorite

A homogeneous **biotite** separate from sample 07Z161A was analyzed. The integrated age (90.9 ± 0.3 Ma) and the plateau age (91.2 ± 0.3 Ma) are within uncertainty. We prefer the plateau age of **91.2 ± 0.3 Ma** for sample 07Z161A because of the higher precision, as the first age step (0.6 percent release) shows argon loss and potential resetting of the sample to 58 Ma. The plateau age represents the cooling age of the pluton.

Sample 07Z161A was identified as granodiorite through geochemical analysis. The sample is dark gray, with 40 percent biotite (<6 mm long) phenocrysts in a very fine-grained groundmass. The sample also contains quartz xenoliths up to 3 cm long.

07Z159A – Monzogranite

A homogeneous **hornblende** separate from sample 07Z159A was analyzed. The integrated age (93.6 ± 0.5 Ma) and the plateau age (92.5 ± 0.5 Ma) are within uncertainty. We prefer the plateau age of 92.5 ± 0.5 Ma for sample 07Z159A, which represents the cooling age of the pluton.

Sample 07Z159A was identified as monzogranite through geochemical analysis. The sample is white to light gray, has a porphyritic texture, with 10 percent feldspar up to 3 mm and 30 percent hornblende and biotite.

07Z417A – Semischist

A homogeneous **hornblende** separate from sample 07Z417A was analyzed. The integrated age (145.4 ± 0.8 Ma) and the weighted mean age (144.0 ± 4.0 Ma) are within uncertainty. We prefer the weighted mean age of 144.0 ± 4.0 Ma for sample 07Z417A, which represents the age of cooling below the closure temperature of hornblende.

A homogeneous **biotite** separate from sample 07Z417A was also analyzed. The integrated age (95.7 ± 0.4 Ma) and the plateau age (101.7 ± 0.6 Ma) are within uncertainty. We prefer the plateau age of 101.7 ± 0.6 Ma for sample 07Z417A, which represents the age of cooling below the closure temperature of biotite.

Sample 07Z417A was identified as a hornblende quartz garnet white mica biotite feldspar semischist from unit **ЄZq** of Athey and others (2022).

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APPENDIX: PLOTS OF $^{40}\text{Ar}/^{39}\text{Ar}$ AGE SPECTRA AND CA/K AND CL/K RATIOS





