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# DATA TABLES RELATED TO GEOLOGY AND GOLD MINERALIZATION IN THE RICHARDSON DISTRICT, EAST-CENTRAL ALASKA

by

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Note: This report (including all analytical data and tables) is available in digital format from the DGGS web site (http://wwwdggs.dnr.state.ak.us) at no charge. The digital data is available as PDF files and Excel spreadsheets.

# DATA TABLES RELATED TO GEOLOGY AND GOLD MINERALIZATION IN THE RICHARDSON DISTRICT, EAST-CENTRAL ALASKA

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## INTRODUCTION

The data included in this report were published by Garth Graham as part of his Master of Science thesis at the University of Alaska Fairbanks in 2002 (Graham, 2002). Diana Jozwik compiled the data and selected text for use in this publication to enable easier public access to the data. Data tables shown here were renumbered and formatted to fit this report. Selected informative text was taken from the thesis, merged, and edited for content. More complete discussion of the subjects covered in this report is included in Graham's thesis, available at the University of Alaska Fairbanks (QE84.A4 G73 2002 AK). The abstract from the thesis is given below:

## ABSTRACT

*"The Richardson district contains multiple granitic units intruding gneiss and schist. The Bald Knob prospect contains gold-bearing quartz veins with the assemblage Bi–Au–hedleyite and high methane fluid inclusions. These features indicate very low $f_{S2}$–$f_{O2}$ conditions, lower than any reported for 90 Ma interior Alaska gold systems, including the nearby Democrat and Buckeye prospects.*

*The Bald Knob and Democrat Lode prospects returned $^{40}Ar/^{39}Ar$ ages of ~104 and ~90 Ma, respectively. Peraluminous dikes possess collisional tectonic signatures and interpreted age of 114 Ma. Younger dikes and a 3 km$^2$ granite body possess arc-type compositions and $^{40}Ar/^{39}Ar$ ages of ~90 Ma.*

*Garnet–biotite geothermometry on metamorphic rocks indicates low-P regional metamorphism (550–600ºC; 3–4 kb) and vertical movement between adjacent fault blocks. Highest temperatures are in the fault block hosting the Bald Knob prospect, suggesting it represents the deepest mineralization exposure in the area and is most proximal to a causative pluton."*

Graham's thesis describes the results of geologic mapping and sample analyses from the Richardson district, east-central Alaska, west-central Big Delta B-5 Quadrangle. The objective of the thesis was to create a better geologic map of a portion of the Richardson district and to propose a model for the geological evolution of the Richardson area. During the summers of 1999 and 2000, the study area was mapped on foot; more than 400 field stations were recorded and more than 300 rock samples collected. Location data (in UTM coordinates with a Clark 1866, NAD27, UTM zone 6 projection), rock type, and method of analysis for each sample are shown in table 1. Magnetic susceptibility measurements, included in table 1, were made with a Kappameter model KT-6 magnetic susceptibility meter. Multiple measurements were routinely made on a single sample and the results averaged.

## ANALYTICAL METHODS AND RESULTS

Placer Dome Exploration (PDX) conducted a large-scale soil sampling program in the area in 1999 and 2000. Hand samples were also collected from various locations during concurrent geologic mapping. The geochemical results from these activities were used to determine subsequent core drilling in both 1999 and 2000. Thirty thin sections, 15 doubly-polished from vein samples, 12 polished sections, and one white mica separate were selected from the core drilled by PDX during 1999 and 2000. This core was halved with a rock saw with one-half of each interval sent for assay and the other retained for additional studies.

Modal estimates were conducted on 36 metamorphic and four igneous hand specimens that were etched and stained for quartz, plagioclase, and K-feldspar using the technique of Ruperto and others

(1964). K-feldspar assumed a bright yellow color, plagioclase stained red, and quartz remained unstained. Modal estimates were made either by standard point-counting using a minimum of 100 points, or by estimation by comparison to standard abundance charts. Modal abundances are listed in tables 2 and 3.

Major- and minor-oxide analyses were performed by Bondar-Clegg, Incorporated, Vancouver, British Columbia, Canada, on 39 rock samples, including 13 from drill core. Samples were crushed and pulverized in Fairbanks before pulps were shipped to Vancouver. Major- and minor-oxide values were obtained using lithium results, including normative values, are listed in tables 4, 5 and 6. Trace-element analyses for 34 of the samples were performed on pressed pellets at the University of Alaska Fairbanks on splits of the pulverized samples using a Rigaku energy-dispersive XRF and a routine created by Rainer Newberry (described in Cameron, 2000). The results of 16 of the samples are listed in tables 5 and 7. Replicate and secondary standard analyses for commercial and UAF XRF analyses indicate major oxides are accurate to within 2 percent of the amount present, while trace elements are accurate to within 5–10 percent of the amount present (Cameron, 2000).

Microprobe data collected on biotite, garnet, white mica, and K-feldspar were processed using the MacIntosh Geothermobarometry program GTB (Spear and Kohn, 1999). Temperatures were calculated for 12 different garnet–biotite distribution models. Of these 12, those of Perchuk and Lavrenteva (1984) and Kleeman and Reinhardt (1994) with Berman (1990) produced similar, consistent temperatures intermediate to those of other models and were selected as most appropriate for biotite–garnet thermometry. Pressures were estimated based on the calculated temperatures, the aluminosilicate stability diagram of Holdaway (1971), and several compositional-based geobarometers (Spear, 1993). Geothermometry data are presented in table 8.

Microprobe analyses were performed on six polished sections of gneiss and one polished section from a gold-bearing vein, using the Cameca SX-50 electron microprobe and Probe for Windows software at the University of Alaska Fairbanks. Silicate compositions were measured using a 10 micron beam at 15 nA on wavelength-dispersive spectrometers. Well-characterized natural and synthetic specimens were employed as standards. On-peak counts were collected for 10 seconds and background counts were collected for 5 seconds. Five points were selected for each silicate. These data were ZAF (atomic mass, absorbance, and fluorescence) corrected and poor-quality results were removed from the data set. Opaque minerals, including gold and bismuth, were identified in the gold-bearing vein using the EDS with a standardless analysis routine. Microprobe analyses are presented in table 9.

Fluid inclusion experiments were performed at the USGS facility in Denver, Colorado, using a Linkam heating/freezing stage cooled with liquid nitrogen. All heating and cooling measurements were computer controlled, with standard-based calibrations performed prior to each session. Chips of a section up to 3 $mm^2$ were taken from eight doubly-polished sample sections, 100 to 150 microns thick, and analyzed individually. The chips, attached by glue to the slide, were removed from the section using acetone. Heating and cooling measurements were performed using Linksys, a Windows-driven program, which has a precision of 0.1° Celsius. The low-temperature measurements included $CO_2$ and clathrate melting temperatures. All measurements except for final homogenization were performed systematically on each inclusion before moving on to the next. After several inclusions were measured, final homogenization temperatures were measured for as many inclusions as possible. Final homogenization observations were made for surrounding inclusions where possible. Once stretching of an inclusion was indicated (by non-repeatable heating experiments), no more homogenization measurements were collected from that chip. Fluid inclusion data are presented in tables 10, 11, and 12.

Five samples were dated using the $^{40}Ar/^{39}Ar$ technique, as described in detail by Douglas (1996). The samples were irradiated for 20 megawatt hours in a reactor at McMaster University along with standard sample MMHB-1 with age 513.9 Ma. The standard is used to estimate J, the irradiation parameter and the flux gradient of the reactor. The irradiated samples were then analyzed in the mass spectrometer at the University of Alaska Fairbanks geochronology laboratory, using an $^{40}Ar/^{39}Ar$ step heating routine 39–40 days after irradiation. The measured argon isotopes were corrected for mass discrimination as well as for interference of Ca, K, and Cl produced from the reactor. Blanks (inlets) were run to determine background levels of argon, and measurements were corrected for the background argon. Ages are quoted with a ±1 sigma level and calculated using the constants of Steiger and Jaeger

(1977). Argon dating results are presented in table 13. The proposed geological events for the Richardson area, based on the radiometric dating, are presented in table 14. Table 15 lists the $^{40}Ar/^{39}Ar$ step-heating results and data.

## MAJOR CONCLUSIONS TAKEN FROM THE THESIS

1. The Richardson area contains two previously unmapped igneous units: the Gold Run Intrusion and felsic dike swarms. The age and composition of the Gold Run Intrusion is indistinguishable from 'classic' 90 Ma Alaskan volcanic arc-related plutons, the closest of which is the Birch Lake pluton. In contrast, the felsic dikes are fine-grained leucocratic granites with significantly older (~114 Ma) ages with syn-collisional trace-element signatures and a shallow (~0.5 km) depth of emplacement.
2. Geothermobarometric model temperatures and pressures for gneiss samples fall above the geothermal gradient, ranging from 560 to 620ºC and 3–4 kbars, respectively, that contrast with similar temperatures but higher pressures recorded in Fairbanks-area rocks. However, these values do not necessarily require different peak metamorphic conditions. Rather, rocks in the Richardson area apparently experienced a younger recrystallization episode at relatively high temperature and low pressure, possibly related to collisional tectonics.
3. Sericite from the selvage of a gold-bearing quartz vein yielded a $^{40}Ar/^{39}Ar$ interpreted age of ~105 Ma, significantly older than the ~90 Ma event age of the Gold Run Intrusion and those commonly associated with most other gold systems in interior Alaska, including the Democrat Dike. Petrography and fluid inclusion studies indicate that the ore-bearing fluid was highly reduced (methane in fluid inclusions) and had low $fS_2$ (lack of sulfide minerals in the presence of native bismuth, hedleyite, and gold). Temperature of formation is estimated between 400 and 500ºC. The mineralogy and fluid inclusion chemistry associated with gold deposition is radically different from the younger Democrat lode deposit. The ~105 Ma age suggests a possibility for a genetic relationship between gold mineralization and emplacement of the felsic dikes.

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Table 1. List of grab samples, approximate locations, assigned rock types and analyses. T.S. = thin section, P.S. = polished section, WRA = whole rock analysis, Geotherm = microprobe, geothermobarometric analysis, FI = fluid inclusion study, Ar/Ar = $^{40}Ar/^{39}Ar$ radiometric dating. Blank sample# indicates observations were recorded but no sample was collected. Keys to rock unit abbreviations are listed at end of this table on page 12

| **Sample#** | **UTMX** | **UTMY** | **Rock type** | **Mag. Susc. (*10^-3 SI)** | **T.S.** | **P.S.** | **WRA** | **Geotherm** | **FI** | **Ar/Ar** |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 537115 | 7137230 | MTR | 0.02 | | | | | | |
| **2** | 537015 | 7137040 | MTR | | | | | | | |
| **3** | 537015 | 7137000 | BLG | | | | | | | |
| **4** | 536900 | 7136900 | MTR | | | | | | | |
| **5** | 536900 | 7136900 | MI | | | | | | | |
| **6** | 536875 | 7136850 | MTR | | | | | | | |
| **7** | 536830 | 7136780 | MI | | | | | | | |
| **8** | 536940 | 7136715 | MTR | | | | | | | |
| **9** | 537200 | 7136920 | BLG | | | | | | | |
| **10** | 537220 | 7137020 | BLG | | | | | | | |
| **11** | 537400 | 7137000 | MI | 0.25 | | | | | | |
| **12** | 537400 | 7137050 | MI | | | | | | | |
| **14** | 537100 | 7137300 | MTR | | | | | | | |
| **15** | 537100 | 7137600 | MTR | | | | | | | |
| **16** | 537200 | 7135950 | MTR | 0.15 | | | | | | |
| **17** | 537050 | 7135850 | MI | 0.14 | | | | | | |
| **17** | 537050 | 7135850 | MTR | | | | | | | |
| **18** | 537030 | 7135830 | QFR | | | | | | | |
| **19** | 537100 | 7135800 | HFL | 0.2 | | | | | | |
| **19** | 537100 | 7135800 | BLG | 0.02 | | | | | | |
| **20** | 537150 | 7135800 | MI | | | | | | | |
| **21** | 537200 | 7135700 | MTR | | | | | | | |
| **22** | 537170 | 7135500 | GN | | | | | | | |
| **23** | 536650 | 7135830 | MTR | 0.1 | | | | | | |
| **24** | 536450 | 7135650 | MTR | | | | | | | |
| **25** | 536600 | 7135600 | BLG | | | | | | | |
| **26** | 536630 | 7134590 | MTR | 0.11 | | | | | | |
| **27** | 536850 | 7135350 | MTR | 0.15 | | | | | | |
| **28** | 536950 | 7135350 | GN | | | | | | | |
| **29** | 537050 | 7135200 | BLG | | | | | | | |
| **30** | 537100 | 7135100 | MTR | 0.12 | | | | | | |
| **31** | 537200 | 7135150 | BLG | 0.15 | | | | | | |
| **32** | 537750 | 7135300 | MTR | 0.14 | | | | | | |
| **33** | 536590 | 7136150 | MTR | | | | | | | |
| **34** | 536450 | 7135900 | FGN | | | | | | | |
| **35** | 536300 | 7135450 | MI | 0.12 | | | | | | |
| **36** | 535650 | 7134850 | SKN | 0.18 | | | | | | |
| **37** | 535450 | 7134300 | QFR | 0 | | | | | | |
| **38** | 535750 | 7134400 | GN | | | | | | | |
| **39** | 535850 | 7134450 | SCH | | | | | | | |
| **40** | 536050 | 7134350 | SGN | | | | | | | |
| **41** | 536050 | 7134400 | GN | | | | | | | |
| **42** | 536050 | 7134450 | FBQ | | | | | | | |
| **43** | 536200 | 7134600 | QFR | | | | | | | |
| **44** | 536200 | 7134800 | GN,HFL | | | | | | | |
| **45** | 536250 | 7134850 | HFL, GN | 0.3,0.15 | | | | | | |

Table 1 continued. List of grab samples, approximate locations, assigned rock types and analyses.

| Sample# | UTMX | UTMY | Rock type | Mag. Susc. (*10^-3 SI) | T.S. | P.S. | WRA | Geotherm | FI | Ar/Ar |
|---|---|---|---|---|---|---|---|---|---|---|
| **46** | 536250 | 7134850 | FGN | | | | | | | |
| **47** | 536250 | 7134850 | HFL | | | | | | | |
| **48** | 536200 | 7134950 | QFR | | | | | | | |
| **49** | 536200 | 7134950 | SGN | | | | | | | |
| **50** | 536250 | 7135500 | BLG | | | | | | | |
| **51** | 536300 | 7135350 | MTR | | | | | | | |
| **52** | 536300 | 7135150 | GN | | | | | | | |
| **53** | 536300 | 7135000 | INT | | | | | | | |
| **54** | 536300 | 7134900 | GN | 0.03 | | | | | | |
| **55** | 536330 | 7134940 | GN | | | | | | | |
| **56** | 536300 | 7134850 | GN | | | | | | | |
| **57** | 536300 | 7134780 | PEG | | | | | | | |
| **58** | 536250 | 7134750 | QFR | 0.01 | | | | | | |
| **59** | 536200 | 7134700 | QTZ | | | | | | | |
| **60** | 536200 | 7134700 | HFL | | | | | | | |
| **61** | 536300 | 7134700 | FGN | | | | | | | |
| **62** | 536300 | 7134600 | GN | | | | | | | |
| **63** | 536500 | 7134700 | GN | | | | | | | |
| **64** | 536450 | 7134750 | BLG | | | | | | | |
| **65** | 536050 | 7135100 | AMPH, GN | ---,0.15 | | | | | | |
| **66** | 535950 | 7135000 | SGN | | | | | | | |
| **67** | 535830 | 7134975 | SGN | | | | | | | |
| **68** | 535600 | 7134850 | SKN | | | | | | | |
| **69** | 535450 | 7134750 | SGN | 0.2 | | | | | | |
| **70** | 535450 | 7134700 | SGN | | | | | | | |
| **71** | 535450 | 7134450 | GGE | | | | | | | |
| **72** | 535450 | 7134450 | QTZ | | | | | | | |
| **73** | 535450 | 7134450 | QFT | | x | | x | | | |
| **74** | 535450 | 7134450 | ALT | | | | | | | |
| **75** | 535500 | 7134300 | ALT | | | | | | | |
| **76** | 535650 | 7134250 | SGN | | | | | | | |
| **78** | 535350 | 7134260 | SCH | | | | | | | |
| **79** | 535000 | 7134130 | PEG | | | | | | | |
| **80** | 534900 | 7134250 | GN | | | | | | | |
| **81** | 534800 | 7134250 | GN | 0.2 | x | | x | | | |
| **82** | 534650 | 7134250 | SGN | 0.06 | | | | | | |
| **83** | 534350 | 7134150 | SGN | 0.15 | | | | | | |
| **84** | 533800 | 7134250 | GN | 0 | | | | | | |
| **85** | 533800 | 7134450 | MI | 0.1 | | | | | | |
| **86** | 533800 | 7134550 | BLG | | | | | | | |
| **87** | 533850 | 7134550 | BLG | | | | | | | |
| **88** | 534000 | 7134650 | BLG | | | | | | | |
| **89** | 534100 | 7134850 | GN | | | | | | | |
| **90** | 534100 | 7134850 | BLG | | | | | | | |
| **91** | 534200 | 7135200 | MI | 0.1 | | | | | | |
| **92** | 534200 | 7135400 | MTR | | | | | | | |
| **93** | 534150 | 7135650 | MI | 0.09 | | | | | | |
| **94** | 534650 | 7135950 | QFR | | | | | | | |
| **95** | 534850 | 7136100 | ALT | | | | | | | |

Table 1 continued. List of grab samples, approximate locations, assigned rock types and analyses.

| Sample# | UTMX | UTMY | Rock type | Mag. Susc. (*10^-3 SI) | T.S. | P.S. | WRA | Geotherm | FI | Ar/Ar |
|---|---|---|---|---|---|---|---|---|---|---|
| **96** | 535300 | 7136450 | ALT | | | | | | | |
| **97** | 535400 | 7136400 | MI | 0.12 | | | | | | |
| **98** | 535750 | 7136650 | MI | | | | | | | |
| | 536000 | 7136700 | BLG | | | | | | | |
| | 536350 | 7136500 | MI | | | | | | | |
| **100** | 535650 | 7137300 | MI | | | | | | | |
| **101** | 535550 | 7137400 | MI | | | | | | | |
| **102** | 535500 | 7137450 | MI | | | | | | | |
| **103** | 535150 | 7137900 | MI | | | | | | | |
| **104** | 535000 | 7138000 | MI | | | | | | | |
| **105** | 534750 | 7138300 | SGN | | | | | | | |
| **106** | 534750 | 7138400 | BLG | | | | | | | |
| **107** | 534750 | 7138500 | GN | | | | | | | |
| | 534850 | 7138550 | SGN | | | | | | | |
| **108** | 534350 | 7138750 | GN | | | | | | | |
| **109** | 534250 | 7138700 | MI | | | | | | | |
| **110** | 534250 | 7138700 | SGN | | | | | | | |
| **111** | 534250 | 7138750 | SGN | | | | | | | |
| **112** | 529900 | 7139200 | GN | | x | | x | | | |
| **113** | 529900 | 7139180 | GN | | | | | | | |
| **114** | 528950 | 7139150 | GN | | | | | | | |
| **115** | 528800 | 7139050 | QFR | | | | | | | |
| **116** | 528750 | 7139100 | ALT | | | | | | | |
| **117** | 528750 | 7139050 | FGN | | | | | | | |
| **118** | 528650 | 7138950 | GN | | x | x | x | | | |
| **119** | 528500 | 7138850 | ALT | | | | | | | |
| **120** | 528200 | 7138750 | ALT | | | | | | | |
| **121** | 528150 | 7138750 | RHY | | | | | | | |
| **122** | 530250 | 7139050 | GN | | x | x | | x | | |
| **123** | 530500 | 7139050 | GN | | x | x | x | | | |
| **124** | 530650 | 7139000 | GN | | x | | x | | | |
| **125** | 530750 | 7139000 | GN+QFR | | x | | x | | | x |
| **126** | 530860 | 7138960 | GN | | | | | | | |
| **127** | 530860 | 7138960 | AMPH | | | | x | | | |
| **128** | 530860 | 7138960 | GN | | x | | x | | | |
| **129** | 531150 | 7139100 | GN | | | | x | | | |
| **130** | 531350 | 7139400 | QFR | | | | | | | |
| **131** | 531350 | 7139450 | GN | | | | | | | |
| **132** | 531350 | 7139450 | QFR | | | | | | | |
| | 531350 | 7139450 | QFR | | | | | | | |
| **133** | 531600 | 7140200 | QFR | | | | | | | |
| | 531600 | 7140200 | SGN | | | | | | | |
| **134** | 531700 | 7140200 | ALT | | | | | | | |
| | 531700 | 7140200 | RHY | | | | | | | |
| | 531700 | 7140200 | FGN | | | | | | | |
| **135** | 531650 | 7140250 | SGN | | | | x | | | |
| **136** | 531750 | 7140500 | QFR | | | | | | | |
| **137** | 531750 | 7140500 | GN | | x | | x | | | |
| **138** | 531900 | 7140800 | QFR | | | | | | | |

Table 1 continued. List of grab samples, approximate locations, assigned rock types and analyses.

| Sample# | UTMX | UTMY | Rock type | Mag. Susc. (*10^-3 SI) | T.S. | P.S. | WRA | Geotherm | FI | Ar/Ar |
|---|---|---|---|---|---|---|---|---|---|---|
| **139** | 532050 | 7141000 | QFR | | | | | | | |
| | 532350 | 7140700 | QFR | | | | | | | |
| **140** | 532900 | 7140450 | QFR | | x | | x | | | |
| **141** | 533000 | 7140400 | GN | | | | | | | |
| | 533000 | 7140400 | QFR | | | | | | | |
| | 533000 | 7140400 | PEG | | | | | | | |
| **142** | 533000 | 7140400 | GN | | x | | x | | | |
| | 533050 | 7140300 | QFR | | | | | | | |
| **143** | 533100 | 7140350 | QFR | | x | | x | | | x |
| **144** | 533100 | 7140050 | GN | | | | | | | |
| **145** | 533050 | 7139750 | QFR | | | | | | | |
| **146** | 533050 | 7139700 | QFR | | | | | | | |
| **147** | 533000 | 7139350 | GN | | | | | | | |
| **148** | 532750 | 7139100 | QFR | | | | | | | |
| **149** | 532600 | 7138950 | GN | | | | | | | |
| **150** | 532600 | 7138850 | GN | | | | | | | |
| **151** | 532500 | 7138350 | QFR | | | | | | | |
| **152** | 532350 | 7138300 | GN | | | | | | | |
| **153** | 532300 | 7138200 | GN | | | | | | | |
| **154** | 532000 | 7138200 | QFR | | | | | | | |
| **155** | 531900 | 7138200 | SGN | | | | | | | |
| **156** | 531500 | 7138600 | AMPH | | | | | | | |
| **157** | 531650 | 7137500 | GN | | | | | | | |
| **158** | 531650 | 7137350 | QFR+GN+ AMPH | | x,x | | x | | | |
| **159** | 531200 | 7136800 | SGN | | | | | | | |
| **160** | 537400 | 7133650 | GN | | | | | | | |
| **161** | 537350 | 7134050 | SGN | | | | | | | |
| **163** | 537650 | 7135500 | MTR | | | | | | | |
| **164** | 537350 | 7136100 | MTR | | | | | | | |
| **165** | 537550 | 7136050 | BLG | | | | | | | |
| **166** | 537550 | 7135900 | MTR | | | | | | | |
| **167** | 537630 | 7135865 | GN | | | | | | | |
| **168** | 537800 | 7135830 | GN | | | | | | | |
| **169** | 537900 | 7135700 | GN | | | | | | | |
| **170** | 537850 | 7135500 | BLG | | | | | | | |
| **171** | 538000 | 7135400 | MTR | | | | | | | |
| **172** | 538100 | 7135250 | GN | | | | | | | |
| **173** | 538050 | 7135050 | MTR | | | | | | | |
| **174** | 538040 | 7135000 | GN | | | | | | | |
| **175** | 537750 | 7134450 | QFR | | | | | | | |
| **176** | 537525 | 7134300 | MI | | | | | | | |
| **177** | 538300 | 7138000 | MTR | | | | | | | |
| **178** | 531500 | 7134500 | MI | | | | | | | |
| **179** | 531550 | 7134450 | GN | | | | | | | |
| **180** | 531550 | 7135150 | GN | | | | | | | |
| **99GG001** | 525760 | 7141860 | PEG | -0.03 | | | | | | |
| **99GG002** | 526100 | 7142150 | MI | -0.02 | | | | | | |
| **99GG003** | 526900 | 7145500 | QFR | 0 | x | | | | | |

Table 1 continued. List of grab samples, approximate locations, assigned rock types and analyses.

| Sample# | UTMX | UTMY | Rock type | Mag. Susc. (*10^-3 SI) | T.S. | P.S. | WRA | Geotherm | FI | Ar/Ar |
|---|---|---|---|---|---|---|---|---|---|---|
| **99GG004** | 526600 | 7143900 | SGN | 0.08 | | | | | | |
| **99GG005** | 527700 | 7143350 | QFR | 0.03 | | | | | | |
| **99GG006** | 527525 | 7141700 | MI | 0.08 | | | | | | |
| **99GG007** | 527890 | 7141290 | PEG | -0.02 | | | | | | |
| **99GG008** | 528200 | 7140040 | MI | 0.1 | x | x | | | | |
| **99GG009** | 527840 | 7140035 | MI | 0.05 | x | x | | | | |
| **99GG010** | 528000 | 7140000 | MI | 0.06 | | | | | | |
| **99GG011** | 527500 | 7139950 | MI | 0.06 | | | | | | |
| **99GG012** | 527350 | 7139870 | MI | 0.15 | | | | | | |
| **99GG013** | 527350 | 7139800 | GN | 0.1 | x | | | | | |
| **99GG014** | 528200 | 7140400 | GN | 0.02 | | | | | | |
| **99GG015** | 528825 | 7139670 | GN | 0.02 | | | | | | |
| **99GG016** | 528360 | 7141760 | QFR | 0.02 | | | | | | |
| **99GG017** | 528400 | 7141750 | GN | 0.06 | | | | | | |
| **99GG018** | 528410 | 7141750 | MGN | 0.12 | x | x | | | | |
| **99GG019** | 528300 | 7140040 | MI | 0.1 | | | | | | |
| **99GG020** | 528400 | 7141900 | QFR | 0.02 | | | | | | |
| **99GG021** | 528460 | 7140900 | MI | -0.2 | | | | | | |
| **99GG022** | 528200 | 7141060 | QFR | 0 | | | | | | |
| **99GG023** | 528400 | 7141900 | AGN | -0.02 | | | | | | |
| **99GG024** | 528460 | 7142640 | SGN | 0.15 | x | x | x | | | |
| **99GG025** | 528270 | 7140760 | GN | 0.02 | | | | | | |
| **99GG026** | 528350 | 7140000 | GN | 0.05 | x | | | | | |
| **99GG027** | 528110 | 7141060 | SGN | 0.1 | | | | | | |
| **99GG028** | 528150 | 7141340 | QTZ | 0 | | | | | | |
| **99GG029** | 528400 | 7140270 | QFR | 0 | | | | | | |
| **99GG030** | 528360 | 7142050 | QFR | 0 | | | | | | |
| **99GG031** | 528490 | 7140274 | GN | 0.08 | x | | x | | | |
| **99GG032** | 528110 | 7141060 | ALT | 0 | | | | | | |
| **99GG033** | 528750 | 7140800 | MI | 0 | | | | | | |
| **99GG034** | 528480 | 7140780 | SGN | 0.06 | | | | | | |
| **99GG035** | 528290 | 7140750 | RHY | 0 | | | | | | |
| **99GG036** | 530520 | 7140200 | QFR | -0.02 | | | | | | |
| **99GG037** | 528400 | 7141750 | QFR | -0.05 | | | | | | |
| **99GG038** | 528825 | 7139670 | ALT | -0.03 | | | | | | |
| **99GG039** | 529500 | 7140700 | MTR | 0 | | | | | | |
| **99GG040** | 529050 | 7139300 | GN | 0 | x | x | x | | | |
| **99GG041** | 529550 | 7140700 | QFR | 0.04 | | | | | | |
| **99GG042** | 529800 | 7137900 | MI | -0.02 | | | | | | |
| **99GG043** | 530500 | 7140000 | GN | 0.08 | x | | | | | |
| **99GG044** | 529730 | 7139500 | BLG | 0.02 | | | | | | |
| **99GG045** | 529800 | 7138700 | GN | 0.01 | | | | | | |
| **99GG046** | 530850 | 7139630 | AMPH | 0.6 | | | | | | |
| **99GG047** | 530270 | 7140450 | PEG | -0.03 | | | | | | |
| **99GG048** | 530300 | 7142000 | QFR | 0 | | | | | | |
| **99GG049** | 530725 | 7138900 | QTZ | 0 | | | | | | |
| **99GG050** | 530530 | 7140230 | GN | 0 | | | | | | |
| **99GG051** | 530530 | 7140230 | QFR | 0 | | | | | | |
| **99GG052** | 530775 | 7138900 | QTZ | 0 | | | | | | |

Table 1 continue. List of grab samples, approximate locations, assigned rock types and analyses.

| Sample# | UTMX | UTMY | Rock type | Mag. Susc. (*10^-3 SI) | T.S. | P.S. | WRA | Geotherm | FI | Ar/Ar |
|---|---|---|---|---|---|---|---|---|---|---|
| **99GG053** | 530350 | 7140550 | AGN | 0 | | | | | | |
| **99GG054** | 531300 | 7137100 | RHY | -0.05 | | | | | | |
| **99GG055** | 531250 | 7138700 | AMPH | 0.25 | | | | | | |
| **99GG056** | 531375 | 7137700 | QFR | 0 | | | | | | |
| **99GG057** | 531250 | 7138700 | GN | 0 | | | | | | |
| **99GG058** | 531000 | 7137200 | QFR | 0 | | | | | | |
| **99GG059** | 531375 | 7137700 | FGN | 0.03 | | | | | | |
| **99GG060** | 532175 | 7138100 | QFR | 0 | | | | | | |
| **99GG061** | 530300 | 7140550 | FGN | 0 | | | | | | |
| **99GG062** | 530300 | 7140550 | QFR | 0 | | | | | | |
| **99GG063** | 528450 | 7142660 | SKN | 0.2 | | | | | | |
| **99GG064** | 531300 | 7137700 | RHY | 0 | | | | | | |
| **99GG065** | 532150 | 7137300 | QFR | 0 | | | | | | |
| **99GG066** | 532175 | 7138100 | SGN | 0.1 | | | | | | |
| **99GG067** | 528270 | 7140760 | RHY | 0.01 | | | | | | |
| **99GG068** | 535000 | 7137480 | MI | 0.06 | | | | | | |
| **99GG069** | 536630 | 7137230 | MI | 0.09 | | | | | | |
| **99GG070** | 536600 | 7137700 | MI | 0.08 | | | | | | |
| **99GG071** | 536000 | 7137300 | QFR | 0 | | | | | | |
| **99GG072** | 533910 | 7139100 | GN | 0.06 | x | | x | | | |
| **99GG073** | 535270 | 7134050 | GN | 0.22 | | | | | | |
| **99GG074** | 534900 | 7138450 | GN | 0.05 | | | | | | |
| **99GG075** | 536100 | 7137000 | MI | 0.08 | | | | | | |
| **99GG077** | 536000 | 7137750 | MTR | 0.05 | | | | | | |
| **99GG078** | 536950 | 7136200 | QFR | 0 | | | | | | |
| **99GG079** | 536100 | 7137150 | MTR | 0.03 | | | | | | |
| **99GG080** | 534100 | 7139100 | QFR | 0 | | | | | | |
| **99GG081** | 536100 | 7137150 | MI | 0.08 | | | | | | |
| **99GG082** | 537200 | 7135700 | QFR | 0 | | | | | | |
| **99GG083** | 537500 | 7135700 | MTR | 0.06 | | | | | | |
| **99GG084** | 537100 | 7134700 | MTR | 0.08 | | | | | | |
| **99GG085** | 534400 | 7133700 | SGN | 0.04 | | | | | | |
| **99GG086** | 537200 | 7135700 | MTR | 0.08 | | | | | | |
| **99GG087** | 537200 | 7135450 | ALT | 0 | | | | | | |
| **99GG088** | 537130 | 7135730 | BLG | 0.4 | | | | | | |
| **99GG089** | 538000 | 7135600 | ALT | 0 | | | | | | |
| **99GG090** | 537300 | 7133650 | MTR | 0.09 | | | | | | |
| **99GG091** | 535350 | 7133900 | QFR | 0 | | | | | | |
| **99GG092** | 536000 | 7137650 | MI | 0.06 | | | | | | |
| **99GG093** | 537200 | 7134900 | GN | 0.06 | | | | | | |
| **99GG094** | 534100 | 7139100 | GN | 0.05 | x | | x | | | |
| **99GG095** | 536150 | 7137100 | BLG | 1.3 | | | | | | |
| **99GG096** | 536600 | 7137130 | QFR | 0 | | | | | | |
| **99GG097** | 537200 | 7136800 | MI | 0.03 | | | | | | |
| **99GG098** | 537750 | 7137400 | BLG | 0.15 | | | | | | |
| **99GG099** | 537750 | 7137400 | ALT | 0 | | | | | | |
| **99GG100** | 536200 | 7137000 | MI | 0.05 | | | | | | |
| **99GG101** | 536630 | 7137230 | MI | 0.08 | | | | | | |
| **99GG102** | 536500 | 7135000 | MGN | 0.25 | | | | | | |

Table 1 continued. List of grab samples, approximate locations, assigned rock types and analyses.

| Sample# | UTMX | UTMY | Rock type | Mag. Susc. (*10^-3 SI) | T.S. | P.S. | WRA | Geotherm | FI | Ar/Ar |
|---|---|---|---|---|---|---|---|---|---|---|
| **99GG103** | 533850 | 7133250 | GN | 0.06 | | | | | | |
| **99GG104** | 536140 | 7137090 | MI | 0 | | | | | | |
| **99GG105** | 528200 | 7140050 | MI | 0.06 | x | | | | | |
| **99GG106** | 527350 | 7139800 | MI | 0.08 | x | | | | | |
| **99GG107** | 533850 | 7133090 | SKN | 0.03 | | | | | | |
| **99GG108** | 530600 | 7139900 | GN | 0.1 | | | | | | |
| **99GG109** | 530600 | 7139900 | QFR | 0.02 | | | | | | |
| **99GG110** | 528000 | 7141300 | AGN | 0.02 | | | | | | |
| **99GG111** | 536200 | 7137000 | BLG | 0.1 | | | | | | |
| | | | | | | | | | | |
| **Drill hole samples and USGS samples** | | | | | | | | | | |
| **77-187 (USGS)** | 542000 | 7139000 | GN | | x | | | x | | |
| **77-452 (USGS)** | 525000 | 7143000 | GN | | x | | | x | | |
| **77-576 (USGS)** | 526000 | 7137200 | GN | | x | | | x | | |
| **BK1-035** | 536600 | 7136400 | BLG | 0.01 | | | | | x | |
| **BK1-082** | 536600 | 7136400 | BLG | 0.02 | | | | | x | |
| **BK1-65** | 536600 | 7136400 | BLG | 0.02 | | | | | x | |
| **BK1-137** | 536600 | 7136400 | BLG | 0.05 | | x | | | | |
| **BK1-146** | 536600 | 7136400 | BLG | 0.52 | x | x | | | | |
| **BK2-012** | 536830 | 7135800 | BLG | | | | | | x | |
| **BK2-047** | 536830 | 7135800 | BLG+VN | 0.05 | | | | | x | x |
| **BK2-65** | 536830 | 7135800 | BLG | 0.27-0.20 | | x | | | | |
| **BK2-45** | 536830 | 7135800 | BLG | 0.05 | | x | | | | |
| **BK2-73** | 536830 | 7135800 | BLG | 0.21 | x | x | | | | |
| **BK2-98** | 536830 | 7135800 | BLG | 0.01 | | x | | | | |
| **BK2-131** | 536830 | 7135800 | BLG | 0.01 | | x | | | | |
| **BK2-135** | 536830 | 7135800 | BLG | 0 | | | | | x | |
| **BK2-152** | 536830 | 7135800 | BLG | 0.01 | | | | | x | |
| **BK3-021** | 536000 | 7135000 | BK dike 1 | 0 | x | | x | | | |
| **BK3-130** | 536000 | 7135000 | BK dike 2 | 0.01 | x | | x | | | |
| **BK3-142** | 536000 | 7135000 | GN | 0.04 | | | | x | | |
| **BK4-062** | 536100 | 7136100 | BLG | 0.11 | x | | x | | | |
| **BK4-263** | 536100 | 7136100 | BLG | 0.22 | x | | x | | | |
| **BK4-99** | 536100 | 7136100 | BLG | 0.08 | | x | | | | |
| **BK4-160** | 536100 | 7136100 | BLG | 0.17 | | x | | | | |
| **BK4-146** | 536100 | 7136100 | BLG | 0.2 | | x | | | | |
| **BK5-65** | 536900 | 7135200 | BLG | 0.07 | | x | | | | |
| **BK5-98** | 536900 | 7135200 | BLG | 0.04-0.02 | | x | | | | |
| **BK5-148** | 536900 | 7135200 | BLG | 0.02 | | x | | | | |
| **BK6-59** | 536250 | 7135200 | BLG | 0.06 | | | x | | | |
| **BK5-150** | 536900 | 7135200 | BLG | 0.38 | x | x | x | | | |
| **BK6-059** | 536250 | 7135200 | BLG | 0.06-0.14 | x | x | x | | | |
| **BK6-121** | 536250 | 7135200 | Migmatite leucosome | 0 | | | x | | | |
| **BK6-125** | 536250 | 7135200 | GN | 0.04 | | | x | | | |

Table 1 continued. List of grab samples, approximate locations, assigned rock types and analyses.

| Sample# | UTMX | UTMY | Rock type | Mag. Susc. (*10^-3 SI) | T.S. | P.S. | WRA | Geotherm | FI | Ar/Ar |
|---|---|---|---|---|---|---|---|---|---|---|
| **BK6-129** | 536250 | 7135200 | Migmatite leucosome | 0.01 | | | x | | | |
| **BK6-131** | 536250 | 7135200 | Migmatite leucosome | 0.01 | | | x | | | |
| **BR1-372** | SW Buck | | GN | | x | | x | | | |
| **BR4-323** | SW Buck | | GN | | x | | x | | | |
| **BR4-328** | SW Buck | | GN+VN | | x | | | | x | x |
| **BR4-334** | SW Buck | | GN | | x | | x | | | |
| **Buckeye Discovery** | 536330 | 7134900 | Quartz, GN, PEG, AGN | | x | | | | x | |
| **GRI-1** | 528200 | 7141500 | Gold Run Intrusion | 0.01 | x | | x | | | x |
| **GRI-2** | 528630 | 7141175 | Gold Run Intrusion | 0.01 | x | | x | | | |
| **GRI-3** | 528400 | 7141350 | Gold Run Intrusion | 0.01 | x | | x | | | |

**Legend:**
MTR, MI, BLG = Bald knob gneiss
GN = undifferentiated gneiss
SKN = marble
QFR = felsic dike
SCH = schistose rock
SGN = schistose gneiss (undifferentiated)
HFL = hornfels
QFT = tourmaline bearing felsic gneiss
ALT = bleached gneissic rock (predominately on Buck Ridge)
RHY = rhyolite
AGN = augen gneiss
PEG = pegmatite
AMPH = amphibolite
QTZ = quartz-rich rock

Table 2. Modal mineralogy of gneisses. Values are visual estimates of percentages from petrographic analysis. UTMX and UTMY are UTM coordinates. Plag=plagioclase, Kspar= K-feldspar, Biot=biotite, Sill=sillimanite, WM=white mica, Gar=garnet, Chl=chlorite, Tr=trace. Buck Ridge coordinates are not known.

| Sample | UTMX | UTMY | Quartz | Plag | Kspar | Biot | Opaques | Sill | WM | Gar | Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **99GG-24** | 528460 | 7142640 | 27 | 26 | | 20 | 5 | 15 | 12 | | |
| **122B** | 530250 | 7139050 | 60 | 20 | | 10 | 2 | 4 | 4 | | |
| **99GG-106** | 527350 | 7139800 | 50 | 15 | 10 | 18 | | 5 | 2 | | |
| **99GG-105** | 528200 | 7140050 | 45 | 10 | 19 | 20 | | 5 | | 1 | |
| **99GG-43** | 530500 | 7140000 | 48 | 10 | 10 | 20 | 1 | 10 | 1 | | |
| **99GG-40** | 529050 | 7139300 | 60 | 25 | | 14 | 1 | | | | |
| **99GG-31** | 528490 | 7140274 | 60 | 20 | | 15 | 1 | 10 | | | |
| **99GG-26** | 528350 | 7140000 | 50 | 17 | 7 | 15 | | 5 | | 1 | |
| **99GG-13** | 527350 | 7139800 | 45 | 14 | 5 | 25 | 10 | | | 1 | |
| **99GG-08** | 528200 | 7140040 | 50 | 17 | 5 | 20 | | 5 | 2 | 1 | |
| **122A** | 530250 | 7139050 | 39 | 35 | | 20 | 5 | | | 1 | |
| **99GG-09** | 527840 | 7140035 | 55 | 10 | | 20 | | 5 | 10 | | |
| **118A** | 528650 | 7138950 | 50 | 25 | | 13 | | 1 | 10 | 1 | |
| **99GG-18** | 528410 | 7141750 | 50 | 15 | | 10 | 2 | 2 | 15 | | 6 |
| **123** | 530500 | 7139050 | 65 | 15 | | 15 | | 4 | | 1 | |
| **128** | 530860 | 7138960 | 30 | 30 | | 19 | | 10 | 10 | | 1 |
| **124B** | 530650 | 7139000 | 60 | 20 | | 15 | | | 5 | | |
| **124C** | 530650 | 7139000 | 60 | 20 | | 10 | | 2 | 10 | | |
| **137** | 531750 | 7140500 | 60 | 15 | | 20 | | 5 | | | |
| **81** | 534800 | 7134250 | 62 | 22 | | 15 | | | 1 | | |
| **142** | 533000 | 7140400 | 65 | 18 | | 10 | | 1 | 5 | 1 | |
| **140** | 532900 | 7140450 | 54 | 23 | | 15 | | 3 | 5 | | |
| **99GG-094** | 534100 | 7139100 | 30 | 45 | 10 | 14 | | | | | 1 |
| **99GG-072** | 533910 | 7139100 | 25 | 40 | 20 | 13 | | | | 1 | 1 |
| **122a** | 530250 | 7139050 | 40 | 40 | | 19 | | | | 1 | |
| **77-187** | 542000 | 7139000 | 50 | 25 | 5 | 15 | | 2 | 2 | 1 | |
| **77W-452** | 525000 | 7143000 | 50 | 30 | | 20 | | | | 1 | |
| **BK3-142** | 536000 | 7135000 | 45 | 25 | 5 | 20 | | 4 | | 1 | |
| **77-576** | 526000 | 7137200 | 50 | 28 | 5 | 15 | | 2 | | 1 | |
| **BK6-059** | 536250 | 7135200 | 40 | 20 | 15 | 17 | 2 | 1 | 5 | | |
| **BK5-150** | 536900 | 7135200 | 45 | 20 | 7 | 15 | 3 | 3 | 7 | | |
| **BK4-062** | 536100 | 7136100 | 50 | 25 | 5 | 15 | 1 | 5 | 5 | | |
| **BK4-263** | 536100 | 7136100 | 40 | 20 | 15 | 15 | 2 | 1 | 5 | | |
| **BR4-323** | SW Buck | | 55 | 20 | | 24 | | 1 | | | |
| **BR1-372** | SW Buck | | 50 | 25 | | 20 | 2 | 3 | | | |
| **BR4-334** | SW Buck | | 55 | 15 | 15 | 15 | | Tr. | | | |

Table 3. Estimated modal mineral abundances (volume %) in felsic dike thin sections.

| Sample | Group | Qtz | Plag | Kspar | Tourm | Mica | Point Cnts. |
|---|---|---|---|---|---|---|---|
| **73** | 1 | 36 | 30 | 32 | 2 | | 102 |
| **143a** | 1 | 35 | 27 | 34 | | 4 | 104 |
| **125** | 1 | 33 | 27 | 32 | | 8 | 109 |
| **158a** | 2 | 36 | 34 | 26 | | 4* | 104 |

Qtz=quartz, Plag=plagioclase, Kspar=K-feldspar, Tourm=tourmaline, Mica=white mica and minor biotite, Point Cnts.= number of points counted, *=biotite altering to chlorite.

Table 4. XRF major oxide and normative values for gneiss samples in the Richardson study area. An=anorthite, Q=quartz, or=orthoclase, ab=albite, C=corundum, hy=hypersthene, mt=magnetite, il=ilmenite, hem=hematite, ap=apatite.

| Sample | 118A | 112A | 123 | 128 | 124B | 124C | 137 | 140 | 142 | 81 | 99GG094 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SiO2 | 71.4 | 81.28 | 85.4 | 60.18 | 83.66 | 73.76 | 65.98 | 69.93 | 84.07 | 78.42 | 71.81 |
| TiO2 | 0.55 | 0.31 | 0.25 | 0.77 | 0.24 | 0.53 | 0.67 | 0.68 | 0.18 | 0.4 | 0.28 |
| Al2O3 | 13.77 | 9.23 | 6.34 | 20.34 | 7.39 | 12.05 | 16.75 | 14.99 | 7.29 | 9.59 | 14.36 |
| Fe2O3 | 3.94 | 2.54 | 2.13 | 6.71 | 2.25 | 4.88 | 5.21 | 5.87 | 2.55 | 3.46 | 3.08 |
| MnO | 0.06 | 0.04 | 0.04 | 0.07 | 0.03 | 0.05 | 0.04 | 0.09 | 0.03 | 0.04 | 0.07 |
| MgO | 1.35 | 0.78 | 0.5 | 2.27 | 0.53 | 1.59 | 1.82 | 1.77 | 0.64 | 1.25 | 0.7 |
| CaO | 2.68 | 0.56 | 0.57 | 0.56 | 0.71 | 0.56 | 0.46 | 0.61 | 0.92 | 1.11 | 2.53 |
| Na2O | 3.22 | 1.13 | 1.08 | 1.23 | 1.54 | 1.23 | 1.24 | 0.63 | 1.49 | 1.7 | 3.08 |
| K2O | 1.35 | 1.91 | 0.99 | 3.92 | 1.33 | 2.82 | 3.84 | 2.91 | 1.13 | 2.5 | 2.75 |
| P2O5 | 0.05 | 0.07 | 0.05 | 0.09 | 0.04 | 0.07 | 0.08 | 0.09 | 0.08 | 0.08 | 0.09 |
| LOI | 0.8 | 1.16 | 0.76 | 3.45 | 0.81 | 1.42 | 2.72 | 1.85 | 0.79 | 0.75 | 0.84 |
| Total | 99.2 | 99.02 | 98.14 | 99.61 | 98.56 | 99 | 98.82 | 99.44 | 99.21 | 99.33 | 99.62 |
| %AN | 32.25 | 19.53 | 21.49 | 17.38 | 20.02 | 18.23 | 14.36 | 31.38 | 24.27 | 25.73 | 31.46 |
| Q | 39.61 | 65.24 | 73.51 | 31.73 | 67.42 | 51.42 | 39.6 | 49.92 | 68.38 | 54.76 | 37.01 |
| or | 7.98 | 11.29 | 5.85 | 23.17 | 7.86 | 16.67 | 22.69 | 17.2 | 6.68 | 14.77 | 16.25 |
| ab | 27.25 | 9.56 | 9.14 | 10.41 | 13.03 | 10.41 | 10.49 | 5.33 | 12.61 | 14.39 | 26.06 |
| an | 12.97 | 2.32 | 2.5 | 2.19 | 3.26 | 2.32 | 1.76 | 2.44 | 4.04 | 4.98 | 11.96 |
| C | 2.26 | 4.45 | 2.58 | 13.27 | 2.22 | 6.12 | 9.91 | 9.91 | 2.13 | 2.26 | 1.93 |
| hy | 4 | 1.94 | 1.25 | 9.97 | 1.32 | 6.21 | 6.73 | 7.75 | 1.59 | 3.54 | 2.09 |
| mt | 2.97 | 1.35 | 0.51 | 3.29 | 0.88 | 2.94 | 3.15 | 3.16 | 2.1 | 2.75 | 2.58 |
| il | 1.04 | 0.59 | 0.47 | 1.46 | 0.46 | 1.01 | 1.27 | 1.29 | 0.34 | 0.76 | 0.53 |
| hem | 0 | 0.88 | 1.4 | 0 | 1.13 | 0 | 0 | 0 | 0.23 | 0 | 0 |
| ap | 0.12 | 0.16 | 0.12 | 0.21 | 0.09 | 0.16 | 0.19 | 0.21 | 0.19 | 0.19 | 0.21 |

Table 4 continued. XRF major oxide and normative values for gneiss samples in the Richardson study area.

| Sample | 99GG072 | 99GG024 | 99GG031 | 99GG040 | BK004-062 | BK004-263 | BK005-150 | BK006-059 | BR1-372 | BR4-323 | BR4-334 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **SiO2** | 70.92 | 55.15 | 73.96 | 85.21 | 69.13 | 69.92 | 70.5 | 69.56 | 73.64 | 71.4 | 71.51 |
| **TiO2** | 0.27 | 1.13 | 0.58 | 0.24 | 0.77 | 0.84 | 0.79 | 0.57 | 0.53 | 0.62 | 0.58 |
| **Al2O3** | 14.5 | 23.92 | 12.82 | 6.44 | 14.46 | 14 | 14.68 | 14.05 | 13.23 | 14.69 | 14.08 |
| **Fe2O3** | 2.95 | 7.84 | 4.84 | 2.28 | 5.55 | 5.09 | 6.5 | 4.64 | 4.52 | 5.37 | 4.37 |
| **MnO** | 0.06 | 0.15 | 0.07 | 0.05 | 0.04 | 0.05 | 0.07 | 0.06 | 0.07 | 0.06 | 0.05 |
| **MgO** | 0.64 | 2.86 | 1.49 | 0.52 | 1.74 | 1.55 | 1.98 | 1.51 | 1.35 | 1.69 | 1.47 |
| **CaO** | 2.62 | 0.76 | 0.81 | 0.76 | 1.39 | 1.24 | 0.6 | 1.13 | 0.87 | 0.67 | 0.83 |
| **Na2O** | 2.64 | 1.47 | 1.19 | 1.54 | 1.3 | 1.34 | 0.75 | 1.62 | 0.97 | 0.9 | 1.21 |
| **K2O** | 3.84 | 3.98 | 2.33 | 0.85 | 3.46 | 3.8 | 2.12 | 3.48 | 2.57 | 2.96 | 3.41 |
| **P2O5** | 0.09 | 0.09 | 0.08 | 0.06 | 0.09 | 0.1 | 0.08 | 0.1 | 0.09 | 0.09 | 0.11 |
| **LOI** | 0.66 | 1.95 | 1.28 | 0.74 | 1.46 | 1.2 | 1.72 | 1.45 | 1.86 | 1.64 | 1.07 |
| **Total** | 99.21 | 99.33 | 99.48 | 98.72 | 99.39 | 99.13 | 99.79 | 98.17 | 99.7 | 100.09 | 98.69 |
| **%AN** | 35.71 | 20.37 | 25.77 | 20.59 | 36.44 | 32.66 | 27.88 | 26.54 | 31.23 | 26.43 | 24.92 |
| **Q** | 34.49 | 23.52 | 53.48 | 70.77 | 41.94 | 42.3 | 52.25 | 41.66 | 53.77 | 49.91 | 47.22 |
| **or** | 22.69 | 23.52 | 13.77 | 5.02 | 20.45 | 22.46 | 12.53 | 20.57 | 15.19 | 17.49 | 20.15 |
| **ab** | 22.34 | 12.44 | 10.07 | 13.03 | 11 | 11.34 | 6.35 | 13.71 | 8.21 | 7.62 | 10.24 |
| **an** | 12.41 | 3.18 | 3.5 | 3.38 | 6.31 | 5.5 | 2.45 | 4.95 | 3.73 | 2.74 | 3.4 |
| **C** | 1.45 | 16.03 | 7.06 | 1.75 | 6.26 | 5.67 | 10.25 | 5.8 | 7.49 | 9 | 7.15 |
| **hy** | 1.75 | 11.97 | 5.73 | 1.3 | 6.68 | 5.18 | 8.82 | 5.47 | 5.05 | 6.92 | 4.86 |
| **mt** | 2.57 | 3.81 | 3.02 | 1.03 | 3.29 | 3.39 | 3.32 | 3 | 2.94 | 3.07 | 3.02 |
| **il** | 0.51 | 2.15 | 1.1 | 0.46 | 1.46 | 1.6 | 1.5 | 1.08 | 1.01 | 1.18 | 1.1 |
| **hem** | 0 | 0 | 0 | 1.03 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **ap** | 0.21 | 0.21 | 0.19 | 0.14 | 0.21 | 0.23 | 0.19 | 0.23 | 0.21 | 0.21 | 0.25 |

Table 5. XRF major and minor element results for amphibolite samples 127 and 158B. Oxides are shown in percent and trace elements are in ppm.

| Samples | 127 | 158B |
|---|---|---|
| SiO2 | 44.87 | 39.4 |
| TiO2 | 4.05 | 5.77 |
| Al2O3 | 5.94 | 10.84 |
| Fe2O3 | 13.3 | 15.04 |
| MnO | 0.29 | 0.28 |
| MgO | 15.74 | 8.02 |
| CaO | 11.57 | 13.41 |
| Na2O | 0.6 | 0.5 |
| K2O | 0.17 | 0.75 |
| P2O5 | 0.77 | 2.22 |
| LOI | 1.61 | 3.14 |
| Total | 99.06 | 99.46 |
| Ba | 228 | 119 |
| Sr | 159 | 164 |
| Y | 18 | 34 |
| Nb | 65 | 92 |
| Zr | 241 | 336 |
| Rb | 12 | 21 |

Table 6. XRF major oxide and normative values in percent (%) for igneous rock samples in the Richardson study area. Norm abbreviations are the same as for table 4. *Sample BK3-125 shown for comparison to adjacent migmatite leucosomes.

| Sample | 73 | 125 | 158 | 129 | 135 | 143 | BK003-021 | BK003-130 |
|---|---|---|---|---|---|---|---|---|
| Rock type | Felsic dike | Felsic dike | Felsic dike | Felsic dike | Felsic dike | Felsic dike | Course dike | Course dike |
| SiO2 | 74.97 | 74.93 | 74.67 | 72.39 | 74.64 | 73.75 | 73.18 | 69.21 |
| TiO2 | 0.03 | 0.08 | 0.09 | 0.08 | 0.05 | 0.04 | 0.03 | 0.14 |
| Al2O3 | 14.23 | 14.18 | 14.34 | 13.94 | 14.4 | 14.22 | 15.59 | 15.98 |
| Fe2O3 | 0.89 | 0.61 | 0.72 | 1.21 | 0.6 | 0.96 | 0.43 | 1.15 |
| MnO | 0.08 | 0.02 | 0.01 | 0.01 | 0 | 0.02 | 0 | 0.02 |
| MgO | 0.11 | 0.22 | 0.28 | 0.19 | 0.11 | 0.09 | 0.14 | 0.28 |
| CaO | 0.42 | 0.52 | 1.38 | 0.46 | 0.46 | 0.67 | 2.15 | 1.57 |
| Na2O | 3.4 | 2.88 | 3.79 | 2.78 | 2.45 | 3.35 | 3.23 | 2.34 |
| K2O | 4.17 | 4.99 | 3.39 | 4.3 | 4.43 | 4.34 | 5.09 | 7.6 |
| P2O5 | 0.17 | 0.14 | 0.1 | 0.1 | 0.06 | 0.2 | 0.07 | 0.54 |
| LOI | 0.79 | 0.85 | 0.75 | 2.54 | 1.74 | 1.08 | 0.4 | 0.71 |
| Total | 99.26 | 99.42 | 99.52 | 98 | 98.94 | 98.72 | 100.31 | 99.54 |
| %AN | 3.27 | 6.4 | 16.18 | 6.48 | 8.36 | 6.64 | 27.19 | 17.71 |
| Q | 38.65 | 38.04 | 36.56 | 38.78 | 42.46 | 36.65 | 30.3 | 24.26 |
| or | 24.64 | 29.49 | 20.03 | 25.41 | 26.18 | 25.65 | 30.08 | 44.91 |
| ab | 28.77 | 24.37 | 32.07 | 23.52 | 20.73 | 28.35 | 27.33 | 19.8 |
| an | 0.97 | 1.67 | 6.19 | 1.63 | 1.89 | 2.02 | 10.21 | 4.26 |
| C | 3.77 | 3.43 | 2.17 | 4.12 | 4.88 | 3.27 | 1.03 | 2.34 |
| hy | 0.27 | 0.55 | 0.7 | 0.47 | 0.27 | 0.22 | 0.35 | 0.7 |
| mt | 0.17 | 0 | 0 | 0 | 0 | 0 | -0.02 | 0.04 |
| il | 0.06 | 0.04 | 0.02 | 0 | 0 | 0 | 0.43 | 1.15 |
| hem | 0.77 | 0.61 | 0.72 | 1.21 | 0.6 | 0.96 | 0.16 | 1.25 |
| ap | 0.39 | 0.32 | 0.23 | 0.23 | 0.14 | 0.46 | 0.04 | 0.12 |
| ru | 0 | 0.06 | 0.08 | 0.1 | 0.07 | 0.04 | 0 | 0 |

Table 6 continued. XRF major oxide and normative values in percent (%) for igneous rock samples in the Richardson study area.

| Sample | GRI-1 | GRI-2 | GRI-3 | BK6-128 | BK6-131 | BK6-121 | BK3-125 |
|---|---|---|---|---|---|---|---|
| **Rock type** | **Gold Run** | **Gold Run** | **Gold Run** | **Migmatite** | **Migmatite** | **Migmatite** | **Gneiss*** |
| **SiO2** | 71.4 | 72 | 71.54 | 73.01 | 74.01 | 73.01 | 71.07 |
| **TiO2** | 0.28 | 0.28 | 0.25 | 0.03 | 0.14 | 0.09 | 0.6 |
| **Al2O3** | 14.69 | 14.27 | 14.36 | 14.84 | 13.96 | 14.67 | 13.08 |
| **Fe2O3** | 2.66 | 2.28 | 2.6 | 0.87 | 0.95 | 1.05 | 4.3 |
| **MnO** | 0.05 | 0.04 | 0.04 | 0.02 | 0 | 0.01 | 0.07 |
| **MgO** | 0.66 | 0.6 | 0.59 | 0.4 | 0.41 | 0.42 | 1.47 |
| **CaO** | 2.2 | 1.85 | 1.92 | 1.15 | 0.9 | 0.81 | 1.2 |
| **Na2O** | 3.06 | 3.07 | 2.98 | 1.86 | 1.79 | 1.91 | 1.89 |
| **K2O** | 4.57 | 4.49 | 4.67 | 6.04 | 5.91 | 6.19 | 4.7 |
| **P2O5** | 0.11 | 0.15 | 0.11 | 0.23 | 0.08 | 0.08 | 0.1 |
| **LOI** | 0.48 | 0.53 | 0.71 | 1.31 | 1.52 | 1.18 | 1.01 |
| **Total** | 100.16 | 99.56 | 99.77 | 99.76 | 99.68 | 99.42 | 99.52 |
| **%AN** | 28.25 | 23.99 | 25.88 | 21.07 | 20.65 | 17.78 | 24.89 |
| **Q** | 30.73 | 32.53 | 31.65 | 36.67 | 38.67 | 36.08 | 37.14 |
| **or** | 27.01 | 26.53 | 27.6 | 35.69 | 34.93 | 36.58 | 27.78 |
| **ab** | 25.89 | 25.98 | 25.22 | 15.74 | 15.15 | 16.16 | 15.99 |
| **an** | 10.2 | 8.2 | 8.81 | 4.2 | 3.94 | 3.5 | 5.3 |
| **C** | 0.97 | 1.36 | 1.18 | 3.7 | 3.17 | 3.55 | 2.94 |
| **hy** | 1.64 | 1.49 | 1.47 | 1 | 1.02 | 1.05 | 4.7 |
| **mt** | 1.9 | 0.77 | 1.87 | 0 | 0 | 0 | 3.04 |
| **il** | 0.53 | 0.53 | 0.47 | 0.04 | 0 | 0.02 | 1.14 |
| **hem** | 0.47 | 1.25 | 0.46 | 0.87 | 0.95 | 1.05 | 0 |
| **ap** | 0.25 | 0.35 | 0.25 | 0.53 | 0.19 | 0.19 | 0.23 |
| **ru** | 0 | 0 | 0 | 0.01 | 0.15 | 0.08 | 0 |

Table 7. Trace element compositions (in ppm) of igneous rocks from the Richardson study area.

| Sample | Unit | Ba | Nb | Rb | Sr | Y | Zr | Nb+Y |
|---|---|---|---|---|---|---|---|---|
| **GRI-3** | Gold Run Intrusion | 1319 | 15 | 204 | 329 | 24 | 146 | 39 |
| **GRI-1** | Gold Run Intrusion | 1194 | 15 | 201 | 311 | 25 | 143 | 40 |
| **GRI-2** | Gold Run Intrusion | 1200 | 14 | 203 | 314 | 22 | 145 | 36 |
| **BK3-021** | BK dike 1 | 1284 | 3 | 103 | 299 | 10 | 62 | 13 |
| **BK3-130** | BK dike 2 | 2013 | 6 | 184 | 364 | 31 | 29 | 37 |
| **125** | Felsic dike | 487 | 5 | 113 | 136 | 15 | 41 | 20 |
| **158** | Felsic dike | 1763 | 5 | 68 | 402 | 14 | 34 | 19 |
| **73** | Felsic dike | 236 | 30 | 298 | 33 | 18 | 28 | 48 |
| **129** | Altered felsic dike | 372 | 12 | 133 | 133 | 21 | 47 | 33 |
| **135** | Altered felsic dike | 239 | 22 | 159 | 119 | 19 | 44 | 41 |
| **143** | Felsic dike | 201 | 25 | 263 | 53 | 17 | 39 | 42 |
| **BK6-121** | Migmatite leucosome | 1824 | 3 | 140 | 313 | 15 | 102 | 18 |
| **BK6-129** | Migmatite leucosome | 1630 | 1 | 134 | 299 | 16 | 56 | 17 |
| **BK6-131** | Migmatite leucosome | 1470 | 5 | 139 | 273 | 23 | 56 | 28 |

Table 8. Samples employed for Geothermometry and Geobarometry from Richardson field area.

| Sample | UTMY | UTMX | Fault Block | Mineral assemblage present | Geobarometer(s) employed | Temp Est. ($^oC$) |
|---|---|---|---|---|---|---|
| **77-187** | 7139000 | 542000 | NE | Quartz-plagioclase-bio-musc-sillimanite-garnet | 1,2,3,4,5 | 610,555 |
| **BK3-142** | 7135000 | 536000 | E | Quartz-plagioclase-biotite-sillimanite-garnet | 1 | 620 |
| **122a** | 7139050 | 530250 | W | Quartz-plagioclase-biotite-garnet | 1 | 580 |
| **77-576** | 7137200 | 526000 | S | Quartz-plagioclase-biotite-sillimanite-garnet | 1 | 555 |
| **77-452** | 7143000 | 525000 | NW | Quartz-plagioclase-biotite-garnet | 2,3 | 560 |

Geobarometers: 1=garnet-sillimanite-plagioclase-quartz (Hodges and Spear, 1982; Hodges and Crowley, 1985; Newton and Haselton, 1981; Ganguly and Saxena, 1984), 2=garnet-muscovite-plagioclase-biotite (Hodges and Crowley, 1985; Ghent and Stout, 1981; Hoisch, 1990), 3=garnet-muscovite-plagioclase-quartz (Hoisch, 1990), 4=garnet-muscovite-sillimanite-quartz (Hodges and Crowley, 1985), 5=garnet-muscovite-biotite-sillimanite (Hodges and Crowley, 1985).

Table 9. Average microprobe data of mineral assemblages for geothermobarometric calculations.

| **sample** | **452c-1** | **452c-1** | **452c-2** | **452c-2** | **452c-2** | **452c-2** | **77187-1** | **77187-1** | **77187-1** | **77187-2** | **77187-2** | **77187-2** | **77187-2** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **mineral** | **g** | **b** | **g** | **h** | **wm** | **p** | **g** | **p** | **b** | **p** | **g** | **b** | **wm** |
| **Na2O** | 0.05 | 0.11 | 0.03 | 0.07 | 1.01 | 9.49 | 0.05 | 7.94 | 0.13 | 7.78 | 0.02 | 0.14 | 0.61 |
| **MgO** | 2.46 | 8.77 | 2.57 | 7.90 | 0.51 | 0.00 | 1.90 | 0.01 | 6.20 | 0.00 | 1.55 | 6.74 | 0.54 |
| **Al2O3** | 21.74 | 19.71 | 22.02 | 20.68 | 36.39 | 23.29 | 21.70 | 24.87 | 21.12 | 25.57 | 21.66 | 21.61 | 37.39 |
| **SiO2** | 36.83 | 34.26 | 37.07 | 35.23 | 43.62 | 63.85 | 36.80 | 61.26 | 33.93 | 60.23 | 36.79 | 34.53 | 45.08 |
| **K2O** | 0.05 | 8.91 | 0.01 | 8.36 | 9.58 | 0.15 | 0.01 | 0.35 | 8.76 | 0.25 | 0.02 | 8.84 | 10.32 |
| **CaO** | 1.19 | 0.05 | 1.30 | 0.09 | 0.02 | 3.33 | 1.62 | 5.37 | 0.05 | 5.98 | 1.49 | 0.04 | 0.05 |
| **TiO2** | 0.04 | 1.75 | 0.05 | 1.10 | 0.31 | 0.07 | 0.02 | 0.01 | 1.67 | 0.07 | 0.00 | 1.40 | 0.19 |
| **FeO** | 32.06 | 19.30 | 33.49 | 19.90 | 1.18 | 0.01 | 30.37 | 0.03 | 21.38 | 0.06 | 28.57 | 20.26 | 1.12 |
| **MnO** | 6.09 | 0.18 | 4.20 | 0.16 | 0.04 | 0.02 | 8.43 | 0.01 | 0.42 | 0.01 | 10.32 | 0.48 | 0.08 |
| **H2Oc** | | 3.85 | | 3.89 | 4.38 | | | | 3.84 | | | 3.88 | 4.51 |
| **Total** | 100.50 | 96.89 | 100.72 | 97.36 | 97.05 | 100.21 | 100.89 | 99.84 | 97.50 | 99.95 | 100.43 | 97.91 | 99.90 |
| **cations per formula unit** | | | | | | | | | | | | | |
| **Na** | 0.01 | 0.03 | 0.00 | 0.02 | 0.27 | 1.62 | 0.01 | 1.37 | 0.04 | 1.34 | 0.00 | 0.04 | 0.16 |
| **Mg** | 0.30 | 2.04 | 0.31 | 1.82 | 0.10 | 0.00 | 0.23 | 0.00 | 1.44 | 0.00 | 0.19 | 1.55 | 0.11 |
| **Al** | 2.06 | 3.62 | 2.08 | 3.76 | 5.86 | 2.41 | 2.06 | 2.60 | 3.89 | 2.68 | 2.06 | 3.93 | 5.85 |
| **Si** | 2.96 | 5.34 | 2.97 | 5.43 | 5.96 | 5.62 | 2.96 | 5.44 | 5.29 | 5.36 | 2.97 | 5.33 | 5.99 |
| **K** | 0.00 | 1.77 | 0.00 | 1.64 | 1.67 | 0.02 | 0.00 | 0.04 | 1.74 | 0.03 | 0.00 | 1.74 | 1.75 |
| **Ca** | 0.10 | 0.01 | 0.11 | 0.01 | 0.00 | 0.31 | 0.14 | 0.51 | 0.01 | 0.57 | 0.13 | 0.01 | 0.01 |
| **Ti** | 0.00 | 0.20 | 0.00 | 0.13 | 0.03 | 0.00 | 0.00 | 0.00 | 0.20 | 0.00 | 0.00 | 0.16 | 0.02 |
| **Fe** | 2.16 | 2.51 | 2.24 | 2.57 | 0.14 | 0.00 | 2.04 | 0.00 | 2.79 | 0.00 | 1.93 | 2.61 | 0.12 |
| **Mn** | 0.41 | 0.02 | 0.28 | 0.02 | 0.00 | 0.00 | 0.57 | 0.00 | 0.06 | 0.00 | 0.71 | 0.06 | 0.01 |
| **Ca site tot** | 2.97 | | 2.95 | | | 1.93 | 2.99 | 1.88 | | 1.91 | 2.95 | | |
| **O** | 12.00 | 22.00 | 12.00 | 22.00 | 22.00 | 16.00 | 12.00 | 16.00 | 22.00 | 16.00 | 12.00 | 22.00 | 22.00 |
| **Fe/Mg** | 7.30 | 1.23 | 7.32 | 1.14 | | | 8.95 | | 1.93 | | 10.20 | 1.69 | |
| **% An** | | | | | | 16 | | 27 | | 30 | | | |
| **-lnKb-g** | 1.78 | | 1.64 | | | | 1.53 | | | | 1.81 | | |
| **avg T,P** | 570C, 2.7 kb | | 590C, 4.2 kb | | | | 605C, 3.6 kb | | | 560C, 3.2 kb | | | |

See text for analytical methods. H2Oc=calculated water content; Ca site tot= # cations in site containing Ca; O=total oxygen per formula unit; T,P from techniques described in text; b=biotite, g=garnet, h=hornblende, p=plagioclase, wm=white mica, -lnKb-g= negative log of (biotite)-Fe/Mg cations (garnet).

Table 9 continued. Average microprobe data of mineral assemblages for geothermobarometric calculations.

| sample | BK3-142-1 | BK3-142-1 | BK3-142-1 | BK3-142-2 | BK3- 142-2 | BK3-142-2 | 77-576-1 | 77-576-1 | 77-576-1 | 77-576-2 | 77-576-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| mineral | g | b | p | g | b | p | g | b | p | g | b |
| Na2O | 0.04 | 0.09 | 7.51 | 0.05 | 0.14 | 6.62 | 0.05 | 0.19 | 8.29 | 0.04 | 0.15 |
| MgO | 2.42 | 7.18 | 0.01 | 2.21 | 6.92 | 0.01 | 2.14 | 7.99 | 0.01 | 2.38 | 7.96 |
| Al203 | 22.07 | 19.85 | 25.93 | 21.72 | 19.85 | 27.63 | 21.73 | 21.25 | 24.93 | 21.70 | 21.78 |
| SiO2 | 37.24 | 34.01 | 59.40 | 36.66 | 33.79 | 57.52 | 36.86 | 34.30 | 60.77 | 36.74 | 34.47 |
| K2O | 0.01 | 9.40 | 0.38 | 0.03 | 9.65 | 0.20 | 0.05 | 9.49 | 0.33 | 0.04 | 9.78 |
| CaO | 1.38 | 0.06 | 6.57 | 1.20 | 0.03 | 8.18 | 0.94 | 0.01 | 5.27 | 1.13 | 0.01 |
| TiO2 | 0.03 | 2.43 | 0.02 | 0.05 | 2.64 | 0.02 | 0.00 | 1.88 | 0.05 | 0.06 | 1.29 |
| FeO | 30.88 | 20.87 | 0.03 | 30.34 | 21.68 | 0.08 | 30.48 | 19.16 | 0.07 | 30.19 | 19.00 |
| MnO | 7.42 | 0.33 | 0.03 | 8.19 | 0.41 | 0.05 | 8.86 | 0.19 | 0.04 | 7.92 | 0.23 |
| H2Oc | | 3.85 | | | 3.86 | | | 3.90 | | | 3.91 |
| Total | 101.51 | 98.08 | 99.88 | 100.45 | 98.99 | 100.30 | 101.10 | 98.37 | 99.76 | 100.21 | 98.59 |
| cations per formula unit | | | | | | | | | | | |
| Na | 0.01 | 0.03 | 1.30 | 0.01 | 0.04 | 1.15 | 0.01 | 0.06 | 1.43 | 0.01 | 0.05 |
| Mg | 0.29 | 1.66 | 0.00 | 0.27 | 1.60 | 0.00 | 0.26 | 1.83 | 0.00 | 0.29 | 1.82 |
| Al | 2.07 | 3.64 | 2.73 | 2.06 | 3.63 | 2.90 | 2.06 | 3.84 | 2.62 | 2.06 | 3.93 |
| Si | 2.96 | 5.29 | 5.30 | 2.96 | 5.24 | 5.13 | 2.96 | 5.26 | 5.41 | 2.96 | 5.28 |
| K | 0.00 | 1.87 | 0.04 | 0.00 | 1.91 | 0.02 | 0.00 | 1.86 | 0.04 | 0.00 | 1.91 |
| Ca | 0.12 | 0.01 | 0.63 | 0.10 | 0.01 | 0.78 | 0.08 | 0.00 | 0.50 | 0.10 | 0.00 |
| Ti | 0.00 | 0.28 | 0.00 | 0.00 | 0.31 | 0.00 | 0.00 | 0.22 | 0.00 | 0.00 | 0.15 |
| Fe | 2.06 | 2.72 | 0.00 | 2.05 | 2.81 | 0.01 | 2.05 | 2.46 | 0.01 | 2.04 | 2.43 |
| Mn | 0.50 | 0.04 | 0.00 | 0.56 | 0.05 | 0.00 | 0.60 | 0.02 | 0.00 | 0.54 | 0.03 |
| Ca site tot | 2.96 | | 1.93 | 2.98 | | 1.93 | 2.99 | | 1.93 | 2.97 | |
| O | 12.00 | 22.00 | 16.00 | 12.00 | 22.00 | 16.00 | 12.00 | 22.00 | 16.00 | 12.00 | 22.00 |
| Fe/Mg | 7.15 | 1.63 | | 7.71 | 1.76 | | 8.01 | 1.35 | | 7.12 | 1.34 |
| % An | | | 33 | | | 41 | | | 26 | | |
| -lnKb-g | 1.48 | | | 1.48 | | | 1.78 | | | 1.67 | |
| avg T,P | | 620C, 3.6 kb | | | 615C, 2.4 kb | | | 565C, 2.8 kb | | 580C, 3.2 kb | |

Table 9 continued. Average microprobe data of mineral assemblages for geothermobarometric calculations.

| sample | 122a-1 | 122a-1 | 122a-1 | 122a-2 | 122a-2 | 122a-2 |
|---|---|---|---|---|---|---|
| mineral | g | b | p | p | g | b |
| Na2O | 0.02 | 0.14 | 8.04 | 7.81 | 0.04 | 0.16 |
| MgO | 2.17 | 7.68 | 0.00 | 0.00 | 2.07 | 8.08 |
| Al2O3 | 21.41 | 19.68 | 25.16 | 25.54 | 21.77 | 18.94 |
| SiO2 | 36.18 | 34.17 | 59.92 | 59.26 | 36.75 | 33.55 |
| K2O | 0.02 | 9.06 | 0.16 | 0.16 | 0.00 | 8.91 |
| CaO | 1.15 | 0.03 | 5.65 | 6.32 | 1.33 | 0.08 |
| TiO2 | 0.06 | 2.63 | 0.01 | 0.02 | 0.09 | 2.72 |
| FeO | 28.30 | 19.33 | 0.14 | 0.08 | 27.85 | 19.31 |
| MnO | 8.33 | 0.21 | 0.05 | 0.01 | 9.87 | 0.26 |
| H20c | | 3.84 | | | | 3.79 |
| Total | 97.64 | 96.76 | 99.14 | 99.20 | 99.77 | 95.80 |
| cations per formula unit | | | | | | |
| Na | 0.00 | 0.04 | 1.40 | 1.36 | 0.01 | 0.05 |
| Mg | 0.27 | 1.79 | 0.00 | 0.00 | 0.25 | 1.91 |
| Al | 2.08 | 3.62 | 2.66 | 2.70 | 2.08 | 3.53 |
| Si | 2.98 | 5.34 | 5.37 | 5.32 | 2.97 | 5.31 |
| K | 0.00 | 1.80 | 0.02 | 0.02 | 0.00 | 1.80 |
| Ca | 0.10 | 0.01 | 0.54 | 0.61 | 0.12 | 0.01 |
| Ti | 0.00 | 0.31 | 0.00 | 0.00 | 0.01 | 0.32 |
| Fe | 1.95 | 2.52 | 0.01 | 0.01 | 1.88 | 2.56 |
| Mn | 0.58 | 0.03 | 0.00 | 0.00 | 0.68 | 0.04 |
| Ca site tot | 2.91 | | 1.94 | 1.97 | 2.93 | |
| O | 12.00 | 22.00 | 16.00 | 16.00 | 12.00 | 22.00 |
| Fe/Mg | 7.31 | 1.41 | | | 7.54 | 1.34 |
| % An | | | 28 | 31 | | |
| -lnKb-g | 1.64 | | | | 1.73 | |
| avg T,P | 585C, 3 kb | | | 570C, 3.2 kb | | |

Table 10. Fluid inclusion samples, locations, and assay values of sampled interval.

| Slide (JGA-) | site | UTM E | UTM N | Au Assay value (ppm) | Gold Group |
|---|---|---|---|---|---|
| **11** | BK2-047 (AuVn) | 7135800 | 536830 | >1 | 3 (high Au) |
| **15** | BK2-152 (s15) | 7135800 | 536830 | 0.115 | 3 (high Au) |
| **2** | BK1-65 | 7136400 | 536600 | .040 | 2 (interm. Au) |
| **1** | BK1-035 | 7136400 | 536600 | 0.095 | 2 (interm. Au) |
| **4** | BK1-082 | 7136400 | 536600 | <0.02 | 1 (Au not detected) |
| **12** | BK2-012 | 7135800 | 536830 | <0.02 | 1 (Au not detected) |
| **13** | BK2-135 | 7135800 | 536830 | <0.02 | 1 (Au not detected) |
| **B3** | Buckeye Discovery (Buckeye) | 7134900 | 536330 | up to 53 | 4 (Discovery high Au) |

Table 11. Fluid inclusion data and estimated fluid parameters.

| Hole | Slide | Inclusion | CO2 | Clath | Cohom | Homog | Au group | Volume | Bars | Density | MoleH20 | Est. Press |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | -60.2 | 12.4 | | 336 | 3 | 40 | | | | |
| 1 | 1 | 3 | -62.3 | 13.3 | | 325 | 3 | 25 | | | | |
| 1 | 1 | 4 | -61.5 | 12.6 | | 320 | 3 | 30 | | | | |
| 1 | 1 | 5 | -58.3 | 12.5 | | 335 | 3 | 45 | | | | |
| 1 | 1 | 6 | -61.5 | 13.6 | | 325 | 3 | 50 | | | | |
| 1 | 1 | 7 | -57.3 | 10.9 | | 320 | 3 | 60 | | | | |
| 1 | 1 | 8 | -62.9 | 14.2 | | 325 | 3 | 35 | | | | |
| 1 | 2 | 1 | -58.7 | 10.6 | | 270 | 2 | 30 | | | | |
| 1 | 2 | 2 | -57.5 | 11 | | 350 | 2 | 45 | | | | |
| 1 | 2 | 3 | -58.6 | 12.7 | | 310 | 2 | 35 | | | | |
| 1 | 2 | 4 | -57.5 | 11.5 | | 350 | 2 | 40 | | | | |
| 1 | 2 | 5 | -57.8 | 11 | | 340 | 2 | 40 | | | | |
| 1 | 2 | 6 | -57.5 | 10.6 | 23 | | 2 | 40 | 70 | 0.2 | 92 | 200 Bars |
| 1 | 4 | 1 | -56.6 | 10.9 | | | 3 | 45 | | | | |
| 1 | 4 | 2 | -56.6 | 10.4 | 27 | 340 | 3 | 45 | 70 | 0.23 | 90 | 200 Bars |
| 1 | 4 | 3 | -56.7 | 10.8 | | 330 | 3 | 40 | | | | |
| 1 | 4 | 4 | -57 | 10.6 | | 335 | 3 | 30 | | | | |
| 1 | 4 | 5 | -56.9 | 10.9 | | 330 | 3 | 30 | | | | |
| 2 | 11 | 1 | -57.3 | 10.9 | | 330 | 1 | 40 | | | | |
| 2 | 11 | 2 | -57.5 | 10.8 | 25.9 | | 1 | 30 | 70 | 0.22 | 85 | 200 Bars |
| 2 | 11 | 3 | -57.8 | 11.8 | 25.2 | | 1 | 25 | 70 | 0.22 | 95 | 200 Bars |
| 2 | 11 | 4 | -57.6 | 10.9 | 25* | | 1 | 45 | 150 | 0.78 | 82 | >1 kbar |

* = CO2 homogenized to liquid **=critical value

Calculations are based on procedures discussed in Roedder (1984).

CO2=Melting temperature of carbon dioxide in degree Celsius; Clath=Clathrate melting temperature in degree Celsius; Cohom=Partial homogenization of carbonic phase in degree Celsius; Homog=Total homogenization of carbonic phase in degree Celsius; Volume=Volume of vapor within inclusion shown in percent; Bars=Fluid inclusion pressure in bars after Angus and others, 1976; Density=CO2 density of the inclusion after Burress, 1981; MoleH2O=Calculated mole percent of H2O in inclusion fluids; Est. Press=Estimated minimum pressure at time of inclusion formation in bars. Employed P-T density isochores from Kennedy, 1954 and diagrams from Brown and Lamb, 1989.

Table 11 continued. Fluid inclusion data and estimated fluid parameters.

| Hole | Slide | Inclusion | CO2 | Clath | Cohom | Homog | Au group | Volume | Bars | Density | Moleh20 | Est. Press |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 11 | 5 | -57.4 | 10.8 | 26.9* | 280 | 1 | 50 | 150 | 0.76 | 80 | > 1 kbar |
| 2 | 11 | 6 | -61.4 | 11.1 | | | 1 | | | | | |
| 2 | 11 | 7 | -58 | 11.5 | | 330 | 1 | 40 | | | | |
| 2 | 11 | 8 | -56.8 | 11.2 | | 320 | 1 | 25 | | | | |
| 2 | 11 | 9 | -58 | 11.7 | | 325 | 1 | 30 | | | | |
| 2 | 11 | 10 | -59.1 | 10.6 | | 315 | 1 | 40 | | | | |
| 2 | 11 | 11 | -58.1 | 11 | | | 1 | 30 | | | | |
| 2 | 11 | 12 | -57 | 10.9 | | 325 | 1 | 30 | | | | |
| 2 | 11 | 13 | -57 | 11.2 | | 310 | 1 | 20 | | | | |
| 2 | 11 | 14 | -57 | 10.4 | | 310 | 1 | 25 | | | | |
| 2 | 11 | 15 | -57.6 | 11.7 | | 310 | 1 | 35 | | | | |
| 2 | 11 | 16 | -59.6 | 13.1 | | 295 | 1 | | | | | |
| 2 | 12 | 1 | -58 | 11.8 | 19 | | 3 | 50 | 65 | 0.17 | 90 | 200 Bars |
| 2 | 12 | 2 | -57.5 | 11.6 | 23 | 330 | 3 | 75 | 70 | 0.2 | 75 | 200 Bars |
| 2 | 12 | 3 | -61.6 | 13.5 | | 345 | 3 | 40 | | | | |
| 2 | 13 | 1 | -58.8 | 12.9 | | 320 | 3 | 20 | | | | |
| 2 | 13 | 2 | -57 | 10.7 | 24.5 | 293 | 3 | 20 | 75 | 0.22 | 95 | 200 Bars |
| 2 | 15 | 1 | -57.6 | 11.7 | | | 1 | 15 | | | | |
| 2 | 15 | 2 | -57 | 10.8 | 26.5 | 319** | 1 | 40 | 75 | 0.23 | 93 | 200 Bars |
| 2 | 15 | 3 | -57 | 10.9 | 27 | 312.5 | 1 | 30 | 75 | 0.23 | 94 | 200 Bars |
| 2 | 15 | 4 | -57 | 10.8 | | | 1 | 35 | | | | |
| 2 | 15 | 5 | -56.6 | 10.7 | | 310 | 1 | | | | | |
| 2 | 15 | 6 | -56.7 | 10.8 | 26.6 | | 1 | 40 | 75 | 0.23 | 95 | 200 Bars |
| 2 | 15 | 9 | -57 | 10.8 | 30 | | 1 | 20 | 80 | 0.3 | 95 | 200 Bars |
| 2 | 15 | 10 | -57 | 10.8 | | | 1 | 15 | | | | |
| 2 | 15 | 11 | -56.6 | 10.3 | 29 | 300 | 1 | 30 | 75 | 0.25 | 92 | 200 Bars |
| 2 | 15 | 12 | -56.6 | 10.5 | | 305 | 1 | 20 | | | | |
| 2 | 15 | 13 | -56.8 | 10.9 | 28.5* | | 1 | 35 | 120 | 0.75 | 82 | >800 bars |
| Buckeye | | 1 | -65 | 15.6 | | 335 | | 60 | | | | |
| Buckeye | | 2 | -61.9 | 13.9 | | | | 50 | | | | |

Table 11 continued. Fluid inclusion data and estimated fluid parameters.

| Hole | Slide | Inclusion | CO2 | Clath | Cohom | Homog | Au group | Volume | Bars | Density | Moleh20 | Est. Press |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Buckeye | | 3 | -57.6 | | | 330 | | 50 | | | | |
| Buckeye | | 4 | -57.5 | 10.1 | | 330 | | 60 | | | | |
| Buckeye | | 5 | -56.7 | 10.1 | | 340 | | 50 | | | | |
| Buckeye | | 6 | 61.7 | 13.3 | | 335 | | 35 | | | | |
| Buckeye | | 7 | -58.6 | 12.2 | 16.2 | 337 | | 35 | 50 | 0.17 | 94 | 200 Bars |
| Buckeye | | 8 | -57.6 | 11.0 | 21.7 | 330 | | 35 | 60 | 0.19 | 95 | 200 Bars |
| Buckeye | | 9 | -58.2 | 10.9 | 22.0 | 325 | | 50 | 60 | 0.19 | 90 | 200 Bars |
| Buckeye | | 10 | -57.4 | 11.0 | 23.9 | 325 | | 35 | 68 | 0.2 | 94 | 200 Bars |
| Buckeye | | 11 | -65.4 | 14.1 | | 350 | | 60 | | | | |

Table 12. Comparison between Bald Knob, Democrat, Ryan Lode fluid inclusion data.

| Sample | Size (μ) | TmCO2 ( °C) | Clathrate T. ( °C) | Th ( °C) | Volume % vapor | Salinity (% NaCl) | Mol % CO2 | Trap P (bars) |
|---|---|---|---|---|---|---|---|---|
| **Demo 1** | 20-60 | -56.6 | not measured | 340-360 | 10-90 | 32-65 | Variable | unknown |
| **Demo 2** | 50-100 | -56.6 | not measured | 155-165 | 10-90 | 8-11.7 | Variable | unknown |
| **BK hiP** | 10-20 | -56.8-57.6 | 10.9 | ≥280 | 35-50 | Low | 20 | >1000 |
| **BK loP** | 10-20 | -56.6-62.9 | 10.4-13.6 | 300-345 | 25-50 | Low | 10 avg | 250-400 |
| **Ryan Lode** | 5-35 | -56.6 to -58.4 | 9.3-12.5 | 206-325 | 10-90 | Low | 12 | 250-300 |
| **Bkeyel** | 10-20 | -61 to -65.4 | not measured | 330-350 | 50-60 | Low? | unknown | unknown |
| **Bkeye2** | 10-20 | -57 to -65.4 | 10-15.5 | 325-337 | 35-50 | Low | 5-10% | 250 |

Demo 1, Demo 2 = Democrat (Pakhomova et al., 1995); BKhiP, BKloP = Bald Knob, high Pressure and low Pressure types (this study); Ryan Lode = Ryan Lode deposit, Fairbanks district (McCoy et al., 1997); Bkeye1,2 = Buckeye high grade vein (this study).

Table 13. Interpreted $^{40}Ar/^{39}Ar$ ages (in Ma) for Richardson area samples.

| Sample number (mineral) | Low-temp fraction(s) age (% Ar) | High-temp fraction(s) age (% Ar) | Plateau age (% Ar) | Interpreted age |
|---|---|---|---|---|
| 125 (WM) | 87 ± 32 (1.5%) | 104.6 ± 1.6 (11.6%) | 102.0 ± 0.5 (81.4%) | >105 Ma |
| 143 (B) | 80.5 ± 1.6 (19%) | 114.0 ± 9 (1.0%) | 92.2 ± 0.6 (76%) | 114 ± 9 Ma |
| GRI-1 (B) | 56.9 ± 3.3 (0.6%) | 91.6 ± 1.7 (6.5%) | 90.7 ± 0.9 (78.3%) | 92 ± 2 Ma |
| AuVn (WM) | excess Ar | 105.6 + 1.8 (1.4%) | 104.8 ± 1.0 (51.4%) | ~ 105 Ma |
| BR4-328 (WM) | 77.5 + 1.1 (5.9%) | 96.6 ± 8.7 (0.8%) | 84.3 ± 0.5 (82.2%) | 85Ma<age< 97Ma |

(B) = biotite; (WM) = White mica; (%Ar) = % total $^{39}Ar$ released in the fraction(s). Spectrometer data in table 15.

Table 14. Ages of geologic events in the Richardson area as suggested by radiometric dating.

| Event | Interpreted age | Evidence |
|---|---|---|
| Cooling from peak metamorphism | ~ 116 Ma | K-Ar age of hornblende from amphibolite (Bundtzen and Reger, 1977) |
| Emplacement of peraluminous felsic dikes following a collisional event | ~ 114 Ma | Highest-temperature fraction age of sample 143; regional correlations |
| First Gold veining event | ~ 105 Ma | Sample AuVn; regional correlations |
| Subduction-related magmatism | ~ 92 Ma | GRI-1 spectrum; regional correlations |
| Second Gold veining event | ~ 90 Ma | Democrat lode deposit age; regional correlations |
| Early Tertiary magmatism | ~ 57 Ma | Post-90 Ma thermal resets to most spectra, especially GRI-1 |

Table 15. $^{40}Ar/^{39}Ar$ step-heating results and data.

NOTES:
Weighted average J (irradiation parameter) calculated from standard MMhb-1 (513.9 Ma)
Runs are step heat analyses of 1-3 single crystals of a mineral phase.
Laser power (in milliwatts) is the heating step from a defocussed argon-ion laser: 8700 mW represents the fusion step in most cases
% 39Ar: the proportion of 39Ar released in each step of a run.
Measured isotopic ratios (and 1-sigma error) are corrected for reactor induced interferences and decay of 37Ar and 39Ar
% Atm. 40Ar*: percent of atmospheric 40Ar in the sample assuming an initial 40Ar/36Ar ratio of 295.5
40Ar*/39ArK (40*/39K) and ages (and 1-sigma error) calculated using the equations and constants quoted in McDougall and Harrison (1988)

UAF084-55 BR4-328 WM 02-14-01 RICHARDSON Weighted average of J from standards = 0.001380 +/- 0.000006

| Laser Power | Fraction 39Ar | 40Ar/39Ar measured | +/- | 37Ar/39Ar measured | +/- | 36Ar/39Ar measured | +/- | % Atm. 40Ar* | Ca/K | Cl/K | 40*/39K | Age (Ma) | +/- (Ma) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.059 | 40.506 | 0.366 | -0.0012 | 0.0033 | 0.0294 | 0.0013 | 21.4 | -0.002 | 0.0004 | 31.80 | 77.5 | 1.1 |
| 150 | 0.098 | 33.700 | 0.229 | -0.0016 | 0.0057 | 0.0012 | 0.0015 | 1.1 | -0.003 | -0.0003 | 33.31 | 81.1 | 1.2 |
| 200 | 0.159 | 33.581 | 0.227 | 0.0020 | 0.0059 | -0.0010 | 0.0021 | -0.9 | 0.004 | -0.0002 | 33.84 | 82.4 | 1.6 |
| 300 | 0.260 | 33.915 | 0.272 | -0.0028 | 0.0016 | -0.0002 | 0.0005 | -0.2 | -0.005 | 0.0002 | 33.95 | 82.6 | 0.7 |
| 600 | 0.518 | 35.631 | 0.204 | -0.0004 | 0.0011 | 0.0014 | 0.0005 | 1.1 | -0.001 | 0.0004 | 35.20 | 85.6 | 0.6 |
| 750 | 0.691 | 35.324 | 0.195 | 0.0005 | 0.0015 | 0.0009 | 0.0005 | 0.8 | 0.001 | 0.0004 | 35.02 | 85.2 | 0.6 |
| 900 | 0.748 | 34.413 | 0.266 | 0.0032 | 0.0054 | 0.0013 | 0.0017 | 1.1 | 0.006 | 0.0000 | 33.99 | 82.7 | 1.4 |
| 1050 | 0.792 | 35.069 | 0.158 | -0.0005 | 0.0056 | 0.0014 | 0.0017 | 1.2 | -0.001 | 0.0001 | 34.63 | 84.2 | 1.2 |
| 1200 | 0.837 | 35.506 | 0.175 | 0.0084 | 0.0046 | 0.0025 | 0.0018 | 2.1 | 0.015 | 0.0004 | 34.74 | 84.5 | 1.3 |
| 1350 | 0.877 | 35.117 | 0.260 | -0.0033 | 0.0044 | 0.0023 | 0.0019 | 2.0 | -0.006 | 0.0004 | 34.40 | 83.7 | 1.5 |
| 1500 | 0.920 | 34.083 | 0.254 | -0.0011 | 0.0049 | 0.0004 | 0.0016 | 0.3 | -0.002 | 0.0008 | 33.95 | 82.6 | 1.3 |
| 2000 | 0.984 | 32.664 | 0.334 | 0.0066 | 0.0028 | 0.0015 | 0.0013 | 1.4 | 0.012 | 0.0007 | 32.18 | 78.4 | 1.2 |
| 2500 | 0.992 | 37.260 | 0.794 | 0.0219 | 0.0180 | 0.0040 | 0.0100 | 3.2 | 0.040 | 0.0020 | 36.05 | 87.6 | 7.2 |
| 3000 | 0.997 | 40.401 | 0.751 | -0.0388 | 0.0236 | -0.0005 | 0.0116 | -0.4 | -0.071 | 0.0018 | 40.52 | 98.2 | 8.3 |
| 8000 | 1.000 | 42.068 | 2.344 | 0.0005 | 0.0743 | 0.0119 | 0.0279 | 8.4 | 0.001 | 0.0018 | 38.52 | 93.5 | 20.1 |
| Integrated | | 35.170 | 0.080 | 0.0004 | 0.0009 | 0.0027 | 0.0003 | 2.3 | 0.001 | 0.0003 | 34.34 | 83.5 | 0.5 |

Table 15 continued. $^{40}Ar/^{39}Ar$ step-heating results and data.

UAF084-54 AuVn WM 02-13-01 RICHARDSON Weighted average of J from standards = 0.001380 +/-0.000006

| Laser Power | Fraction 39Ar | 40Ar/39Ar measured | +/- | 37Ar/39Ar measured | +/- | 36Ar/39Ar measured | +/- | % Atm. 40Ar* | Ca/K | Cl/K | 40*/39K | Age (Ma) | +/- (Ma) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 0.014 | 48.057 | 0.453 | 0.0091 | 0.0040 | 0.1409 | 0.0041 | 86.7 | 0.017 | 0.0014 | 6.41 | 15.9 | 2.9 |
| 150 | 0.016 | 90.431 | 1.718 | -0.0289 | 0.0371 | 0.1641 | 0.0169 | 53.7 | -0.053 | 0.0004 | 41.89 | 101.4 | 11.8 |
| 200 | 0.019 | 70.330 | 1.379 | -0.0042 | 0.0273 | 0.0743 | 0.0119 | 31.2 | -0.008 | -0.0026 | 48.35 | 116.6 | 8.5 |
| 300 | 0.027 | 52.032 | 0.410 | 0.0075 | 0.0088 | 0.0262 | 0.0031 | 14.9 | 0.014 | 0.0010 | 44.26 | 107.0 | 2.3 |
| 450 | 0.049 | 50.224 | 0.398 | -0.0023 | 0.0031 | 0.0195 | 0.0013 | 11.5 | -0.004 | 0.0006 | 44.44 | 107.4 | 1.3 |
| 600 | 0.091 | 45.507 | 0.247 | -0.0013 | 0.0020 | 0.0088 | 0.0008 | 5.7 | -0.002 | 0.0005 | 42.89 | 103.8 | 0.8 |
| 750 | 0.176 | 43.320 | 0.174 | -0.0022 | 0.0019 | 0.0022 | 0.0005 | 1.5 | -0.004 | 0.0006 | 42.63 | 103.1 | 0.5 |
| 900 | 0.285 | 42.725 | 0.228 | 0.0000 | 0.0008 | 0.0009 | 0.0004 | 0.6 | 0.000 | 0.0006 | 42.42 | 102.7 | 0.6 |
| 1050 | 0.400 | 42.917 | 0.238 | -0.0017 | 0.0007 | 0.0006 | 0.0003 | 0.4 | -0.003 | 0.0004 | 42.71 | 103.3 | 0.6 |
| 1200 | 0.486 | 42.626 | 0.167 | 0.0002 | 0.0010 | 0.0012 | 0.0005 | 0.8 | 0.000 | 0.0006 | 42.25 | 102.3 | 0.5 |
| 2000 | 0.758 | 43.874 | 0.487 | 0.0007 | 0.0004 | 0.0014 | 0.0001 | 1.0 | 0.001 | 0.0005 | 43.42 | 105.0 | 1.2 |
| 8000 | 0.986 | 43.635 | 0.602 | -0.0001 | 0.0005 | 0.0012 | 0.0002 | 0.8 | 0.000 | 0.0005 | 43.25 | 104.6 | 1.4 |
| 8700 | 1.000 | 45.057 | 0.389 | -0.0028 | 0.0038 | 0.0046 | 0.0022 | 3.0 | -0.005 | -0.0003 | 43.67 | 105.6 | 1.8 |
| Integrated | | 43.949 | 0.196 | -0.0003 | 0.0003 | 0.0047 | 0.0001 | 3.1 | 0.000 | 0.0005 | 42.54 | 102.9 | 0.7 |

UA F084-52 125 WM 02-13-01 RICHARDSON Weighted average of J from standards = 0.001380 +/-0.000006

| Laser Power | Fraction 39Ar | 40Ar/39Ar measured | +/- | 37Ar/39Ar measured | +/- | 36Ar/39Ar measured | +/- | % Atm. 40Ar* | Ca/K | Cl/K | 40*/39K | Age (Ma) | +/- (Ma) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 150 | 0.002 | 82.592 | 10.071 | -0.0025 | 0.2330 | 0.1381 | 0.1096 | 49.4 | -0.005 | -0.0060 | 41.77 | 101.1 | 76.3 |
| 200 | 0.002 | 37.192 | 8.150 | -0.0883 | 0.1996 | 0.0743 | 0.1810 | 59.1 | -0.162 | -0.0281 | 15.19 | 37.4 | 130.2 |
| 300 | 0.006 | 51.133 | 3.018 | 0.0824 | 0.0679 | 0.0648 | 0.0549 | 37.5 | 0.151 | 0.0062 | 31.96 | 77.9 | 38.9 |
| 450 | 0.015 | 50.404 | 0.995 | 0.0155 | 0.0273 | 0.0319 | 0.0139 | 18.7 | 0.028 | -0.0011 | 40.95 | 99.2 | 9.9 |
| 600 | 0.070 | 46.095 | 0.292 | -0.0145 | 0.0047 | 0.0084 | 0.0019 | 5.4 | -0.027 | 0.0014 | 43.57 | 105.4 | 1.5 |
| 750 | 0.260 | 44.017 | 0.174 | -0.0062 | 0.0014 | 0.0051 | 0.0007 | 3.4 | -0.011 | 0.0004 | 42.48 | 102.8 | 0.6 |
| 900 | 0.602 | 43.622 | 0.199 | -0.0028 | 0.0012 | 0.0051 | 0.0005 | 3.4 | -0.005 | 0.0004 | 42.10 | 101.9 | 0.6 |
| 1050 | 0.884 | 42.898 | 0.169 | -0.0016 | 0.0009 | 0.0029 | 0.0003 | 2.0 | -0.003 | 0.0005 | 42.01 | 101.7 | 0.4 |
| 1200 | 0.919 | 43.009 | 0.449 | -0.0153 | 0.0083 | -0.0034 | 0.0031 | -2.4 | -0.028 | 0.0005 | 43.99 | 106.4 | 2.4 |
| 2000 | 0.977 | 43.055 | 0.333 | -0.0071 | 0.0078 | -0.0001 | 0.0024 | 0.0 | -0.013 | 0.0002 | 43.05 | 104.1 | 1.9 |
| 8000 | 1.000 | 43.965 | 0.574 | 0.0090 | 0.0244 | 0.0044 | 0.0067 | 2.9 | 0.016 | 0.0002 | 42.65 | 103.2 | 4.8 |
| Integrated | | 43.724 | 0.097 | -0.0038 | 0.0011 | 0.0047 | 0.0005 | 3.2 | -0.007 | 0.0005 | 42.30 | 102.4 | 0.6 |

Table 15 continued. $^{40}Ar/^{39}Ar$ step-heating results and data.

UAF084-53 143 BI 02-14-01 RICHARDSON Weighted average of J from standards = 0.001380 +/- 0.000006

| Laser Power | Fraction 39Ar | 40Ar/39Ar measured | +/- | 37Ar/39Ar measured | +/- | 36Ar/39Ar measured | +/- | % Atm. 40Ar* | Ca/K | Cl/K | 40*/39K | Age (Ma) | +/- (Ma) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.000 | -58.624 | 91.623 | 0.8905 | 3.5216 | 0.7584 | 1.8822 | -382.0 | 1.635 | 0.3167 | -282.86 | -892.4 | 2525.1 |
| 150 | 0.190 | 36.220 | 0.650 | 0.0080 | 0.0024 | 0.0106 | 0.0007 | 8.6 | 0.015 | 0.0283 | 33.08 | 80.5 | 1.6 |
| 200 | 0.370 | 38.493 | 0.224 | 0.0008 | 0.0031 | 0.0015 | 0.0008 | 1.1 | 0.001 | 0.0242 | 38.03 | 92.3 | 0.8 |
| 300 | 0.519 | 38.055 | 0.215 | 0.0012 | 0.0028 | 0.0009 | 0.0008 | 0.7 | 0.002 | 0.0180 | 37.76 | 91.7 | 0.8 |
| 450 | 0.718 | 38.434 | 0.377 | 0.0017 | 0.0028 | 0.0008 | 0.0009 | 0.6 | 0.003 | 0.0201 | 38.17 | 92.6 | 1.1 |
| 600 | 0.869 | 38.003 | 0.308 | 0.0001 | 0.0030 | 0.0000 | 0.0011 | 0.0 | 0.000 | 0.0211 | 37.98 | 92.2 | 1.1 |
| 750 | 0.926 | 38.229 | 0.271 | -0.0069 | 0.0088 | -0.0004 | 0.0026 | -0.3 | -0.013 | 0.0193 | 38.32 | 93.0 | 1.9 |
| 900 | 0.950 | 37.771 | 0.385 | -0.0123 | 0.0194 | 0.0017 | 0.0060 | 1.4 | -0.022 | 0.0156 | 37.23 | 90.4 | 4.3 |
| 1050 | 0.962 | 37.966 | 0.542 | -0.0394 | 0.0324 | -0.0144 | 0.0110 | -11.2 | -0.072 | 0.0133 | 42.20 | 102.1 | 7.8 |
| 1200 | 0.972 | 37.980 | 0.731 | -0.0295 | 0.0433 | 0.0196 | 0.0166 | 15.3 | -0.054 | 0.0145 | 32.15 | 78.3 | 11.8 |
| 1500 | 0.980 | 38.910 | 0.738 | -0.0096 | 0.0542 | 0.0071 | 0.0198 | 5.4 | -0.018 | 0.0152 | 36.78 | 89.3 | 13.9 |
| 2000 | 0.991 | 38.251 | 0.559 | 0.0179 | 0.0244 | 0.0033 | 0.0096 | 2.5 | 0.033 | 0.0171 | 37.25 | 90.5 | 6.8 |
| 8800 | 1.000 | 41.606 | 1.222 | -0.0027 | 0.0518 | -0.0192 | 0.0117 | -13.6 | -0.005 | 0.0108 | 47.24 | 114.0 | 8.7 |
| Integrated | | 37.909 | 0.164 | 0.0007 | 0.0016 | 0.0024 | 0.0005 | 1.9 | 0.001 | 0.0218 | 37.17 | 90.3 | 0.7 |

UAF083-56 GRI-1 Bl#1 02-04-01 RICHARDSON Weighted average of J from standards = 0.001380 +/- 0.000006

| Laser Power | Fraction 39Ar | 40Ar/39Ar measured | +/- | 37Ar/39Ar measured | +/- | 36Ar/39Ar measured | +/- | % Atm. 40Ar* | Ca/K | Cl/K | 40*/39K | Age (Ma) | +/- (Ma) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 150 | 0.006 | 37.907 | 0.636 | 0.1028 | 0.0144 | 0.0496 | 0.0044 | 38.7 | 0.189 | 0.0286 | 23.23 | 56.9 | 3.3 |
| 200 | 0.019 | 39.946 | 0.255 | 0.0241 | 0.0078 | 0.0113 | 0.0028 | 8.3 | 0.044 | 0.0367 | 36.59 | 88.9 | 2.0 |
| 300 | 0.076 | 37.656 | 0.171 | 0.0082 | 0.0010 | 0.0021 | 0.0005 | 1.6 | 0.015 | 0.0378 | 37.01 | 89.9 | 0.5 |
| 450 | 0.221 | 37.430 | 0.439 | 0.0066 | 0.0006 | -0.0001 | 0.0002 | -0.1 | 0.012 | 0.0384 | 37.42 | 90.9 | 1.1 |
| 600 | 0.364 | 37.589 | 0.504 | 0.0066 | 0.0011 | -0.0006 | 0.0005 | -0.5 | 0.012 | 0.0379 | 37.73 | 91.6 | 1.3 |
| 750 | 0.544 | 37.470 | 0.855 | 0.0127 | 0.0009 | 0.0006 | 0.0003 | 0.5 | 0.023 | 0.0376 | 37.26 | 90.5 | 2.0 |
| 900 | 0.802 | 37.497 | 0.730 | 0.0295 | 0.0006 | 0.0006 | 0.0003 | 0.4 | 0.054 | 0.0379 | 37.30 | 90.6 | 1.7 |
| 1050 | 0.935 | 37.144 | 0.211 | 0.1014 | 0.0015 | -0.0005 | 0.0005 | -0.4 | 0.186 | 0.0383 | 37.27 | 90.5 | 0.6 |
| 1200 | 0.980 | 37.649 | 0.221 | 0.3201 | 0.0044 | -0.0011 | 0.0015 | -0.9 | 0.587 | 0.0379 | 37.98 | 92.2 | 1.2 |
| 1500 | 0.990 | 37.298 | 0.297 | 0.9425 | 0.0143 | -0.0004 | 0.0029 | -0.5 | 1.730 | 0.0342 | 37.48 | 91.0 | 2.1 |
| 2000 | 0.996 | 37.261 | 0.359 | 0.5345 | 0.0238 | 0.0003 | 0.0053 | 0.1 | 0.981 | 0.0232 | 37.20 | 90.3 | 3.8 |
| 8800 | 1.000 | 51.353 | 0.565 | 0.2672 | 0.0186 | 0.0502 | 0.0060 | 28.8 | 0.490 | 0.0142 | 36.53 | 88.7 | 4.3 |
| Integrated | | 37.554 | 0.264 | 0.0549 | 0.0005 | 0.0008 | 0.0002 | 0.6 | 0.101 | 0.0377 | 37.29 | 90.5 | 0.8 |

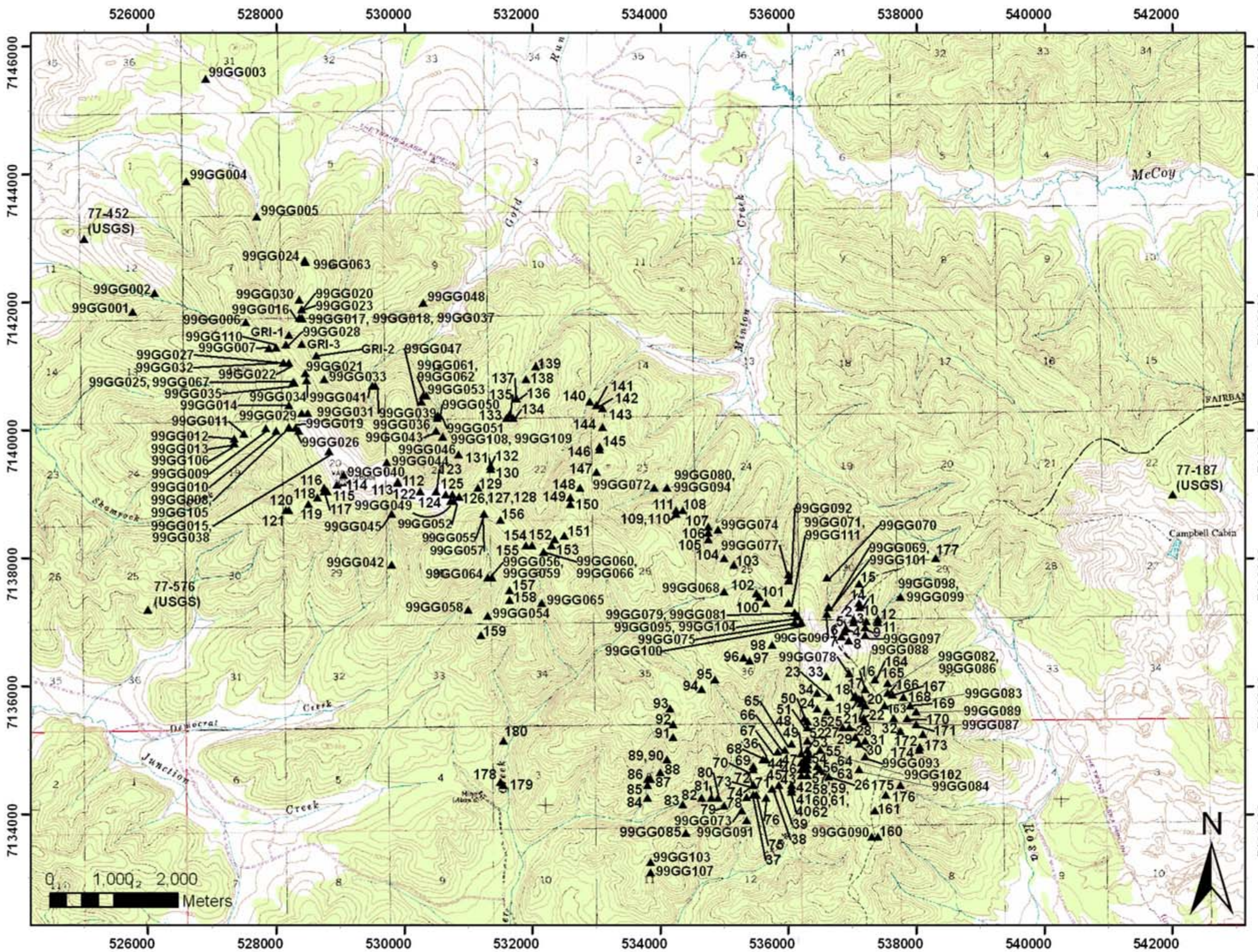


Figure 1. Location of analyzed samples from the Richardson district, Big Delta B-5 Quadrangle, Alaska.