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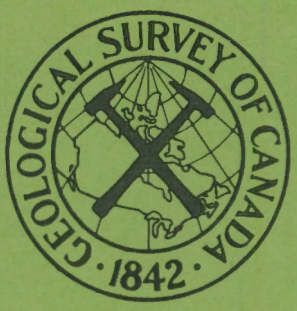

GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

P. G. KILLEEN
GEOPHYSICS

PAPER 71-2

AGE DETERMINATIONS AND GEOLOGICAL STUDIES

K-Ar Isotopic Ages, Report 10

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

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1972

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1972

CONTENTS

Illustrations

ABSTRACT

One hundred and fifty-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.

RÉSUMÉ

L'auteur donne le résultat de cent cinquante-six nouvelles datations, par la méthode du rapport potassium-argon, de roches et minéraux provenant tous du Canada. Dans la plupart des cas, la datation est accompagnée d'une description de la roche et du concentré minéral utilisés; l'auteur fait aussi de brefs commentaires d'interprétation de la signification géologique de ces datations. Il décrit brièvement, dans ses grandes ligues, les procédés expérimentaux employés et donne la liste des constantes et des teneurs isotopiques entrant dans le calcul des datations. Pour faciliter la consultation au lecteur, il donne deux échelles des temps géologiques disposées sous forme de tableau.

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 10

INTRODUCTION

This is the tenth report of potassium-argon age measurements completed in the Geochronology Laboratories of the Geological Survey of Canada. One hundred and fifty-six new determinations are listed, bringing the total number of published ages to 1,624.

The papers in this series of K-Ar age reports have not always followed a strict numerical sequence and the list below will serve to identify the complete series to the present time:-

GSC 60-17, Report No. 1; determinations 59-1 to 59-98
GSC 61-17, Report No. 2; determinations 60-1 to 60-152
GSC 62-17, Report No. 3; determinations 61-1 to 61-204
GSC 63-17, Report No. 4; determinations 62-1 to 62-190
GSC 64-17, Report No. 5; determinations 63-1 to 63-184
GSC 65-17, Report No. 6; determinations 64-1 to 64-165
GSC 66-17, Report No. 7; determinations 65-1 to 65-153
GSC 67-2A, Report No. 8; determinations 66-1 to 66-176
GSC 69-2A, Report No. 9; determinations 67-1 to 67-146
This paper, Report No. 10; determinations 70-1 to 70-156

Many of the age determinations in these reports are plotted on GSC Map 1256A (see Douglas, 1970) which is the most recent compilation of Canadian geochronology at the time of printing.

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.

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 $= 1.19 \times 10^{-4}$

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) and he is now preparing a report in which the ages are revised as shown in Table 2*. As in the earlier publication, the close of orogeny is chosen as the boundary between time divisions but a distinction is now made between orogenic and epeirogenic or cooling ages. The time of closing of orogeny lies within the relatively short interval between the youngest orogenic phase and the beginning of the almost immediately following epeirogenic cooling period. Pegmatites are commonly the youngest orogenic materials and their ages may be determined by the U-Pb method. The beginning of the epeirogenic cooling period is determined closely by the K-Ar method on orogenic amphibole. Averages for each are calculated for the type regions and the figures shown in the table are intermediate between the two. They are subject to revision as more dates become available and give a more representative sampling of the type regions.

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*Stockwell, C.H.
(In prep.): Fifth report on structural provinces, orogenies, and time classification of the Canadian Precambrian Shield; Geol. Surv. Can.

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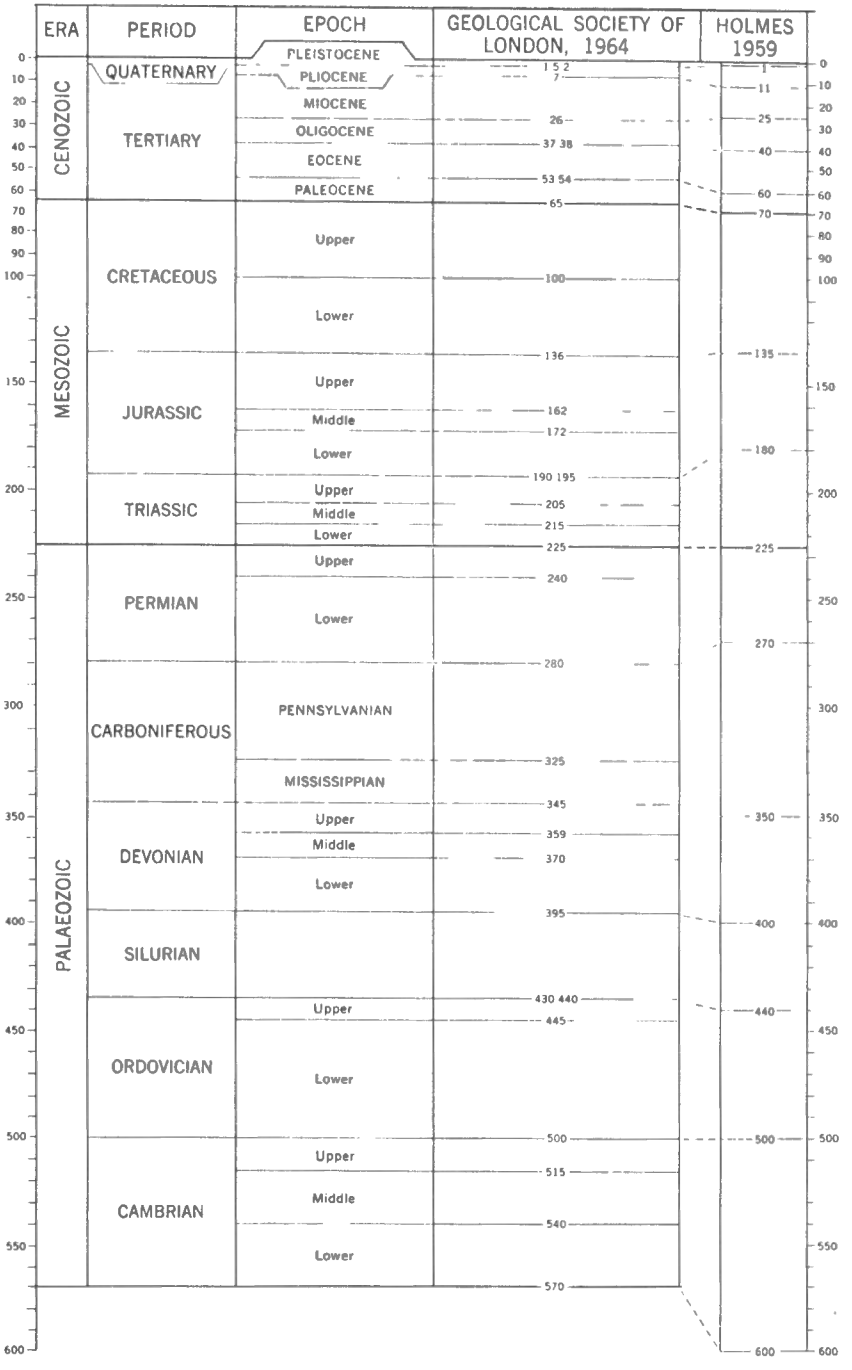

Table 1. Phanerozoic time scale.

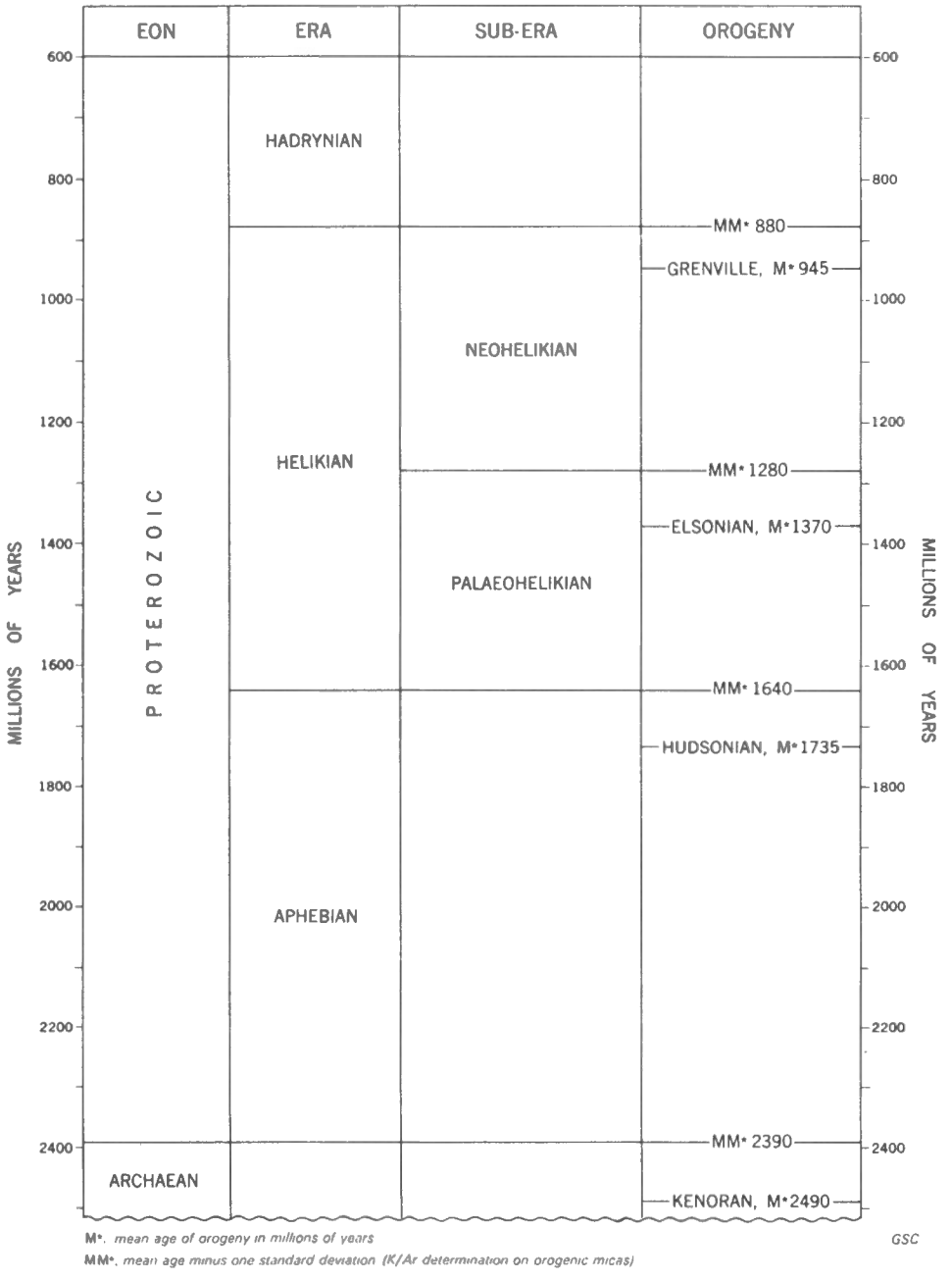

Table 2. Precambrian time scale for the Canadian Shield (after Stockwell, 1964).

British Columbia

(GSC No. 70-1 to 70-44)

GSC 70-1 Hornblende, K-Ar age 143 ± 8 m.y.

K = 0.40%, $^{40}Ar/^{40}K$ = 0.0087, radiogenic Ar = 47%
Concentrate: Pleochroic light brown to bluish green hornblende with less than 2% biotite impurity and less than 5% tiny fragments of rock matrix.

From gneissic granodiorite.
(103 F) Southeast tip of Cadman Island, in Kano Bay of Graham Island, Queen Charlotte Islands, British Columbia, 53°17.5'N, 132°38.5'W. Map-unit JS, B.C. Dept. Mines Bull. 54. Sample 65-AB-20, collected by A. Sutherland Brown, interpreted by J.E. Reesor.

This specimen of the Kano batholith is a dark, mafic rich, medium grained rock with a "porphyritic" or more likely slightly cataclastic texture in which large anhedral to subhedral plagioclase, poikilitic hornblende and some ragged clotlike masses of biotite occur in a finer mosaic of anhedral plagioclase, quartz, and magnetite. The plagioclase is unzoned or very weakly so, and both it and the hornblende are fresh and the biotite at most very slightly altered.

The estimated mineral composition of the rock is: plagioclase (An_{44}) 65%, quartz 8%, hornblende 28%, biotite 5%, magnetite 3%, and traces of apatite and zircon.

The sample is representative of the syntectonic part of the composite Kano batholith (West Kano). The locality from which it was collected is highly foliated, phacoidal, hornblende diorite to quartz diorite. This phase cuts the Kunga Formation (Karnian to Sinumurian) and underlies the Masset Formation (Paleocene-Eocene). It is intruded by the younger phases of the composite batholith which intrude and metamorphose the Masset Formation and that have K-Ar ages as follows: GSC 70-2, biotite 30 ± 3 m.y.; GSC 67-16*, hornblende 26 ± 6 m.y.; GSC 67-17*, biotite 29 ± 2 m.y. The age of GSC 70-1, given as 143 ± 8 m.y. is as expected and identical to the only other date of a syntectonic batholith in the Queen Charlotte Islands, i.e. GSC 67-20*, from San Christoval batholith on Darwin Sound, 142 ± 16 m.y.

*See Geol. Surv. Can. Paper 69-2A, 1970.

GSC 70-2 Biotite, K-Ar age 30 ± 3 m.y.

K = 7.08%, $^{40}Ar/^{40}K$ = 0.0018, radiogenic Ar = 54%
Concentrate: Buff-brown biotite with about 5% chlorite as attached patches. Many of the mica flakes contain abundant opaque grains.

From granodiorite.
(103 F) Head of Dawson Inlet, Graham Island (Queen Charlotte Islands), British Columbia, 53°13'N, 132°29'W. Central Kano Massif. Sample 65-AB-19 collected by A. Sutherland Brown, interpreted by J.E. Reesor.

British Columbia

The rock is a fine- to medium-grained, grey granodiorite with feldspar phenocrysts up to 6 mm and more in length. It consists of subhedral plagioclase (45%) with marked occillatory zoning, K feldspar (15%) which is mostly orthoclast but includes minor perthite, quartz (25%), hornblende (5%) mantling augite (6%), and ragged grains of biotite (4%). The specimen is slightly more quartzose and richer in potash feldspar than the average for this pluton.

This date of 30 ± 3 m.y. on the Central Kano phase is slightly older, as predicted, than a hornblende-biotite pair of 26 ± 6 m.y. and 29 ± 2 m.y. respectively determined for the East Kano phase (GSC 67-16 and -17)*.

*See Geol. Surv. Can. Paper 69-2A, 1970.

GSC 70-3 Hornblende, K-Ar age 156 ± 10 m.y.

K = 0.33%, $^{40}Ar/^{40}K$ = 0.0095, radiogenic Ar = 42%.
Concentrate: Slightly pleochroic light green to light brown hornblende with some associated chlorite alteration. Grain surfaces are commonly pitted.

From quartz diorite.
(103 G) Chinukundl Creek, Graham Island, Queen Charlotte Islands, British Columbia, 53°19'N, 131°58'W. Chinukundl Pluton. Sample 65-AB-22, collected by A. Sutherland Brown, interpreted by J.E. Reesor.

The rock is a medium- to coarse-grained biotite-hornblende quartz diorite consisting of plagioclase (65%), quartz (15%), hornblende (10%), biotite-chlorite (7%), and opaques (3%). Texture is seriate with intense sericite alteration of the zoned plagioclase laths and partial to complete chloritization of hornblende and biotite.

The Chinukundl Pluton was not seen in contact with the Haida Formation (Albian), but was encountered in a drillhole through Haida and Yakoun Formations (Royalite Queen Charlotte). However, the hole log does not provide sufficient information to distinguish between a metamorphic or unconformable contact. Therefore, together with some uncertainty in the age determination due to the high degree of alteration of the rock, the age cannot be considered to be firmly established.

GSC 70-4 Hornblende, K-Ar age 74 ± 4 m.y.

K = 0.75%, $^{40}Ar/^{40}K$ = 0.0044, radiogenic Ar = 57%.
Concentrate: Clean, pleochroic, dark green to light brown hornblende with no visible impurities.

From granite.
(104 O) Head of Nazcha Creek, British Columbia, 60°12'N, 131°06'W. Map-unit 26, GSC Map 18-1968. Sample Y-8RA-1-65, collected and interpreted by J.E. Reesor.

British Columbia

The Glundebery Batholith, from which this sample was taken, is a roughly equidimensional body comprised largely of very distinctive, coarse-grained hornblende granite characterized by a waxy, pale green-buff weathering of perthitic potash feldspar, and abundance of watery quartz, common occurrence of miarolitic cavities, and a peculiar 'aggregate' texture resulting from a predominance of subhedral feldspar crystals with a minimum of matrix. Locally, however, textures may be extremely variable.

The K-Ar age of 74 m.y. is in close agreement with that obtained on a sample submitted previously by J.E. Reesor (K-Ar age 79 m.y., GSC 66-1, in GSC Paper 67-2, Pt. A) from the same batholith. The age helps confirm the field data which show that granitic bodies of this type are among the youngest of the granitic intrusions in the region.

GSC 70-5 Hornblende, K-Ar age 164 ± 9 m.y.

K = 1.34%, $^{40}Ar/^{40}K$ = 0.0100, radiogenic Ar = 70%.
Concentrate: Olive-brown to dark green and blue-green hornblende.

From granodiorite.
(82 N) West side of Tangier River, British Columbia, 51°20'N, 117°50'W. Fang Creek Stock, map-unit B, GSC Map 4-1961. Sample WB-129W-9, collected by J.O. Wheeler, interpreted by J.E. Reesor.

This hornblende from a specimen of hornblende-biotite quartz monzonite was run to check an apparently anomalous age of 168 m.y. determined on biotite from the same rock. The age of the Fang Stock is discussed more fully under determination GSC 62-23 (see GSC Paper 63-17, p. 18, 1963).

GSC 70-6 Hornblende, K-Ar age 80 ± 5 m.y.

K = 0.71%, $^{40}Ar/^{40}K$ = 0.0048, radiogenic Ar = 65%.
Concentrate: Clean, pleochroic, dark green to olive-brown hornblende with no visible impurities.

From gneissic diorite.
(103 A) Raymond Passage, British Columbia, 52°09'30"N, 128°15'25"W. Map-unit E, GSC Map 9-1966. Sample SAA67-491, collected by D.T.A. Symons, interpreted by A.J. Baer.

This rock is a homogeneous, medium-grained, faintly foliated diorite. It is composed of about 60% plagioclase (An_{45}) in long laths, 28% poikiloblastic green hornblende, 8% chloritized biotite and 2% quartz.

The age confirms the apparent radiometric "younging" from west to east across the Coast Mountains. Field evidence does not yet supply a satisfactory explanation for this systematic variation.

British Columbia

GSC 70-7 Hornblende, K-Ar age 12 ± 2 m.y.

$K = 0.94\%$, $^{40}Ar/^{40}K = 0.0007$, radiogenic Ar = 36%.
Concentrate: Clean, dark green to opaque hornblende.

From granite.
(93 D) Two and one-third miles southeast of Salisbury Cone, King Island, British Columbia, 52°07'55"N, 127°47'00"W. Map-unit 12a, GSC Map 9-1966. Sample Rd 65-20525, collected and interpreted by A.J. Baer.

This rock is a beige, medium-grained hornblende granite with miarolitic cavities. It is composed of about 55% subhedral K-feldspar, commonly stubby and perthitic, 23% anhedral quartz crystals and 12% dark bluish green hornblende. Magnetite is an accessory mineral.
For interpretation see GSC 70-8.

GSC 70-8 Hornblende, K-Ar age 13 ± 2 m.y.

$K = 0.97\%$, $^{40}Ar/^{40}K = 0.0008$, radiogenic Ar = 32%.
Concentrate: Clean concentrate of thick-grained, dark green to opaque hornblende.

From granite.
(93 D) Details as for GSC 70-7.

This granite belongs in a group of syenitic and granitic intrusions cutting all other known rocks in the area, except for basaltic lavas of probable Miocene or Pliocene age. The age is in agreement with available field evidence. A brown basaltic dyke and a blue porphyritic dyke, both thought to be younger than these granite bodies have been dated at 12.5 ± 2.7 m.y. and 14.5 ± 1 m.y. respectively by the K-Ar whole rock method (D. T. A. Symons in GSC Paper 68-72, 1969; and determinations 67-31, 67-32 in GSC Paper 69-2A, 1970).

GSC 70-9 Whole rock, K-Ar age 49 ± 5 m.y.

$K = 2.43\%$, $^{40}Ar/^{40}K = 0.0029$, radiogenic argon = 86%.
Concentrate: Crushed whole rock.

From tuff.
(94 E) On ridge 3 miles south of Stikine River, 3 miles west of Chapea Creek, British Columbia, 57°19'N, 127°40'W. Within map-unit 15 of neighboring GSC Map 9-1957, and map-unit 9 of GSC Map 962A. Sample E-69-39-04C, collected and interpreted by G.H. Eisbacher.

The sample was taken from a fine-grained, partly welded, acidic ash fall tuff made up of volcanic glass shards and sporadic crystals of plagioclase, quartz, and biotite. It occurs within the upper Sustut Group which is

characterized by the common occurrence of acidic tuffs interlayered with conglomerates (Eisbacher, 1970). This unit can be correlated with rocks for which W.A. Bell determined a Paleocene age from fossil plants collected by Lord (1948) in the McConnell Creek map-area. Nevertheless the Eocene age of the specimen seems to represent a reasonable age of deposition for the tuff because it fits roughly K-Ar dates of very shallow granitic intrusives within the Coast and Omineca Geanticline of northern British Columbia (Hutchison, 1970; Gabrielse, 1967). Stratigraphically, the dated tuff sheet occurs in a higher part of the section than the tuff dated as GSC 70-10 which yielded an older age of 53 ± 6 m.y.

GSC 70-10 Whole rock, K-Ar age 53 ± 6 m.y.

K = 2.01%, $^{40}Ar/^{40}K$ = 0.0031, radiogenic Ar = 89%.
Concentrate: Crushed whole rock.

From tuff.

(94 D) At the bend of Thutade Lake, below the peak of Mount Jorgensen, British Columbia, 56°54'N, 126°56'W. Map-unit 9 of GSC Map 962A. Sample E-69-42-09, collected and interpreted by G.H. Eisbacher.

The sample was taken from the lowest exposed acidic ash fall tuff of the Sustut Group near Thutade Lake. The tuff consists of partly welded glass shards and scarce crystals of plagioclase, quartz, and biotite. The date indicates an early Eocene age for the deposition of the tuff, although W.A. Bell suggested a Paleocene age for fossil plants extracted from tuffs of the same section. The date agrees broadly with K-Ar dates of shallow granitic extrusives within Coast and Omineca Geanticlines.

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British Columbia

GSC 70-11 Biotite, K-Ar age 122 ± 6 m.y.

K = 7.17%, $^{40}Ar/^{40}K$ = 0.0074, radiogenic Ar = 89%.
Concentrate: Relatively pure, Roman green biotite with less than 5% free chlorite contamination. Most of the mica flakes have split edges with a deeper yellow colour.

From granite.
(94 C) Aiken Lake area, British Columbia, 56°20 1/3'N, 125°49'W. Map-unit 13 (Hogem Batholith), GSC Map 1030A. Sample IB 67-7, collected and interpreted by T.N. Irvine.

The biotite is from granodiorite collected from the Hogem Batholith, a major plutonic complex more than 100 miles long and 25 miles wide situated in north-central British Columbia (Roots, GSC Mem. 274). The rock is a massive aggregate of 50% strongly zoned sodic plagioclase, 20% microcline, 70% quartz and 6% biotite, plus minor magnetite, hornblende, chlorite, epidote, sphene and apatite. The minerals generally appear primary, and are relatively free of alteration. The biotite shows some chlorite along cleavages, but most of the chlorite is in separate grains or clots.

The age date is, to the writers knowledge, the first obtained from the Hogem Batholith. It falls within the range of the many dates available for the Cassiar Batholith, which lies to the north in the same tectonic belt, and the indicated lower Cretaceous age is a plausible primary date.

GSC 70-12 Muscovite, K-Ar age 128 ± 6 m.y.

K = 6.22%, $^{40}Ar/^{40}K$ = 0.0078, radiogenic Ar = 94%.
Concentrate: Slightly yellow-stained muscovite with less than 5% feldspar inclusions as the only impurity.

From schist.
(94 C) Aiken Lake area, British Columbia, 56°31.5'N, 125°36'W. Map-unit 2 (Ingenika Group), GSC Map 1030A. Sample IB 67-22, collected and interpreted by T.N. Irvine.

See GSC 70-13 for description and interpretation.

GSC 70-13 Biotite, K-Ar age 124 ± 6 m.y.

K = 6.93%, $^{40}Ar/^{40}K$ = 0.0075, radiogenic Ar = 88%.
Concentrate: Brownish orange biotite with about 10% chlorite both as free flakes and as edge alteration of the mica flakes.

From schist.
(94 C) Details as for GSC 70-12.

The sample is a strongly foliated, crenulated garnet-biotite-quartz-muscovite schist collected from the Ingenika Group of Roots (GSC Mem. 274). The minerals are generally fresh. Some chlorite occurs in small patches near the garnet, but very little appears to be derived from the biotite.

British Columbia

The Ingenika Group is part of a major metamorphic complex in north-central British Columbia, in line with, and having similar setting to, the Shuswap metamorphic rocks. As a depositional unit, the group was considered by Roots to be lower Cambrian or older, with its metamorphism being possibly as young as Mississippian. Map relations suggested that it was the basement for Permian or later sedimentary and volcanic rocks into which the Polaris ultramafic complex is intruded. However, the Polaris complex has given K-Ar dates of 152 and 164 m.y. (GSC 66-18, 19 in GSC Paper 67-2A, 1968), which appear to be reasonably valid primary ages, therefore the present date, supported by the date of 124 m.y. obtained for muscovite from the same sample, point to a more complicated history. It seems likely that the present ages reflect updating due to the thermal event that produced the Eocene dates shown by a sample collected only a few miles to the east from the Wolverine metamorphic complex (see GSC 70-14, 15).

GSC 70-14 Muscovite, K-Ar age 47 ± 3 m.y.

K = 8.69%, $^{40}Ar/^{40}K$ = 0.0028, radiogenic Ar = 71%.
Concentrate: Clean muscovite with very slight yellow staining and less than 5% biotite inclusions.

From granite.
(94 C) Aiken Lake area, British Columbia, 56°23'N, 125°21.5'W. Map-unit C (Wolverine Complex), GSC Map 1034A. Sample IB 67-198, collected and interpreted by T.N. Irvine.

See GSC 70-15 for description and interpretation.

GSC 70-15 Biotite, K-Ar age 43 ± 3 m.y.

K= 7.29%, $^{40}Ar/^{40}K$ = 0.0025, radiogenic Ar = 70%.
Concentrate: Relatively pure, amber-brown biotite with less than 10% chlorite on some flake edges. There is some variation in the depth of colour of the mica flakes.

From granite.
(94 C) Details as for GSC 70-14.

The sample is a fine-grained, pinkish granitic rock showing fairly strong lineation. It is from the Wolverine Complex in the Aiken Lake area and consists of about 35% K-feldspar, 25% sodic plagioclase, 25% quartz, 6% muscovite, 5% biotite, and 1% chlorite, zircon, apatite and sphene.

The Wolverine Complex in the Aiken Lake area was described by Roots (GSC Mem. 274) as comprising highly metamorphosed and granitized rocks derived from Ingenika and Tenakihi group sediments. He considered the sediments to be Cambrian or older, and the metamorphism, possibly as young as Mississippian. However, the present Eocene date, supported by the date of 47 m.y. for muscovite from the same sample (see GSC 70-15), points to a much later thermal event. Identical Eocene ages have been obtained by

British Columbia

J.E. Muller on samples of Wolverine Complex rocks collected in the Pine Pass area some 70 miles to the southeast (see GSC 70-42, 43 and 44 this paper), and the reader is referred to Muller's discussion of these puzzling results.

GSC 70-16 Muscovite, K-Ar age 60 ± 3 m.y.

K = 8.30%, $^{40}Ar/^{40}K$ = 0.0036, radiogenic Ar = 69%.
Concentrate: Clear muscovite with less than 2% biotite and chlorite contamination. Some of the mica flakes are slightly yellow stained.

From chips of gneiss and schist.
(83 D) Canoe River near Hugh Allan Creek, British Columbia, 55°25'N, 118°42'W. Map-unit 1 (Malton Gneiss), Canoe River map-area. Sample GQ-67-400.1 to 400.16 collected by C.A. Giovanella and interpreted by R.B. Campbell.

See GSC 70-18 for description and interpretation.

GSC 70-17 Biotite, K-Ar age 66 ± 3 m.y.

K = 7.46%, $^{40}Ar/^{40}K$ = 0.0039, radiogenic Ar = 79%.
Concentrate: Clean, greenish brown biotite with only trace impurities of quartz. Some of the mica flakes are a darker brown than the majority.

From chips of gneiss and schist.
(83 D) Details as for GSC 70-16.

See GSC 70-18 for description and interpretation.

GSC 70-18 Biotite, K-Ar age 57 ± 3 m.y.

K= 7.27%, $^{40}Ar/^{40}K$ = 0.0034, radiogenic Ar = 73%.
Concentrate: Clean, light green biotite with no alteration or impurities, though some of the flakes have split edges with a brownish colour.

From granite.
(83 D) Canoe River, about 5 miles southeast of Hugh Allan Creek, British Columbia, 52°22.5'N, 118°38.5'W. Map-unit 1, (Malton Gneiss), see GSC Map 15-1967. Sample GQ-67-351-360, collected by C.A. Giovanella, interpreted by R.B. Campbell.

Samples (1514, 1515, 1594) were collected from the body of gneiss (Malton Complex) that outcrops on both sides of the Rocky Mountain Trench at Canoe River. The gneiss is heterogeneous in nature, ranging from leucogranite to amphibolite in composition. The body may represent a part of an

ancient Precambrian basement, because it is complexly deformed, its boundaries are tectonic, and its bulk composition is markedly different from any known strata in the region.

Specimen GQ-67-400.1 (GSC 70-16 and 17) is a pale grey, schistose leucocratic, muscovite-biotite-quartz-feldspar gneiss, with a total content of micas of 10-12 per cent. In outcrop it is intercalated with various gneisses and darker schists.

Specimen GQ-67-351.360 (GSC 70-18) is a pale buff, gneissic granite or quartz monzonite, containing about equal amounts of quartz, microcline, and plagioclase (An_{10}). Minor constituents are biotite (3-4%), fluorite (1%) and magnetite, allanite, and zircon (1%). The rock has a distinctly metamorphic fabric, with schistosity and weak lineation approximately concordant with structures in nearby layered gneisses. In outcrop the rock is markedly homogeneous over a width of 100 feet, and its boundaries are not exposed. This granite is considered to be part of the gneiss complex rather than a younger stock because of its conformable metamorphic fabric and because similar intrusions were not found in the Proterozoic to Cambrian rocks nearby.

The young ages reported here are consistent with ages for micas from the Malton Complex reported earlier (see GSC Paper 69-2A, determination 67-43 at 53 ± 4 m.y., and 59 ± 5 m.y.). These dates apparently reflect the approximate end of thermal events related to major orogenesis in the area. It seems most unlikely that they represent the age of formation of either the gneisses or the intermixed granitic rocks of the Malton Complex. An attempt to date the gneisses using Rb-Sr whole rock isochron methods has not been successful to date.

GSC 70-19 Biotite, K-Ar age 58 ± 18 m.y.

K = 7.06%, $^{40}Ar/^{40}K$ = 0.0035, radiogenic Ar = 31%.
Concentrate: Light brownish coloured biotite with about 15% chlorite (both attached and as free flakes). Some of the mica flakes are deeper brown, and some contain dark pleochroic haloes.

From biotite-hornblende quartz diorite.
(104 N) Headwaters of Fenn Creek, British Columbia, 59°22'N, 133°12'W. Map-unit 12d, GSC Map 1082A. Sample GA-MCM-68, collected by J.W.H. Monger, interpreted by H. Gabrielse.

This sample is considered representative of the Mount McMaster body, a roughly equidimensional, crudely circular in plan, stock of quartz diorite. The rock is even grained, medium grained, leucocratic, biotite-hornblende quartz diorite ranging to hornblende-biotite quartz diorite. Plagioclase and quartz each comprise about 40 per cent of the rock. Orthoclase is relatively minor. Total mafics commonly range between 15 and 20 per cent.

On stratigraphic data the body can only be dated as post-Permian. A similar body in Jennings River map-area to the east yielded K-Ar ages of 48 and 46 m.y. on hornblende and biotite respectively (GSC 67-9 and 67-10)*.

* See Geol. Surv. Can. Paper 69-2A, 1970.

British Columbia

GSC 70-20 Hornblende, K-Ar age 177 ± 9 m.y.

$K = 0.78\%$, $^{40}Ar/^{40}K = 0.0109$, radiogenic Ar = 79%.
Concentrate: Relatively clean, pleochroic light brown to bluish green hornblende. Thicker grains are almost opaque. No biotite or chlorite impurities were detected.

From hornblende-quartz diorite.
(104 O) On crest of ridge southeast of Christmas Creek, British Columbia, 59°18'N, 131°40.5'W. See B.C. Dept. of Mines Bull. 19, Tuya-Teslin area, and Map-unit 21, GSC Map 18-1968. Sample TO 66-106, collected by D.J. Tempelman-Kluit, interpreted by H. Gabrielse.

The sample is typical of Christmas Creek Batholith; medium-grained, homogeneous, mesocratic, hornblende-quartz diorite. Two pairs of discordant ages have been obtained previously from samples of the batholith (GSC 67-7* and 67-8* yielding 128 m.y. on hornblende and 56 m.y. on biotite; GSC 66-2* and 66-3 yielding 146 m.y. on hornblende and 73 m.y. on biotite). The previous samples were collected near contacts with younger plutons and it is assumed that the discordant ages are the result of reheating. The sample determined in this case was collected near the middle of the exposed batholith and probably is a much closer approximation of the age of emplacement than the earlier determinations.

*See Geol. Surv. Can. Papers 67-2A (1968) and 69-2A (1970).

GSC 70-21 Hornblende, K-Ar age $\begin{matrix} 112 \pm 28 \text{ m.y.} \\ 120 \pm 26 \text{ m.y.} \end{matrix}$

$K = 0.19\%$, $^{40}Ar/^{40}K = \begin{matrix} 0.0067 \\ 0.0072 \end{matrix}$, radiogenic Ar = $\begin{matrix} 29\% \\ 38\% \end{matrix}$.
Concentrate: Clean, pleochroic light green to dark green hornblende with no visible impurities.

From hornblende-biotite-quartz diorite.
(104 J) On ridge on east side of Tachilta Lake, British Columbia, 58°38.5'N, 130°56'W. Map-unit 6a, GSC Map 21-1962. Sample GA-Tach-68, collected by J.W.H. Monger, interpreted by H. Gabrielse.

See GSC 70-22 for description and interpretation.

GSC 70-22 Biotite, K-Ar age 137 ± 6 m.y.

$K = 7.26\%$, $^{40}Ar/^{40}K = 0.0083$, radiogenic Ar = 92%.
Concentrate: Moderately chloritized light brownish green biotite with about 8% chlorite content. Some of the mica flakes also have split edges.

British Columbia

From hornblende-biotite-quartz diorite.
(104 J) Details as for GSC 69-1629.

The dated sample appears to be representative of several stocks of very fresh, homogeneous, medium-grained, hornblende-biotite quartz diorite that outcrop in the Tachilta Lakes area. The stocks are intrusive into Carboniferous and/or Permian strata of the Cache Creek Group. They are generally about equidimensional in plan.

In view of the low radiogenic Ar and potassium content of the hornblende it seems probable that the determination on biotite (137 m.y.) is the most reliable. However, further determinations are required for confirmation.

GSC 70-23 Hornblende, K-Ar age 184 ± 10 m.y.

K = 0.85%, $^{40}Ar/^{40}K$ = 0.0113, radiogenic Ar = 75%.
Concentrate: Clean, pleochroic light brown to dark green hornblende with no significant impurities.

From hornblende-quartz diorite.
(104 O) On ridge crest southwest of lake at head of Plate Creek, British Columbia, 59°53'N, 130°45.5'W. Sample GA-65-123b, collected and interpreted by H. Gabrielse.

The rock is a mesocratic, medium-grained, slightly porphyritic, hornblende-quartz diorite containing relatively litte quartz. Hornblende forms fresh euhedral crystals and comprises about 20 per cent of the rock. Plagioclase (about An_{45}) comprises about 55 per cent and the remainder consists of approximately equal amounts of quartz and potash feldspar.

The age of 184 m.y. is in close agreement with ages previously obtained from samples of Nome Lake Batholith (GSC 67-5 and 67-6* at 183 m.y.) and from a hornblende from Simpson Peak Batholith (GSC 67-65* at 181 m.y.). A previous determination on another sample from Plate Creek (GSC 67-11*) gave an age of 159 m.y.

*See Geol. Surv. Can. Paper 69-2A, 1970.

GSC 70-24 Biotite, K-Ar age 87 ± 4 m.y.

K = 7.82%, $^{40}Ar/^{40}K$ = 0.0052, radiogenic Ar = 74%.
Concentrate: Hetrogenous concentrate of light brown, greenish, and dark brown biotites. Many of the flakes have split edges but no inclusions or alteration.

From quartz monzonite.
(104 O) Ridge crest 6 miles northeast of confluence of Klinkit Creek and Jennings River, British Columbia, 59°28'N, 131°13'W. Map-unit 24 (Klinkit Batholith), GSC Map 18-1968. Sample GAB-66-8B, collected by M. Bjarnason, interpreted by H. Gabrielse.

British Columbia

The rock is a leucocratic, medium- to coarse-grained, sugary, foliated quartz monzonite. Biotite is the only visible mafic mineral and generally comprises less than 10 per cent of the rock. Perthitic potash feldspar, plagioclase and quartz occur in about equal amounts.

The batholith cannot be dated by stratigraphic data (other than being post-Permian). Granite of the Tuya Batholith on trend to the southeast has yielded an age of 92 m.y. (GSC 67-13*).

*See Geol. Surv. Can. Paper 69-2A, 1970.

GSC 70-25 Hornblende, K-Ar age 161 ± 8 m.y.

K = 0.47%, $^{40}Ar/^{40}K$ = 0.0099, radiogenic Ar = 60%.
Concentrate: Relatively clean, pleochroic olive-green to light green hornblende with less than 2% muscovite and a trace of feldspar as impurities.

From quartz monzonite.
(104 J) Three miles east of Itsillititu Creek, British Columbia, 58°15.5'N, 130°15.5'W. Sample GA-67-97, collected and interpreted by H. Gabrielse.

See GSC 70-26 for description and interpretation.

GSC 70-26 Biotite, K-Ar age 141 ± 7 m.y.

K = 5.80%, $^{40}Ar/^{40}K$ = 0.0086, radiogenic Ar = 93%.
Concentrate: Light brownish olive biotite with about 5% chlorite and 10% hornblende contamination. Some of the mica flakes are of darker brown colour than most.

From quartz monzonite.
(104 J) Details as for GSC 70-25.

The rock is a grey, slightly megacrystic, medium-grained, biotite-hornblende quartz monzonite. The stock is exposed in the core of Hotailuh Range and has been barely unroofed. Intruded rocks are mainly volcanics of Late Triassic (Karnian) age.

The discordant ages suggest that at least the biotite has lost radiogenic argon. The hornblende age is similar to that of one of the groupings obtained from samples of the Hotailuh Batholith exposed to the southeast. Unlike the Hotailuh Batholith the granitic rocks of the stock are relatively fresh.

GSC 70-27 Hornblende, K-Ar age 147 ± 8 m.y.

K = 0.665%, $^{40}Ar/^{40}K$ = 0.0090, radiogenic Ar = 78%.
Concentrate: Pleochroic light green to brownish yellow hornblende with 5% biotite contamination. Other impurities about 1% chlorite and a trace of quartz.

British Columbia

From granodiorite.
(104 I) On Cassiar-Stewart Road, British Columbia, 58°09.6'N, 129°51.9'W. Map-unit 15b, GSC Map 62-29 (Hotailuh Batholith). Sample GA-1390, collected by J.G. Souther, interpreted by H. Gabrielse.

See GSC 70-28 for description and GSC 70-34 for interpretation.

GSC 70-28 Biotite, K-Ar age 139 ± 6 m.y.

K = 7.57%, $^{40}Ar/^{40}K$ = 0.0085, radiogenic Ar = 92%.
Concentrate: Relatively clean, light brown biotite with 5% amphibole contamination. About 5% of the flakes are blistered, but otherwise unaltered.

From granodiorite.
(104 I) Details as for GSC 70-27.

The rock is a medium- to coarse-grained biotite-hornblende granodiorite characterized by slightly pinkish weathering feldspar and exhibiting the classic reaction series of clinopyroxene cores mantled with hornblende and hornblende partly replaced by biotite.

See GSC 70-34 for interpretation.

GSC 70-29 Hornblende, K-Ar age $\begin{matrix} 166 \pm 8 \text{ m.y.} \\ 157 \pm 11 \text{ m.y.} \end{matrix}$

K = 0.65%, $^{40}Ar/^{40}K = \begin{matrix} 0.0102 \\ 0.0096 \end{matrix}$, radiogenic Ar = $\begin{matrix} 67\% \\ 32\% \end{matrix}$.
Concentrate: Clean, pleochroic, light brown to dark green hornblende with no visible impurities.

From granite.
(104 I) On Cassiar-Stewart Road, British Columbia, 58°08'30"N, 129°52'00"W. Map-unit 15b, GSC Map 29-1962. Sample GA 2/9/61-2A, collected and interpreted by H. Gabrielse.

This is a medium to coarse grained, pinkish weathering, hornblende and biotite-bearing granitic rock of typical hypidiomorphic texture and containing roughly equal (30% each) perthite and plagioclase. The mafic minerals show a rather well defined reaction series in which pyroxene is replaced by hornblende, hornblende by biotite, and, locally, biotite by chlorite.

See GSC 70-34 for interpretation.

British Columbia

GSC 70-30 Hornblende, K-Ar age 155 ± 8 m.y.

K = 0.38%, $^{40}Ar/^{40}K$ = 0.0094, radiogenic Ar = 63%.
Concentrate: Relatively pure, pleochroic, light green to yellow hornblende with less than 5% biotite as inclusions. Impurities consist of about 10% free chlorite and a trace of quartz.

From quartz monzonite.
(104 I) Near crest of Coke Hill, British Columbia, 58°10.5'N, 129°38.5'W. Map-unit 15b, GSC Map 29-1962. Sample GAD 67-132-3, collected and interpreted by H. Gabrielse.

The rock is a leucocratic, medium-grained hornblende-quartz monzonite or granodiorite characterized by the very pale salmon-pink colour of the feldspars.

See GSC 70-34 for interpretation.

GSC 70-31 Hornblende, K-Ar age 163 ± 9 m.y.

K = 0.50%, $^{40}Ar/^{40}K$ = 0.0099, radiogenic Ar = 77%.
Concentrate: Relatively clean, pleochroic olive-green to light green hornblende with less than 5% biotite and a trace of quartz impurity.

From quartz monzonite/granodiorite.
(104 I) Six miles southeast of Cake Hill, British Columbia, 58°07.5'N, 129°30'W. Map-unit 15b, GSC Map 29-1962. Sample GAD 67-132-2, collected by C. Dodds, interpreted by H. Gabrielse.

See GSC 70-32 for description and GSC 70-34 for interpretation.

GSC 70-32 Biotite, K-Ar age 163 ± 7 m.y.

K = 7.55%, $^{40}Ar/^{40}K$ = 0.0100, radiogenic Ar = 93%.
Concentrate: Clean, light brown biotite with less than 2% hornblende impurity.

From quartz monzonite/granodiorite.
(104 I) Details as for GSC 70-31.

The rock is a medium-grained, leucocratic to mesocratic biotite-hornblende quartz monzonite or granodiorite. In some cases the hornblende has cores of augite.

See GSC 70-34 for interpretation.

British Columbia

GSC 70-33 Hornblende, K-Ar age $\frac{215 \pm 11 \text{ m.y.}}{213 \pm 11 \text{ m.y.}}$

$K = 0.54\%$, $^{40}Ar/^{40}K = \frac{0.0134}{0.0132}$, radiogenic Ar = $\frac{47\%}{68\%}$.

Concentrate: Clean, pleochroic olive-green to dark green hornblende with less than 5% attached quartz and a trace of muscovite as impurities.

From monzonite/quartz monzonite.

(104 J) Triangulation station 6447 on summit of Cake Hill, British Columbia, 58°10'N, 129°39'W. Map-unit 15b, GSC Map 29-1962. Sample GAD 67-132-1, collected by C. Dodds, interpreted by H. Gabrielse.

The rock is a medium grained, slightly megacrystic, leucocratic to mesocratic biotite-hornblende monzonite or quartz monzonite.

See GSC 70-34 for interpretation.

GSC 70-34 Hornblende, K-Ar age $\frac{217 \pm 11 \text{ m.y.}}{217 \pm 11 \text{ m.y.}}$

$K = 0.69\%$, $^{40}Ar/^{40}K = \frac{0.0135}{0.0135}$, radiogenic Ar = $\frac{79\%}{79\%}$.

Concentrate: Clean, brownish green to dark green pleochroic hornblende with no visible impurities.

From diorite.

(104 J) Three miles north of Stikine River, British Columbia, 58°04.5'N, 129°57.5'W. Map-unit 15b, GSC Map 29-1962. Sample GA-67-98C, collected and interpreted by H. Gabrielse.

The rock is a medium grained mesocratic hornblende diorite characterized by prismatic crystals of hornblende. The hornblende shows minor replacement by biotite.

All K-Ar ages listed were obtained from samples of the Hotailuh Batholith exposed in Hotailuh and Three Sisters Ranges of the Cassiar Mountains in north-central British Columbia. The batholith consists of relatively uniform biotite-hornblende granodiorite or hornblende granodiorite. Plagioclase typically shows a pervasive clouding which imparts a pink tinge to the rock. Commonly, the hornblende crystals have a core of clinopyroxene.

The granitic rocks are intrusive into volcanic rocks and minor sedimentary rocks which to the west in Dease Lake map-area have yielded a Karnian (early Upper Triassic) fauna. In this region the Karnian rocks are commonly overlain conformably by Norian (mid-Upper Triassic) limestone. Lower Jurassic strata appear to overlie the Upper Triassic rocks unconformably near the batholith. On Mount Meehaus, south of the confluence of Tanzilla and Stikine Rivers (see GSC Map 21-1962) conglomerate in the Lower Jurassic sequence carries pebbles and cobbles of granitic rocks similar in lithology to those of the Hotailuh Batholith. Nowhere are Lower Jurassic

strata known to rest directly on rocks of the Hotailuh Batholith. The available field evidence, however, favours a latest Triassic or earlier Jurassic age for the Hotailuh Batholith.

Determination No.	Sample No.	Age (m.y.)	Mineral
GSC 70-27	GA 1390	147 ± 8	Hornblende
GSC 70-28	GA 1390	139 ± 6	Biotite
GSC 70-29 *	GA 2/9/61/2A	157 ± 11	Hornblende
	GA 2/9/61/2A	166 ± 11	Hornblende
GSC 70-30	GAD-132-3	155 ± 8	Hornblende
GSC 70-31	GAD-132-2	163 ± 9	Hornblende
GSC 70-32	GAD-132-2	163 ± 7	Biotite
GSC 70-33	GAD-132-1	215 ± 11	Hornblende
	GAD-132-1	213 ± 11	Hornblende
GSC 70-34	GA 67-98C	217 ± 11	Hornblende
	GA 67-98C	217 ± 11	Hornblende

*An earlier determination on biotite from this sample was reported as 193 m.y. (see GSC 62-71, GSC Paper 63-17). It should be noted, however, that this biotite had been 30% chloritized and contained inclusions of quartz.

In view of the indicated stratigraphic age the two groupings of K-Ar ages (about 215 m.y. and 162 m.y.) are enigmatic. The older ages seem best to fit the field data. If they are valid a thermal event at about 162 m.y. must have effected a uniform argon loss throughout large parts of the batholith. The 162 m.y. events may have coincided with the emplacement of a quartz-monzonite stock exposed in the core of Hotailuh Range.

See GSC 70-25 and 26.

GSC 70-35 Biotite, K-Ar age 102 ± 5 m.y.

$K = 7.74\%$, $^{40}Ar/^{40}K = 0.0062$, radiogenic Ar = 86%.
Concentrate: Relatively pure, yellowish olive biotite with less than 5% chlorite contamination as free flakes.

From quartz monzonite.
(104 J) On ridge 2 miles northwest of confluence of three Forks Creek and Turnagain River, British Columbia, 58°42.5'N, 128°43.5'W. Map-unit 15a, GSC Map 29-1962. Sample GA-67-102A, collected and interpreted by H. Gabrielse.

British Columbia

This sample is typical of the quartz monzonites that comprise the most widespread lithology in Cassiar Batholith. The rock is grey, medium- to coarse-grained, in part megacrystic, leucocratic quartz monzonite. It contains about equal amounts of calcic oligoclase and quartz. Biotite is the only mafic mineral and comprises about 5 per cent of the rock.

The K-Ar age of 102 m.y. is in good agreement with ages previously obtained on samples collected farther northwest (GSC 60-28, GSC 67-15 and GSC 67-12 at 98 ± 8 m.y., 105 ± 5 m.y. and 105 ± 5 m.y. respectively*). Also note Baadsgaard et al., 1961; Potassium-argon dates of biotites from Cordilleran granites, Bull. Geol. Soc. Am., vol. 72, No. 5.

*See Geol. Surv. Can. Papers 61-17 (1961) and 69-2A (1970).

GSC 70-36 Hornblende, K-Ar age 44 ± 6 m.y.

$K = 0.15\%$, $^{40}Ar/^{40}K = 0.0026$, radiogenic Ar = 22%.
Concentrate: Clean, unaltered, pleochroic bluish green to light brown hornblende with less than 1% biotite contamination.

From orebody.
(92 C) 5,100-foot level, Cave zone, Sunro Mine, British Columbia, 48°27'N, 124°03'W. Sample KQ-SUNRO, collected and interpreted by R.V. Kirkham.

The rock consisted of about 40 to 50 per cent dark, vitreous, coarse-grained hornblende with approximately 35 per cent pyrrhotite, 10 per cent chalcopyrite, and 5 to 10 per cent carbonate, chlorite, and other minerals. The sulphides occurred as a reticulate network in the hornblende.

The hornblende formed as an alteration product of Eocene Metchosin basalt. Its intimate association with the sulphides and its unaltered nature indicate that the date is probably that of the period of mineralization. However, because of the unusually low potassium content of this hornblende the sample would be very susceptible to contamination, hence, caution should be exercised in application of this date.

GSC 70-37 Muscovite, K-Ar age revised to 45 ± 3 m.y.

$K = 8.61\%$, $^{40}Ar/^{40}K = 0.0026$ radiogenic Ar = 60%.
Concentrate: Consists mostly of clean muscovite but some flakes contain small inclusions of quartz and attached fragments of brown biotite. An orange-yellow stain is evident on some flakes. Chlorite not detected.

From quartz-muscovite-biotite schist.
(93 O) Near Nation River, British Columbia, 55°23'30"N, 123°39'50"W. Map-unit A, GSC Map 11-1961. Sample IV. Collected and interpreted by J.E. Muller.

See GSC 70-44 for interpretation.

British Columbia

GSC 70-38 Muscovite, K-Ar age revised to 50 ± 6 m.y.

K = 8.42%, $^{40}Ar/^{40}K$ = 0.0030 radiogenic Ar = 74%.
Concentrate: Pure muscovite. Some flakes are partly coated with thin films of iron hydroxide. Chlorite not detected.

From pegmatitic granite.
(93 O) Northwest of Nation River, British Columbia, 55°23'30"N, 123°39'50"W. Map-unit A, GSC Map 11-1961. Sample IVa. Collected and interpreted by J.E. Muller.

The muscovite occurs as books, several inches thick, in pegmatitic granite intimately mixed with Wolverine gneiss and schist.

See GSC 70-44 for interpretation.

GSC 70-39 Muscovite, K-Ar age revised to 47 ±3 m.y.

K = 8.79%, $^{40}Ar/^{40}K$ = 0.0028, radiogenic Ar = 61%.
Concentrate: Most of the muscovite flakes are clean but a few contain minor inclusions of quartz and attached specks of brown biotite. Chlorite not detected.

From quartz-feldspar-muscovite gneiss.
(93 O) Wolverine Range, south of Nation River, British Columbia, 55°19'N, 123°30'W. Map-unit A, GSC Map 11-1961. Sample 118 I (previously reported as GSC 61-33), collected and interpreted by J.E. Muller.

See GSC 70-44 for description and interpretation.

GSC 70-40 Biotite, K-Ar age $\frac{44 \pm 3 \text{ m.y.}}{44 \pm 4 \text{ m.y.}}$

K = $\frac{7.50\%}{7.59\%}$, $^{40}Ar/^{40}K$ = $\frac{0.0026}{0.0026}$, radiogenic Ar = $\frac{67\%}{66\%}$
Concentrate: Clean, unaltered reddish brown biotite with less than 1% hornblende contamination. A few flakes contain colourless inclusions with associated weak pleochroic haloes.

From muscovite-biotite-plagioclase gneiss.
(93 O) On ridge 1/2 mile west of point 5166, British Columbia, 55°07'35"N, 123°29'15"W. Map-unit A, GSC Map 11-1961 (Pine Pass). Sample MEKA 66-13, collected and interpreted by J.E. Muller.

British Columbia

The rock is dark coloured gneissic mica-schist with small pink feldspars and "pinheads" of red garnet. It consists of a fine-grained well-foliated intergrown assemblage of biotite (27.1%), muscovite (24.4%), with lenses and elongate aggregates of quartz (38.0%) and plagioclase, commonly oriented in foliation (10.5%).

See GSC 70-44 for interpretation.

GSC 70-41 Muscovite, K-Ar age 46 ± 3 m.y.

K = 8.55%, $^{40}Ar/^{40}K$ = 0.0027, radiogenic Ar = 58%.
Concentrate: Relatively clean, slightly stained muscovite with less than 5% biotite contamination. A few of the flakes carry oriented prismatic inclusions.

From muscovite-biotite-plagioclase gneiss.
(93 O) Details as for GSC 70-40.

See GSC 70-44 for interpretation.

GSC 70-42 Biotite, K-Ar age 43 ± 4 m.y.

K = 6.99%, $^{40}Ar/^{40}K$ = 0.0025, radiogenic Ar = 77%.
Concentrate: Relatively clean, slightly altered khaki biotite with less than 5% hornblende, 2% free chlorite and a trace of quartz contamination.

From biotite-hornblende-plagioclase gneiss.
(93 O) On ridge 1 1/2 miles northeast of point 6048, British Columbia, 55°32'10"N, 123°52'40"W. Map-unit A (Wolverine Complex), GSC Map 11-1961. Sample MEKA 66-11, collected and interpreted by J.E. Muller.

The rock is well-foliated medium grained gneiss and contains plagioclase, slightly saussuritized, anhedral and with twinning across foliation, to 3 mm size (39.2%); quartz, elongate, in part interstitial (20.3%); hornblende, euhedral to anhedral (25.8%); biotite, subparallel (10.0%); and small square K-feldspar inclusions in plagioclase. Hornblende, biotite and plagioclase contain small quartz inclusions. Biotite crystals are partly intergrown in quartz, feldspar and hornblende.

See GSC 70-44 for interpretation.

GSC 70-43 Muscovite, K-Ar age 40 ± 2 m.y.

K = 8.75%, $^{40}Ar/^{40}K$ = 0.0024, radiogenic Ar = 64%.
Concentrate: Clean, but yellow-stained muscovite. The stain is confined to split edges of about 25% of the mica flakes.

British Columbia

From granite greisen.

(93 O) 0.5 mile west of point 5166, British Columbia, 55°07'35"N, 123°29'15"W. Map-unit A (Wolverine Complex), GSC Map 11-1961. Sample MEKA 66-14, collected and interpreted by J.E. Muller.

The rock is medium to coarse grained light coloured muscovite-granite-greisen, containing altered plagioclase, subhedral to corroded (18.2%); quartz, anhedral, equant (47.4%); orthoclase to 7 mm size, containing oriented muscovite flakes; quartz; plagioclase (22.4%); and minor brown (?) garnet. Replacement of plagioclase by orthoclase is apparent. The sample was taken from a dyke intrusive into the gneiss of GSC 70-40.

See GSC 70-44 for interpretation.

GSC 70-44 Biotite, K-Ar age 45 ± 2 m.y.

K = 6.57%, $^{40}Ar/^{40}K$ = 0.0026, radiogenic Ar = 79%.
Concentrate: Slightly altered and blistered brown biotite with less than 2% hornblende impurity. Total chlorite content is about 4%.

From biotite amphibolite.

(93 O) On ridge 1 1/2 miles northeast of point 6048, British Columbia, 55°32'10"N, 123°52'40"W. Map-unit A (Wolverine Complex), GSC Map 11-1961. Sample MEKA 66-12, collected and interpreted by J.E. Muller.

The rock, interlayered with that of GSC 70-42, is a strongly foliated, dark coloured biotite amphibolite consisting of hornblende, fresh, euhedral, to 5 mm size (62.5%); biotite, well aligned and rather fresh (9.4%); plagioclase (11.0%) and quartz (16.1%), both anhedral, fine granular and interstitial; and minor apatite and opaques. Biotite is commonly included in hornblende and is slightly bent and strained.

The following discussion concerns determinations made in 1967 and 1968 on samples from the Wolverine Metamorphic Complex in Pine Pass area. They include new samples, collected in 1966, and new determinations on samples IVa, IV and 118VI previously reported as GSC 60-23, 61-31 and 61-33 respectively. In view of the concordance of the results of these new determinations, all of which fall in the age-range of 40 to 50 m.y., it is considered that the original determinations on GSC 60-23, 61-31, and 61-33 are in error. The same reasoning must also apply to determinations GSC 61-30 (H31), 61-32 (IV) and 62-67 (H4O), and all are now superseded by the new data tabulated.

The four localities, with a total of nine new analyses, some of which have been repeated, occur in a 30-mile stretch of the belt of Wolverine Complex metamorphic rocks, directly west of the Rocky Mountain Trench.

British Columbia

Determination No.	Age (m.y.)	Mineral
On ridge 1/2 mile W of point 5166:-		
GSC 70-40	44 ± 4 m.y.	Gneiss; biotite
	44 ± 3 m.y.	Gneiss; repeat biotite
GSC 70-41	46 ± 3 m.y.	Gneiss; muscovite
GSC 70-43	40 ± 2 m.y.	Granite-greisen, intruding above gneiss; muscovite
On ridge 1 1/2 miles NE of point 6048:-		
GSC 70-42	43 ± 4 m.y.	Gneiss; biotite
GSC 70-44	45 ± 2 m.y.	Amphibolite; biotite
Northwest of Nation River:-		
GSC 70-37	45 ± 3 m.y.	Schist; muscovite
GSC 70-38	50 ± 6 m.y.	Pegmatite intruding above schist; muscovite
South of Nation River:-		
GSC 70-39	47 ± 3 m.y.	Gneiss; muscovite

Taking the dates at face-value they indicate that the last thermal event in the Wolverine Complex occurred at around 45 m.y., or in middle Eocene time.

Unmetamorphosed sediments of the Sifton Formation, dated within Pine Pass and McLeod Lake areas by pollen and leaves as either Paleocene/Eocene or Maestrichtian are exposed in the Rocky Mountain Trench. Conglomerates in these beds contain quartzite, argillite, and limestone apparently derived from Rocky Mountain strata to the east, but no Wolverine-type gneissic or granitic rocks. The early Tertiary rocks are not known to overlie the Wolverine Complex. It is therefore possible that the complex was still at sufficient depth and temperature in late Cretaceous to earliest Tertiary time to permit diffusion of radiogenic argon. It was subsequently, by vertical movement along the Rocky Mountain Trench faults, elevated, unroofed and cooled to permit retention of argon.

A slightly older date of 52 m.y. was obtained from a sample of nepheline syenite gneiss, collected by J.O. Wheeler (GSC 64-22, GSC Paper 65-17) in the Selkirk Mountains, also in proximity to the Rocky Mountain Trench, and interpreted in similar fashion.

British Columbia

Many Tertiary dates are also known from the Shuswap Complex, generally considered geologically similar to the Wolverine. It is in places unconformably overlain by volcanic and sedimentary rocks, dated by the fossil flora as middle Eocene and by potassium-argon ages as 45-50 m.y. Gabrielse and Reesor (1964) did not believe the Tertiary ages could reflect structural and metamorphic events. However, the Eocene volcanism could have been a thermal event affecting argon-retention in the complex. As the writer has noted earlier (GSC Paper 61-17, p. 106) metamorphism may proceed over long periods of time and potassium-argon dates record only the time of final cooling and unroofing of the metamorphic rocks.

References

Gabrielse, H.G. and Reesor, J.E.
1964: Geochronology of plutonic rocks in two areas of the Canadian Cordillera, in Roy. Soc. Can., Spec. Publ. No. 8, pp. 96-138.

Muller, J.E.
1961: Notes on age determinations made on Cordilleran rocks; Geol. Surv. Can., Paper 61-17, pp. 98-107.

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1961: Radioactive dating of Tertiary plant-bearing deposits; Science, vol. 133, pp. 1079-1080.

Also Geol. Surv. Can. Papers 61-17, 62-17, 65-17.

Yukon Territory

(GSC No. 70-45 to 70-50)

GSC 70-45 Muscovite, K-Ar age 94 ± 5 m.y.

$K = 8.43\%$, $^{40}Ar/^{40}K = 0.0056$, radiogenic Ar = 70%.
Concentrate: Clear muscovite with approximately 7% closely associated chlorite. Some of the mica flakes have split edges with slight yellow staining.

From sheared granodiorite.
(105 K) Five and a half miles northeast of mouth of Vangorda Creek, Yukon Territory, 62°17.5'N, 133°16.5'W. Sample TO68-469, collected and interpreted by D. Tempelman-Kluit.

See GSC 70-46 for description and interpretation.

GSC 70-46 Biotite, K-Ar age 94 ± 5 m.y.

$K = 7.77\%$, $^{40}Ar/^{40}K = 0.0057$, radiogenic Ar = 67%.
Concentrate: Light orange biotite with about 10% chloritization. A few of the flakes have split edges.

From sheared granodiorite.
(105 K) Details as for GSC 70-45.

The rock is well foliated, medium grained biotite-muscovite orthogneiss of granodioritic composition. It is mapped as part of unit 12a in a geological sketch map published in GSC Paper 68-1A, pp. 46-47.

The sample was taken to test whether the foliated margin of the Anvil Batholith is the same age as, or younger than, its unfoliated core. Ages already determined for unfoliated granitic rocks of the Anvil Batholith are:

GSC Sample*	Age	Rock	Dated Mineral
65-41	90 ± 5	quartz monzonite	biotite
65-42	79 ± 6	quartz monzonite	muscovite
65-43	87 ± 5	quartz monzonite	biotite

Two ages determined on coexisting biotite and muscovite in thermally (?) metamorphosed rocks near the margin of Anvil Batholith are also pertinent:

GSC Sample*	Age	Rock	Dated Mineral
67-48	93 ± 4	biotite muscovite schist	biotite
67-47	99 ± 5	biotite muscovite schist	muscovite

*See Geol. Surv. Can. Papers 66-17 (1967) and 69-2A (1970).

Yukon Territory

The ages determined on the biotite and muscovite of the present sample are in exact agreement and correspond fairly well to the determinations listed above. The age of the present sample also compares well with those obtained from samples of granitic rock in other parts of the Yukon Territory northeast of the Tintina Trench.

GSC 70-47 Muscovite, K-Ar age $\frac{64 \pm 3 \text{ m.y.}}{70 \pm 3 \text{ m.y.}}$

$K = 8.19\%$, $^{40}Ar/^{40}K = \frac{0.0038}{0.0042}$, radiogenic Ar = $\frac{91\%}{91\%}$.

Concentrate: Clear muscovite in which about 10% of the flakes are intergrown with chlorite. Trace impurities of quartz.

From quartz-sericite schist.

(115 P) North side of bridge, road junction at Stewart Crossing, Yukon Territory, 63°23'N, 136°40'W. Map-unit 4, GSC Map 1143A. Sample 1-44-6B/PB, collected and interpreted by W.H. Poole.

The quartz-sericite schist is white, light green and brown (where schistosity planes are coated by limonite), fine grained and approaching a phyllite, and weakly crenulated along cross-cutting cleavage planes. In this section, muscovite and minor biotite and chlorite parallel the main schistosity.

The schist is part of the Yukon Group metamorphic rocks and is quite similar lithologically to the "Upper Schist" Formation in the Keno Hill mining camp 50 miles to the northeast. The age of strata within the group in most places is either unknown or uncertain, and varies from Precambrian to Mesozoic. The sample was analyzed to determine the age of regional metamorphism.

The average of the two analyses, 67 ± 3 m.y., is close to the Cretaceous-Tertiary boundary. To the southwest across the Tintina Fault, many K-Ar mineral dates on metamorphic rocks fall in the 160-180 m.y. range. But to the northeast, in the Keno Hill area, muscovite concentrates from three samples of similar schist have yielded dates of 84 ± 8, 93 ± 12 and 101 ± 6 m.y. (GSC 65-46, 47 and 48)* indicative of early Late Cretaceous. The reason for the range in the three is not known, and similarly the reason for their marked difference with the present date of 67 ± 3 m.y. is not known. Nevertheless, it appears that the present date is anomalously young by at least 17 m.y. or 25% (in comparison to 84 m.y.). Deformation and metamorphism associated with movement along Tintina Fault may be the cause of loss of argon, but if so, it is strange that a K-Ar biotite date of 85 ± 7 m.y. (GSC 65-50)* from a quartz monzonite stock near and northeast of Tintina Fault and 12 miles northwest of the present sample location, has not also been similarly affected.

*See Geol. Surv. Can. Paper 66-17 (1967).

Yukon Territory

GSC 70-48 Muscovite, K-Ar age 87 ± 4 m.y.

K = 8.59%, $^{40}Ar/^{40}K$ = 0.0052, radiogenic Ar = 84%.
Concentrate: Clean, slightly blistered muscovite.

From cataclastic granodiorite.
(105 B) Cassiar Mountains along Alaska Highway at bench mark, elev. 3,064 feet, 1/2 mile east of Porcupine Creek, Wolf Lake map-area, Yukon Territory, 60°04'47"N, 130°49'35"W. Map-unit 15a, GSC Map 10-1960. Sample PB-3-64, collected and interpreted by W.H. Poole.

The granodiorite is a light greenish grey, fine to medium grained, homogeneous rock with a well-developed foliation resulting from cataclasis. The rock has small streaks of fine chlorite and larger crystals of muscovite, which mark the foliation planes.

In thin section, the cataclastic texture is obvious. Original quartz crystals are highly strained with lenticular form and partly recrystallized to a micropolygonal texture. Feldspars are fractured, bent and clouded with fine white mica. Some potash feldspar has microcline twinning. All feldspars have ragged edges. Muscovite is unaltered and bent. Some chlorite is bent and in part intergrown with muscovite.

The western border, up to several miles wide, of the Cassiar Batholith where it crosses the Alaska Highway, consists of cataclastic granodiorite and quartz monzonite in which the original mafic varietal minerals have been altered to chlorite, and secondary muscovite has grown. A few miles north of the sample locality, the intensity of cataclasis diminishes eastwards and thus the cataclastic granite grades into undeformed granite of the main part of the batholith.

The batholith north of the Alaska Highway has yielded K-Ar biotite dates of 98 m.y. (GSC 60-28)* and 101 m.y. (Baadsgaard et al., 1961). An interpreted early Late Cretaceous age of intrusion is consistent with the geological setting.

About 15 miles to the west, the Seagull Batholith of leuco-quartz monzonite and alaskite appeared to be younger on structural evidence (Poole et al., 1960) and this hypothesis was supported by a Tertiary K-Ar biotite date of 59 m.y. (GSC 59-14)*. Subsequently, another sample of the Seagull Batholith yielded 97 ± 5 m.y. and 92 ± 4 m.y. by duplicate analysis (GSC 70-50). To resolve this difference, the 59 m.y. sample (GSC 59-14)* was re-analyzed and has yielded a revised age of 98 ± 5 m.y. (GSC 70-49).

The present sample was analyzed to determine the age of cataclasis, believed to be younger than 98-101 m.y. and older than the now-discredited 59 m.y. date. The determined date of 87 ± 4 m.y. is younger than Cassiar 98-101 m.y. dates as it should be, and by surprise, younger than the Seagull 92-97-98 m.y. dates. In addition, the 87 m.y. date is much younger than the muscovite date of 105 ± 5 m.y. date (GSC 67-12)* from the same rock (called a granitic gneiss) collected about 5 miles to the south. The two dates were expected to be the same and no geological explanation for the marked difference is apparent. Nevertheless, at this time, it is reasonable to assume that the Cassiar Batholith (98-101 m.y.) was cataclastized almost immediately after

emplacement (cf. 105 m.y.) and the Seagull Batholith was emplaced almost immediately after that (92-97-98 m.y.). Thus the 87 m.y. date is regarded as being too young, for unknown reasons.

References

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.

Poole, W.H., Roddick, J.A. and Green, L.H.
1960: Wolf Lake, Yukon Territory; Geol. Surv. Can., Map 10-1960.

*See Geol. Surv. Can. Papers 60-17 (1960), 61-17 (1961) and 69-2A (1970).

GSC 70-49 Biotite, K-Ar age 98 ± 5 m.y.

$K = 6.44\%$, $^{40}Ar/^{40}K = 0.0059$, radiogenic Ar = 91%.
Concentrate: Relatively clean, light reddish brown biotite with less than 2% free chlorite contamination. The mica shows no visible alteration or inclusions.

From leuco-quartz monzonite.
(105 B) Near ridge crest, east side of Seagull Creek, 3.7 miles north of mouth, Yukon Territory, 60°02'32"N, 131°10'11"W. Map-unit 16, GSC Map 10-1960. Sample 5-1-2/P, collected and interpreted by W.H. Poole.

This date is the result of a re-analysis of reserve biotite concentrate of GSC 59-14* which had yielded a 59 m.y. date years ago. The potassium content was verified by isotope dilution. The biotite was re-analyzed because the 59 m.y. date was markedly different from the 92-97 m.y. dates on another sample of the same granite (see GSC 70-50 below). The old date of 59 m.y. should be extirpated and replaced by the new 98 m.y. date.

*See GSC 70-50 for description and interpretation.

GSC 70-50 Biotite, K-Ar age $\begin{matrix} 97 \pm 5 \text{ m.y.} \\ 92 \pm 4 \text{ m.y.} \end{matrix}$

$K = 7.26\%$, $^{40}Ar/^{40}K = \begin{matrix} 0.0058 \\ 0.0055 \end{matrix}$, radiogenic Ar = $\begin{matrix} 59\% \\ 70\% \end{matrix}$.
Concentrate: Relatively clean, light brownish orange biotite with about 5% each of chlorite and muscovite.

Yukon Territory

From leuco-quartz monzonite.

(105 B) Ridge crest, east side of Seagull Creek, 6.5 miles north of mouth, Yukon Territory, 60°4.5'N, 131°09'W. Map-unit 16, GSC Map 10-1960. Sample Y-3-RA-1-65, collected by J.E. Reesor, interpreted by W.H. Poole.

Both samples (GSC 70-49 and 70-50) are representative of leuco-quartz monzonite from the Seagull Batholith and were collected about 3 miles apart. The rock is massive, coarse grained, miarolitic and pinkish buff. Granitic texture is distinct. Miarolitic cavities vary from tiny crystallined vugs to large concentrations of black tourmaline and terminated quartz elsewhere in the batholith. Characteristic of the granite is the buff to orange-brown weathered surface, and the dark colour of the quartz. Quartz constitutes one third or slightly more of the rock. Potash feldspar exceeds plagioclase, and is microperthite which commonly encloses plagioclase (albite-oligoclase). Biotite comprises about 4 per cent of the rock and is black and vitreous, and slightly altered to chlorite, iron ore and in places, muscovite. Accessory fluorite and zircon are associated with biotite.

The three new dates 92, 97 and 98 m.y. are very similar and suggest that the batholith was intruded and cooled during mid-Cretaceous as a product of the late phase of the Columbian Orogeny. The batholith evidently is only slightly younger than the Cassiar Batholith to the east (98-101 m.y., see GSC 70-48 for discussion).

The Seagull Batholith is one of several post-tectonic, potash-rich, steep-walled and flat-topped intrusions in northern British Columbia and southern Yukon. One such, the Glundebery Batholith, 45 miles to the south (Gabrielse, 1969) is a miarolitic hornblende granite. Hornblende has yielded K-argon dates of 79 ± 11 m.y. (GSC 66-1)* and 74 ± 4 m.y. (GSC 70-4), which are about 25 per cent younger than the present Seagull dates. The Tuya and Parallel Creek Batholiths, also representative of these young, potassic granites, occur 10 miles east of the Glundebery Batholith. They comprise biotite granite and quartz monzonite (Gabrielse, 1969), from which biotite has yielded dates of 92 ± 5 m.y. from the Tuya and 78 ± 4 m.y. from the Parallel Creek (GSC 67-13 and 67-14)*.

It is reasonable to suppose that all these intrusions are of the same age although each differs slightly from the other by one characteristic or another – the varietal mineral, miarolitic cavities, fluorite, tourmaline, etc. If they were emplaced and cooled at the same time, then the range in ages cannot be explained. They may on the other hand represent two or more pulses of plutonism separated by intervals of time substantially greater than the experimental error limits. If this is the case, geological evidence of such a sequence of pulses has not been found.

References

Gabrielse, H.
1969: Geology of Jennings River map-area, British Columbia (104-O); Geol. Surv. Can., Paper 68-55.

Poole, W.H., Roddick, J.A. and Green, L.H.
1960: Wolf Lake, Yukon Territory; Geol. Surv. Can., Map 10-1960.

*See Geol. Surv. Can. Papers 60-17 (1960), 67-2A (1968) and 69-2A (1970).

District of Franklin

(GSC No. 70-51 to 70-68)

GSC 70-51 Whole rock, K-Ar age 841 ± 124 m.y.

K = 0.29%, $^{40}Ar/^{40}K$ = 0.0620, radiogenic Ar = 74%.
Concentrate: Crushed whole rock.

From diabase.
(37 F) Six miles southeast of Neergaard Lake, Baffin Island, District of Franklin, 70°04'00"N, 79°36'15"W. Sample JDM-90/1-68, collected by W.C. Morgan, interpreted by G.D. Jackson.

The rock is a grey, fine to medium grained, subophitic diabase consisting of plagioclase, clinopyroxene, hornblende and biotite, with accessory magnetite, apatite and quartz. The diabase is considered to be unmetamorphosed.

Field relations suggest that this age may be somewhat too low, possibly due to the uncertainty in the potassium determination at the very low content indicated.

GSC 70-52 Phlogopite, K-Ar age 1660 ± 52 m.y.

K = 7.83%, $^{40}Ar/^{40}K$ = 0.1558, radiogenic Ar = 98%.
Concentrate: Clean, unaltered, light orange coloured phlogopite. Less than 5% of the flakes have split edges.

From biotite-pyroxene granulite.
(38 C) Byam Martin Mountains, Bylot Island, District of Franklin, 73°15'N, 78°06'W. Sample JD-177/1-68, collected and interpreted by G.D. Jackson.

The rock is a massive, dark greenish grey biotite-clinopyroxene granulite with lesser amounts of sphene-leucoxene, muscovite, hornblende and opaques. It is probably a metamorphosed basic or ultrabasic rock.

See GSC 70-67 for interpretation.

GSC 70-53 Biotite, K-Ar age 1685 ± 53 m.y.

K = 6.60%, $^{40}Ar/^{40}K$ = 0.1592, radiogenic Ar = 98%.
Concentrate: Brownish orange biotite with a high chlorite content. X-ray examination indicates 26% chlorite, but it is not distinguishable optically. This may indicate that the mica and chlorite are very finely intermixed. There is also a trace of attached muscovite contamination.
From garnetiferous gneiss.
(38 B) Pond Inlet, Baffin Island, District of Franklin, 72°42'10"N, 77°58'15"W. Sample JD-18-67, collected and interpreted by G.D. Jackson.

District of Franklin

This rock is pale grey, medium-grained, equigranular, foliated quartz-feldspar-garnet-biotite gneiss with accessory magnetite, muscovite, apatite and zircon. The plagioclase has bent twin lamellae and is slightly altered to kaolin-sericite. Biotite shows only a trace of alteration to chlorite in thin section examination.

See GSC 70-67 for interpretation.

GSC 70-54 Biotite, K-Ar age 1675 ± 55 m.y.

K = 7.81%, $^{40}Ar/^{40}K$ = 0.1578, radiogenic Ar = 97%.
Concentrate: Clean, light brownish green biotite with less than 5% hornblende contamination and no visible alteration. A few of the flakes have split edges.

From migmatite.
(37 G) Eight miles south of head of North Arm, Baffin Island, District of Franklin, 71°44'20"N, 76°21'00"W. Sample JD-234/3-68, collected and interpreted by G.D. Jackson.

The sample is a grey, medium-grained migmatite or granodioritic gneiss consisting of quartz, plagioclase, microcline, myrmekite, microperthite, hornblende and biotite, with accessory apatite, zircon and magnetite. The biotite and hornblende are unaltered but occur in close association and contain inclusions of the accessories.

See GSC 70-67 for interpretation.

GSC 70-55 Biotite, K-Ar age 1795 ± 55 m.y.

K = 7.61%, $^{40}Ar/^{40}K$ = 0.1752, radiogenic Ar = 99%.
Concentrate: Light greenish brown biotite with about 8% chlorite as an alteration product of the mica. Some of the flakes are darker brown and have split edges.

From granitoid gneiss.
(37 E) Fourteen miles west-northwest of King Lake, Baffin Island, District of Franklin, 70°13'30"N, 75°37'15"W. Sample JD-54/2-68, collected and interpreted by G.D. Jackson.

The rock is a grey-pink, medium-grained, porphyroblastic (K-feldspar), foliated granitoid gneiss consisting of quartz, microcline, plagioclase, hornblende, biotite and myrmekite, with accessory magnetite, sphene, apatite and zircon. The hornblende and biotite are closely associated and the biotite shows slight alteration to chlorite.

See GSC 70-67 for interpretation.

District of Franklin

GSC 70-56 Biotite, K-Ar age 1675 ± 52 m.y.

K = 7.19%, $^{40}Ar/^{40}K$ = 0.1582, radiogenic Ar = 99%.
Concentrate: Light greenish brown biotite with about 7% chlorite as an alteration product of the mica. Other impurities consist of less than 2% muscovite and hornblende. Some of the biotite flakes have split edges.

From migmatite.
(37 H) Eight miles southwest of head of Cambridge Fiord, Baffin Island, District of Franklin, 71°08'50"N, 75°23'15"W. Sample JD-244-68, collected and interpreted by G.D. Jackson.

The rock is a pale to medium-grey, medium grained, layered, quartz-plagioclase-biotite-hornblende migmatite with alternating, discontinuous felsic and mafic layers. Accessory minerals include microcline, sphene, apatite, pyrite, zircon, allanite and epidote. The hornblende is fresh, but the biotite is slightly altered to chlorite.

See GSC 70-67 for interpretation.

GSC 70-57 Biotite, K-Ar age 1685 ± 50 m.y.

K = 6.80%, $^{40}Ar/^{40}K$ = 0.1594, radiogenic Ar = 90%.
Concentrate: Brownish biotite with about 20% chloritization. Most of the mica flakes contain dark pleochroic haloes.

From phyllite.
(37 A) Longstaff Bluff, central western coast of Baffin Island, District of Franklin, 68°57'N, 75°15'W. Sample JD-9/2-67, collected and interpreted by G.D. Jackson.

This is a grey, very fine grained, foliated and slightly crenulated schistose phyllite consisting of quartz, biotite, muscovite, plagioclase, chlorite and accessory sphene, zircon, magnetite and goethite-hematite. Outlines of original "porphyroblasts" are now filled by a very fine aggregate of the rock-forming minerals.

See GSC 70-67 for interpretation.

GSC 70-58 Biotite, K-Ar age $\begin{matrix}1660 \pm 55 \text{ m.y.} \\ 1690 \pm 55 \text{ m.y.}\end{matrix}$

K = $\begin{matrix}8.00\% \\ 8.00\%'\end{matrix}$ $^{40}Ar/^{40}K$ = $\begin{matrix}0.1556 \\ 0.1599'\end{matrix}$, radiogenic Ar = $\begin{matrix}99\% \\ 99\%.\end{matrix}$
Concentrate: Clean, olive-brown biotite with a trace of hornblende impurity.

District of Franklin

From migmatite.
(38 A) Cape Coutts, northern Baffin Island, District of Franklin, 72°16'N, 74°57'W. Sample JD-16-67, collected and interpreted by G.D. Jackson.

See GSC 70-59 for description and GSC 70-67 for interpretation.

GSC 70-59 Hornblende, K-Ar age 1785 ± 60 m.y.

K = 1.16%, $^{40}Ar/^{40}K$ = 0.1739, radiogenic Ar = 98%.
Concentrate: Clean, olive-green to dark green pleochroic hornblende with no visible impurities or alteration.

From migmatite.
(38 A) Details as for GSC 70-58.

The rock is a lit-par-lit migmatite with alternating mesocratic and leucocratic layers. It consists mainly of oligoclase-andesine, biotite, quartz, hornblende, microcline, apatite, and accessory zircon.

See GSC 70-67 for interpretation.

GSC 70-60 Muscovite, K-Ar age 1680 ± 55 m.y.

K = 8.77%, $^{40}Ar/^{40}K$ = 0.1589, radiogenic Ar = 99%.
Concentrate: Clean, clear muscovite with only trace impurities of quartz. Some flakes have a yellow-brown colour on their edges.

From pegmatite.
(37 A) Fox B Station, Baffin Island, District of Franklin, 68°36'N, 73°16'W. Sample JD-5/2-67, collected and interpreted by G.D. Jackson.

White, medium to coarse pegmatite with graphic texture and consisting of albite, quartz, tourmaline, muscovite and a trace of chlorite.

See GSC 70-67 for interpretation.

GSC 70-61 Biotite, K-Ar age 1735 ± 55 m.y.

K = 7.19%, $^{40}Ar/^{40}K$ = 0.1662, radiogenic Ar = 99%.
Concentrate: Relatively clean, brownish orange biotite with about 10% chlorite. Most of the mica flakes contain pleochroic haloes.

District of Franklin

From metasiltstone.

(37 A) Fox B Station, central west coast of Baffin Island, District of Franklin, 68°36'N, 73°16'W. Sample JD-5/1-67, collected and interpreted by G.D. Jackson.

This is a grey, thin to thick bedded, fine-grained metasiltstone consisting of quartz, albite, red-brown biotite, and accessory apatite.

See GSC 70-67 for interpretation.

GSC 70-62 Biotite, K-Ar age 1690 ± 54 m.y.

K = 7.98%, $^{40}Ar/^{40}K$ = 0.1599, radiogenic Ar = 98%.
Concentrate: Light brown biotite with no chlorite. A few of the mica flakes have split edges and some are a little darker brown in colour.

From granulite.

(37 H) Dexterity Fiord, Baffin Island, District of Franklin, 71°15'N, 73°11'W. Sample JD-270/2-68, collected and interpreted by G.D. Jackson.

The rock is medium grained, light grey-green with black mafic blotches up to 15 mm across. It consists mainly of plagioclase, biotite, green hornblende and quartz, with minor apatite, clinopyroxene, opaques and zircon.

See GSC 70-67 for interpretation.

GSC 70-63 Biotite, K-Ar age 1665 ± 53 m.y.

K = 8.13%, $^{40}Ar/^{40}K$ = 0.1564, radiogenic Ar = 99%.
Concentrate: Clean, unaltered, light brownish orange biotite. Some flakes have split edges.

From granulite.

(37 H) East side of Dexterity Fiord, Baffin Island, District of Franklin, 71°10'20"N, 73°06'15"W. Sample JDD-229/4-68, collected by A. Davidson, interpreted by G.D. Jackson.

The rock is a grey-green, medium-grained, layered, foliated granulite with medium-fine mafic and medium-coarse feldspathic layers. Essential minerals are plagioclase, antiperthite, biotite, clinopyroxene, hypersthene and quartz. Accessory minerals are apatite, zircon and magnetite.

See GSC 70-67 for interpretation.

District of Franklin

GSC 70-64 Biotite, K-Ar age 1625 ± 52 m.y.

K = 7.56%, $^{40}Ar/^{40}K$ = 0.1511, radiogenic Ar = 98%.
Concentrate: Relatively clean, unaltered, light greenish brown biotite. Hornblende contamination amounts to less than 2%. Some of the mica flakes have split edges.

From migmatite.
(27 F) Six miles southwest of head of Walker Arm, Baffin Island, District of Franklin, 70°13'00"N, 71°58'00"W. Sample JD-13-67, collected and interpreted by G.D. Jackson.

The sample is from a grey, medium-grained, foliated quartz-plagioclase-microcline-amphibole-biotite migmatite with accessory myrmekite, muscovite, apatite, sphene and magnetite. The feldspars are slightly altered to kaolin-sericite, but the biotite and hornblende are unaltered.

See GSC 70-67 for interpretation.

GSC 70-65 Muscovite, K-Ar age 1810 ± 56 m.y.

K = 7.07%, $^{40}Ar/^{40}K$ = 0.1775, radiogenic Ar = 99%.
Concentrate: Relatively clean, clear muscovite with less than 2% free feldspar impurity. Some of the mica flakes have yellow-stained split edges.

From pegmatite.
(27 C) Eighteen miles west of head of Clyde Inlet, Baffin Island, District of Franklin, 69°52'40"N, 71°06'00"W. Sample JDD-315/5-68, collected by A. Davidson, interpreted by G.D. Jackson.

The sample is from a muscovite pegmatite within a mass of marble and may be considered as a "sweat" product.

See GSC 70-67 for interpretation.

GSC 70-66 Biotite, K-Ar age 1665 ± 80 m.y.

K = 7.69%, $^{40}Ar/^{40}K$ = 0.1563, radiogenic Ar = 98%.
Concentrate: Relatively clean, greenish brown biotite with about 2% chlorite as free flakes.

From gneiss.
(27 D) Henry Kater Peninsula, central east coast of Baffin Island, District of Franklin, 69°10'N, 67°13'W. Sample JD-11/1-67, collected and interpreted by G.D. Jackson.

District of Franklin

A medium-grained, indistinctly laminated, equigranular, migmatic paragneiss consisting of quartz, oligoclase-andesine, microcline, biotite and accessory apatite and magnetite.

See GSC 70-67 for interpretation.

GSC 70-67 Biotite, K-Ar age 1665 ± 55 m.y.

K = 7.86%, $^{40}Ar/^{40}K$ = 0.1564, radiogenic Ar = 99%.
Concentrate: Clean, olive-buff biotite with no visible impurities or alteration, though there is some variation in colour intensity.

From pegmatite.
(27 D) Henry Kater Peninsula, central east coast of Baffin Island, District of Franklin, 69°10'N, 67°13'W. Sample JD-11/2-67, collected and interpreted by G.D. Jackson.

The sample is from a coarse, pink and white pegmatite consisting of quartz, plagioclase, muscovite, biotite, microcline and myrmekite.

These ages (GSC 70-52 through GSC 70-67) have been determined for samples of metamorphic rocks and associated pegmatites and are consistent with placing these rocks in the Churchill Tectonic Province. While these rocks have undoubtedly been metamorphosed and deformed during the Hudsonian Orogeny, the dates themselves probably indicate the time when these rocks were regionally uplifted and cooled below the temperature of radiogenic closure immediately following the orogeny, possibly during a period of widespread epeirogenic uplift.

At the same time geological investigations in north-central Baffin Island (Jackson, 1966, 1969) have indicated the presence of pre-Hudsonian gneisses. This conclusion has been substantiated by two Rb/Sr isochrons determined for the writer by the Geochronological Laboratories of the Geological Survey of Canada. A suite of samples collected in the Mary River area (71°27'N, 79°45'W) gave an isochron of 2341 ± 145 m.y., and a suite of samples collected from a gneiss dome near the McBeth River (69°28'N, 70°35'W) gave an isochron of 2285 ± 150 m.y. These dates are believed to represent partial updating of Archean rocks during the Hudsonian Orogeny. It is concluded that pre-Hudsonian rocks cannot be identified by using K-Ar age dating techniques in north-central Baffin Island.

References

Jackson, G.D.
1966: Geology and mineral possibilities of the Mary River region, northern Baffin Island; Can. Mining J., vol. 87, No. 6, pp. 57-61.

1969: Reconnaissance of north-central Baffin Island; in Report of Activities, April to October 1968, Geol. Surv. Can., Paper 69-1, Pt. A, pp. 171-176.

District of Franklin

GSC 70-68 Whole rock, K-Ar age 504 ± 73 m.y.

K = 0.49%, $^{40}Ar/^{40}K$ = 0.0338, radiogenic Ar = 76%.
Concentrate: Crushed whole rock.

From diabase.
(27 G) North coast of Sillem Island, Gibbs Fiord, Baffin Island, District of Franklin, 71°02'10"N, 71°43'45"W. Sample JDB-385/3-68, collected by S.L. Blusson, interpreted by G.D. Jackson.

The rock is a grey, medium-grained, subophitic diabase consisting of plagioclase, clinopyroxene, hornblende and magnetite, with accessory quartz, biotite, apatite and myrmekite. The diabase is considered to be unmetamorphosed.

The date of 504 ± 73 m.y. approximates the age of intrusion of the diabase.

District of Mackenzie

(GSC No. 70-69 to 70-74)

GSC 70-69 Whole rock, K-Ar age 1835 ± 220 m.y.

K = 0.28%, $^{40}Ar/^{40}K$ = 0.1816, radiogenic Ar = 95%.
Concentrate: Crushed whole rock.

From gabbro.
(85 J) North of Yellowknife, District of Mackenzie, 62°42'N, 114°13'W. Map-unit 10, GSC Map 868A. Sample FA-4-68, collected and interpreted by W.F. Fahrig.

This sample was run to recheck sample FA-255-62 (GSC 63-54)* for which an age of 2185 m.y. was reported. See comment on sample GSC 70-70. The 1835 ± 220 m.y. date is thought to be the more reliable K-Ar age.

*See Geol. Surv. Can. Paper 64-17, Part 1, 1965.

GSC 70-70 Whole rock, K-Ar age 1595 ± 160 m.y.

K = 0.75%, $^{40}Ar/^{40}K$ = 0.1469, radiogenic Ar = 95%.
Concentrate: Crushed whole rock.

From diabase.
(76 D) Southeast of Lac de Gras, District of Mackenzie, 64°23'N, 110°05'W. Map-unit 7, GSC Map 977A. Sample FA-3-68, collected and interpreted by W.F. Fahrig.

This determination was a recheck of sample FA-244-62 for which an age of 2105 m.y. was reported (GSC 63-53)*. Estimates of laboratory error were not given in the original analysis, however the present result is considered to be a more reliable K-Ar age for this material. (It will be noted, however, that the location is different and the sample material is different as indicated by the higher potassium content.)

*See Geol. Surv. Can. Paper 64-17, Part 1, 1965.

GSC 70-71 Biotite, K-Ar age 1815 ± 55 m.y.

K = 7.94%, $^{40}Ar/^{40}K$ = 0.1782, radiogenic Ar = 99.7%.
Concentrate: Clean, light yellowish olive biotite with no visible impurities.

From granodiorite.
(86 H) Central south shore of 3-mile-long, narrow lake south of Point Lake, District of Mackenzie, 65°04'N, 113°03'W. Map-unit A (Massive Granitic Rocks), GSC Paper 66-24. Sample BK-66-748, collected and interpreted by H.H. Bostock.

District of Mackenzie

The sample is of medium-grained, buff-grey, equigranular granodiorite. Major minerals are calcic oligoclase, quartz, and biotite; minor minerals are hornblende, epidote, microcline, and sphene; accessory minerals are muscovite, apatite, allanite, and zircon.

The sample dated is from granodiorite in the core of a northward plunging antiformal zone structurally below volcanic rocks of the Yellowknife Group at Point Lake. An heterogeneous phase of the granitic body exists along its margins and is thought to be unconformably overlain by conglomerate and some volcanic rocks belonging to the upper part of the volcanic succession on the shores of Point Lake (as originally described by Stockwell, 1933). Remnants of volcanic rocks within the heterogeneous phase of the granodiorite are thought to be related to older basic volcanic rocks on the flanks of the antiformal zone. These observations suggest that the granodiorite was emplaced and unroofed between two phases of basic volcanism both currently assigned to the Yellowknife Group in this area, an hypothesis that is consistent with data on sphenes and zircons from the granodiorite which indicate an Archean age of approximately 2700 m.y. for both of these minerals.

Two K-Ar muscovite ages on separate granodiorite boulders from the conglomerate possibly derived from the heterogeneous granodiorite zone, are 2660 ± 75 and 2560 ± 75 m.y. Muscovite in these boulders is thought to be of secondary origin having developed along with quartz, albite, muscovite, and chlorite in the conglomerate matrix. These dates indicate that intrusion of the granodiorite and metamorphism of the conglomerate probably belong to the same tectonic cycle and insofar as they may encompass all the events which occurred during development of the unconformity between volcanic phases, they suggest that this unconformity may not have been a major one.

The K-Ar biotite data provide an estimate of the time at which biotite cooled below approximately 100 to 150 degrees centigrade (Damon in Hamilton and Farquhar, 1968). It is not known however, whether any event of structural significance can be attached to the biotite age, 1815 ± 55 m.y., in the area about Point Lake. Similar biotite ages have been obtained from granitic rocks near Yamba Lake (Fraser in Wanless et al., 1965) and in the southeast part of the Fort Enterprise area (Fraser in Lowdon, 1960); however biotite ages from metasediments belonging to the Yellowknife Group, a knotted schist (cordierite-andalusite) and a migmatite (cordierite-sillimanite), between Yamba Lake and the granodiorite reported here are significantly older (2275 ± 60 m.y. and 2125 ± 60 m.y. respectively). It seems unlikely therefore that the biotite ages of these rocks reflect simple epirogenic uplift. Decreasing K-Ar biotite age with increasing metamorphic grade within the Yelloknife metasediments, and lowest ages characteristic of the granitic rocks, in this area may suggest that a higher geothermal heat flux existed in granitic areas through most of the Aphebian Era and might be responsible for the late onset of argon retention by biotite. On the other hand the data are too limited to detect more complex local changes in low level thermal activity that may have occurred in this region during the Aphebian Era.

District of Mackenzie

References

Damon, P.E.
1968: A comparison of the isotopic mineral age variations and petrologic changes induced by contact metamorphism; in E.I. Hamilton and R.H. Farquhar, Radiometric Dating for Geologists, Interscience, John Wiley & Sons, 1968.

Lowdon, J.A.
1960: Age determinations by the Geological Survey of Canada, Report 1, Isotopic ages; Geol. Surv. Can., Paper 60-17, pp. 1-57.

Stockwell, C.H.
1933: Great Slave Lake-Coppermine River area, N.W.T.; Geol. Surv. Can., Sum. Rept. 1932, Pt. C, pp. 37-63.

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

GSC 70-72 Biotite, K-Ar age 2125 ± 60 m.y.

K = 7.62%, $^{40}Ar/^{40}K$ = 0.2300, radiogenic Ar = 98%.
Concentrate: Orange-brown biotite with about 5% chloritization. Some of the mica flakes have pleochroic haloes and some have split edges. There is less than 2% muscovite contamination.

From migmatite.
(86 H) West shore of long, intricate bay at east end of Point Lake, District of Mackenzie, 65°09.5'N, 112°09.5'W. Map-unit A (hybrid rocks), GSC Paper 66-24. Sample BK-64-491, collected and interpreted by H.H. Bostock.

The sample is from a biotite-rich band in medium- to fine-grained grey migmatite derived from sediments of the Yellowknife Group in the Point Lake area. Major minerals are calcic oligoclase, quartz, biotite and cordierite; minor minerals are muscovite and sillimanite; accessory minerals are zircon and opaques.

The age determined represents an estimate of the time at which the rock cooled below 100 to 150 degrees centigrade (Damon in Hamilton and Farquhar, 1968 (see GSC 70-71)) and retention of radiogenic argon began. The possible significance of this date (2125 m.y.) is discussed under GSC 70-71.

GSC 70-73 Hornblende, K-Ar age 1750 ± 60 m.y.

K = 1.12%, $^{40}Ar/^{40}K$ = 0.1688, radiogenic Ar = 94%.
Concentrate: Pleochroic light green to light brown hornblende with about 5% free chlorite contamination.

District of Mackenzie

From gneiss.

(75 K) North side of Magpie Lake and about 15 miles south of the McDonald Fault, District of Mackenzie, 62°27'38"N, 108°52'05"W. Map-unit 3, GSC Map 1123A (Reliance). Sample RM-172-46-65, collected and interpreted by E.W. Reinhardt.

This sample is a grey, foliated, medium-grained gneiss containing 15 per cent reddish brown biotite, 10 per cent green hornblende, 23 per cent quartz, and 47 per cent plagioclase of composition An_{37}. Accessory minerals include apatite, zircon, tourmaline, opaque oxides and sulphides. The hornblende is slightly altered to chlorite and clinozoisite and biotite shows about 3 per cent chloritization. Foliation is mainly defined by tabular plates of biotite and lenticular aggregates of quartz. Apart from medium strain in the quartz and slight raggedness of biotite along its short dimensions, evidence of cataclastic deformation is lacking, the texture being essentially mosaic.

The gneiss belongs to a complex of highly migmatized metasediments and metavolcanics that occur along the south side of the McDonald Fault. Although the migmatization and primary metamorphism of these rocks reflects a plutonic environment, they also show in varying degrees evidence of lower intensity retrograde metamorphism probably related to penetrative deformation associated with movements of the McDonald Fault System.

The hornblende was dated in anticipation of an older age believed to be more representative of the time of plutonic migmatization and metamorphism. It was considered that the influence of deformation might be gradationally less proceeding southeast from the McDonald Fault with a comparable gradation in K-Ar dates. A previous K-Ar biotite age of 1835 ± 60 m.y. (GSC 63-80)* from crushed granitic gneiss collected on Dion Lake, 17 miles to the west of the current locality differs significantly from another previous K-Ar biotite age of 2460 m.y. (GSC 61-82)* from biotite-hornblende paragneiss from Nelson Lake, 30 miles southeast of the current locality. The latter date (2460 m.y.) has been interpreted by C.H. Stockwell as a survival value of Kenoran metamorphism and the present interpreter reasoned that a similar survival value might be obtained from a relatively undeformed gneiss closer to the McDonald Fault where Hudsonian values are typical. It appears that the present hornblende age of 1750 ± 60 m.y. is no exception and reflects post-plutonic deformational and retrograde effects discussed in previous interpretations by Reinhardt (GSC 66-79*, GSC 66-80* and GSC Paper 69-21).

*See Geol. Surv. Can. Papers 62-17 (1963), 64-17, Part 1 (1965), and 67-2A (1968).

GSC 70-74 Whole rock, K-Ar age 1560 ± 118 m.y.

K = 1.63%, $^{40}Ar/^{40}K$ = 0.1417, radiogenic Ar = 95%.
Concentrate: Crushed whole rock.

District of Mackenzie

From diabase.

(76 O) On mainland approximately 8 miles east of Kanuyak Island, District of Mackenzie, 67°25'N, 107°34'W. See Map-unit 20, GSC Map 45-1963 (Fraser). Sample FDW 113A-62, collected by M. Williams, interpreted by J.A. Fraser.

The sample, a grey, brown weathering, massive, aphanitic rock containing scattered phenocrysts of plagioclase, was collected from the chilled margin of one of several similar dykes of diabase that trend north-northwest to north and intrude granite and gneiss of the Slave Province in the region east of Bathurst Inlet. The sample is apparently composed chiefly of plagioclase and clinopyroxene but exact identification of the mineral constituents is not possible in thin section because of the fineness of grain. A specimen of medium-grained diabase from the central part of the same dyke comprises andesine (55%), clinopyroxene (20%), serpentine (20%), and magnetite (5%).

The age (1560 m.y.) suggests that the dyke sampled represents a swarm that is significantly older than the Mackenzie dykes which are also common in this region. The latter trend north-northeast and are known to yield ages of about 1200 m.y.

District of Keewatin

(GSC No. 70-75)

GSC 70-75 Biotite, K-Ar age 710 ± 31 m.y.

$K = 6.76\%$, $^{40}Ar/^{40}K = 0.0505$, radiogenic Ar = 99%.
Concentrate: Brownish orange biotite with a trace of free muscovite impurity. Some of the biotite flakes are darker brown than most and have pitted surfaces. Some flakes carry tiny opaque inclusions.

From biotite gneiss.
(37 H) District of Keewatin, 71°02'N, 75°20'W. Sample FA-6-68, collected and interpreted by W.F. Fahrig.

The biotite was extracted from country rock gneisses in contact with a dyke which is one of a swarm running down the main axis of Baffin Island. These dykes are believed to be 650-700 m.y. old so the present biotite age is in good agreement.

Manitoba

(GSC No. 70-76 to 70-78)

GSC 70-76 Biotite, K-Ar age 2610 ± 70 m.y.

K = 7.72%, $^{40}Ar/^{40}K$ = 0.3296, radiogenic Ar = 99%.
Concentrate: Light yellowish olive biotite with about 13% free chlorite contamination.

From quartz monzonite/granodiorite.
(52 M) Near Sasaginnigak Lake, Manitoba, 51°35'N, 95°35'W. Map-unit 7, GSC Map 428A (Carroll Lake). Sample EEA-1, collected and interpreted by I.F. Ermanovics.

The rock is coarse-grained, buff pink to white, massive to weakly foliated and consists mainly of plagioclase, alkali feldspar, quartz, biotite and altered amphibole.

This granodioritic pluton is distinguished from others in the area by its large size (700 square miles) and abundant textural and compositional variation (Ermanovics, 1970, GSC Paper 69-42, map-units 12 to 15). Compositionally the plutonic mass is intermediate to the early diapiric granodiorite and diorite bodies (K-Ar age, 2670 m.y., GSC 60-88 and 89, GSC Paper 61-17, pp. 52 and 53) and late leuco-quartz monzonites in the area (K-Ar age, 2440 m.y., GSC 60-87, GSC Paper 61-17, p. 52); it intrudes the former and in turn is intruded by the latter. More K-Ar ages for late quartz monzonite bodies are required for southeastern Manitoba to establish the extent of 'Kenoran' plutonism and to differentiate it from earlier (Archean?) plutonism. See discussion following GSC 70-77.

GSC 70-77 Biotite, K-Ar age 2445 ± 70 m.y.

K = 8.04%, $^{40}Ar/^{40}K$ = 0.2928, radiogenic Ar = 99%.
Concentrate: Clean, greenish brown biotite with no visible impurities.

From granodiorite gneiss.
(53 D) Island near northwest shore of Charron Lake, Manitoba, 52°46'15"N, 95°14'00"W. Map-unit 4, Berens River-Deer Lake map-area. Sample EE 69-1027B, collected and interpreted by I.F. Ermanovics.

The rock is dark grey, medium grained, sheared, and contains pink alkali feldspar augen. The main constituent minerals are plagioclase, alkali feldspar, quartz, biotite, relict hornblende and minor sphene, magnetite, apatite, epidote, and traces of muscovite and zircon.

The sample is of granodiorite from a major sheared zone and is 20 feet from a zone containing veins of flinty crushed rocks (GSC Paper 70-29).

The green-brown biotite is recrystallized mica and provides an age for the shearing in these rocks. Biotite from a paragneiss inclusion in granodiorite from without the sheared zone (3,000 feet from present locality, sample 60-86, GSC Paper 61-17, p. 51) gives an age of 2600 m.y. The

shearing of these pre-Kenoran rocks is thus coincident with other Kenoran events in the area e.g. quartz monzonite intrusion (GSC 60-87, GSC Paper 61-17, p. 52, K-Ar age 2440 m.y.) and metamorphic biotite and muscovite from retrograded schists within greenstones at Manigitagan (GSC 61-128 and 129, GSC Paper 62-17, p. 74, K-Ar age, ca. 2445 m.y.).

A tentative working hypothesis, utilizing K-Ar ages of groups of metasedimentary-volcanic rocks and intrusive igneous rocks from southeastern Manitoba and the Western Superior Structural Province, comprises a K-Ar age pattern in the range of 2670 to 2440 m.y. age. These values are increased by 100 m.y. when Rb-Sr isochrons are used to date similar events (if one uses an ^{87}Rb decay constant of 1.39×10^{-11} yr^{-1}); the range remains the same. So far, only igneous intrusive rocks yield the older K-Ar ages and because these rocks intrude the metasediments, the metasediments are inferred to be older. The reason for this dichotomous age relationship may be that retrograde metamorphism or simply a second, milder metamorphism - the Kenoran event (ca. 2450 m.y.) has produced a selective thermal overprint confined largely to the metavolcanic-sedimentary belts. Additionally, late leuco-quartz monzonite intrusions following the Kenoran metamorphism form discrete bodies, as well as remobilizing alkalis and permeating older plutons to produce younger K-Ar ages in them.

The main inferred orogeny (Archean Orogeny?) and metamorphism must be represented by the minimum age, ca. 2700 m.y. given by the plutons of that age. This age is a minimum for the metamorphism based on the assumption that plutonism generally follows the peak of metamorphism in orogeny. No metavolcanic-sedimentary rocks have as yet yielded explicit dates of that event by K-Ar methods and in all probability none should be forthcoming.

GSC 70-78 Biotite, K-Ar age 1725 ± 55 m.y.

K = 6.70%, $^{40}Ar/^{40}K$ = 0.1653, radiogenic Ar = 99%.
Concentrate: Buff-coloured biotite with about 5% free chlorite and 5% fine-grained opaque inclusions as impurities. Some of the mica flakes contain pleochroic haloes and segregations of "iron".

From paragneiss.

(53 N) On Fox River 9 miles west of its junction with Stupart River, Manitoba, 55°58.5'N, 93°39'W. Part of Operation Winisk. Sample 198 BK/67-1 collected and interpreted by H.H. Bostock.

The sample is of medium-grained, dark grey weathering, dark grey, hornblende-biotite-plagioclase gneiss from the first outcrop on Fox River upstream from Paleozoic cover in which biotite suitable for dating was observed.

The age represents the time of cooling of the rock below the point of argon retention and is characteristic of the Churchill Province; however similar ages are known farther south within the northwestern part of the Superior Province, Cross Lake subprovince (see Bell in Wanless et al., 1968).

Manitoba

Reference

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 67-2A, Sample 66-109, p. 92.

Ontario

(GSC No. 70-79 to 70-84)

GSC 70-79 Whole rock, K-Ar age 1055 ± 90 m.y.

K = 1.46%, $^{40}Ar/^{40}K$ = 0.0827, radiogenic Ar = 96%.
Concentrate: Crushed whole rock.

From diabase.
(43 K) Four miles west-northwest of Sutton Narrows, Ontario, 54°27'N, 84°47'W. Sample 109 BK/67-1, collected and interpreted by H.H. Bostock.

The sample is of dark grey-green, fine-grained, equigranular diabase, and represents the sill which intrudes sediments of probable Aphebian age at Sutton Ridges.

Elongation of the Sutton Ridges sill in a northwesterly direction suggests the possibility that it might be correlative to the Mackenzie dyke swarm (Fahrig et al., 1965)*. The sill however, might be of Aphebian or younger Precambrian age based on its cross-cutting relationships. Although the whole rock method applied to fine-grained diabase may be expected to yield a minimum age only, it was anticipated that an age significantly greater than 1300 m.y. would exclude the possibility of correlation with the Mackenzie dyke swarm. The age determined is inconclusive so far as this problem is concerned.

Reference

Fahrig, W.F., Gaucher, E.H. and Larochelle, A.
1965: Palaeomagnetism of diabase dykes in the Canadian Shield; Can. J. Earth Sci., vol. 2, No. 4, pp. 278-298.

GSC 70-80 Whole rock, K-Ar age 1455 ± 170 m.y.

K = 0.43%, $^{40}Ar/^{40}K$ = 0.1284, radiogenic Ar = 90%.
Concentrate: Crushed whole rock.

From diabase.
(43 G) Eight miles northeast of Nowashe Lake, Ontario, 53°54'N, 83°14'W. Sample 93 BK/67-11, collected and interpreted by H.H. Bostock.

The sample is of mottled, olive and dark grey-green, medium- to fine-grained, equigranular diabase, and represents a sill which intrudes sediments of probable Aphebian age near Nowashe Lake.

Diabase bodies west of James Bay commonly produce northwesterly trending outcrop patterns. These suggested that the diabase might be related to the Mackenzie dyke swarm (Fahrig et al., 1965)*. Sediments into which these diabase bodies are emplaced indicated that the intrusions are of Aphebian or younger Precambrian age. Although the whole rock method applied to fine-grained diabase may be expected to yield a minimum age only, it was

anticipated that an age significantly greater than 1300 m.y. would exclude the possibility of correlation with the Mackenzie dyke swarm. The age determined is inconclusive so far as this problem is concerned.

Reference

Fahrig, W.F., Gaucher, E.H. and Larochelle, A.
1965: Palaeomagnetism of diabase dykes in the Canadian Shield; Can. J Earth Sci., vol. 2, No. 4, pp. 278-298.

GSC 70-81 Actinolite, K-Ar age 1400 ± 116 m.y.

K = 0.03%, $^{40}Ar/^{40}K$ = 0.1217, radiogenic Ar = 25%.
Concentrate: Clean concentrate of light green actinolite with no visible impurities. The amphibole forms long prismatic crystals.

From amphibole-rich shear zone.
(41 P) 1,000-foot level, Siscoe Metals of Ontario Mine, Gowganda, Ontario, 47°40'30"N, 80°44'30"W. Fault in Nipissing Diabase, Ont. Dept. Mines Map P-374. Sample JF 69-GHF-1, collected and interpreted by J.L. Jambor.

The sample consists of medium-grained actinolite, pinkish axinite, and pale green epidote forming a 1- to 2-inch-thick seam in the Glory Hole fault, a major post-ore thrust which cuts the Nipissing diabase sheet on the western side of the Miller Lake diabase basin, Gowganda. The sample was selected for dating in order to obtain a minimum age for the silver-bearing ore veins typical of those throughout the Cobalt-Gowganda mining camp.

The age of 1400 m.y. obtained for the sample represents the period of fault filling and youngest major movement. This age coincides with the 1465 ± 168 m.y. age obtained for post-ore quartz diabase dyke intrusion (see GSC 70-82).

GSC 70-82 Whole rock, K-Ar age 1465 ± 168 m.y.

K = 0.42%, $^{40}Ar/^{40}K$ = 0.1295, radiogenic Ar = 90%.
Concentrate: Crushed whole rock.

From quartz diabase.
(41 P) Gowganda 8513B drift, 850 level, Siscoe Mine, Ontario, 47°40'30"N, 80°44'30"W. Ont. Dept. of Mines Map P-374. Sample JF 69-8513B, collected and interpreted by J.L. Jambor.

The sample dated is the absolute chilled margin of a northeast striking quartz diabase dyke which intrudes Nipissing diabase close to the No. 6 shaft of the Siscoe Mine in the Miller Lake basin at Gowganda. The dyke is shown on maps by Moore (1956), and McIlwaine (1966, 1969). An extensive petrographic description of the dyke is given by Sangster (1964).

The dyke was generally considered to be post-ore, but Scott (1964) concluded that it is pre-ore. On the assumption that the dyke is of the Abitibi-type described by Fahrig and Wanless (1963), the period of silver mineralization therefore occurred less than 1230 m.y. ago.

On the 850 level of the Siscoe Mine, numerous apophyses of the dyke occur close to and in direct contact with the silver ore veins. Scott's (1964) observation that ore and gangue minerals in places cut the dyke was verified. In such cases, however, the veinlets are less than 1 cm and usually no more than 1 or 2 mm wide. Detailed laboratory examination indicates that the veinlets are material remobilized from the main ore vein. This conclusion is based on the following observations: (1) Normal wall alteration accompanies the main ore vein where it is in contact with Nipissing diabase, but such alteration is absent in the quartz diabase dyke. The dyke matrix has undergone soda metasomatism, but clinopyroxene phenocrysts persist to the chilled edge and the normal chloritized alteration is absent. (2) The dyke chill contacts are identical regardless of whether the contact is with Nipissing diabase or the ore veins. This would not be the case if the dyke was pre-ore. (3) The dyke has thermally metamorphosed the gangue minerals in the ore vein. The spheralitic texture in the vein is unlike that seen anywhere else in the Cobalt-Gowganda area, and the sphenalites consist of microscopic clinopyroxene aggregates.

The reported age is that of dyke intrusion. This places the period of Ag-Ni-Co ore formation between approximately 2100 (Nipissing) and 1465 m.y.

References

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1966: Nicol Township; Ont. Dept. Mines; Prelim. Geol. Map P-374.

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1964: Silver mineralization in Number 13 vein system, Siscoe Metals of Ontario, Gowganda; unpubl. M.Sc. thesis, Univ. Western Ontario.

Ontario

GSC 70-83 Hornblende, K-Ar age 2515 ± 72 m.y.

$K = 0.34\%$, $^{40}Ar/^{40}K = 0.3079$, radiogenic AR = 98%.
Concentrate: Clean, non-pleochroic green hornblende with minor chlorite on the edges of some crystals.

From quartz monzonite.
(31 M) One-quarter mile east of eastern boundary of claim T 26 738, 20 miles southeast of Cobalt, Ontario, 47°13'40"N, 79°39'30"W. Map-unit 3e, Ont. Dept. Mines Map P-289. Sample JF-69S-SL-U3, collected and interpreted by J.L. Jambor.

The sample is from McIlwaine's (1968) quartz monzonite unit 3e, one of several Archean granitic plutons which intrude older metavolcanics in the Cobalt-South Lorrain area. Among this group of plutons on the same map-sheet is a granodiorite which was previously dated (Wanless et al., 1967) at 1975 ± 175 m.y.

The age of 2515 ± 72 m.y. obtained for the present sample is considered to represent the date of intrusion and crystallization of the pluton. Although attempts to obtain biotite concentrates for dating of the Lorrain ("Algoman") granite to the north at Cobalt were unsuccessful, it is worth noting that the Round Lake batholith between Cobalt and Kirkland Lake has been dated at 2570 m.y. (Aldrich and Wetherill, 1960) and 2605 m.y. (Lowdon et. al., 1963). The aforementioned younger age of 1975 m.y. obtained for the South Lorrain granodiorite may be a reflection of thermal metamorphic effects from the underlying Nipissing diabase intrusion, which is known at Cobalt and Gowganda to be in this age range.

References

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1960: Rb-Sr and K-Ar ages of rock in Ontario and northern Minnesota; J. Geophys. Res., vol. 65, pp. 337-340.

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1968: South Lorrain township (north part); Ont. Dept. Mines, Prelim. Geol. Map P-289.

Wanless, R.K. et al.
1967: Age determinations and geological studies, K-Ar isotopic ages, Report 7; Geol. Surv. Can., Paper 66-17, p. 87.

Lowdon, J.A. et al.
1963: Age determinations and geological studies (including Isotopic ages - Report 3); Geol. Surv. Can., Paper 62-17, p. 91.

Ontario

GSC 70-84 Biotite, K-Ar age 1180 ± 40 m.y.

K = 7.17%, $^{40}Ar/^{40}K$ = 0.0962, radiogenic Ar = 98%.
Concentrate: Clean, olive-green coloured biotite with no visible alteration or impurities.

From granite-gneiss.
(31 F) Faraday township, Ontario, 45°03'N, 77°55'W. Map-unit 8 (Faraday Batholith, southern part). Ontario Dept. of Mines Map 1957-1. Sample 58-RC-12, collected by S.C. Robinson, interpreted by H.W. Little.

This sample of Faraday granite-gneiss was collected by S.C. Robinson in 1958. An age of 1245 ± 30 m.y. was reported by him (Can. Mineralogist, vol. 6, part 4, p. 519), and subsequently an age of 1195 ± 70 m.y. was published in GSC Paper 60-17, p. 24. As pointed out by Robinson "the exceptionally great age is not in keeping with that of the Grenville orogeny", and indeed it is more than 100 m.y. greater than any other age recorded on the geochronological map except near the Grenville front, and nearly 200 m.y. greater than the accepted age of the Grenville orogeny. Because of the importance of this age in tectonic interpretations it was checked and found to be in close agreement with the previous value reported in Paper 60-17 (GSC 59-52).

Quebec

(GSC No. 70-85 to 70-107)

GSC 70-85 Hornblende, K-Ar age 978 ± 40 m.y.

$K = 1.30\%$, $^{40}Ar/^{40}K = 0.0750$, radiogenic Ar = 99%.
Concentrate: Clean, pleochroic olive-green to light bluish green hornblende with less than 2% attached quartz impurity.

From porphyroidal gneiss.
(31 G) Artists Lookout, Gatineau Parkway, Quebec, 45°31'13"N, 75°52'07"W. Sample WN-9-68, collected by D.D. Hogarth and R.K. Wanless, interpreted by D.D. Hogarth (University of Ottawa).

This is the dominant rock type of the Wakefield syenite batholith which cuts early granite pegmatite, phlogopite-apatite veins, marble and gneisses. It is in turn cut by diabase dykes, late pegmatites and aplite. The regional metamorphism postdates the intrusion of the Wakefield syenite.

GSC 70-86 Hornblende, K-Ar age 972 ± 40 m.y.

$K = 1.34\%$, $^{40}Ar/^{40}K = 0.0744$, radiogenic Ar = 97%.
Concentrate: Pleochroic light green to bluish green hornblende with less than 2% each of muscovite and quartz impurity.

From actinolitic gneiss.
(31 G) Mile 8, 600 feet south of Mackenzie-King Estate parking lot, Kingsmere section of Gatineau Parkway, Quebec, 45°28'38"N, 75°50'44"W. Sample WN-7-68c, collected by D.D. Hogarth and R.K. Wanless, interpreted by D.D. Hogarth (University of Ottawa).

This sample of actinolitic gneiss was collected 4 feet from the contact of a diabase dyke (GSC 70-88) which at this locality is 70 feet wide. The "Grenville" age yielded by this gneiss sample indicates that the thermal effect of the dyke was not great, and certainly not as pronounced as in the case of a dyke 1.5 miles to the north.

GSC 70-87 Hornblende, K-Ar age 988 ± 41 m.y.

$K = 1.33\%$, $^{40}Ar/^{40}K = 0.0760$, radiogenic Ar = 96%.
Concentrate: Relatively clean, pleochroic light yellow to light bluish green hornblende with less than 10% attached quartz and a trace of biotite impurity.

From diorite.
(31 G) Near the intersection of Mountain and Klock roads, Gatineau Park area, Quebec, 45°27'56"N, 75°50'25"W. Sample 868, collected by D.D. Hogarth and R.K. Wanless, interpreted by D.D. Hogarth (University of Ottawa).

Quebec

This is one of a series of narrow diorite dykes which cut marble, diopsidic and actinolitic gneisses in the Kingsmere area. These rocks preserve their igneous texture but show effects of metamorphism. Diorite dykes in the Meach Lake area transect the Wakefield syenite (GSC 70-85) but have been fragmented during the regional metamorphism. The K-Ar ages, however, are essentially identical and represent the time of metamorphism rather than original emplacement.

GSC 70-88 Whole rock, K-Ar age 488 ± 45 m.y.

K = 0.20%, $^{40}Ar/^{40}K$ = 0.0326, radiogenic Ar = 79%.
Concentrate: Crushed whole rock.

From diabase.
(31 G) Mile 8, Kingsmere section, Gatineau Parkway, Quebec, 45°28'38"N, 75°50'44"W. Sample WN-7-68A, collected by D.D. Hogarth and R.K. Wanless, interpreted by D.D. Hogarth (University of Ottawa).

This is the middle dyke of a series of three which transect the rocks along the Gatineau Parkway (actinolite gneiss in this area). See GSC 70-89 for further discussion.

GSC 70-89 Whole rock, K-Ar age 408 ± 70 m.y.

K = 0.25%, $^{40}Ar/^{40}K$ = 0.0266, radiogenic Ar = 84%.
Concentrate: Crushed whole rock.

From diabase.
(31 G) Near Penguin Parking Lot, Gatineau Park, Quebec, 45°29'53"N, 75°50'00"W. Sample WN-21-68, collected by D.D. Hogarth and R.K. Wanless, interpreted by D.D. Hogarth (University of Ottawa).

This is the northern dyke of a series of three (GSC 70-88). The two dated diabase dykes postdate the regional metamorphism and are the youngest igneous rocks of the area. They give rather similar dates to diabases of the Fort Coulonge area (415 ± 70 m.y.) and the Ste. Adèle area (425 ± 73 m.y.), but these ages are difficult to reconcile with the absence of dykes cutting Ordovician limestones.

GSC 70-90 Actinolite, K-Ar age 1080 ± 40 m.y.

K = 0.53%, $^{40}Ar/^{40}K$ = 0.0854, radiogenic Ar = 94%.
Concentrate: Clean, nonpleochroic, light green to colourless amphibole which occurs in crystalline and fibrous form.

Quebec

From peridotite
(31 G) West of Leamy Creek, Gatineau Park, Quebec, 45°28'07"N, 75°47'41"W. Sample 927, collected by D.D. Hogarth and R.K. Wanless, interpreted by D.D. Hogarth (University of Ottawa).

See GSC 70-91 for description and interpretation.

GSC 70-91 Phlogopite, K-Ar age 994 ± 40 m.y.

K = 4.42%, $^{40}Ar/^{40}K$ = 0.0766, radiogenic Ar = 96%.
Concentrate: Light brown to colourless phlogopite with a trace of amphibole contamination and some serpentine. About 10 per cent of the phlogopite flakes have split edges.

From peridotite.
(31 G) Details as for GSC 70-90.

Small lenses of this actinolite-diopside-hypersthene-forsterite rock are interlayered with quartzite, marble and diopsidic gneiss. Intrusive relationships with other rocks were not observed, but they are some of the oldest dated rocks in the region, though not as old as the phlogopite-apatite veins.

GSC 70-92 Hornblende, K-Ar age 2195 ± 68 m.y.

K = 0.62%, $^{40}Ar/^{40}K$ = 0.2427, radiogenic Ar = 99%.
Concentrate: Pleochroic olive-brown to light green hornblende with about 5% attached feldspar contamination.

From gneiss.
(32 B) North shore of Baie Noiseux, Noiseux tp., Quebec, 48°31'N, 75°50'W. Sample CZ-212-68, collected and interpreted by B.W. Charbonneau.

The rock is typically dark grey weathering, medium grained, massive to weakly layered and composed of green hornblende, plagioclase (oligoclase-andesine) biotite, some clinopyroxene, quartz and minor amounts of garnet, magnetite and traces of sphene and carbonate.

The sample is from a belt of the above hornblende gneiss which is the dominant rock type underlying a large magnetic anomaly in the area which was the reason for the study (Charbonneau, 1969). The sample is from a locality which is shown as being several miles within the Grenville Province based on previous regional work (Faessler, 1935) but is now interpreted as being several miles within the structural boundary of the Superior Province. The age of 2195 ± 68 m.y. is interpreted as being the age of Kenoran metamorphism updated by heating associated with the border phases of the Grenville activity. The Grenville-Superior boundary in this section is considered a gradational feature. Faults were mapped but these are older features than the front and intersect it at a low angle and are obliterated.

Quebec

References

Charbonneau, B.W.
1969: A Grenville front magnetic anomaly, Megiscane Lake area, Quebec, in Report of Activities, April to October, 1968; Geol. Surv. Can., Paper 69-1, Pt. A, pp. 70-77.

Faessler, C.
1935: Megiscane River Headwaters area; Annual Report of the Quebec Bureau of Mines, Pt. C, pp. 29-38.

GSC 70-93 Hornblende, K-Ar age 1950 ± 64 m.y.

K = 0.79%, $^{40}Ar/^{40}K$ = 0.1997, radiogenic Ar = 98%.
Concentrate: Relatively pure, pleochroic, olive-brown to dark green hornblende with some fine opaque inclusions (magnetite).

From gneiss.
(32 B) South shore of Lac Dumont, Logan twp., Quebec, 48°34'N, 75°40'W. Sample CZ-326-68, collected and interpreted by B.W. Charbonneau.

The description of this rock is similar to GSC 70-92 except this locality is several miles to the east. The age of 1950 ± 53 m.y. is interpreted in a similar fashion. It should be noted that whereas sample GSC 70-92 is eight miles from the structural position of the Grenville-Superior boundary, sample GSC 70-93 is interpreted as being only seven miles from the boundary and this might explain the younger age.

Note: Two more age determinations are in process on hornblendes from two separate localitites in a mixed gneiss unit (minor hornblende gneiss bands in a dominant granitic gneiss host) near the interpreted trace of the structural position of the Grenville front (i.e. several miles to the south). These dates should help more closely define the radiometric age position of the Grenville-Superior boundary and a more extended geochronological interpretation should then be possible.

GSC 70-94 Hornblende, K-Ar age 978 ± 40 m.y.

K = 0.92%, $^{40}Ar/^{40}K$ = 0.0750, radiogenic Ar = 98%.
Concentrate: Clean, nonpleochroic bluish green hornblende with no visible impurities.

From carbonatite.
(32 B) West shore of Lac Mercier, Deschamps tp., Quebec, 48°36'N, 75°33'W. Sample CZ-100-68, collected and interpreted by B.W. Charbonneau.

See GSC 70-95 for description and interpretation.

Quebec

GSC 70-95 Biotite, K-Ar age 973 ± 36 m.y.

K = 7.02%, $^{40}Ar/^{40}K$ = 0.0745, radiogenic Ar = 99%.
Concentrate: Clean, light brownish coloured biotite with no visible impurities.

From carbonatite.
(32 B) Details as for GSC 70-94.

The sample is from the northwestern side of a mafic carbonatite intrusion approximately 3 miles long by 1 mile wide which cuts granite gneiss. The body rakes to the southeast. The rock is fresh, coarse grained, black, massive and is composed of green clinopyroxene (aegerine-augite), red-brown biotite, brown hornblende, abundant carbonate and up to 1% magnetite, as well as traces of apatite and sphene. Spectrochemical assays on the carbonate fraction of this rock have yielded 0.56% Sr, 0.14% Ba, 0.13% Ce and 0.13% La. These high values are supporting evidence of the carbonatitic nature of this intrusion. There is excellent agreement between the biotite and hornblende ages. The age of 973 ± 36 m.y. to 978 ± 40 m.y. is interpreted as time of intrusion.

GSC 70-96 Whole rock, K-Ar age 1220 ± 45 m.y.

K = 2.37%, $^{40}Ar/^{40}K$ = 0.1001, radiogenic Ar = 99%.
Concentrate: Crushed whole rock.

From diabase.
(32 P) Four miles east of Kawachagamits, Quebec, 51°39'N, 73°54'W. Sample FA-2-68, collected and interpreted by W.F. Fahrig.

The sample is chilled material from a dyke whose trend is similar to that of sample FA-1-68 (GSC 70-97) and is from the same region. The difference in the two ages suggests that dyke intrusions of two distinct ages may be represented.

GSC 70-97 Whole rock, K-Ar age 1925 ± 60 m.y.

K = 2.26%, $^{40}Ar/^{40}K$ = 0.1959, radiogenic Ar = 99%.
Concentrate: Crushed whole rock.

From diabase.
(32 P) Ten miles northeast of Woollett Lake, Quebec, 51°33'N, 73°33'W. Sample FA-1-68, collected and interpreted by W.F. Fahrig.

The sample is chilled material from the edge of a diabase dyke intrusion. Biotite from country gneiss in contact with this dike gave a

concordant age of 1935 ± 58 (GSC 66-132)*, so this is considered to be a reliable estimate of the age of the dyke intrusion.

*See Geol. Surv. Can. Paper 67-2A, 1968.

GSC 70-98 Biotite, K-Ar age 1820 ± 55 m.y.

K = 8.20%, $^{40}Ar/^{40}K$ = 0.1794, radiogenic Ar = 99%.
Concentrate: Clean, light green biotite with no chlorite, though some of the flakes carry small amounts of an orange coloured alteration product attached to them.

From granitic augen gneiss.
(24 B) Wheeler River area, Quebec, 56°27'N, 67°27'W.
Sample TA-67-T70, collected and interpreted by F.C. Taylor.

The sample was taken from coarse grained biotite granitic gneiss variously shown as Archean or Proterozoic on geological maps. The age is interpreted as being that of metamorphism; a product of the Hudsonian orogeny.

GSC 70-99 Muscovite, K-Ar age 1670 ± 55 m.y.

K = 8.60%, $^{40}Ar/^{40}K$ = 0.1568, radiogenic Ar = 98%.
Concentrate: Clean, clear muscovite with some yellow-brown coloration of split flake edges.

From pegmatitic granite.
(24 B) South-southeast of junction of Whale and Wheeler Rivers, Quebec, 56°23'N, 66°48'W. Sample TA-67-T109, collected and interpreted by F.C. Taylor.

This sample is from a coarse grained, white, muscovite granite that intrudes granitic gneisses east of the Labrador Trough. The age, 1670 ± 55 m.y., is the age of the intrusion and suggests that it is penecontemporaneous with the regional metamorphism.

GSC 70-100 Biotite, K-Ar age 1625 ± 50 m.y.

K = 7.80%, $^{40}Ar/^{40}K$ = 0.1506, radiogenic Ar = 98%.
Concentrate: Clean, light brownish coloured biotite with no visible impurities. A few of the flakes have split edges.

From granite.
(23 P) Northeastern Quebec, 55°36'N, 65°01'W. Sample BA-30, collected by C.K. Bell, interpreted by F.C. Taylor.

Quebec

The sample was taken from a massive biotite granite associated with granulite. The age is considered to be that of intrusion of the granite, which is interpreted as a Hudsonian orogenic event.

GSC 70-101 Muscovite, K-Ar age 415 ± 17 m.y.

K = 5.65%, $^{40}Ar/^{40}K$ = 0.0272, radiogenic Ar = 94%.
Concentrate: Impure muscovite with 18% chlorite. Most of the mica flakes are stained, contain tiny black inclusions and have split edges.

From sandstone.

(22 B) 400 yards west of Miguasha pier, north shore of Chaleur Bay, Quebec, 48°06'20"N, 66°20'50"W. Map-unit 9, GSC Map 286A. Sample PB-68-149, collected and interpreted by W.H. Poole.

The sandstone is brown to grey to green, medium grained, friable, micaceous, and rippled and crossbedded. Thin sections display an argillaceous matrix with detrital muscovite and biotite.

The Upper Devonian Escuminac Formation, from the basal few feet of which this sample was collected, is a nonmarine lacustrine deposit, 390 feet thick (Dineley and Williams, 1968). It forms the upper of the Devonian nonmarine formations that are confined to a broad syncline in western Chaleur Bay. The Escuminac is essentially flat-lying with dips of a few degrees. It is overlain unconformably by middle Carboniferous Bonaventure conglomerates. The objective of the analysis was to date the detrital muscovite and thus aid in identifying the source area.

The date of 415 ± 17 m.y. corresponds to the Silurian Period. Clearly the mica concentrate contains some of its predepositional radiogenic argon. Two source areas are reasonable from geological reconstruction: 1) to the north, the metamorphic belt of the Cambro-Ordovician Shickshock Group which has yielded K-Ar muscovite dates of 478, 495 and 530 m.y.; and 2) to the south and east, the Miramichi Geanticlinal belt which have yielded K-Ar muscovite dates of 400, 417, 432, 435, 442 and 463 m.y. Both sources are believed to represent Taconian metamorphism although the range in dates is difficult to explain.

Depositional current directions in the Escuminac Formation and in the underlying Fleurant conglomerate indicate flow from east to west (Dineley and Williams, 1968). Thus it seems probable that the Cambro-Ordovician Mictaw and Maquereau Formations at the northern end of the Miramichi Geanticline, especially the undescribed offshore extension, were the source of the muscovite detritus.

Reference

Dineley, D.L. and Williams, B.P.J.
1968: The Devonian continental rocks of the lower Restigouche River, Quebec; Can. J. Earth Sci., vol. 5, pp. 945-953.

Quebec

GSC 70-102 Whole rock, K-Ar age $\frac{176 \pm 10 \text{ m.y.}}{176 \pm 10 \text{ m.y.}}$.

$K = \frac{0.41\%}{0.41\%}$, $^{40}Ar/^{40}K = \frac{0.0108}{0.0108}$, radiogenic Ar = $\frac{74\%}{39\%}$.

Concentrate: Crushed whole rock.

From diabase.

(12 E) De Puyjalon Cliff, north shore of Anticosti Island, Quebec, 49°47.5'N, 63°15'W. Sample BF-L1-64, collected by R. Sanschagrin, described by R.D. Stevens and interpreted by T.E. Bolton and R.K. Wanless.

This is the same sample material identified as GSC 65-129 in GSC Paper 66-17, but note that the latitudinal designation of 49°55'N published therewith is incorrect.

The rock is a fresh, fine to medium grained diabase consisting mainly of plagioclase laths (55%) and subophitic clinopyroxene (40%), with about 3% opaque iron oxides and about 2% red-brown iddingsite pseudomorphous after original olivine.

See GSC 70-105 for interpretation.

GSC 70-103 Whole rock, K-Ar age 168 ± 8 m.y.

$K = 0.44\%$, $^{40}Ar/^{40}K = 0.0102$, radiogenic Ar = 54%.

Concentrate: Crushed whole rock.

From diabase.

(12 E) De Puyjalon Cliff, Anticosti Island, Quebec, 49°47 1/2'N, 63° 12 1/2'W. Sample identified as DIKE No. 2 (WEST), collected by T.E. Bolton and interpreted by T.E. Bolton and R.K. Wanless.

The rock is a medium-fine, fresh, ophitic diabase consisting of plagioclase laths and colourless clinopyroxene with intersticies filled by chlorite/magnetite and orange iddingsite/serpentine pseudomorphs which may represent original olivine.

See GSC 70-105 for interpretation.

GSC 70-104 Whole rock, K-Ar age $\frac{180 \pm 10 \text{ m.y.}}{176 \pm 10 \text{ m.y.}}$.

$K = 0.36\%$, $^{40}Ar/^{40}K = \frac{0.0110}{0.0108}$, radiogenic Ar = $\frac{69\%}{44\%}$.

Concentrate: Crushed whole rock.

Quebec

From diabase.

(12 E) De Puyjalon Cliff, Anticosti Island, Quebec, 49°47 1/2'N, 63°12 1/2'W. Sample identified as DIKE No. 1 (EAST), collected by T.E. Bolton and interpreted by T.E. Bolton and R.K. Wanless.

The rock is a fresh, fine-grained, ophitic diabase consisting of unaltered plagioclase laths (50%), colourless clinopyroxene (40%), green and brownish green serpentinous or chloritic pseudomorphs after original olivine (8%), and grains and crystals of opaque iron oxides.

See GSC 70-105 for interpretation.

GSC 70-105 Whole rock, K-Ar age 191 ± 10 m.y.

K = 0.36%, $^{40}Ar/^{40}K$ = 0.018, radiogenic Ar = 62%.
Concentrate: Crushed whole rock.

From diabase.

(12 E) Squaw Cove Road, Anticosti Island, Quebec, 49°46'N, 63°10'W. Sample identified as DIKE No. 3 (INLAND), collected by T.E. Bolton and interpreted by T.E. Bolton and R.K. Wanless.

The rock is a fresh, fine-grained, ophitic diabase essentially identical to GSC 70-104.

In 1964 a sample of the diabase was collected by R. Sanschargrin for T.E. Bolton and the age determination was published in GSC Paper 66-17 as sample GSC 65-129. At that time it was felt that the result was somewhat low but the error limits assigned spanned the anticipated age range.

T.E. Bolton visited the region in 1969 and selected samples from three new localities to be used for paleomagnetic studies and further K-Ar age investigation. The age results obtained for these samples (GSC 70-102 through 105) are all reasonably consistent in spite of slight variations in the potassium concentration, radiogenic argon-40 content, and degree of weathering of the samples. Since the specimens were collected from widely separated localities the age results may be taken as support for the hypothesis that the dyke samples were emplaced during a single episode of diabase intrusion. The time of emplacement is given by the average value of 178 ± 8 m.y., i.e. mid-Upper Jurassic. See Wanless and Stevens (1971) for a more extensive discussion of work on these Anticosti dykes.

Reference

Wanless, R.K. and Stevens, R.D.
1971: Note on the age of diabase dykes, Anticosti Island, Quebec; Proc. Geol. Assoc. Can., vol. 23, pp. 77-78.

Quebec

GSC 70-106 Hornblende, K-Ar age $\begin{matrix} 437 \pm 21 \text{ m.y.} \\ \underline{437 \pm 20 \text{ m.y.}} \end{matrix}$

K = 0.47% (I.D.), $^{40}Ar/^{40}K = \begin{matrix} 0.0288 \\ 0.0288 \end{matrix}$, radiogenic Ar = $\begin{matrix} 64\% \\ 71\% \end{matrix}$.

Concentrate: Clean, pleochroic green to yellowish green hornblende with less than 5% included quartz and biotite. Biotite is attached to the edges of some of the hornblende grains.

From amphibolite.

(22 A) Mount Serpentine area, Gaspé Peninsula, 1,200 feet upstream on a southeast tributary of Salmon Hole Brook. The mouth of the tributary is 2.2 miles from Dartmouth River, Quebec, 48°56'20"N, 64°43'00"W. Map-unit 3-7, Quebec Dept. Mines Map 662. Sample PB-67-1B, collected and interpreted by J. Béland, Univ. Montreal.

The rock is a dark green, fine-grained schistose and lineated amphibolite. In thin section, hornblende, which makes up 45 per cent of the rock, consists of elongate subhedra with parallel alignment which produces the linear fabric. It is pleochroic light yellow to blue-green and unaltered. The remainder of the rock is indeterminant feldspar (albite?) and micaceous. Microstringers contain epidote, calcite and feldspar.

See GSC 70-107 for interpretation.

GSC 70-107 Muscovite, K-Ar age $\begin{matrix} 434 \pm 18 \text{ m.y.} \\ 414 \pm 18 \text{ m.y.} \\ \underline{422 \pm 18 \text{ m.y.}} \end{matrix}$

K = 8.65%, $^{40}Ar/^{40}K = \begin{matrix} 0.0286 \\ 0.0270 \\ 0.0277 \end{matrix}$, radiogenic Ar = $\begin{matrix} 95\% \\ 96\% \\ 82\% \end{matrix}$.

Concentrate: Clean, clear muscovite with slight yellow staining and a trace of chlorite.

From schist.

(22 A) Mount Serpentine area, Gaspé Peninsula, 1,500 feet north of Salmon Hole Brook at a point 2.2 miles from its mouth on Dartmouth River, Quebec, 48°56'40"N, 64°43'20"W. Map-unit 3-7, Quebec Dept. Mines Map 662. Sample PB-67-1A, collected and interpreted by J. Béland, Univ. Montreal.

The rock is a grey muscovite schist with muscovite metacrysts ranging up to 8 mm in diameter. The "groundmass" is grey to light pink, fine grained and quartzofeldspathic. In thin section, the "groundmass", 85 per cent of the rock, is a fine-grained aggregate of quartz and clouded, untwinned feldspar (albite?). Chlorite parallels the schistosity and comprises 5 per cent of the rock. Muscovite, 10 per cent of the rock, has a wide range of sizes; it is kinked and fractured, and in part intergrown with chlorite.

Quebec

The amphibolite and muscovite schist are representative of part of the "Ladystep Series" (Jones, 1935) which forms an inlier of pre-Silurian metamorphic rocks and serpentinite. The complex has been thrust northeastward against Lower and Middle Devonian strata, and on the southwest flank is overlain unconformably by upper Silurian (Pridolian according to Lespérance and Bourque, 1970, p. 1879) and Lower Devonian (Gedinnian) strata. The unconformity is visible in several places. A basal breccia-conglomerate contains abundant clasts of metamorphic rocks derived from the complex. The complex itself consists of a great variety of rocks: basic and acidic metavolcanics, mica schists, quartzofeldspathic gneiss, augen gneiss, amphibolite and small serpentinite bodies. There is a marked similarity in composition and metamorphism of the complex to the Shickshock Group on trend to the west. The objective of the analyses was to determine the age of metamorphism.

The hornblende dates duplicate one another at 437 ± 21 m.y. and on the Geological Society 1964 time-scale, considering the limits of error, span the Middle Ordovician - Middle Silurian interval, with the mid point on the Ordovician-Silurian boundary. The three muscovite dates, on the other hand, differ from one another sufficiently that one would suspect heterogeneity of the concentrate. The outer limits of the dates, again with the error in mind, encompass Middle Ordovician - Silurian time, while the average of 423 m.y. represents early Silurian. The average of all five dates in 429 m.y., also early Silurian, probably near the Ordovician-Silurian boundary.

From regional considerations, the age of the protoliths of the "Ladystep Series" and Shickshock Group is certainly pre-Middle Ordovician, probably Early Ordovician, and possibly older. The age of metamorphism is equally in doubt. It certainly is pre-Silurian, probably between late Middle and late Early Ordovician that is early Middle Ordovician, or about 470 m.y. in absolute age. This figure differs from 429 m.y. by about 9 per cent. It can be argued that the original 470 m.y. regional metamorphism and ultramafic intrusion were subsequently altered slightly during post-Early Devonian thrusting and brecciation. The "Ladystep Series" is actually bordered by a tear-thrust fault which cuts through Early and Middle Devonian strata. Or perhaps the Ladystep metamorphic rocks became uplifted during late Ordovician or earliest Silurian and cooled through the critical argon-retention isotherm at about that time. Or perhaps the rocks cooled in early Ordovician but were redeformed, degassed and uplifted during latest Ordovician or earliest Silurian, that is 429 m.y. It is also possible that first metamorphism and uplift are not as early as assumed above but did take place in latest Ordovician time. Other data is required before a choice can be made.

Whatever the correct interpretation, the present dates differ considerably from other dates already obtained for the Shickshock Group: muscovite of 530 m.y. and 495 m.y. and biotite of 495 m.y. (GSC 61-184, 185, 186)*. These dates place the metamorphism between Middle Cambrian and Early Ordovician. Thus the dating so far obtained is either too old or too young to agree with what can be deduced from general regional considerations.

Quebec

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*See Geol. Surv. Can. Paper 62-17, 1963.

New Brunswick

(GSC No. 70-108 to 70-121)

GSC 70-108 Biotite, K-Ar age 486 ± 20 m.y.

K = 6.53%, $^{40}Ar/^{40}K$ = 0.0324, 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 (1965) 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.

The granite in the sample is massive, homogeneous, undeformed and coarse grained. Large light pink potash feldspar anhedra commonly 1 cm in diameter are evenly distributed throughout the rock. Plagioclase is light grey oligoclase, which in thin section is well twinned, weakly zoned and irregularly clouded. Quartz, about 15% of the rock, is slightly strained and in some specimens has a bluish shade, a feature which combined with the pink of the potash feldspar, produces a slight purplish colour to the rock. Biotite is pleochroic light yellow to dark brown and in thin section can be seen to have a 'blistered' texture, presumably resulting from incipient alteration (chloritization?). Dark opaque alteration products partly rim the biotite crystals and lie along some cleavage planes. Aggregates of chlorite have developed from hornblende and biotite.

The sample was collected from the Fairville granite (Hayes and Howell, 1937; Alcock, 1938) and forms one pluton about one mile in diameter within an assemblage of gneisses, granites, gabbros and diorites collectively called the Golden Grove intrusions, which cut the Precambrian (Hadrynian?) Green Head Group. Some gneisses are metamorphosed Green Head.

The age(s) of the intrusions and of the metamorphism is important to the understanding of the tectonics of southern New Brunswick, and unfortunately is much in doubt. Alcock (1938) reviewed the hypotheses bearing on the age of the intrusions. From studies made prior to 1900, Barley and Matthew favoured a Precambrian age, and later Matthew wondered whether some might be mid-Paleozoic (Devonian) like those elsewhere in New Brunswick. Hayes regarded the intrusions as Precambrian. Alcock hedged his bets by opting for three ages, early Precambrian (post-Green Head), later Precambrian (post-Coldbrook) and Middle Devonian. Much later Poole (1967) proposed that the intrusions are Middle Ordovician in age, and in 1970 he repeated this stand (Poole, 1970). On the other hand, Potter et al. (1968) on the small-scale geological map of New Brunswick cautiously favoured a Devonian age by designating the intrusions as "Precambrian or Lower Paleozoic" with the proviso "may be totally or in part of Devonian age". The controversy continues.

Any hypothesis must satisfactorily encompass and interpret: a) the existance of granite, gneiss and quartz pebbles in conglomerate interbedded with Coldbrook volcanics (Alcock, 1938); b) lack of plutonic rocks known to cut Cambrian strata (Alcock, 1938); c) the granite clasts in a Cambrian

conglomerate (Weeks, 1957); and d) the isotopic age dates. The first three features, if confirmed by modern studies, indicate the presence of Precambrian intrusion, while the last if taken at face value, suggests Cambro-Ordovician intrusion. In all, the possibility of plutonism of at least two ages is strong.

Biotite from the present samples yielded a date of 479 ± 20 m.y. (GSC 67-128)[1], and when compared with similar biotite dates in the belt of 508 m.y. from gneiss (GSC 62-159)[2] and of 500 m.y. from gabbro about 55 miles to the northeast (GSC 62-160)[2], seemed to point to an Early or Middle Ordovician age of intrusion (and? metamorphism). To further strengthen this important interpretation, the argon was re-extracted from additional biotite concentrate on hand and re-analyzed. The potassium analysis was not repeated. The resulting date of 486 ± 20 m.y. unreservedly confirms the earlier analysis.

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[1] Geol. Surv. Can. Paper 69-2A, pp. 69-70, 1970.

[2] Geol. Surv. Can. Paper 63-17, pp. 102-103, 1963.

New Brunswick

GSC 70-109 Biotite, K-Ar age $\frac{362 \pm 16 \text{ m.y.}}{348 \pm 16 \text{ m.y.}}$

K = 7.00%, $^{40}Ar/^{40}K = \frac{0.0233}{0.0224}$, radiogenic Ar = $\frac{95\%}{97\%}$.

Concentrate: Impure, light greenish coloured biotite with about 19% chlorite alteration.

From quartz monzonite.

(21 G) Near Hawkshaw, east end of new bridge over Saint John River, New Brunswick, 45°58'25"N, 67°14'40"W. Map-unit 20, GSC Map 37-1959. Sample PB-68-100, collected and interpreted by W.H. Poole.

The quartz monzonite is pink, coarse grained and biotitic, massive, undeformed and fresh, with large pink potash feldspar phenocrysts-metacrysts. In thin section, plagioclase is slightly clouded. Accessories are epidote, magnetite, apatite and pyrite. About 8 per cent of the rock is biotite, partly altered to chlorite. Biotite is pleochroic straw-yellow to very dark brown. The rock is typical of the Devonian granites in central New Brunswick, most of which have yielded K-Ar mica dates in the range 380-400 m.y. The sample was analyzed to check an anomalously low date of 312 m.y. (GSC 60-136)* collected about 1/4 mile to the south in an area now covered by waters of the Mactaquac Dam.

The two dates, 362 ± 16 m.y. and 348 ± 16 m.y., were obtained from the same biotite concentrate using the one potassium analysis but different argon extractions and analyses. The second analysis was carried out because the first was still lower than expected (380-400 m.y.). It must be concluded that some later metamorphic or alteration event has released some radiogenic argon. It is not reasonably possible that this part of the batholith was uplifted and cooled through an argon-retention isotherm at a date later than the rest of the batholith.

*See Geol. Surv. Can. Paper 61-17, 1961.

GSC 70-110 Muscovite, K-Ar age 429 ± 18 m.y.

K = 7.78%, $^{40}Ar/^{40}K$ = 0.0282, radiogenic Ar = 94%.
Concentrate: Yellow-stained muscovite with only about 20% clear flakes. Brown chlorite impurity amounts to about 15%. Fine-grained opaques (5%) are included in the muscovite flakes.

From micaceous sandstone.

(21 G) Railway cut 1 mile northwest of Lawrence Station, New Brunswick, 45°26'20"N, 67°11'30"W. Map-unit 5, GSC Map 20-1966. Sample PB-66-70, collected and interpreted by W.H. Poole.

The sandstone is light grey-green, medium grained and calcareous, with detrital muscovite sprinkled on the bedding planes. In thin section, the rock comprises subrounded quartz grains in a matrix of silt, clay (?) and about 20 per cent calcite cement. Perhaps 2 per cent of the rock consists of detrital muscovite, as long (0.1 to 0.5 mm), straight and thin flakes. Lesser detrital biotite has altered to chlorite.

New Brunswick

The micaceous sandstone is strongly folded but the associated secondary cleavage is of the fracture type and not well developed. The rocks are undated although probably upper Silurian and/or lower Devonian. Analysis of the detrital muscovite was made to (hopefully) yield the age of the metamorphic rocks in the source area, and to evaluate this use of K-Ar dating. A date older than 405 m.y., about the age of sedimentation, was expected, but the actual age of the source-area micas and location are uncertain, so that an age older than 405 m.y. cannot be satisfactorily evaluated from a geological point of view at this time.

The detrital muscovite yielded 429 ± 18 m.y., a date near the Ordovician-Silurian boundary. It is older than the age of sedimentation, and provided the analysis is correct, it records some radiogenic argon formed before sedimentation. Metamorphic and plutonic rocks in the Avalon zone of southern New Brunswick (Green Head-Coldbrook-Cambrian rocks, etc.) formed during the late half of the Ordovician are a possible source; no fossils of undoubted Middle and Late Ordovician age have been found in southern New Brunswick. Micas formed during this period would range from about 490 to 435 m.y. Some argon could well have been lost during Silurian (?) erosion, transportation, sedimentation, diagenesis and weak metamorphism. Thus it is possible that the detrital muscovite was derived from rocks of this age (or of course older).

GSC 70-111 Biotite, K-Ar age 378 ± 16 m.y.

$K = 7.29\%$, $^{40}Ar/^{40}K = 0.0245$, radiogenic Ar = 98%.
Concentrate: Red-brown biotite with a few inclusions of apatite and about 8 per cent chlorite as an alteration product of the mica. A few fragments of free hornblende are also present.

From granodiorite.

(21 S) Southwest Miramichi River, west bank, 2 1/2 miles 030 azimuth of the outlet of Miramichi Lake, New Brunswick, 46°29'45"N, 66°56'27"W. Map-unit 20, GSC Map 37-1959. Sample 5-35-1/PB, collected and interpreted by W.H. Poole.

This date is the result of a re-analysis of reserve biotite concentrate of GSC 62-158* which had yielded a 423 m.y. date. The granodiorite is mineralogically and texturally like many Devonian granites, and the earlier analysis recorded radiogenic argon of 100 per cent. The date expected was less than 400 m.y.

The granodiorite is grey, coarse grained, slightly porphyritic and massive. In thin section, nearly 25% is quartz, 50% clouded plagioclase, 6% microcline and 19% biotite. Biotite is pleochroic tan to dark brown and relatively free of inclusions. Some biotite is partly chloritized and other biotite completely so.

The present date of 378 ± 16 m.y. is very much like other Acadian-type granites of Miramichi Geanticlinal belt, which range from 364 to 398 m.y. The 423 m.y. date should be extirpated from the records, and the new date substituted.

*See Geol. Surv. Can. Paper 63-17, 1963.

New Brunswick

GSC 70-112 Muscovite, K-Ar age 401 ± 17 m.y.

K = 7.85%, $^{40}Ar/^{40}K$ = 0.0262, radiogenic Ar = 95%.
Concentrate: Impure muscovite with about 15% chlorite contamination and tiny black opaque inclusions.

From schist.
(21 O) Roadcut near North Sevogle River, 200 yards northeast of bridge, 2 miles east of Peabody Lake, New Brunswick, 47°08'05"N, 66°07'10"W. Map-unit 1, GSC Map 1220A. Sample PB-68-125, collected and interpreted by W.H. Poole.

The rock is a dark grey-green, carbonate-chlorite-muscovite schist with a well developed schistosity and a younger crosscutting crenulation. In thin section, muscovite and chlorite are intergrown.

The schist is part of the Tetagouche Group of Middle and Late (?) Ordovician age. The objective was to determine the age of metamorphism; cataclastic granites and associated metamorphism have yielded pre-Devonian dates in central New Brunswick and are interpreted to be late Ordovician. Most granites in this belt are Devonian.

The resulting date of 401 ± 17 m.y. is clearly a Devonian date and much like some of the granite dates in northern New Brunswick which range from 364 to 399 m.y. Thus, either the metamorphism is Devonian or the metamorphic rocks and granites (in northern New Brunswick) were uplifted and cooled below a critical isotherm during Devonian, at which time radiogenic argon began to accumulate in the micas.

GSC 70-113 Whole rock, K-Ar age 167 ± 28 m.y.

K = 0.42% (XRF), $^{40}Ar/^{40}K$ = 0.0102, radiogenic Ar = 35%.
Concentrate: Crushed whole rock.

From basalt.
(21 P) Caraquet, road metal pit, on shore, 500 yards west of Pointe à Brideau, New Brunswick, 47°47'40"N, 64°56'35"W. Map-unit Tm, Geological Map NR-1, published by New Brunswick Dept. Natural Resources 1968. Sample PB-68-141A, collected and interpreted by W.H. Poole.

See GSC 70-114 for description and interpretation.

GSC 70-114 Whole rock, K-Ar age 180 ± 31 m.y.

K = 0.42% (XRF), $^{40}Ar/^{40}K$ = 0.0111, radiogenic Ar = 44%.
Concentrate: Crushed whole rock.

From basalt.
(21 P) Details as for GSC 70-113.

New Brunswick

The basalt is dark grey to black, dense, equigranular, fine grained and massive. In thin section, plagioclase and pyroxene display a diabasic texture.

The basalt forms a master dyke 50 feet wide and three narrower bordering dykes. The master dyke is vertical, trends 040°, and has been traced by intermittent outcrop for 25 miles inland from the coast. It cuts flat-lying Pennsylvanian sandstone. The dyke is faulted and crushed along the southeast wall and is well fractured throughout.

The age of the dyke is unknown other than that it is younger than the Pennsylvanian sandstone.

The two samples were collected within the master dyke and about 25 feet apart in the pit. The two dates differ by 7 per cent which is disappointingly large, although each number falls well within the error limits of the other. The two dates including the quoted errors span the interval Middle Triassic-Jurassic, while the dates without the quoted errors span late Early Jurassic - early Middle Jurassic.

So few such post-Paleozoic dykes have been dated isotopically and paleomagnetically in eastern Canada, that it is difficult to evaluate these present dates. Late Triassic dates were expected – like that of the Shelburne dyke in southern Nova Scotia at 194 ± 32 m.y. (GSC 66-155), the four dates on the North Mountain Basalt, Nova Scotia, quoted by Carmichael and Palmer (1968) ranging from 178 tp 217 m.y., and the one from a dyke on George Island, Prince Edward Island (which cuts Pennsylvanian-Permian siltstones and sandstones) of 207 ± 8 m.y. (N.J. Snelling, pers. comm., 1967). The present two dates are lower than all of these.

On the other hand, five dates on the De Puyjalon dykes, north coast of Anticosti Island range from 168 to 191 m.y. (average 178 m.y.) (Wanless and Stevens, 1971) and are much like the present dates, although this area is part of an entirely different geological province. (See GSC 70-99 through GSC 70-102, this paper.)

The writer's best guess is that the dyke is Late Triassic and the low dates reflect slight degassing resulting from faulting and incipient alteration. The dyke should be dated paleomagnetically.

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GSC 70-115 Hornblende, K-Ar age 376 ± 18 m.y.

$K = 0.22\%$, $^{40}Ar/^{40}K = 0.0243$, radiogenic Ar = 86%.
Concentrate: Clean, pleochroic, light green to light brown hornblende with a trace of quartz impurity.

New Brunswick

From amphibolite.

(21 J) Plaster Rock-Renous Highway, 2 miles west of Irving's Juniper Road, New Brunswick, 46°52.3'N, 66°53.3'W. Map-unit 1b, Tuadook Lake area (R. Skinner; in Report of Activities, April to October; GSC Paper 67-1, Pt. A, 1968). Sample SC-21D-68, collected and interpreted by R. Skinner.

The rock is a black, fine-grained amphibolite with porphyroblasts of hornblende up to 6 mm in length, and is vaguely foliated with lenses and veinlets of very fine grained plagioclase that makes up about 10 per cent of the rock. The hornblende is pleochroic from olive green to straw yellow in thin-section.

See GSC 70-119 for interpretation.

GSC 70-116 Muscovite, K-Ar age 386 ± 16 m.y.

K = 8.73%, $^{40}Ar/^{40}K$ = 0.0251, radiogenic Ar = 92%.
Concentrate: Clear muscovite with a slight yellow stain on a few flakes. Some of the mica flakes contain black and red opaque inclusions, and a few have split edges.

From foliated granite.

(21 J) Plaster Rock-Renous Highway, 1 mile southeast of Renous Airstrip road, New Brunswick, 46°48.5'N, 66°36.2'W. Map-unit 3a, Tuadook Lake map. Sample SC-8A1-68, collected and interpreted by R. Skinner.

The rock is a pink, medium-grained, foliated biotite-muscovite granite containing about 40% perthite (some rimmed with plagioclase), 35% strained and fractured quartz, 20% altered andesine (An_{32}), 2% muscovite, 1% partly altered very fine grained biotite, and 0.5% magnetite.

See GSC 70-119 for interpretation.

GSC 70-117 Muscovite, K-Ar age 379 ± 16 m.y.

K = 8.37%, $^{40}Ar/^{40}K$ = 0.0246, radiogenic Ar = 94%.
Concentrate: Mainly clear muscovite with a trace of chlorite both as inclusions and as free flakes. The mica with chlorite inclusions has a greenish colour. Some of the muscovite flakes have split edges with an orange stain or alteration.

From muscovite-biotite-quartz schist.

(21 J) On the Plaster Rock-Renous Highway, 1 mile southeast of Renous Airstrip road, New Brunswick, 46°48.5'N, 66°36.2'W. Map-unit 1a, Tuadook Lake map. Sample SC-8A-68, collected and interpreted by R. Skinner.

See GSC 70-118 for description, and GSC 70-119 for interpretation.

New Brunswick

GSC 70-118 Biotite, K-Ar age 376 ± 16 m.y.

K = 7.33%, $^{40}Ar/^{40}K$ = 0.0244, radiogenic Ar = 98%.
Concentrate: Heterogeneous greenish brown biotite of varying colour intensity. Impurities consist of about 10% free chlorite and 2% muscovite.

From muscovite-biotite-quartz schist.
(21 J) Details as for GSC 70-117.

The sample is fine grained and schistose, and contains approximately 50% quartz, 25% each of muscovite and biotite and 1% of magnetite.

See GSC 70-119 for interpretation.

GSC 70-119 Muscovite, K-Ar age 382 ± 16 m.y.

K = 8.33%, $^{40}Ar/^{40}K$ = 0.0247, radiogenic Ar = 92%.
Concentrate: Relatively clean muscovite with less than 2% chlorite impurity. Some flakes are slightly brown-stained and some have split edges.

From granite.
(21 J) 2.3 miles west of Renous Airstrip road, on Plaster Rock-Renous Highway, New Brunswick, 46°49.5'N, 66°39.6'W. Map-unit 5b (see R. Skinner in Report of Activities, April to October 1967, GSC Paper 67-1, Pt. A, 1968). Sample SC-104-68, collected and interpreted by R. Skinner.

The sample is a pink, porphyritic muscovite-biotite granite and contains phenocrysts of perthite up to 7 mm long set in a matrix of fine-grained, massive, strained quartz, altered plagioclase, perthite, microcline, and about 2 per cent biotite, some of which is altered to chlorite.

Five samples were collected from the central part of the Miramichi Geanticline and were analyzed to determine the age of metamorphism of the metamorphic rocks and the age of intrusion of the igneous rocks (Skinner, 1970). The schist (GSC 70-117 and 118) and amphibolite (GSC 70-115) represent the oldest rocks in central New Brunswick, probably Cambro-Ordovician in age. They have been intruded by cataclastic granite (GSC 70-116) representative of the "old" upper Ordovician or lower Silurian granite that has been deformed and altered; later the schist, amphibolite and cataclastic granite were intruded by granite (GSC 70-119) during the Acadian orogeny in middle Devonian time.

GSC 70-117 and 118 are from muscovite-biotite schist intruded by sills and lenses of cataclastic granite (GSC 70-116) a few inches thick and lying about 1 mile east of a tongue of a granodiorite batholith of probable middle Devonian age and 1 mile west of a small batholith of "old" upper Ordovician or lower Silurian cataclastic granite and granodiorite. The granitic sills are probably related to the "old" granite. GSC 70-115 is from a

lens of massive amphibolite interlayered with more typically laminated fine-grained amphibolite, which in turn is interlayered with andesite and metasediments of probable Cambro-Ordovician age, all of which are intruded by Devonian (?) granitic and gabbroic sills and dykes. GSC 70-119 is from massive, pink porphyritic, biotite granite and muscovite-rich lenses up to a few inches thick, which is part of a batholithic tongue of massive, medium-grained, grey granodiorite of probable middle Devonian age.

The oldest K-Ar date obtained in the Miramichi Geanticline is 497 m.y. from massive biotite quartz monzonite GSC 61-178, 27 miles to the southwest in the Hayesville map-area (Poole, 1963). Gneiss intruded by the quartz monzonite gave younger ages: GSC 61-188, 417 m.y.; GSC 62-156, 432 m.y.; and GSC 63-158, 385 m.y. Biotite augen gneiss, which lies 13 miles to the southwest of GSC 70-117 and 118, is believed to be representative of the "old" granitic terrane and to be about the same age as GSC 61-189 (497 m.y.), but gave a K-Ar age of 399 m.y. (early Devonian).

> Editorial note: A revision of some of the central New Brunswick ages in excess of 400 m.y. is in progress. Present indications are that their reported ages may be too high and at least some are in the range of 365 to 375 m.y.

It was expected that the K-Ar dates from GSC 70-115, 116, 117 and 118 would yield pre-Devonian ages thus indicating equivalent metamorphic history to the gneisses in the Hayesville map-area. The middle Devonian ages obtained indicate that the schist, amphibolite and granitic sills were metamorphosed and/or were raised by crustal upwarp of geanticline during the Acadian orogeny and retention of radiogenic argon began from that time. The supposed middle Devonian age of granite GSC 70-119 was confirmed.

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See Geol. Surv. Can. Papers 62-17 (1963), 63-17 (1963) and 64-17, Part 1 (1965).

GSC 70-120 Whole rock, K-Ar age 354 ± 17 m.y.

$K = 4.65\%$, $^{40}Ar/^{40}K = 0.0228$, radiogenic Ar = 91%.
Concentrate: Crushed whole rock.

New Brunswick

From dacite.

(12 A) 13 level, MacLean Orebody, Buchans, New Brunswick, 48°50'N, 56°50'W. Map-unit 5, east half Red Indian Lake map (GSC Map 1196A). Sample SP-682-A, collected and interpreted by D.F. Sangster.

See GSC 70-121 for description and interpretation.

GSC 70-121 Whole rock, K-Ar age 360 ± 16 m.y.

K = 4.13%, $^{40}Ar/^{40}K$ = 0.0232, radiogenic Ar = 98%.
Concentrate: Crushed whole rock.

From sericitized dacite.

(12 A) 13 level, MacLean Orebody, Buchans, New Brunswick, 48°51'N, 56°50'W. Map-unit 5, Red Indian Lake map, east-half (GSC Map 1196A). Sample SP-682-B, collected and interpreted by D.F. Sangster.

This sericitized dacite is medium-grained, thin bedded, and underlies the MacLean Cu-Pb-Zn orebody. Bedded dacitic tuff forms most of the wall-rock of the MacLean and other orbodies of the area. Adjacent to these orebodies, the dacite tuff is altered to sericite schist with relict grains of quartz, feldspar, mica, opaques, and minor chlorite. Geological evidence suggests sulphide deposition to be roughly contemporaneous with volcanism. By dating the time of footwall rock alteration, it was hoped to confirm the Silurian age assigned to these volcanics by Williams (1967). However, the 354 and 360 m.y. ages appear to date a later thermal event associated with granodiorite intrusions which lie 1 1/2 miles northeast of the mine area.

References

Swanson, E.A. and Brown, R.L.
1962: Geology of the Buchans orebodies; Trans. Can. Inst. Mining Met., vol. LXV, pp. 284-292.

Williams, H.
1967: Red Indian Lake (East Half), Newfoundland; Geol. Surv. Can., Open File Report No. 5.

Nova Scotia

(GSC No. 70-122 to 70-126)

GSC 70-122 Muscovite, K-Ar age 476 ± 19 m.y.

K= 7.97%, $^{40}Ar/^{40}K$ = 0.0317, radiometric Ar = 95%.
Concentrate: Impure muscovite with about 17% chlorite contamination. Most of the mica flakes have split edges and are green-tinted.

From quartzose greywacke.
(11 D) Phoenix Island at Dipper Point, southwest of Sheet Harbour, Nova Scotia, 44°46'50"N, 62°37'30"W. Map-unit 5, Geological Map of Nova Scotia, published by N.S. Dept. Mines, 1965. Sample PB68-67, collected and interpreted by W.H. Poole.

See GSC 70-123 for description and interpretation.

GSC 70-123 Muscovite, K-Ar age 496 ± 20 m.y.

K = 8.16%, $^{40}Ar/^{40}K$ = 0.0332, radiogenic Ar = 96%.
Concentrate: Clear muscovite with about 5% chlorite contamination. Some of the mica flakes have split edges.

From quartzose greywacke.
(11 D) Taylor Head Peninsula, west shore, 1.4 miles north of Taylor Head, Nova Scotia, 44°48'00"N, 62°33'55"W. Map-unit 5, Geological Map of Nova Scotia, published by N.S. Dept. Mines, 1965. Sample PB68-180, collected by I.M. Harris, interpreted by W.H. Poole.

The quartzose greywacke in each sample is lithologically identical. It is grey-green and medium to coarse grained. The samples were collected within the basal part of thick graded beds. A few laminae are crowded with detrital muscovite, 1 to 2 mm in diameter. Thin sections show subangular to subrounded quartz grains and minor feldspar in a sericitic and chloritic matrix. Accessory zircon, tourmaline, epidote and sphene are abundant. Muscovite and chlorite are interlayered in many detrital grains.

The Goldenville Formation from which the samples were collected, comprises up to 18,000 feet of quartzose greywacke, which is gradationally overlain by the slate-bearing Halifax Formation containing earliest Ordovician (Tremalocian). Thus the Goldenville is Cambrian, and probably Late Cambrian in age. Primary sole markings of the greywacke beds suggest a source area to the southeast of Nova Scotia. The objective was to determine the age of micas in the source area and to evaluate this use of K-Ar dating.

The resulting dates of 476 ± 10 m.y. and 496 ± 20 m.y. were expected to be the same because they were collected on strike 3 miles apart on what could be the same turbidite deposit. Within the experimental error, the dates are sufficiently similar to be regarded as the same. On the Geological Society of London 1964 time-scale, the dates and error limits span the interval Late Cambrian-Middle Ordovician. These dates cannot record

the age of micas in the source area. It appears that there are four possible explanations of the dates (assuming no analytical error larger than suspected): 1) the dates record the time (Late Cambrian) of erosion, and transportation, deposition and diagenesis of the Goldenville sediment; 2) the dates record the age of diagenesis and alteration during compaction and lithification; 3) the dates record the age of first formation of a cleavage moderately well developed in interbedded grey slate if such "Acadian" cleavage does indeed begin to develop soon after deposition in response to basin tectonics and dewatering; and 4) the dates record an incomplete stage of degassing during metamorphism and deformation in the Devonian Acadian Orogeny. Perhaps explanations 1) and 2) contribute mainly to the resulting dates and any detrital muscovites in other samples which yield K-Ar dates appreciably older than the age of deposition would be interpreted as containing relic source-area radiogenic argon not completely degassed by the processes associated with erosion-deposition-alteration.

These two dates, on the other hand, provide an interesting challenge to those geologists who would be tempted to interpret the somewhat uniform K-Ar dates, 350-400 m.y., on the central and southern mainland Nova Scotia as the result of epeirogenic uplift and cooling through a critical isotherm below which temperature radiogenic argon is retained in the muscovite lattice. The two dates are markedly different from the 350-400 m.y. dates, and these Goldenville rocks surely have undergone the same epeirogenic history as central and southern Nova Scotia.

GSC 70-124 Biotite, K-Ar age 390 ± 17 m.y.

$K = 7.75\%$, $^{40}Ar/^{40}K = 0.0254$, radiogenic Ar = 88%.
Concentrate: Dark olive-buff biotite with a trace of tiny opaque inclusions. Most of the mica flakes have split edges with an orange-yellow alteration.

From gneiss.
(11 E) On road near Cook Brook 5 miles north of mouth, Cobequid Mountains, Nova Scotia, 45°28'55"N, 63°44'50"W. Map-unit 3, GSC Map 874A. Sample PB68-57, collected and interpreted by W.H. Poole.

See GSC 70-125 for description and interpretation.

GSC 70-125 Muscovite, K-Ar age 417 ± 17 m.y.

$K = 8.36\%$, $^{40}Ar/^{40}K = 0.0273$, radiogenic Ar = 96%.
Concentrate: Yellow-stained muscovite with very few clear flakes. Many have split edges and most of the yellow stain is in these edges. About 1% chlorite occurs as attached impurity.

From gneiss.
(11 E) Details as for GSC 70-124.

Nova Scotia

The rock is a dark grey, medium-grained muscovitic-biotite gneiss. Under the microscope, it is seen to comprise alternating laminae rich in quartz and feldspar and laminae rich in micas. Cataclasis has been intense. Quartz is highly sheared, strained and partly recrystallized; feldspar is granulated and some crystals are augen-shaped; and micas are bent. Biotite comprises about 15 per cent of the rock, is pleochroic light brown-yellow to dark brown, and has some fine opaque minerals along its cleavage planes. Muscovite, 5 per cent of the rock, is less deformed than biotite.

The Cobequid Mountains are apparently underlain by Siluro-Devonian sedimentary and volcanic rocks and Devonian granites, and are flanked to the north and south by Carboniferous strata. The biotite gneiss extends through these rocks (Eisbacher, 1970). The objective was to date the cataclasis of the gneiss.

The two dates, biotite 390 ± 17 m.y. and muscovite 417 ± 17 m.y. span the Silurian and Early Devonian. The muscovite date is 7 per cent older than the biotite date. Geologically, a Devonian (Acadian) age of the cataclasis is the simplest and most reasonable interpretation. The muscovite date thus is too old, and the biotite date about right. On the other hand, the cataclasis could have occurred during Ordovician or earlier time (if pre-Silurian rocks are in the future identified in the Cobequid Mountains) and the micas became partly degassed during Devonian granite intrusion. (Or, argon outgassing was not complete prior to uplift through a critical argon-retention isotherm during Devonian time). It is interesting to note the "old" K-Ar dates in the Antigonish Highlands some 75 miles on trend to the east: biotite 432 ± 20 and 582 ±32 m.y. (GSC 66-156, -157, -158).* The real significance of these dates is not yet apparent in terms of plutonism and tectonics.

Reference

Eisbacher, G.H.
1970: Deformation mechanics of mylonitic rocks and fractured granites in Cobequid Mountains, Nova Scotia, Canada; Bull. Geol. Soc. Am., vol. 81, pp. 2009-2020.

*See Geol. Surv. Can. Paper 67-2A, 1968.

GSC 70-126 Muscovite, K-Ar age 401 ± 17 m.y.

$K = 7.04\%$, $^{40}Ar/^{40}K = 0.0262$, radiogenic Ar = 92%.
Concentrate: Clean, clear muscovite with less than 2% feldspar contamination. Some of the flakes contain opaque inclusions.

From skarn.
(11 N) Meat Cove zinc deposit, Nova Scotia, 47°00'30"N, 60°35'30"W. Map-unit 1, GSC Preliminary Map 55-22. Sample SP-698, collected and interpreted by D.F. Sangster.

Muscovite flakes and books occurring in massive sphalerite and mica-serpentine skarn developed in George River Group (?) crystalline limestone adjacent to syenite. Formation of muscovite appears to be

synchronous with sphalerite and coeval with the syenite intrusion. Age of muscovite therefore records time of sphalerite mineralization. Nearby granodiorite correlated on geologic evidence with the syenite has yielded a K-Ar age of 401 m.y. (Fairbairn et al., 1960) in excellent agreement with the age of muscovite in skarn.

References

Fairbairn, H.W., Hurley, P.M., Pinson, W.H. and Cormier, R.F.
1960: Age of the granitic rocks of Nova Scotia; Bull. Geol. Soc. Am., vol. 71, pp. 399-414.

Neale, E.R.W.
1956: Cape St. Lawrence, Inverness, and Victoria Counties, Nova Scotia; Geol. Surv. Can., Paper 55-22.

1963: Pleasant Bay, N.S.: Geol. Surv. Can., Map 1119A.

Prince Edward Island

(GSC No. 70-127 to 70-130)

GSC 70-127 Biotite, K-Ar age 381 ± 16 m.y.

K = 7.85%, $^{40}Ar/^{40}K$ = 0.0247, radiogenic Ar = 93%.
Concentrate: Relatively clean light brownish biotite. Many of the mica flakes contain dark haloes and a few contain rutile inclusions. Less than 5% of the biotite flakes have split edges.

From biotite paragneiss boulder.
(21 I) At sharp bend in road, Woodstock area, Prince Edward Island, 46°43'30"N, 64°07'45"W. O'Leary map-area. Sample PC 98/68, collected and interpreted by V.K. Prest.

The rock is a medium-grained muscovite-biotite paragneiss consisting of quartz, orthoclase, plagioclase, muscovite, biotite and accessory magnetite, zircon and fibrous amphibole.

See GSC 70-130 for an interpretation of this age determination.

GSC 70-128 Biotite, K-Ar age 376 ± 16 m.y.

K = 7.90%, $^{40}Ar/^{40}K$ = 0.0243, radiogenic Ar = 92%.
Concentrate: Light greenish coloured biotite with approximately 10% free chlorite contamination. Some flakes show an orange-coloured alteration on split edges.

From gneiss boulder.
(11 L) At bend in road between Baltic and Spring Valley, Prince Edward Island, 46°30'30"N, 63°39'10"W. Sample PC 8/68, collected and interpreted by V.K. Prest.

The rock is a medium- to coarse-grained muscovite-biotite granite gneiss consisting of quartz, orthoclase, plagioclase, muscovite, biotite, and accessory magnetite, chlorite and zircon.

See GSC 70-130 for an interpretation of this age determination.

GSC 70-129 Biotite, K-Ar age 387 ± 16 m.y.

K = 7.37%, $^{40}Ar/^{40}K$ = 0.0251, radiogenic Ar = 98%.
Concentrate: Clean, orange coloured biotite with no visible alteration or impurities. Some flakes contain pleochroic haloes.

From gneiss boulder.
(11 L) South side of knoll at rear of farm buildings, French River area of Prince Edward Island, 46°31'30"N, 63°30'05"W. Sample PC 99/68, collected and interpreted by V.K. Prest.

Prince Edward Island

The rock is a dark, brownish to black staurolite-biotite gneiss consisting of large porphyroblastic staurolite, reddish brown biotite, muscovite, quartz, plagioclase, amphibole and magnetite.

See GSC 70-130 for an interpretation of this age determination.

GSC 70-130 Biotite, K-Ar age 383 ± 16 m.y.

K = 7.35%, $^{40}Ar/^{40}K$ = 0.0249, radiogenic Ar = 82%.
Concentrate: Light brownish coloured biotite with about 10% chlorite alteration. Some of the mica flakes also have split edges.

From porphyritic biotite granite boulder.
Northwest corner of farm field, St. Peters, Prince Edward Island, 46°26'00"N, 62°35'30"W. Sample PC 83/68, collected and interpreted by V.K. Prest.

This rock is a medium to coarse grained prophyritic biotite granite consisting of quartz, orthoclase, plagioclase, biotite and accessory chlorite, apatite, magnetite and zircon.

Four additional glacial erratics from Prince Edward Island have been dated. Three of the samples (GSC 70-128, 129 and 130) were large erratics emplanted on a till surface by the receding Wisconsin ice sheet. The fourth sample (GSC 70-127) was from a large boulder located very close to the marine limit in western Prince Edward Island, and hence probably emplanted at the start of the postglacial marine phase. These samples were dated, as were other boulders in previous years, in order to establish their most probable source areas; this is important geologically in view of controversy regarding the Laurentide Ice Sheet in the Maritime Provinces.

The four ages are in close accord, ranging between 376 ± 16 and 387 ± 16 m.y., and are in harmony with most of those obtained earlier and are indicative of a source area in the Devonian igneous and metamorphic complex in New Brunswick. This deduction is also in keeping with the trend of those glacial striae on Prince Edward Island that are indicative of the main flow of Wisconsin ice. Of the earlier ages obtained on glacial erratics found on Prince Edward Island, only one was indicative of a Precambrian source area. In view of the numerous K-Ar ages pointing to a Devonian source area, and the trend of ice-flow features on the Island, it is probable that the Precambrian boulder was first carried southward from the Shield by Laurentide ice, and then eastward by confluent Laurentide and Appalachian ice. An anorthosite boulder from north-central Prince Edward Island, similar to the ultrabasic intrusive rocks north of the St. Lawrence River, may also have followed this circuitous route to the Island. Two other anorthosite boulders, however, found in an area of granitoid boulders, one of which has just been dated in the Devonian age-range, are unlike the Shield anorthosites and perhaps have been derived from the Gaspé Peninsula.

Some previously determined ages* on glacial boulders are recorded as GSC 65-135, 65-134, 65-133, and 66-163 at 1125 ± 40, 500 ± 20, 387 ± 12

and 668 ± 81 m.y. A very few more dates of 'foreign stones' from Prince Edward Island will serve to complete the boulder-tracing program. This study has provided valuable information pertinent to the whole problem of glacier movements in the Maritimes. As late ice-flow trends in the Maritimes differ markedly from the earlier main ice flow in most places, it is important to have factual data for use in mineral exploration programs utilizing boulder- or mineral-tracing techniques.

*See Geol. Surv. Can. Papers 66-17 (1967) and 67-2A (1968).

Newfoundland

(GSC No. 70-131 to 70-156)

GSC 70-131 Whole Rock, K-Ar age 38 ± 6 m.y.

$K = 1.50\%$, $^{40}Ar/^{40}K = 0.0022$, radiogenic Ar = 38%.
Concentrate: Crushed whole rock.

From aphanitic volcanic rock.
(13 M) Shore of Mistastin Lake, Newfoundland (Labrador), 55°52'N, 63°41'W. Sample CP 68-135, collected and interpreted by K. L. Currie.

See GSC 70-132 for description and interpretation.

GSC 70-132 Whole Rock, K-Ar age 36 ± 4 m.y.

$K = 1.72\%$, $^{40}Ar/^{40}K = 0.0021$, radiogenic Ar = 40%.
Concentrate: Crushed whole rock.

From scoria.
(13 M) Shore of Mistastin Lake, Newfoundland (Labrador), 55°52'N, 63°47'W. Sample CP 68-155A, collected and interpreted by K. L. Currie.

Samples GSC 70-131 and 132 are scoriaceous, black aphanitic rocks collected on the northwest shore of Mistastin Lake. Microscopically the specimens appear to contain large amounts of devitrified glass, with pyroxene and plagioclase phenocrysts. The potassium-argon age of 202 m.y. obtained for a similar but more massive rock 3 miles to the southwest (GSC Paper 65-17, determination 64-162). This age is fully supported by paleomagnetic determinations (Currie and Larochelle, 1969), and the young ages of the present samples are therefore concluded to be anomalous, possibly because of argon loss from the vesicular rocks.

Reference

Currie, K. L. and Larochelle, A.
1969: A paleomagnetic study of volcanic rocks from Mistastin Lake, Labrador, Canada; Earth Planetary Sci. Letters, vol. 6, pp. 309-315.

GSC 70-133 Biotite, K-Ar age 1320 ±50 m.y.

$K = 6.17\%$, $^{40}Ar/^{40}K = 0.1118$, radiogenic Ar = 97%.
Concentrate: Relatively clean, slightly blistered khaki biotite with 3=5% hornblende contamination. About 20% of the flakes contain oriented acicular inclusions, and about 2% opaque blebs.

Newfoundland

From granite.

(13 E) Southeast corner of Lake Michikamau, Newfoundland (Labrador), 53°55'N, 63°31'W. Sample MM-9-66, collected and interpreted by I.M. Stevenson.

This specimen is from an extensive area of massive, medium grained, white weathering, locally porphyritic granitic rocks that outcrop along the south shore of Lake Michikamu. Typically, these rocks consist of phenocrysts of pink feldspar in a greenish matrix of plagioclase, microcline, quartz, hornblende and biotite; locally they may vary from granite through granodiorite to a quartz-poor syenitic rock. Epidote, occurring both as an alteration product of plagioclase and ferromagnesian minerals and also as a deuteric mineral, is everywhere abundant.

The position of the Grenville Front in Lake Winokapau map-area has not been definitely established, and this age determination provides additional information pertinent to solving the problem.

GSC 70-134 Biotite, K-Ar 1570 ± 50 m.y.

K = 7.76%, $^{40}Ar/^{40}K$ = 0.1435, radiogenic Ar = 99%.
Concentrate: Clean, dark olive-buff biotite. Some flakes are a little greener in colour.

From granite gneiss.

(13 J) 2 miles west of Makkovik Lake, Newfoundland (Labrador), 54°48'N, 59°43'W. Sample N-199-8, collected and interpreted by I.M. Stevenson.

This specimen of medium-grained, lineated grey granite is from a highly disturbed region of mainly granitic rocks situated some two miles west of Makkovik Lake. Plagioclase, quartz, alkali-feldspar and olive-green biotite, present in order of decreasing abundance, are the main minerals.

The determined age on the biotite indicates that these rocks were apparently unaffected by the Grenville orogeny, as the age indicates that the last orogeny in this region occurred during early Elsonian time.

GSC 70-135 Biotite, K-Ar age 1150 ±40 m.y.

K = 7.49%, $^{40}Ar/^{40}K$ = 0.0926, radiogenic Ar = 98%.
Concentrate: Light greenish brown biotite with about 10% chlorite alteration. Hornblende contamination amounts to about 5%, occurring as free grains. Some of the biotite flakes have split edges.

From paragneiss.

(13 J) 8 miles south of White Bear Lake, Newfoundland (Labrador), 54°24'N, 59°34'W. Sample SG-256-68, collected and interpreted by I.M. Stevenson.

Newfoundland

This rock is a coarse, dark, foliated, biotite-rich paragneiss cut by numerous quartz stringers. Feldspar, quartz and biotite, in decreasing amounts, are the main constituent minerals in the specimen, with biotite forming approximately 30 per cent of the whole.

The determined age of 1150 ± 40 m.y. indicates that the specimen was obtained from within the Grenville Province, thereby further outlining the position of the Grenville Front in this part of Labrador.

GSC 70-136 Biotite, K-Ar age 1580 ±50 m.y.

K = 7.48%, $^{40}Ar/^{40}K$ = 0.1446, radiogenic Ar = 98%.
Concentrate: Light brownish coloured biotite with a slight trace of chlorite attached to some of the flakes. Fine opaque inclusions are present in less than 2% of the mica flakes.

From granite.
(13 J) Approximately 4 miles upstream from mouth of Pamiulik River, Newfoundland (Labrador), 54°42'N, 58°35'W. Sample SG-129-68, collected and interpreted by I. M. Stevenson.

This specimen is from a coarse, massive to slightly foliated, grey to buff, medium grained granite peculiar to much of Benedict Mountains. To date, it has been assumed that these mountains lie south of the Grenville Front, but recently derived structural data have indicated that this may not be so.

This age determination will aid in more accurately locating the position of the eastern extension of the Grenville Front in Labrador, insofar as it indicates that rocks of Benedict Mountains have apparently been little affected by the Grenville orogeny.

GSC 70-137 Biotite, K-Ar age 1165 ± 40 m.y.

K = 7.87%, $^{40}Ar/^{40}K$ = 0.0943, radiogenic Ar = 98%.
Concentrate: Clean, unaltered greenish coloured biotite with no significant impurities.

From biotite-hornblende gneiss.
(13 J) 2 miles north of Groswater Bay, Newfoundland (Labrador), 54°24'N, 58°01'W. Sample SG-58-68, collected and interpreted by I. M. Stevenson.

This specimen was from a hill of coarse, gneissic, grey, biotite granite similar to that prevalent over much of this region south of Benedict Mountains. Hills in this area commonly have cores of dark, resistant metamorphosed gabbro, and it is possible that the determined age marks the age of intrusion of the gabbro.

Newfoundland

GSC 70-138 Biotite, K-Ar 1425 ± 50 m.y.

K = 7.44%, $^{40}Ar/^{40}K$ = 0.1246, radiogenic Ar = 98%.
Concentrate: Relatively clean, light brownish coloured biotite. There is a trace (less than 2%) of free hornblende impurity, and some of the mica flakes have split edges.

From granite gneiss.
(13 I) Southeast shore of Bryan Bay, Newfoundland (Labrador), 54°38'N, 57°38'W. Sample SG-94-68, collected and interpreted by I. M. Stevenson.

The rock is a fresh, massive to slightly foliated, medium grained, grey granite. Alkali feldspar, plagioclase, quartz, and fresh, reddish brown biotite, present in decreasing amounts, are the main minerals present.

The K-Ar age of 1425 ± 50 m.y. indicates that the last period of orogeny in this region took place during late middle Elsonian time, and that these rocks do not lie within the Grenville Province.

GSC 70-139 Biotite, K-Ar age 1530 ±50 m.y.

K = 7.81%, $^{40}Ar/^{40}K$ = 0.1377, radiogenic Ar = 98%.
Concentrate: Clean, greenish brown biotite with no impurities or alteration.

From pegmatite.
(24 P) Ungava Peninsula, Newfoundland (Labrador), 59°55'N, 64°18'W. No geological map reference. Sample TA67-T321E, collected and interpreted by F. C. Taylor.

The sample is from biotite pegmatite which cuts an anothosite of possible metamorphic origin. The age is considered to represent the time of intrusion of the dyke; a product of the Hudsonian orogeny.

GSC 70-140 Hornblende, K-Ar 1550 ± 55 m.y.

K = 0.98%, $^{40}Ar/^{40}K$ = 0.1404, radiogenic Ar = 93%.
Concentrate: Slightly pleochroic, light green to brownish hornblende. The amphibolite is very fine grained and many of the grains carry attached feldspar fragments (less than 5%).

From hornblende lamprophyre.
(13 O) Makkovik village, Newfoundland (Labrador), 55°05'N, 59°12'W. Sample TA-68-T101, collected by E. R. Deutsch (Memorial University), interpreted by F. C. Taylor.

This sample is from a dark greenish grey, fine grained, amygdaloidal, hornblende lamprophyre dyke. The hornblende, which is fresh,

subhedral, greyish yellow to medium olive-brown, lies in a highly altered matrix of indeterminate plagioclase with calcite and chlorite. The plagioclase is altered to epidote and sericite. Amygdules consist of calcite and chlorite. The age 1,550 ± 55 m.y., is probably the age of the intrusion of the dyke.

The only other age determinations on lamprophyre minerals in the district are from biotite lamprophyres from Cape Aillik, 10 miles to the north. These ages (GSC 62-180, 62-181, 62-182)* are in the range 535-590 m.y. The present age suggests two periods of lamprophyre emplacement in the Makkovik district.

*See Geol. Surv. Can. Paper 63-17, 1963.

GSC 70-141 Whole Rock, K-Ar age 729 ± 55 m.y.

K = 2.07%, $^{40}Ar/^{40}K$ = 0.0521, radiogenic Ar = 91%.
Concentrate: Crushed whole rock.

From chilled diabase.
(13 O) Aillik Bay, coast of Labrador, Newfoundland, 55°12'N, 59°12'W. Sample FA-4-67, collected and interpreted by W.F. Fahrig.

This whole-rock K-Ar age of chilled dyke material is considered to provide a first approximation of the age of intrusion.

GSC 70-142 Whole Rock, K-Ar age 1340 ± 120 m.y.

K = 1.04%, $^{40}Ar/^{40}K$ = 0.1145, radiogenic Ar = 95%.
Concentrate: Crushed whole rock.

From diabase.
(13 I) Munday Island, coast of Labrador, Newfoundland, 54°24'N, 57°12'W. Sample FA-5-67, collected and interpreted by W.F. Fahrig.

This sample represents the chilled margin of a dyke intrusion and provides a first approximation of the age of intrusion.

GSC 70-143 Muscovite, K-Ar age 400 ± 17 m.y.

K = 6.94%, $^{40}Ar/^{40}K$ = 0.0260, radiogenic Ar = 99%.
Concentrate: Impure muscovite with about 20% iron-stained feldspar contamination which could not be removed from the concentrate.

From micaceous sandstone.
(12 H) 6 miles southwest of Springdale on Trans-Canada Highway,

Newfoundland

Newfoundland, 49°27'12"N, 56°11'27"W. Map-unit 15c, GSC Map 40-1962. Sample WF-165-67, collected by W.A. Nash, interpreted by H. Williams.

The age determination was made on detrital muscovite contained in red micaceous sandstones of the Springdale Group. These rocks are cut by Acadian granites (Devonian) and generally considered correlatives of the Silurian Botwood Group. The high feldspar content of the concentrate makes this age suspect. The determination at 400 m.y. is close to the age of detrital muscovite in the Botwood Group (422 m.y.) but both groups are cut by intrusions dated in the range 400-425 m.y.

GSC 70-144 Muscovite, K-Ar age 524 ± 21 m.y.

K = 7.39%, $^{40}Ar/^{40}K$ = 0.0354, radiogenic Ar = 97%.
Concentrate: Relatively clean muscovite consisting of 70% clear flakes and 30% yellow-stained flakes. There is a trace of chlorite attached to the mica flakes, and some contain up to 5% opaque grains.

From siltstone-shale.
(12 H) Headland opposite Kings Bay, Green Bay, Newfoundland, 49°35'26"N, 56°09'23"W. Map-unit 15d, GSC Map 40-1962. Sample WF-164-67, collected and interpreted by H. Williams.

This age determination was made on detrital muscovite contained in grey to red calcareous shales and siltstones that are correlated with the silurian or younger Springdale Group. The age determination of 524 ± 21 m.y. provides a maximum limit for the age of the enclosing rocks, but more important, indicates a source terrain affected by an orogenic event of this age. This terrain is undoubtedly the mica-rich metasedimentary rocks of the Fleur de Lys Group exposed nearby toward the west, and the indicated age of metamorphism agrees with several lines of indirect evidence indicating that the Fleur de Lys Group was metamorphosed and cut by intrusions in pre-Ordovician time.

GSC 70-145 Muscovite, K-Ar 613 ± 24 m.y.

K = 5.36%, $^{40}Ar/^{40}K$ = 0.0424, radiogenic Ar = 98%.
Concentrate: Impure yellow-stained muscovite with 15% chlorite, 5% included opaques and a trace of quartz. Only about 25% of the mica flakes are clean and colourless.

From siltstone.
(1 M) West shore of Brunette Island, Fortune Bay, Newfoundland, 47°17'00"N, 55°52'30"W. Map-unit 4, GSC Map 8-1965. Sample WF-163, -67, collected by W.A. Nash, interpreted by H. Williams.

Newfoundland

The age determination was made on detrital muscovite contained in grey siltstones and sandstones. These beds have been assigned to the late Precambrian on lithologic evidence and the detrital muscovite age suggests a similar provenance to the beds at Chapel Island and Long Island nearby, (see GSC 70-146 and 147).

GSC 70-146 Muscovite, K-Ar age 565 ± 26 m.y.

K = 6.47%, $^{40}Ar/^{40}K$ = 0.0386, radiogenic Ar = 98%.
Concentrate: Rather impure, yellow-stained muscovite with about 10% chlorite and other indeterminate impurities.

From sandstone.
(1 M) Northwest shore of Long Island, Belle Bay, Newfoundland, 47°34'25"N, 55°23'05"W. Map-unit 14 (Rencontre Formation), GSC Map 8-1965. Sample WF-159-67, collected by W. A. Nash, interpreted by H. Williams.

The age determination was made on detrital muscovite from medium to coarse-grained purplish sandstone of the Rencontre Formation. The Rencontre is one of several undated formations in this part of Newfoundland and the age of contained detrital muscovite gives a maximum limit to the age of the formation.

GSC 70-147 Muscovite, K-Ar age 517 ± 21 m.y.

K = 7.36%, $^{40}Ar/^{40}K$ = 0.0348, radiogenic Ar = 95%.
Concentrate: Yellow-stained muscovite with about 10% chlorite and 5% opaque and indeterminate impurities.

From siltstone.
(1 M) East shore of Chapel Island, Belle Bay, Newfoundland, 47°33'25"N, 55°21'48"W. Map-unit 4, GSC Map 8-1965. Sample WF-162-67, collected by W. A. Nash, interpreted by H. Williams.

The age determination was made on detrital muscovite and the indicated age gives a maximum limit to the age of the enclosing rock. These beds on Chapel Island have been assigned to the late Precambrian but appear to be in structural continuity with lower Palaeozoic(?) beds of the Rencontre Formation on Long Island nearby (Anderson, pers. comm. 1965). A similar age of detrital muscovites in both suggests a similar provenance.

GSC 70-148 Biotite, K-Ar age 352 ± 15 m.y.

K = 7.41%, $^{40}Ar/^{40}K$ = 0.0226, radiogenic Ar = 89%.
Concentrate: Light brownish olive biotite with about 10% chlorite as an alteration product of the mica.

Newfoundland

From quartz monzonite.

(2 F) Funk Island, 35 miles offshore from northeastern Newfoundland, 49°45'30"N, 53°11'20"W. Map-unit 5, GSC Map 1227A. Sample WF-467-64. Collected and interpreted by H. Williams.

The sample was collected from an outcrop of massive, coarse-grained, pink, porphyritic (perthite), biotite "granite" of the type that is so abundant along the eastern flank of the mobile belt in Newfoundland. The age dates the time of emplacement of the granite, which is interpreted as late Devonian (Acadian) rather than early Carboniferous, as Carboniferous rocks of Newfoundland occur as cover upon the Acadian deformed zone. The age of 352 ± 15 m.y. compares favourably with other isotopic age determinations on similar granites southwestward along the regional structural trend.

GSC 70-149 Biotite, K-Ar 384 ± 16 m.y.

K = 7.70%, $^{40}Ar/^{40}K$ = 0.0249, radiogenic Ar = 96%.
Concentrate: Brownish coloured biotite with about 10% chlorite.

From granodiorite.

(12 H) In road cut on Baie Verte road 4,000 feet southwest of Kidney Pond, Newfoundland, 49°41'40"N, 56°23'20"W. Map-unit 10b, GSC Map 35-1960. Sample NA 20.5-66, collected and interpreted by E.R.W. Neale.

The rock is a coarse, pinkish grey, massive granite with pink K-feldspar phenocrysts (30%) up to 1 1/2 inches across in a medium-grained groundmass of quartz (20%), plagioclase (40%), biotite (7%) and accessories (3%).

The specimen is from a high level, massive (post D.3) granite which intrudes the Eo-Cambrian Fleur de Lys Group immediately to the west of the Baie Verte Road Fault. The Devonian age obtained is similar to that of the Partridge Point granite which intrudes the Fleur de Lys rocks farther north and also to an age obtained on late (post D.2) micas in the Fleur de Lys schists.

Reference

Neale, E.R.W. and Kennedy, M.J.
1967: Relationship of the Fleur de Lys Group to younger rocks of the Burlington Peninsula, Newfoundland; Geol. Assoc. Can.; Spec. Paper 4, pp. 139-169.

GSC 70-150 Muscovite, K-Ar age 361 ± 16 m.y.

K = 8.60%, $^{40}Ar/^{40}K$ = 0.0233, radiogenic Ar = 94%.
Concentrate: Clean, clear muscovite with traces of plagioclase and K-feldspar.

From granite.

(12 I) Partridge Point, Newfoundland, 50°09'30"N, 56°09'W. Map-unit 8, GSC Map 16-1959. Sample NA-G5-66, collected and interpreted by E. R. W. Neale.

The rocks is a massive, equigranular leucocratic muscovite granite which occurs as dykes and sills within psammitic and pelitic strata of the Fleur de Lys Supergroup at Partridge Point. The granite is clearly post major orogeny (i.e. post D_2 of the Fleur de Lys) and the Devonian age coincides closely with that of a large post orogenic pluton which cuts the Fleur de Lys rocks farther to the south (GSC 60-148 in GSC Paper 61-17). A K-Ar age of 355 m.y. (GSC 60-149) obtained on muscovite developed along S_2 schistosity in nearby Fleur de Lys schists probably records a Devonian updating event associated with intrusion of the Partridge Point dykes and sills.

GSC 70-151 Biotite, K-Ar age 348 ± 15 m.y.

K = 7.06%, $^{40}Ar/^{40}K$ = 0.0224, radiogenic Ar = 97%.
Concentrate: Slightly altered olive-green biotite with about 5% hornblende contamination. Most flakes are altered to chlorite on the edges and most contain colourless prismatic inclusions surrounded by weak pleochroic haloes. Total chlorite content is 8-10%.

From granite.

(2 E) West shore of Pacquet Harbour, south of Pacquet Village, Newfoundland, 49°58'30"N, 55°53'W. Map-unit 13 (Dunamaggon Granite), GSC Map 22-1958. Sample NA-39-66, collected and interpreted by E. R. W. Neale.

This massive, equigranular, hornblende-biotite granite known as the Dunamaggon Granite (Baird, 1951), intrudes amphibolite and basic metavolcanic rocks of the Pacquet Harbour group of the Fleur de Lys Supergroup (Church, 1969, in press). Its Devonian age corresponds closely with that of GSC 70-150 and also with that of another GSC 60-148 in GSC Paper 61-17) post orogenic granite which cuts rocks of the Fleur de Lys Supergroup.

References

Baird, D. M.
1951: The Geology of Burlington Peninsula, Newfoundland; Geol. Surv. Can., Paper 51-21, p. 70.

Church, W. R. (in press):
Metamorphic Rocks of the Burlington Peninsula and adjoining areas of Newfoundland; the Gander Conference, M. Kay ed.; Am. Assoc. Petrol. Geol. Spec. Vol.

Newfoundland

GSC 70-152 Biotite, K-Ar age 397 ± 17 m.y.

K = 7.75%, $^{40}Ar/^{40}K$ = 0.0259, radiogenic Ar = 96%.
Concentrate: Light brown biotite with about 10% attached chlorite. Some flakes of mica are much darker than the majority.

From quartz monzonite.
(1 M) South end of Medonnegonix Lake, Newfoundland, 47°57'20"N, 55°24'30"W. Map-unit 17, GSC Map 8-1965. Sample AA-2-78-1, collected and interpreted by F.D. Anderson.

The rock is a coarse-grained, pink to grey quartz-monzonite with large phenocrysts of potash feldspar. The specimen was taken from the southwestern margin of the Ackley Batholith. The isotopic date of 397 m.y. agrees reasonably well with the date of 368 m.y. (GSC 60-150)* obtained from the northwestern margin and 392 m.y. (GSC 62-190)* obtained from the southeastern margin of the batholith.

*See Geol. Surv. Can. Papers 61-17 (1961) and 63-17 (1963).

GSC 70-153 Muscovite, K-Ar age 392 ± 16 m.y.

K = 8.61%, $^{40}Ar/^{40}K$ = 0.0255, radiogenic Ar = 93%.
Concentrate: Clean, clear muscovite with slight yellow staining on split edges.

From pegmatite.
(2 D) Trans Canada Highway, west of Gloverton, about 1 mile north of road turnoff to Alexander Bay Station, Newfoundland, 48°41'20"N, 54°06'30"W. Map-unit 1C, GSC Map 1129 A. Sample PB67-129, collected and interpreted by W.H. Poole.

The pegmatite is white, and simple in mineralogy. About 70% of the rock consists of albite-oligoclase crystals up to several centimetres long, which are fractured and partly crushed. Quartz, about 20%, is sheared and recrystallized. Garnet is rare. The balance of the rock is muscovite in large, bent crystals.

See GSC 70-154 for interpretation.

GSC 70-154 Hornblende, K-Ar age 412 ± 20 m.y.

K = 8.61%, $^{40}Ar/^{40}K$ = 0.0270, radiogenic Ar = 63%.
Concentrate: Pleochroic light yellow to light bluish green hornblende with less than 5% attached quartz.

Newfoundland

From amphibolite.

(2 D) Trans Canada Highway, west of Gloverton, about 1 mile north of road turnoff to Alexander Bay Station, Newfoundland, 48°41'20"N, 54°06'30"W. Map-unit 1C, GSC Map 1129A. Sample PB67-130, collected and interpreted by W.H. Poole.

The amphibolite is dark grey, fine to medium grained, and faintly banded. In thin section it is seen to comprise 50% quartz and plagioclase, 5% sphene, and 45% hornblende which is unaltered and pleochroic light yellow to light bluish green. Chlorite filled microfractures in the rock.

The pegmatite and amphibolite (GSC 70-153 and and 70-154) with granitic gneiss comprise the zone of metamorphic rocks formed along the boundary between the Precambrian (?) Love Cove Group and the Cambro-Ordovician Gander Lake Group to the west. The regional metamorphic belt lies on the east side of the "central mobile belt" of Newfoundland. The objective was to date the metamorphism.

The dates, muscovite 392 ± 16 m.y. and hornblende 412 ± 20 m.y., together (and considering the error on each), span the Silurian and much of Early Devonian. The muscovite date is higher than most mica dates in this eastern metamorphic belt; most other mica dates fall in the 350-390 m.y. range, and are assumed to reflect the mid-Devonian, Acadian Orogeny. The hornblende date, on the other hand, is too high although the error enables one to 'squeeze' it to about 390 m.y. It seems safe to assume that the regional metamorphism is Devonian as well as the granitic plutons.

GSC 70-155 Whole rock, K-Ar age 269 ± 38 m.y.

K = 0.76%, $^{40}Ar/^{40}K$ = 0.0169, radiogenic Ar = 77%.
Concentrate: Crushed whole rock.

From basalt dyke.

(2 C) On shore, north side of Smith Sound, about 1/2 mile west of Smith Point, Newfoundland, 48°11'20"N, 53°51'15"W. Unmarked dyke cuts map-unit 6, GSC Map 1130A. Sample PB67-102, collected and interpreted by W.H. Poole.

The interior of the basalt dyke, from which the sample was taken, is brownish grey, fine grained and massive. In thin section, about 40% consists of well twinned labradorite laths. The balance is interstitial groundmass with fine-grained biotite, iron ore and calcite.

The dyke is 2 feet wide, is nearly vertical, strikes 085 and has intruded gently deformed Cambrian shale. The dyke itself is undeformed.

The date of 269 ± 38 m.y. spans late Pennsylvanian and Permian time. Igneous and tectonic activity in eastern Newfoundland is believed to have ended with the Devonian Acadian Orogeny. Dyke intrusion from Devonian to Mesozoic is possible. The date cannot be evaluated geologically.

Newfoundland

GSC 70-156 Muscovite, K-Ar age 540 ± 21 m.y.

K = 7.66%, $^{40}Ar/^{40}K$ = 0.0366, radiogenic Ar = 98%.
Concentrate: Yellow-stained muscovite with about 10% brown chlorite contamination (mainly within the mica flakes). Some of the flakes have split edges.

From micaceous sandstone.
(1 N) Shore cliffs at The Beach, 1/4 mile northeast of the ferry landing, Bell Island, Newfoundland, 47°38'00"N, 52°55'10"W. Map-unit 9, GSC Map 1018A. Samples PB67-4 and PB67-5 combined, collected and interpreted by W.H. Poole.

The micaceous sandstone is grey to light greenish grey and medium grained, and contains some phosphatic linguloid shells. Glistening white muscovite is abundantly concentrated on bedding planes; some laminae could well be referred to as 'muscovite sandstone'. In thin section, quartz grains and glauconite make up 90% of the rock. About 5% consists of thin, fresh muscovite plates, and the balance is pelitic matrix, calcite cement and phosphatic shell.

The Bell Island Group from which the sample was taken is Early Ordovician in age and with the overlying Wabana Group contains the sedimentary iron ores of the Wabana mine. These strata in eastern Newfoundland form the top of a conformable Lower Cambrian-Lower Ordovician sequence. The underlying Precambrian (Hadrynian) sedimentary and volcanic rocks and Holyrood granite lack sufficient muscovite to be a reasonable source for the Bell Island strata. The analysis was made in an attempt to determine the age of the source area micas and to evaluate this use of K-Ar age determination.

The 540 ± 21 m.y. date spans all the Middle Cambrian, whereas the strata were deposited about 495 m.y. (Early Ordovician). Thus if the analysis is correct, the detrital muscovite does contain some of its pre-depositional radiogenic argon. The strata are flat lying and lack penetrative secondary structures. There is no evidence that the strata were ever deeply buried beneath younger Phanerozoic strata, but still there is no evidence that they were not so buried. The Holyrood Granite, presumed to underlie Bell Island, has yielded a Rb-Sr whole-rock isochron of 574 ± 11 m.y. (McCartney et al. 1966). It is possible that an area of late Precambrian or early Cambrian plutonic and metamorphic rocks underlie the Atlantic continental shelves or opposite parts of western Europe and Africa, and could have shed the detrital muscovite to Bell Island strata.

Reference

McCartney, W.D., Poole, W.H., Wanless, R.K., Williams, H. and Loveridge, W.D.
1966: Rb-Sr age and geological setting of the Holyrood Granite, southeast Newfoundland; Can. J. Earth Sci., vol. 3, pp. 947-957.