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AGE OF THE BOOTJACK STOCK, QUESNEL TERRANE, SOUTH-CENTRAL BRITISH COLUMBIA* (93A)

By D.G. Bailey
Bailey Geological Consultants (Canada) Ltd.
D.A. Archibald
Queen's University

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INTRODUCTION

The Bootjack stock in south-central British Columbia is a zoned nepheline syenite intrusion related to a magmatic event which gave rise to the adjacent Polley stock, host to the Cariboo Bell porphyry copper-gold deposits. Hodgson *et al.* (1976) considered the Bootjack Stock to be a deeper level phase of the subvolcanic Polley stock. A K-Ar date of 184 $\pm$ 7 Ma published by Hodgson *et al.* (1976) from hydrothermal biotite related to sulphide mineralization was considered by these authors to be a "median" age of the Polley stock in that intrusive events bracketed the time of formation of the metasomatic biotite.

Bailey (1978, 1988), on the basis of a whole-rock K-Ar date obtained from the fine-grained margin of the Bootjack stock, and on geological grounds, considered the Bootjack stock to be much younger than the adjacent Polley stock.

This note reports new data obtained from a coarse-grained amphibole-rich phase of the Bootjack stock which support the conclusion of Hodgson *et al.*, that the Bootjack and Polley stocks are probably magmatically related.

GEOLOGICAL SETTING

The Bootjack stock and the adjacent Polley stock occur within the south-central part of the Mesozoic Quesnel Terrane, a tectonic belt bounded to the west by the mainly Paleozoic Cache Creek Group and to the east by Paleozoic rocks of the Barkerville Terrane (Bailey, 1988) over which it has been thrust (Struik, 1983) (Figure 1-8-1). Rocks of the Quesnel Terrane comprise a lower assemblage of mainly fine-grained epiclastics, overlain by a bimodal shoshonitic volcanic suite ranging from alkaline basalt (alkali olivine basalt to analcite-bearing basalt) at the base to felsic volcanic breccias (mainly laharic debris flows with abundant trachyte and latite clasts) toward the top. Overlying this assemblage is a younger analcite-rich basalt unit which, in turn, is overlain by remnants of a probably Middle Jurassic successor basin assemblage (Figure 1-8-2). From fossil evidence the age of the lower basalt is Carnian to Norian while the overlying felsic volcanic rocks are Sinemurian and younger (Bailey, 1988).

Observations discussed by Bailey and Hodgson (1979) indicate the Polley stock is a subvolcanic intrusive complex emplaced within a volcanic edifice coevally with volcanism and that the age of crystallization of the stock is the same as the Sinemurian and younger felsic volcanic rocks.

AGE OF THE BOOTJACK STOCK

Hornblende from a coarse-grained porphyritic phase of the Bootjack stock was collected for radiometric dating by the $^{40}Ar/^{39}Ar$ method to define the age of the stock and to determine whether the Polley and the Bootjack stocks have similar ages, as suggested by Hodgson *et al.* (1976)

ANALYTICAL METHOD

Samples and three flux monitors (LP-6 biotite; *see* Table 1-8-1) were irradiated with fast neutrons in position 5C of the

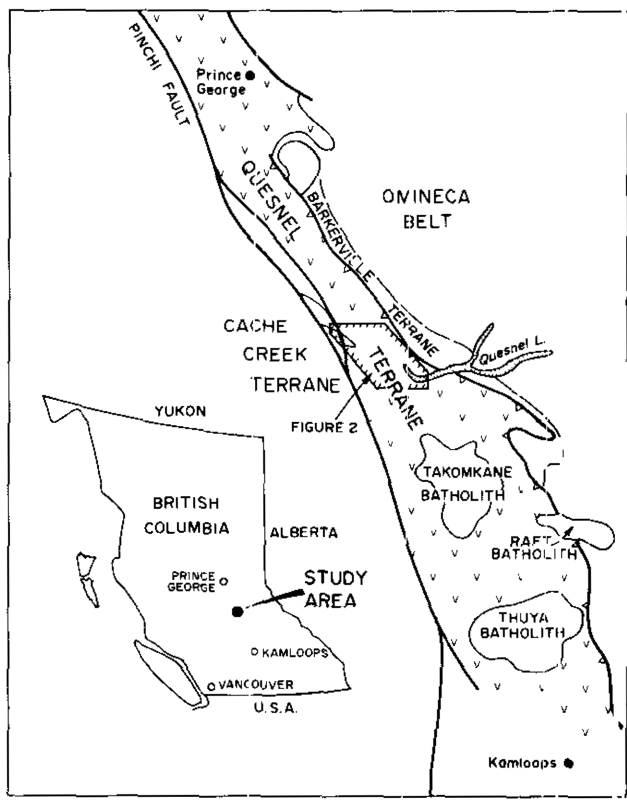

Figure 1-8-1. Location of Quesnel Terrane, south-central British Columbia.

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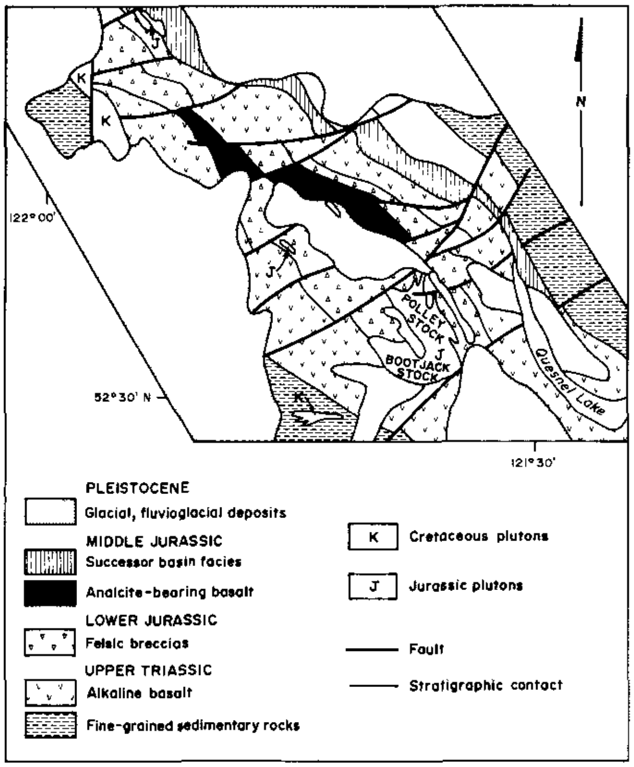

Figure 1-8-2. Generalized Triassic-Jurassic geology, central Quesnel belt. Younger Mesozoic and Tertiary strata not shown (after Bailey, 1988).

McMaster nuclear reactor (Hamilton, Ontario) for 1.04 days. The monitors were distributed throughout the irradiation container and the J-values for individual samples were determined by interpolation.

For step-heating experiments, irradiated samples were loaded into a quartz furnace-tube and heated using a Lindberg tube furnace. The bakeable, ultrahigh vacuum, stainless steel, argon extraction system is operated on-line with a substantially modified A.E.I. MS-10 mass spectrometer run in the static mode. Total fusion analyses were done using a custom five-position turret system and resistively heated tantalum-tube crucibles. Measured mass spectrometric ratios were extrapolated to zero time, corrected for an $^{40}Ar/^{36}Ar$ atmospheric ratio of 295.5 and corrected for neutron-induced ^{40}Ar from potassium and ^{39}Ar and ^{36}Ar from calcium (*see* Table 1-8-1). Ages and errors were calculated using the formula given by Dalrymple *et al.* (1981) and the constants recommended by Steiger and Jäger (1977). The errors shown in Table 1-8-1 represent the analytical precision at 2σ assuming that the error in J-value is zero.

Results

The age spectrum for the amphibole from the Bootjack stock is shown in Figure 1-8-3; analytical data are listed in Table 1-8-1. The small, low-temperature (500° to 875°C) gas fractions, representing approximately 15 per cent of the total ^{39}Ar released, are characterized by low $^{37}Ar/^{39}Ar$ ratios (which correspond to low Ca/K ratios) and record the presence of a small amount of fine-grained biotite enclosed in the somewhat poikilitic hornblende. The age and thermal significance of these steps are not known. The five steps from 920° to 1020° C correspond to the principle release of ^{39}Ar from the amphibole. The dates for these steps yield a well defined plateau age of 203.1 ± 2.0 (2σ) Ma for 80 per cent of the ^{39}Ar released. The $^{37}Ar/^{39}Ar$ ratios for this segment of the age spectrum are in the range 2.09 to 2.66 (Ca/K ratios of about 3.8 to 4.9), which is typical of alkali amphiboles. The three highest temperature steps account for about 5 per cent of the ^{39}Ar released and have poorly defined dates and significantly higher $^{37}Ar/^{39}Ar$ ratios than the amphibole. The form of the age spectrum is more likely the result of mixing of three phases rather than thermal overprinting of the amphibole. Thus, we interpret the plateau age as being the best estimate of the age of emplacement of the Bootjack stock.

The new $^{40}Ar/^{39}Ar$ date invalidates the K-Ar whole-rock date (117.3 ± 2.7 (2σ) Ma (recalculated from 111 Ma using the constants of Steiger and Jäger, 1977), reported by Bailey (1978). The whole-rock sample is from the fine-grained margin of the stock (sample number BML-4/5, chemical analysis number 51 in Bailey, 1978) and is characterized by abundant biotite and feldspar. Although the K-Ar date has no age significance, the discordance between it and the amphibole date probably indicates that the area was affected by a thermal event (of unknown magnitude) in post-mid-Jurassic

TABLE 1-8-1
ANALYTICAL DATA, BOOTJACK STOCK AMPHIBOLE

DB-87-2 Hb (80/115) J = 0.006374

Temp. °C	40/39 (1)	36/39 (1)	37/39 (1, 2)	Vol. ^{39}Ar x 10-9 cc NTP (3)	f39	%^{40}Ar Rad.	Date (5)	$\pm 2\sigma$ Ma
600	22.574	0.0279	0.493	3.544	0.0691	63.45	157.6	±7.2
700	20.613	0.0199	0.419	1.205	0.0235	71.49	162.0	±13.4
775	24.852	0.0339	0.441	0.873	0.0170	59.67	163.0	±24.9
825	18.786	0.0116	0.721	1.187	0.0231	81.89	168.8	±7.6
875	18.777	0.0077	1.465	1.391	0.0271	88.33	181.5	±5.2
920	19.217	0.0032	2.089	4.810	0.0938	95.74	200.3	±2.5
950	19.148	0.0020	2.289	7.579	0.1478	97.71	203.5	±2.0
980	18.974	0.0012	2.333	9.455	0.1843	98.88	204.0	±1.4
1000	19.061	0.0017	2.534	8.819	0.1719	98.15	203.5	±2.7
1020	19.157	0.0024	2.663	10.536	0.2054	97.27	202.8	±1.7
1040	21.151	0.0183	7.903	0.648	0.0126	77.06	179.2	±16.9
1070	22.927	0.0168	16.089	0.365	0.0071	83.45	209.7	±21.7
1200	25.272	0.0497	168.400	0.882	0.0172	91.82	277.3	±23.6

wt. = 150 mg
Total ^{39}Ar = 51.294 × 10-9 cm^3 NTP
I.A. = 197.9 ± 3.9 Ma
P.A. = 203.1 ± 2.0 Ma

(1) True ratios corrected for fractionation and discrimination using $^{40}Ar/^{36}Ar$ atmos. = 295.5
(2) $^{37}Ar/^{39}Ar$ is corrected for the decay of ^{37}Ar during and after irradiation using a ^{37}Ar half-life of 35.1 days.
(3) Volume of ^{39}Ar is determined using equilibration peak height and mass spectrometer sensitivity.
(4) Isotope production ratios for the McMaster reactor are from Masliwec (1981). (40/39)K = 0.0156
(36/39)Ca = 0.390169
(37/39)Ca = 1536.1
(5) Ages calculated using the constants recommended by Steiger and Jäger (1977). Errors represent the analytical precision only (i.e. error in J value = 0). Flux monitor used: LP-6 Biotite at 128.5 Ma.

time. The region borders the Omineca crystalline belt and contains several small plutons of possibly Cretaceous age (*e.g.* the Gavin Lake stock to the southwest) which may have overprinted minerals less argon retentive than amphibole.

DISCUSSION

The Polley and Bootjack stocks together comprise a number of intrusive phases which, from the southwest to the northeast, have been emplaced at successively shallower levels. The map distribution of rock types represents an oblique section through the intrusive complex, indicating it has been tilted down to the northeast (Figure 1-8-4).

Metasomatic biotite from the Polley stock yields a conventional K-Ar date of 184 ± 7 Ma (Hodgson *et al.*, 1976). As discussed above, the whole-rock K-Ar date may indicate post-Jurassic thermal overprinting of the region; biotite from the Polley stock may have been similarly affected. As hydrothermal activity, volcanism and plutonism were essentially coeval events (Bailey and Hodgson, 1979), this date must be viewed as a minimum age for magmatic crystallization at subvolcanic levels. On the other hand, the plateau age of 203.1 ± 2.0 (2σ) Ma for amphibole of the Bootjack stock indicates the age of magmatic cooling at a deeper crustal level of an early intrusive phase, possibly representing the time of the onset of felsic volcanism.

It may be speculated that, as the last period of basaltic volcanism, stratigraphically beneath the felsic volcanic rocks, is characterised by sodium enrichment (Bailey, 1978), the nepheline syenite of the Bootjack stock may represent the result of differentiation of a sodium-rich mafic magma. Successively younger phases of the intrusive complex, from diorite through monzonite to syenite, and their extrusive equivalents, latite and trachyte, may indicate increasing potassium enrichment of such an initially sodium-rich parent.

The age data reported here, together with the results of earlier dating (Hodgson *et al.*, 1976) suggest that plutonism and accompanying volcanism related to the Bootjack and Polley stocks occurred over a relatively long period of time, from lower Sinemurian to possibly the Aalenian stages, or through most of the Early Jurassic period.

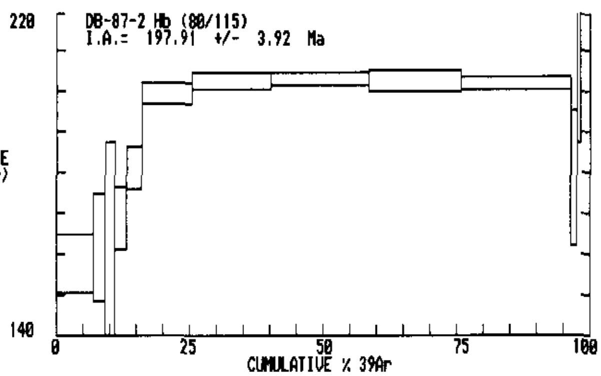

Figure 1-8-3. $^{40}Ar/^{39}Ar$ age spectrum of amphibole from the Bootjack stock. The vertical thickness of the bars represents the 2σ errors for each step.

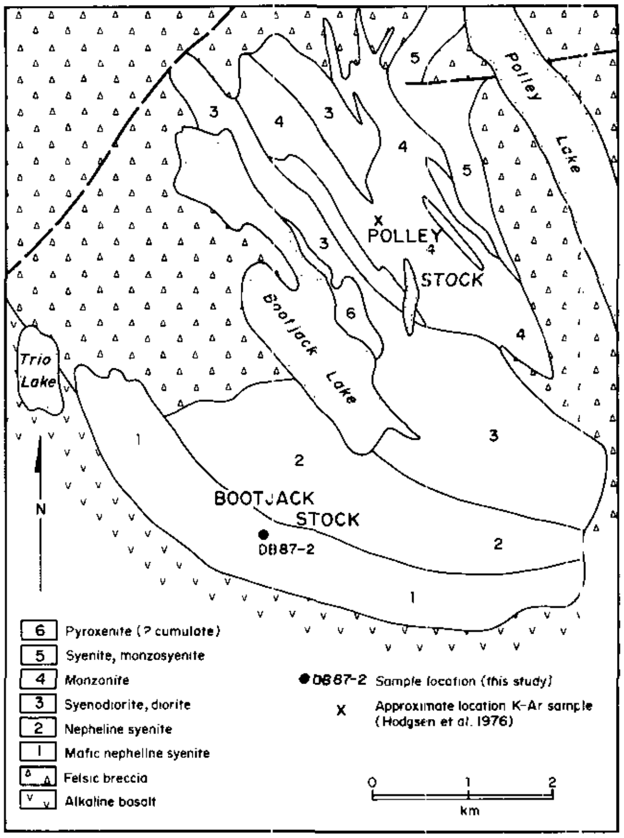

Figure 1-8-4. Generalized geology of Bootjack and Polley stocks (after Hodgson *et al.*, 1976; Bailey 1988 and unpublished) showing sample locations.

ACKNOWLEDGMENTS

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