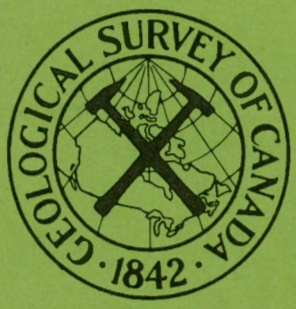

GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

PAPER 69-2A

AGE DETERMINATIONS AND GEOLOGICAL STUDIES

K-Ar Isotopic Ages, Report 9

R. K. Wanless, R. D. Stevens,
G. R. Lachance and R. N. Delabio

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ABSTRACT

One hundred and forty-six new potassium-argon age determinations carried out on Canadian rocks and minerals are reported. In most instances the age determination is accompanied by a description of the rock and mineral concentrate used; brief interpretive comments regarding the geological significance of each age is also provided. The experimental procedures employed are described in brief outline and the constants used in the calculation of ages and isotopic abundances are listed. Two geological time scales are reproduced in tabular form for ready reference.

The age-determination program is a co-ordinated effort involving the field geologists acknowledged in the accompanying text, and the chemists, geologists, mineralogists, and physicists of the research laboratories of the Geological Survey listed below:

R.D. Stevens, R.K. Wanless - Argon extraction, mass spectrometry, age calculation, and potassium determination using isotope dilution techniques.

G.R. Lachance - Potassium determination using X-ray fluorescence techniques.

R.N. Delabio - X-ray diffractometry and mineralogy of the concentrates.

AGE DETERMINATIONS AND GEOLOGICAL STUDIES

K-Ar Isotopic Ages, Report 9

INTRODUCTION

This is the ninth report of potassium-argon age measurements completed in the Geochronology Laboratories of the Geological Survey of Canada. One hundred and forty-six new determinations are listed, bringing the total number of published ages to 1,468.

A map showing the location of dated samples is not included because all dates have been compiled on Map 1256A, Isotopic Age Map of Canada (1:5,000,000 scale) which will accompany the fifth edition of Geology and Economic Minerals of Canada to be published in 1970 (Douglas, 1970).

Experimental Procedures

The concentration of potassium in mica and whole-rock samples was routinely determined using X-ray fluorescence methods (Lachance, in Wanless et al., 1965, pp. 4-7), and the reliability of this technique has been demonstrated (Wanless et al., 1966, Table 1, p. 2). For amphibole concentrates the potassium content was determined using isotope dilution techniques and solid-source, triple-filament mass spectrometry (Wanless et al., 1968, pp. 1-6).

Radio-frequency induction heating was employed to fuse the samples in vacuo. A calibrated quantity of enriched Ar^{38} was added to the liberated gas which was then purified by passage through cold-traps, hot CuO, and over a Ti sponge-getter. Isotopic analyses were carried out in a modified A.E.I. MS-10 mass spectrometer operated in the static mode.

The various factors to be considered in assigning experimental error limits to individual age determinations have been discussed in detail in Report 5 (Wanless et al., 1965, pp. 1-4). All reported errors are at the 95 per cent confidence level.

Original manuscript submitted: 1 April, 1970.
Final version approved: 14 April, 1970.
Authors' address: Geological Survey of Canada,
601 Booth Street,
Ottawa 4, Ontario.

Constants Employed in Age Calculations

The following constants have been employed to calculate the reported ages:

$\lambda_\beta = 4.72 \times 10^{-10}\ yr^{-1}$; $\lambda_\varepsilon = 0.585 \times 10^{-10}\ yr^{-1}$; K^{40} atomic abundance = 1.19×10^{-4}

Geological Time Scale

The Phanerozoic time scales of the Geological Society of London (1964), and Holmes (1959) are summarized in tabular form in Table 1. A time scale and subdivisions for the Precambrian of the Canadian Shield were presented by Stockwell (1964; his Table II), and for reference it is reproduced in essence as Table 2 of this paper.

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Stockwell, C.H.
1964: Fourth report on structural provinces, orogenies, and time classification of the Canadian Precambrian Shield; *in* Age determinations and geological studies; *Geol. Surv. Can.*, Paper 64-17, Pt. II, pp. 1-21.

Wanless, R.K., Stevens, R.D., Lachance, G.R., and Edmonds, C.M.
1968: Age determinations and geological studies, K-Ar isotopic ages, Report 8; *Geol. Surv. Can.*, Paper 67-2, Pt. A.

Wanless, R.K., Stevens, R.D., Lachance, G.R., and Rimsaite, J.Y.H.
1965: Age determinations and geological studies, Pt. 1 - Isotopic ages, Report 5; *Geol. Surv. Can.*, Paper 64-17, pp. 1-126.

1966: Age determinations and geological studies, K-Ar isotopic ages, Report 6; *Geol. Surv. Can.*, Paper 65-17.

Errata

GSC Paper 62-17

Determination GSC 61-79:
Co-ordinates should read 61°33'40"N, 110°52'30"W.

GSC Paper 63-17

Determination GSC 62-189:
Co-ordinates should read 47°28'N, 54°05'W.

GSC Paper 64-17 (Part 1)

Determination GSC 63-40:
Co-ordinates should read 64°05'N, 115°41'W.

GSC Paper 66-17

Determination GSC 65-77:
Co-ordinates should read 67°46.5'N, 83°18'W.

Determination GSC 65-129:
Co-ordinates should read 49°45'N, 63°15'W.

GSC Paper 67-2 (Part A)

Determination GSC 66-170:
Co-ordinates should read 47°37'N, 56°00'W.

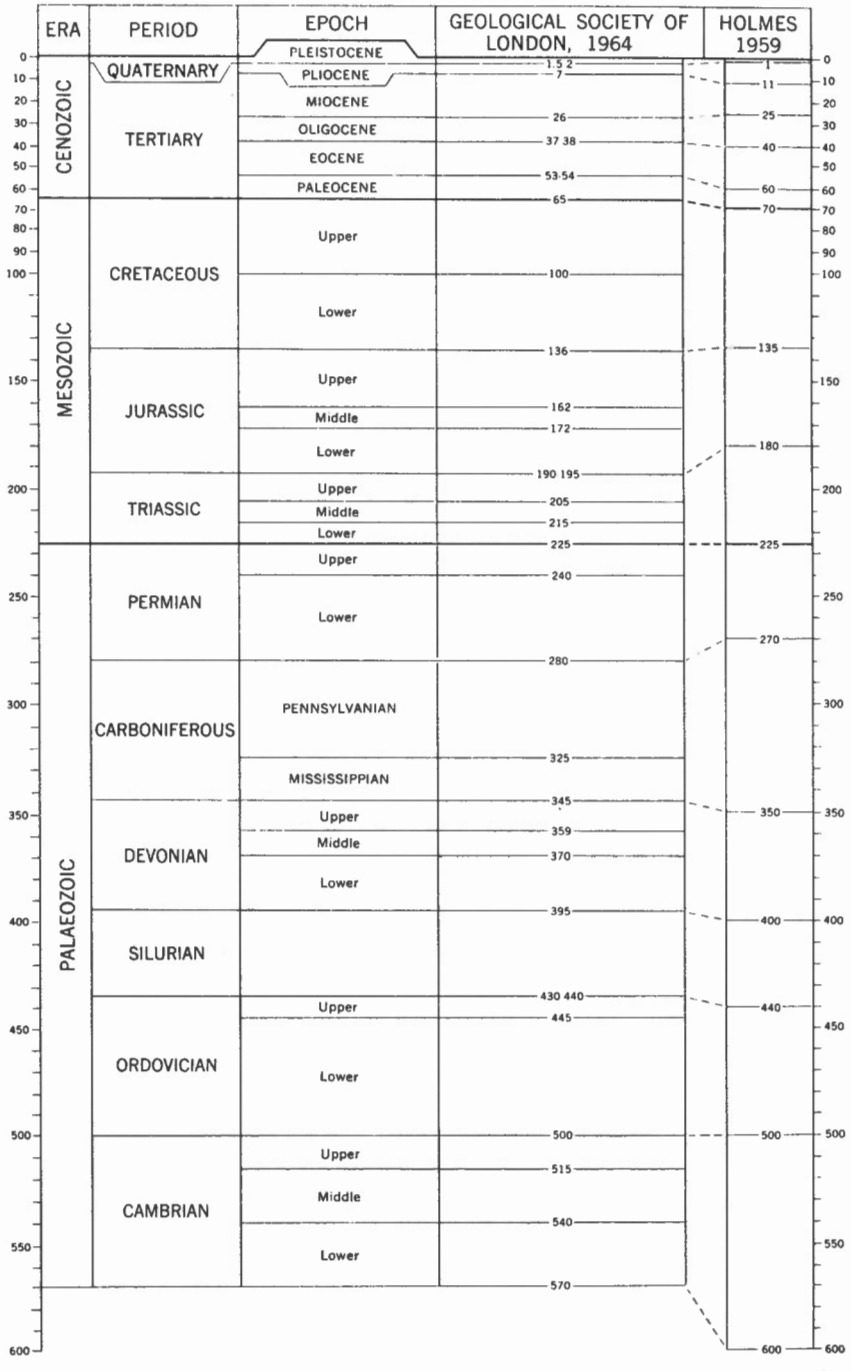

Table 1. Phanerozoic time scale.

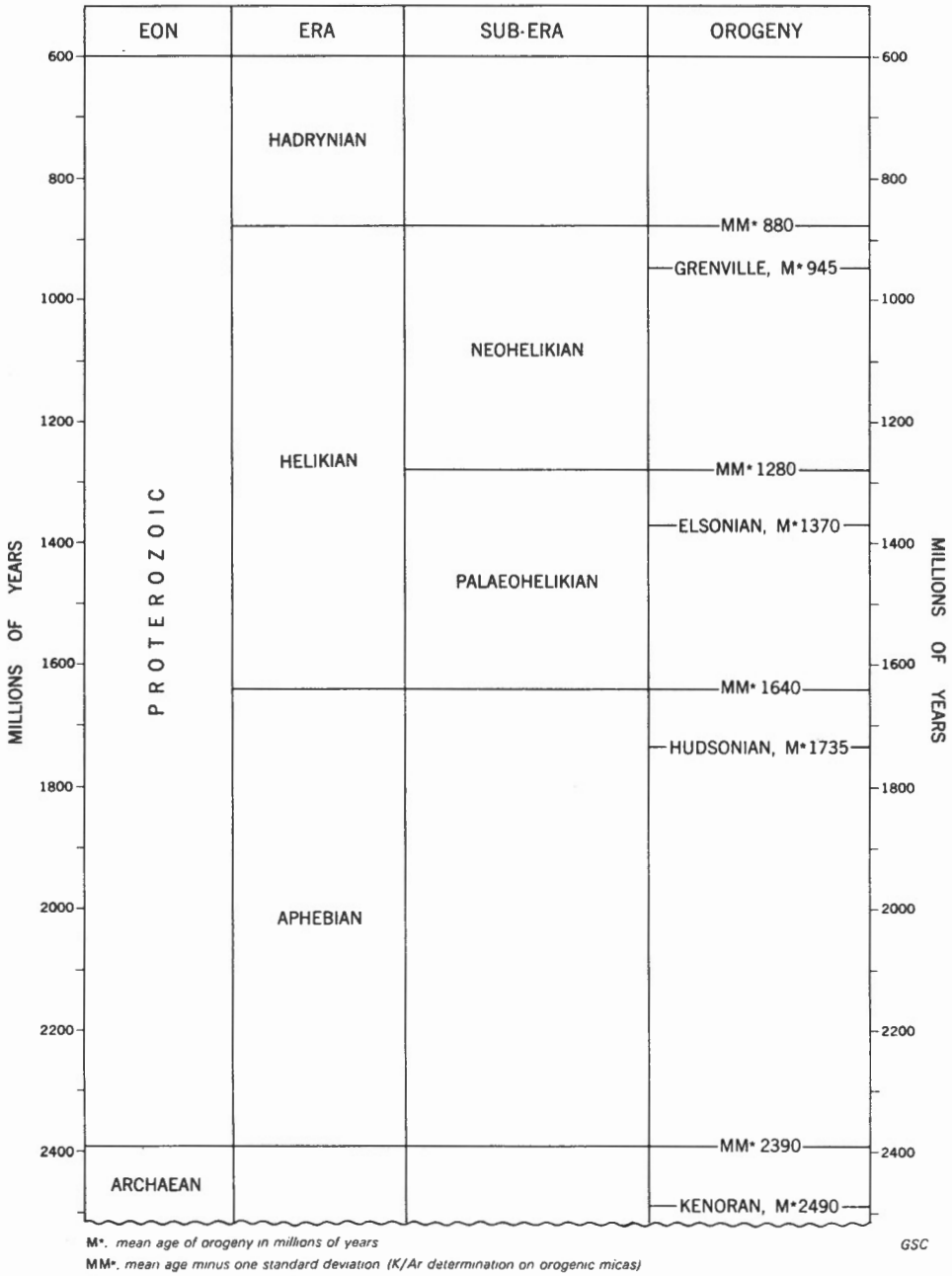

Table 2. Precambrian time scale for the Canadian Shield (after Stockwell, 1964).

British Columbia

GSC 67-1 Muscovite, K-Ar age 58 ± 3 m.y.

K = 8.70%, Ar^{40}/K^{40} = 0.0035, radiogenic Ar = 76%.
Concentrate: Clean, clear muscovite with some yellow staining on split flake edges.

From granite/quartz monzonite.
(104 O) On ridge crest south of Little Rancheria River, British Columbia, 59°39'N, 130°20.5'W. Map-unit 23a Cassiar Batholith, GSC Map 18-1968. Sample GA 67-87-1, collected and interpreted by H. Gabrielse.

The sample was taken from a stock(?) within the Cassiar Batholith and comprises leucocratic, even-grained, medium-to-coarse muscovite-quartz-monzonite. Fluorite is an abundant accessory mineral. Plagioclase, potash feldspar, and quartz are present in about equal amounts. Contacts between this body and biotite-quartz-monzonites characteristic of Cassiar Batholith have not been observed.
See GSC 67-2 for further comment.

GSC 67-2 Muscovite, K-Ar age 53 ± 3 m.y.

K = 8.66%, Ar^{40}/K^{40} = 0.0032, radiogenic Ar = 66%.
Concentrate: Clean, clear muscovite with slight yellow staining on split flake edges. No visible impurities.

From pegmatite.
(104 O) In shear zone south of Little Rancheria River, British Columbia, 59°39'N, 130°27.5'W. GSC Map 18-1968. Sample GAC 67-28A, collected by G.C. Crawford, interpreted by H. Gabrielse.

The muscovite occurs in coarse-grained pegmatite that cuts augen gneisses in a shear zone along the west side of Cassiar Batholith. Concentrations of fluorite occur locally. The age of 53 m.y. is in good agreement with 58 m.y. obtained on muscovite from the fluorite-bearing quartz monzonite to the east (GSC 67-1).

GSC 67-3 Hornblende, K-Ar age 181 ± 14 m.y.

K = 0.62%, Ar^{40}/K^{40} = 0.0111, radiogenic Ar = 89%.
Concentrate: Clean, pleochroic bright green to olive-green hornblende with less than 5% free chlorite and traces of quartz and biotite as impurities.

From quartz monzonite.
(104 O) On ridge crest, 0.65 mile north of Simpson Peak, British Columbia, 59°44'N, 131°26'45"W. Simpson Peak Batholith, GSC Map 18-1968, map-unit 22. Sample TO 66-161B, collected by D.J. Tempelman-Kluit, interpreted by H. Gabrielse.

See GSC 67-6 for description and interpretation.

British Columbia

GSC 67-4 Biotite, K-Ar age 165 ± 8 m.y.

$K = 7.40\%$, $Ar^{40}/K^{40} = 0.0101$, radiogenic Ar = 93%.
Concentrate: A mixture of dark olive-buff biotite and pale, bleached biotite. Chlorite occurs as free flakes to the extent of about 10%.

From quartz monzonite.
(104 O) Details as for GSC 67-3.

See GSC 67-6 for description and interpretation.

GSC 67-5 Hornblende, K-Ar age 183 ± 9 m.y.

$K = 0.60\%$, $Ar^{40}/K^{40} = 0.0112$, radiogenic Ar = 76%.
Concentrate: Clean, pleochroic olive-green to dark green hornblende with less than 5% attached quartz and a trace of biotite.

From quartz monzonite.
(104 O) Ridge on east side of Nome Lake, British Columbia, 59°37'N, 130°53.5'W. Nome Lake Batholith, map-unit 22, GSC Map 18-1968. Sample GAD 67-84-1, collected by C. Dodds, interpreted by H. Gabrielse.

See GSC 67-6 for description and interpretation.

GSC 67-6 Biotite, K-Ar age 183 ± 8 m.y.

$K = 6.68\%$, $Ar^{40}/K^{40} = 0.0112$, radiogenic Ar = 92%.
Concentrate: Relatively pure greenish brown biotite with less than 5% free chlorite contamination. Some of the mica flakes have split edges.

From quartz monzonite.
(104 O) Details as for GSC 67-5.

The two batholiths (Simpson Peak and Nome Lake) from which the samples were collected consist of medium- to coarse-grained, massive, homogeneous, locally porphyritic, biotite-hornblende, quartz monzonite and granodiorite. The concordant biotite and hornblende ages on the sample from Nome Lake Batholith and the close agreement of these ages with the hornblende age from Simpson Peak Batholith (183, 183, and 181 m.y.) indicate an Early Jurassic age of emplacement. The plutons can be dated only as post-Permian by stratigraphic means.

GSC 67-7 Hornblende, K-Ar age 128 ± 6 m.y.

$K = 1.06\%$, $Ar^{40}/K^{40} = 0.0078$, radiogenic Ar = 86%.
Concentrate: Green to brownish yellow, pleochroic hornblende

with 5% biotite and a trace of quartz as impurities. Total chlorite content is less than 1%.

From quartz diorite.

(104 O) Ridge crest 5 miles southwest of south end of Aconitum Lake, British Columbia, 59°22'30"N, 131°44'W. See B.C. Dept. Mines Bull. 19 (Tuya-Teslin area) and map-unit 21, GSC Map 18-1968. Sample BU 66J-51-39, collected by S. L. Blusson, interpreted by H. Gabrielse.

See GSC 67-8 for description and interpretation.

GSC 67-8 Biotite, K-Ar age 56 ± 3 m.y.

K = 7.36%, Ar^{40}/K^{40} = 0.0033, radiogenic Ar = 80%.
Concentrate: Relatively clean, yellowish olive biotite with about 10% of the flakes darker brown in colour. Some flakes are blistered but unaltered. Impurities consist of less than 1% amphibole.

From quartz diorite.

(104 O) Details as for GSC 67-7.

The sample is typical of the Christmas Creek Batholith, a mesocratic, medium-grained, biotite-hornblende quartz diorite. In contrast to the quartz diorite of GSC 67-9 and 10 the constituent minerals show variable amounts of alteration. Epidote, saussurite, and sericite are common. The discordant ages (128 m.y. on hornblende and 56 m.y. on biotite) possibly reflect a reheating of the pluton by the emplacement of the quartz diorite stock a few miles to the north (GSC 67-9, 10). The ages should be compared with another discordant pair from the same pluton collected near the eastern boundary of the batholith (GSC 66-2 and 66-3: ages of 73 and 146 m.y. respectively on biotite and hornblende). To the east the Christmas Creek Batholith is cut by a younger pluton, the Glundebery Batholith, which has given a hornblende age of 79 m.y. (GSC 66-1).

GSC 67-9 Hornblende, K-Ar age 48 ± 4 m.y.

K = 0.64%, Ar^{40}/K^{40} = 0.0028, radiogenic Ar = 52%.
Concentrate: Relatively clean, pleochroic dark green to brownish yellow hornblende with less than 5% biotite impurity and a trace of quartz.

From quartz diorite.

(104 O) On ridge 4 miles west of centre of Aconitum Lake, British Columbia, 59°23'45"N, 131°40'30"W. See B.C. Dept. Mines Bull. 19 (Tuya-Teslin area) and map-unit 21, GSC Map 18-1968. Sample BU 66J-51-27, collected by S. L. Blusson, interpreted by H. Gabrielse.

See GSC 67-10 for description and interpretation.

British Columbia

GSC 67-10 Biotite, K-Ar age 46 ± 2 m.y.

K = 7.52%, Ar^{40}/K^{40} = 0.0027, radiogenic Ar = 76%.
Concentrate: Clean buff to olive biotite with less than 1% free chlorite and amphibole impurity.

From quartz diorite.
(104 O) Details as for GSC 67-9.

This sample was collected from a stock of very fresh, medium- to coarse-grained, biotite-hornblende quartz diorite. The freshness of the minerals and the strongly developed zoning in the plagioclase feldspar are characteristic. The concordant ages of 48 m.y. on hornblende and 46 m.y. on biotite indicate an Early Tertiary age. If so, this and similar small plutons in the region are the youngest granitic plutons known in the northern Cordillera.

GSC 67-11 Hornblende, K-Ar age 159 ± 10 m.y.

K = 0.70%, Ar^{40}/K^{40} = 0.0097, radiogenic Ar = 85%.
Concentrate: Reasonably clean, bright green to brownish green pleochroic hornblende with less than 5% free chlorite and a trace of quartz.

From quartz diorite.
(104 O) Two miles southwest of lake at head of Plate Creek, British Columbia, 59°52'30"N, 130°45'W. Map-unit 19, GSC Map 18-1968. Sample TO 66-162A, collected by D. J. Tempelman-Kluit, interpreted by H. Gabrielse.

The Plate Creek Stock is a roughly equidimensional granitic pluton comprising equigranular, fine- to medium-grained, mesocratic, biotite-hornblende-quartz diorite. Typically the hornblende (most abundant mafic mineral) is subhedral to euhedral and the plagioclase is strongly altered to sericite and saussurite. The age of 159 m.y. on hornblende indicates a mid-Jurassic age of emplacement but confirmation is required. The pluton can only be dated as post-late Paleozoic by stratigraphic means.

GSC 67-12 Muscovite, K-Ar age 105 ± 5 m.y.

K = 8.46%, Ar^{40}/K^{40} = 0.0063, radiogenic Ar = 80%.
Concentrate: Clean, clear muscovite. About 5% of the flakes have a yellow stain along their edges.

From granitic gneiss.
(104 O) On Yukon-British Columbia boundary, 60°00'N, 130°44'W. Map-unit 23, GSC Map 18-1968. Sample TO 66-162, collected by D. J. Tempelman-Kluit, interpreted by H. Gabrielse.

This sample is representative of a zone of leucocratic, strongly foliated, slickensided, fine- to medium-grained, granitic augen-gneiss that

forms the western margin of the Cassiar Batholith in the Wolf Lake (105 B) and Jennings River (104 O) map-areas. The muscovite age of 105 m.y. is presumed to date the time of deformation of these rocks. It may also approximate the date of intrusion. An age of 87 m.y. was obtained on muscovite from the sheared granitic rocks in Wolf Lake map-area to the north (K-Ar 1180A; sample Pb-3-64, unpublished determination).

GSC 67-13 Biotite, K-Ar age 92 ± 5 m.y.

K = 7.61%, Ar^{40}/K^{40} = 0.0055, radiogenic Ar = 91%.
Concentrate: Clean, slightly blistered, brownish green biotite with less than 2% free chlorite impurity.

From granite.
(104 O) Peak northeast of Ash Creek, British Columbia, 59°04.3'N, 130°43'W. Map-unit 25A, Tuya Batholith, GSC Map 18-1968. See also B.C. Dept. of Mines Bulletin No. 19. Sample Y-11RA-1, collected by J.E. Reesor, interpreted by H. Gabrielse.

Tuya Batholith is a grey to buff-orange weathering, medium- and even-grained biotite granite pluton characteristic of several potassium-rich granitic bodies lying west of the Cassiar Batholith. The rock contains about equal amounts of potash feldspar, plagioclase, and quartz. Biotite is the most abundant mafic mineral.

For evaluation of this age see GSC 67-14.

GSC 67-14 Biotite, K-Ar age 78 ± 4 m.y.

K = 7.58%, Ar^{40}/K^{40} = 0.0046, radiogenic Ar = 71%.
Concentrate: Clean, greenish biotite with less than 2% free chlorite flakes.

From granite.
(104 O) Four miles east of High Tuya Lake, British Columbia, 59°13.5'N, 130°23.5'W. Map-unit 11, B.C. Dept. of Mines Bulletin No. 19 and map-unit 25, GSC Map 18-1968. Sample GA 67-93, collected and interpreted by H. Gabrielse.

The Parallel Creek Batholith is a grey to buff-orange weathering medium-grained, even-grained biotite granite pluton characteristic of several potassium-rich granitic bodies lying west of the Cassiar Batholith. The rock contains about equal amounts of fresh perthitic potash feldspar, plagioclase, and quartz. Biotite is the most abundant mafic mineral.

The K-Ar age of 78 m.y. is as yet unconfirmed but a Late Cretaceous age seems reasonable in view of the freshness and composition of the rocks and the lack of evidence of deformation. The age might be compared with that obtained for biotite from the similar and possibly connected Tuya Batholith (92 m.y., GSC 67-13).

British Columbia

GSC 67-15 Biotite, K-Ar age 105 ± 5 m.y.

K = 7.65%, Ar^{40}/K^{40} = 0.0063, radiogenic Ar = 90%.
Concentrate: Buff-brown biotite with 7% chlorite attached to the mica flakes. The only other impurity is a trace of hornblende.

From granite.
(104 I) Two miles south-southeast of Spike Mountain, British Columbia, 58°49'N, 129°52'W. Map-unit 15a, Cassiar Batholith, GSC Map 29-1962. Sample GAD 67-102-3, collected by C. Dodds, interpreted by H. Gabrielse.

This sample is typical of the quartz monzonites that comprise the most widespread lithology in the Cassiar Batholith. The rock consists of about equal amounts of perthitic potash feldspar, plagioclase, and quartz. Textures range from even-grained to megacrystic and from medium- to coarse-grained. Biotite is the most abundant mafic mineral.

The K-Ar age of 105 m.y. is in close agreement with ages of 98 m.y. (GSC 60-28) and 101 m.y. (Baadsgaard et al., 1961) previously obtained on samples of similar lithology from the Cassiar Batholith. A sample of foliated granitic rock from the west side of Cassiar Batholith in the Jennings River map-area also yielded a K-Ar age of 105 m.y. (GSC 67-12).

GSC 67-16 Hornblende, K-Ar age 26 ± 6 m.y.

K = 0.44%, Ar^{40}/K^{40} = 0.0015, radiogenic Ar = 6%.
Concentrate: Pleochroic olive-green to dark green hornblende with about 10% attached biotite and a trace of quartz contamination.

From granodiorite.
(103 F) Shields Bay, Graham Island (Q.C.I.), British Columbia, 53°17'N, 132°26'W. East Kano Massif. Sample 65 AB-21, collected and interpreted by A. Sutherland Brown (B.C. Dept. Mines Petroleum Resources).

See GSC 67-17 for description and interpretation.

GSC 67-17 Biotite, K-Ar age 29 ± 2 m.y.

K = 7.52%, Ar^{40}/K^{40} = 0.0017, radiogenic Ar = 69%.
Concentrate: Relatively clean, light brown biotite with a trace of attached chlorite and about 2% hornblende contamination.

From granodiorite.
(103 F) Details as for GSC 67-16.

The specimen 65AB-21 is a fine-grained granodiorite consisting approximately of: plagioclase (An_{35-25}) 55%, potash feldspar 8%, quartz 20%,

hornblende 10%, augite 1%, biotite 5%, opaque ores 1%, apatite, trace. The rock is fresh with simply zoned plagioclase laths, and combined highly irregular grains of fresh mafic minerals in a matrix of highly irregular to poikilitic, unaltered potash feldspar and quartz. The mafic minerals have small augite cores within the hornblende parts of the ragged grains. On the average the rock is a quartz monzonite with about 20% quartz and a colour index of about 13. The specimen submitted is mafic-rich and less acid than the average.

This specimen is from the eastern phase of the Kano complex batholith - the phase that was judged to be youngest. It metamorphosed Masset Formation basalts and rhyolites of Early Tertiary age and cuts all older rocks. It was judged younger than the Central Kano Batholith mainly because of its much finer grain, and more acid character.

GSC 67-18 Hornblende, K-Ar age 38 ± 2 m.y.

K = 1.04%, Ar^{40}/K^{40} = 0.0022, radiogenic Ar = 33%.
Concentrate: Olive-green to dark green pleochroic hornblende with approximately 15% biotite contamination. The mica occurs both as free flakes and as attachments to the amphibole. There is also a trace of quartz and chlorite impurity.

From granite.
(103 B) Barry Inlet, Moresby Island, Queen Charlotte Group, British Columbia, 52°34'N, 131°48'W. Pocket Inlet Pluton, no published geological map. Sample 65-AB 10, collected and interpreted by A. Sutherland Brown (B.C. Dept. Mines Petroleum Resources).

See GSC 67-19 for description and interpretation.

GSC 67-19 Biotite, K-Ar age 39 ± 2 m.y.

K = 7.30%, Ar^{40}/K^{40} = 0.0023, radiogenic Ar = 71%.
Concentrate: Relatively pure, light brownish olive biotite with about 10% chlorite mainly as free flakes, but also on the edges of biotite flakes.

From granite.
(103 B) Details as for GSC 67-18.

The sample was collected near the centre of the Pocket Batholith. It is a fairly coarse, porphyritic granite consisting of about 40% plagioclase (An_{28}), 20% perthite, 35% quartz (strained), 3% biotite, 2% hornblende, and less than 1% opaques. Texture is somewhat seriate, the plagioclase is subhedral with normally zoned margins and some fretted myrmekitic borders, and the perthitic orthoclase is mainly interstitial.

The Pocket Batholith is a post-tectonic pluton that visibly intrudes the syntectonic San Christoval Batholith and amphibolitized Karmutsen basalts

of its metamorphic aureole. The Karmutsen Formation is pre-early Karnian, while the San Christoval Batholith is post-Kunga Formation, i.e. post-Sinemurian and probably pre-Albian, as San Christoval-like pebbles occur in basal Haida Formation conglomerates.

GSC 67-20 Hornblende, K-Ar age 142 ± 14 m.y.

K = 0.43%, Ar^{40}/K^{40} = 0.0086, radiogenic Ar = 54%.
Concentrate: Clean, dark green hornblende with only a trace of chlorite impurity.

From quartz diorite.
(103 B) Eastern Darwin Sound 2 miles south of Bigsby Inlet, Queen Charlotte Islands, British Columbia, 52°34'30"N, 131°40'W. Sample 65-AB 9, collected by A. Sutherland Brown, interpreted by J.E. Reesor.

Sample 65-AB 9 is a foliated diorite with the following approximate composition: plagioclase (An_{35}) 60%, quartz 1%, hornblende 31%, biotite 8%. The plagioclase is sericitized and the biotite deformed and altered in part to muscovite and chlorite. The hornblende is poikilitic and fresh.

This specimen is from the eastern contact of the San Christoval Batholith, a syntectonic pluton of hornblende diorite to quartz diorite characterized by fairly intense foliation, numerous inclusions and some migmatitic borders. The pluton intrudes the Karmutsen Formation (pre-Mid-Karnian) and lower part of the Kunga Formation (Karnian and Norian). It is not in contact with the Yakoun Formation of Middle Jurassic age. Granitoid clasts of similar nature are found first in minor amount in the Haida Formation (Albian). The main deformation was judged to be Late Jurassic and the date 142 ± 14 m.y. fits well with this.

GSC 67-21 Biotite, K-Ar age 84 ± 4 m.y.

K = 7.61%, Ar^{40}/K^{40} = 0.0050, radiogenic Ar = 87%.
Concentrate: Clean, but very slightly altered olive-green biotite with about 1% hornblende contamination. About 50% of the flakes contain needle-like oriented inclusions.

From granodiorite.,
(103 J) Three quarters of a mile south of north tip of Melville Island, British Columbia, 54°24'10"N, 130°44'00"W. Geological map in GSC Paper 66-33 by Hutchison. Sample Rd 65-30448, collected and interpreted by W.W. Hutchison.

The specimen is a coarse-grained, buff weathering granodiorite whose texture is defined by stumpy altered crystals of plagioclase (An_{25} approx.) which are aggregated in clots separated by coarse anhedral quartz and interstitial microcline perthite. The major mafic mineral is fresh biotite

(4%) commonly associated with fine-grained aggregates of epidote, sphene, white mica, allanite and opaque minerals.

The specimen was collected from the Melville Island Stock (approximately 5 miles diameter) which has intruded low grade metavolcanic rocks of unknown age. This body appears to be younger than most of the plutonic rocks of the outer islands because of the more leucocratic nature of the rock, the very clean, sharp intrusive contacts, the lack of foliation in the body itself and the roughly circular shape of the body in plan. The K-Ar date of 84 ± 4 m.y. on the biotite of this body is slightly, but significantly, younger than the K-Ar date of 96 ± 5 m.y. from plutonic rock at the southwest tip of Dundas Island (see GSC 66-4). Most K-Ar dates on plutonic rocks from the outer islands range from 95 to 140 m.y. The inference, on geological evidence, that Melville Island pluton is younger than most plutonic rocks of this westerly belt is supported by the reported date.

GSC 67-22 Biotite, K-Ar age 37 ± 2 m.y.

K = 6.84%, Ar^{40}/K^{40} = 0.0022, radiogenic Ar = 62%.
Concentrate: Relatively clean, slightly blistered, coarse, olive-green biotite. Individual mica flakes are about 1/8 inch across and contain occasional opaque inclusions. Impurities consist of 5% chlorite and 2% hornblende.

From pegmatite.
(103 H) Twenty miles southwest of Kitimat, British Columbia, 53°47'N, 129°02'W. Map-unit 5, GSC Map 932A. Sample KB-30-64, collected and interpreted by E. D. Kindle.

The sample was obtained from a coarse pegmatite dyke occurring in the Coast Range hornblende-quartz diorite. The pegmatite consists mainly of orthoclase, biotite and quartz. Individual crystals range up to 6 inches in diameter.

The age determination of 37 ± 2 m.y. indicates the age of the pegmatite and the local Coast Range quartz diorite to be in the late Eocene or early Oligocene Range. The copper minerals of the pegmatite were latest in the sequence and are therefore possibly of Oligocene age.

GSC 67-23 Biotite, K-Ar age 115 ± 6 m.y.

K = 7.41%, Ar^{40}/K^{40} = 0.0069, radiogenic Ar = 89%.
Concentrate: Clean, unaltered khaki biotite with less than 1% opaques and a trace of hornblende. Less than 1% of the flakes contain tiny colourless inclusions with associated weak pleochroic haloes. Total chlorite content is less than 1%.

From very coarse grained biotite quartz monzonite.
(103 H) West shore of Campania Island, 1/2 mile south of Jewsbury Peninsula, British Columbia, 53°03'00"N, 129°26'45"W. Only published geological map is small scale sketch map in GSC Paper

British Columbia

66-1, p. 83. Sample is from map-unit 5. Sample Rd 65-20171, collected by A. J. Baer, and interpreted by J. A. Roddick.

The rock is a very coarse grained quartz monzonite consisting of about 45% quartz, 30% plagioclase, 20% potash feldspar and 5% biotite, with minor epidote and muscovite. The plagioclase is irregularly altered (principally the cores of zoned crystals) to sericite and clay minerals, and contains scattered flakes of muscovite. The K-feldspar is usually microcline, and includes partly replaced plagioclase, biotite and quartz granules. The rock texture is normal hypidiomorphic with relatively little fine material.

See GSC 67-24 for interpretation.

GSC 67-24 Biotite, K-Ar age 104 ± 4 m.y.

K = 7.65%, Ar^{40}/K^{40} = 0.0063, radiogenic Ar = 88%.
Concentrate: Clean, but very slightly altered and blistered olive-green biotite with less than 1% hornblende contamination. About 1% of the flakes contain a few colourless inclusions with associated weak pleochroic haloes. Total chlorite content is about 3%.

From medium-grained biotite quartz diorite.

(103 H) Southern Pitt Island, southeast of Ring Point, British Columbia, 53°15'00"N, 129°35'30"W. Only published geological map is small scale sketch map in GSC Paper 66-1, p. 83. Sample is from map-unit 3. Sample HS 28-2a-63 collected by W. W. Hutchison, and interpreted by J. A. Roddick.

The quartz diorite consists of 70% plagioclase, 20% quartz, 7% biotite, and 3% combined chlorite, apatite, K-feldspar and opaques. A few of the plagioclase crystals are zoned, and the rock has a regular hypidiomorphic texture.

Age determinations GSC 67-23 and 24 were made on specimens collected from the western zone of the Coast Crystalline Belt which has so far consistently yielded dates older than the central (60-80 m.y.) and the eastern (40-50 m.y.) zones.

The date of 115 ± 6 m.y. on the quartz monzonite of Campania Island is particularly interesting as the clean quartz monzonite plutons of the Coast Crystalline Belt are generally regarded to be considerably younger (usually Tertiary). The western zone has yielded dates exceeding 100 m.y. from four localities. The oldest date (139 ± 7 m.y.) is from the diorite on the west shore of Gill Island (GSC 66-10) about 10 miles northeast of GSC 67-23. The quartz diorite on Anger Island, about 50 miles northwest of GSC 67-23 yielded dates of 103 and 111 m.y. (GSC 64-5 and 6). GSC 67-24 (104 ± 4 m.y.) is from quartz diorite apparently related to that on Anger Island but 35 miles to the southeast.

As no stratigraphic controls are present in this area, various interpretations are possible. The diorite on Gill Island appears to be distinctly older than the quartz diorite and quartz monzonite in the western zone.

British Columbia

The last two are distinctly different rocks but similar in age owing either to a common time emplacement or of unroofing. No definite evidence indicates that both rocks were affected by a thermal event post-dating their emplacement.

GSC 67-25 Biotite, K-Ar age 49 ± 4 m.y.

K = 7.93%, Ar^{40}/K^{40} = 0.0029, radiogenic Ar = 76%.
Concentrate: Clean, very pale brown biotite with about 2% hornblende contamination and less than 1% chlorite.

From quartz diorite.
(103 H) About 1/2 mile east of middle fork at head of Kiltuish River, British Columbia, 53°15'45"N, 128°16'30"W. Only published geological map is small scale sketch map in GSC Paper 66-1, p. 83. Sample is from map-unit 3. Sample Rd65-10473, collected and interpreted by J. A. Roddick.

The rock is a coarse-grained biotite-hornblende quartz diorite consisting of about 70% plagioclase, 10% quartz, 10% biotite, 10% hornblende, and minor chlorite, opaques and apatite. Only a few of the plagioclase crystals are zoned and more are altered. The mafic minerals have irregular shapes, the hornblende being particularly poikiloblastic. The quartz is mainly interstitial and the chlorite is restricted to isolated patches.

The age of 49 m.y. is compatible with dates of other rocks in the belt east of the metasedimentary belt in the northern Coast Mountains. The date is similar to GSC 64-12 (48 m.y.) on biotite schist from Hawksbury Island about 40 miles to the northwest, and to GSC 66-6 (50 ± 5 m.y.) and 66-7 (48 ± 9 m.y.) on quartz diorite of the Quottoon Pluton in Terrace (W/2) map-area, about 90 miles to the northwest.

The 49 m.y. date may be that of intrusion of the quartz diorite but because similar dates are obtained from different rock types, the writer prefers to interpret it as the date of unloading (sufficient to set the isotopic 'clock') in response to uplift that was progressive from west to east.

GSC 67-26 Biotite, K-Ar age 109 ± 5 m.y.

K = 7.49%, Ar^{40}/K^{40} = 0.0066, radiogenic Ar = 90%.
Concentrate: Relatively clean, but somewhat altered greenish biotite with about 10% chlorite as free flakes and as alteration material on the mica.

From granodiorite.
(103 A) Central Island of the Anderson Group, British Columbia, 52°45'30"N, 129°22'30"W. Map 9-1966, in GSC Paper 66-25, map-unit C. Sample HS-18-18b-63, collected by W.W. Hutchison and interpreted by A.J. Baer.

The rock is a medium- to fine-grained light grey granodiorite consisting mainly of slightly sericitized plagioclase (60%), quartz displaying

patchy extinction (20%), interstitial potassic feldspar (8%) and biotite (10%). Biotite is of two types. The first one forms large jagged flakes displaying olive-brown pleochroism, whereas the second one is in thin straight flakes with a greyish brown pleochroism. The first type represents 80% of all the biotite and is thought to be older than the second. The two types could not be separated for analysis.

The date obtained confirms that, in the northern Coast Mountains of British Columbia apparent K-Ar ages become systematically older to the southwest. The 109 m.y. figure dates the last thermal event that affected these rocks, but its geological significance is not known.

GSC 67-27 Hornblende, K-Ar age 100 ± 6 m.y.

$K = 0.47\%$, $Ar^{40}/K^{40} = 0.0060$, radiogenic Ar = 56%.
Concentrate: Pleochroic, olive-green to light bluish green hornblende with a trace of biotite and less than 2% attached quartz. The main impurity consists of about 10% included opaques, possibly magnetite.

From hornblende gabbro.
(103 A) Raymond Passage shoreline at entrance to Hochstader Basin, British Columbia, 52°06'30"N, 128°17'00"W. Map-unit F, GSC Map 9-1966, GSC Paper 66-25. Sample SAA-67-436, collected and interpreted by D. T. A. Symons.

For description see GSC 67-28 and for interpretation see GSC 67-32.

GSC 67-28 Biotite, K-Ar age 90 ± 4 m.y.

$K = 7.00\%$, $Ar^{40}/K^{40} = 0.0054$, radiogenic Ar = 64%.
Concentrate: Light brownish olive biotite with about 5% chlorite and 5% hornblende contamination. Black opaque inclusions in some flakes make up less than 2% impurity.

From hornblende gabbro.
(103 A) Details as for GSC 67-27.

The sample comes from a massive unaltered gabbro-diorite pluton. It is composed of laths of andesine feldspar with slight sericite alteration and euhedral crystal laths of hornblende, with minor amounts of primary pyroxene, brown biotite, magnetite and pyrite.
See GSC 67-32 for interpretation.

GSC 67-29 Hornblende, K-Ar age 87 ± 5 m.y.

$K = 0.92\%$, $Ar^{40}/K^{40} = 0.0052$, radiogenic Ar = 63%.
Concentrate: Olive-brown to dark green pleochroic hornblende with about 10% free biotite impurity.

British Columbia

From andesite.

(93 D) Fisher Channel, north end of unnamed island, British Columbia, 52°13'00"N, 127°50'30"W. See GSC Map 9-1966, GSC Paper 66-25. Sample SAA-67-211, collected and interpreted by D. T. A. Symons.

See GSC 67-30 for description and GSC 67-32 for interpretation.

GSC 67-30 Biotite, K-Ar age 81 ± 4 m. y.

K = 7.35%, Ar^{40}/K^{40} = 0.0049, radiogenic Ar = 75%.
Concentrate: Relatively pure dark olive-buff biotite with a trace of chlorite on flake edges. Some of the biotite flakes are of darker brown colour.

From andesite.

(93 D) Details as for GSC 67-29.

This sample comes from a green andesitic dyke that was originally a fine-grained diabase. It is composed of anhedral crystals of andesine feldspar which has been partially altered to sericite and sausserite, of stubby euhedral laths of brown biotite with a trace of chlorite alteration, of minor brown to green anhedral crystals of poikilitic hornblende with corroded boundaries, and of trace amounts of accessory titanomagnetite, leucoxene, zircon and apatite.

See GSC 67-32 for interpretation.

GSC 67-31 Whole rock, K-Ar age 14.5 ± 1 m. y.

K = 3.37%, Ar^{40}/K^{40} = 0.0008, radiogenic Ar = 46%.
Concentrate: Crushed whole rock.

From spherulitic gabbro.

(103 A) North shore of Denny Island opposite Cyprus Island, British Columbia, 52°09'15"N, 128°04'00"W. Dyke possibly related to map-units 10 or 13, GSC Map 9-1966, GSC Paper 66-25. Sample SAA-67-535, collected and interpreted by D. T. A. Symons.

This sample comes from a dyke of medium bluish grey spherulitic gabbro. The spherulites are large rounded crystals of quartz surrounded by radiating fibres of chlorite. Fine-grained chlorite laths form a significant portion of the matrix. Andesine feldspar occurs as euhedral crystals altered to sausserite which range in size from fine-grained matrix material to phenocryst size. Altered orthoclase is also present in the matrix. There are minor amounts of hornblende forming small, ragged randomly-oriented laths altering to biotite, of titanomagnetite altering to hematite, and of diopside.

For interpretation see GSC 67-32.

British Columbia

GSC 67-32 Whole rock, K-Ar age 12.5 ± 2.7 m.y.

K = 1.64%, Ar^{40}/K^{40} = 0.00073, radiogenic Ar = 34%.
Concentrate: Crushed whole rock.

From diabase.

(103 A) Shoreline of Seaforth Channel at northernmost point of Thorburne Island, British Columbia, 52°12'15"N, 128°08'00"W. Dyke related to map-unit 14 or 15, GSC Map 9-1966, GSC Paper 66-25. Sample SAA-67-486, collected and interpreted by D. T. A. Symons.

This sample comes from a dark grey, fine grained diabase composed dominantly of subhedral laths of andesine which show slight sericitic alteration. Minor amounts of titanomagnetite in subhedral crystals with slight peripheral hematite alteration and of diopside in euhedral crystals with slight biotite and chlorite alteration are also present. Olivine, apatite, and pyrite occur in trace amounts.

The geology of the Bella Coola and Laredo Sound map-areas has been reported on by Baer (1967). GSC 67-27 and 28 at 100 ± 6 m.y. and 90 ± 4 m.y. respectively come from one sample from within a massive, unaltered diorite-gabbro pluton about 3 miles in diameter. Baer (pers. comm.) considered that the pluton was intruded during the time interval Middle Jurassic to Late Cretaceous so that this mid-Cretaceous age of 95 ± 4 m.y. (average) is in good agreement. It is, however, somewhat younger than the Middle to Late Jurassic age which was determined paleomagnetically for these plutons (Symons, 1969).

GSC 67-29 and 30 at 87 ± 5 m.y. and 81 ± 4 m.y. respectively come from one sample from a 4-foot-wide, deformed, green andesitic dyke intruding foliated quartz diorite (map-unit D). This dyke is one of a swarm which were intruded as several generations during the time interval Middle Jurassic to Late Cretaceous and/or Paleocene, and which were metamorphosed to the greenschist facies during the last major orogeny (Late Cretaceous or Paleocene) to affect the area. The foliated quartz diorite (map-unit D) has been intruded by massive quartz monzonite (map-unit 11) which has been dated at 77 ± 5 m.y. (GSC 64-7 and 64-8) some 15 miles north-northwest of the present sampling site, giving a minimum age for the orogeny. Thus, the mid-Late Cretaceous age of 84 ± 3 m.y. (average) found for this dyke is a realistic age for the orogeny, and it agrees with the paleomagnetic conclusion (Symons, 1969) that these dykes have a secondary partial thermoremanent magnetization acquired during a Late Cretaceous or Paleocene orogeny.

GSC 67-31 at 14.5 ± 1 m.y. comes from a sample of one of a group of bluish porphyritic dykes which are unmetamorphosed and undeformed. Baer (pers. comm.) considers that these basic sodic dykes are probably related to some rhyolitic volcanic rocks (map-unit 13; Baer, 1966) of Early or Middle Tertiary age. Thus the finding of a Middle Miocene age of 14.5 ± 1 m.y. for the date of intrusion is consistent with his interpretation and with the finding of a primary thermoremanent magnetization (TRM) of Early to Middle Tertiary age in these dykes (Symons, 1969).

Finally, GSC 67-32 at 12.5 ± 2.7 m.y. comes from one of a prominent swarm of unmetamorphosed and undeformed brown basaltic dykes. Baer

(pers. comm.) relates these dykes to either basaltic flows of map-unit 14 which he correlates (Baer, 1966) with the plateau lava flows of the interior of British Columbia which Mathews and Rouse (1963) have dated paleontologically and radiometrically as Late Miocene or Early Pliocene, or basaltic rocks of map-unit 15 of Pleistocene or Holocene age. Paleomagnetic evidence suggests that the brown basaltic dykes have a primary TRM of Late Miocene or Early Pliocene age. Also, these dykes cut the blue porphyritic dykes now dated at 14.5 ± 1 m.y. (GSC 67-31, above). Thus, this age of 12.5 ± 2.7 m.y. dates the time of intrusion of the brown basaltic dykes as Late Miocene, relates the dykes to map-unit 14 and is consistent with all other evidence bearing on their age.

References

Baer, A.J.
1967: Bella Coola and Laredo Sound map-area, British Columbia, 93D and 103A; *Geol. Surv. Can.*, Paper 66-25, 13 pp.

Mathews, W.H., and Rouse, G.E.
1963: Late Tertiary volcanic rocks and plant-bearing deposits in British Columbia; *Bull. Geol. Soc. Am.*, vol. 74, pp. 55-60.

Symons, D.T.A.
1969: Geological implications of paleomagnetic studies in the Bella Coola and Laredo Sound map-areas, British Columbia (93D and 103A); *Geol. Surv. Can.*, Paper 68-72.

GSC 67-33 Hornblende, K-Ar age 79 ± 5 m.y.

K = 0.82%, Ar^{40}/K^{40} = 0.0047, radiogenic Ar = 58%.
Concentrate: Slightly iron-stained bluish green hornblende with a trace of quartz impurity.

From quartz diorite.
(103 A) East shore of Gunboat Passage, northeast of Bella Bella, British Columbia, 52°10'10"N, 128°00'30"W. Map-unit D, GSC Paper 66-25. Sample Rd65-20053, collected and interpreted by A.J. Baer.

See GSC 67-34 for description and interpretation.

GSC 67-34 Biotite, K-Ar age 75 ± 5 m.y.

K = 6.39%, Ar^{40}/K^{40} = 0.0045, radiogenic Ar = 85%.
Concentrate: Relatively clean, altered khaki biotite with about

5% hornblende contamination. Most flakes are blistered and altered to chlorite on the edges. A few flakes are almost entirely altered, and the total chlorite content of the concentrate is 15%.

From quartz diorite.

(103 A) Details as for GSC 67-33.

The specimen is from a medium-grained, moderately foliated biotite-hornblende quartz diorite. Major minerals are plagioclase (An_{45}) in subhedral to anhedral crystals, K-feldspar in anhedral crystals of perthite and microcline, quartz in small grains with undulatory extinction, biotite in irregular jagged flakes, and hornblende in small crystals, locally poikiloblastic.

Ages indicated by hornblende and biotite may be considered to be identical within the limits of experimental error. Pebbles and cobbles possibly derived from this pluton have been found in a conglomerate palynologically dated from the Oligocene to Miocene. The radiometric dates thus appear to give a reliable minimum age for the emplacement of the quartz diorite.

GSC 67-35 Biotite, K-Ar age 67 ± 5 m.y.

$K = 7.03\%$, $Ar^{40}/K^{40} = 0.0040$, radiogenic Ar = 81%.
Concentrate: Relatively clean, slightly altered, olive-green biotite with about 6% chlorite as free grains and as alteration on the edges of biotite flakes. A few of the flakes contain oriented needle-like inclusions; 1-2% hornblende is present as an impurity.

From quartz monzonite porphyry.

(93 L) In the section 2,782 to 2,851 feet of drillhole 28 collared at 5,600 feet elevation on the north side of Hudson Bay Glacier, British Columbia, 54°49'30"N, 127°18'W. Map-unit 7, Figure 11, 1966, Minister of Mines, B.C., Ann. Rept., Sample 28-2846, collected and interpreted by R. V. Kirkham.

The sample is from a pink and white, fine- to coarse-grained porphyry, consisting mainly of strongly zoned oligoclase (38%), quartz (35%), perthitic K-feldspar (21%) and biotite (2 to 3%). Quartz, K-feldspar and plagioclase phenocrysts comprise about 52% of the rock.

This sample is from a covered quartz monzonite porphyry intrusion that is spatially and probably genetically related to the Glacier Gulch Molybdenum deposit. Geological evidence indicates that this intrusion postdates most of the molybdenum mineralization; that is, it cuts an intrusion that is highly veined and mineralized but it contains only sparse molybdenite and quartz veins.

References - see GSC 67-38.

British Columbia

GSC 87-36 Biotite, K-Ar age 60 ± 5 m.y.

K = 7.17%, Ar^{40}/K^{40} = 0.0036, radiogenic Ar = 72%.
Concentrate: Relatively clean, slightly altered pale, reddish brown biotite. Most flakes show chlorite alteration on the edges, and about 5% contain oriented acicular inclusions. About 5% contain pleochroic haloes. Hornblende contamination amounts to about 2% and total chlorite content is 4-5%.

From quartz latite porphyry.
(93 L) Exposed in an outcrop measuring 30 by 40 feet in a crevasse near the toe of Hudson Bay Glacier, British Columbia, 54°49'30"N, 127°18'W. Map-unit 7, Figure 11, 1966, Minister of Mines, B.C., Ann. Rept. Sample RK-65-81, collected and interpreted by R. V. Kirkham.

The rock is a light grey quartz latite porphyry with medium- and coarse-grained oligoclase (30%), quartz (4%), biotite (3%) and pyrite (2.5%) phenocrysts set in a very fine grained and aphanitic potash feldspar-rich matrix.

It is not known whether this sample is from a dyke or a plug. The porphyry body is, however, cut by numerous veinlets containing chalcopyrite and pyrite, but it apparently post-dates the molybdenum mineralization. This date is, therefore, consistent with the ages for GSC 67-35, GSC 67-37, and GSC 67-38.

References - see GSC 67-38.

GSC 67-37 Biotite, K-Ar age 63 ± 4 m.y.

K = 6.81%, Ar^{40}/K^{40} = 0.0037, radiogenic Ar = 80%.
Concentrate: Pinkish buff biotite with less than 2% of the flakes containing opaque inclusions. Some flakes are altered on their edges to brownish chlorite and the total chlorite content amounts to about 8%. Molybdenite flakes constitute the main impurity and amount to about 5%.

From quartz-biotite veinlets.
(93 L) Exposed underground in the 3,500-foot-level of the Glacier Gulch Molybdenum property, British Columbia, 54°49'30"N, 127°18'W. The veinlets cut map-unit 5, Figure 11, 1966, Minister of Mines, B.C., Ann. Rept. Sample RK-67-97A, collected and interpreted by R. V. Kirkham.

The sample is from 1/16 to 1/8 inch quartz-biotite veinlets in bleached and altered light brownish grey granodiorite. The veinlets contain lesser amounts of molybdenite, pyrite and chalcopyrite. The biotite is dark reddish brown and occurs mostly as medium and coarse grains.

Since molybdenite is present in these veinlets, this sample presumably dates the molybdenum mineralization. However, since biotite from GSC 67-35 yielded a date of 67 ± 5 m.y. and since that intrusion post-dates

most of the molybdenum mineralization this date appears to be somewhat young. N.C. Carter, University of British Columbia, obtained a date of 69 ± 3 m.y. on the vein biotite from this sample (White et al.). Nevertheless, it should be noted that all three dates overlap when the limits of error are taken into consideration.

References - see GSC 67-38.

GSC 67-38 Hornblende, K-Ar age 65 ± 6 m.y.

K = 2.04%, Ar^{40}/K^{40} = 0.0039, radiogenic Ar = 76%.
Concentrate: Somewhat impure dark green hornblende in which 50% of the grains contain tiny opaque blebs. Impurities consist of mica (10%), chlorite (5%) and a trace of quartz.

From small quartz-hornblende-sulphide veinlets.
(93 L) Immediately east of the Hudson Bay Glacier, British Columbia, 54°49'30"N, 127°18'W. The veinlets cut map-unit 2, Figure 11, 1966, Minister of Mines, B.C., Ann. Rept. Sample RK-65-99A, collected and interpreted by R. V. Kirkham.

The sample is from 1/32 to 1 inch veinlets that consist of quartz, hornblende, molybdenite, other sulphides and minor amounts of chlorite, pistacite, biotite, albite, scheelite, sericite, ferroan dolomite and calcite. The hornblende occurs as coarse-grained relatively pure crystals and as fine-grained highly poikilitic and altered crystals.

This sample was meant to date the period of molybdenum mineralization. However, for the same reasons as those cited for sample GSC 67-37 this date is thought to be probably slightly young. Nevertheless, taking the limits of error into consideration it can be seen that the dates from GSC 67-35, 67-36, 67-37 and 67-38 overlap to some degree. Hence, it is apparent that without supporting geological evidence, the dates cannot be used with confidence to separate the various periods of intrusion and mineralization.

References

Kirkham, R.V.
1966: Glacier Gulch Molybdenum deposit, Minister of Mines, B.C. Ann. Rept., pp. 86-91.

White, W.H., Harakal, J.E., and Carter, N.C.
1968: Potassium-argon ages of some ore deposits in British Columbia; *Can. Inst. Mining Met.*, Bull., vol. 61, pp. 1326-1334.

GSC 67-39 Biotite, K-Ar age 120 ± 6 m.y.

K = 7.38%, Ar^{40}/K^{40} = 0.0072, radiogenic Ar = 90%.
Concentrate: Relatively pure greenish brown biotite with about 5% free chlorite contamination.

British Columbia

From 'granite'.

(92 F) One mile east of Pocahontas Bay, northeast coast of Texada Island, British Columbia, 49°43'25"N, 124°24'30"W. GSC Map 17-1968. Sample MEKA 67-1, collected and interpreted by J. E. Muller.

The sample is from a small stock of granodiorite intruding Triassic Karmutsen basaltic rocks on Texada Island. It is thought to be equal in age to another similar stock related directly to the metasomatic iron deposits of the island (still to be dated). The apparent Early Cretaceous age is matched on Vancouver Island by only one date (GSC 64-3, 121 ± 35 m.y.), from a porphyry dyke intruding magnetite of the Brynnor Mine. Other dates on Vancouver Island are either Middle to Late Jurassic, between 143 and 167 m.y. or Early Tertiary, between 35 and 59 m.y. Within wider limits the date conforms to those found on coastal islands south of Skeena River (103-139 m.y., mainly Early Cretaceous) and similar dates from the Alaskan Alexander Archipelago. The dates are from locations along the west side of the Coast Crystalline Belt. More dates are needed to establish whether Jurassic plutonism continued right into Early Cretaceous time or whether there were several pulses of plutonic activity.

GSC 67-40 Biotite, K-Ar age 36 ± 3 m.y.

K = 7.12%, Ar^{40}/K^{40} = 0.0021, radiogenic Ar = 67%.
Concentrate: Relatively clean, slightly altered olive-green biotite with 2% hornblende and less than 1% quartz contamination. Most flakes carry weak pleochroic haloes. Total chlorite content is 7%.

From quartz diorite.

(93 J) On Eaglet Lake, 1 mile north of Giscome, British Columbia, 54°06'N, 122°22'W, southeast McLeod Lake map-area. Sample 115-528 TD, collected and interpreted by H. W. Tipper.

The rock is a light grey quartz diorite, medium-grained, equigranular, nonfoliated. It is mainly quartz and plagioclase with fairly fresh biotite and minor hornblende.

This igneous body is apparently intrusive into the Wolverine Complex of unknown age. No stratigraphic evidence is available to confirm or deny this age.

GSC 67-41 Biotite, K-Ar age 93 ± 4 m.y.

K = 7.15%, Ar^{40}/K^{40} = 0.0056, radiogenic Ar = 84%.
Concentrate: Relatively clean, slightly altered and blistered olive-green biotite with 5% free chlorite and 1% hornblende contamination. Total chlorite content is 10%. About 5% of the flakes contain opaque inclusions.

British Columbia

From quartz monzonite.

(93 G) In quarry where Stone Creek forestry road crosses P. G. E. Railway, British Columbia, 53°38'N, 122°38'W. Map-unit 7B, GSC Map 49-1960. Sample 505-19 TD, collected and interpreted by H. W. Tipper.

This rock is a coarse-grained biotite quartz monzonite, grey in colour and nonfoliated. Composed of grey to smoky quartz, potash and plagioclase feldspar, biotite, and accessory sphene, apatite, and magnetite. Some chloritization of the biotite is evident.

This igneous body is a small stock intruding Upper Triassic(?) shales. Boulders from this or similar stocks occur in a nearby conglomerate, possibly of Late Cretaceous age. The K-Ar age suggests a mid- to Late Cretaceous age of intrusion.

GSC 67-42 Hornblende, K-Ar age 73 ± 4 m.y.

$K = 0.63\%$, $Ar^{40}/K^{40} = 0.0044$, radiogenic Ar = 77%.
Concentrate: Relatively clean, dark olive-green hornblende with 1-2% attached quartz and less than 1% mica contamination.

From granodiorite.

(92 O) China Head Mountain, British Columbia, 51°10'N, 122°23'W. See GSC Map 29-1963. Sample 98-724 TD, collected and interpreted by H. W. Tipper.

The rock is a porphyritic, medium-grained, nonfoliated hornblende granodiorite. The hornblende is euhedral, generally fresh, with few inclusions. No chloritization noted.

The granodiorite body is a stock intruding sedimentary strata (Jackass Mountain Group) of Early Cretaceous age (Albian-Aptian). The age of the stock should be Late Cretaceous to Oligocene. The K-Ar age of 73 ± 4 m.y. suggests a latest Cretaceous age and this is not unreasonable.

GSC 67-43 Biotite, K-Ar age 53 ± 4 m.y.
59 ± 5 m.y.

$K = 7.67\%$, $Ar^{40}/K^{40} = \begin{matrix} 0.0032 \\ 0.0035 \end{matrix}$, radiogenic Ar = $\begin{matrix} 76\% \\ 82\% \end{matrix}$.
Concentrate: Clean, unaltered pale brown biotite (phlogopite) with about 1% quartz and 1% hornblende contamination.

From gneiss.

(83 D) Three point five miles north, 65 degrees east from Clemina Station, British Columbia, 52°36'00"N, 119°01'20"W. Map-unit 1C, GSC Map 65-1 (Canoe River W1/2), and map-unit 1, GSC Map 15-1967. Sample 282-CAcC-1, collected and interpreted by R. B. Campbell.

See GSC 67-44 for description and interpretation.

British Columbia

GSC 67-44 Hornblende, K-Ar age 114 ± 12 m.y.

K = 0.745%, Ar^{40}/K^{40} = 0.00685, radiogenic Ar = 63%.
Concentrate: Clean, pleochroic dark green to yellow hornblende with less than 1% of biotite and quartz impurity.

From gneiss.

(83 D) Details as for GSC 67-43.

The rock is fine- to medium-grained, speckled black and white but generally of dark aspect, well foliated and lineated amphibolite. It consists mainly of unaltered plagioclase, yellowish green hornblende, and pale brown biotite.

The sample was taken from a body of gneiss in which dominant granitoid layers are interspersed with amphibolite and schist. The gneiss lies along the Rocky Mountain Trench mostly in the extreme northern end of Monashee Mountains but partly in the adjacent Rocky Mountains (map-unit 1, GSC Map 15-1967). The contacts of the gneiss with the enveloping upper Proterozoic and lower Paleozoic rocks are tectonic and thus the gneiss is an exotic mass with respect to the surrounding rocks. Insofar as its overall composition varies so markedly from that of the adjacent rocks the gneiss seems unlikely to have formed by the metamorphic transformation of any known strata in the region. It may be that the gneiss is part of the ancient Precambrian basement; a segment of the Churchill Province of the Precambrian Shield. Potassium-argon ages have failed to support such designation, however, ages of mica of 72 ± 5 m.y. (GSC 65-24) and of 66 ± 3 m.y., 60 ± 3 m.y., and 57 ± 3 m.y. (samples K-Ar 1514, 1515 and 1594 - unpublished) are all reasonably consistent with the biotite ages of 53 ± 4 m.y. and 59 ± 5 m.y. reported here. These ages, however, differ substantially from the 114 ± 12 m.y. age for hornblende (GSC 67-44).

At the present time the writer can offer no opinion for the unexpectedly young and consistent ages of the micas nor for the appreciably older hornblende age. Study of the problem is continuing.

Yukon Territory

GSC 67-45 Hornblende, K-Ar age 99 ± 6 m.y.

K = 0.56%, Ar^{40}/K^{40} = 0.0059, radiogenic Ar = 55%.
Concentrate: Clean, pleochroic, pale brown to dark green hornblende with less than 5% attached quartz and less than 5% free chlorite contamination.

From granodiorite.
(115 J) Eight thousand feet south of headwaters fork of Canadian Creek, Yukon Territory, 62°42.9'N, 138°50.8'W. Map-unit 3, GSC Map 1048A. Sample FJ67-122-1, collected and interpreted by D.C. Findlay.

See GSC 67-46 for description and interpretation.

GSC 67-46 Biotite, K-Ar age 95 ± 5 m.y.

K = 7.58%, Ar^{40}/K^{40} = 0.0057, radiogenic Ar = 84%.
Concentrate: Pure, unaltered, dark olive-buff biotite with no visible impurities. Some flakes have split edges.

From granodiorite.
(115 J) Details as for GSC 67-45.

The rock is a medium- to coarse-grained hornblende-biotite granodiorite containing 25% quartz, 55% plagioclase, 15% orthoclase, up to 5% biotite and hornblende and accessory magnetite. The sample consists of several pieces of unaltered nx-size drill core from a hole drilled to test the depth extension of several silver-lead veins cutting the intrusion.

This sample is from an intrusion of unknown size in the Dawson Range area south of Yukon River and north of Klotassin River. The intrusion is petrographically similar to plutons of the Carmacks area (115 I) to the southeast that have been assigned a "Jurassic or later" age by Bostock (GSC Mem. 189, 1937). No other age determinations on granitic rocks from the general Snag-Carmacks region age available, and the Cretaceous age obtained from the present sample is consistent with known geological data.

GSC 67-47 Muscovite, K-Ar age 99 ± 5 m.y.

K = 6.54%, Ar^{40}/K^{40} = 0.0060, radiogenic Ar = 91%.
Concentrate: Very impure muscovite. Most flakes are charged with very fine grained black inclusions causing the muscovite to be silvery grey in bulk colour. Some flakes also contain biotite and chlorite inclusions. Total chlorite content amounts to about 10%.

From schist.
(105 K) Nine hundred and thirty-five to 942 feet in Anvil diamond drill-hole MS 2, Yukon Territory, 62°22'N, 133°23'W. Map-unit 7,

Yukon Territory

GSC Map 13-1961, and map-unit 3 of sketch map in GSC Paper 68-1A, pp. 46-47. Sample TO 67-2a, collected and interpreted by D. Tempelman-Kluit.

See GSC 67-48 for description and interpretation.

GSC 67-48 Biotite, K-Ar age 93 ± 4 m.y.

K = 5.80%, Ar^{40}/K^{40} = 0.0056, radiogenic Ar = 82%.
Concentrate: Relatively altered, brownish orange biotite in which some flakes have been partly altered to brownish 'chlorite'. Total chlorite content is about 20%.

From schist.
(105 K) Details as for GSC 67-47.

The rock is a regionally metamorphosed (almandine-amphibolite facies), fine-grained biotite-muscovite-quartz schist with a well developed crenulation foliation, on which an older axial plane foliation, defined by preferred orientation of muscovite, is completely transposed. The sample was taken to test the possibility of regional metamorphism of the lead-zinc host rocks of the Anvil district prior to thermal metamorphism during the mid-Cretaceous. However the concordant ages determined from biotite and muscovite of the sample apparently reflect only the later thermal metamorphism related to intrusion of the Anvil Batholith. The ages determined agree with those published previously for granitic rocks of the Anvil Batholith; all indicate a period of intrusion and thermal metamorphism about mid- or Late Cretaceous time. It is not known whether the slight difference between the ages determined previously for quartz monzonite nearby and the ages of the present sample are significant. Related dates previously published are tabulated below.

Sample	Age	Rock	Mineral
GSC 65-41	90 ± 5	Quartz Monzonite	Biotite
GSC 65-42	79 ± 6	Quartz Monzonite	Muscovite
GSC 65-43	87 ± 5	Quartz Monzonite	Biotite

GSC 67-49 Biotite, K-Ar age 88 ± 4 m.y.

K = 7.66%, Ar^{40}/K^{40} = 0.0053, radiogenic Ar = 94%.
Concentrate: Clean, brownish orange biotite. About 2% of the flakes contain tiny opaque inclusions.

From schist.
(105 H) On ridge crest, 1.2 mile west of peak 7680, Yukon Territory, 61°39'40"N, 128°34'00"W. Map-unit 2, GSC Map 6-1966. Sample BU 66-115-5, collected and interpreted by S. L. Blusson.

Yukon Territory

The rock is a medium-grained quartz-biotite-muscovite schist containing appreciable plagioclase, very fine fibrous sillimanite, and incipient porphyroblasts of andalusite.

The date is in agreement with several others obtained in the metamorphic terrain of central and eastern Yukon northeast of Tintina Trench, from both schists and intrusive granitic rock (see Baadsgaard et al., 1961, and GSC 65-34, 35, 36, 38, 39, 40, 41, 43, 45). Field and petrographic evidence point to more than one metamorphic event in this area and it is probable that these K-Ar dates reflect only the last event related to granite intrusion.

Reference

Baadsgaard, H., Folinsbee, R.E., and Lipson, J.
1961: Potassium-argon dates of biotites from Cordilleran granites; *Bull. Geol. Soc. Am.*, vol. 72, pp. 689-702.

District of Franklin

GSC 67-50 Muscovite, K-Ar age 354 ± 15 m.y.

K = 8.22%, Ar^{40}/K^{40} = 0.0228, radiogenic Ar = 91%.
Concentrate: Clean, clear muscovite with trace impurities of quartz and K-feldspar. About 5% of the flakes are stained pale green.

From pegmatite.
(340 E) On coast, 1/2 mile south of small inlet on east coast of Ayles Fiord, Ellesmere Island, District of Franklin, 82°48'N, 79°50'W. Map-unit 1, GSC Map 16-1956. Sample CBF-66-139, collected and interpreted by T. Frisch.

The sample comes from a small muscovite-potash feldspar-quartz pegmatite dyke in well-foliated quartz monzonitic augen-gneiss. The augen-gneiss occurs as a concordant mass in steeply-dipping metamorphic rocks of greenschist facies metamorphic grade, which are low-grade members of the Cape Columbia Complex. Pegmatite dykes and segregations are found only in the augen-gneiss and are considered to be essentially contemporaneous with the gneiss.

The augen-gneiss was interpreted in the field to be an infaulted, or even remobilized higher-grade part of the Cape Columbia Complex, the basement of the Franklinian Geosyncline, for the following reasons. Deformed amphibolite bodies and post-metamorphic diabase dykes are intimately associated with the gneiss, but not with the enclosing greenschist facies rocks. This association and the petrography of the gneiss are typical of the higher-grade parts of the Cape Columbia Complex. An alternative interpretation is that the gneiss represents an intrusion that was subsequently deformed into a gneiss, but no evidence for intrusion was found.

Either interpretation is consistent with the age determined. The latter is considerably younger than the youngest age obtained heretofore (389 ± 21 m.y.) for the Cape Columbia Complex, which is known to be pre-Middle Ordovician. This would be expected in a basement rock involved in later tectonism. On the other hand, four age determinations on northern Ellesmere Island plutonic rocks, which are at most only moderately deformed and unmetamorphosed, fall in the range 376 to 347 m.y. This sixth Devonian age determined strengthens the conclusion that major thermal and perhaps tectonic activity occurred in the eugeosyncline in Devonian, probably Early Devonian or Caledonian time. See also discussion of GSC 67-51 and 52.

GSC 67-51 Biotite, K-Ar age 347 ± 15 m.y.

K = 5.90%, Ar^{40}/K^{40} = 0.0223, radiogenic Ar = 96%.
Concentrate: Impure, slightly altered olive-green biotite with more than 10% hornblende contamination. Most flakes are altered to chlorite on the edges, and 10% contain oriented needle-like inclusions. Total chlorite content is about 10%.

From quartz monzonite.
(340 E) Near coast, 2 miles south of Cape Richards, District of Franklin,

District of Franklin

82°58'N, 79°10'W. See GSC Map 16-1956. Sample CBF-65-289, collected and interpreted by T. Frisch.

See GSC 67-52 for description and interpretation.

GSC 67-52 Hornblende, K-Ar age 390 ± 18 m.y.

K = 0.94%, Ar^{40}/K^{40} = 0.0253, radiogenic Ar = 88%.
Concentrate: Impure, dark green hornblende with 5% attached quartz, more than 5% biotite and more than 5% chlorite contamination. Most grains contain tiny opaque inclusions.

From quartz monzonite.
(340 E) Details as for GSC 67-51.

The two minerals coexisted in a quartz monzonite forming the outer parts of a zoned igneous complex intrusive into greenschist facies rocks of the pre-Middle Ordovician basement complex of the Franklinian Geosyncline. The quartz monzonite typically has 18% (by volume) quartz, 24% microcline perthite, 45% plagioclase (An_{25-10}), 4% hornblende and 3% biotite (partly chloritized). It was protoclastically deformed, apparently at the time of intrusion. Rocks in the central part of the complex are syenites and quartz syenites with marked alkalic affinities (late differentiates include riebeckite granite).

The cataclasis that occurred during intrusion of this rock is probably reflected in the low biotite age, as compared to the age of the hornblende, a mineral known to be more argon-retentive. The hornblende age coincides with that determined on a syenodiorite intrusive into a large serpentinized peridotite body 30 miles southeast of Cape Richards, on M'Clintock Inlet. It also agrees within the limits of experimental error, with the determination (376 ± 16 m.y.) on biotite from the Cape Fanshawe Martin gabbro-peridotite intrusion 8 miles to the west of Cape Richards. These three dates, on two varieties of mineral from three different localities and rocks, are good evidence of felsic and mafic igneous intrusion in, or prior to Early Devonian (Caledonian) time in northern Ellesmere Island. This plutonism may well be responsible for the several low ages (445 to 389 m.y.) previously determined for the Cape Columbia Complex, which is known to be pre-Middle Ordovician in age. See also discussion of GSC 67-50.

GSC 67-53 Whole rock, K-Ar age 607 ± 75 m.y.

K = 0.77%, Ar^{40}/K^{40} = 0.0419, radiogenic Ar = 96%.
Concentrate: Crushed whole rock.

From chilled basalt.
(57 F) Boothia Peninsula, District of Franklin, 70°04'N, 92°02'W. Sample FA-13-66, collected by W.F. Fahrig.

District of Franklin

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

GSC 67-54 Whole rock, K-Ar age 964 ± 112 m.y.

K = 0.72%, Ar^{40}/K^{40} = 0.0736, radiogenic Ar = 86%.
Concentrate: Crushed whole rock.

From basalt.
(47 A) Eastern Melville Peninsula, District of Franklin, 68°28'N, 83°22'W. Sample FA-12-66, collected by W.F. Fahrig.

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

GSC 67-55 Whole rock, K-Ar age 672 ± 110 m.y.

K = 0.23%, Ar^{40}/K^{40} = 0.0472, radiogenic Ar = 77%.
Concentrate: Crushed whole rock.

From diabase.
(37 G) West of Murray River, northern Baffin Island, District of Franklin, 71°16'N, 78°20'W. See G.D. Jackson, Can. Mining J., June 1966. Sample JD-C267/3-65, collected by J. Crawford, interpreted by G.D. Jackson.

The sample was taken from the chilled margin of a diabase dyke, one of several that intrude all other Precambrian rocks in the area. It is dark greenish grey and slightly porphyritic with 10% phenocrysts of aligned labradorite, clinopyroxene and dark mica. The clinopyroxene is mainly pigeonite and the dark mica is biotite or stilpnomelane partly pseudomorphous after an earlier mineral species.

The dyke age is considered to be minimal but suggests that it was probably emplaced during Hadrynian time. So far as is known no diabase dykes have been found to intrude the lower Paleozoic strata in nearby areas.

GSC 67-56 Biotite, K-Ar age 1865 ± 60 m.y.

K = 6.17%, Ar^{40}/K^{40} = 0.1859, radiogenic Ar = 100%.
Concentrate: Rather impure concentrate of patchily bleached olive-green biotite with about 10% muscovite, 5% opaques and 1% hornblende contamination. Most of the mica flakes carry strong pleochroic haloes. About 5% are heavily altered and iron-stained. Total chlorite content is 5%.

From metapyroclastic(?) rock.
(37 G) South of No. 1 Iron Deposit at Mary River, northern Baffin Island, District of Franklin, 71°19'N, 79°15'W. See G.D. Jackson,

District of Franklin

Can. Mining J., June 1966. Sample JD-97C/3-65, collected and interpreted by G. D. Jackson.

The sample was taken from a metamorphic rock derived from either an acid pyroclastic or a conglomerate. It consists mainly of quartz grains and aggregates up to 1/4 inch across, and light grey quartz-feldspar lenses and masses up to 2 feet across, in a dark grey matrix with slightly crenulated mica-rich laminae.

This rock is part of a complex that underlies the iron-formation and No. 1 orebody at Mary River. The sedimentary and volcanic rocks in this complex have been tentatively assigned to the lower part of the Mary River Group, but an unconformity may separate them from the overlying rocks.

The date obtained is older than those for other rocks in the Mary River region and is the second oldest in northern Baffin Island. The age may represent a composite of older and younger metamorphic ages, or possibly a pre-Hudsonian event.

GSC 67-57 Muscovite, K-Ar age 1655 ± 50 m.y.

K = 8.61%, Ar^{40}/K^{40} = 0.1553, radiogenic Ar = 99%.
Concentrate: Relatively clean, very slightly stained muscovite with about 1% free chlorite and hornblende as impurities. There is a trace of quartz, and less than 1% of the flakes carry intergrown biotite.

From gneissic granite.
(37 G) Between Fish Lake and Iron Lake, northern Baffin Island, District of Franklin, 71°27'N, 79°50'W. See G.D. Jackson, Can Mining J., vol. 87, No. 6. Sample JD-C55/1-65, collected by J. Crawford, interpreted by G. D. Jackson.

The rock is a light pink gneissic granite in which the mafic minerals tend to occur in elongated lenticular rods up to 1 1/2 inch long. Its main constituents are quartz (37%), microcline (36%), albite (17%), muscovite (5%), biotite (4%) and chlorite (1%).

These 'rodded' granitoids appear to occur stratigraphically and structurally below the Mary River Group, or alternatively may be intrusive into it. The 1655 ± 50 m.y. date represents a minimum age for the metamorphism and intense deformation of these 'rodded' gneisses.

GSC 67-58 Muscovite, K-Ar age 1675 ± 50 m.y.

K = 8.22%, Ar^{40}/K^{40} = 0.1581, radiogenic Ar = 98%.
Concentrate: Clean, clear muscovite with a trace of K-feldspar contamination.

From quartz monzonite pegmatite.
(37 G) North of Fish Lake, Baffin Island, District of Franklin,

District of Franklin

71°26'30"N, 79°51'W. See G.D. Jackson, Can. Mining J., vol. 87, No. 6. Sample JD-C54/1-65, collected by J. Crawford, interpreted by G.D. Jackson.

The specimen is from a coarse quartz monzonite pegmatite consisting of quartz (15%), albite (40%), orthoclase (40%), muscovite (5%), and small amount of garnet, green biotite, pyrite and iron oxides.

The pegmatite intrudes metasediments and metavolcanics of the Mary River Group (including the iron-formation). The K-Ar date is interpreted as a minimum age for the pegmatite and for the Mary River Group rocks which it cuts.

GSC 67-59 Whole rock, K-Ar age 566 ± 71 m.y.

$K = 0.75\%$, $Ar^{40}/K^{40} = 0.0387$, radiogenic Ar = 90%.
Concentrate: Crushed whole rock.

From diabase.

(37 G) Between Muriel and David Lakes, Baffin Island, District of Franklin, 71°23'29"N, 79°41'27"W. See map in Can. Mining J., vol. 87, No. 6. Sample JD-C90/2-65, collected and interpreted by G.D. Jackson.

The rock is a dark greenish black subophitic to intergranular diabase dyke intruding the Precambrian rocks of the area. The age of 566 ± 71 m.y. is thought to represent the approximate date of intrusion.

GSC 67-60 Hornblende, K-Ar age 1525 ± 55 m.y.

$K = 0.15\%$, $Ar^{40}/K^{40} = 0.1374$, radiogenic Ar = 90%.
Concentrate: Relatively clean, pleochroic light green to bluish green hornblende with less than 2% free opaque contaminants.

From amphibolite.

(37 G) One mile east-northeast of Iron Lake, Baffin Island, District of Franklin, 71°27'59"N, 79°47'37"W. See Mary River Group, Can. Mining J., vol. 87, No. 6. Sample JD-C49/1-65, collected and interpreted by G.D. Jackson.

The rock is an amphibolite or hornblende gneiss of the Mary River Group, and consists of 67% hornblende, 20% plagioclase (labradorite-bytownite), 12% quartz, 0.5% magnetite, 0.5% muscovite and chlorite, and traces of orthoclase, leucoxene and sulphides.

The sample was taken from a metamorphosed sill or flow that is cut by pegmatites and outcrops along a shear zone. An associated sample (GSC 67-62) from the same shear zone yielded an older age of 1670 ± 55 m.y. The difference in age of these two samples cannot yet be explained.

District of Franklin

GSC 67-61 Hornblende, K-Ar age $\frac{1005 \pm 40 \text{ m.y.}}{963 \pm 39 \text{ m.y.}}$

$K = 1.11\%$, $Ar^{40}/K^{40} = \frac{0.0777}{0.0735}$, radiogenic Ar $\frac{93\%}{97\%}$.

Concentrate: Relatively pure olive-green to bluish green hornblende with less than 5% biotite contamination as inclusions and free flakes. Quartz is present as a trace impurity.

From pyroxene amphibolite.

(37 G) Between Fish and McOuat Lakes, Baffin Island, District of Franklin, 71°26'55"N, 79°53'49"W. See Mary River Group, Can. Mining J., vol. 87, No. 6. Sample JD-323-65, collected and interpreted by G. D. Jackson.

The rock is a pyroxene amphibolite derived from the metamorphism of basalt overlying iron-formation of the Mary River Group. It is a very fine grained, dark greenish black rock consisting of 51% hornblende, 12% quartz, 12% diopside, 11% calcite, 5.5% epidote, 5% talc, 3% plagioclase, 0.5% sphene, and accessory magnetite, apatite and chlorite. Orientation of the hornblende gives rise to a lineation in the rock.

This metavolcanic rock is believed to be of pre-Hudsonian age and two age determinations were run to verify the unexpectedly young date obtained. A large diabase dyke dated at 566 m.y. (GSC 67-59) outcrops within 600 feet of the sample location. Also, tourmaline-rich dykelets and highly leached iron-formation in the general area suggest that a localized thermal event may be responsible for the young ages obtained.

GSC 67-62 Muscovite, K-Ar age 1670 ± 55 m.y.

$K = 8.52\%$, $Ar^{40}/K^{40} = 0.1574$, radiogenic Ar = 99%.

Concentrate: Clean, clear muscovite with less than 2% biotite inclusions. Some flakes have a brown stain or alteration on their edges.

From meta-orthoquartzite.

(37 G) North of Iron Lake, Baffin Island, District of Franklin, 71°27'48"N, 79°50'09"W. See Can. Mining J., vol. 87, No. 6. Sample JD-C50/1-65, collected and interpreted by G.D. Jackson.

The rock is a faintly foliated, sugary to granoblastic meta-orthoquartzite consisting of quartz (92.8%), muscovite (7.2%) and traces of zircon, rutile-sphene, and opaques.

The quartzite is part of the Mary River Group, and the sample was taken from a shear zone of possibly late or post-Hudsonian age. The K-Ar age of 1670 ± 55 m.y., however, suggests that shearing was coincident with Hudsonian metamorphism. Some subsequent movement has occurred along the zone. Another sample (GSC 67-60) from an amphibolite in the same shear zone has yielded a younger age of 1525 ± 55 m.y. The reason for this difference is not yet apparent.

District of Franklin

GSC 67-63 Biotite, K-Ar age 1685 ± 50 m.y.

K = 7.57%, Ar^{40}/K^{40} = 0.1595, radiogenic Ar = 99%.
Concentrate: Clean, deep olive-buff biotite with no visible impurities. Some flakes have split edges.

From schist.

(37 G) One point five mile east of Sheardown Lake, Baffin Island, District of Franklin, 71°18'25"N, 79°15'11"W. See "Amphibolite", Can. Mining J., vol. 87, No. 6. Sample JD-100/1-65, collected and interpreted by G.D. Jackson.

The sample is from a finely foliated biotite schist consisting of biotite (80%), quartz (11%), plagioclase (2%), muscovite (5%), leucoxene and magnetite (1%), and accessory sphene, chlorite, rutile, epidote, zircon and andalusite.

The biotite schist forms shear zones around pods of less metamorphosed mafic rocks (amphibolites), metasediments and granitic rocks. The K-Ar date of 1685 ± 50 m.y. is thought to approximate the age of regional metamorphism in this area.

GSC 67-64 Biotite, K-Ar age 1465 ± 50 m.y.

K = 7.60%, Ar^{40}/K^{40} = 0.1295, radiogenic Ar 98%.
Concentrate: Clean, dark olive-buff biotite with no chlorite or other impurities.

From pegmatite.

(25 A) Brutton Islands, eastern entrance to Hudson Strait, District of Franklin, 60°37'N, 64°46'W. Sample RM-303A, collected by E.W. Reinhardt, interpreted by F.C. Taylor.

This sample is from an 18-inch-thick pegmatite dyke that cuts granulite on the Brutton Islands. The pegmatite is typical of many in the area and consists of pink potash feldspar and quartz with tiny interstitial magnetite veinlets.

The age, 1465 ± 50 m.y., dates the time of intrusion of the pegmatite dyke and provides a minimum age for the granulites which it intrudes. This figure also suggests that the dyke was emplaced at the end of the Hudsonian Orogeny.

District of Mackenzie

GSC 67-65 Hornblende, K-Ar age 80 ± 5 m.y.

K = 0.99%, Ar^{40}/K^{40} = 0.0048, radiogenic Ar = 86%.
Concentrate: Clean, pleochroic light green to olive-green hornblende with only traces of biotite and quartz contamination.

From quartz monzonite.
(105 I) At elevation 4,100 feet, right limit of creek at headwaters of South Nahanni River, District of Mackenzie, 62°51'25"N, 128°49'30"W. Map-unit 11, GSC Map 14-1961. Sample BU 66-27-5, collected and interpreted by S. L. Blusson.

See GSC 67-66 for description and interpretation.

GSC 67-66 Biotite, K-Ar age 87 ± 4 m.y.

K = 7.24%, Ar^{40}/K^{40} = 0.0052, radiogenic Ar = 82%.
Concentrate: Relatively clean, brownish olive biotite with about 5% amphibole and less than 5% free chlorite contamination. Some of the mica flakes have split edges.

From quartz monzonite.
(105 I) Details as for GSC 67-65.

The rock is a medium grey, porphyritic, biotite-bearing hornblende quartz monzonite with more than 40% of 1/2-inch subhedral megacrysts of perthitic potash feldspar. Biotite forms less than 5% of the rock, hornblende about 15%, and dark, watery quartz 15 to 20%.

The dates on this homogeneous hornblende quartz monzonite stock (80-87 m.y.) are significantly lower than those on biotite quartz monzonite in the Flat River area (110 m.y.) to the south and on biotite granodiorite in the Itsi Range (96 m.y.) to the west. This suggests two periods of granitic intrusion in the area; an earlier one in which biotite is the principal mafic mineral and a later one in which hornblende predominates.

GSC 67-67 Whole rock, K-Ar age 769 ± 78 m.y.

K = 1.13%, Ar^{40}/K^{40} = 0.0556, radiogenic Ar = 95%.
Concentrate: Crushed whole rock.

From basalt.
(86 K) Near head of Husky Creek, Coppermine River area, District of Mackenzie, 66°31.3'N, 116°04.6'W. Map-unit 12, GSC Map 18-1960 (Fraser). Sample BLS-161-66, collected and interpreted by W. R. A. Baragar.

The rock is a fine-grained basalt composed essentially of plagioclase, pyroxene, amphibole, and magnetite. The plagioclase is extensively altered to an indeterminate finely-divided aggregate and some pyroxene is altered to amphibole.

District of Mackenzie

The age determined may give the age of alteration rather than that of eruption. Previously determined potassium-argon ages of Coppermine basalts range from 1200 m.y. (GSC Paper 64-17, p. 67) to 730-740 m.y. (GSC Paper 64-17, p. 60). Other ages determined tend to group near these extremes. Possibly the extreme ages represent eruption and alteration respectively. The Coppermine basalts are slightly folded and overlain unconformably by a younger succession of sedimentary rocks. These are intruded by sills that yield an age of 605 m.y. (GSC Paper 65-17, p. 41). Hence the period of gentle folding that warped the Coppermine basalts prior to deposition of the younger series may have been the occasion of the up-dating of many of the ages obtained for the Coppermine flows.

GSC 67-68 Whole rock, K-Ar age 1570 ± 115 m.y.

K = 1.72%, Ar^{40}/K^{40} = 0.1431, radiogenic Ar = 98%.
Concentrate: Crushed whole rock.

From (?)diabase.

(86 H) Eighteen miles west of Rockinghorse Lake, District of Mackenzie, 65°53'N, 113°03 1/2'W. Map-unit "Basic Dykes", GSC Paper 66-24. Samples BK-66-128, collected and interpreted by H. H. Bostock.

The sample is fine-grained, grey-green, porphyritic diabase containing greenish albite-oligoclase phenocrysts up to 1 centimetre in length. Hornblende, epidote, biotite, chlorite, quartz, carbonate and leucoxene pseudomorphous after sphene are present in the matrix.

The sample is lithologically similar to east-striking porphyritic dykes (see also GSC 67-71) that have intruded gneisses west of Contwoyto Lake, and to flows present near the base of the Epworth Group (K-Ar whole rock age 1600 ± 135 m.y. (GSC 65-67), Fraser in Wanless et al., 1967). Fraser interprets the latter age to be metamorphic because the Epworth Group is intruded elsewhere by older granitic rocks associated with the Hudsonian Orogeny. The data suggest that the present sample has been affected by metamorphism associated with the Hudsonian Orogeny, and are consistent with the hypothesis that Aphebian intermediate volcanism, which occurred northwest and west of the Itchen Lake area, may have extended as far east as Contwoyto Lake.

GSC 67-69 Whole rock, K-Ar age 961 ± 60 m.y.
965 ± 58 m.y.

K = 2.79%, Ar^{40}/K^{40} = 0.0733, radiogenic Ar = 97%.
0.0737 97%
Concentrate: Crushed whole rock.

From gabbro.

(86 H) East shore of Rockinghorse Lake, District of Mackenzie, 65°55 1/2'N, 112°14 1/2'W. Map-unit 12, "Diabase-gabbro sills",

District of Mackenzie

GSC Paper 66-24, Map 8-1966. Sample BK-65-596, collected and interpreted by H. H. Bostock.

The sample is altered, fine-grained, grey-green, equigranular gabbro from a sill up to 30 feet thick emplaced within the Goulburn Group. Albite-oligoclase, epidote, amphibole, quartz, carbonate, chlorite, sphene and magnetite-ilmenite are present.

The age obtained is a minimum age of alteration of this sill. Alteration is much more severe than that evident in a larger neighbouring sill (dated at 1555 ± 135 m.y. (GSC 65-68), Bostock in Wanless et al., 1967).

GSC 67-70 Muscovite, K-Ar age 2560 ± 75 m.y.

K = 8.54%, Ar^{40}/K^{40} = 0.3181, radiogenic Ar = 99%.
Concentrate: Clean, slightly blistered muscovite with less than 1% chlorite contamination. Occasional flakes contain rare colourless and opaque inclusions.

From granodiorite boulder.
(86 H) Point on north shore of south arm of Point Lake, District of Mackenzie, 65°15'N, 113°01'W. Map-unit 4, GSC Paper 66-24, Map 8-1966. Sample BK-66-619, collected and interpreted by H. H. Bostock.

The sample is altered, massive, medium grained, light grey-green granodiorite from a boulder 1 1/2 feet in diameter from conglomerate near the top of the volcanic section at Point Lake.

The age obtained corroborates a previous age (2660 ± 75 m.y. (GSC 65-64), Bostock in Wanless et al., 1967) determined on a similar boulder from the opposite shore of the lake. The muscovite is secondary and the age reflects low grade metamorphism of the conglomerate during the Kenoran Orogeny.

GSC 67-71 Whole rock, K-Ar age 1240 ± 80 m.y.

K = 2.33%, Ar^{40}/K^{40} = 0.1204, radiogenic Ar = 98%.
Concentrate: Crushed whole rock.

From (?)diabase.
(76 E) Twenty-five miles southwest of Peacock Hills, District of Mackenzie, 65°44'N, 111°42'W. Map-unit 12, "Basic Dykes", GSC Paper 66-24, Map 8-1966. Sample BK-65-824, collected and interpreted by H. H. Bostock.

The sample is from a coarsely porphyritic, west- northwest-striking, intermediate dyke about 60 feet thick that has intruded granitic gneisses. In addition to oligoclase-andesine phenocrysts, hornblende, epidote, biotite, chlorite, quartz, carbonate, apatite and leucoxene are present.

District of Mackenzie

The sample is lithologically similar to GSC 67-68 and the dyke, which it represents, is thought to have been intruded during the Aphebian Era (see discussion for that sample). The age determined for the present sample may be of metamorphic origin related to the emplacement of the Mackenzie diabase dyke swarm in this area.

GSC 67-72 Biotite, K-Ar age 1695 ± 50 m.y.

K = 7.33%, Ar^{40}/K^{40} = 0.1606, radiogenic Ar = 99%.
Concentrate: Altered khaki biotite. About 1/3 of the flakes are altered to chlorite on the edges and along cracks. Less than 1% of the flakes contain weak pleochroic haloes. Total chlorite content is about 15% and about 1% hornblende is the only other impurity.

From porphyritic quartz monzonite.

(85 H) Taltson Bay, southeast shore of Great Slave Lake, District of Mackenzie, 61°26'24"N, 112°41'27"W. Map-unit 5, GSC Map 377A. Sample RM-397-58-66, collected and interpreted by E.W. Reinhardt.

The sample is a pink, porphyritic quartz monzonite containing about 45% sodic andesine, 18% microcline, mainly as phenocrysts, and 15% biotite. Evidence that this rock was subjected to penetrative deformation is shown by mild cataclasis of plagioclase along grain boundaries, bending of biotite flakes, and the recrystallized aspect of interstitial quartz.

The sample is representative of biotite-hornblende quartz monzonite that typically occurs as steeply-dipping sill-like masses in the Thubun Lakes area (see GSC Paper 67-1). In addition, field relationships indicate that this quartz monzonite was the latest major granitoid intrusion emplaced in the migmatitic complex along the south side of the McDonald Fault. K-Ar ages of micas from a sample of grey, gneissic granodiorite collected from a pluton north of Thubun Lakes are 1735 m.y. (muscovite, GSC 66-79) and 1890 m.y. (biotite, GSC 66-78). These ages are thought to reflect post-migmatitic recrystallization developed through shearing and mylonitization of the granodiorite. Cataclastic deformation and recrystallization in the porphyritic quartz monzonite are generally much less conspicuous so that a somewhat older age, more indicative of the time of migmatic crystallization, was expected. However, the biotite age of 1695 m.y. from the present sample also appears to record late cataclastic deformation rather than an earlier migmatic event, although the possibility that the date approximates a truly late migmatic age for the quartz monzonite cannot be entirely discounted.

GSC 67-73 Biotite, K-Ar age 1785 ± 55 m.y.

K = 7.90%, Ar^{40}/K^{40} = 0.1740, radiogenic Ar = 99%.
Concentrate: Relatively clean, dark olive-buff biotite with less than 5% free chlorite impurity. Some flakes exhibit yellow-coloured split edges.

District of Mackenzie

From granite.

(85 H) Central Butte Island, Great Slave Lake, District of Mackenzie, 61°43'50"N, 113°19'20"W. Map-unit 5, GSC Map 377A. Sample RM-5-1-66, collected and interpreted by E. W. Reinhardt.

The sample is a fine-grained, massive, salmon-pink granite containing clots of biotite. The modal composition, estimated from a thin section, is quartz 35%, microcline 35%, oligoclase 10%, and opaque minerals 2%. The plagioclase is extensively altered to fine-grained muscovite and reddish iron oxide. The biotite is randomly oriented within the clot-like aggregates and muscovite is associated with either biotite or microcline. Neither mica shows significant deformation but biotite is slightly altered to chlorite.

The sample was collected 10 feet from an observed intrusive contact between the granite and arkose of the Wilson Island Group. Another sample of granite taken 300 feet from this contact shows less quartz, greater dissemination of biotite, which is also highly chloritized, and increased grain size. Presumably this indicates a general depletion in quartz away from the contact and the sample used for the determination (nearest the contact) represents a contaminated border facies.

The interpretation of the biotite age is indefinite because three plausible petrogenetic evolutions can be proposed for the granite:

(1) The biotite age dates a local phase of granitic intrusion that is related to dioritic intrusions mapped by C. H. Stockwell (map-unit 13, GSC Map 377A) in the East Arm of Great Slave Lake. The time of these intrusions is indicated by a biotite age of 1845 m. y. (GSC 61-78) obtained from biotite-hornblende granite collected southeast of Wilson Lake. The fact that granitic phases of the dioritic intrusions are known elsewhere in the East Arm and the reasonable agreement of the biotite age with that of the present determination provides some evidence for this interpretation. Following this reasoning, the present date would provide a minimum age for the Wilson Island Group in the vicinity of Wilson and Outpost Islands.

(2) The biotite age dates a low-grade metamorphism which affected both the Wilson Island Group and the intrusive granite. Some support for this interpretation is offered by biotite and muscovite K-Ar ages of 1825 m. y. (GSC 67-75) and 1785 m. y. (GSC 67-74) from quartz-mica schist collected from Outpost Islands, 5 miles to the west (see discussion for GSC 67-76). If the biotite from the granite is metamorphic, then the time of actual intrusion could be as early as Archean as suggested by the value of 2555 m. y. (GSC 61-77) determined on biotite in granitized paragneiss from Simpson Islands (directly to the east). As shown by field work in 1968 (see GSC Paper 69-1A, pp. 179-181) the granitized paragneisses in this locality are metasedimentary remnants in a complex of plutonic granites and migmatites.

(3) The biotite age dates granitic intrusion that was contemporaneous with, but unrelated to the dioritic intrusions referred to above.

None of the above interpretations can be adequately documented because they all hinge on making the correct correlations among a diverse assemblage of granitic rocks. As far as the age of the Wilson Island Group is concerned, the difference between the first and third interpretations is academic. In the opinion of the writer, the first interpretation is more reasonable than the others.

District of Mackenzie

GSC 67-74 Muscovite, K-Ar age 1785 ± 55 m.y.

K = 8.60%, Ar^{40}/K^{40} = 0.1740, radiogenic Ar = 99%.
Concentrate: Clean, clear muscovite with less than 4% chlorite inclusions and slight traces of quartz and biotite.

From quartz-mica schist.
(85 H) Outpost Islands, Great Slave Lake, District of Mackenzie, 61°44'08"N, 113°27'26"W. Map-unit 1A on GSC Map 377A, and map-unit A on GSC Map 50-28A. Sample RM-9-1-66, collected and interpreted by E.W. Reinhardt.

See GSC 67-75 for description and interpretation.

GSC 67-75 Biotite, K-Ar age 1825 ± 50 m.y.

K = 7.60%, Ar^{40}/K^{40} = 0.1799, radiogenic Ar = 99%.
Concentrate: Relatively pure dark olive-buff biotite with less than 10% chlorite as free flakes not associated with alteration of the biotite. Other impurities consist of a trace of quartz and a yellow material on split flake-edges.

From quartz-mica schist.
(85 H) Details as for GSC 67-74.

The sample is a core specimen from the site of an abandoned gold-tungsten mine (Fox Group of claims) and is representative of quartz-mica schists that form the lower part of the Wilson Island Group as exposed on Outpost Islands. The bedding in these schists has a general northeastward strike, dips steeply and faces southeast.

In thin section, the sample has an estimated modal composition of quartz 65%, muscovite 18%, staurolite 8%, and biotite 6%. Parallel alignment of muscovite and biotite plates defines the schistosity. Quartz grains (0.5 millimetre) are arranged in a mosaic fabric within the schistosity and staurolite occurs as large skeletonal grains (1-2 millimetres). Chlorite (1-2%) occurs either as independent grains or intergrown with biotite. Accessory constituents include apatite and opaque minerals.

The biotite age (1825 ± 50 m.y.) and the muscovite age (1785 ± 55 m.y.) from this rock date the metamorphism of the Wilson Island Group and therefore establish an approximate minimum age for its deposition.

GSC 67-76 Biotite, K-Ar age 1630 ± 50 m.y.

K = 6.14%, Ar^{40}/K^{40} = 0.1514, radiogenic Ar = 99%.
Concentrate: Light greenish brown biotite with about 10% chlorite contamination. The chlorite occurs as free flakes rather than as an alteration product.

District of Mackenzie

From "diorite".

(75 L) Small island off southwest corner of Et-then Island, Great Slave Lake, District of Mackenzie, 62°09'N, 111°53'W. Map-unit 13, GSC Map 377A (C. H. Stockwell). Sample HY-107a-66, collected and interpreted by P. F. Hoffman.

See GSC 67-77 for description and interpretation.

GSC 67-77 Biotite, K-Ar age 1795 ± 55 m. y.

K = 7.11%, Ar^{40}/K^{40} = 0.1757, radiogenic Ar = 99%.
Concentrate: Relatively clean, light brown biotite with about 5% attached chlorite. Some of the mica flakes are darker in colour than most.

From "diorite".

(85 I) Small island at northeast end of Hearne Channel, East Arm of Great Slave Lake, District of Mackenzie, 62°11'N, 112°06'W. Map-unit 13, GSC Map 377A. Sample HY-106b-66, collected and interpreted by P. F. Hoffman.

Both samples are from dioritic igneous bodies which intrude sedimentary formations in the Great Slave Supergroup and were mapped as unit 13 on GSC Map 377A of C. H. Stockwell. These bodies are shown as underlying the Great Slave Supergroup on some subsequent GSC maps, but recent work (see P. F. Hoffman, GSC Paper 68-42, p. 43) has confirmed that they intrude the Stark Formation and all older rocks. They underlie the Et-then Group but are not in contact with the post-Stark Formations of the Great Slave Supergroup. Sample GSC 67-76 is from a dyke which intrudes the Stark Formation whereas the body from which sample GSC 67-77 was collected is in contact only with the Seton Formation (Kahochella Group), which it intrudes, but it too is believed to post-date the Stark Formation.

One previous diorite body was dated as being 1845 m. y. old (GSC 61-78). The age of sample GSC 67-77 (1795 ± 55 m. y.) is in agreement with this previous determination, whereas that for sample GSC 67-76 (1630 ± 50 m. y.) is considerably younger. However, the higher potassium and lower chlorite content of the former sample renders its age determination the more reliable of the two. It is considered to be a maximum age for the Et-then Group and a minimum age for the Stark Formation and all older rocks of the Great Slave Supergroup.

GSC 67-78 Hornblende, K-Ar age 1780 ± 60 m. y.

K = 0.99%, Ar^{40}/K^{40} = 0.1731, radiogenic Ar = 98%.
Concentrate: Clean, pleochroic brownish green to bluish green hornblende containing a few opaque blebs. Traces of chlorite and quartz are the only impurities.

District of Mackenzie

From hornblende segregation in quartz monzonite.

(75 E) Three miles northwest of La Loche River, District of Mackenzie, 61°51'14"N, 111°36'03"W. Map-unit 9, GSC Map 525A (Taltson Lake). Sample RM-67-9-66, collected and interpreted by E.W. Reinhardt.

The concentrate was derived mainly from a small (2 inch) hornblende-rich segregation in a sample of pink, massive, medium-grained hornblende-biotite quartz monzonite which contains about 40% perthitic microcline, 30% calcic oligoclase, and 25% quartz. The mafic constituents are green hornblende and highly chloritized biotite. The quartz is commonly aggregated, interstitial, and strained. Plagioclase shows extensive fine-grained alteration and neither it nor microcline show any significant cataclasis. The hornblende-rich segregation is made up almost entirely of green hornblende arranged in a mosaic with interstitial fine-grained plagioclase and K-feldspar. The segregation obviously represents relict sedimentary or volcanic material that could not be totally incorporated in the magmatic fraction but which nevertheless, should yield hornblende of the same generation as occurs in the quartz monzonite.

The rock sample was collected from the least deformed central part of a northeastward-trending concordant body of quartz monzonite. This body averages 2 miles in width and is terminated to the southwest by the La Loche River Fault but extends for an undetermined distance to the northeast (see GSC Paper 67-1, Part A, pp. 40-43). At the contacts the quartz monzonite is gneissic and grades into layered migmatites. The body appears to have escaped the effects of intense penetrative deformation and partial retrograde recrystallization that characterizes the surrounding rocks. The hornblende age thus should give the approximate time of emplacement for the quartz monzonite. The value obtained (1780 ± 60 m.y.), however, is close to other ages (GSC 67-72, GSC 66-78, GSC 66-79) that are considered to reflect post-magmatic crystallization in granitic rocks from this vicinity. The present determination is therefore tentatively regarded as being more representative of recrystallization that post-dated primary plutonic crystallization.

GSC 67-79 Hornblende, K-Ar age 647 ± 32 m.y.

$K = 0.42\%$, $Ar^{40}/K^{40} = 0.0451$, radiogenic Ar = 86%.
Concentrate: Altered green hornblende. Most grains have patches of chloride alteration and tiny opaque blebs. About 10% of the grains contain large opaque inclusions, while others carry attached mica flakes (about 3%).

From hornblende diorite.

(86 N) Between Dismal Lakes and Coppermine, District of Mackenzie, 67°33'N, 116°23'W. See GSC Map 18-1960. Sample FA-15-66, collected by W.F. Fahrig.

The sample was taken from a gently dipping diabase sheet near Coronation Gulf. The K-Ar age determination is thought to represent the approximate age of intrusion.

District of Mackenzie

GSC 67-80 Biotite-hornblende mixture, K-Ar age 1400 ± 75 m.y.

K = 2.75%, Ar^{40}/K^{40} = 0.1212, radiogenic Ar = 99%.
Concentrate: Mixture of 60-70% altered brown biotite and 30-40% highly altered green hornblende. The biotite flakes are altered to chlorite on their edges and total chlorite content of the concentrate is 25%.

From diabase.
(86 K) East of McTavish Arm of Great Bear Lake, District of Mackenzie, 66°18'N, 117°47'W. See GSC Map 18-1960. Sample FA-16-66, collected by W.F. Fahrig.

The sample was taken from a gently dipping diabase sheet in the vicinity of Port Radium. The K-Ar age determination may represent the approximate time of intrusion.

GSC 67-81 Impure biotite, K-Ar age 718 ± 27 m.y.

K = 4.70%, Ar^{40}/K^{40} = 0.0512, radiogenic Ar = 97%.
Concentrate: Impure, but unaltered brown biotite with 20-30% highly altered green hornblende and 5% altered pyroxene contamination. Total chlorite content is 5%.

From diabase.
(86 C) District of Mackenzie, 64°30'N, 117°25'W. See GSC Map 2-58. Sample FA-20-66, collected by W.F. Fahrig.

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

GSC 67-82 Impure biotite, K-Ar age 1685 ± 95 m.y.

K = 2.49%, Ar^{40}/K^{40} = 0.1595, radiogenic Ar = 98%.
Concentrate: A mixture of 50% unaltered reddish brown biotite, 20% altered hornblende, 10% pyroxene, and other opaque material.

From diabase.
(85 J) Horn River area, District of Mackenzie, 62°31'N, 114°00'W. Sample FA-22-66, collected by W.F. Fahrig.

The sample was collected from the gently dipping differentiated sheet east of Yellowknife Bay. The K-Ar age determination is thought to represent the approximate age of intrusion.

District of Mackenzie

GSC 67-83 Biotite-hornblende mixture, K-Ar age 631 ± 40 m.y.

K = 2.91%, Ar^{40}/K^{40} = .0438, radiogenic Ar = 96%.
Concentrate: A mixture of 60% unaltered brown biotite and 40% very highly altered green hornblende. Most biotite flakes carry strong pleochroic haloes and the hornblende grains contain opaque inclusions. Total chlorite content is 2-3%.

From diabase.
(76 M) District of Mackenzie, 67°40'N, 111°03'W. See GSC Map 4-1963. Sample FA-18-66, collected and interpreted by W.F. Fahrig.

The sample was taken from a gently dipping diabase sheet near Coronation Gulf. The K-Ar age determination is thought to represent the approximate age of intrusion.

GSC 67-84 Whole rock, K-Ar age 1445 ± 140 m.y.

K = 0.87%, Ar^{40}/K^{40} = 0.1270, radiogenic Ar = 96%.
Concentrate: Crushed whole rock.

From basalt.
(76 D) District of Mackenzie, 64°03'N, 110°15'W. GSC Paper 5-47. Sample FA-19-66, collected and interpreted by W.F. Fahrig.

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

GSC 67-85 Impure biotite, K-Ar age 1020 ± 85 m.y.

K = 2.51%, Ar^{40}/K^{40} = 0.0792, radiogenic Ar = 97%.
Concentrate: A mixture of 2/3 unaltered brown biotite and 1/3 altered, pale green hornblende. Most of the hornblende grains contain tiny opaque inclusions.

From diabase.
(75 L) Eastern Great Slave Lake area, District of Mackenzie, 62°45'N, 110°23'W. See GSC Paper 25-51. Sample FA-21-66, collected and interpreted by W.F. Fahrig.

The sample was collected from the diabase sheets of the East Arm of Great Slave Lake. The K-Ar age determination is thought to represent the approximate age of intrusion.

GSC 67-86 Whole rock, K-Ar age 1200 ± 135 m.y.

K = 0.61%, Ar^{40}/K^{40} = 0.0983, radiogenic Ar = 93%.
Concentrate: Crushed whole rock.

District of Mackenzie

From basalt.

(76 E) District of Mackenzie, 65°55'N, 111°01'W. GSC Map 45-1963. Sample FA-17-66, collected and interpreted by W. F. Fahrig.

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

District of Keewatin

GSC 67-87 Hornblende, K-Ar age 2585 ± 70 m.y.

K = 0.63%, Ar^{40}/K^{40} = 0.3236, radiogenic Ar = 89%.
Concentrate: Clean but slightly altered pleochroic brownish yellow to dark green hornblende with only a trace of mica and quartz contamination. Up to 10% of the grains have slight chlorite alteration on the edges.

From hornblende gabbro.
(55 L) Zero point three mile northeast of the northwest end of Southern Lake, District of Keewatin, 62°15'30"N, 94°27'W. See GSC Map 55-17. Sample DM-103-1966, collected and interpreted by A. Davidson.

The medium-grained, equigranular hornblende gabbro contains approximately equal parts of hornblende and andesine, with minor quartz and biotite and accessory sphene, apatite, and magnetite, with traces of secondary epidote, chlorite, and calcite. Plagioclase is in part clouded; where fresh, it shows oscillatory zoning. Hornblende is strongly pleochroic from pale brown to deep green. Large grains have uralitic cores whose texture suggests replacement of original pyroxene.
See GSC 67-89 for interpretation.

GSC 67-88 Biotite, K-Ar age 1805 ± 55 m.y.

K = 7.56%, Ar^{40}/K^{40} = 0.1768, radiogenic Ar = 99%.
Concentrate: Relatively clean, dull, light green biotite with less than 10% free chlorite contamination.

From biotite-quartz monzonite.
(55 L) Two point five miles northeast of northeast shore of Southern Lake, District of Keewatin, 62°13'45"N, 94°17'W. See GSC Map 55-17. Sample DM-162-1966, collected and interpreted by A. Davidson.

The rock is a porphyritic biotite-quartz monzonite composed of approximately equal parts of quartz, oligoclase, and microcline, with less than 5% other minerals. Greenish biotite occurs as scattered flakes and is in part altered to chlorite accompanied by epidote, calcite, sphene, and fluorite. Where fresh, it encloses small sphene grains surrounded by pleochroic haloes. Plagioclase is in part replaced by scattered flakes of muscovite.
See GSC 67-89 for interpretation.

GSC 67-89 Biotite, K-Ar age 2010 ± 50 m.y.

K = 7.47%, Ar^{40}/K^{40} = 0.2101, radiogenic Ar = 99%.
Concentrate: Relatively clean, light green biotite with less than 5% hornblende contamination. There is also a slight trace of chlorite and some of the biotite flakes have split edges with a yellow alteration.

District of Keewatin

From biotite-quartz monzonite.

(55 L) Three miles east of east shore of Kaminak Lake, District of Keewatin, 62°14'N, 94°37'W. See GSC Map 55-17. Sample DM-144-1966, collected and interpreted by A. Davidson.

The rock is a massive, medium-grained biotite-quartz monzonite composed of approximately equal parts of quartz, microcline and oligoclase, with about 5% combined biotite and hornblende, biotite being the more abundant. Microcline forms poikilitic megacrysts. Sphene and epidote are accessory. Biotite is greenish brown to buff, occurs in scattered ragged grains; apart from minor chlorite it is fresh and has straight cleavage.

The three rocks described above, GSC 67-87, 88 and 89, are from plutonic complexes that intrude the deformed and metamorphosed volcanic rocks that underlie part of the region west of Hudson Bay. The various plutonic rocks, ranging from gabbro to granite in composition, form intimately associated plutons that are probably related in time. In the vicinity of Quartzite and Kaminak Lakes, where these samples were taken, both the metavolcanic and plutonic rocks are cut by north-trending diabase dykes that are themselves truncated by the sedimentary rocks of the Aphebian Hurwitz Group. Thus the plutonic rocks are pre-Hurwitz and consequently pre-Hudsonian in age. To the group of ages reported above must be added a K-Ar age of 1925 m.y. determined on biotite in gneiss included in the granitoid body, east of Kaminak Lake (GSC 60-61, GSC Paper 61-17), and part of the same complex from which samples 67-87 and 67-89 were collected.

A clue to the history of the plutonic rocks is given by the pre-Hurwitz dykes that cut them. Where samples for age determination were taken, the diabase is moderately fresh or mildly altered, as are the plutonic rocks. To the north, at Quartzite and Helika Lakes, the diabase contains metamorphic minerals, including stilpnomelane, indicative of greenschist grade. Some 10 miles farther north the diabase is metamorphosed to biotite-epidote amphibolite, and the plutonic rocks are considerably altered and recrystallized.

The reported radiometric ages are in keeping with the geological interpretation that the plutonic rocks are pre-Hudsonian (and pre-Hurwitz). The oldest age of 2585 m.y. determined on hornblende from diorite GSC 67-87 suggests that at least some of the plutonic rocks are Kenoran, that hornblende is a better argon retainer than biotite where later slight metamorphism and alteration has occurred, and that the biotite ages, intermediate between Kenoran and Hudsonian ages, may be up-dated by the effects of the Hudsonian Orogeny to the north.

GSC 67-90 Biotite, K-Ar age 1005 ± 40 m.y.

K = 2.69%, Ar^{40}/K^{40} = 0.0776, radiogenic Ar = 98%.
Concentrate: Impure, altered brown biotite with about 5% highly altered hornblende contamination. The mica flakes are altered to chlorite on their edges and contain bleached patches. Total chlorite content is about 25%.

District of Keewatin

From diabase.

(46 L) West of Repulse Bay, District of Keewatin, 66°22'N, 87°41'W. Sample FA-14-66, collected by W.F. Fahrig.

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

Saskatchewan

GSC 67-91 Muscovite, K-Ar age 1575 ± 55 m.y.

K = 8.77%, Ar^{40}/K^{40} = 0.1438, radiogenic Ar = 99%.
Concentrate: Clean clear muscovite. Some of the flakes carry a slight yellow stain on their edges.

From pegmatite drill core.

(64 E) Eleven thousand feet northeast of Courtenay Lake, Saskatchewan, 57°26'24"N, 103°54'12"W. Map-unit 1, GSC Map 596A. Sample DH-C.L.2, collected and interpreted by J. J. Brummer and S.K. Moller (Falconbridge Nickel Mines Ltd.).

The pegmatite sample, from drillhole C.L.2 at 666 feet, forms part of a 19-foot-long intersection of fresh pegmatite. Surface exposures show the pegmatite to be post-folding and hence post-metamorphism in age, as it cuts across the bedding of the metasedimentary sequence present in the area. It is probably associated with the porphyritic granite present in the area northwest of Courtenay Lake. This granite extends from Reynolds Lake for a distance of at least 80 miles to the southwest.

The date appears to be slightly younger than other ages in the vicinity (1645-1780 m.y.). However, a date of 1550 m.y. was recorded on the Churchill River between Snake Lake and Lac Ile à la Crosse (GSC 60-69). It is difficult to say whether this slight difference has any significance or not. In any event it appears that the age of intrusive rocks at Courtenay Lake is slightly younger than those dated elsewhere in the Churchill Province.

Manitoba

GSC 67-92 Muscovite, K-Ar age 1660 ± 55 m.y.

K = 8.70%, Ar^{40}/K^{40} = 0.1559, radiogenic Ar = 99%.
Concentrate: Clean, clear muscovite with very slight yellow staining on some flakes. Some flakes contain biotite inclusions (less than 5%).

From granodiorite.
(54 L) On South Knife River 12.5 miles west of its junction with Matonabee Creek, Manitoba, 58°27'N, 95°42.5'W. No published geological map, but part of Operation Winisk. Sample 239BK/67-1, collected and interpreted by H.H. Bostock.

See GSC 67-93 for description and interpretation.

GSC 67-93 Biotite, K-Ar age 1670 ± 55 m.y.

K = 7.42%, Ar^{40}/K^{40} = 0.1574, radiogenic Ar = 99%.
Concentrate: Relatively clean, olive coloured biotite with less than 2% muscovite impurity. Some of the biotite flakes are almost opaque with pleochroic haloes and segregations of iron oxides.

From granodiorite.
(54 L) Details as for GSC 67-92.

The rock is a massive, medium-grained, light grey, quartz monzonite ranging to granodiorite and containing quartz, oligoclase (An_{15}), microcline, biotite, and muscovite, with accessory apatite, garnet, chlorite and zircon. No contacts are exposed but pegmatite presumably related to this pluton intrudes high grade paragneiss farther west. The rock is less altered than most granitic rocks in the area. The age of biotite and muscovite (average 1665 m.y.), which is thought to be a minimum date for emplacement of this pluton, falls within one standard deviation of the mean age for the Hudsonian Orogeny. It strengthens earlier indications that the granitic rocks about Churchill are of Hudsonian age, and since none are known to intrude the Churchill Formation, it provides a tentative maximum age for the latter formation.

Reference

Bostock, H.H.
1970: Deer River map-area; *Geol. Surv. Can.*, Paper 69-24.

GSC 67-94 Whole rock, K-Ar age 865 ± 99 m.y.

K = 0.77%, Ar^{40}/K^{40} = 0.0642, radiogenic Ar = 92%.
Concentrate: Crushed whole rock.

Manitoba

From basalt.

(63 J) Manitoba, 54°55'N, 98°03'W. Sample FA-23-66, collected and interpreted by W.F. Fahrig.

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

GSC 67-95 Biotite enriched whole rock, K-Ar age 1095 ± 115 m.y.

K = 0.88%, Ar^{40}/K^{40} = 0.0868, radiogenic Ar = 94%.
Concentrate: Biotite-enriched whole rock - the product of an unsuccessful attempt to make a biotite concentrate.

From gneiss.

(53 L) West-southwest of Gods Lake, Manitoba, 54°15'N, 95°06'W. Sample FA-24-66, collected and interpreted by W.F. Fahrig.

The sample was taken from country rock in contact with a diabase dyke, and the K-Ar age determination is thought to represent the approximate age of intrusion of the dyke.

GSC 67-96 Whole rock, K-Ar age 1555 ± 205 m.y.

K = 0.20%, Ar^{40}/K^{40} = 0.1416, radiogenic Ar = 82%.
Concentrate: Crushed whole rock.

From diabase.

(53 K) Manitoba, 54°18'N, 93°16'W. Sample FA-25-66, collected and interpreted by W.F. Fahrig.

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

Ontario

GSC 67-97 Biotite, K-Ar age 1080 ± 40 m.y.

K = 6.42%, Ar^{40}/K^{40} = 0.0853, radiogenic Ar = 97%.
Concentrate: Relatively pure, amber-brown biotite with minor impurities of hornblende and altered feldspar. The mica is fresh and unaltered.

From gabbro.
(52 H) Disraeli Lake, Ontario, 49°07'N, 88°59'W. Map-unit 11, Ont. Dept. Mines Preliminary Map 357. Sample 67FR480, collected and interpreted by J.M. Franklin.

This sample is fresh, dark green, medium-grained gabbro, composed of augite, olivine, biotite, hornblende, plagioclase and accessory serpentine and magnetite. It forms part of a cyclindrical plug which varies from olivine gabbro in the centre through pyroxene gabbro to syenite on the rim. The rim contains up to 3% disseminated chalcopyrite.

This body cuts the Sibley Group, thus fixing the uppermost time limit for Sibley deposition. The age is similar to the 1080 m.y. date of the Duluth gabbro complex (Faure, 1964) and to the 980 to 1100 m.y. age range for Keweenawan volcanic rocks of the Keweenaw Peninsula of Michigan (Faure and Chaudhuri, 1967). Thus this body apparently forms part of the same magmatic suite as the other Neohelikian volcanic and intrusive rocks of the Lake Superior region.

Reference: See GSC 67-104.

GSC 67-98 Biotite, K-Ar age 993 ± 35 m.y.

K = 6.12%, Ar^{40}/K^{40} = 0.0765, radiogenic Ar = 98%.
Concentrate: Relatively clean, brownish orange biotite with less than 5% included opaques and about 5% plagioclase contamination.

From gabbro.
(52 A) Great Lakes Nickel property, northwest of Fort William, Ontario, 48°04'N, 89°35'W. Map-unit 10, Ont. Dept. Mines Map 2065. Sample 67FR479B, collected and interpreted by J.M. Franklin.

This sample is fresh, dark green, medium-grained gabbro, composed of hypersthene, augite, olivine, biotite (MacRae and Reeve, 1968) and accessory pyrrhotite, pentlandite, chalcopyrite and other sulphide phases (Mainwaring, 1968).

It was taken from the sulphide-bearing layer of the Great Lakes Nickel intrusion. This layer occurs above a porphyritic marginal zone, is terminated by a thin but continuous chromitite horizon, and is overlain by a coarser grained gabbro layer. The layers are regular; the body forms a trough with limbs dipping 20 degrees to 35 degrees and has an axial plunge of 16 degrees to the east. Layers above the chromite horizon dip more gently

than those below. The entire body is 1,300 feet wide, 10,000 feet long, and over 3,000 feet thick. It is intruded into the Rove Shale Formation of the Animikie Series.

Biotite is associated primarily with sulphide-bearing portions of the intrusion. It occurs within pegmatitic sulphide-silicate patches and with interstitial sulphide-oxide accumulations. The pegmatitic nature of the silicate minerals, and the abundance of magnetite associated with sulphide accumulations indicates a fairly high oxygen partial pressure in the sulphide melt. The interstitial texture of the sulphide indicates that they probably crystallized later than their silicate host. On crystallization the sulphide melt probably expelled any oxygen dissolved in it. The increased pO_2 surrounding the sulphide area promoted the formation of magnetite. In addition, excess water could join with any residual silicate liquid to form biotite, or react with existing silicates to produce the same result.

Thus the age of this sample, as it was determined from biotite extracted from the rock, is the age of final sulphide crystallization. It is probable that the sulphide minerals crystallized after the major portion of the silicate phase was crystallized.

The petrographic and age similarity of the Great Lakes body to the Pine River dyke (see GSC 67-99) indicates the contemporaneity of their crystallization. Field relations suggest that the Great Lakes body formed adjacent to this dyke; magma carried up the fissure dyke accumulated in a large structural trap, and cooled slowly.

Comparison of this date with that of the Duluth complex (Faure, 1964) and the Keweenawan volcanic rocks (Faure and Chaudhuri, 1967 and GSC 67-104) indicates a co-magmatic origin for these bodies.

Reference: See GSC 67-104.

GSC 67-99 Biotite, K-Ar age 1045 ± 40 m.y.

K = 4.56%, Ar^{40}/K^{40} = 0.0818, radiogenic Ar = 98%.
Concentrate: Brownish orange biotite with about 15% free chlorite contamination. Most of the mica flakes have split edges.

From gabbro.

(52 A) Near the International Boundary on Pine River, Ontario, 48°04'N, 89°31'W. Map-unit 10, Ont. Dept. Mines Map 2065. Sample 67FR482, collected and interpreted by J. M. Franklin.

This sample is moderately altered, dark green, medium-grained gabbro composed of labradorite, augite and serpentine with minor chlorite, altered olivine, ilmenite, magnetite, biotite, and accessory pyrrhotite, chalcopyrite, pentlandite and other sulphide phases (Heslop, 1968). It was taken from the central portion of a dyke which trends N65°E and is traceable for several miles in outcrop and by diamond drilling.

This dyke forms part of a swarm which parallels the shore of Lake Superior trending N65°E to N70°E, and extends from south of the United

States border (Pigeon Point) to the islands east of Sibley Peninsula. All of these dykes are petrographically similar, and all intrude the Rove shale formation of the Animikie Series (Group). They are mineralogically and texturally different however, from the Kaministikwan rocks (Tanton, 1931) or the Disraeli Lake plug (sample GSC 67-97). The similarity in age of these dykes to the Disraeli plug, the Duluth gabbro complex, and the Keweenawan volcanic rocks suggests that although the process of crystallization and end products of differentiation of each may be different, they all belong to the Lake Superior petrographic province. This date fixes the time of formation of nickel mineralization in this region of Helikian and Aphebian rocks.

Reference: See GSC 67-104.

GSC 67-100 Whole rock, K-Ar age 924 ± 90 m.y.

K = 1.25%, Ar^{40}/K^{40} = 0.0697, radiogenic Ar = 92%.
Concentrate: Crushed whole rock.

From chilled diabase.
(52 A) Creswell Silver Mine, Ontario, 48°18'N, 89°40'W. Sample 67FR478, collected and interpreted by J. M. Franklin.

The sample is fine-grained, fresh, black gabbro from the chilled margin of a diabase sheet. It is composed of plagioclase microlites, biotite, hornblende, augite, calcite, chlorite and ilmenite-magnetite, with accessory chalcopyrite and pyrite. It is the marginal phase of an olivine diabase sill, regionally referred to as "Logan" sills or Kaministikwan intrusive rocks (Tanton, 1931).

This sheet intrudes the Rove Formation of the Animikie Series, and overlies the Creswell Mining Company's silver deposit. Calcite-quartz-fluorite-barite veins cut the shale, and contain native silver and sulphide minerals below the diabase; these veins usually terminate at or within the first few feet of the diabase. Where a vein appears to penetrate the diabase, it usually occupies a fault zone. A few veins continue into the chilled margin of the diabase, with no accompanying fault movement; in such cases all metal content is below the contact between diabase and shale. Thus it would appear that the veins are contemporaneous with or slightly later than the period of diabase emplacement.

This date fixes the time of cooling of the sheet, and sets a limit on the time of vein formation.

Reference: See GSC 67-104.

GSC 67-101 Whole rock, K-Ar age 837 ± 115 m.y.

K = 0.38%, Ar^{40}/K^{40} = 0.0617, radiogenic Ar = 76%.
Concentrate: Crushed whole rock.

Ontario

From gabbro.

(52 H) Kama Bay, Lake Superior, 15 miles east of Nipigon, Ontario, 49°03'N, 88°03'W. Map-unit 11, Ont. Dept. Mines Preliminary Map 357. Sample 67FR472, collected and interpreted by J. M. Franklin.

This sample is light green, fine grained chill margin from a small sill exposed along Highway 17, at Kama Bay, near Nipigon, Ontario. It is composed of carbonate, plagioclase and saussurite. The rock has been altered from a more typical diabase chill margin, possibly due to assimilation of the limy mudstone which it intrudes.

The age is that of cooling of the diabase sill. See sample GSC 67-103 for further discussion.

GSC 67-102 Whole rock, K-Ar age 1000 ± 140 m.y.

K = 0.30%, Ar^{40}/K^{40} = 0.0774, radiogenic Ar = 82%.
Concentrate: Crushed whole rock.

From chilled diabase.

(52 A) Red Rock, Ontario, 48°59'N, 88°20'W. Map-unit 11b, Ont. Dept. Mines Preliminary Map 357. Sample 67FR476, collected and interpreted by J. M. Franklin.

The sample is fine grained, dark green diabase, taken from just above the chilled margin of diabase sheet. See sample GSC 67-103 for discussion.

GSC 67-103 Whole rock, K-Ar age 963 ± 134 m.y.

K = 0.32%, Ar^{40}/K^{40} = 0.0735, radiogenic Ar = 79%.
Concentrate: Crushed whole rock.

From diabase/gabbro.

(52 A) Red Rock, Ontario, 48°59'N, 88°20'W. Map-unit 10, Ont. Dept. Mines Preliminary Map 357. Sample 67FR475, collected and interpreted by J. M. Franklin.

This sample is from a fresh, dark green, fine grained chill margin at the base of a diabase sheet. It is composed of plagioclase microlites, slightly altered mafic minerals, and ilmenite.

The age of this rock (GSC 67-101, 102, and 103) indicates the time of cooling of the diabase sheet. It confirms the probably co-magmatic relationship of this sheet with the Great Lakes Nickel complex (GSC 67-98), the Keweenawan flow rocks (GSC 67-104 and Faure and Chaudhuri, 1967), and the Duluth gabbro complex (Faure, 1964). It also sets the younger limit on the age of the Sibley Group, which the diabase intrudes.

Reference: See GSC 67-104.

Ontario

GSC 67-104 Whole rock, K-Ar age 821 ± 98 m.y.

K = 0.69%, Ar^{40}/K^{40} = 0.0602, radiogenic Ar = 92%.
Concentrate: Crushed whole rock.

From basalt.

(42 D) South shore of Ignace Island, 1 mile west of Hope Island, Lake Superior, Ontario, 48°46'N, 87°55'W. See Ont. Dept. Mines Preliminary Map 358. Sample 67FR454, collected and interpreted by J. M. Franklin.

This sample is moderately fresh, black, porphyritic amygdaloidal basalt, composed of plagioclase microlites and phenocrysts, pyroxene, olivine, hematite, alteration minerals and glass, with accessory sulphides and native copper. It was taken from a flow in the middle or upper Osler Group.

The date obtained may indicate the age of extrusion and cooling of the Osler Group. However, it is possible that this age is too young. The age of similar rocks in the Keweenawan Peninsula is between 980 and 1100 m.y. (Faure and Chaudhuri, 1967); the age of rocks associated with the Tribag copper deposit is probably 1055 ± 55 m.y. (Roscoe, in Wanless et al., 1966). Roscoe notes (Wanless et al., 1967, pp. 84, 85) that some samples appear to have undergone loss of radiogenic argon, thus yielding anomalously low (830 ± 84 and 915 ± 140) ages (GSC 65-105, 106).

Due to the high plagioclase content, and the alteration and weathering effects, it is possible that this sample has undergone argon loss. Its age should be 1000 m.y. as compared with ages of probable co-magmatic rocks such as the Duluth gabbro (Faure, 1964), the Great Lakes Nickel body and Logan sills (GSC 67-98, 100).

References

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1964: The age of the Duluth Gabbro complex and the Endion sill by the whole-rock Rb-Sr method: M.I.T. 12th Annual Progress Report, pp. 255-257.

Faure, G., and Chaudhuri, S.
1967: The geochronology of the Keweenawan rocks of Michigan and the origin of the copper deposits: Report No. 1, Laboratory for Isotope Geology and Geochemistry, Department of Geology, Ohio State University.

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1968: Mineralogy and textured relationships of the Mount Mollie sulphides, Pine Bay area, Thunder Bay district, Ontario. B.Sc. thesis, University of Western Ontario.

MacRae, N.D., and Reeve, E.J.
1968: Differentiation sequence of the Great Lakes Nickel intrusion. Fourteenth Annual Institute on Lake Superior Geology, abstract.

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1968: Sulphide assemblages of the Great Lakes Nickel intrusion. Fourteenth Annual Institute on Lake Superior Geology, abstract.

Ontario

Tanton, T.L.
1931: Fort William and Port Arthur, and Thunder Cape map-area, Thunder Bay District, Ontario, *Geol. Surv. Can.*, Mem. 167.

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1967: Age determinations and geological studies, G.S.C. Paper 66-17, p. 85.

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1966: Age determinations and geological studies, G.S.C. Paper 65-17, p. 58.

GSC 67-105 Muscovite, K-Ar age $\frac{2615 \pm 75 \text{ m.y.}}{2635 \pm 70 \text{ m.y.}}$

K = $\frac{8.90\%}{7.88\%}$, Ar^{40}/K^{40} = $\frac{0.3309}{0.3353}$, radiogenic Ar = $\frac{99\%}{99\%}$.

Concentrate: Clean, clear muscovite with very slight yellow staining on flake edges.

From pegmatitic ore vein.

(52 A) Omega Mine, Ontario, 48°46'N, 88°44'W. See Ont. Dept. Mines Ann. Rept. 38 (1929), Pt. 6. Sample SP-622, collected by D.F. Sangster and J. Franklin, interpreted by D.F. Sangster.

The sample comprises muscovite occurring in a sphalerite-galena-pyrite vein containing amethystine quartz, barite, and minor fluorite as gangue material in the Ogema Mine, at or near the contact between pegmatite of unknown age and Archean biotite schist. Mineralization cements breccia fragments of schist and pegmatite. Although mica is a common constituent of both these rocks, clean, clear muscovite is also found as part of the sulphide and gangue vein material. It is this muscovite which was hand-picked for dating in an attempt to establish the date of mineralization.

Elsewhere in the Port Arthur area, veins of similar composition and texture, but without muscovite, cut Proterozoic Sibley Group red shales and siltstone as well as Archean granite. Sibley rocks do not occur near the Ogema Mine but, on the basis of mineralogy and texture, the Ogema vein has been assumed to be equivalent to these other veins. The Ogema is the only one known to contain dateable material.

Two alternatives are suggested as interpretations for the Archean age of the vein muscovite:

1. That the Ogema vein is actually of Archean age, the muscovite representing its true age, and the vein is not equivalent to similar veins which elsewhere cut the Proterozoic Sibley Group.
2. The vein is indeed post-Sibley but the muscovite has been incorporated from the Archean wall-rocks without being up-dated during vein formation. Because the vein muscovite is lighter in colour and coarser grained than mica in either the pegmatite or the schist, it was hoped that this apparent recrystallization would have re-set the K-Ar clock at the time of vein formation. The older age obtained suggests this may not have happened.

Ontario

GSC 67-106 Biotite, K-Ar age 2505 ± 70 m. y.

K = 7.00%, Ar^{40}/K^{40} = 0.3062, radiogenic Ar = 99%.
Concentrate: Greenish brown biotite containing about 20% chlorite as free flakes. There is also a trace of quartz impurity and some of the mica flakes have split edges.

From granite.
(43 G) Sixteen miles north of Ekwan River and 12 miles west of Nowashe Lake, Ontario, 53°44.5'N, 83°24.5'W. Part of Operation Winisk. Sample BK/67-83, collected and interpreted by H. H. Bostock.

The rock is massive, medium-grained, grey-white granodiorite containing plagioclase (An_{18}), quartz, microcline, chlorite, biotite, carbonate and opaque minerals with accessory zircon, apatite and amphibole. Scattered inclusions of more mafic granodiorite are present and the rock is veined by pink, massive, fine-grained quartz monzonite.

The age of biotite (2505 m.y.), which is a minimum date of metamorphism, is close to the mean for the Kenoran Orogeny. It suggests that, in this area, any westward continuation of the Cross Lake Belt of generally Aphebian metamorphic ages must pass north of latitude 54 degrees.

Reference

Sanford, B.V., Norris, A.W., and Bostock, H.H.
1967: Operation Winisk; *Geol. Surv. Can.*, Paper 67-60.

GSC 67-107 Biotite, K-Ar age 2505 ± 65 m. y.

K = 7.75%, Ar^{40}/K^{40} = 0.3066, radiogenic Ar = 99%.
Concentrate: Relatively clean, greenish brown biotite with about 4% free chlorite contamination. Some flakes have darker brown split edges.

From granodioritic gneiss.
(43 G) Four miles west-southwest of Patchepawapoka Lake, Ontario, 53°54'N, 83°44.5'W. Operation Winisk. Sample 95BK/67-1, collected and interpreted by H. H. Bostock.

The sample is from white weathering, slightly foliated grey, seriate, medium-grained biotite granodiorite. In addition to essential minerals the rock contains a little epidote and accessory apatite, zircon, sphene and magnetite.

Associated with this granodiorite are patches of pinkish red massive, medium-grained, chlorite quartz monzonite and minor, more mafic granodiorite. The relative ages of these rocks are not known.

The K-Ar age obtained is typical of the Superior Province of the Canadian Shield and is thought to represent the metamorphic age of biotite at this locality. It suggests that Hudsonian metamorphism, which is widely

evident in the far northwestern Superior Province (Stockwell, 1965), did not effect the older basement rocks on the southern flank of the Cape Henrietta Maria Arch.

GSC 67-108 Whole rock, K-Ar age 1455 ± 175 m.y.

K = 0.39%, Ar^{40}/K^{40} = 0.1282, radiogenic Ar = 92%.
Concentrate: Crushed whole rock.

From basalt.
(52 D) Rainy River area, Ontario, 48°45'N, 94°00'W. Ont. Dept. Mines Map 1954-2. Sample FA-4-66, collected and interpreted by W.F. Fahrig.

The K-Ar age determination is thought to represent the approximate intrusion of the diabase dyke.

GSC 67-109 Impure biotite, K-Ar age 2000 ± 60 m.y.

K = 4.85%, Ar^{40}/K^{40} = 0.2086, radiogenic Ar = 99%.
Concentrate: A mixture of 70% slightly altered dark brown biotite, 10-15% altered green hornblende, and 5% opaques. The biotite is altered to chlorite on flake edges and total chlorite content is about 10%.

From granite gneiss.
(42 C) North of Lake Superior, Ontario, 48°50'N, 85°30'W. Sample FA-10-65, collected and interpreted by W.F. Fahrig.

The sample was taken from country rock in contact with a diabase dyke, and the K-Ar age determination is thought to represent the approximate time of intrusion of the dyke.

GSC 67-110 Hornblende, K-Ar age 1440 ± 55 m.y.

K = 0.31%, Ar^{40}/K^{40} = 0.1263, radiogenic Ar = 94%.
Concentrate: Slightly impure and slightly altered green hornblende with rather more than 5% altered biotite and 10% chlorite. Most grains contain tiny opaque inclusions.

From diabase.
(41 J) North of Lake Huron, Ontario, 46°20'N, 83°45'W. Sample FA-26-65, collected and interpreted by W.F. Fahrig.

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

Ontario

GSC 67-111 Whole rock, K-Ar age 1235 ± 150 m.y.

K = 0.81%, Ar^{40}/K^{40} = 0.1022, radiogenic Ar = 92%.
Concentrate: Crushed whole rock.

From basalt.
(41 J) Ontario, 46°20'N, 82°33'W. GSC Map 1970. Sample FA-7-66, collected and interpreted by W.F. Fahrig.

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

GSC 67-112 Whole rock, K-Ar age 1295 ± 135 m.y.

K = 0.81%, Ar^{40}/K^{40} = 0.1091, radiogenic Ar = 92%.
Concentrate: Crushed whole rock.

From basalt.
(41 J) Ontario, 46°47'N, 83°45'W. Sample FA-6-66, collected and interpreted by W.F. Fahrig.

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

Quebec

GSC 67-113 Biotite, K-Ar age 2020 ± 70 m.y.
2045 ± 70 m.y.

K = 7.52%, Ar^{40}/K^{40} = 0.2120, radiogenic Ar = 99%.
0.2160 99%

Concentrate: Very light brown biotite with a trace of attached chlorite. Some of the mica flakes have split edges.

From biotite/tonalite.

(32 G) North shore of Granite Island, Lac Chibougamau, Quebec, 47°49.7'N, 74°13.2'W. Map-unit 5, Quebec Dept. Natural Resources map of Lemoine Twp. NW1/4 in preparation, and map-unit 10, GSC Map 304A. Sample ALLARD-1, collected and interpreted by G.O. Allard (Quebec Dept. of Natural Resources).

The biotite tonalite is a white, medium-grained rock made up of quartz, clusters of biotite, plagioclase, and minor amounts of microcline. The plagioclase is zoned and the cores are heavily saussuritized. The oligoclase rims are clear. The biotite has an orange-red tint and varies from completely fresh in some slides to completely chloritized in others. Clusters of epidote are noted in some slides. The quartz is everywhere highly strained and recrystallized to a fine-grained mosaic. Only a couple of thin sections showed minor amounts of microcline present. An analysis by the Quebec Department of Natural Resources laboratory indicated the trondhjemitic nature of the rock and the low K_2O content which is characteristic of the Chibougamau greenstone belt.

The biotite tonalite appears to be the youngest unit of the zoned Chibougamau Lake pluton but it is thought that all the units of the pluton are roughly contemporaneous. All of them have been affected by the Kenoran folding and low grade metamorphism.

The sample is located 8 to 9 miles northwest of the Grenville Front and it was not expected that the influence of the Grenville metamorphism would be felt in this location.

The area is cut by numerous wide shears (all the copper mines are associated with the shears) where the meta-anorthosite and other rocks are converted to sericite-quartz-chlorite-carbonate 'paper' schists over widths of 500 feet and more. It is possible that the intense shearing and hydrothermal alteration has affected the age of all the rocks of the area, including this tonalite.

GSC 67-114 Biotite, K-Ar age 1685 ± 55 m.y.

K = 7.93%, Ar^{40}/K^{40} = 0.1592, radiogenic Ar = 99%.
Concentrate: Clean, deep olive-buff biotite with no visible impurities or alteration. About 10% of the flakes have a somewhat darker colour.

From gneiss.

(25 A) East coast of Ungava Bay, south of Port Burwell, Quebec, 60°04'N, 65°00'W. Sample BA-328, collected by C.K Bell, interpreted by F.C. Taylor.

Quebec

This sample is from a biotite-diopside gneiss that occurs within an area of dominantly granulite metamorphic facies rocks. The gneiss is moderately well foliated, dominantly greyish green and consists approximately of 40% each of diopside and biotite. Small amounts of interstitial plagioclase and trace amounts of apatite and hornblende comprise the remainder of the rock. The biotite is fresh, pleochroic from pale yellowish orange to dark reddish brown and free from impurities.

The age, 1685 ± 55 m.y., agrees with other age determinations from metamorphic rocks in the region and confirms that this region lies in the Churchill Province and that the metamorphism is a product of the Hudsonian Orogeny.

GSC 67-115 Whole rock, K-Ar age 1270 ± 115 m.y.

K = 1.16%, Ar^{40}/K^{40} = 0.1060, radiogenic Ar = 94%.
Concentrate: Crushed whole rock.

From diabase.
(24 J) South of Ungava Bay, Quebec, 58°30'N, 66°30'W. Sample FA 670047, collected and interpreted by F.C. Taylor.

This sample is from the chill zone of a diabase dyke. The K-Ar age is considered to be the approximate age of the intrusion.

GSC 67-116 Whole rock, K-Ar age 1155 ± 100 m.y.

K = 1.37%, Ar^{40}/K^{40} = 0.0932, radiogenic Ar = 97%.
Concentrate: Crushed whole rock.

From basalt.
(24 I) East of George River, Ungava Bay area, Quebec, 58°23'30"N, 64°49'00"W. Sample FA-2-67, collected and interpreted by W.F. Fahrig.

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

GSC 67-117 Hornblende, K-Ar age 1695 ± 60 m.y.

K = 0.96%, Ar^{40}/K^{40} = 0.1610, radiogenic Ar = 98%.
Concentrate: Pleochroic olive-green to dark blue-green hornblende with about 5% free biotite and a trace of attached quartz as impurities.

From gabbro
(24 B) Between Wheeler and Whale Rivers, Quebec, 56°22'N, 66°36'W. Sample TA 67-T 99, collected and interpreted by F.C. Taylor.

Quebec

This sample is from a well-jointed, massive, coarse-grained gabbro that lies in a gneissic terrain consisting chiefly of granitic rocks.

The gabbro consists of light bluish grey weathering plagioclase, greyish olive green weathering amphibole and minor amounts of biotite.

The age, 1695 ± 60 m.y., is similar to ages from the granitic rocks in the region (GSC 60-128, 1635 m.y.; GSC 63-134, 1810 m.y.; GSC 63-135, 1730 m.y.) and suggests this gabbro is syntectonic and a product of the Hudsonian Orogeny.

GSC 67-118 Biotite, K-Ar age 1705 ± 50 m.y.

K = 7.74%, Ar^{40}/K^{40} = 0.1620, radiogenic Ar = 98%.
Concentrate: Relatively pure olive-brown biotite with no chlorite contamination. Some of the mica flakes have split edges and some are darker in colour.

From granite.

(24 G) Near Lake on upper reaches of Whale River, Quebec, 57°29'N, 66°34'W. Sample BA-156, collected by C.K. Bell, interpreted by F.C. Taylor.

This sample is from a moderate orange-pink to light grey, medium- to coarse-grained, massive to weakly foliated granite. It is probably of plutonic origin.

The age, 1705 ± 50 m.y., agrees well with other ages obtained on samples from rocks east of the Labrador Trough and confirms that this part of the Canadian Shield was involved in the Hudsonian Orogeny. The age is the time of intrusion and crystallization of this granite pluton.

GSC 67-119 Biotite, K-Ar age 854 ± 31 m.y.

K = 7.47%, Ar^{40}/K^{40} = 0.0632, radiogenic Ar = 99%.
Concentrate: Relatively clean, unaltered brown biotite with less than 5% hornblende contamination.

From anorthositic gabbro.

(23 A) South of Atikonak Lake, Quebec, 52°16'N, 64°36'W. Map-unit 7, GSC Map 23-1967. Sample SG-255-66, collected and interpreted by I.M. Stevenson.

This specimen is from an extensive body of massive, anorthositic gabbro which cuts gneisses of known Grenville age. The gabbro is but little metamorphosed relative to the adjacent gneisses, but the age of 854 ± 31 m.y. indicates that the gabbro was emplaced either during or prior to the Grenville Orogeny.

GSC 67-120 Hornblende, K-Ar age 950 ± 40 m.y.

K = 1.45%, Ar^{40}/K^{40} = 0.0723, radiogenic Ar = 98%.

Quebec

Concentrate: Very clean, olive-green to dark green pleochroic hornblende.

From pegmatite.

(21 L) In road-cut 700 yards west of Baie de l'Echo, Lac St.-Charles, Quebec, 46°56'15"N, 71°24'00"W. Sample FO-1-68, collected and interpreted by F.F. Osborne (Université Laval).

The hornblende is from a 2- to 5-inch-thick lenticle of secretion pegmatite contained within a gneissic fayalite nordmarkite. Micropegmatite is the principal material of the medium-grained rock. A hornblende strongly absorptive in deep brown and optically similar to that of the pegmatite is the principal dark mineral. Iron-rich olivine, clouded plagioclase, biotite strongly absorptive in brown, and quartz are subordinate constituents.

The rock is dark green when fresh but weathers to pale beige and is decolorized by hot HCl, the feldspar becoming white.

The prominent foliation of the body, approximately 3 by 5 miles in outcrop, has such a complex pattern that it is inferred to be protoclastic. Hence the hornblende date should represent a time near the end of the deformation.

The series to which this nordmarkite belongs is not clear. The nordmarkite of Big Megantic Mountain is petrographically similar to this rock but is much younger. The rock is similar in some respects to the charnockitic varieties occurring near Québec City.

GSC 67-121 Whole rock, K-Ar age 2140 ± 230 m.y.

K = 0.23%, Ar^{40}/K^{40} = 0.2331, radiogenic Ar = 91%.
Concentrate: Crushed whole rock.

From basalt.

(32 D) Western Quebec, 48°51'N, 79°29'W. Quebec Dept. Mines Map 1401. Sample FA-3-66, collected and interpreted by W.F. Fahrig.

The K-Ar age determination is thought to represent the approximate date of intrusion of the diabase dyke.

GSC 67-122 Whole rock, K-Ar age 1095 ± 90 m.y.

K = 1.46%, Ar^{40}/K^{40} = 0.0866, radiogenic Ar = 97%.
Concentrate: Crushed whole rock.

From diabase.

(32 D) Quebec, 48°15'N, 79°01'W. Sample FA-10-66, collected by W.F. Fahrig.

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

Quebec

GSC 67-123 Hornblende, K-Ar age 2035 ± 65 m.y.

K = 0.35%, Ar^{40}/K^{40} = 0.2140, radiogenic Ar = 93%.
Concentrate: Clean, but slightly altered dark green hornblende with only a trace of quartz impurity. Most grains contain fine opaque inclusions.

From diabase.
(32 F) Western Quebec, 49°51'N, 77°21'W. Sample FA-9-66, collected and interpreted by W.F. Fahrig.

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

GSC 67-124 Whole rock, K-Ar age 1485 ± 165 m.y.

K = 0.57%, Ar^{40}/K^{40} = 0.1322, radiogenic Ar = 92%.
Concentrate: Crushed whole rock.

From basalt.
(32 C) Western Quebec, 48°26'N, 77°04'W. Sample FA-8-66, collected and interpreted by W.F. Fahrig.

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

GSC 67-125 Whole rock, K-Ar age 1255 ± 165 m.y.

K = 0.35%, Ar^{40}/K^{40} = 0.1044, radiogenic Ar = 95%.
Concentrate: Crushed whole rock.

From chilled diabase.
(32 O) West of Lake Mesgouez, Quebec, 51°42'45"N, 75°30'00"W. Sample FA-19-65, collected and interpreted by W.F. Fahrig.

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

GSC 67-126 Biotite, K-Ar age 1035 ± 35 m.y.

K = 6.61%, Ar^{40}/K^{40} = 0.0806, radiogenic Ar = 99%.
Concentrate: Relatively clean, unaltered reddish brown biotite with 2% hornblende and 1-2% free chlorite contamination.

From diabase.
(32 G) Southwest of Chibougamau, Quebec, 49°41'40"N, 74°29'00"W. Sample FA-20-65, collected and interpreted by W.F. Fahrig.

Quebec

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

GSC 67-127 Whole rock, K-Ar age 423 ± 73 m.y.

K = 0.45%, Ar^{40}/K^{40} = 0.0278, radiogenic Ar = 75%.
Concentrate: Crushed whole rock.

From basalt.
(31 G) Quebec, 45°46'N, 74°31'W. Quebec Dept. of Mines Map 408E.
Sample FA-11-66, collected and interpreted by W.F. Fahrig.

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

New Brunswick

GSC 67-128 Biotite, K-Ar age 479 ± 20 m.y.

K = 6.53%, Ar^{40}/K^{40} = .0319, radiogenic Ar = 97%.
Concentrate: Slightly altered olive-green biotite with about 1% hornblende impurity. Most flakes show slight chlorite alteration at their edges and the total chlorite content is about 10%. A few of the mica flakes contain opaque inclusions.

From granite.

(21 G) New road-cut near top of hill in Milford (suburb of Saint John), New Brunswick, 45°16'05"N, 66°06'30"W. Map-unit 14, GSC Map 1113A. Sample PB-65-277. Collected and interpreted by W.H. Poole.

Biotite was separated from a granite which is purplish grey, massive, homogeneous, undeformed and coarse grained. In thin section, oligoclase is well twinned, weakly zoned and irregularly clouded. Potash feldspar forms large anhedra which are clouded mainly along incipient fractures. Quartz, about 15% of the rock, is slightly strained. About 10% of the rock consists of biotite and chlorite, and traces of hornblende. Biotite is pleochroic light yellow to dark brown. Dark opaque alteration products rim biotite crystals and lie along some cleavage planes. Biotite has an internal 'blistered' appearance. Some aggregates of chlorite have developed from biotite and hornblende.

The body has been called the Fairville granite and described by Hayes and Howell (1937) and Alcock (1938), and forms one member of an assemblage of gneisses, granites, gabbros, and diorite, called the Golden Grove intrusions, which cut the Precambrian Green Head Group. The age of these intrusions is much in doubt. It could be that the assemblage contains intrusions of more than one age. Alcock believed that the plutonic rocks may have been intruded in three periods: (1) Precambrian, post-Green Head and pre-Coldbrook, (2) Precambrian, post-Coldbrook and pre-Paleozoic, and (3) Devonian. Hayes favoured a Precambrian age for them all. Pebbles of granite occur in conglomerate intercalated in Coldbrook volcanics (Alcock, 1938) and in Cambrian conglomerate (Weeks, 1957, p. 142).

The biotite date of 479 ± 20 m.y. covers most of Early and Middle Ordovician. The date is similar to a date of 508 m.y. on biotite from a gneiss in the same belt some 6 miles to the northeast (GSC 62-159), and is similar to a date of 500 m.y. on biotite from a gabbro which cuts Coldbrook rocks, about 55 miles to the northeast (GSC 62-160). The 479 ± 20 m.y. date supports the interpretation of a Middle Ordovician age made by Poole (1967, p. 23). Nevertheless, the presence of granitic clasts in Cambrian and Precambrian (Coldbrook) rocks indicates that granites older than Middle Ordovician have yet to be identified.

References

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1938: Geology of Saint John region, New Brunswick; *Geol. Surv. Can.*, Mem. 216.

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1967: Tectonic evolution of Appalachian region of Canada, in Collected Papers on Geology of the Atlantic, edited by E.R.W. Neale and H. Williams; *Geol. Assoc. Can.*, Special Paper No. 4, pp. 9-51.

Weeks, L.J.
1957: The Appalachian region, in Geology and Economic Minerals of Canada 4th ed., edited by C.H. Stockwell; *Geol. Surv. Can.*, Econ. Geol. Ser. No. 1, pp. 123-205.

Newfoundland

GSC 67-129 Hornblende, K-Ar age 2720 ± 80 m.y.

$K = 1.58\%$, $Ar^{40}/K^{40} = 0.3567$, radiogenic Ar = 100%.
Concentrate: Clean, pleochroic, pale brown to green hornblende with only traces of quartz and biotite impurity.

From granulite/gneiss.
(14 M) Mt. Razorback, Newfoundland (Labrador), 59°10'N, 63°33'W. Sample TA 67-T346, collected and interpreted by F.C. Taylor.

This sample is from a well foliated, medium-grained to porphyroblastic, light grey hornblende-quartz-feldspar-gneiss. The hornblende is fresh, relatively free of impurities and pale brown to green. Feldspars consist of microcline and sodic to intermediate plagioclase both fresh and slightly altered. Remnants of highly altered pyroxene, with reaction rims consisting of chlorite and epidote, occur sporadically. Accessory magnetite and zircon are common.

The sample lies in an area shown as Archean by Stockwell (1965) and the age of 2720 m.y. confirms that this part of the Labrador coast is underlain by Archean rocks. The age reflects the period of metamorphism.

Reference

Stockwell, C.H.
1965: Tectonic map of the Canadian Shield; *Geol. Surv. Can.*, Map 4-1965.

GSC 67-130 Hornblende, K-Ar age 2050 ± 65 m.y.

$K = 0.86\%$, $Ar^{40}/K^{40} = 0.2164$, radiogenic Ar = 98%.
Concentrate: Pleochroic light green to dark green hornblende with less than 2% biotite and a trace of quartz as impurities.

From amphibolite.
(14 L) South of Nachvak Fd., Newfoundland (Labrador), 58°56'N, 63°30'W. Sample TA 67-T283, collected and interpreted by F.C. Taylor.

This sample is from a massive to slightly foliated, medium-grained, dark green amphibolite. It lies 11 miles west of GSC 63-173 (2545 m.y.) and it was anticipated that a similar age would be obtained from this sample. The younger age, 2050 m.y., is probably the result of argon loss due to extensive faulting in the area that has produced large zones of mylonite with which this amphibolite is closely associated.

The west boundary of the Ramah Group lies 2 1/2 miles east of the present sample site. The Ramah Group lies unconformably on rocks similar to those in the general area of this sample. The figure 2050 is therefore a maximum age for the Ramah Group if the faulting associated with this sample is pre-Ramah. However it is known that some faulting is post-Ramah, the

west boundary of the Ramah Group is in many places a thrust fault, and therefore the above maximum age for the Ramah (2050 m.y.) must be used with discretion.

GSC 67-131 Hornblende, K-Ar age 1680 ± 60 m.y.

$K = 1.35\%$, $Ar^{40}/K^{40} = 0.1587$, radiogenic Ar = 99%.
Concentrate: Clean, pleochroic, olive-green to green hornblende with only a trace of quartz impurity.

From anorthosite.

(14 L) Nachvak Fd. area, Newfoundland (Labrador), 58°59'N, 63°46'W. Sample RM-361-A, collected by E.W. Reinhardt, interpreted by F.C. Taylor.

This sample is from a medium- to coarse-grained, grey to creamy grey, moderately well foliated anorthosite. The sample site lies 11 miles west-northwest of GSC 67-130 and is west of the area considered to be Archean. It is shown by Stockwell (1965) to lie in the Nain Province. The age 1680 m.y. indicates this rock was involved in the Hudsonian Orogeny rather than the Elsonian and casts doubt on the existence of the Nain Province in this region. As the anorthosite is well foliated, 1680 m.y. is probably the age of the metamorphic event rather than the age of intrusion of the anorthosite.

Reference

Stockwell, C.H.
1965: Tectonic map of the Canadian Shield; *Geol. Surv. Can.*, Map 4-1965.

GSC 67-132 Whole rock, K-Ar age 1180 ± 60 m.y.

$K = 3.34\%$, $Ar^{40}/K^{40} = 0.0960$, radiogenic Ar = 98%.
Concentrate: Crushed whole rock.

From andesite.

(14 L) South of Nachvak Fd., Newfoundland (Labrador), 58°54'N, 63°11'W. Sample RM-384-E, collected by E.W. Reinhardt, interpreted by F.C. Taylor.

This sample is from a massive to vesicular to amygdaloidal, locally pillowed volcanic rock from the north side of Ramah Bay, 2 1/2 miles southwest of North Head. It is both overlain and underlain by orthoquartzite of the Ramah Group. The rock is fine grained, brown weathering, and consists of a very fine grained matte of sericite with small amounts of epidote, and scattered medium-grained crystals of greyish yellow to moderate green chlorite. Small amounts of quartz, calcite, magnetite and ilmenite are also present. There is no identifiable feldspar and only the faintest outline of feldspar grains is visible. The alteration is possibly deuteric.

Newfoundland

The age, 1180 ± 60 m.y., suggests the Ramah Group is older than the Mugford Group as reported by Douglas (1953). Previously a whole-rock age on basalt of the Mugford Group gave an age of 948 ± 90 m.y. (GSC 64-163). These two figures would tend to confirm Douglas's observations but as both these whole-rock determinations are of highly altered rock the two figures must be used with caution as the effect of the alteration is not fully understood.

Reference

Douglas, G.V.
1953: Notes on localities visited on the Labrador coast in 1946 and 1947; *Geol. Surv. Can.*, Paper 53-1.

GSC 67-133 Biotite, K-Ar age 1565 ± 50 m.y.

K = 7.07%, Ar^{40}/K^{40} = 0.1428, radiogenic Ar = 99%.
Concentrate: Relatively pure, dark greenish biotite with less than 5% free chlorite contamination.

From granite.
(13 O) Six miles northeast of Village of Makkovik, Newfoundland (Labrador), 55°08'N, 59°03'W. Sample SSG-369-65-CHR, collected by Sunil S. Gandhi, interpreted by A. P. Bevan (both of British Newfoundland Exploration Ltd.).

The rock is a coarse-grained, porphyritic granite with feldspar phenocrysts up to 1 inch long and traces of fluorite.

The sample is from the central part of a large stock of coarse, fresh, potassic granite (Kranck, 1953, p. 22) at Cape Strawberry. Another sample, located exactly 1/2 mile east of it and from the same granite body also gave a comparable K-Ar age of 1600 ± 34 m.y. The Strawberry Granite is clearly intrusive into the folded and metamorphosed feldspathic quartzites of the Aillik Group. The Aillik Group is believed to be of Early Proterozoic age, folded during the Hudsonian orogenic cycle, and the Strawberry Granite belongs to the widespread post-Kinematic granite intrusions of the same orogeny.

GSC 67-134 Biotite, K-Ar age 1610 ± 55 m.y.

K = 7.04%, Ar^{40}/K^{40} = 0.1489, radiogenic Ar = 99%.
Concentrate: Relatively pure, olive-coloured biotite with a trace of hornblende impurity and less than 3% quartz inclusions. Some of the mica flakes exhibit split edges.

From "diorite".
(13 O) East shore of Adlavik Harbour (Long Tickle), Newfoundland (Labrador), 55°01'50"N, 58°48'20"W. Sample WRS-3-65-CHR,

collected by W. R. Sutton, interpreted by A. P. Bevan (British Newfoundland Exploration Ltd.).

The sample is from a "dioritic dyke" in an area of syenite and granitic rocks related to the Benedict Granite.

GSC 67-135 Biotite, K-Ar age 1620 ± 60 m. y.

K = 7.49%, Ar^{40}/K^{40} = 0.1504, radiogenic Ar = 99%.
Concentrate: Yellowish olive biotite with about 15% chlorite contamination. This chlorite occurs mainly as free flakes in the concentrate.

From granite.
(13 O) Two thousand feet southeast of Round Pond, near Makkovik, Newfoundland (Labrador), 55°01.5'N, 59°08.5'W. Sample SSG-450-65-CHR, collected by Sunil S. Gandhi, interpreted by A. P. Bevan (both of British Newfoundland Exploration Ltd.).

The sample is from a small granite stock, the Round Pond Granite, intrusive into a thick conglomerate formation of the Aillik Group. The granite is fresh, and close to adamellite in composition. Granite of similar character forms a large stock a few miles to the southwest, named as Monkey Hill Granite. Although the Round Pond Granite differs in character from the Strawberry Granite, both are believed to be part of the same cycle of widespread post-Kinematic granitic intrusions of the Hudsonian Orogeny.

GSC 67-136 Biotite, K-Ar age 951 ± 34 m. y.

K = 7.41%, Ar^{40}/K^{40} = .0724, radiogenic Ar = 99%.
Concentrate: Relatively clean, unaltered olive-green biotite with 5% hornblende impurity.

From granite gneiss.
(13 F) North bank of Goose River, Newfoundland (Labrador), 53°27'N, 61°21'W. Map-unit 2, GSC Map 7-1967. Sample SG-64-65, collected and interpreted by I. M. Stevenson.

This specimen is from an extensive area of porphyritic granite gneiss that locally has been intruded by fresh, pink granite. The age of 951 ± 34 m. y. would indicate that the granite was probably intruded into the gneisses at about this time, and no appreciable deformation or metamorphism has occurred since that period.

GSC 67-137 Biotite, K-Ar age 950 ± 34 m. y.

K = 6.78%, Ar^{40}/K^{40} = 0.0723, radiogenic Ar = 98%.
Concentrate: Unaltered, light brown biotite with about 5% hornblende impurity.

Newfoundland

From diorite.

(13 F) West of Goose Bay, Newfoundland (Labrador), 53°06'N, 60°40'W. Map-unit 5C, GSC Map 7-1967. Sample SG-118-65, collected and interpreted by I. M. Stevenson.

This specimen is from a dark, medium-grained, massive diorite which is part of the Mealy Mountain intrusive anorthositic complex. Because of the resistant nature of the diorite, little evidence of the Grenville Orogeny has been retained in these rocks. The age of 950 ± 34 m. y. clearly indicates, however, that these rocks in Goose Bay map-area lie well within the Grenville Province.

GSC 67-138 Biotite, K-Ar age 853 ± 32 m. y.

K = 7. 96%, Ar^{40}/K^{40} = 0. 0631, radiogenic Ar = 97%.
Concentrate: Relatively clean, unaltered olive-green biotite with about 2% hornblende impurity.

From pegmatite.

(13 C) Northwest end of Dominion Lake, Newfoundland (Labrador), 52°45'N, 61°52'W. Map-unit 1, GSC Map 6-1967. Sample W-36-65, collected by D. Wetmore, interpreted by I.M. Stevenson.

This sample is typical of the quartzofeldspathic gneisses which underlie much of the area south of Churchill River. These gneisses are for the most part of sedimentary origin, but most inherent primary sedimentary features have been obliterated by metamorphism and structural deformation. The age of 853 ± 32 m. y. indicates the most recent major orogeny to have been near the close of the Grenville in this locality.

GSC 67-139 Whole rock, K-Ar age 524 ± 78 m. y.

K = 0. 37%, Ar^{40}/K^{40} = 0. 0354, radiogenic Ar = 66%.
Concentrate: Crushed whole rock.

From granite gneiss.

(24 P) Northern Labrador, Newfoundland, 59°48'N, 64°40'W. Sample FA-1-67, collected and interpreted by W. F. Fahrig.

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

GSC 67-140 Whole rock, K-Ar age 2425 ± 225 m. y.

K = 0. 54%, Ar^{40}/K^{40} = 0. 2887, radiogenic Ar = 94%.
Concentrate: Crushed whole rock.

Newfoundland

From basalt.

(14 L) Little Ramah Bay, north coast of Labrador, Newfoundland, 58°49'N, 63°10'W. Sample FA-3-67, collected and interpreted by W.F. Fahrig.

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

GSC 67-141 Biotite, K-Ar age 544 ± 22 m.y.

K = 6.24%, Ar^{40}/K^{40} = 0.0377, radiogenic Ar = 97%.
Concentrate: Relatively clean, slightly altered reddish brown biotite with about 5% hornblende and 2% chlorite. A few flakes are altered to chlorite on the edges.

From diabase.

(13 H) Newfoundland (Labrador), 53°44'N, 56°49'W. Map-unit 9, GSC Map 22-1962. Sample FA-2-66, collected and interpreted by W.F. Fahrig.

The K-Ar age determination is thought to represent the approximate age of intrusion of the diabase dyke.

GSC 67-142 Muscovite, K-Ar age 385 ± 16 m.y.

K = 8.46%, Ar^{40}/K^{40} = 0.0250, radiogenic Ar = 96%.
Concentrate: Clean, clear muscovite with less than 1% attached quartz and a trace of biotite.

From granite.

(12 A) Five miles south along road from Noel Pauls Brook to canal at north end of Meelpaeg Lake, Newfoundland, 48°27'15"N, 56°35'08"W. Map-unit 14, Red Indian map-area, GSC terminal map on open file. Sample WF-182-66, collected and interpreted by H. Williams.

The rock is a medium- to coarse-grained, massive, pink to grey granite that is commonly porphyritic with perthitic feldspar phenocrysts. Biotite is the most common mica and is ubiquitous. Muscovite is present only locally. This granite is widespread in south-central Newfoundland where it cuts Ordovician and Silurian rocks and folded Paleozoic metamorphic rocks. The isotopic date of 385 m.y. indicates that the granite is of Devonian age and is related to the Acadian Orogeny recognized throughout most of the Canadian Appalachian Region.

GSC 67-143 Muscovite, K-Ar age 399 ± 17 m.y.

K = 8.30%, Ar^{40}/K^{40} = 0.0260, radiogenic Ar = 95%.

Newfoundland

Concentrate: Slightly yellow-stained but otherwise clean muscovite. About 5% of the flakes have split edges.

From granite boulder.

(11 P) On coastline 1 mile south of La Hune Harbour, Newfoundland, 47°32'35"N, 56°53'00"W. Map-unit 9, Burgeo map-area, in preparation. Sample WF-141-67, collected and interpreted by H. Williams.

The dated muscovite was contained in a grey, medium-grained, massive granite boulder collected from a conglomerate of unknown age. The indicated Devonian age for the granite boulder establishes a lower limit for the age of the enclosing rock. The conglomerate is overlain by several hundred feet of dominantly silicic volcanic rocks with minor limestone and these are cut by coarse-grained biotite granite and also post-biotite granite mafic dykes. The latter intrusions are generally considered to be of Devonian age. These relationships indicate that the conglomerate and volcanic rocks in the vicinity of Cape La Hune belong to the Devonian System and are orogenic deposits that accumulated between periods of intrusive activity.

GSC 67-144 Muscovite, K-Ar age 422 ± 17 m.y.

K = 7.83%, Ar^{40}/K^{40} = 0.0277, radiogenic Ar = 96%.
Concentrate: Rather impure, yellow-stained muscovite with about 3% chlorite contamination. Some flakes carry opaque inclusions.

From sandstone.

(2 E) Burnt Arm, Exploits Bay, opposite town of Botwood, Newfoundland, 49°10'18"N, 55°17'00"W. Map-unit 20, GSC Map 60-1963. Sample WF-167-67, collected by W.A. Nash, interpreted by H. Williams.

The age determination was made on detrital muscovite from grey, even grained, micaceous sandstone of the Botwood Formation. Silurian conglomerates interlayered with the sandstones nearby, and several lines of indirect geological evidence, all indicate a Silurian age for the Botwood Formation. Source areas for the detrital muscovite are not presently apparent and nearby intrusions, which contain little muscovite, cut the Botwood Formation. A large composite intrusion cutting the formation south of Botwood is dated at 410 m.y. (GSC 63-182) and biotite from its metamorphic aureole gives an age of 423 m.y. (GSC 62-188). The isotopic age of the detrital muscovite at 422 m.y. is sufficiently close as to suggest updating by the dated intrusion to the south.

Mid-Atlantic Ridge

GSC 67-145 Whole rock, K-Ar age $\frac{9 \pm 2 \text{ m.y.}}{7 \pm 2 \text{ m.y.}}$

K = 0.98%, $Ar^{40}/K^{40} = \frac{0.00052}{0.00040}$, radiogenic Ar = 68%. 37

Concentrate: Crushed whole rock.

From basalt.
"Bald Mountain" sea-mount, Mid-Atlantic Ridge, 45°13'N, 28°54'W. Sample BIO-MAR-19-66-33, collected and interpreted by F. Aumento.

See GSC 67-146 for description and interpretation.

GSC 67-146 Whole rock, K-Ar age 7 ± 2 m.y.

K = 0.98%, Ar^{40}/K^{40} = 0.00040, radiogenic Ar = 35%.
Concentrate: Crushed whole rock.

From basalt.
Details as for GSC 67-145. Sample BIO-MAR-19-66-33, collected and interpreted by F. Aumento.

The rock is an iron-rich alkali basalt from a north-south elongated sea-mount (Bald Mountain) approximately 62 kilometres west of the axis of the Mid-Atlantic Ridge. The sample used for age determination was fine-grained, free from phenocrysts or xenocrysts, and had a pilotaxitic arrangement of microlites. The specimen was very fresh.

This was one of several samples collected on a dredge traverse by the C.S.S. Hudson across the Mid-Atlantic Ridge at 45°N latitude. This and other samples were dated in order to arrive at an estimate of the ocean floor spreading rate in the area. The mean age of 8 m.y. on this sample yields a calculated spreading rate of 0.8 cm/yr., which is considerably lower than a range of 2.6 to 3.2 cm/yr. calculated from K-Ar and fission track ages on other samples as reported by Aumento et al., 1968.

Reference

Aumento, F., Wanless, R.K., and Stevens, R.D.
1968: Potassium-argon ages and spreading rates on the Mid-Atlantic Ridge at 45°North; *Science*, vol. 161, pp. 1338-1339.