GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF MINES
AND TECHNICAL SURVEYS

PAPER 65-17

AGE DETERMINATIONS AND GEOLOGICAL STUDIES
K-Ar Isotopic Ages, Report 6

(Report, 4 tables and 1 figure)

R. K. Wanless, R. D. Stevens, G. R. Lachance,
and J. Y. H. Rimsaite

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DEPARTMENT OF MINES AND TECHNICAL SURVEYS

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ABSTRACT

New potassium-argon age determinations are reported for 165 Canadian mineral and rock samples, listed according to their provincial and territorial distribution. Each sample is described, and a geological interpretation of its determined age is given. The techniques employed are described in outline form, and the analytical precision is discussed. Two recent geological time-scales are summarized in tabular form.

The age determination program is a coordinated 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 by isotope dilution techniques.

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

J.Y.H. Rimsaite - X-ray diffractometry and mineralogy of the concentrates.

AGE DETERMINATIONS AND GEOLOGICAL STUDIES BY THE GEOLOGICAL SURVEY OF CANADA

INTRODUCTION

by R. K. Wanless

This is the sixth in the series of annual releases of potassium-argon age measurements carried out in the isotope geology laboratories of the Geological Survey of Canada. Previous reports included a total of 828 determinations and an additional 165 measurements completed during 1964 are presented here.

Procedure

The samples were examined mineralogically and all mineral concentrates were analyzed by X-ray diffraction to determine the degree of chloritization. X-ray fluorescence techniques were used to determine the potassium content. A high-frequency generator was employed to fuse the sample material in vacuo, and standard isotope dilution techniques were used to determine the radiogenic argon content.

Precision of Age Determinations

In Report 5 (GSC Paper 64-17, Part I) the factors to be considered when calculating error limits for individual age determinations was discussed. It was pointed out that the assumed uncertainty in determining potassium in the low concentration range made the calculation of error limits for whole rock samples impractical. In order to resolve this problem mass spectrometric isotopic dilution techniques were developed and used to determine the potassium concentration in a suite of whole rock and mineral samples. The isotope dilution results are compared in Table I with the values obtained using X-ray fluorescence techniques (see Lachance, in Wanless et al., 1965, pp. 4-7). It will be noted that the determinations of the amount of potassium present at low concentration levels agree within $\pm$ 10%, and that the agreement improves markedly in the higher concentration range.

TABLE I

Comparison of Potassium Determinations

No.	SAMPLE	PER CENT POTASSIUM ISOTOPE DILUTION		X-RAY FLUORESCENCE[2]
P 207	Muscovite	8.59 ± 0.10[1]		8.66 ± 0.13
G-1	Whole Rock Granite	4.57) 4.63)	4.60	4.51[3]
W-1	Whole Rock Diabase	0.54) 0.53)	0.535	0.53[3]
P-1-1	Whole Rock Picrite	0.21) 0.19) 0.21)	0.20	0.19 ± 0.01[4] 0.17 ± 0.01(FP)[5]
FA-138-62	Whole Rock Gabbro	1.04) 1.09) 1.09)	1.07	1.04
F-26-62	Whole Rock Gabbro	0.40) 0.39)	0.395	0.36
FA-190-62(3)	Whole Rock Gabbro	0.34) 0.28)	0.31	0.28
FA-164-62(3)	Whole Rock Gabbro	1.24		1.30

1. Average of five determinations.
2. X-ray fluorescence determinations by G.R. Lachance, Geological Survey of Canada.
3. Used as standard.
4. X-ray fluorescence determination in analytical chemistry laboratories, Geological Survey of Canada.
5. FP = flame photometric determination in analytical chemistry laboratories, Geological Survey of Canada.

Error limits may now therefore be assigned for the complete range of potassium values and the preliminary table presented on page 3 of Report 5 may be extended as follows:

TABLE II

Error Limits Assigned to Potassium Determinations

% K	% Error (σ K)
5 - 9	$\pm$ 1.5
3 - 5	$\pm$ 5
1 - 3	$\pm$ 6
0.5 - 1	$\pm$ 8
0.2 - 0.5	$\pm$ 10

The values listed above have been incorporated in the calculation of error limits (95% confidence) as detailed in Report 5, for all age determinations published in this report.

Constants Employed in Age Calculations

Age calculations are based on the following potassium-40 decay constants:

$$\lambda_e = 0.585 \times 10^{-10}\ yr^{-1}$$

$$\lambda_{total} = 5.30 \times 10^{-10}\ yr^{-1}$$

Geological Time-scale

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

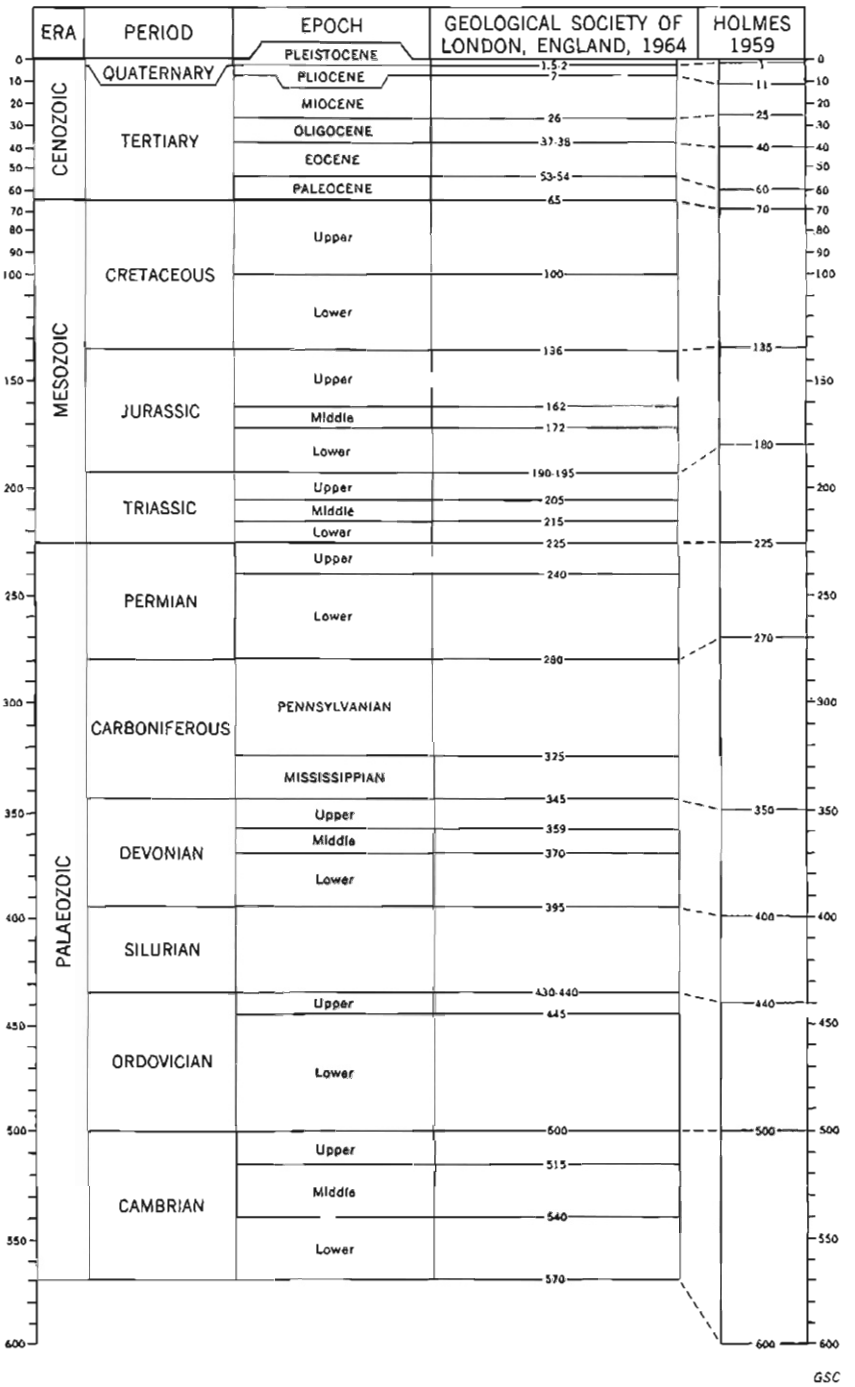

Table III. Phanerozoic time-scale (after Geological Society, London, England, and Holmes).

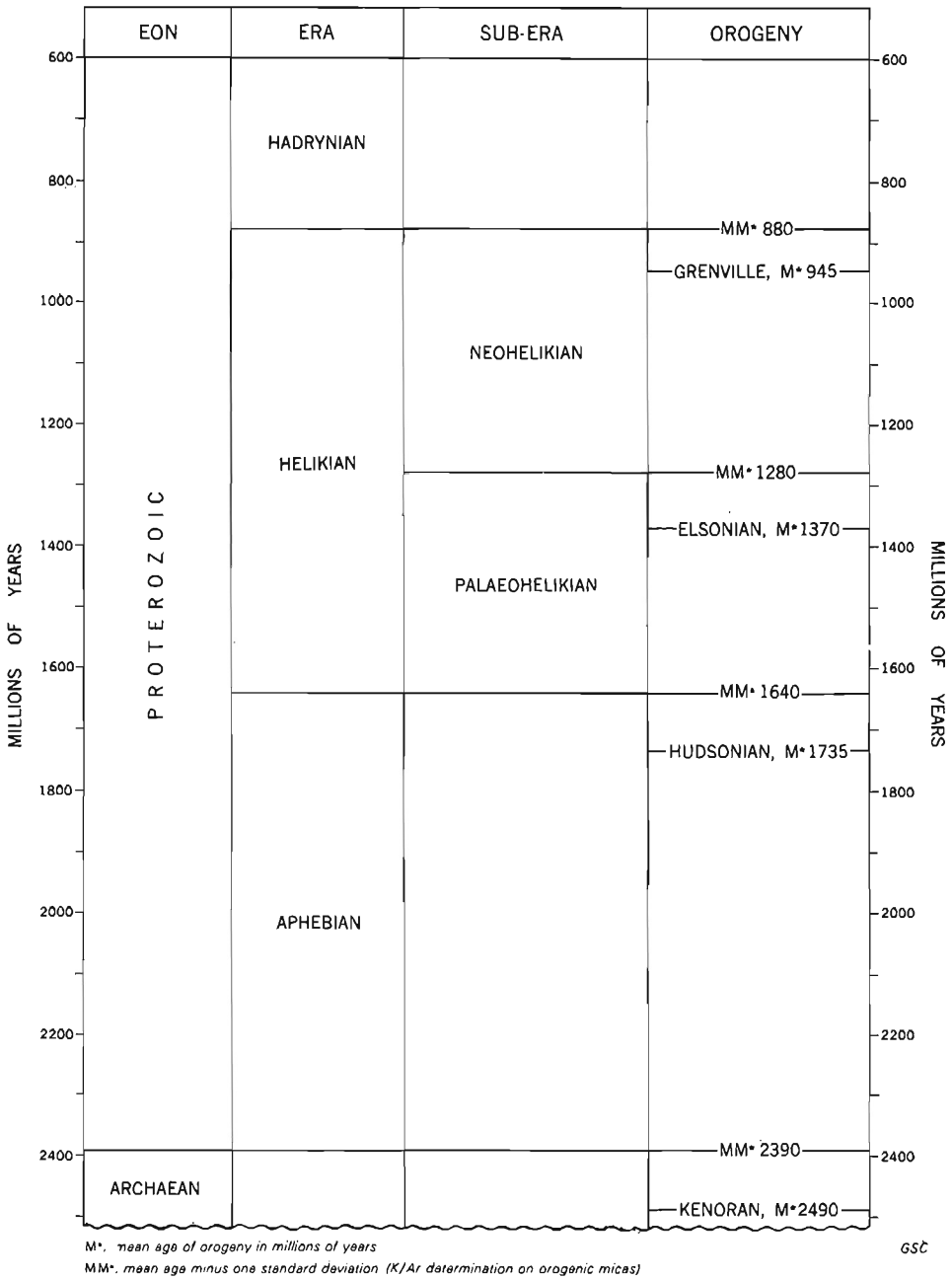

Table IV. Precambrian time-scale for the Canadian Shield (after Stockwell, 1964).

References

Geological Society
1964: Geological Society Phanerozoic time scale; Quart. J. Geol. Soc. London, vol. 120 S, pp. 260-262.

Holmes, A.
1959: A revised geological time scale; Trans. Edinburgh Geol. Soc., vol. 17, pt. 3, pp. 183-216.

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

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

K-Ar ISOTOPIC AGES—REPORT 6

Compiled by R. D. Stevens

British Columbia

GSC 64-1 Whole Rock, K-Ar age 245 ± 80 m.y.

$K = 0.23\%$, $Ar^{40}/K^{40} = 0.0154$; radiogenic Ar = 34%. Concentrate; crushed whole rock.

From weakly foliated amphibolite.
(104 P) Between Blue River and Iverson Creek, British Columbia; 59°32'N, 129°58'W. Map-unit 4, GSC Map 54-10 (McDame). Sample WJ-62-74, collected and interpreted by W. J. Wolfe.

The amphibolite is medium grained with poorly defined foliation imparted by the segregation of thin lenses of white plagioclase feldspar. It is composed of 65% unaltered green hornblende, 35% partly zoisitized plagioclase, and minor accessory sphene.

The sample is taken from the outer zone of contact metamorphism related to the Blue River ultramafic intrusion. The amphibolite of this zone represents the metamorphic equivalent of the Sylvester Group basic volcanic rocks of Upper Devonian to Middle Mississippian age (Gabrielse, 1963, G. S. C. Memoir 319). Redistribution of argon in the rock presumably accompanied metamorphic recrystallization, and the whole rock age is interpreted as representative of the approximate time of ultramafic intrusion. The field relations indicate that the ultramafic rocks of the Cassiar belt are post-Middle Mississippian and pre-Lower Cretaceous (approximate age of the Cassiar Batholith) in age. The amphibolite date (245 m.y.) is in agreement with these field relations. The relationship between the ultramafic rocks and Middle to Upper Permian limestones and basalts that unconformably overlie the Sylvester Group remains ambiguous.

GSC 64-2 Biotite, K-Ar age 167 ± 10 m.y.

$K = 6.13\%$, $Ar^{40}/K^{40} = 0.0102$; radiogenic Ar = 65%. Concentrate; reasonably clean concentrate of brown, partly altered biotite. About 50% of the biotite flakes are altered to chlorite and contain inclusions of epidote. Hornblende constitutes a minor impurity. Total chlorite content 30%.

British Columbia

From granodiorite facies of batholith.

(92 F) Road cut from Macmillan, Bloedel, and Powell River road up Redford Creek, 3/4 mile in a straight line northeast of the Brynnor mines open pit, British Columbia; 49°03'N, 125°25'W. Cf. map-unit 5, GSC Map 932A (2nd edition). Sample E-63-2, collected and interpreted by G. E. P. Eastwood, B. C. Dept. of Mines and Petroleum Resources.

For interpretation see determination GSC 64-3.

GSC 64-3 Biotite, K-Ar age 121 ± 35 m.y.

$K = 4.29\%$, $Ar^{40}/K^{40} = 0.0073$; radiogenic Ar = 35%. Concentrate; reasonably clean concentrate of orange-reddish biotite. Impurities consist of dull green chlorite and altered amphibole. The biotite flakes contain zircon inclusions surrounded by faint pleochroic haloes. Total chlorite content 30%.

Composite of two samples from a grey feldspar porphyry dyke that intrudes magnetite.

(92 F) From bench at 300 feet elevation in Brynnor mines open pit, British Columbia; 49°03'N, 125°26'W. Sample E-63-4 from south wall of pit and sample E-63-5 from east wall. Collected and interpreted by G. E. P. Eastwood, B. C. Dept. of Mines and Petroleum Resources.

These samples were taken primarily with a view to bracketing the age of the magnetite, but the results also throw considerable light on the geological history of the Kennedy Lake area. The granodiorite sample is from a lobe that is replaced by small bodies of magnetite in four places along the contact with limestone, and the porphyry dyke intrudes magnetite in the pit wall 100 feet beneath sample E-63-4. The dyke was not actually traced across the pit floor, but there is little doubt that the two samples of the composite are from the same dyke. The wall segments are mutually on strike, and this dyke is lithologically distinct from all other dykes in the pit in containing visible biotite. The estimated determinative error of 40 m.y. does not permit close dating of either the porphyry dyke or the magnetite, but it is clear that neither is related to the orogeny that deformed Upper Cretaceous sediments on southern Vancouver Island. Since no intermediate orogeny is known, the dyke is assigned to the closing stages of the Jurassic

orogeny. The ages, therefore, are consistent with a deduction that deposition of the magnetite was a late episode in the consolidation of the batholith.

The geological evidence suggests that the granodiorite is not appreciably older than 167 m.y. An erosional remnant of Bonanza pyroclastic rocks is preserved along the north contact of the batholith and there is no reason to suppose that a full Bonanza sequence was not originally present. This remnant was involved in the regional folding, faulted, and intruded by small bodies of older porphyry prior to emplacement of the batholith. The batholith is, therefore, probably not older than Middle Jurassic.

GSC 64-4 Muscovite, K-Ar age 85 ± 15 m.y.

K = 8.87%, Ar^{40}/K^{40} = 0.0051; radiogenic Ar = 57%. Concentrate; muscovite sheets with minute specks between (001) cleavage planes.

From granite pegmatite.

(83 D) 5 1/2 miles S7°W from Tete Jaune Station, British Columbia; 52°54'N, 119°31'W. No published geological map. Sample MF-60-4.6, collected and interpreted by R. Mulligan.

The sample was taken from a pegmatite dyke, one of a number of unzoned perthite-quartz-muscovite pegmatites among the quartz-mica-garnet-kyanite schists and gneisses referred to the late Precambrian Kaza Group (Campbell, 1965[1]). The pegmatites as a rule are roughly concordant with the highly deformed enclosing rocks and are similar in mineralogical composition, even being reported to contain kyanite in places.

Considering these features, and the lack of nearby granitic bodies, it was thought that the pegmatites might have originated as a result of, and at the same time as, the enclosing rocks, and that this metamorphism might be distinctly older than the major late Mesozoic intrusions of the region.

As the 85 m.y. age falls within the age range for these intrusions, no special significance can be attached to it.

Reference

[1] Campbell, R.B.
1965: Canoe River West-Half (83DW 1/2) Map-area; in Geol. Surv. Can., Paper 65-1, pp. 43-46.

British Columbia

GSC 64-5 Biotite, K-Ar age 103 ± 6 m.y.

K = 7.44%, Ar^{40}/K^{40} = 0.0062; radiogenic Ar = 69%. Concentrate; reasonably clean concentrate of fine brown biotite (average diameter of the flakes is about 0.3 mm). Minor impurities consist of chlorite and a few grains of hornblende, feldspar and quartz. Total chlorite content 10%.

From coarse granodiorite.
(103 G) Northwest shore of Anger Island, British Columbia; 53°30' 45"N, 130°01'09"W. No geological map reference. Sample HS-33-2-63, collected and interpreted by W.W. Hutchison.

For description and interpretation see GSC 64-6.

GSC 64-6 Biotite, K-Ar age 111 ± 6 m.y.

K = 7.66%, Ar^{40}/K^{40} = 0.0067; radiogenic Ar = 76%. Concentrate; clean concentrate of coarse, euhedral brown biotite crystals about 5 mm in diameter. Some biotite crystals are intergrown with feldspar which adheres to the biotite. Total chlorite content 5%.

From coarse granodiorite.
(103 G) Northwest shore of Anger Island, British Columbia; 53°30' 45"N, 130°01'09"W. No geological map reference. Sample HS-33-2-63, collected and interpreted by W.W. Hutchison.

The sample is a light grey, almost massive quartz diorite which contains prominent randomly oriented euhedral crystals of coarse biotite, a finer biotite, quartz, plagioclase, and hornblende. In thin section it is seen to consist of subeuhedral normally zoned plagioclase, anhedral clusters of quartz, and interstitial microcline that in places surrounds the slightly saussuritized plagioclase (An_{20} - An_{25}). The mafic minerals consist mainly of hornblende with lesser amounts of biotite and clear epidote.

This quartz diorite sample is typical of the southern part of a pluton (15 x 5 miles) that was apparently forcibly emplaced into sedimentary rocks and diorite of unknown age. The southern part of the pluton is characterized by the occurrence of two biotites in the quartz diorite. The finer biotite defines the foliation and the coarser, euhedral but slightly poikilitic biotite is oriented randomly. The coarser biotite flakes probably formed after the finer biotite flakes.

British Columbia

The ages of the two concentrates are essentially the same, within the limits of analytical error. Assuming two generations of biotite, there are three major possibilities. The two generations may have formed within the time limits of the analytical error, or the formation of the second generation may have affected the Ar^{40}/K^{40} ratio of the first generation, or both generations are older than the indicated time owing to argon loss during some later thermal event. The indicated age is therefore taken as a minimum for the crystallization of this pluton and does not contradict any known geological information.

GSC 64-7 Fine biotite, K-Ar age 77 ± 5 m.y.

K = 7.21%, Ar^{40}/K^{40} = 0.0046; radiogenic Ar = 66%. Concentrate; reasonably clean concentrate of fine-grained olive-brown biotite (-100, +150 mesh). About 15% of the biotite flakes are partly altered to chlorite and contain acicular inclusions. Minor impurities consist of a few grains of quartz, feldspar, and hornblende. Total chlorite content 10%.

From quartz diorite.
(103 A) Ellerslie Bay on Spiller Channel, British Columbia; 52°32' 01"N, 128°01'55"W. Sample SE-13-24-63 collected by J.G. Souther, interpreted by A.J. Baer.

For description and interpretation see GSC 64-8.

GSC 64-8 Coarse biotite, K-Ar age 77 ± 5 m.y.

K = 7.96%, Ar^{40}/K^{40} = 0.0046; radiogenic Ar = 73%. Concentrate; clean concentrate of coarse-grained olive-brown biotite (-4, +14 mesh). Some mica flakes are altered to chlorite along the edges and contain small prisms of apatite and acicular inclusions. Total chlorite content 4%.

From quartz diorite.
(103 A) Ellerslie Bay on Spiller Channel, British Columbia; 52°32' 01"N, 128°01'55"W. Sample SE-13-24-63 collected by J.G. Souther, interpreted by A.J. Baer.

This material is from the same rock as GSC 64-7. The specimens are from an elongate, well foliated body of granodiorite, approximately 30 miles long and less than 10 miles wide. The rock is medium grained and homogeneous. Two types of biotite flakes are visible on the hand specimen; small flakes less than 5 mm across and larger ones that reach 10 to 15 mm.

The smaller biotite flakes are parallel with the foliation, whereas the larger ones are randomly oriented, commonly thicker than the small ones, and in "books". They are apparently younger. Thin sections show subaligned, subeuhedral, tabular plagioclase, anhedral interstitial quartz, biotite, hornblende, and accessory chlorite, sphene, epidote, and magnetite. The biotite flakes are coarse, slightly ragged, and occasionally slightly chloritized. The two generations of flakes visible in hand specimen are not easily distinguished in thin section.

The sample is in many respects very similar to GSC 64-6 (HS-33-2-63), and the plutons from which these rocks come have been correlated on the basis of field evidence. The consistent age (77 m.y.) indicated by both generations of biotite might correspond only to the time of crystallization of the second one, the older one having lost its radiogenic argon at that time. It is, however, possible that both ages represent the time of initial crystallization.

GSC 64-6 (HS-33-2-63) is from the central part of the Coast Mountains, whereas GSC 64-7 and 8 (SE-13-24-63) are from the eastern margin of it. This different location might account for the difference in age between the two samples.

GSC 64-9 Biotite, K-Ar age 45 ± 12 m.y.

$K = 5.04\%$, $Ar^{40}/K^{40} = 0.0026$; radiogenic Ar = 34%. Concentrate; clean concentrate of brown, partly altered biotite. Altered flakes contain numerous inclusions. Total chlorite content 40%.

From coarse quartz monzonite.

(103 P) East shore of Observatory Inlet, approximately 4 miles SW of Dawkins Point, British Columbia; 55°12'55"N, 129°51'05"W. Sample SE-50-08-63, collected by J.G. Souther, interpreted by A.J. Baer.

The specimen is from a pinkish-white, massive, coarse-grained pluton of quartz monzonite. In thin section, the rock is seen to consist essentially of coarse, ragged crystals of microcline perthite, subeuhedral tabular oligoclase, and clusters of subeuhedral quartz. Biotite is the principal mafic mineral, and is accompanied by minor amounts of hornblende, sphene, and magnetite.

From field evidence, the pluton of quartz monzonite is younger than, and intrusive into, a well foliated granodiorite of unknown age. The massive post-tectonic quartz monzonite has many similarities with that on

Labouchere Channel (GSC 64-10) with which it was correlated in the field. The age of 45 m.y. is the youngest found so far in the Coast Mountains between the 51st and 56th parallels. It is not sensibly different from the age of 57 m.y. measured for the Labouchere Channel pluton. Both dates record only the last important thermal event that affected the biotite. They appear to date the time of intrusion of a series of post-tectonic granite plutons in the Coast Mountains.

GSC 64-10 Biotite, K-Ar age 57 ± 6 m.y.

K = 7.68%, Ar^{40}/K^{40} = 0.0034; radiogenic Ar = 60%. Concentrate; clean concentrate of olive-brownish biotite. About 30% of the biotite flakes are partly bleached and about 10% of the flakes are altered to chlorite and contain inclusions of epidote. Total chlorite content 15%.

From quartz monzonite.

(93 D) Ovesen Point, Labouchere Channel, British Columbia; 52° 25'N, 127°14'W. No geological map reference. Sample BT-89-A-63, collected and interpreted by A.J. Baer.

The specimen is from a massive, homogeneous quartz monzonite pluton. The rock is medium to fine grained and white. Some muscovite appears to accompany the biotite. In thin section the rock is seen to consist of coarse, tabular plagioclase (An_{25}), microcline and coarse anhedral quartz aggregates. Mafic minerals are biotite, with minor muscovite, and rarely hornblende. Occasionally the biotite is slightly mantled by muscovite.

The pluton is sharply intrusive into metasediments, diorite and gneisses of unknown age. The foliation of the pluton, visible mainly in the marginal zone, is grossly concentric. The foliation of the intruded rocks is locally disturbed to conform with the contacts of the pluton.

From field evidence, emplacement of the pluton appears to be a very late event and the age of 57 m.y. might quite possibly indicate time of emplacement.

GSC 64-11 Biotite, K-Ar age 67 ± 5 m.y.

British Columbia

K = 7.68%, Ar^{40}/K^{40} = 0.0040; radiogenic Ar = 78%.
Concentrate; reasonably clean concentrate of greenish-brown biotite. Minor impurities consist of hornblende, sphene, epidote, quartz, and a few flakes of partly chloritized biotite. Chlorite not detected by X-ray.

From quartz diorite.
(103 H) North shore of Bishop Bay on Ursula Channel, British Columbia; 53°28'30"N, 128°51'30"W. No geological map reference. Sample BT-75-01-63, collected and interpreted by A. J. Baer.

The specimen is from a foliated quartz diorite pluton extending approximately 10 by 30 miles. The rock is homogeneous, medium to coarse grained, and pale grey. In thin section it shows subeuhedral plagioclase, and clusters of quartz and interstitial microcline that tend to surround smaller plagioclase. The coarser biotite flakes are completely fresh, finer grained flakes are slightly intergrown with hornblende and partly chloritized.

In the field, the quartz diorite pluton appears as a complex intrusive body of the late tectonic type. It cuts biotite garnet schists of unknown age. The age of 67 m.y. does not contradict any field evidence (see GSC 64-12).

GSC 64-12 Biotite, K-Ar age 48 ± 5 m.y.

K = 7.69%, Ar^{40}/K^{40} = 0.0029; radiogenic Ar = 59%.
Concentrate; clean concentrate of olive-brown biotite. About 20% of the biotite flakes are partly altered to chlorite and contain inclusions of epidote along the edges. Total chlorite content 10%.

From biotite schist.
(103 H) On the west shore of Devastation Channel, 1/2 mile north of Kitsaway Island, British Columbia; 53°38'N, 128°52'W. Sample SEF-62-06A-63, collected by P. E. Fox, interpreted by A. J. Baer and W. W. Hutchison.

The specimen is from a dark grey biotite-hornblende-plagioclase-quartz schist that is part of a zone of metasediments and gneisses that extend from Skeena River to Dean Channel. These metasediments are conformably wrapped around a pluton of quartz diorite (67 m.y., GSC 64-11) that appears to have pushed them aside during its emplacement. At one point along the contact, blocks of metasediments have been found inside the quartz diorite. Foliation of the quartz diorite is better developed in the immediate vicinity

of the contact than inside the pluton. As the emplacement of the pluton is apparently younger than the metasediments, the ages of 48 m.y. for a biotite schist, and 67 m.y. for the quartz diorite (GSC 64-11) are inconsistent with the field evidence. The biotite in the schist appears to have formed by regional metamorphism, but about 1 1/2 miles north of the location of the sample, a white, garnet-bearing microgranite forms an intrusive dilational stockwork in the biotite schist. This stockwork is not visible at the locality where the sample was taken, but its intrusion might have affected the biotite. The 48 m.y. age may therefore reflect the age of the younger stockwork.

GSC 64-13 Biotite, K-Ar age 51 ± 6 m.y.

$K = 7.43\%$, $Ar^{40}/K^{40} = 0.0030$; radiogenic Ar = 60%. Concentrate; clean concentrate of reddish-brown biotite. About 40% of the biotite flakes are bleached and about 25% are partly altered to chlorite. A few biotite flakes are intergrown with muscovite. Total chlorite content 25%.

From muscovite-biotite quartz monzonite.
(83 D) 4 miles S 80°E from head of Angus Horne Lake, British Columbia; 52°21'40"N, 119°39'00"W. No geological map reference. Sample 57-CAc-1(c), collected and interpreted by R.B. Campbell.

See GSC 64-14 for description and interpretation.

GSC 64-14 Muscovite, K-Ar age 54 ± 6 m.y.

$K = 8.93\%$, $Ar^{40}/K^{40} = 0.0032$; radiogenic Ar = 49%. Concentrate; clean concentrate of muscovite. Some flakes contain small adhering specks of biotite.

From muscovite-biotite quartz monzonite.
(83 D) 4 miles S 80°E from head of Angus Horne Lake, British Columbia; 52°21'40"N, 119°39'00"W. No geological map reference. Sample 57-CAc-1(c), collected and interpreted by R.B. Campbell.

The rock is medium-grained, equigranular muscovite-biotite-quartz monzonite consisting of quartz, sodic plagioclase, potash feldspar, muscovite, biotite, and minor apatite. Alteration is slight.

The sample is from a small granitic mass that intrudes highly deformed and metamorphosed rocks of the early Palaeozoic Cariboo Group

and of the Shuswap Metamorphic Complex. The mass is apparently post-tectonic.

The close agreement of age for biotite at 51 m.y. (GSC 64-13) and muscovite at 54 m.y. (GSC 64-14), plus the fact that the granitic body is apparently posttectonic suggest that these minimum ages are probably close to the true age of the intrusive rock. From this it follows that the most recent period of deformation and metamorphism in the surrounding rocks took place prior to 54 m.y. ago. In this regard note that at least one phase of the deformation and metamorphism is older than 143 m.y. (see GSC 63-6).

GSC 64-15 Biotite, K-Ar age 96 ± 5 m.y.

K = 7.58%, Ar^{40}/K^{40} = 0.0058; radiogenic Ar = 87%. Concentrate; clean concentrate of biotite. The biotite flakes contain long prismatic inclusions of apatite, and some are altered to chlorite and epidote along the edges. Total chlorite content 10%.

From quartz monzonite.

(82 M) 1.3 miles N 50°E of Dunn Peak, British Columbia; 51°27'N, 119°56'W. Sample 95-CAc-2(A), collected and interpreted by R.B. Campbell.

The rock is a pink, medium-grained porphyritic K feldspar-biotite quartz monzonite containing quartz, potash feldspar, sodic plagioclase, biotite, and minor accessory and alteration minerals.

See GSC 64-16 for geological interpretation.

GSC 64-16 Biotite, K-Ar age 80 ± 6 m.y.

K = 7.16%, Ar^{40}/K^{40} = 0.0048; radiogenic Ar = 61%. Concentrate; clean concentrate of brown biotite. The biotite flakes contain very small specks between (001) sheets, and some are partly altered to chlorite and fine-grained epidote. Total chlorite content 20%.

From granodiorite.

(82 M) On west shore of Adams Lake, opposite small islands 9 miles from N end, British Columbia; 51°17'20"N, 119°29'40"W. Sample 193-CAc-1(A), collected and interpreted by R.B. Campbell.

British Columbia

The rock is a grey, medium-grained, seriate, quartz monzonite containing quartz, potash feldspar, sodic plagioclase, biotite, and minor accessory and alteration minerals.

Both samples (GSC 64-15 and GSC 64-16) were taken from a batholith that intrudes rocks of the Shuswap Metamorphic Complex, low-grade metamorphic rocks of probable Carboniferous age, and an assemblage of pillow lavas of probable Mesozoic age. The batholith is apparently post-tectonic and has produced a metamorphic aureole in the low-grade and unmetamorphosed rocks along its contact.

The minimum ages of the biotite from the two samples (96 m.y. and 80 m.y.) indicate that the period of intrusion and hence the most recent metamorphic and tectonic events took place in the late Cretaceous or earlier.

GSC 64-17 Biotite, K-Ar age 46 ± 5 m.y.

K = 7.76%, Ar^{40}/K^{40} = 0.0027; radiogenic Ar = 49%. Concentrate; clean concentrate of brown biotite. About 10% of the biotite flakes are partly altered to chlorite and contain acicular inclusions and crusts of iron oxide. A few biotite flakes are intergrown with muscovite and chlorite. Total chlorite content 5%.

From porphyritic granite.

(82 M) In road cut along north branch of Scotch Creek, 3.5 miles north of junction, British Columbia; 51°04'20"N, 119°21'30"W. Map-unit "plutonic rocks", GSC Map 604 (G.M. Dawson). Sample 142-CAc-2(A), collected and interpreted by R.B. Campbell.

The rock is a pink, medium- to coarse-grained, porphyritic (K-feldspar), quartz monzonite containing quartz, potash feldspar, sodic plagioclase, biotite, and minor accessory and alteration minerals.

The sample was taken from a small granitic mass that intrudes low-grade metamorphic rocks of probable Carboniferous age. The intrusion appears to be posttectonic.

The biotite age of 46 m.y. is a minimum age of intrusion and of the metamorphism and deformation of the surrounding rocks.

British Columbia

GSC 64-18 Phlogopite. K-Ar age 51 ± 10 m.y.

K = 7.04%, Ar^{40}/K^{40} = 0.0030; radiogenic Ar = 47%. Concentrate; reasonably clean concentrate of orange-buff phlogopite. The phlogopite flakes are peppered with minute opaque specks and are partly altered to colourless chlorite along the edges. Impurities consist of carbonate fragments and a few grains of apatite. Total chlorite content 20%.

From schistose biotite marble.
(82 M) 0.7 mile N 27°E of mouth of Kinbasket Creek, British Columbia; 51°58'N, 118°01.5'W. No geological map reference. Sample WB-63-71A, collected and interpreted by J.O. Wheeler.

For description and interpretation see GSC 64-20.

GSC 64-19 Biotite, K-Ar age 58 ± 6 m.y.

K = 7.79%, Ar^{40}/K^{40} = 0.0034; radiogenic Ar = 58%. Concentrate; clean concentrate of orange-reddish biotite. The biotite flakes contain rounded inclusions of quartz. Total chlorite content 2%.

From schistose, micaceous quartzite.
(82 N) Columbia River near Surprise Rapids, 4.4 miles N 43°W of mouth of Bush River, British Columbia; 51°47'N, 117°43'W. Map-unit 3a, GSC Map 43-1962 (Rogers Pass). Sample WB-63-1B-2, collected and interpreted by J.O. Wheeler.

For description and interpretation see GSC 64-20.

GSC 64-20 Muscovite, K-Ar age 67 ± 10 m.y.

K = 7.47%, Ar^{40}/K^{40} = 0.0040; radiogenic Ar = 53%. Concentrate, reasonably clean concentrate of muscovite. Some flakes contain opaque inclusions and attached fragments of altered biotite. Minor impurities consist of quartz and feldspar. Total chlorite content 3%.

From schistose, micaceous quartzite.
(82 N) Columbia River near Surprise Rapids, 4.4 miles N 43°W of mouth of Bush River, British Columbia; 51°47'N, 117°43'W. Map-unit 3a, GSC Map 43-1962 (Rogers Pass). Sample WB-63-1B-2, collected and interpreted by J.O. Wheeler.

British Columbia

GSC 64-18, from phlogopite megacrysts in a phlogopite marble from the Chancellor Formation east of the Rocky Mountain Trench, gives an age of 51 m.y. GSC 64-19, from biotite megacrysts in a schistose micaceous quartzite from the floor of the Rocky Mountain Trench, gives an age of 58 m.y. GSC 64-20, from muscovite from the matrix of the same quartzite, gives an age of 67 m.y.

The above samples come from near the eastern margin of the metamorphic belt that underlies the northern Selkirk Mountains and extends eastward for 2 or 3 miles into the Rocky Mountains north of Bush River. As a group the ages are slightly younger than those to the west near the centre of the metamorphic belt (GSC 62-49 at 72 m.y., GSC 62-50 at 73 m.y.). The age of the muscovite is, within experimental error, equivalent to the age of the muscovite west of the Trench (72 m.y.). Ages of the biotite and phlogopite are younger than the biotite west of the Trench (73 m.y.) and apparently represent a greater loss of argon in these minerals near the edge of the metamorphic belt.

GSC 64-21 Phlogopite, K-Ar age 408 ± 15 m.y

K = 7.96%, Ar^{40}/K^{40} = 0.0266; radiogenic Ar = 90%. Concentrate; clean concentrate of coarse, orange-red phlogopite. The phlogopite is slightly altered to chlorite along fractures. Total chlorite content 8%.

From porphyritic lamprophyre.

(82 K) 5 1/4 miles S 83°W from Mount Alexandra, British Columbia; 51°58'N, 117°19'W. GSC Map 4-1961 (Rogers Pass). Sample WB-105A-61, collected and interpreted by J.O. Wheeler.

This sample is from altered phlogopite-bearing "lamprophyre" that cuts the Middle Cambrian Arctomys Formation and gives an age of 408 ± 15 m.y. This date suggests it may be contemporaneous with an early phase of intrusion of the Ice River Complex - about 70 miles southeast. The oldest age so far obtained from the complex is 392 ± 10 m.y. from a biotite pyroxenite (Rapson, 1963; Gabrielse and Reesor, 1964).

References

Gabrielse, H., and Reesor, J.E.
1964: Geochronology of plutonic rocks in two areas of the Canadian Cordillera; in "Geochronology in Canada", F.F. Osborne, editor; Roy. Soc. Can., Special Pub., No. 8, pp. 97-129.

British Columbia

Rapson, J.E.
1963: Age and aspects of metamorphism associated with the Ice River Complex, British Columbia; Bull. Canadian Petroleum Geology, vol. 11, pp. 116-124.

GSC 64-22 Biotite, K-Ar age 52 ± 6 m.y.

K = 7.99%, Ar^{40}/K^{40} = 0.0031; radiogenic Ar = 63%. Concentrate; clean concentrate of greenish biotite. About 10% of the flakes are reddish-brown. Some flakes contain inclusions of epidote along fractures. Chlorite not detected.

From biotite syenite.
(82 M) 6.2 miles S 70°W of Kinbasket River bridge, British Columbia; 51°55.5'N, 118°10.5'W. No geological map reference. Sample WB-63-73-5A, collected and interpreted by J.O. Wheeler.

The sample is from biotite from a body of nepheline syenite gneiss in the core of a nappe in the northern Selkirk Mountains. The core is surrounded by layers of the Horsethief Creek Group metamorphosed to schists and gneisses of the kyanite-almandine-muscovite subfacies of the almandine-amphibolite facies.

The date of 52 ± 4 m.y. compares favourably with the younger set of dates of 51 m.y. (GSC 64-18) and 58 m.y. (GSC 64-19) from the eastern flank of the northern Selkirk metamorphic belt, but is a little younger than the dates of 72 and 73 m.y. (GSC 62-49 and 50 respectively) from the central part of the belt.

The date indicates that about 50 m.y. ago, following a period of metamorphism in the latest Mesozoic, the region of the northern Selkirks and adjacent Rockies cooled sufficiently so that no more argon was lost from the biotite. The nepheline syenite was apparently completely recrystallized during the Mesozoic metamorphism so that it is impossible to tell by the K-Ar method if it was originally emplaced in mid-Palaeozoic time concurrently with other alkaline suites such as the Ice River Complex.

GSC 64-23 Whole Rock, K-Ar age 97 ± 12 m.y.

K = 3.00%, Ar^{40}/K^{40} = 0.0058; radiogenic Ar = 91%. Concentrate; crushed whole rock. From monzonite.

British Columbia

(82 K) Near north end of Upper Arrow Lake, British Columbia; 51°44'N, 117°55'W. Map-unit B, GSC Map 4-1961. Sample FKC-18, collected and interpreted by P. E. Fox.

This sample was taken from the centre of the pyroxene monzonite body that makes up the core of Adamant pluton. The rock consists of about equal amounts of tabular andesine, blocky orthoclase microperthite, subhedral augite, and 5% to 10% subhedral hypersthene. Magnetite and ilmenite are present in accessory amounts, and small amounts of hornblende and biotite, which mantle the pyroxenes, are also present. The texture is typically hypidiomorphic-granular, medium grained, mean grain size being 1.5 mm.

The peripheral rock enclosing the monzonite body consists for the most part of hornblende quartz monzonite. A thin layer of biotite-hornblende granodiorite occurs along the east margin of the pluton. The 97 m.y. date from the monzonite can be compared with K-Ar ages previously determined from the peripheral rock. Biotite from the south and north contact yielded ages of 281 m.y. and 200 m.y. respectively. Hornblende from the 281 m.y. sample gave an indicated age of 116 m.y. A potash feldspar from rock near the east margin yielded an age of 92 m.y. Biotite from a pegmatite dyke and a quartz-rich segregation yielded ages of 131 m.y. and 90 m.y. respectively. Some of the implications of this group of ages has been discussed by Gabrielse and Reesor[1].

Reference

[1]Gabrielse, H., and Reesor, J.E.
1964: Geochronology of plutonic rocks in two areas of the Canadian Cordillera; in Geochronology in Canada, Royal Soc. Can. Special Publication No. 8.

Yukon Territory

GSC 64-24 Biotite, K-Ar age 187 ± 10 m.y.

K = 7.48%, Ar^{40}/K^{40} = 0.0115; radiogenic Ar = 85%. Concentrate; clean concentrate of brown biotite. The biotite flakes vary in colour from brown to greenish-brown and some contain acicular inclusions along fractures and bleached edges. Total chlorite content 8%.

From gneiss.
(115 J) Bank of Yukon River, 3 3/4 miles downstream from the mouth of Pedlar Creek, Yukon Territory; 62°53 1/2'N, 138° 51'W. Sample GC 63-259 C, collected and interpreted by L.H. Green.

See GSC 64-25 for description, and GSC 64-27 for interpretation of the age.

GSC 64-25 Hornblende, K-Ar age 161 ± 38 m.y.

K = 0.89%, Ar^{40}/K^{40} = 0.0099; radiogenic Ar = 58%. Concentrate; clean concentrate of pleochroic blue-green to olive-brown hornblende. The hornblende fragments contain inclusions of quartz and epidote. Impurities consist of a trace of biotite, chlorite, feldspar, and quartz.

From gneiss.
(115 J) Bank of Yukon River, 3 3/4 miles downstream from mouth of Pedlar Creek, Yukon Territory; 62°53 1/2'N, 138°51'W. Sample GC 63-259 C, collected and interpreted by L. H. Green.

The rock is a quartz-feldspar-biotite-hornblende gneiss. It is fine grained, grey, and well foliated.

The gneiss is believed to have formed through the alteration of sedimentary rock and is similar to rocks mapped as Yukon Group about 10 miles to the north (GSC Map 711A). In the locality, numerous granitic pegmatites cut the gneiss. Outcrops are almost continuous between the locality and a point some 2 miles upstream where a gradational contact occurs between similar gneiss and recrystallized quartzite. The apparent difference in metamorphic rank is believed to reflect the original composition of the rocks rather than an intrusive contact.

See GSC 64-27 for interpretation.

Yukon Territory

GSC 64-26 Muscovite, K-Ar age 178 ± 7 m.y.

K = 7.84%, Ar^{40}/K^{40} = 0.0109; radiogenic Ar = 82%. Concentrate; clean concentrate of muscovite. Minor impurities consist of a few grains of epidote, quartz and feldspar.

From granitic gneiss.
(115 O) Bank of Yukon River, 3 miles downstream from Thistle Creek, Yukon Territory; 63°06'45"N, 139°29'30"W. Map-unit A, GSC Map 711A. Sample GC 63-270A, collected and interpreted by L. H. Green.

See GSC 64-27 for description and interpretation.

GSC 64-27 Biotite, K-Ar age 182 ± 8 m.y.

K = 7.32%, Ar^{40}/K^{40} = 0.0112; radiogenic Ar = 78%. Concentrate; clean concentrate of red-brown biotite. Minor impurities consist of a few fragments of epidote, dark green chlorite and muscovite. The biotite flakes contain inclusions of zircon and quartz. Total chlorite content 3%.

From granitic gneiss.
(115 O) Bank of Yukon River, 3 miles downstream from Thistle Creek, Yukon Territory; 63°06'45"N, 139°29'30"W. Map-unit A, GSC Map 711A. Sample GC 63-270A, collected and interpreted by L. H. Green.

The rock is a fine-grained, light grey granitic gneiss. The specimen is from a strongly foliated gneissic granite mapped as intrusive into gneiss, quartzite schist, and slate of the Yukon Group. Both units are considered of Precambrian age and later. The gneissic granite is generally similar, if not identical to, gneiss mapped as Yukon Group.

The two specimens (GC 63-259C and GC 63-270A) were taken to test the possibility of pre-Mesozoic intrusion and metamorphism in the broad area of southwestern Yukon that is underlain by crystalline rocks. Neither supports this. The area involved lies between Shakwak and Tintina Trenches and extends northwest into Alaska. Earlier workers suggested that these rocks formed part of a crystalline basement that had been intruded by earlier granitic rocks, possibly of Precambrian age, which were later foliated and in turn intruded by granitic rocks of Mesozoic age. Names used by these writers include: "Pelly gneiss" for granitic gneisses in both Yukon and Alaska, "Nasina series" for metamorphosed sedimentary rocks in the Yukon and "Birch Creek schist" for similar rocks in Alaska, "Klondike schist" for

quartz-muscovite-chlorite schist derived from igneous( ) rock in the Yukon, and "Yukon Group" to include all three types in the Yukon. Recently, Green and Roddick (1962, p. 18) have suggested that a Precambrian age cannot be proven and that some of the metamorphic rocks are of Palaeozoic age. Previous age determinations and their approximate distance from GSC 64-24 and 25 are as follows:

From schist of probable sedimentary origin (Nasina series, Yukon Group, Birch Creek schist)

214 m.y.	GSC 59-9	290 miles SE
140 m.y.	GSC 59-11	110 miles SSE
147 m.y.	GSC 61-41	130 miles SSE
222 m.y.	GSC 61-42	(same as GSC 59-9)

From quartz-muscovite-chlorite schist of igneous(?) origin (Klondike schist)

138 m.y.	GSC 60-33	70 miles N
175 m.y.	GSC 61-40	105 miles NW

From gneiss of either igneous or sedimentary origin (Pelly gneiss)

202 m.y.	GSC 62-82	95 miles NW
187 m.y. 161 m.y.	GSC 64-24 and 25	
178 m.y. 182 m.y.	GSC 64-26 and 27	30 miles NW

From granitic rocks

223 m.y.	GSC 59-10	170 miles SE
176 m.y.	GSC 59-12	105 miles SSE
58 m.y.	GSC 59-13	100 miles S
65 m.y.	GSC 60-31	135 miles SSE
58 m.y.	GSC 60-32	130 miles S

None of the ages determined supports the concept of Precambrian intrusion and metamorphism but rather suggest that the metamorphic rocks may have formed, or undergone a period of alteration that obliterated any evidence of preceding ones, in early Mesozoic time. Granitic rocks associated with this alteration may have supplied the granitic debris that first appears in early Jurassic conglomerate in Whitehorse area (see GSC 59-10). This appears to have been followed by the intrusion of younger granitic rocks

that cut the older metamorphic rocks and also form the Coast Range and Cassiar batholiths. Most age determinations from rocks assigned to this later period are 100 m.y. or less.

Reference

Green, L.H., and Roddick, J.A.
1962: Dawson, Larsen Creek, and Nash Creek map-areas, Yukon Territory; Geol. Surv. Can., Paper 62-7.

District of Franklin

GSC 64-28 Biotite, K-Ar age 1,595 ± 50 m.y.

K = 7.53%, Ar^{40}/K^{40} = 0.1465; radiogenic Ar = 99%. Concentrate; slightly altered brown-red biotite. The flakes are altered to chlorite on the edges. Total chlorite content is 3%, hornblende 2%.

From quartz monzonite.
(46 P) 10 miles southwest of Barrow Falls, District of Franklin; 67°18'N, 81°33'W. No geological map reference. Sample HF 365, collected and interpreted by W. W. Heywood.

The rock is a light grey, medium-grained, gneissic quartz monzonite consisting of quartz, plagioclase, orthoclase, biotite and minor accessories. The rock intrudes metasediments and the age serves to set a lower limit on deformation in this area. It also extends the Churchill Province and the Hudsonian orogeny into the eastern part of Melville Peninsula.

GSC 64-29 Biotite, K-Ar age 1,975 ± 60 m.y.

K 7.19%, Ar^{40}/K^{40} = 0.2043; radiogenic Ar = 98%. Concentrate; reasonably clean concentrate of brown biotite. Some flakes are greenish, and slightly altered to chlorite and epidote along the edges. Impurities consist of deep green amphibole and a few grains of quartz. Total chlorite content 3%, amphibole 5%.

From biotite-quartz-feldspar gneiss.
(48 A) District of Franklin; 72°10'N, 83°32'W. Map-unit 1, GSC Map "Admiralty Inlet". Sample BE-63-F41, collected by T.O. Frisch, interpreted by R.G. Blackadar.

This sample is a medium-grained, grey, biotite-quartz-feldspar gneiss that is typical of the crystalline complex of northern Baffin Island. The rock consists of quartz 40%, biotite 10%, hornblende 15%, plagioclase 25%, K-feldspar 10%, and traces of magnetite, carbonate, apatite, and sphene.

The 1,975 m.y. date is about 400 m.y. older than GSC 62-85 (1,590 m.y.), but still is compatible with placing these rocks in the Churchill Province. GSC 62-85 is from the same crystalline complex, but is 50 miles west of GSC 64-29.

District of Franklin

GSC 64-30 Biotite, K-Ar age 1,730 ± 55 m.y.

K - 7.48%, Ar^{40}/K^{40} = 0.1656; radiogenic Ar = 99%. Concentrate; reasonably clean concentrate of brownish-buff biotite. About 40% of the biotite flakes are partly altered to chlorite and contain inclusions of epidote. Total chlorite content 30%.

From biotite gneiss.
(47 F) District of Franklin; 70°50'N, 86°50'W. Map-unit 1, GSC Map "Bernier Bay". Sample CD-164, collected by B.G. Craig, interpreted by R.G. Blackadar.

The sample was taken from a schistose, biotite-rich layer in quartz-feldspar gneiss, and consists of plagioclase, quartz, biotite, chlorite, and traces of apatite and magnetite.

For interpretation see GSC 64-31.

GSC 64-31 Biotite, K-Ar age 1,730 ± 55 m.y.

K 7.27%, Ar^{40}/K^{40} = 0.1659; radiogenic Ar = 98%. Concentrate; reasonably clean concentrate of dark brown biotite. A few flakes are altered to chlorite. Impurities consist of amphibole (10%), altered feldspar (trace), and quartz (trace). Total chlorite content 4%.

From biotite-quartz-feldspar gneiss.
(48 D) District of Franklin; 73°00'N, 81°00'W. Map-unit 1, GSC Map "Admiralty Inlet". Sample Da-63-31, collected by W.L. Davison, interpreted by R.G. Blackadar.

The specimen was taken from a well-banded biotite-quartz-feldspar gneiss consisting of plagioclase, quartz, biotite, and a trace of apatite.

With these two dates a total of five age determinations are now available for the Precambrian metamorphic rocks of northern Baffin Island, viz:

GSC 64-29 at 1,975 m.y.
GSC 64-30 at 1,730 m.y.
GSC 64-31 at 1,730 m.y.
GSC 62-86 at 1,700 m.y.
GSC 62-85 at 1,590 m.y.

District of Franklin

The additional information supplied by these two new dates substantiates the northward extension of the Churchill Province proposed by Stockwell in 1961.

GSC 64-32 Whole Rock, K-Ar age 903 ± 140 m.y.

K = 0.47%, Ar^{40}/K^{40} = 0.0678; radiogenic Ar = 79%.
Concentrate; crushed whole rock.

From basaltic rock.
(48 B) Borden Peninsula, District of Franklin; 72°37'N, 85°00'W. Map-unit 2, GSC Map 1133A (Memoir 328). Sample BE-63-F-15, collected by T.O. Frisch, interpreted by R.G. Blackadar.

The sample was taken from a very fine-grained basaltic rock.

For interpretation see GSC 64-33.

GSC 64-33 Whole rock, K-Ar age 639 ± 25 m.y.

K = 5.80%, Ar^{40}/K^{40} = 0.0445; radiogenic Ar = 96%.
Concentrate; crushed whole rock.

From basaltic(?) rock.
(47 F) 1 mile east of Cape Appel, District of Franklin; 70°07'N, 86°12'W. Map-unit 4, GSC Map 3-1958. Sample 63 BE 43-2, collected and interpreted by R.G. Blackadar.

The sample was taken from a fine-grained basaltic rock one inch above the contact of a gabbro sill and the underlying micaceous siltstone.

GSC 64-33 is from intrusive rocks that cut the Eqalulik and Uluksan Groups of Proterozoic rocks in northern Baffin Island. This locality is about 200 miles south of the location of GSC 64-32, which is a presumed volcanic rock cut by dykes similar to GSC 64-33. As expected, age determination has established that GSC 64-32 is considerably older than GSC 64-33. However, K-Ar ages of 915 and 1,140 m.y. were obtained on samples GSC 63-19 and 63-20 from intrusive rocks similar to GSC 64-33, but from a locality near GSC 64-32.

The potassium content of GSC 64-33 is exceptionally high (5.4%) for a basaltic rock. No information is available on the possibility of sedimentary contamination in this rock.

District of Franklin

The Proterozoic age of both the volcanic formation and the intrusive diabase is established.

GSC 64-34 Muscovite, K-Ar age 1,750 ± 50 m.y.

K = 8.37%, Ar^{40}/K^{40} = 0.1685; radiogenic Ar = 99%. Concentrate; clean concentrate of muscovite.

From mica schist.
(37 F) North side of No. 4 showing, Baffinland Iron Mines, Mary River, Baffin Island, District of Franklin; 71°29'N, 79°53'W. No geological map reference. Sample Derry No. 2, collected by D.R. Derry, interpreted by R.G. Blackadar.

See GSC 64-35 for description and interpretation.

GSC 64-35 Biotite, K-Ar age 1,610 ± 210 m.y.

K = 2.36%, Ar^{40}/K^{40} = 0.1491; radiogenic Ar = 98%. Concentrate; clean concentrate of altered biotite. About 80% of the biotite flakes are partly or completely altered to chlorite, epidote and sphene. Chlorite is the main constituent of the concentrate.

From mica schist.
(37 F) North side of No. 4 showing, Baffinland Iron Mines, Mary River, Baffin Island, District of Franklin; 71°29'N, 79°53'W. No geological map reference. Sample Derry No. 2, collected by D.R. Derry, interpreted by R.G. Blackadar.

Samples GSC 64-34 (muscovite) and GSC 64-35 (altered biotite) are from the same specimen of mica schist. This rock was from the north side of the iron-formation at the No. 4 showing. It should logically give the age of the deformation and alteration of the iron-bearing strata and of the formation of the iron minerals in their present form.

It is noted that the basal Palaeozoic just west of the No. 1 deposit includes a conglomerate containing pebbles of high-grade iron. It seems likely, therefore, that the high-grade deposits were either concentrated during the orogeny 1,750 m.y. ago or, if they had been concentrated by previous supergene agencies, were metamorphosed during this event.

District of Franklin

The 1,610 ± 210 m.y. age on sample GSC 64-35 cannot be regarded as meaningful because of the very high degree of alteration of the biotite.

GSC 64-36 Muscovite, K-Ar age 1,725 ± 50 m.y.

$K = 8.71\%$, $Ar^{40}/K^{40} = 0.1652$; radiogenic Ar = 99%. Concentrate; muscovite cleavage fragment 2 inches in diameter. The muscovite contains dark grey to black pyrrhotite plates between (001) sheets. Its surface is coated with limonite crusts and fine-grained mud. Chlorite not detected.

From schist.

(27 C) South of Barnes Ice Cap, Baffin Island, District of Franklin; 69°11'N, 71°29'W. No geological map reference. Sample Derry No. 1, collected by D.R. Derry, interpreted by R.G. Blackadar.

The sample is a coarse mica schist, almost all mica, that formed a unit in a series of highly-altered sediments striking across the axis of Baffin Island at about Clyde Inlet. Because of the difference in prevailing strike it was thought this might be of a different age and tectonic province from the area containing the iron deposits farther north. From the age determinations this does not seem to be the case.

District of Mackenzie

GSC 64-37 Biotite, K-Ar age 2,490 ± 80 m.y.

K = 7.45%, Ar^{40}/K^{40} = 0.3027; radiogenic Ar = 99%. Concentrate; clean concentrate of brown biotite. The biotite flakes contain small specks of zircon surrounded by pleochroic haloes. Some flakes are bleached pale buff. Total chlorite content 8%.

From staurolite-andalusite gneiss.
(76 G) District of Mackenzie; 65°47'N, 107°53'W. Map-unit 3a, GSC Map 17-1956 (G. M. Wright). Sample T-90-63, collected and interpreted by L. P. Tremblay.

The sample is a medium-grained staurolite-quartz-biotite gneiss. This gneiss contains about 40% reddish brown biotite. It is made up of large, ragged, sieve-like staurolite metacrysts and large (2 x 1 mm) oriented biotite flakes in a fine-grained (0.1 mm) base of granoblastic quartz and tiny muscovite flakes. Tourmaline and zircon are also present.

The age dates the metamorphism of the Slave Province.

GSC 64-38 Muscovite, K-Ar age 2,380 ± 100 m.y.

K = 8.04%, Ar^{40}/K^{40} = 0.2796; radiogenic Ar = 98%. Concentrate; reasonably clean concentrate of muscovite. About 20% of the muscovite flakes are coated with thin brown films. Total chlorite content 4%.

From argillite.
(76 G) District of Mackenzie; 65°58'N, 107°30'W. Map-unit 12, GSC Map 17-1956. Sample TG-65-63, collected and interpreted by L. P. Tremblay.

This muscovite comes from a thinly layered, massive grey argillite. It occurs as large flakes in heavy concentrations on bedding planes or on planes parallel with them and is found only in a few places near the base of the Goulburn Group.

Thin sections show the argillite to consist of layers made up of subrounded grains cemented with fine sericite and chlorite or of grains scattered in a felted mass of sericite and chlorite. The large muscovite flakes are found along and near the contacts of two layers. For the following reasons this muscovite is considered to be mainly clastic: (1) the flakes are in general oriented parallel with the bedding planes; (2) the flakes are much larger than the other clastic grains and the other sericite flakes of the cement

and matrix; (3) the flakes are very thin if compared to their length; (4) the flakes are associated with chlorite grains that are definitely clastic; (5) the flakes are of the 2M type.

As the large muscovite flakes are detrital, their age is the age of the rocks from which they came. This age is about the age of the metamorphism of the Slave Province possibly somewhat lower because some argon may have been lost during transportation of the flakes before deposition. This age is not that of the Goulburn Group but indicates that this group is younger. See samples GSC 63-27 and GSC 64-37.

GSC 64-39 Whole Rock, K-Ar age 1,050 ± 95 m.y.

K = 1.70%, Ar^{40}/K^{40} = 0.0820; radiogenic Ar = 96%.
Concentrate; crushed whole rock.

From gabbro.
(76 G) Near southern tip of first bend of Western River west of Bathurst Trench, District of Mackenzie; 65°46'N, 106°32'W. Map-unit 18, GSC Map 17-1956. Sample T 189-62, collected and interpreted by L. P. Tremblay.

The rock is a reddish-black, medium-grained, massive gabbro. It is made up of about 60% pyroxene, 25% feldspar, and 15% opaque substances. Much of the pyroxene is altered to chlorite, and all feldspars are heavily altered and coloured dusty red.

The sample is from a dyke trending north-northwesterly and cutting a gabbro sill mapped in and near the base of the Goulburn succession. The sill was dated at 1,215 m.y. (see GSC 63-27). The date on the dyke is lower than that on the sill, and this agrees with the field relationships and suggests that both (sill and dyke) are related intrusions emplaced at somewhat different times.

GSC 64-40 Biotite, K-Ar age 2,140 ± 60 m.y.

K = 7.90%, Ar^{40}/K^{40} = 0.2332; radiogenic Ar = 99%.
Concentrate; clean concentrate of pale buff and brown biotite. The biotite flakes contain inclusions of secondary flaky and acicular minerals along fractures and on (001) cleavage planes. Total chlorite content less than 1%.

District of Mackenzie

From cordierite gneiss.

(76 G) About 6 miles west of the headwaters of Ellice River, District of Mackenzie; 65°22'N, 106°02'W. Map-unit 3, GSC Map 17-1956. Sample T 25-63, collected and interpreted by L. P. Tremblay.

The sample is a rusty grey, medium-grained, crudely foliated gneiss. It is made up of large anhedral feldspar grains (about 50%) and occasional large cordierite grains in a base of quartz and mixtures of biotite, muscovite, and chlorite. The cordierite is heavily altered to sericite and chlorite, and the biotite is also, in part, heavily altered to chlorite.

The sample comes from a location at the boundary between the Churchill and Slave Provinces. This boundary is marked by a gradual increase in metamorphism towards the east (Churchill Province), and is located where the sediments of the Slave Province become gneisses of the Churchill. The age is great for the Churchill Province, and indicates that the sample was a Slave Province rock only slightly reworked by the metamorphism of the Hudsonian orogeny.

GSC 64-41 Biotite, K-Ar age 1,990 ± 52 m.y.

K = 7.93%, Ar^{40}/K^{40} = 0.2064; radiogenic Ar = 99%. Concentrate; clean concentrate of buff biotite. Some of the biotite flakes are slightly altered and contain epidote inclusions. A few flakes contain zircon inclusions surrounded by dark pleochroic haloes. Total chlorite content 3%.

From biotite schist.

(76 G) About 4 miles east of Bathurst Trench, District of Mackenzie; 65°59'N, 106°33'W. Map-unit 8, GSC Map 17-1956. Sample T 36-63, collected and interpreted by L. P. Tremblay.

The sample is a black, fine- to medium-grained biotite schist with a few grains of hornblende. The dark minerals are contained in a fine-grained matrix of quartz, feldspar, and epidote. A few epidote grains and some zircon with pleochroic haloes were noted in the biotite. Chlorite alteration is rare.

The sample is from an area in the Churchill Province near the Slave-Churchill boundary. Because of the nature of the rock and its texture it was expected that this sample would yield a Slave Province age. The age

obtained indicates that the rock was, as thought, probably part of the Slave Province but that it was somewhat reworked by the metamorphism of the Hudsonian orogeny.

GSC 64-42 Whole Rock, K-Ar age 1,660 ± 140 m.y.

$K = 2.30\%$, $Ar^{40}/K^{40} = 0.1555$; radiogenic Ar = 96%.
Concentrate; crushed whole rock.

From slightly metamorphosed basalt.
(86 C) District of Mackenzie; 65°00'N, 116°31'W. Map-unit 8, GSC Map 697-A. Sample MC-21-63, collected and interpreted by J.C. McGlynn.

This whole rock age determination was made on a basic volcanic rock from a sequence of such rocks that conformably overlie sediments of the Snare Group in the Grant Lake area. The rock is fine grained and massive and comprises plagioclase laths, hornblende, and minor amounts of iron-ore. Hornblende is partly altered to chlorite, and plagioclase to white mica and epidote. The few amygdules in the rock are filled with carbonate and quartz. The volcanic rocks are only slightly metamorphosed and therefore a sample was submitted in an attempt to date the actual time of volcanism thus giving a good minimum age for the underlying sediments. However the age (1,660 m.y.) is about equivalent to that of granitic rocks thought to be younger than the volcanic rocks. Therefore it is impossible to be certain whether the age is that of volcanism or metamorphism related to the intrusion of granitic rocks. See GSC 64-43 for further discussion.

GSC 64-43 Whole Rock, K-Ar age 1,505 ± 210 m.y.

$K = 0.56\%$, $Ar^{40}/K^{40} = 0.1350$; radiogenic Ar = 90%.
Concentrate; crushed whole rock.

From basalt.
(86 C) District of Mackenzie; 64°59'50"N, 116°31'W. Map-unit 8, GSC Map 697A. Sample MC-20-63 collected and interpreted by J.C. McGlynn.

This sample is from a sequence of basic volcanic rocks that conformably overlie sediments of the Snare Group in the Grant Lake area. The basalt is very fine-grained and massive and consists of plagioclase laths, hornblende, and minor amounts of iron-ore. Hornblende is partly altered to chlorite, and plagioclase to white mica and epidote. The volcanic rocks are only slightly metamorphosed and therefore this sample was submitted in the

hope of dating the time of volcanism, thus giving a good minimum age for the underlying sediments. However the age (1,505 m.y.) is much younger than the age of granitic rocks thought to be younger than the volcanic rocks and is also younger than a date from a sample collected nearby (i.e. GSC 64-42) from the same volcanic pile.

In view of the very low potassium content (0.56%) of this rock the indicated age must be regarded as a minimum limit. With its higher potassium content (2.30%), and consequent greater reliability, GSC 64-42 at 1,660 m.y. should be considered a better age determination for this volcanic sequence or metamorphism.

GSC 64-44 Whole Rock, K-Ar age 1,790 ± 140 m.y.

K = 4.50%, Ar^{40}/K^{40} = 0.1749; radiogenic Ar = 100%.
Concentrate; crushed whole rock.

From dacite.
(86 O) Coronation Gulf area, District of Mackenzie; 63°47'30"N, 115°59'00"W. Map-unit 7, GSC Map 18-1962. Sample MC 318-1-61, collected and interpreted by J.C. McGlynn.

This sample is from a sequence of intermediate volcanic rocks that overlie sediments of the Snare Group with apparent conformity in the Basler Lake area. The dacites are fine-grained and massive and consist of biotite, plagioclase, quartz, and minor iron-ore. Amygdules in the rock are filled with quartz and chlorite. As these rocks were only slightly metamorphosed a sample was submitted in the hope of dating the time of volcanism. However the age (1,790 m.y.) is about equivalent to that of granites that cut the Snare rocks. Therefore it is impossible to decide if the age is that of volcanism or of metamorphism related to the intrusion of granitic rocks.

GSC 64-45 Biotite, K-Ar age 1,815 ± 50 m.y.

K = 6.71%, Ar^{40}/K^{40} = 0.1785; radiogenic Ar = 98%.
Concentrate; reasonably clean concentrate of biotite. The biotite flakes vary in colour from orange-brown to greenish. The green flakes are partly altered to chlorite. Minor impurities consist of muscovite, quartz and iron oxides. Total chlorite content 15%.

District of Mackenzie

From granodiorite.

(86 C) District of Mackenzie; 64°45'36"N, 116°45'00"W. Map-unit A, GSC Map 697A. Sample MC 127-63, collected and interpreted by J.C. McGlynn.

See GSC 64-46 for description and interpretation.

GSC 64-46 Muscovite, K-Ar age 1,855 ± 52 m.y.

$K = 8.61\%$, $Ar^{40}/K^{40} = 0.1851$; radiogenic Ar = 98%. Concentrate; reasonably clean concentrate of muscovite. Minor impurities consist of quartz, feldspar, and iron oxides.

From granodiorite.

(86 C) District of Mackenzie; 64°45'36"N, 116°45'00"W. Map-unit A, GSC Map 697A. Sample MC 127-63, collected and interpreted by J.C. McGlynn.

These micas (GSC 64-45, 46) are from a fine-grained faintly gneissic granodiorite that consists of plagioclase, microcline, quartz, muscovite, and slightly altered biotite. This granodiorite cuts Snare and Cameron Bay sediments and volcanic rocks and these dates give the age of the Hudsonian orogeny in the Bear Structural Province. The muscovite-biotite pair was submitted as such pairs are rather rare in the Bear Province. Agreement between the two ages is within the limits of accuracy.

GSC 64-47 Whole Rock, K-Ar age 1,740 ± 200 m.y.

$K = 0.86\%$, $Ar^{40}/K^{40} = 0.1669$; radiogenic Ar = 92%. Concentrate; crushed whole rock.

From andesite.

(86 G) 12 miles northeast of Rocknest Lake, District of Mackenzie; 65°47'N, 114°02'W. Map-unit 5, GSC Map 18-1960. Sample FDV 28-59, collected by T.N. Irvine, interpreted by J.A. Fraser.

The sample is a greenish grey, fine-grained, massive, andesite containing 30% light green phenocrysts of albite up to 1 cm long which are partly altered to carbonate and epidote. The groundmass is composed of albite and chlorite with minor carbonate, epidote, and ore minerals. The texture is ophitic.

The andesite is interlayered with basal quartzite and argillite of the Epworth Group. It is not known at present whether the andesite was emplaced as flow(s) or sill(s). If the andesite is extrusive, only the basal sediments can be older than 1,740 m.y. If, however, the andesite intrudes the sediments, they must be generally older than 1,740 m.y. Evidence in upper Epworth strata of increasing metamorphism towards the Great Bear Lake granite, known to be Hudsonian in age, supports the interpretation that the Epworth sediments are generally older than 1,740 m.y. Consequently the andesite is considered to be intrusive rather than extrusive.

GSC 64-48 Muscovite, K-Ar age 1,830 ± 60 m.y.

K = 8.92%, Ar^{40}/K^{40} = 0.1810; radiogenic Ar = 99%. Concentrate; clean concentrate of muscovite. Some flakes are stained pinkish-buff and contain very small inclusions of quartz.

From quartz monzonite pegmatite.
(76 J) 30 miles SE of mouth of Western River, District of Mackenzie; 66°03'N, 106°24'W. Map-unit 4, GSC Map 45-1963. Sample DF 155-62, collected by J.A. Donaldson, interpreted by J.A. Fraser.

The sample is a very coarse-grained, pink and white, quartz-muscovite pegmatite made up of oligoclase, quartz, and potash feldspar, with about 2% deep green to yellowish brown biotite and 3% sheaves of muscovite.

The pegmatite is exposed 10 miles east of the Bathurst Fault in an area underlain by gneissose plutonic rocks, apparently derived in part from Yellowknife strata that show evidence of metamorphism later than Kenoran granitization. This metamorphism probably reflects to a minor degree the influence of deformation associated with the fault and, as the age (1,830 m.y.) would indicate, recrystallization during the Hudsonian orogeny. The contact between the Slave and Churchill Structural Provinces has been drawn, therefore, within a few miles, and to the west, of the sample locality.

GSC 64-49 Biotite, K-Ar age 1,840 ± 60 m.y.

K = 7.63%, Ar^{40}/K^{40} = 0.1826; radiogenic Ar = 99%. Concentrate; clean concentrate of pale brown biotite. Most flakes contain dark brown, platy inclusions along fractures and on (001) cleavage planes. Total chlorite content 3%.

District of Mackenzie

From granulite.
(76 J) 17 miles east of south tip of Bear Island, District of Mackenzie; 66°54'N, 106°07'W. Map-unit 4, GSC Map 45-1963. Sample DF-205-62, collected by J.A. Donaldson, interpreted by J.A. Fraser.

For description and interpretation see GSC 64-50.

GSC 64-50 Muscovite, K-Ar age 1,765 ± 55 m.y.

K = 6.90%, Ar^{40}/K^{40} = 0.1710; radiogenic Ar = 98%. Concentrate; reasonably clean concentrate of muscovite. Some flakes contain small specks of altered biotite and orange-yellow crusts. Minor impurities consist of quartz, feldspar, and a few opaque grains. Total chlorite content 1%.

From granulite.
(76 J) 17 miles east of south tip of Bear Island, District of Mackenzie; 66°54'N, 106°07'W. Map-unit 4, GSC Map 45-1963. Sample DF-205-62, collected by J.A. Donaldson, interpreted by J.A. Fraser.

The granulite sample is dark grey, medium to coarse grained, and massive. It is composed of plagioclase (40%), quartz (30%), brown biotite (15%), fresh muscovite (10%), and kyanite (5%). The plagioclase occurs as insets 8 mm long and also as a constituent of the groundmass. Accessory minerals present are magnetite, ilmenite, pyrite, pyrrhotite, and zircon. The texture is granular. A biotite (GSC 64-49) and a muscovite (GSC 64-50) from this rock were dated.

Rocks of this lithological type are common in the area between Bathurst Inlet and Ellice River where the Slave and Churchill Structural Provinces are in contact. They are possibly, in part, metamorphosed equivalents of Yellowknife Group sediments. Both the muscovite and the biotite yield ages that reflect the effect of the Hudsonian orogeny. The sample locality is therefore considered to lie within the Churchill Province.

GSC 64-51 Muscovite, K-Ar age 2,500 ± 80 m.y.

K = 8.75%, Ar^{40}/K^{40} = 0.3048; radiogenic Ar = 99%. Concentrate; clean concentrate of muscovite.

District of Mackenzie

From pegmatite.
(76 M) 13 miles SSW of Cape Barrow, District of Mackenzie; 67°50'N, 110°30'W. Map-unit 5a, GSC Map 45-1963. Sample PB-347 C-62, collected by W.H. Poole, interpreted by J.A. Fraser.

Muscovite collected from a simple pegmatite in massive to very slightly foliated granite west of the Bathurst fault occurs as light silver brown foliae. Mica cleavage fragments range up to 5 cm in diameter and are marked by triangular lining and crinkling.

The age (2,500 m.y.) is characteristic of the Slave Structural Province (Kenoran orogeny). Other ages determined for lithologically similar rocks within 75 miles of the sample locality are predominantly Kenoran. A noticeable exception is that of sample GSC 63-66 (1,810 m.y.) which is situated within a mile of the Bathurst fault. This age possibly dates metamorphism associated with movement along the fault.

GSC 64-52 Biotite, K-Ar age 1,965 ± 60 m.y.

K = 7.46%, Ar^{40}/K^{40} = 0.2027; radiogenic Ar = 98%. Concentrate; clean concentrate of brown biotite. The biotite flakes are intergrown with quartz along the edges and contain a few dark pleochroic haloes. Some flakes are partly altered to chlorite. Total chlorite content 10%.

From granite.
(76 J) 24 miles approximately NE of mouth of Western River, District of Mackenzie; 66°38 3/4'N, 106°42'W. Map-unit 5b, GSC Map 45-1963. Sample PB-161-62, collected by W.H. Poole, interpreted by J.A. Fraser.

For description and interpretation see GSC 64-53.

GSC 64-53 Muscovite, K-Ar age 1,890 ± 60 m.y.

K = 8.33%, Ar^{40}/K^{40} = 0.1902; radiogenic Ar = 99%. Concentrate; reasonably clean concentrate of muscovite. The muscovite flakes contain needle-like inclusions and quartz grains. Total chlorite content 3%.

From granite.
(76 J) 24 miles approximately NE of mouth of Western River, District of Mackenzie; 66°38 3/4'N, 106°42'W. Map-unit 5b,

District of Mackenzie

GSC Map 45-1963. Sample PB-161-62, collected by W.H. Poole, interpreted by J.A. Fraser.

Quartz monzonite is exposed over a wide area east of Bathurst Inlet where it intrudes or replaces gneisses and schists probably derived from Yellowknife strata. The sample is light grey, medium to fine grained, massive to slightly foliated, and consists of microcline (35%), quartz (30%), and albite (25%), with accessory zircon and apatite. Biotite, amounting to less than 4%, is evenly distributed in 1 mm flakes intergrown with muscovite and sericite. The feldspar crystals are bent and fractured and the quartz grains show strain extinction.

The age of the muscovite (GSC 64-53 at 1,890 m.y.) indicates that the rocks in this region were metamorphosed during the Hudsonian orogeny. The biotite age (GSC 64-52 at 1,965 m.y.), however, shows the biotite to have been incompletely reconstituted since its original (Kenoran?) crystallization and suggests, therefore, that the sample locality lies near the Slave-Churchill boundary. The muscovite-biotite pair from samples GSC 63-71, 72 offer a further example of an intermediate age due to the proximity to the Slave-Churchill boundary, although in this case it is the muscovite that yields the greater age.

GSC 64-54 Whole Rock, K-Ar age 863 ± 115 m.y.

K = 0.77%, Ar^{40}/K^{40} = 0.0640; radiogenic Ar = 86%.
Concentrate; crushed whole rock.

From basalt.
(86 M) 25 miles NW of Dismal Lakes, District of Mackenzie; 67°44'N, 118°25'W. Map-unit 12, GSC Map 18-1960. Sample FD 106-59, collected and interpreted by J.A. Fraser.

This sample of Coppermine River basalt was taken from the upper part of the flow sequence. It is a dark grey, aphanitic, massive rock, cut by fractures that are bordered by zones of hematite alteration 2 mm thick. Plagioclase and pyroxene in subophitic relationship are accompanied by minor magnetite and hematite.

From field evidence it is known that the basalt is younger than Hornby Bay strata and older than Coppermine River sediments. The age (863 m.y.) lies within the range of ages previously determined by whole rock analysis for basalt from the Coppermine River region.

District of Mackenzie

GSC 64-55 Whole Rock, K-Ar age 788 ± 110 m.y.

K = 0.73%, Ar^{40}/K^{40} = 0.0572; radiogenic Ar = 97%.
Concentrate; crushed whole rock.

From basalt.
(86 O) North of Coppermine Mountains, District of Mackenzie; 67°24'N, 115°50'W. Map-unit 12, GSC Map 18-1960. Sample HF 149-59, collected by W.W. Heywood, interpreted by J.A. Fraser.

This basalt of the Coppermine River Group collected from the middle part of the flow sequence is a dark grey, aphanitic, massive rock that contains labradorite (45%), clinopyroxene (35%), ore minerals (10%), minor carbonate, and a few altered phenocrysts of euhedral plagioclase and anhedral augite. The texture is diabasic. Planar fractures that cut the sample are stained with hematite alteration products. The age (788 m.y.) lies within the range of previously determined basalt whole rock ages (740 m.y. - 1,100 m.y.) on material from the Coppermine River region.

GSC 64-56 Whole Rock, K-Ar age 605 ± 110 m.y.

K = 0.54%, Ar^{40}/K^{40} = 0.0417; radiogenic Ar = 73%.
Concentrate; crushed whole rock.

From diabase.
(87 D) 25 miles SW of Libby Lake, District of Mackenzie; 68°03'N, 118°20'W. Map-unit 18a, GSC Map 18-1960. Sample FD 199-59, collected and interpreted by J.A. Fraser.

The sample is from a diabase sill that intrudes dolomite of the Coppermine River Group. It is dark grey, fine-grained, massive, and consists of labradorite (50%), clinopyroxene (45%), and magnetite (4%), with traces of biotite and olivine. The pyroxene is altered in part to serpentine and carbonate. The texture is ophitic.

The age of the diabase (605 m.y.) sets a lower limit on the age of the Coppermine River sediments and on the Coppermine River basalt, which from field evidence is known to be older than the sediments. The youngest whole rock age so far determined for the basalt is 740 m.y. (GSC 63-77), a result that is consistent with this interpretation.

District of Mackenzie

GSC 64-57 Whole Rock, K-Ar age 1,065 ± 100 m.y.

K = 1.30%, Ar^{40}/K^{40} = 0.0836; radiogenic Ar = 94%.
Concentrate; crushed whole rock.

From basalt.
(86 O) South edge of September Mountains, District of Mackenzie; 67°08'N, 115°50'W. Map-unit 12, GSC Map 18-1960. Sample FD 252-59, collected and interpreted by J.A. Fraser.

The sample is a dark brownish to greenish grey, fine-grained, massive basalt collected from the base of the Coppermine River flow sequence. The principal minerals are andesine, clinopyroxene and serpentine. Quartz, magnetite, hematite, and chlorite are minor constituents. The texture is subdiabasic.

For interpretation of age see GSC 64-58.

GSC 64-58 Whole Rock, K-Ar age 793 ± 130 m.y.

K = 0.71%, Ar^{40}/K^{40} = 0.0576; radiogenic Ar = 88%.
Concentrate; crushed whole rock.

From basalt.
(86 O) South edge of Coppermine Mountains, District of Mackenzie; 67°14'N, 115°52'W. Map-unit 12, GSC Map 18-1960. Sample FD 253-59, collected and interpreted by J.A. Fraser.

The sample is a reddish to purplish brown, very fine-grained basalt composed of labradorite, clinopyroxene, serpentine, and minor hematite. Scattered throughout the rock are amygdules from 1 to 2 mm in diameter filled with white calcite and quartz.

The rock sampled is stratigraphically above that of GSC 64-57 but below flows for which whole rock ages have been previously reported. These range from 740 m.y. to 1,100 m.y. and since the younger ages were obtained from material collected towards the upper part of the flow sequence the possibility of two (or more) peaks of extrusive activity widely separated in time was recognized. The present determinations cast doubt on this hypothesis but otherwise contribute nothing new to our understanding of the age of the basalts.

District of Mackenzie

GSC 64-59 Biotite, K-Ar age 1,760 ± 55 m.y.

K = 7.46%, Ar^{40}/K^{40} = 0.1700; radiogenic Ar = 99%. Concentrate; clean concentrate of brown biotite. The biotite flakes contain grey-brown to black, zoned, pleochroic haloes and a few prismatic inclusions of zircon. Some of the biotite flakes are partly altered to greenish-grey chlorite and contain fine-grained inclusions of epidote. Total chlorite content 20%.

From biotite granite.
(86 G) Four miles east of Calder Lake, District of Mackenzie; 65°54'N, 114°55'W. Map-unit 3, GSC Map 18-1960. Sample FD 170-64, collected and interpreted by J.A. Fraser.

The sample is a pale grey, medium-grained, massive granite composed mainly of anhedral orthoclase, myrmekite and strained quartz, and zoned euhedra of partly sericitized oligoclase. The biotite is reddish brown and contains inclusions of zircon with pleochroic haloes. Muscovite is less abundant than biotite and appears to have crystallized after it. Accessory minerals include apatite, magnetite, and pyrite. Locally phenocrysts of white-weathering feldspar 1 cm or more across make up 10 per cent of the rock.

Granite and related rocks are known to underlie a large region that extends westward from the sample locality to Great Bear Lake. The age (1,760 m.y.) compares closely with that of metamorphosed Epworth argillite (GSC 64-60) exposed half a mile to the east, and sets a lower limit on the age of Epworth strata.

GSC 64-60 Biotite, K-Ar age 1,815 ± 55 m.y.

K = 6.55%, Ar^{40}/K^{40} = 0.1783; radiogenic Ar = 99%. Concentrate; reasonably clean concentrate of brown biotite. The biotite flakes contain quartz inclusions and small prisms of zircon surrounded by dark, zoned pleochroic haloes. Some flakes contain as many as fifteen haloes. About 30% of the biotite flakes are partly discoloured greenish grey. Total chlorite content 20%.

From knotted schist.
(86 G) East of Calder Lake, District of Mackenzie; 65°54'N, 114°54'W. Map-unit 8, GSC Map 18-1960. Sample FD 171-64, collected and interpreted by J.A. Fraser.

District of Mackenzie

The sample is a fine-grained, grey schist composed mainly of strained quartz, potassic feldspar, chlorite, and fresh reddish brown biotite that contains inclusions of zircons with strongly pleochroic haloes. Muscovite, tourmaline, apatite, and pyrite are present as minor constituents. Andalusite occurs as scattered ovoidal anhedra up to 3 mm in diameter in parts of the rock where feldspar is absent. Crenulated bedding laminae from 1 to 3 mm thick, defined by compositional and textural differences are intersected at a small angle by the schistosity.

The schist has been derived from argillite of the Epworth Group, which, in this region shows a progressive increase in metamorphic grade towards its contact with massive granite, half a mile west of the sample locality. The age (1,815 m.y.) indicates that metamorphism of the argillite took place during the Hudsonian orogeny and that the Epworth sediments, therefore, cannot be younger than Aphebian. The granite, as might be expected, also yields Hudsonian ages. (See for example GSC 64-59.)

GSC 64-61 Biotite, K-Ar age 1,770 ± 50 m.y.

$K = 7.58\%$, $Ar^{40}/K^{40} = 0.1720$; radiogenic Ar = 100%. Concentrate; reasonably clean concentrate of greenish-brown biotite. The biotite flakes are intergrown with quartz along the edges and some are altered to chlorite. Total chlorite content 10%.

From granite-gneiss.
(86 G) 12 miles northeast of Rocknest Lake, District of Mackenzie; 65°46'N, 114°03'W. Map-unit 3d, GSC Map 18-1960. Sample FD 96-64, collected and interpreted by J.A. Fraser.

The granite-gneiss is a heterogeneous, pink to grey, medium- to coarse-grained rock consisting of irregular, discontinuous biotite-rich laminae from 1 mm to 2 mm thick separated by quartzo-feldspathic layers from 1 mm to 4 mm thick. Minerals in the sample form a sutured mosaic comprising highly strained quartz, microcline, sericitized plagioclase, and from 3 to 5% olive-brown biotite partly altered to chlorite. Augen of pink feldspar up to 3 cm long oriented parallel with the foliation are found in some parts of the gneiss.

The gneiss is exposed in an anticlinal core where it underlies basal sediments of the Epworth Group. The sediments show no evidence of metamorphism or intrusion by granitic material. Epworth argillite exposed 30 miles to the northwest is, however, metamorphosed against massive granite known to be Hudsonian in age. Biotite from the gneiss also yields a Hudsonian age (1,770 m.y.) but the lithology and structure of the gneiss

and its relationship to the overlying strata suggest that it belongs to the Archaean basement and that the biotite has lost argon as a result of metamorphism associated with the Hudsonian orogeny.

GSC 64-62 Biotite, K-Ar age 1,860 ± 55 m.y.

K = 7.58%, Ar^{40}/K^{40} = 0.1858; radiogenic Ar = 99%. Concentrate; clean concentrate of orange-red biotite. Some flakes are slightly altered along (001) fractures. Total chlorite content 5%.

From granulite.
(76 I) 5 miles northwest of Ellice River, 56 miles east of the mouth of Western River, District of Mackenzie; 66°23 1/2'N, 105°08'W. Map-unit 4d, GSC Map 45-1963. Sample DF 126-62, collected by J.A. Donaldson, interpreted by J.A. Fraser.

The sample is a medium grey and brown, medium-grained, crudely foliated pyroxene-biotite granulite containing quartz (30%), perthite (10%), andesine (45%), reddish brown biotite (10%), hypersthene (10%), and traces of apatite and ore minerals.

Granulite and gneiss, probably derived from Yellowknife Group sediments and volcanic rocks, underlie a large area east of Bathurst Inlet. The age (1,860 m.y.) indicates that these rocks have been affected by the Hudsonian orogeny and suggests, therefore, that the sampling locality lies within the Churchill Structural Province, a conclusion supported by other ages in the same general region.

GSC 64-63 Biotite, K-Ar age 1,975 ± 56 m.y.

K = 7.50%, Ar^{40}/K^{40} = 0.2042; radiogenic Ar = 99%. Concentrate; clean concentrate of amber brown biotite. About 10% of the biotite flakes are partly bleached and contain fine-grained inclusions in altered areas. Total chlorite content 5%.

From granulite.
(66 M) 10 miles southwest of Chester Bay, 6 miles west of Perry River, District of Mackenzie; 67°35'N, 102°23'W. Map-unit 5d, GSC Map 45-1963. Sample DF 120-62, collected by J.A. Donaldson, interpreted by J.A. Fraser.

District of Mackenzie

The sample, a light grey, fine- to medium-grained, massive to faintly foliated granulite, is composed of quartz (40%) showing strongly preferred orientation, andesine (45%), unaltered reddish brown biotite (6%), hypersthene (5%), magnetite (4%), and traces of apatite.

This lithology is typical of the plutonic rocks between MacAlpine Lake and Queen Maud Gulf. Few ages have been determined for rocks from this region but those reported are clearly Hudsonian. The age of the biotite (1,975 m.y.), however, is similar in magnitude to ages determined for rocks from the transitional zone along the Slave-Churchill boundary, which at present is assumed to lie more than 50 miles west of the sample locality.

GSC 64-64 Whole Rock, K-Ar age 619 ± 85 m.y.

K = 0.80%, Ar^{40}/K^{40} = 0.0429; radiogenic Ar = 78%.
Concentrate; crushed whole rock.

From basalt.
(86 C) District of Mackenzie; 64°27'N, 117°00'W. Map-unit 11, GSC Map 697A. Sample FA 162-62(5), collected and interpreted by W.F. Fahrig.

The sample is from the chilled contact of a basaltic intrusion and consists of unaltered phenocrysts of plagioclase, pyroxene, and iron-ores in an extremely fine-grained, devitrified glass matrix.

The 619 m.y. date indicates the approximate age of intrusion.

GSC 64-65 Whole Rock, K-Ar age 614 ± 65 m.y.

K = 1.30%, Ar^{40}/K^{40} = 0.0425; radiogenic Ar = 92%.
Concentrate; crushed whole rock.

From basalt.
(86 F) District of Mackenzie; 65°15'N, 116°19'W. Map-unit 9, GSC Map 1014A. Sample FA-164-62(3), collected and interpreted by W.F. Fahrig.

The sample is from the chilled contact of a basaltic intrusion and consists of extensively saussuritized phenocrysts of plagioclase and unaltered phenocrysts of pyroxene in a semi-opaque devitrified glass matrix.

The 614 m.y. date indicates the approximate age of intrusion.

District of Mackenzie

GSC 64-66 Whole Rock, K-Ar age 1,050 ± 150 m.y.

$K = 0.42\%$, $Ar^{40}/K^{40} = 0.0824$; radiogenic Ar = 72%.
Concentrate; crushed whole rock.

From basalt.
(86 C) Zebulon Lake, District of Mackenzie; 65°02'N, 117°45'W. Map-unit 9, GSC map 1014A. Sample FA-153-62(3), collected and interpreted by W. F. Fahrig.

The sample is from the chilled contact of a basaltic intrusion and consists of small saussuritized phenocrysts of plagioclase, and partly altered phenocrysts of pyroxene in a very fine-grained matrix.

The 1,050 m.y. date indicates the approximate age of intrusion.

GSC 64-67 Biotite, K-Ar age 2,410 ± 80 m.y.

$K = 7.85\%$, $Ar^{40}/K^{40} = 0.2859$; radiogenic Ar = 100%.
Concentrate; clean concentrate of olive-brown biotite. About 20% of the biotite flakes are partly altered to green chlorite. Some biotite flakes are orange-brown and contain oriented needle-like inclusions. Total chlorite content 15%.

From granodiorite.
(77 A) Island in a small lake 48 miles south of Cape Alexander, District of Mackenzie; 68°16'N, 106°11'W. Map-unit 5c, GSC Map 45-1963. Sample BK-327-62, collected by H. H. Bostock, interpreted by J. A. Fraser.

The sample is a grey, fine-grained, massive, granodiorite made up of oligoclase (60%), quartz (20%), microcline (15%), and fresh brown biotite (5%) in flakes 0.5 mm across. Traces of epidote, muscovite, and magnetite are present.

The granodiorite is representative of the terrane east of the mouth of Bathurst Inlet in which Yellowknife volcanic rocks and sediments are intruded or replaced by massive granitic rocks. The age of the biotite (2,410 m.y.) and that of GSC 63-61 (2,270 m.y.) define a sector east of the inlet belonging to the Slave Structural Province. The Archaean rocks in this region are similar in gross geological aspect to those west of the inlet and present a marked contrast with the gneisses and granulites that underlie much of the Churchill Province to the east.

District of Mackenzie

GSC 64-68 Whole Rock, K-Ar age 1,100 ± 130 m.y

K = 0.69%, Ar^{40}/K^{40} = 0.0874; radiogenic Ar = 93%.
Concentrate; crushed whole rock.

From basalt.

(86 O) Lava flow, photo A13614-198, Site 10W, District of Mackenzie; 67°16'N, 115°56'W. Map-unit 12, GSC Map 18, 1960. Sample RN-132, collected by W.A. Robertson. No geological interpretation available.

GSC 64-69 Whole Rock, K-Ar age 718 ± 120 m.y.

K = 0.30%, Ar^{40}/K^{40} = 0.0511; radiogenic Ar = 62%.
Concentrate; crushed whole rock.

From diabase.

(86 O) 40 feet above base of sill, photo A13614-194, Site 9A, District of Mackenzie; 67°32'N, 115°48'W. Map-unit 18A, GSC Map 18, 1960. Sample RN-136, collected by W.A. Robertson. No geological interpretation available.

District of Keewatin

GSC 64-70 Biotite, K-Ar age 1,760 ± 60 m.y.

K = 6.71%, Ar^{40}/K^{40} = 0.1703; radiogenic Ar = 98%. Concentrate; reasonably clean concentrate of olive-brown biotite. About 30% of the biotite flakes are partly altered to chlorite and contain fine-grained inclusions of epidote. Impurities consist mainly of altered amphibole. Total chlorite content 15%, amphibole 5%.

From hornblende granodiorite.

(65 H) North shore of Ameto Lake, near west end of lake, District of Keewatin; 61°40'N, 97°20'W. Map-unit 2, GSC Map 53-22. Sample EA-429-63, collected by D. M. Carmichael, interpreted by K. E. Eade.

The sample is a medium-grained, homogeneous, grey granodiorite. Rocks of this unit have the characteristics of high level intrusive bodies.

As the Hurwitz Group unconformably overlies the granodiorite, the sedimentary rocks must be younger than 1,760 m.y.

GSC 64-71 Biotite, K-Ar age 1,685 ± 120 m.y.

K = 4.02%, Ar^{40}/K^{40} = 0.1595; radiogenic Ar = 95%. Concentrate; impure concentrate of brown biotite. Impurities consist of pale green amphibole, altered biotite flakes, and a few grains of altered feldspar. Total chlorite content 10%, amphibole 30%.

From gabbro.

(65 G) South shore of Griffin Lake, near west end of lake, District of Keewatin; 61°17'N, 98°55'W. Map-unit A, GSC Paper 53-22 (C. S. Lord). Sample EA-88-62, collected and interpreted by K. E. Eade.

The sample is a medium-grained, dark green to black gabbro from sills present in the lower part of the Hurwitz Group.

On the basis of this determination, the sedimentary rocks of the Hurwitz Group are older than 1,685 m.y.

District of Keewatin

GSC 64-72 Whole Rock, K-Ar age 1,595 ± 210 m.y.

K = 0.37%, Ar^{40}/K^{40} = 0.1467; radiogenic Ar = 83%. Concentrate; crushed whole rock.

From basalt.

(44 P) Base of Mount Allen on Gilmour Island, District of Keewatin (Hudson Bay); 59°50'N, 80°10'W. Sample TA-167-63, collected by F.C. Taylor, interpreted by I.M. Stevenson.

The rock is a massive, dark, fine-grained basalt typical of the flow rocks of the Ottawa Islands. The purpose of the age determination was to confirm the suspected Proterozoic age of the islands in an attempt to correlate them with the Belcher Islands and the Cape Smith-Wakeham Bay Belt.

GSC 64-73 Biotite, K-Ar age 1,110 ± 100 m.y.

K = 1.70%, Ar^{40}/K^{40} = 0.0883; radiogenic Ar = 95%. Concentrate; partly concentrated biotite. The sample is composed of fresh and altered biotite, chlorite, hornblende, altered pyroxene, and a few opaque grains. Some flakes of altered biotite and chlorite contain fine-grained inclusions of epidote. A few biotite flakes contain large zoned pleochroic haloes.

From gabbro.

(65 F) District of Keewatin; 61°18'N, 98°39'W. No published geological map. Sample FA-32-63(2), collected and interpreted by W.F. Fahrig.

The rock is a coarse ophitic gabbro composed of saussuritized plagioclase, uralitized pyroxene, quartz, iron-ores, apatite, and orange-brown biotite.

The date obtained indicates the approximate age of intrusion.

GSC 64-74 Phlogopite, K-Ar age 1,685 ± 50 m.y.

K = 6.62%, Ar^{40}/K^{40} = 0.1596; radiogenic Ar = 98%. Concentrate; reasonably clean concentrate of pale buff phlogopite. Impurities consist of altered feldspar. Total chlorite content 2%.

District of Keewatin

From porphyritic biotite syenite.

(56 D) Small island north of Christopher Island, Baker Lake, District of Keewatin; 64°07'30"N, 94°35'00"W. Feeder dyke to map-unit 4, GSC Paper 64-20. Sample DF-A 810-64, collected and interpreted by J. A. Donaldson.

The phlogopite occurs as unaltered phenocrysts in a fine-grained trachytic dyke, feeder to the Christopher Island Formation of the Dubawnt Group. The age agrees well with two previous Dubawnt determinations (GSC 60-60, 1,720 m.y.; GSC 61-100, 1,770 m.y.). Thin-section examination of another previously dated "Dubawnt" sample (GSC 61-101, 2,240 m.y.) revealed that it belongs to the basement rather than to the volcanic suite of the Dubawnt Group. Additional determinations are necessary to determine whether the only other dated Dubawnt sample (GSC 59-35, 1,515 m.y.) is anomalous. Volcanic rocks of the Dubawnt Group show no evidence of having been involved in the Hudsonian orogeny.

Alberta

GSC 64-75 Whole Rock, K-Ar age 145 ± 18 m.y.

K = 1.70%, Ar^{40}/K^{40} = 0.0088; radiogenic Ar = 69%.
Concentrate; crushed whole rock, mainly feldspar.

From granite.
(82 G) "Ginger Hill", Alberta; 49°29'N, 114°15'W. Map-unit 29, GSC Map 5-1959 (Carbondale River). Sample NC 74-4, collected and described by D.K. Norris, interpreted by R.D. Stevens.

The specimen is a fine-grained, altered rhyodacite porphyry pebble in a conglomerate that lies about 600 feet stratigraphically below the top of the Blairmore Group and 50 feet below a fossiliferous bed carrying upper Blairmore flora of Albian age (W.A. Bell, GSC Memoir 285, 1956). Thus, the time of deposition of the conglomerate should be about 115 m.y. ago, and the age of the pebbles greater.

The determined age of 145 m.y. represents the minimum age of the source terrain of porphyry from which this pebble was derived.

Saskatchewan

GSC 64-76 Whole Rock, K-Ar age 1,630 ± 180 m.y.

K = 0.82%, Ar^{40}/K^{40} = 0.1512; radiogenic Ar = 95%.
Concentrate; crushed whole rock.

From basalt.
(74 N) South shore of Martin Lake, Saskatchewan; 59°31'06"N, 108°36'26"W. Map-unit 11, GSC Map 54-15. Sample S 1, collected and interpreted by L. P. Tremblay.

The rock is a dark green, fine-grained, massive basalt. It is made up of large euhedral andesine laths in a mesh of smaller euhedral andesine laths with much interstitial mafic material and some opaque substances.

The sample is from basalt flow and dates the last volcanism of the Martin Formation. Ages on related rocks (a sill and a dyke, see GSC 63-98 and GSC 63-97) agree with the field relationships as they are slightly less than this age of the flow, but suggest that all may be derived from the same gabbro source. The age of the basalt is however younger than the main period of uranium mineralization in the area, which occurred at about 1,750 m.y. as determined by U-Pb ages on pitchblendes.

Manitoba

GSC 64-77 Whole Rock, K-Ar age 1,445 ± 180 m.y.

$K = 0.38\%$, $Ar^{40}/K^{40} = 0.1272$; radiogenic Ar = 81%.
Concentrate; crushed whole rock.

From basalt.
(64 1) NW shore of Molson Lake, Manitoba; 54°15'N, 96°55'W. Map-unit 11, GSC Map 32-1961. Sample FA-12-63(1) collected and interpreted by W. F. Fahrig.

The rock is from the chilled contact phase of a basaltic intrusion, and consists of unaltered plagioclase laths and anhedral pyroxene crystals (partly or wholly altered to uralite and chlorite) contained in a fine-grained groundmass of evenly distributed opaque material, amphibole, and chlorite. Clusters of opaque mineral surrounded by rims of uralite appear to be alteration products of pyroxene. The plagioclase laths are partly corroded and a small percentage exhibit zoning. A narrow devitrified glassy zone marks the contact with the country rock.

The 1,445 m.y. date indicates the approximate age of intrusion.

GSC 64-78 Whole Rock, K-Ar age 1,105 ± 140 m.y.

$K = 0.61\%$, $Ar^{40}/K^{40} = 0.0880$; radiogenic Ar = 73%.
Concentrate; crushed whole rock.

From gabbro.
(53 L) Island in God's Lake, Manitoba; 54°47'N, 94°16'W. No geological map reference. Sample FA-40 63(1) collected and interpreted by W. F. Fahrig.

The rock is a chilled contact phase of a basic intrusion. It consists of plagioclase laths, saussuritized light brown pyroxene present as anhedral, corroded crystals, and very small fresh flakes of reddish-brown biotite.

The 1,105 m.y. date represents the approximate age of intrusion.

GSC 64-79 Whole Rock, K-Ar age 1,280 ± 180 m.y.

$K = 0.45\%$, $Ar^{40}/K^{40} = 0.1073$; radiogenic Ar = 72%.
Concentrate; crushed whole rock.

Manitoba

From gabbro.

(63 I) Manitoba; 54°10'N, 96°47'W. Map-unit 11, GSC Map 32-1961. Sample FA-13-63(2), collected and interpreted by W.F. Fahrig.

The rock consists of small highly altered phenocrysts of pyroxene evenly distributed throughout a very fine-grained groundmass of devitrified glass, amphibole, chlorite and opaque material (magnetite). Small plagioclase laths are also present in the groundmass and make up about 2 per cent of the rock.

The 1,280 m.y. date indicates the approximate age of intrusion.

GSC 64-80 Biotite, K-Ar age 1,755 ± 60 m.y.

$K = 7.76\%$, $Ar^{40}/K^{40} = 0.1692$; radiogenic Ar = 99%. Concentrate, clean concentrate of olive-brown biotite. About 30% of the biotite flakes are partly altered to chlorite and contain acicular inclusions and fine-grained epidote along the fractures. Total chlorite content 20%.

From quartz monzonite.

(63 J) From point south of inlet to Clark Creek, east shore of Conlin Lake, Manitoba; 54°44'N, 98°30'W. GSC Prelim. Paper "Wekusko Lake" (in preparation). Sample BA-G-150, collected and interpreted by C.K. Bell.

The rock is a massive, unfoliated, biotite-quartz monzonite from an intrusive stock that lies well within the Superior Province. This should be compared with GSC 63-105, 1,785 m.y., for a similar intrusive stock that occurs close to the Churchill-Superior boundary, and GSC 63-99, 1,790 m.y., for a late pegmatite from the Wekusko Lake (Churchill Province) area. These late granitic intrusions represent late stages of the Hudsonian orogeny and, while not abundant, they are widespread in both provinces and within the boundary zone.

GSC 64-81 Biotite, K-Ar age 2,680 ± 85 m.y.

$K = 8.05\%$, $Ar^{40}/K^{40} = 0.3466$; radiogenic Ar = 99%. Concentrate; clean concentrate of brown biotite. A few flakes are slightly bleached and contain minute inclusions. Total chlorite content 2%.

Manitoba

From plagioclase-quartz-biotite gneiss
(63 J) 2 miles northeast of Little Manitou Rapids, Nelson River, Manitoba; 54°49'N, 98°02'W. GSC Prelim. Paper "Wekusko Lake" (in preparation). Sample BA-T-145, collected by E. Beuce, interpreted by C.K. Bell.

The sample is of a granulite facies gneiss composed of oligoclase, quartz, untwinned orthoclase, biotite, hornblende, and orthopyroxene, with accessory apatite, magnetite, and sphene. The age of 2,680 m.y. places this rock in the Superior Province. It is of interest to compare this age with GSC 60-83, a hypersthene granite (2,400 m.y.) that lies in stratigraphically the same position relative to the assumed Churchill-Superior Province front, 100 miles to the northeast. These hypersthene bearing granites and gneisses form a belt that coincides with the Nelson River gravity high which runs along the southeast side of the boundary. Rocks of younger age lie on both sides of this granulite-charnockite belt. These anomalous ages are thought to be the product of the retrogressive metamorphism caused by the overlapping of the Hudsonian orogeny on Superior Province rocks. For some reason these hypersthene bearing rocks resisted the effects of metamorphism and have remained the oldest rocks in the Upper Nelson River area.

GSC 64-82 Hornblende, K-Ar age 1,690 ± 170 m.y.

$K = 0.82\%$, $Ar^{40}/K^{40} = 0.1602$; radiogenic Ar = 96%. Concentrate; clean concentrate of pleochroic blue-green to brown hornblende, with a trace of chlorite and feldspar.

From hornblende diorite.
(63 J) On railway bend one mile north of Resting Lake, Manitoba; 54°52'15"N, 98°44'00"W. GSC Prelim. Paper "Wekusko Lake" (in preparation). Sample BA-F-137, collected and interpreted by C.K. Bell.

The rock is a brick-red weathering, medium-grained, dark red hornblende-biotite syenodiorite, typical of a large stock that lies on the Churchill-Superior boundary. No other similar rocks have been found in the Upper Nelson River area. This stock is thought to be intruded by the sulphide-bearing peridotites common to the Wabowden-Thompson nickel belt and it is closely associated with a nickel showing at Wabowden. As the rock has been only slightly metamorphosed, it probably represents one of the later rocks to have been intruded during the Hudsonian orogeny and it may be associated with the late granites (GSC 64-105, 1,785 m.y.; GSC 64-80, 1,755 m.y.) in the area.

Manitoba

GSC 64-83 Hornblende, K-Ar age 2,435 ± 170 m.y.

$K = 1.30\%$, $Ar^{40}/K^{40} = 0.2906$; radiogenic Ar = 98%. Concentrate; clean concentrate of pleochroic blue-green to chalcedony-yellow hornblende. Some of the hornblende fragments contain fine-grained impurities along fractures. Impurities detected by X-ray are traces of mica, quartz, and K-feldspar.

From anorthosite.

(63 J) Large island in the east central part of Kiskitto Lake, Manitoba; 54°16'00"N, 98°30'45"W. GSC Prelim. Paper "Wekusko Lake" (in preparation). Sample BA-H-144, collected by P. Hay, interpreted by C.K. Bell.

This hornblende fills the interstices between labradorite crystals in a very coarse-grained anorthosite sill (Football Anorthosite). These sills have been traced intermittently for over 50 miles in the Cross Lake-Upper Nelson River area and they are thought to be related to local anorthosite batholiths and stocks. As would be expected, this age coincides with the age of the nearby granulites (GSC 64-81, 2,680 m.y.). These anorthosites were intruded during the Kenoran orogeny about the time the granulites were being formed. They have not been affected by the later Hudsonian metamorphism that has transgressed into the Superior Province in many areas.

Ontario

GSC 64-84 Muscovite, K-Ar age 1,055 ± 35 m.y.

$K = 8.14\%$, $Ar^{40}/K^{40} = 0.0825$; radiogenic Ar = 96%. Concentrate; reasonably clean concentrate of muscovite. The muscovite flakes display a fibrous, radial structure. Impurities consist of calcite fragments (15%).

From breccia cement.

(41 N) Ontario; 47°04'N, 84°31'W. No geological map reference. Sample 63-RF-11, collected by P. E. Giblin and S. M. Roscoe.

The sample is from muscovite rosettes in calcite associated with quartz, chalcopyrite, and pyrite cementing sericitized breccia fragments. The 1,055 m.y. date indicates the age of mineralization and a possible relation to nearby Keweenawan copper mineralization.

GSC 64-85 Biotite, K-Ar age 2,375 ± 140 m.y.

$K = 3.43\%$, $Ar^{40}/K^{40} = 0.2783$; radiogenic Ar = 97%. Concentrate; impure concentrate of olive-brown biotite. Some of the biotite flakes are partly altered to chlorite and contain small acicular inclusions. Impurities, listed in order of decreasing abundance, are: chlorite, hornblende, altered and fresh feldspar, quartz, muscovite, and rutile. Total chlorite content 40%.

From biotite granite.

(32 D) Southwest of Grassy Lake, Ontario; 48°05'13"N, 79°49'53"W. Map-unit 9a, Ontario Dept. Mines Map 1950-3. Sample HK/ON/3-142, collected and interpreted by R. H. C. Holman.

A medium- to coarse-grained, pink hornblende syenite composed of potash feldspar, plagioclase, hornblende, biotite, and chlorite.

The McElroy stock is the largest of several syenitic bodies intruding Timiskaming rocks in the Kirkland Lake area. The age of 2,375 m.y. gives an approximate date for this intrusive activity and a minimum age for the Timiskaming rocks in the area.

GSC 64-86 Muscovite, K-Ar age 2,690 ± 80 m.y.

$K = 8.45\%$, $Ar^{40}/K^{40} = 0.3492$; radiogenic Ar = 99%.

Ontario

Concentrate; clean concentrate of muscovite. Minor impurities consist of a few grains of altered biotite. Total chlorite content 2%.

From feldspar-biotite-muscovite-quartz pegmatite.
(42 L) North end of trench 050 S/030 E, Ontario; 50°41'N, 87° 00'W. Sample 63-GF-71, collected and interpreted by D. F. Sangster.

See GSC 64-87 for description and interpretation.

GSC 64-87 Biotite, K-Ar age 2,555 ± 70 m.y.

$K = 6.10\%$, $Ar^{40}/K^{40} = 0.3175$; radiogenic Ar = 99%. Concentrate; concentrate of green biotite. A few biotite flakes are orange-brown, and some flakes are intergrown with bright green chlorite. Total chlorite content 30%.

From feldspar-biotite-muscovite-quartz pegmatite.
(42 L) North end of trench 050 S/030E, Ontario; 50°41'N, 87° 00'W. No geological map reference. Sample 63-GF-71, collected and interpreted by D. F. Sangster.

Both micas are from a specimen of feldspar-mica-quartz pegmatite that lacks defined zoning. Pink perthite, biotite, mica, quartz, minor plagioclase, and tourmaline occur as large crystals in a pegmatite sill cutting quartz-biotite-garnet schist.

The quartz-biotite-garnet schist, interlayered with magnetite-quartz iron-formation, shows two distinct periods of structural deformation separated by a period when simple pegmatite sills were intruded. The post-pegmatite orogeny is evidenced by boudinage structure in these bodies, resulting in a separation of up to three feet between boudins.

The two dates on the specimen (2,555 m.y. biotite, GSC 64-87, and 2,690 m.y. muscovite, GSC 64-86) fall within the range of the Kenoran orogeny and presumably date the second period of structural deformation. Directions of magnetic polarization in enclosing magnetite iron-formation are coincident with structural and petrofabric lineations imposed on the rock by the second deformation. See also GSC 64-88 for further discussion.

GSC 64-88 Biotite, K-Ar age 2,510 ± 65 m.y.

$K = 7.61\%$, $Ar^{40}/K^{40} = 0.3070$; radiogenic Ar = 99%.

Ontario

Concentrate; clean concentrate of olive-green biotit
Most of the flakes contain opaque inclusions, and abou
of the flakes contain colourless apatite inclusions. Mos
flakes are blistered. Total chlorite content is less than
10%.

From schist.

(42 L) North end of trench 050S/030E, Ontario; 50°41'N, 87°00'W. No geological map reference. Sample 63-GF-70, collected and interpreted by D. F. Sangster.

The biotite analyzed is from a specimen of quartz-biotite schist interlayered with magnetite-quartz iron-formation. The schist is composed of biotite, plagioclase, potash feldspar, quartz, minor garnet and opaque material. Alteration is slight and confined to chloritization of biotite.

The rocks show two distinct periods of structural deformation separated by a period when simple pegmatite sills were intruded. The second deformation appears to have been the milder of the two. The age indicated by biotite in the schist (2,510 m.y.) agrees well with biotite from the pegmatite (2,555 m.y.; GSC 64-87). Muscovite, coexisting with biotite in the pegmatite, gave an age of 2,690 m.y. (GSC 64-86). All dates fall within the range of the Kenoran orogeny but the older date may possibly be near the true age of pegmatite intrusion whereas the younger biotite dates would represent a re-establishment of equilibrium in biotite during the second deformation. The results suggest that muscovite is able to retain argon better than biotite and was relatively unaffected by later, lower-grade metamorphism.

Directions of magnetic polarization in intercalated iron-formation are subparallel with structural and petrofabric lineations in the schist and magnetite-quartz layers.

GSC 64-89 Hornblende, K-Ar age 2,620 ± 230 m.y.

$K = 0.77\%$, $Ar^{40}/K^{40} = 0.3328$; radiogenic Ar = 95%.
Concentrate; clean concentrate of blue-green to olive-brown pleochroic hornblende. Hornblende fragments contain a few quartz and feldspar inclusions and are slightly altered along the cleavage planes. A trace of chlorite is present.

From gneissic granodiorite.

(41 J) Road cut on Highway 17, 0.4 mile east of Livingston Creek, Ontario; 46°16'00"N, 83°27'25"W. Map-unit 2, GSC Map 6-1961. Sample SH-85-60, collected and interpreted by C. H. Stockwell.

Ontario

This sample is a medium-grained, pinkish grey, gneissic granodiorite composed of quartz, oligoclase, hornblende, biotite, and rare small zircons. The biotite is somewhat altered to dark opaque material but the hornblende is fresh.

The granodiorite forms a basement unconformably beneath the Huronian which here comprises the Mississagi and Thesalon Formations. The contact with underlying granodiorite lies about 0.2 mile west of where the sample was obtained and 2.5 miles south of the Murray fault. Previously determined dates on biotite from the pre-Huronian basement have given rather erratic results due to loss of argon, such as 1,915 m.y. (GSC 61-145) 1,520 m.y. (GSC 61-147) and 1,685 m.y. (GSC 59-42). However, muscovite at 2,455 m.y. (GSC 60-105) and hornblende of the present sample at 2,620 m.y. retain argon better and confirm the suspected Archaean age of the basement.

GSC 64-90 Fine Muscovite, K-Ar age 2,360 ± 70 m.y.

K = 8.88%, Ar^{40}/K^{40} = 0.2754; radiogenic Ar = 99%. Concentrate; clean concentrate of fine-grained muscovite (-80, +150 mesh). Most flakes are about 200 microns in diameter. A few flakes are intergrown with quartz.

From pegmatite.
(52 K) Highway 105, 11 miles northeast of Ear Falls, Ontario; 50°44'30"N, 93°24'00"W. No geological map reference. Sample PC-80-61, collected by V.K. Prest.

This sample and the following one (GSC 64-91) were taken from a pegmatite composed of white microcline and albite in crystals up to 1/2 inch long, grey quartz, muscovite, and a little biotite. The pegmatite is crossed by shear fractures along which abundant fine-grained muscovite and sericite have developed in parallel orientation. In less sheared parts, remnants of coarser muscovite about 1/8 inch across remain.

This sample (GSC 64-90) is a concentrate of the fine-grained muscovite, whereas the following one (GSC 64-91) is a concentate of the remnant coarse-grained muscovite.

See GSC 64-91 for interpretation of the age determinations.

GSC 64-91 Coarse Muscovite, K-Ar age 2,340 ± 70 m.y.

K = 8.87%, Ar^{40}/K^{40} = 0.2709; radiogenic Ar = 99%.

Ontario

Concentrate; clean concentrate of coarse-grained muscovite (+ 35 mesh to 2 mm diameter). Most of the muscovite flakes are intergrown with quartz. Some flakes are composite and stained.

From pegmatite.

(52 K) Highway 105, 11 miles northeast of Ear Falls, Ontario; 50°44'30"N, 93°24'00"W. Sample PC-80-61, collected by V.K. Prest.

See GSC 64-90 for description of the sample material.

The pegmatite has evidently suffered post-crystallization deformation with the development of fine-grained muscovite. It occurs in the Superior Province in a belt some 400 miles long where previous ages (biotite, 1,700 m.y.; biotite, 2,225 m.y.; and hornblende, 1,860 m.y.) suggest an extensive zone of superimposed Hudsonian deformation.

It was hoped that the coarse muscovite would give the age of primary crystallization, and that the fine muscovite would give the age of the later deformation. However, the ages obtained are essentially identical Superior dates showing no indication of 1,700 m.y. Hudsonian metamorphism.

GSC 64-92 Whole Rock, K-Ar age 2,000 ± 240 m.y.

K = 0.57%, Ar^{40}/K^{40} = 0.2083; radiogenic Ar = 94%.
Concentrate; crushed whole rock.

From gabbro.

(42 L) Island in Ogoki Lake, Ontario; 50°49'N, 87°11'W. No geological map reference. Sample FA-55-63(9) collected and interpreted by W.F. Fahrig.

The rock is a fresh gabbro with ophitic texture consisting of medium-grained slightly saussuritized plagioclase with light brown clinopyroxene, magnetite and biotite flakes.

The 2,000 m.y. date represents the approximate age of intrusion.

GSC 64-93 Whole Rock, K-Ar age 2,080 ± 250 m.y.

K = 0.64%, Ar^{40}/K^{40} = 0.2222; radiogenic Ar = 87%.
Concentrate; crushed whole rock.

Ontario

From chilled gabbro.
(42 L) Island in Ogoki Lake, Ontario; 50°49'N, 87°11'W. No geological map reference. Sample FA-55-63(1) collected and interpreted by W. F. Fahrig.

Chilled contact of basaltic intrusion consisting of phenocrysts of slightly saussuritized plagioclase and slightly uralitized pyroxene in a semi-opaque devitrified glass matrix.

The 2,080 m.y. date represents the approximate age of intrusion.

GSC 64-94 Biotite, K-Ar age 2,490 ± 75 m.y.

K = 6.66%, Ar^{40}/K^{40} = 0.3029; radiogenic Ar = 99%. Concentrate; impure concentrate of partly altered olive-brown biotite. About 50% of the biotite flakes are partly altered to chlorite and contain fine-grained inclusions of epidote. Total chlorite content 30%.

From granodiorite.
(42 L) Island in Ogoki Lake, Ontario; 50°49'N, 87°11'W. No geological map reference. Sample FA-55-63(12), collected and interpreted by W. F. Fahrig.

The rock is a pink, slightly foliated granodiorite consisting chiefly of interlocking, equidimensional grains of plagioclase and quartz with light brown to green flakes of biotite. Biotite flakes appear fresh and are fairly well aligned.

The 2,490 m.y. date represents the approximate age of metamorphism.

GSC 64-95 Biotite, K-Ar age 2,520 ± 80 m.y.

K = 7.01%, Ar^{40}/K^{40} = 0.3092; radiogenic Ar = 98%. Concentrate; partly altered olive-brown biotite. About 50% of the biotite flakes are partly altered to chlorite. Total chlorite content 35%.

From granodiorite.
(42 L) Island in Ogoki Lake, Ontario; 50°49'N, 87°11'W. No geological map reference. Sample FA-55-63(13), collected and interpreted by W. F. Fahrig.

Ontario

The rock is a coarse-grained foliated buff-pink granodiorite containing partly chloritized brown biotite.

The 2,520 m.y. date represents the age of the last major regional metamorphism in this area.

GSC 64-96 Biotite, K-Ar age 2,595 ± 85 m.y.

$K = 7.71\%$, $Ar^{40}/K^{40} = 0.3265$; radiogenic Ar = 99%. Concentrate; clean concentrate of brown biotite. About 30% of the biotite flakes are partly altered to chlorite and epidote. A few flakes contain zircon inclusions surrounded by dark brown pleochroic haloes. Total chlorite content 15%.

From granodiorite.

(42 L) Island in Ogoki Lake, Ontario; 50°49'N, 87°11'W. No geological map reference. Sample FA-55-63(16) collected and interpreted by W.F. Fahrig.

The rock is a pink to buff granodiorite consisting chiefly of interlocking equidimensional grains of plagioclase, quartz, biotite and muscovite. Plagioclase is partly altered to saussurite, epidote is well developed as an alteration product. There is little chlorite, but some pyroxene.

The 2,595 m.y. date represents the age of metamorphism.

GSC 64-97 Biotite, K-Ar age 2,435 ± 145 m.y.

$K = 4.21\%$, $Ar^{40}/K^{40} = 0.2909$; radiogenic Ar = 99%. Concentrate; impure concentrate of orange-brown biotite. Some biotite flakes are partly altered to chlorite and contain needle-like inclusions. Impurities consist of pyroxene, amphibole, chlorite, opaque grains, and a few fragments of feldspar. Total chlorite content 15%.

From gabbro.

(42 L) Island in Ogoki Lake, Ontario; 50°49'N, 87°11'W. No geological map reference. Sample FA-55-63(4) collected and interpreted by W.F. Fahrig.

The rock is a gabbro consisting of laths and equidimensional crystals of saussuritized plagioclase, light brown pyroxene crystals altered to chlorite and uralite, with magnetite and chloritized reddish-brown biotite

The 2,435 m.y. date represents the approximate age of intrusion.

Ontario

GSC 64-98 Whole Rock, K-Ar age 1,825 ± 195 m.y.

K = 0.88%, Ar^{40}/K^{40} = 0.1800; radiogenic Ar = 96%.
Concentrate; crushed whole rock.

From diabasic gabbro.
(42 L) Island in Ogoki Lake, Ontario; 50°49'N, 87°11'W. No geological map reference. Sample FA-55-63(11), collected and interpreted by W. F. Fahrig.

The rock is a coarse ophitic gabbro consisting of partly saussuritized plagioclase, partly uralitized pyroxene, iron ores, and a trace of chloritized biotite.

The date obtained indicates the approximate age of intrusion.

GSC 64-99 Biotite, K-Ar age 2,295 ± 60 m.y.

K = 6.93%, Ar^{40}/K^{40} = 0.2618; radiogenic Ar = 98%.
Concentrate; clean concentrate of brown, partly altered biotite. About 60% of the biotite flakes are locally altered to chlorite and fine-grained epidote. Total chlorite content 40%.

From biotite granite.
(42 L) Island in Ogoki Lake, Ontario; 50°49'N, 87°11'W. No geological map reference. Sample FA-55-63(1) collected and interpreted by W. F. Fahrig.

The sample is a coarse-grained, grey to buff foliated biotite granite. The biotite is light brown in thin section and contains minor intergrowths of chlorite.

The rock is in contact with the basalt GSC 64-93 and the K-Ar age of the biotite is the approximate age of intrusion of the basalt.

GSC 64-100 Biotite, K-Ar age 1,240 ± 45 m.y.

K = 7.11%, Ar^{40}/K^{40} = 0.1025; radiogenic Ar = 98%.
Concentrate; reasonably clean concentrate of orange-reddish biotite. Impurities consist of a few fragments of feldspar, chlorite, serpentine, amphibole, pyroxene, and olivine. Total chlorite content 6%.

Ontario

From olivine diabase.

(41 P) North end of Obabika Lake, Ontario; 47°08'N, 80°18'W. Ontario Dept. Mines Map 54-1. Sample FA-86-63(2), collected and interpreted by W. F. Fahrig.

The rock is an ophitic gabbro consisting of partly saussuritized plagioclase laths, fairly fresh, light brown clinopyroxene, slightly chloritized reddish brown biotite, and anhedral magnetite.

The 1,240 m.y. date represents the approximate age of intrusion.

GSC 64-101 Biotite, K-Ar age 1,055 ± 40 m.y.

K = 6.35%, Ar^{40}/K^{40} = 0.0827; radiogenic Ar = 85%. Concentrate; clean concentrate of orange-brown biotite. About 10% of the biotite flakes are partly altered to chlorite. Some flakes contain small zircon inclusions surrounded by large dark brown pleochroic haloes. Total chlorite content 5%

From biotite gabbro.

(52 A) Entrance to Pine Bay, west end of Lake Superior, Ontario; 48°01 2/3'N, 89°30'W. Map-unit 4, GSC Map 355A. Sample FA-62-63(3), collected and interpreted by W. F. Fahrig.

The rock is an ophitic gabbro consisting of medium-grained, well twinned, fresh plagioclase laths with interstitial light brown, partly uralitized pyroxene, chlorite, magnetite, and reddish brown to light brown, fresh biotite.

The 1,055 m.y. date represents the approximate age of intrusion.

GSC 64-102 Biotite, K-Ar age 1,125 ± 40 m.y.

K = 6.39%, Ar^{40}/K^{40} = 0.0899; radiogenic Ar = 99%. Concentrate; reasonably clean concentrate of brown biotite. Minor impurities consist of chlorite, amphibole, feldspar, epidote and a few opaque grains. Total chlorite content 4%.

From gabbro.

(42 F) 3 1/2 miles west of Hillsport on C.N.R., Ontario; 49°28'N, 87°37'W. Map-unit 4, Ontario Dept. Mines Map P98. Sample FA-63-63(3), collected and interpreted by W. F. Fahrig.

Ontario

The rock is a fine-grained gabbro with poorly developed diabasic texture. Highly saussuritized plagioclase laths, pyroxene altered to amphibole, chlorite, and reddish-brown biotite.

The 1,125 m.y. date represents the approximate age of intrusion.

GSC 64-103 Biotite, K-Ar age 2,150 ± 140 m.y.

K = 3.13%, Ar^{40}/K^{40} = 0.2351; radiogenic Ar = 94%
Concentrate; impure concentrate of brown biotite. Impurities consist of altered feldspar and pyroxene, amphibole, chlorite, and opaque grains. Total chlorite content 15%, amphibole 15%.

From coarse ophitic gabbro.
(41 O) SE corner of upper Green Lake, Ontario; 47°07'N, 82°31 1/2'W. Map-unit 7, Ontario Dept. Mines Map 2013. Sample FA-84-63(3), collected and interpreted by W. F. Fahrig.

The age of 2,150 m.y. obtained from this biotite is very much greater than was expected on the basis of geological evidence. To investigate and clarify this problem, a whole rock age was determined on another sample FA-84-63(1) from the same locality. See GSC 64-104 at 1,485 m.y.

GSC 64-104 Whole Rock, K-Ar age 1,485 ± 120 m.y.

K = 1.00%, Ar^{40}/K^{40} = 0.1321; radiogenic Ar = 93%.
Concentrate; crushed whole rock.

From gabbro.
(41 O) Upper Green Lake, Ontario; 47°07'N, 82°31 1/2'W. Map-unit 7, Ontario Dept. Mines Map 2013. Sample FA-84-63(1), collected and interpreted by W. F. Fahrig.

The rock is a fine-grained ophitic gabbro consisting of saussuritized plagioclase, uralitized and chloritized pyroxene, iron ores, quartz, and a trace of brown biotite.

The 1,485 m.y. date represents the approximate age of intrusion.

Ontario

GSC 64-105 Impure Biotite, K-Ar age 1,705 ± 140 m.y.

K = 1.45%, Ar^{40}/K^{40} = 0.1620; radiogenic Ar = 98%. Concentrate; partly concentrated biotite. The sample consists of amphibole, altered pyroxene, feldspar, chlorite, orange-brown biotite, and opaque grains. The sample was too small for further concentration. Chlorite and biotite are in about equal amounts.

From coarse-grained ophitic gabbro.
(42 F) 2 miles NNE of Manitouwadge Lake, Ontario; 49°09 1/2'N, 85°47'W. Map-unit 9, Ontario Dept. Mines Map 1957-8. Sample FA-68-63(3), collected and interpreted by W. F. Fahrig.

The rock is an ophitic gabbro consisting of heavily saussuritized plagioclase laths, interstitial light brown clinopyroxene altered to uralite and chlorite and light brown to reddish brown biotite partly altered to chlorite and magnetite.

The 1,705 m.y. date represents the approximate age of intrusion.

GSC 64-106 Impure Biotite, K-Ar age 1,925 ± 145 m.y.

K = 1.41%, Ar^{40}/K^{40} = 0.1959; radiogenic Ar = 90%. Concentrate; the sample consists mainly of amphibole, altered pyroxene, and biotite, with less abundant chlorite, plagioclase, and opaque grains. Total chlorite content 5%.

From coarse-grained biotitic ophitic gabbro.
(52 F) NW shore of Kakagi Lake, Ontario; 49°12 1/2'N, 93°59'W. Map-unit 7, Ontario Dept. Mines Map 52 C. Sample FA-33-63(3), collected and interpreted by W. F. Fahrig.

The specimen is a gabbro consisting of randomly oriented, slightly saussuritized plagioclase laths, light brown pyroxene, yellowish to reddish brown fresh subhedral crystals of biotite and opaque material (probably magnetite).

The 1,925 m.y. date represents the approximate age of intrusion.

Ontario

GSC 64-107 Biotite, K-Ar age 950 ± 75 m.y.

K = 2.92%, Ar^{40}/K^{40} = 0.0723; radiogenic Ar = 96%. Concentrate; orange-brown biotite with pyroxene, feldspar, amphibole, and a few opaque grains. Some biotite flakes are slightly bleached. Sample was too small for further concentration. Total chlorite content 4%.

From olivine diabase.
(41 P) Southeast corner of Hybrid Lake, Ontario; 47°10 1/2'N, 82°57'W. Map-unit 7, Ontario Dept. Mines Map 2013. Sample FA-85-63(3) collected and interpreted by W. F. Fahrig.

The rock is an ophitic gabbro consisting of slightly saussuritized, well twinned plagioclase laths, fresh clinopyroxenes, fresh red-brown biotite, and magnetite.

The 950 m.y. date represents the approximate age of intrusion.

GSC 64-108 Impure Biotite, K-Ar age 1,675 ± 140 m.y.

K = 1.61%, Ar^{40}/K^{40} = 0.1576; radiogenic Ar = 96%. Concentrate; partly concentrated biotite. The sample is composed of altered pyroxene, amphibole, chlorite, feldspar, biotite, and opaque grains.

From gabbro.
(52 F) Contact Bay, Wabigoon Lake, Ontario; 49°41 1/2'N, 92°50 1/2'W. Map-unit 5, Ontario Dept. Mines Map 50E. Sample FA-41-63(2), collected and interpreted by W. F. Fahrig.

The rock is a coarse-grained ophitic gabbro consisting of intensely saussuritized plagioclase, uralitized pyroxene, iron ores, and brown biotite.

The 1,675 m.y. date represents the approximate age of intrusion.

GSC 64-109 Impure Biotite, K-Ar age 2,155 ± 165 m.y.

K = 2.61%, Ar^{40}/K^{40} = 0.2358; radiogenic Ar = 100%.

Ontario

Concentrate; partly concentrated biotite. The sample is composed of amphibole-pyroxene intergrowths, biotite, chlorite, opaque grains, and a few fragments of feldspar.

From gabbro.

(42 C) Dog Lake, west of Rabbit Island, Ontario; 48°17'N, 84°12 1/2'W. Map-unit 3, Ontario Dept. Mines Map 44C. Sample FA-74-63(2), collected and interpreted by W. F. Fahrig.

This rock is a medium-grained ophitic gabbro consisting of uralitized pyroxene, plagioclase, quartz, iron ores, and brown biotite.

The 2,155 m.y. date represents the approximate age of intrusion.

GSC 64-110 Biotite. K-Ar age 2,120 ± 55 m.y.

K = 6.84%, Ar^{40}/K^{40} = 0.2296; radiogenic Ar = 99%. Concentrate; reasonably clean concentrate of brown biotite. Some biotite flakes are overgrown by green zoned biotite and chlorite. Impurities consist of altered hornblende fragments. A few chlorite flakes contain epidote inclusions. Total chlorite content 4%, hornblende 3%.

From gabbro.

(42 B) Jenner Bay, Missinaibi Lake, Ontario; 48°23'N, 83°46'W. Map-unit 9, Ontario Dept. of Mines Map 51G. Sample FA-70-63(2) collected and interpreted by W. F. Fahrig.

The rock is an ophitic gabbro consisting of partly saussuritized plagioclase laths, pyroxene highly altered to hornblende and chlorite, chloritized reddish brown biotite, and magnetite.

The 2,120 m.y. date represents the approximate age of intrusion.

GSC 64-111 Biotite and Hornblende, K-Ar age 1,660 ± 135 m.y.

K = 1.00%, Ar^{40}/K^{40} = 0.1557; radiogenic Ar = 91%. Concentrate; partly concentrated biotite. The sample is composed mainly of green, altered hornblende with less abundant brown and green biotite, chlorite, and a few feldspar fragments.

Ontario

From gabbro.

(41 J) Ontario, 46°07'N, 82°52'W. Map-unit 11, Ontario Dept. Mines Map 2032. Sample FA-82-63(2) collected and interpreted by W. F. Fahrig.

The rock is a coarse-grained ophitic gabbro consisting of saussuritized plagioclase, uralitized hornblende, iron ores, micrographic quartz - K-feldspar intergrowth, and brown biotite.

The 1,660 m.y. date indicates the approximate age of intrusion.

GSC 64-112 Whole Rock, K-Ar age 1,200 ± 130 m.y.

K = 0.74%, Ar^{40}/K^{40} = 0.0982; radiogenic Ar = 88%. Concentrate, crushed whole rock.

From gabbro.

(41 O) Ontario; 47°02'N, 83°14'W. Ontario Dept. Mines Map 1950-6. Sample FA-46-62(2), collected and interpreted by W. F. Fahrig.

This rock is a fine-grained basalt consisting of extensively saussuritized plagioclase, partly uralitized pyroxene and iron ores.

The 1,200 m.y. date indicates the approximate age of intrusion.

GSC 64-113 Whole Rock, K-Ar age 984 ± 120 m.y.

K = 0.62%, Ar^{40}/K^{40} = 0.0756; radiogenic Ar = 92%. Concentrate; crushed whole rock.

From gabbro.

(52 A) Ontario; 48°21 1/2'N, 88°48'W. Map-unit "Diabase dyke and related rocks", GSC Publication 1902. Sample FA-49-63(1), collected and interpreted by W. F. Fahrig.

The rock is a glassy, contact phase of basaltic intrusive material. It consists of randomly oriented microlites of plagioclase in a matrix of devitrified glass, along with small reddish brown patches of biotite, pyroxene, and opaque material.

The 948 m.y. date represents the approximate age of intrusion.

Ontario

GSC 64-114 Whole Rock, K-Ar age 1,560 ± 200 m.y.

K = 0.37%, Ar^{40}/K^{40} = 0.1421; radiogenic Ar = 77%.
Concentrate; crushed whole rock.

From gabbro.
(42 L) Ontario; 50°25 1/2'N, 87°37 1/2'W. Map-unit 5, Ontario Dept. Mines Map No. 1958-1. Sample FA-54-63(2), collected and interpreted by W. F. Fahrig.

The rock is a chilled contact phase of a basic intrusion consisting of partly saussuritized plagioclase, colourless to pale greenish clinopyroxenes, reddish brown biotite flakes partly altered to chlorite and magnetite.

The 1,560 m.y. date represents the approximate age of intrusion.

GSC 64-115 Whole Rock, K-Ar age 1,545 ± 200 m.y.

K = 0.29%, Ar^{40}/K^{40} = 0.1402; radiogenic Ar = 70%.
Concentrate; crushed whole rock.

From basalt.
(42 E) South end of Barbara Lake, Ontario; 49°18'N, 87°48'W. Map-unit 5a, Ontario Dept. Mines Map P 92. Sample FA-56-63(1), collected and interpreted by W. F. Fahrig.

The rock is a basalt consisting of plagioclase laths and clinopyroxene in devitrified glassy matrix.

The 1,545 m.y. date represents the approximate age of intrusion.

GSC 64-116 Whole Rock, K-Ar age 1,205 ± 170 m.y.

K = 0.63%, Ar^{40}/K^{40} = 0.0989; radiogenic Ar = 81%.
Concentrate; crushed whole rock.

From basalt.
(42 D) Ontario; 48°26'N, 86°14'W. No geological map reference. Sample FA-67-63(1), collected and interpreted by W. F. Fahrig.

Ontario

The specimen is from the chilled contact of a basaltic intrusion. The rock consists of subparallel, slightly saussuritized plagioclase phenocrysts, and a small number of iron ore and pyroxene phenocrysts in a semi-opaque devitrified glass matrix.

The 1,205 m.y. date indicates the approximate age of intrusion.

GSC 64-117 Whole Rock, K-Ar age 1,650 ± 220 m.y.

K = 0.61%, Ar^{40}/K^{40} = 0.1542, radiogenic Ar = 87%.
Concentrate; crushed whole rock.

From basalt.
(53 C) Margot Lake, Ontario; 52°28'N, 93°02'W. Map-unit "a", Ontario Dept. Mines Map 47G. Sample FA-36-63(1), collected and interpreted by W. F. Fahrig.

The rock is a chilled contact phase of a basaltic intrusion, consisting of slightly altered, corroded plagioclase laths and pyroxene crystals in devitrified glassy matrix.

The 1,650 m.y. date represents the approximate age of intrusion.

GSC 64-118 Whole Rock, K-Ar age 1,030 ± 100 m.y.

K = 1.50%, Ar^{40}/K^{40} = 0.0800; radiogenic Ar = 90%.
Concentrate; crushed whole rock.

From basalt.
(42 D) Ontario; 48°15 1/2'N, 86°09'W. No published geological map. Sample FA-65-63(2), collected and interpreted by W. F. Fahrig.

The rock is a basalt consisting of plagioclase microlites in groundmass of devitrified glass with minor corroded pyroxene crystals.

The 1,030 m.y. date represents the approximate age of intrusion.

GSC 64-119 Whole Rock, K-Ar age 43[illegible] ± 75 m.y.

K = 0.50%, Ar^{40}/K^{40} = 0.0286; radiogenic Ar = 64%.
Concentrate; crushed whole rock.

Ontario

From gabbro.
(31 C) Ontario; 44°26 2/3'N, 76°17 1/2'W. Map-unit 13, GSC Map 27-1962. Sample FA-89-63(1), collected and interpreted by W. F. Fahrig.

The rock is a fine-grained ophitic gabbro consisting of plagioclase, partly uralitized pyroxene, iron ores, and quartz.

The 434 m. y. date represents the approximate date of intrusion.

GSC 64-120 Biotite, K-Ar age 1,960 ± 130 m. y.

K = 3.95%, Ar^{40}/K^{40} = 0.2012; radiogenic Ar = 97%. Concentrate; impure concentrate of orange reddish biotite. Some biotite flakes are partly altered to chlorite and epidote. Impurities consist mainly of colourless chlorite and pale green amphibole. Total chlorite content 60%.

From gabbro.
(52 1) Ontario; 51°35'N, 88°34'W. Map-unit 6a, GSC Map 8-1961. Sample FA-44-63(2), collected and interpreted by W. F. Fahrig.

The rock is a coarse-grained ophitic gabbro consisting of intensely saussuritized plagioclase, partly uralitized augite, patches of serpentine (probably pseudomorphic after olivine) iron ores and several per cent of red-brown biotite.

The date obtained indicates the approximate age of intrusion.

GSC 64-121 Impure Biotite, K-Ar age 1,495 ± 125 m. y.

K = 1.55%, Ar^{40}/K^{40} = 0.1334; radiogenic Ar = 90%. Concentrate; partly concentrated Fe-Mg minerals, including biotite. The sample is composed of orange-brown biotite, amphibole, partly altered pyroxene, chlorite, feldspar, and opaque grains. Some of the biotite flakes are partly altered to chlorite.

From gabbro.
(42 B) Ontario; 48°22'N, 84°00'W. Map-unit 6, Ontario Dept. Mines Map 51G. Sample FA-71-63, collected and interpreted by W. F. Fahrig.

Ontario

The rock is a coarse-grained ophitic gabbro consisting of plagioclase, augite, iron ores and red-brown biotite. The only alteration consists of minor uralitization of the pyroxene.

The 1,495 m.y. date indicates the approximate age of intrusion.

GSC 64-122 Biotite, K-Ar age 817 ± 70 m.y.

K = 3.92%, Ar^{40}/K^{40} = 0.0598; radiogenic Ar = 94%. Concentrate; partly concentrated biotite sample composed of orange-red biotite, fresh and altered pyroxene, and a few fragments of hornblende. Chlorite not detected.

From gabbro.
(31 G) Northeast of intersection of C.N.R. and Gananoque River, Ontario; 44°22'N, 76°11 1/2'W. Map-unit 13, GSC Map 27-1962. Sample FA-87-63(2), collected and interpreted by W.F. Fahrig.

The rock is a fresh ophitic gabbro containing 1 or 2 per cent of red biotite.

The 817 m.y. date indicates the approximate age of intrusion.

GSC 64-123 Mafic Minerals, K-Ar age 1,730 ± 150 m.y.

K = 1.48%, Ar^{40}/K^{40} = 0.1658; radiogenic Ar = 99%. Concentrate; the sample consists of partly concentrated Fe-Mg minerals, mainly pyroxene and hornblende with less frequent biotite flakes and a few feldspar fragments.

From gabbro.
(42 B) Ontario; 48°21'N, 83°53'W. Map-unit 9, Ontario Dept. Mines Map 51G. Sample FA-72-63(2), collected and interpreted by W.F. Fahrig.

The rock is a medium-grained ophitic gabbro composed of partly saussuritized plagioclase, partly uralitized pyroxene, iron ores, and brown biotite.

The date obtained indicates the approximate age of intrusion.

Quebec

GSC 64-124 Biotite, K-Ar age 1,595 ± 50 m.y.

$K = 7.48\%$, $Ar^{40}/K^{40} = 0.1465$; radiogenic Ar = 99%. Concentrate; clean concentrate of biotite. The biotite flakes vary in colour from green to red-brown. Some of the biotite flakes are almost opaque, and a few are partly altered to bright green chlorite and epidote. Total chlorite content 10%.

From granite.
(24 I) North side of Korok River, 6 miles downstream from mouth of Sukaliuk Brook, Quebec; 58°35'N, 64°54'W. No geological map reference. Sample TA-64-T10, collected and interpreted by F. C. Taylor.

This sample is from a biotite granite that intrudes micaceous paragneiss at the sample locality. The granite is medium-grained to porphyritic, grey to pink, and in some places is well foliated. In thin section the feldspars can be seen to be free of alteration except for a slight cloudiness and they consist of microcline, albite, and rare orthoclase. Biotite, which is dark green to reddish-brown, is only slightly altered to chlorite. Epidote, chlorite, and apatite occur in accessory amounts.

The determined age gives the time of intrusion and suggests that this occurred during the late stages of the Hudsonian orogeny.

GSC 64-125 Hornblende, K-Ar age 341 ± 60 m.y.

$K = 0.66\%$, $Ar^{40}/K^{40} = 0.0218$; radiogenic Ar = 17%. Concentrate; impure brown-green hornblende. Much of the amphibole is altered to green and brown chlorite, and some is replaced by carbonate. Twenty per cent of the grains are charged with small iron oxide grains. Total chlorite content is 30%.

From quartz syenite.
(31 G) Gaboriault-Nevers Quarry at Rawcliffe, Quebec; 45°40'45"N, 74°33'00"W. Sample Gren. No. 1, collected and interpreted by R. D. Stevens.

See GSC 64-126 for description and interpretation.

Quebec

GSC 64-126 Whole Rock, K-Ar age 427 m.y.

$K = 4.50\%$, $Ar^{40}/K^{40} = 0.0280$; radiogenic Ar = 94%.
Concentrate; crushed whole rock.

From quartz syenite.
(31 G) Gaboriault-Nevers Quarry at Rawcliffe, Quebec; 45°40'45"N, 74°33'00"W. Sample Gren. No. 1, collected and interpreted by R.D. Stevens.

The rock is a coarse-grained, pink quartz syenite consisting of strongly kaolinized orthoclase and perthite (70%), chloritized brown-green hornblende (15%), quartz (5%), iron oxides (5%), carbonate (5%), and accessory apatite. The sample is from "the Chatham-Grenville Intrusive" which cuts rocks of the Grenville Province at the extreme southern margin of the shield.

A considerable range of ages has been obtained on samples from this intrusive body. Ages of 663 ± 45 and 622 ± 42 m.y. on amphibole have been reported by Philpotts and Miller (1964), whereas Stockwell (in Wanless, Stevens, Lachance, and Rimsaite, 1964) reported an age of 540 ± 24 m.y. on a perthite (GSC 63-133). The even lower ages reported here (341 and 427 m.y.) indicate considerable radiogenic argon loss from the more altered phases of the rock. The stock is, however, now well established as being younger than the Grenville orogeny and older than the alkaline rocks of the Monteregian Hills.

References

Philpotts, A.R., and Miller, J.A.
1964: "The age of the Chatham-Grenville intrusive, Quebec"; Can. Mineralogist, vol. 8, pt. 1, pp. 114-116.

Wanless, R.K., Stevens, R.D., Lachance, G.R., and Rimsaite, J.Y.H.
1964: "Age determinations and geological studies, pt. 1 - Isotopic Ages, Rept. 5", GSC Paper 64-17, p. 94.

GSC 64-127 Whole Rock, K-Ar age 225 ± 30 m.y.

$K = 2.20\%$, $Ar^{40}/K^{40} = 0.0139$; radiogenic Ar = 84%.
Concentrate; crushed whole rock.

Quebec

From andesite.

(22 N) West shore of Manicouagan Lake, Quebec; 51°22.6'N, 68°22'W. Map-unit 4, GSC Map 55-2. Sample CP-63-905, collected and interpreted by K. L. Currie.

The rock is a fine-grained andesite collected from a volcanic neck on the west shore of Manicouagan Lake. The lavas connected to the neck unconformably overlie upper Ordovician limestones. The extrusion of lavas was a late event in the formation of the Manicouagan volcano-tectonic sink, which is therefore dated as uppermost Permian. Together with the upper Pennsylvanian age from Clearwater Lake, and the lower Cretaceous ages from the Monteregian intrusions, the date suggests that late Palaeozoic and Mesozoic volcanism was a persistent, though local phenomenon in central and southern Quebec.

GSC 64-128 Muscovite, K-Ar age 441 ± 15 m.y.

K = 6.42%, Ar^{40}/K^{40} = 0.0291; radiogenic Ar = 94%. Concentrate; impure concentrate of muscovite. Some muscovite flakes are coated with yellow crusts. Impurities consist mainly of quartz and feldspar, some opaque aggregates and chlorite flakes, and a few grains of zircon and rutile. Total chlorite content 8%.

From foliated quartzite fragment in breccia.

(21 L) 1/4 mile southwest of the northwest end of Lac du Huit (Clapham Lake), Quebec; 46°05'19"N, 71°13'08"W. Map-unit "Coleraine Breccia", Quebec Dept. Mines Prelim. Map No. 1030 (Report 295). Sample PB-4-R, collected by P. H. Riordon (Asbestos Corp.), interpreted by W. H. Poole and P. H. Riordon.

The quartzite clast is a foliated, medium grey, fine-grained rock with sericitic muscovite glistening on schistosity planes. In thin section, quartz makes up about 70% of the rock and occurs as lensoid, anhedral crystals less than 0.2 mm in diameter, with sutured boundaries. Untwinned alkali feldspar, perhaps 10% of the rock, is intermixed with quartz. The remainder is muscovite and chlorite in about equal proportions. Some muscovite crystals are straight and others curved. Only a little microscopic scaly sericite (secondary?) is present.

The quartzite clast was collected from the Coleraine Breccia (Riordon, 1954). The Breccia lies conformably beneath Beauceville slate

whose lateral equivalents contain late Middle Ordovician graptolites, and it lies above unfossiliferous Caldwell schists. Ultramafic and gabbroic rocks have been emplaced between the Caldwell and Coleraine-Beauceville rocks.

The breccia in most places is composed almost entirely of quartzite fragments. Typically, the fragments have rounded corners and range from 1 inch across to 6-foot blocks. The blocks appear to fit together like the pieces of a jigsaw puzzle with only minor interstitial material of the same composition. The individual smaller fragments cannot be matched with their neighbours and have evidently moved some distance. That the orientation of the foliation is peculiar to each fragment and that quartz stringers terminate abruptly at the margins of the fragments indicate that the metamorphism during which the dated muscovite grew preceded brecciation. The quartzite is believed to have been derived from the Caldwell.

The breccia has an uncertain origin. It has characteristics that point in part to explosive volcanic activity and in large part to sedimentary processes. It follows that the breccia must have formed earlier than the fossiliferous part of the Beauceville. The metamorphism giving rise to the muscovite in the fragments and, by extrapolation, to the muscovite in the Caldwell must be older than the late Ordovician Taconic orogeny during which the Beauceville was deformed (Riordon, 1957; Neale et al., 1961). A pre-Beauceville, post-Caldwell orogeny was proposed by Cooke (1955) and supported by Riordon (1957).

The present muscovite date of 441 ± 15 m.y. compared not unfavourably with the muscovite dates of 420 and 440 (GSC 61-182 and 61-183) from the Sutton-Green Mountain anticline lying about 80 miles on trend to the southwest of the present area, and with the muscovite date of 414 m.y. (GSC 62-121) on Caldwell schist in the Thetford mines area. These four dates fall from mid-Ordovician to mid-Silurian on Kulp's time scale (1961), and are not consistent with the alleged pre-Middle Ordovician age of the metamorphism. Furthermore, muscovites from granitic bodies emplaced in the ultramafic rocks (which are apparently younger than Beauceville) returned 477 and 481 m.y. ages which led to a suggested minimum age for the Middle Ordovician of 480 m.y., revised from Kulp's 445 m.y. (Poole, Béland, and Wanless, 1963).

Several possible explanations for these inconsistent relations are apparent. The four Caldwell (and Coleraine) muscovites may be pre-Middle Ordovician and have been partly degassed by one or more post-Beauceville (post-Middle Ordovician) events. Or, perhaps the deformed muscovite in the granite bodies was not formed after Beauceville sedimentation but at some indeterminate time before. Perhaps the ultramafic bodies and included granitic bodies are much older than Caldwell metamorphism, Coleraine Breccia, Beauceville, and Taconic orogeny, and were emplaced as solids

during the Taconic (? or Acadian) orogeny. In any case additional field work designed to investigate the age and mode of emplacement of the ultramafic body and its relationship to Caldwell, Coleraine, and Beauceville rocks seems necessary. The significance of gabbro fragments in the Coleraine Breccia and of the gradation from gabbro breccia to quartzite breccia must be established. Isotopic age determination by other methods less susceptible to imprinted metamorphic events may provide a clearer age relation picture. At this stage, it must be admitted that the isotopic ages, geological field relations, and the time scale cannot be reconciled.

References

Cooke, H. C.
1955: An early Palaeozoic orogeny in the Eastern Townships of Quebec; Geol. Assoc. Canada, vol. 7, pt. 1, pp. 113-121.

Kulp, J. L.
1961: Geologic time scale; Science, vol. 133, No. 3459, pp. 1105-1114.

Poole, W. H., Béland, J., and Wanless, R. K.
1963: Minimum age of Middle Ordovician rocks in southern Quebec; Bull. G. S. A., vol. 74, pp. 1063-1066.

Riordon, P. H.
1954: Thetford Mines-Black Lake area, Frontenac, Megantic, and Wolfe counties; Quebec Dept. Mines Prelim. Rept. 295.

1957: Evidence of a pre-Taconic orogeny in southeastern Quebec; Bull. G. S. A., vol. 68, pp. 389-394.

GSC 64-129 Biotite, K-Ar age 2,600 ± 70 m.y.

$K = 7.61\%$, $Ar^{40}/K^{40} = 0.3279$; radiogenic Ar = 98%. Concentrate; reasonably clean concentrate of partly altered olive-green biotite. Total chlorite content 20%.

From granite.

(32 C) Castagnier township, between Amos and Mattagami Lake on Mattagami road, Quebec; 48°50'N, 77°50'W. GSC Map 703A. Sample 63 RF-500, collected and interpreted by S. M. Roscoe.

Quebec

The sample is from a granite or quartz monzonite in the Castagnier batholith. This is a very large batholith located centrally and entirely within the most extensive greenstone belt of the Superior Province. The K-Ar age of 2,600 m.y. is Kenoran and is in the upper part of the range found for Kenoran micas elsewhere in this region.

GSC 64-130 Phlogopite, K-Ar age 2,550 ± 85 m.y.

$K = 5.27\%$, $Ar^{40}/K^{40} = 0.3167$; radiogenic Ar = 99%. Concentrate; clean concentrate of orange-buff, partly altered phlogopite. The phlogopite flakes contain inclusions of epidote and quartz. Total chlorite content is 40%.

From chalcopyrite ore.

(92 F) Normetal mine, 6,800 ft. level, Sta. 18 + 45E along ore zone, Quebec; 49°00'15"N, 79°22'00"W. Quebec Dept. Nat. Resources Map PM 1401. Sample 63-RF-418-B, collected and interpreted by S. M. Roscoe.

The rock consists of biotite intergrown with chalcopyrite. It was taken from along the north fringe of the Normetal zinc-copper deposit. The mineralized rock was evidently metamorphosed 2,550 m.y. ago, at the time of intrusion of granite and of regional metamorphism in the area. Biotite from a granite 10 miles away was previously dated at 2,545 m.y. (GSC 61-168). The Normetal ore is clearly early Kenoran or pre-Kenoran in age.

GSC 64-131 Biotite, K-Ar age 395 ± 15 m.y.

$K = 6.42\%$, $Ar^{40}/K^{40} = 0.0257$; radiogenic Ar = 95%. Concentrate; clean concentrate of brown biotite. Some biotite flakes are altered along fractures and contain acicular inclusions. Total chlorite content 10%.

From feldspar-quartz-biotite porphyry.

(22 A) At Copper Mountain Adit, Murdochville, Quebec; 48°58'N, 65°30'W. Map-unit 10, Quebec Dept. Mines Map 1225. Sample MB-Cu Mtn., collected and interpreted by W. D. McCartney.

The rock is a grey and pink, altered feldspar-quartz-biotite porphyry. Former feldspar phenocrysts average 1/4 inch in diameter and are altered to soft clay-like material. Biotite phenocrysts average 1/8 inch in diameter and are virtually unaltered. Quartz forms widely scattered rounded phenocrysts up to 1/2 inch in diameter. The matrix is a fine-grained,

equigranular mosaic of quartz and sericitized feldspar, and includes very minor amounts of chlorite.

The porphyry transects beds of the Lower Devonian Grand Grève Formation in the adit in Copper Mountain, Murdochville. The sample contains about 0.5% chalcopyrite, and the porphyry is believed to be related to the copper mineralization of Gaspé Copper Mines, Ltd.

The indicated age of 395 m.y. is unusually old for an intrusive in Lower Devonian beds.

GSC 64-132 Muscovite, K-Ar age 360 ± 15 m.y.

K = 8.68%, Ar^{40}/K^{40} = 0.0232; radiogenic Ar = 94%. Concentrate; clean concentrate of muscovite. About 30% of the muscovite flakes are partly covered with yellow crusts and contain a few quartz inclusions.

From a quartz vein with minor sulphides.
(21 E) South of St. Cécile Mountain on Maheu molybdenum property, Quebec; 45°41'N, 70°58'W. GSC Map 379A (vein is not a map-unit). Sample MB-63-47, collected and interpreted by W D. McCartney.

The sample represents selected parts of a quartz-feldspar-muscovite vein containing molybdenite, pyrrhotite, galena and rare stannite. The vein lies in banded hornfels of Ordovician age (Beauceville Series). As shown by the age of 360 m.y., mineralization is clearly related to the nearby St. Cécile granite formerly assigned a K-Ar age of 362 m.y. (see sample GSC 59-90, Lowdon 1960, GSC Paper 60-17).

GSC 64-133 Biotite, K-Ar age 2,575 ± 80 m.y.

K = 7.79%, Ar^{40}/K^{40} = 0.3223; radiogenic Ar = 99%. Concentrate; clean concentrate of red-brown biotite. The biotite flakes contain fine-grained acicular and platy inclusions along the fractures and on cleavage planes. Chlorite not detected.

From granite-gneiss.
(35 C) Quebec; 60°28'N, 77°02'W. Sample BK-130-63, collected by H.H. Bostock, interpreted by I.M. Stevenson.

Quebec

The sample is from a dark grey, foliated, slightly schistose granite-gneiss, similar to that found over much of this region of New Quebec. The rock consists of feldspar 70%, quartz 20%, amphibole 4%, biotite 3%, and magnetite, etc. 3%.

The K-Ar age of the biotite is in general agreement with ages determined for similar material collected elsewhere in this part of the Superior Province.

GSC 64-134 Biotite, K-Ar age 2,480 ± 70 m.y.

$K = 7.61\%$, $Ar^{40}/K^{40} = 0.3002$; radiogenic Ar = 99%. Concentrate; reasonably clean concentrate of brown biotite. About 10% of the biotite flakes are altered to chlorite and contain inclusions of epidote. Total chlorite content 10%.

From granite.
(34 F) Quebec; 57°35'N, 76°50'W. Sample BK-88-63, collected by H.H. Bostock, interpreted by I.M. Stevenson.

The specimen of medium-grained, dark grey, massive granite is typical of the granites along this part of the east shore of Hudson Bay. It consists of feldspar 50%, quartz 45%, biotite 3%, and accessory minerals 2%. The rock is commonly well sheeted, and may be porphyritic.

The K-Ar age of the specimen substantiates other K-Ar determinations on similar granites in this part of the Superior Province.

GSC 64-135 Whole Rock, K-Ar age 1,385 ± 125 m.y.

$K = 1.40\%$, $Ar^{40}/K^{40} = 0.1195$; radiogenic Ar = 98%. Concentrate; crushed whole rock.

From basalt.
(34 C) West side of Richmond Gulf, Quebec; 56°20'N, 76°30'W. Sample SC-9B-63, collected by R. Skinner, interpreted by I.M. Stevenson.

The specimen is a fine-grained, dark green basalt typical of the volcanic flow rocks of the Manitounuk Group. The sample is from a west-dipping, massive, sill-like body that forms the coast of Hudson Bay west of Richmond Gulf. The basalt is amygdaloidal, the cavities being filled with

secondary calcite, quartz, and epidote. Phenocrysts of grey-green feldspar up to 1/2 inch long form about 40% of the rock, and the specimen is heavily pyritized.

The Proterozoic age of the Manitounuk Group is confirmed.

GSC 64-136 Biotite, K-Ar age 1,695 ± 50 m.y.

K = 8.04%, Ar^{40}/K^{40} = 0.1608; radiogenic Ar = 100%. Concentrate; reasonably clean concentrate of dark olive-green biotite. Some biotite flakes are intergrown with light green chlorite. Total chlorite content 15%.

From paragneiss.

(25 C) South end of Diana Bay, Quebec; 60°49'N, 69°52'W. Sample SG-199-63, collected and interpreted by I.M. Stevenson.

The rock is a medium-grained, pink and black paragneiss containing plentiful biotite concentrated in layers and lenses. These metasedimentary gneisses which lie northeast of the geosynclinal rocks of the Labrador Trough, are markedly different in appearance to the vast complex of Archaean granitic rocks west of the Labrador geosyncline. They are probably not equivalent to the latter.

The age of 1,695 m.y. confirms the Hudsonian age of the most recent orogeny in this area, thereby placing these rocks in the Churchill Province.

GSC 64-137 Muscovite, K-Ar age 1,630 ± 45 m.y.

K = 8.66%, Ar^{40}/K^{40} = 0.1514; radiogenic Ar = 98%. Concentrate; clean concentrate of muscovite. The muscovite flakes contain a few inclusions of quartz, attached specks of brown biotite and a few opaque grains. Chlorite not detected.

From gneiss.

(25 C) Quebec; 60°43'N, 69°33'W. Sample TA-269-63, collected by F.C. Taylor, interpreted by I.M. Stevenson.

Quebec

The specimen is a dark grey, medium-grained, contorted feldspar-quartz paragneiss typical of many of the metasedimentary rocks northeast of the Labrador geosyncline. This sample, and GSC 64-136, are both from within the Churchill Province.

GSC 64-138 Biotite, K-Ar age 2,690 ± 65 m.y.

K = 7.93%, Ar^{40}/K^{40} = 0.3486; radiogenic Ar = 99%.
Concentrate: reasonably clean concentrate of brown biotite. The biotite flakes contain small needle-like inclusions along fractures and in bleached areas. Chlorite not detected.

From granite.
(35 A) Quebec; 60°39'N, 73°55'W. Sample SG-148-63, collected and interpreted by I.M. Stevenson.

See GSC 64-139 for description and interpretation.

GSC 64-139 Hornblende, K-Ar age 2,540 ± 180 m.y.

K = 1.10%, Ar^{40}/K^{40} = 0.3139; radiogenic Ar = 98%.
Concentrate; reasonably clean concentrate of pleochroic olive-brown to green hornblende. The hornblende is slightly altered along the fractures and contains fine-grained inclusions. A trace of biotite is present.

From granite.
(8 M) Quebec; 60°39'N, 73°55'W. Sample SG-148-63, collected and interpreted by I.M. Stevenson.

The rock is a medium-grained, dark grey, massive granite composed mainly of microcline, oligoclase, quartz, and biotite. The feldspars are fairly fresh and the quartz is only mildly strained. This type of granite is typical of many of the basement Archaean granites encountered during Operation Leaf River.

The Kenoran age of the most recent orogeny in this area is confirmed.

GSC 64-140 Whole Rock, K-Ar age 695 ± 115 m.y.

Quebec

$K = 0.54\%$, $Ar^{40}/K^{40} = 0.0492$; radiogenic Ar = 81%.
Concentrate; crushed whole rock.

From basalt.
(35 C) North of Chukotat River, Quebec; 60°53'N, 77°45'W. No geological map reference. Sample SG-131-63, collected and interpreted by I.M. Stevenson.

The specimen is from a fine-grained, pillowed, dark green andesitic flow rock that forms part of the volcanic complex of the Cape Smith-Wakeham Bay belt of presumed Proterozoic age. The specimen was dated for comparison with rocks of the Belcher and Ottawa Islands. The reported age of 695 m.y. is believed to be anomalously young.

GSC 64-141 Biotite, K-Ar age 2,585 ± 70 m.y.

$K = 7.96\%$, $Ar^{40}/K^{40} = 0.3246$; radiogenic Ar = 99%.
Concentrate; clean concentrate of orange-brown biotite. The biotite flakes contain fine-grained inclusions along fractures, and a few are altered to chlorite. Total chlorite content 4%.

From granite-gneiss.
(34 B) Quebec; 56°37'N, 75°22'W. Sample SG-8-63, collected and interpreted by I.M. Stevenson.

The rock is a dark grey, medium-grained granitic gneiss typical of Archaean gneisses throughout much of the area.

The Kenoran age of the most recent orogeny in this part of the map-area is confirmed.

GSC 64-142 Biotite, K-Ar age 2,410 ± 62 m.y.

$K = 7.79\%$, $Ar^{40}/K^{40} = 0.2852$; radiogenic Ar = 99%.
Concentrate; reasonably clean concentrate of biotite. The biotite flakes vary in colour from green to brown. About 20% of the flakes are partly altered to chlorite and fine-grained epidote. Minor impurities consist of muscovite and quartz. Total chlorite content 10%.

Quebec

From granite-gneiss.

(34 O) Near south end of Couture Lake, Quebec; 59°48'N, 75°18'W. No geological map reference. Sample SG-101-63, collected and interpreted by I.M. Stevenson.

The specimen is from a medium-grained, pinkish grey, slightly foliated granite-gneiss typical of the rocks underlying much of the area mapped during Operation Leaf River.

The Kenoran age of the most recent orogeny in this part of the map-area is confirmed.

GSC 64-143 Muscovite, K-Ar age 2,280 ± 65 m.y.

K = 5.44%, Ar^{40}/K^{40} = 0.2598; radiogenic Ar = 98%. Concentrate; impure concentrate of muscovite composed of about 50% clean muscovite flakes, 30% muscovite flakes with adhering specks of biotite, chlorite, and quartz, and 20% altered feldspar. Total chlorite content 5%.

From paragneiss.

(32 O) 0.5 mile south of west end of Lac des Montagnes, Quebec; 51°37'30"N, 75°57'00"W. Map-unit 3, Quebec Dept. Natural Resources Prelim. Map No. 1504. Sample SH-1-63, collected by G. Valiquette, interpreted by C.H. Stockwell.

This sample is a grey, medium-grained well foliated paragneiss composed of quartz, feldspar, biotite, muscovite, garnet, and sillimanite. The micas are fresh. The sample is from a belt of metasedimentary rocks that extend in a northeasterly direction for 30 miles or more and is bordered to the north and south by large areas of apparently younger granitic rocks. The determined age is approximately that of the period of metamorphism.

GSC 64-144 Biotite, K-Ar age 2,395 ± 80 m.y.

K = 8.05%, Ar^{40}/K^{40} = 0.2825; radiogenic Ar = 54%. Concentrate; clean concentrate of olive-green biotite. Some flakes are slightly bleached and contain a few inclusions of quartz, zircon, and apatite. Total chlorite content 4%.

Quebec

From porphyritic granite.

(23 F) Quebec; 53°43'30"N, 69°37'00"W. Map-unit 7, GSC Map 56-1959. Sample SG-83-59, collected by I.M. Stevenson, interpreted by C.H. Stockwell.

This granite is a coarse-grained, massive rock composed of quartz, microcline, plagioclase, biotite, and hornblende. Phenocrysts of salmon pink feldspar are up to 1 inch long. The determined age is approximately the age of intrusion.

GSC 64-145 Whole Rock, K-Ar age 1,855 ± 150 m.y.

$K = 1.40\%$, $Ar^{40}/K^{40} = 0.1844$; radiogenic Ar = 97%. Concentrate; crushed whole rock.

From granodiorite.

(32 G) Island in Lac le Royer, Quebec; 49°36'15"N, 74°26'40"W. Map-unit 6, Quebec Dept. Mines Map 1236. Sample SH-54-62, collected and interpreted by C.H. Stockwell.

The whole rock age of 1,855 m.y. was obtained on the same sample that gave a biotite age of 2,085 m.y. (GSC 63-137) and a muscovite age of 2,295 m.y. (GSC 63-136). The sample is from the Dauversière stock of the Superior Province and was collected at a locality 8 miles northwest of the Grenville front. A point count by D.B. Craig gave volume percentages as follows: biotite 7.4, muscovite 2.1, potash feldspar 0.7.

This and the subsequently described eight determinations (up to and including GSC 64-153) were made on whole rock samples to give further information on the problem of anomalous ages across the Grenville front at the Chibougamau Highway locality. Dates on biotite and muscovite had already been obtained on the same samples. The samples are described in order from a point 8 miles northwest of the front to a point 40 miles southeast of it, the last giving a normal age for the Grenville orogeny. The problem of anomalous ages across the Grenville front has been discussed in previous progress reports (Geol. Surv. Can., Paper 62-17, pp. 132-133, Paper 63-17, pp. 129-130, Paper 64-17, Part II, p. 21). The whole rock dates give some additional information on the migration of argon and present further problems which will be discussed in a later report.

GSC 64-146 Whole Rock, K-Ar age 1,490 ± 135 m.y.

Quebec

K = 1.70%, Ar^{40}/K^{40} = 0.1326; radiogenic Ar = 98%.
Concentrate; crushed whole rock.

From granodiorite.
(32 G) Island in Dauversière Lake, Quebec; 49°33'45"N, 74°23'45"W. Map-unit 6, Quebec Dept. Mines Map 1236. Sample SH-53-62, collected and interpreted by C.H. Stockwell.

The whole rock age of 1,490 m.y. was obtained on the same sample that gave a biotite age of 1,815 m.y. (GSC 62-153) and a muscovite age of 2,340 m.y. (GSC 62-154). The sample is from the Dauversière stock of the Superior Province and was collected at a locality 5 miles northwest of the Grenville front. A point count by D.B. Craig gave volume percentages as follows: biotite 10.4, muscovite 3.4, potash feldspar 2.8.

GSC 64-147 Whole Rock, K-Ar age 706 ± 70 m.y.

K = 1.80%, Ar^{40}/K^{40} = 0.0501; radiogenic Ar = 95%.
Concentrate; crushed whole rock.

From granite.
(32 G) East shore of Lac la Dauversière, Quebec; 49°34'50"N, 74°19'25"W. Map-unit 6, Quebec Dept. Mines Map 1236. Sample SH-18-63, collected by G. Duquette, interpreted by C.H. Stockwell.

The whole rock age of 706 m.y. was obtained on the same sample that gave a biotite age of 2,485 m.y. (GSC 63-143) and a muscovite age of 2,025 m.y. (GSC 63-144). The sample is from the Dauversière stock, in the Superior Province at a locality 2.5 miles northwest of the Grenville front. A point count by D.B. Craig gave volume percentages as follows: biotite 10.7, muscovite 3.3, potash feldspar 0.5

(Sample SH-17-63, as reported previously, gave a whole rock date of 1,675 m.y. (GSC 63-147), biotite 3,300 m.y. (GSC 63-146), and muscovite 1,630 m.y. (GSC 63-145). It is from the Dauversière stock 2 miles northwest of the Grenville front. A point count by D.B. Craig gave volume percentages as follows: biotite 1.4, muscovite 8.4, potash feldspar 3.5.)

Quebec

GSC 64-148 Whole Rock, K-Ar age 1,305 ± 120 m.y.

K = 1.90%, Ar^{40}/K^{40} = 0.1100; radiogenic Ar = 96%.
Concentrate; crushed whole rock.

From gneissic granodiorite.
(32 G) Chibougamau Highway, 0.9 mile northeast of Lake Dufresne, La Dauversière tp., Quebec; 49°35'10"N, 74°15'55"W. Map-unit 6, Quebec Dept. Mines Map 1236. Sample SH-9-59, collected and interpreted by C.H. Stockwell.

The whole rock age of 1,305 m.y. was obtained from the same sample that gave a biotite age of 1,840 m.y. (GSC 60-107). The sample is from the Dauversière stock, in the Superior Province, at a locality 3/4 mile northwest of the Grenville front. A point count by D.B. Craig gave volume percentages as follows: biotite 9.6, muscovite 6.4, potash feldspar 0.5.

GSC 64-149 Whole Rock, K-Ar age 982 ± 90 m.y.

K = 1.80%, Ar^{40}/K^{40} = 0.0754; radiogenic Ar = 90%.
Concentrate; crushed whole rock.

From paraschist.
(32 G) Road cut on Chibougamau Highway, 0.6 mile northwest of a bridge over the narrows in Lac Dufresne, Quebec; 49°35'15"N, 74°15'35"W. Map-unit 1, Quebec Dept. Mines Map 1236. Sample SH-55-62, collected and interpreted by C.H. Stockwell.

The whole rock age of 982 m.y. was obtained from the same sample that gave a biotite age of 1,315 m.y. (GSC 62-146) and a muscovite age of 1,060 m.y. (GSC 62-147). The sample is from the Grenville Province about 0.2 mile southeast of the Grenville front. A point count by D.B. Craig gave volume percentages as follows: biotite 9.6, muscovite 7.9, potash feldspar 0.0.

GSC 64-150 Whole Rock, K-Ar age 915 ± 90 m.y.

K = 1.70%, Ar^{40}/K^{40} = 0.0689; radiogenic Ar = 91%.
Concentrate; crushed whole rock.

Quebec

From micaceous gneiss.

(32 G) Road cut on Chibougamau Highway, 0.4 mile east of bridge over the narrows in Lac Dufresne, Quebec; 49°34'30"N, 74°15'05"W. Map-unit 5a, Quebec Dept. Mines Map 1236. Sample SH-52-62, collected and interpreted by C.H. Stockwell.

The whole rock age of 915 m.y. was obtained from the same sample that gave a biotite age of 1,050 m.y. (GSC 62-148) and a muscovite age of 1,010 m.y. (GSC 62-149). The sample is from the Grenville Province and was taken at a locality 0.8 mile southeast of the Grenville front. A point count by D.B. Craig gave volume percentages as follows: biotite 3.1, muscovite 10.1, potash feldspar 8.2.

GSC 64-151 Whole Rock, K-Ar age 1,075 ± 100 m.y.

$K = 1.70\%$, $Ar^{40}/K^{40} = 0.0850$; radiogenic Ar = 97%. Concentrate; crushed whole rock.

From orthogneiss.

(32 G) Road cut on Chibougamau Highway at mile 117.7, Charron tp., Quebec; 49°34'00"N, 74°15'25"W. Quebec Dept. Mines Map 1235. Sample SH-8-59, collected and interpreted by C.H. Stockwell.

The whole rock age of 1,075 m.y. was obtained from the same sample that gave a biotite age of 1,270 m.y. (GSC 60-108) and a muscovite age of 960 m.y. (GSC 61-162). The sample is from the Grenville Province and was collected at a locality 1.6 miles southeast of the Grenville front. A point count by D.B. Craig gave volume percentages as follows: biotite 8.9, muscovite 1.4, and potash feldspar 0.3.

GSC 64-152 Whole Rock, K-Ar age 1,265 ± 110 m.y.

$K = 1.50\%$, $Ar^{40}/K^{40} = 0.1053$; radiogenic Ar = 97%. Concentrate; crushed whole rock.

From granitic gneiss.

(32 G) Railway cut just west of Chibougamau Highway, Quebec; 49°32'50"N, 74°11'30"W. Map-unit 7a, Quebec Dept. Mines Map 1235. Sample SH-58-62, collected and interpreted by C.H. Stockwell.

Quebec

The whole rock age of 1,265 m.y. was obtained from the same sample that gave a biotite age of 1,425 m.y. (GSC 63-141) and a muscovite age of 985 m.y. (GSC 63-142). The sample was collected from the Grenville Province at a point 4.5 miles southeast of the Grenville front. Because of the uneven grain it is difficult to estimate the proportions of the constituent minerals but, based on point counts by D.B. Craig, the volume percentages appear to be about as follows: biotite 5.9, muscovite 0.3, potash feldspar 6.2.

(Biotite from a locality 9 miles southeast of the Grenville front gave a date of 1,105 m.y. (GSC 62-150), as reported previously).

GSC 64-153 Whole Rock, K-Ar age 882 ± 75 m.y.

K = 3.50%, Ar^{40}/K^{40} = 0.0658; radiogenic Ar = 98%. Concentrate; crushed whole rock.

From paragneiss.

(32 H) Northeast side of Chibougamau Highway at mile 71.9, near the north end of Lac d'Argenson (Lac Chigoubiche), Lorne tp., Quebec; 49°08'44"N, 73°35'04"W. Map-unit 1a, Quebec Dept. Mines Prelim. Map 1157. Sample SH-6-59, collected and interpreted by C.H. Stockwell.

The whole rock age of 882 m.y. was obtained from the same sample that gave a biotite age of 950 m.y. (GSC 62-151) and a muscovite age of 980 m.y. The sample is from a locality well within the Grenville Province at a locality 40 miles southeast of the front. A point count by D.B. Craig gave volume percentages as follows: biotite 8.1, muscovite 1.7, potash feldspar 20.4.

New Brunswick

GSC 64-154 All micas, K-Ar age 375 ± 17 m.y.

K = 5.45%, Ar^{40}/K^{40} = 0.0243; radiogenic Ar = 89%. Concentrate; composite impure mica concentrate consisting mainly of biotite, muscovite, and (?) sericite. From granitic drill chips.

(21 I) Westmorland Co., New Brunswick; 46°04'40"N, 64°24'00"W. Sample SW-1 Tray 6890, collected and interpreted by R.D. Howie.

This sample composed of chips of fine-grained granitic rock, is from the basement rocks reached by the Shell Westmorland No. 1 hole. In this area there is evidence for pre-Carboniferous uplift and erosion, (Gussow, W.C., 1953, A.A.P.G. Bull., vol. 37, No. 7, p. 1,812), after the emplacement of the granite. A 375 m.y. date for the granitic material is in accord with the idea of a Devonian intrusion invading the pre-Carboniferous basement rocks (Howie, R.D. and Cumming, L.M., 1963. GSC Bull. 89, p. 5).

GSC 64-155 Muscovite, K-Ar age 505 ± 45 m.y.

K = 4.45%, Ar^{40}/K^{40} = 0.0339; radiogenic Ar = 100%. Concentrate; impure concentrate of muscovite. Some muscovite flakes are stained yellow and contain small attached fragments of biotite. Impurities consist of carbonate aggregates, chlorite, and quartz. Total chlorite content 15%.

From calcareous quartzite.

(21 O) Restigouche River, 0.3 mile below Larry Gulch, New Brunswick; 47°42'57"N, 67°26'20"W. Map-unit E, GSC Map 910A. Sample 6-45-2/PB, collected and interpreted by W.H. Poole.

The analysis was made on detrital muscovite in Middle Ordovician quartzite in an attempt to determine the age of the source rocks of the sediments. The calcareous quartzite is fine grained, medium grey, hard, and crossbedded. Flakes of muscovite of different sizes lie on bedding laminae. The muscovite flakes are round and range up to 2 mm in diameter. In thin section, the muscovite, making up 8% of the rock, is seen to occur as thin plates molded on quartz grains. About 3% of the rock is detrital biotite substantially altered to chlorite and 6% is chlorite. Clearly, the muscovite and biotite are detrital; all lie on bedding surfaces. Pelitic rocks interbedded with quartzites are dull-lustered slaty argillites.

New Brunswick

The quartzites are probably Middle Ordovician, that is, about 445 m.y. on Kulp's scale (1961) or 480 m.y. on the scale revision proposed by Poole, Béland, and Wanless (1963). The returned age of 505 m.y. is sufficiently older than either age and therefore identifies a mica from the source area rather than one that either grew in the quartzite or was entirely recrystallized and degassed during sedimentation or younger events. The 505 m.y. is remarkably similar to the 495 m.y. mica pair from the metamorphic aureole of Mount Albert ultramafic body (GSC 61-185, 61-186) which cuts volcanic and sedimentary rocks of the probably Cambrian-Lower Ordovician (?) Shickshock Group of Gaspé. It seems improbable that these and similar rocks, now buried, shed detritus to Middle Ordovician sediments. Rather, at this point, it seems probable that the muscovite flakes were derived from a terrane older than 505 m.y. and that they have been up-dated to some degree by Ordovician erosion, transportation, and diagenesis, and, possibly by younger weak metamorphism. More samples must be analyzed to test further this hypothesis and to establish a pattern of ages.

References

Kulp, L.J.
1961: Geologic time scale; Science, vol. 133, No. 3459, pp. 1105-1114.

Poole, W.H., Béland, J., and Wanless, R.K.
1963: Minimum age of Middle Ordovician rocks in southern Quebec; Bull. G.S.A., vol. 74, pp. 1063-1066.

GSC 64-156 Whole Rock, K-Ar age 317 ± 30 m.y.

K = 4.70%, Ar^{40}/K^{40} = 0.0202; radiogenic Ar = 96%. Concentrate; crushed whole rock.

From phyllitic slate.
(21 H) Cape Spencer on Bay of Fundy, New Brunswick; 45°11'40"N, 65°54'45"W. Map-unit 10, GSC Map 478A (Alcock, Mem. 216). Sample PB-63-5, collected and interpreted by W.H. Poole.

Phyllitic slate was collected within the metamorphic aureole of a supposed Carboniferous cataclastic granite (Alcock, 1938) in order to obtain the isotopic age of the granite which itself lacks minerals suitable for K-Ar dating. The sample was taken 5 feet from the granite contact. The slate is dark purplish grey, is soft and friable, and contains well developed bedding plane schistosity cut by a strain-slip cleavage. In thin section, the slate

comprises about 85% foliated sericite groundmass with 15% microscopic porphyroblasts of chlorite. The cleavage has bent and broken the schistosity.

The slate is part of the Carboniferous pre-Westphalian B West Beach Formation of volcanic and sedimentary rocks (Alcock, 1938); an Upper Mississippian-Lower Pennsylvanian age seems most probable. The Mississippian-Pennsylvanian boundary on Kulp's scale (1961) is about 310 m.y. Alcock argued that the granitic rocks are older than the Middle Pennsylvanian (Westphalian B) Lancaster Formation which unconformably overlies the West Beach and which lacks quartz veins and metamorphic aspects of the West Beach.

The returned age of 317 m.y. is remarkably close to that expected. It can be concluded that Alcock's interpretations were correct, the granite is Carboniferous, and the metamorphism of the granite expelled all relict radiogenic argon. On the other hand, it should be remembered that West Beach sedimentation, metamorphism, and intrusion all are very nearly the same age and indistinguishable by K-Ar method. Actually, an analysis of West Beach shale or argillite far from the granite may yield a similar isotopic age.

References

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

Kulp, L.J.
1961: Geologic time scale; Science, vol. 133, No. 3459, pp. 1105-1114.

Newfoundland

GSC 64-157 Whole Rock, K-Ar age 960 ± 90 m.y.

K = 1.90%, Ar^{40}/K^{40} = 0.0734; radiogenic Ar = 92%.
Concentrate; crushed whole rock.

From amygdaloidal basalt.
(13 L) Newfoundland (Labrador); 54°18'30"N, 62°02'00"W. Map-unit 5, GSC Map 53-14. Sample No. 40, collected by S. M. Roscoe, interpreted by C. H. Stockwell.

The rock is composed of tiny feldspar laths in a dark, isotropic groundmass. Amygdales are filled with carbonate and chlorite. This basalt is from the Seal Lake Group, which unconformably overlie granitoid gneisses and anorthosite along the northern margin of the belt. Its relationship with similar Grenville-like rocks along the southern margin of the belt is obscured by faulting, but its lack of intense metamorphism suggests that it is younger than these gneisses. The age obtained is consistent with these observations and isotopic ages from the older igneous and metamorphic rocks.

GSC 64-158 Whole Rock, K-Ar age 334 ± 100 m.y.

K = 0.28%, Ar^{40}/K^{40} = 0.0214; radiogenic Ar = 27%.
Concentrate; crushed whole rock.

From gabbro.
(12 A) 8 miles west of Canada Bay, Newfoundland; 50°44'N, 56°25'W. No geological map reference. Sample 75, collected by P. Clifford, interpreted by W. F. Fahrig.

The rock is a fine-grained subophitic gabbro from near the edge of a diabase dyke. The rock consists of plagioclase, pyroxene, iron ores and a minute amount of red biotite. The pyroxenes are locally uralitized and chloritized.

The 334 m.y. date indicates the approximate age of intrusion.

GSC 64-159 Biotite, K-Ar age 398 ± 15 m.y.

K = 7.91%, Ar^{40}/K^{40} = 0.0260; radiogenic Ar = 97%.
Concentrate; clean concentrate of biotite. About 10% of the biotite flakes are altered to green chlorite along the edges

and contain small acicular inclusions. The biotite flakes contain a few inclusions of quartz and apatite. Total chlorite content 5%.

From biotite granodiorite.

(2 E) Southern extremity of Fredericton Harbour, Notre Dame Bay, Newfoundland; 49°25'40"N, 54°22'06"W. Sample WF-590-63, collected and interpreted by H. Williams.

The sample was collected from an outcrop of grey, massive to mildly foliated, medium-grained hornblende-biotite granodiorite. The granodiorite cuts Middle Ordovician rocks of the Gander Lake Group[1] in Botwood map-area and is surrounded by a thin thermal metamorphic aureole. Other intrusions included in the same map-unit in Botwood map-area are dated isotopically at 380, 410, 440, and 450 million years[2]. All of the intrusions are considered to be post Middle Silurian; either because they cut Middle Silurian strata, or because they occur near continuous stratigraphic sections in which Ordovician and Silurian rocks lie conformably. The present determination of 398 million years falls within the late Silurian or early Devonian of recent time scales and serves to support this conclusion.

References

[1]Williams, H.
1964: Botwood map-area, Newfoundland; Geol. Surv. Can., Prelim. map 60-1963.

[2]Williams, H.
1964: In age determinations and geological studies; Geol. Surv. Can., Paper 64-17.

GSC 64-160 Biotite, K-Ar age 1,185 ± 45 m.y.

$K = 7.57\%$, $Ar^{40}/K^{40} = 0.0966$; radiogenic Ar = 97%. Concentrate; clean concentrate of olive-greenish biotite. About 20% of the biotite flakes are altered to chlorite along fractures and edges, and contain inclusions of epidote and quartz. Total chlorite content 10%.

From diorite.

(13 E) North shore of Disappointment Lake, Newfoundland (Labrador); 53°48'30"N, 62°36'00"W. No geological map reference. Sample SH-28-62, collected and interpreted by C.H. Stockwell.

Newfoundland

The sample is a dark grey, massive rock composed of andesine, biotite, hornblende, a little quartz, and plentiful epidote and accessory titanite. The sample was collected for the purpose of helping to locate the Grenville front which separates the Elsonian orogen of the western Nain Province from the Grenville orogen. The determined age is intermediate between the two but geological considerations suggest that the sample is from the Grenville side of the boundary.

GSC 64-161 Hornblende, K-Ar age 2,570 ± 180 m.y.

$K = 1.80\%$, $Ar^{40}/K^{40} = 0.3206$; radiogenic Ar = 99%. Concentrate; clean concentrate of brown hornblende. The hornblende is slightly altered along fractures and cleavage planes. Trace of biotite and chlorite.

From diorite.

(23 H) Gabbro Lake, outcrop just N of road to Grand Falls, Newfoundland (Labrador); 53°45'30"N, 65°21'30"W. Map-unit 8, GSC Map 17-1961. Sample SH-34-62, collected and interpreted by C. H. Stockwell.

The hornblende at 2,570 m.y. is from the same sample as the biotite (GSC 62-175) which gave an age of 2,210 m.y. The diorite lies within an area surrounded by rocks of the Kaniapiskau Supergroup which is Aphebian in age. In the previous report the 2,210 m.y. date obtained on biotite suggested that the diorite either intruded the Kaniapiskau or formed a basement beneath it. The hornblende appears to have retained argon better than the biotite and the 2,570 m.y. date indicates that the diorite forms an inlier of Archaean basement within the Kaniapiskau rocks of the Labrador Trough.

GSC 64-162 Whole Rock, K-Ar age 202 ± 25 m.y.

$K = 1.90\%$, $Ar^{40}/K^{40} = 0.0125$; radiogenic Ar = 72%. Concentrate; crushed whole rock.

From andesite.

(13 M) 1 mile southwest of Mistastin Lake, Newfoundland (Labrador); 55°51'N, 63°26'W. No published geological map. Sample TA-64-T2, collected and interpreted by F. C. Taylor.

This sample consists of light olive-grey, fine-grained andesite that shows scattered plagioclase phenocrysts up to 2 mm long. The andesite is flat lying and forms a prominent butte-like hill in a generally level terrain.

Newfoundland

Although the contact with the underlying late Palaeohelikian basement rocks was not seen the andesite undoubtedly lies unconformably on them.

The age determination on this andesite indicates a Middle Triassic age. Except for the well known Triassic volcanic rocks of Nova Scotia no other Triassic volcanism has been reported in Eastern Canada. Whether this andesite represents a remnant of a large area of Triassic volcanism or is of limited distribution will have to wait on mapping of this region. Other flat lying strata, such as the sedimentary Siamarnekh Formation to the north (Wheeler, 1964) are possibly related to this andesite.

References

Wheeler, E.P.
1964: Unmetamorphosed sandstone in northern Labrador; Geol. Soc. Am. Bull., vol. 75, pp. 569-570.

GSC 64-163 Whole Rock, K-Ar age 948 ± 90 m.y.

$K = 1.50\%$, $Ar^{40}/K^{40} = 0.0721$; radiogenic Ar = 88%. Concentrate; crushed whole rock.

From basalt.

(14 F) West side of Mugford Harbour, Cod Island, Newfoundland (Labrador); 57°47'N, 61°43'W. No published geological map. Sample TA-64-T6, collected and interpreted by F.C. Taylor.

This sample, from the eastern part of the Nain Province, consists of greenish grey aphanitic basalt. The basalt is from a volcanic flow forming part of the gently folded Mugford Group. This group lies unconformably on rocks of probable Archaean age and may also lie unconformably on the sedimentary Ramah Group (Douglas, 1953). The underlying basement rocks nearby at Mugford Harbour have been dated at 2,225 m.y. on biotite (GSC 62-171) and 2,045 m.y. on hornblende (GSC 63-180). These rocks were considered by Stockwell (in Wanless et al., 1965) as probably being products of the Kenoran orogeny (about 2,500 m.y.) and the younger ages probably due to "subsequent events of a more moderate nature".

The 948 m.y. date for the present sample represents the age of the volcanism and the Mugford Group and shows them to be Neohelikian.

Newfoundland

Assuming the Ramah Group to be older and overlain unconformably by the Mugford as suggested by Douglas (1953) the 948 m.y. figure also provides a minimum age for the Ramah Group.

References

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

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.

GSC 64-164 Biotite, K-Ar age 1,340 ± 40 m.y.

$K = 7.69\%$, $Ar^{40}/K^{40} = 0.1141$; radiogenic Ar = 98%. Concentrate; clean concentrate of orange-red biotite. Some of the biotite flakes contain a few inclusions of quartz and rare zircon grains surrounded by faintly zoned pleochroic haloes. Minor impurities consist of a few fragments of garnet and quartz coated with yellow crusts. Total chlorite content 3%.

From garnet-quartz-feldspar gneiss.
(14 E) On west side of lake, 8 miles southwest of west end of Hebron Fiord, Newfoundland (Labrador); 57°50'N, 63°29'W. No geological map reference. Sample TA-64-T7, collected and interpreted by F.C. Taylor.

This sample is from a medium- to coarse-grained, well laminated, grey to light-grey paragneiss. The paragneiss consists chiefly of quartz with scattered grains of garnet, plagioclase, reddish brown biotite, chlorite, and magnetite.

For interpretation see GSC 64-165.

GSC 64-165 Biotite, K-Ar age 1,330 ± 40 m.y.

$K = 7.89\%$, $Ar^{40}/K^{40} = 0.1131$; radiogenic Ar = 98%. Concentrate; clean concentrate of orange-brown biotite. Minor impurities consist of a few feldspar fragments. Chlorite not detected.

Newfoundland

From biotite-quartz-feldspar gneiss.

(14 L) North end of the north arm of Saglek Fiord, Newfoundland (Labrador); 58°33'N, 63°27'W. No geological map reference. Sample TA-64-T8, collected and interpreted by F.C. Taylor.

This sample is from a yellowish grey, well and thinly laminated, fine-grained paragneiss. It is composed of hypersthene, plagioclase, quartz, reddish brown biotite, and rarer magnetite and apatite. Garnet is locally present.

The two ages (GSC 64-164 and 165) show excellent agreement with an age previously obtained in this region (GSC 63-176, 1,300 ± 45 m.y.). They give the time of the last metamorphism (Elsonian orogeny) and lie in the western Nain Province. GSC 64-165 is probably close to the boundary between the eastern and western Nain Provinces and suggests that the older ages, such as GSC 63-173, 2,545 m.y. are confined to a coastal strip of Labrador at this latitude.