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PAPER 74-2

AGE DETERMINATIONS AND GEOLOGICAL STUDIES
K-Ar Isotopic Ages, Report 12

R.K. WANLESS, R.D. STEVENS
G.R. LACHANCE and R.N.D. DELABIO

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CONTENTS

	Page
Abstract/Résumé	1
Introduction	1
Experimental procedures	1
Constants employed in age calculations	4
Geological time-scales	4
References	4
Errata	5
Isotopic Ages, Report 12	6
British Columbia	6
Yukon Territory	19
District of Franklin	22
District of Mackenzie	26
District of Keewatin	30
Saskatchewan	32
Manitoba	35
Ontario	37
Quebec	45
Labrador-Newfoundland	52
Newfoundland	62
Appendix	64
Index of published GSC age determinations by NTS co-ordinates	64

Illustrations

Figure 1.	Phanerozoic time-scale	2
2.	Precambrian time-scale	3
3.	K-Ar dates and generalized geology, east-central Wolf Lake map-area, Yukon Territory	21

AGE DETERMINATIONS AND GEOLOGICAL STUDIES
K-Ar Isotopic Ages, Report 12

ABSTRACT

One hundred and ninety-eight new potassium-argon age determinations carried out on Canadian rocks and minerals are reported. Each age determination is accompanied by a description of the rock and mineral concentrate used; brief interpretative comments regarding the geological significance of each age are also provided. The experimental procedures employed are described in brief outline and the constants used in the calculation of ages are listed. Two geological time-scales are reproduced in tabular form for ready reference and an index of all published GSC K-Ar age determinations by primary NTS quadrangle has been prepared.

RESUME

L'auteur présente 198 nouvelles datations au potassium-argon effectuées sur des roches et des minéraux d'origine canadienne. Chaque datation est accompagnée d'une description de la roche ou du concentré mineral utilise ainsi que d'une brève interpretation touchant l'aspect géologique. Les méthodes expérimentales qui ont servi aux datations sont aussi résumées et l'auteur joint une liste des constantes utilisées dans les calculs. Deux échelles des temps géologiques sont reproduites sous forme de tableau ce qui facilite les références et l'on a préparé, par quadrilatère du SRCN, un index de toutes les datations au potassium-argon publiées par la Commission géologique du Canada.

INTRODUCTION

This is the twelfth report of potassium-argon age measurements completed in the Geochronological Laboratories of the Geological Survey of Canada. One hundred and ninety-eight new determinations are reported, bringing the total number of published ages to 1985.

Since the reports in the series have not followed the same numerical sequence, the list following will serve to identify the complete series: -

GSC 60-17, Report No. 1 - determinations
59-1 to 59- 98
GSC 61-17, Report No. 2 - determinations
60-1 to 60-152
GSC 62-17, Report No. 3 - determinations
61-1 to 61-204
GSC 63-17, Report No. 4 - determinations
62-1 to 62-190
GSC 64-17, Report No. 5 - determinations
63-1 to 63-184
GSC 65-17, Report No. 6 - determinations
64-1 to 64-165
GSC 66-17, Report No. 7 - determinations
65-1 to 65-153
GSC 67-2A, Report No. 8 - determinations
66-1 to 66-176
GSC 69-2A, Report No. 9 - determinations
67-1 to 67-146
GSC 71- 2, Report No. 10 - determinations
70-1 to 70-156
GSC 73- 2, Report No. 11 - determinations
72-1 to 72-163
This paper, Report No. 12 - determinations
73-1 to 73-198

Many of the age determinations reported are plotted on GSC Map 1256A (*see* Douglas, 1970) which is the most recent compilation of Canadian geochronology.

Instances have again been found of samples containing excessively large quantities of radiogenic argon, thus yielding anomalously old ages. Four of the five examples reported this year (*see* GSC 73-78, 79, 156, 170 and 171) are from chilled margins of diabase dykes. In one instance (GSC 73-156) the sample was collected from an area near the Grenville Front where excess argon has previously been reported (Wanless *et al.*, 1970).

Data are presented for 28 rocks ranging in age from Devonian to Archean which have yielded both hornblende and biotite mineral concentrates. In 18 instances the hornblende ages are higher, ranging from 0. 25% to 29. 3%, while in 10 cases the biotite yielded ages from 0. 6% to 41% greater than the associated hornblende. The exclusion of three results in which the presence of excess argon is suspected (one hornblende and two biotites) reduces the ranges to 0. 25% to 18. 9% for the hornblendes and 0. 6% to 16. 7% for the biotite concentrates. The results obtained for the remaining 25 pairs indicate that in 68% of the cases hornblende ages are greater, with the average age difference amounting to 10%. For the total group the hornblende ages are found to be 4. 7% greater on the average than the associated biotite ages.

Appendix 1 comprises an updated index of all published GSC K-Ar age determinations listed according to the primary NTS quadrangle to facilitate rapid retrieval.

Experimental Procedures

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

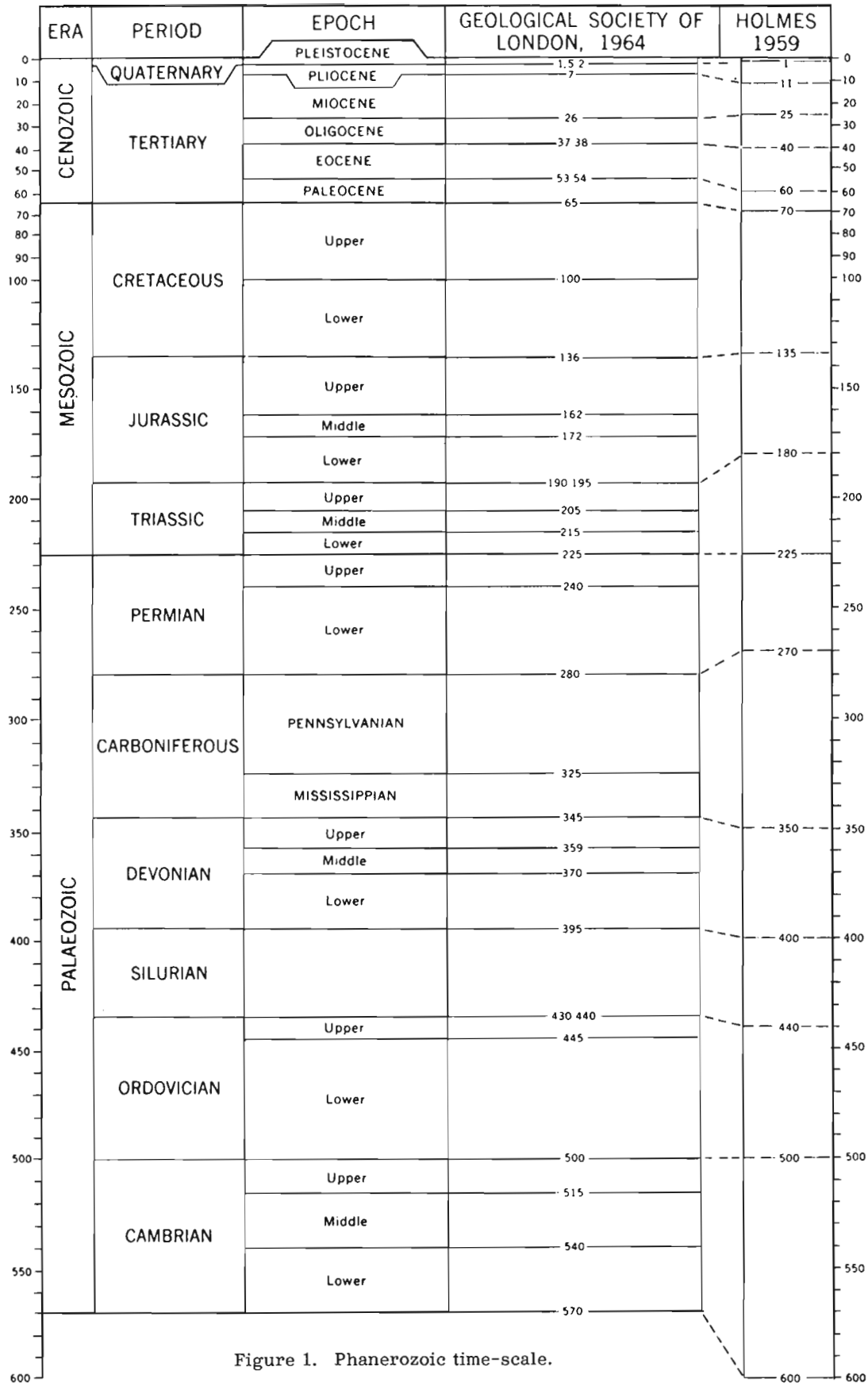

Figure 1. Phanerozoic time-scale.

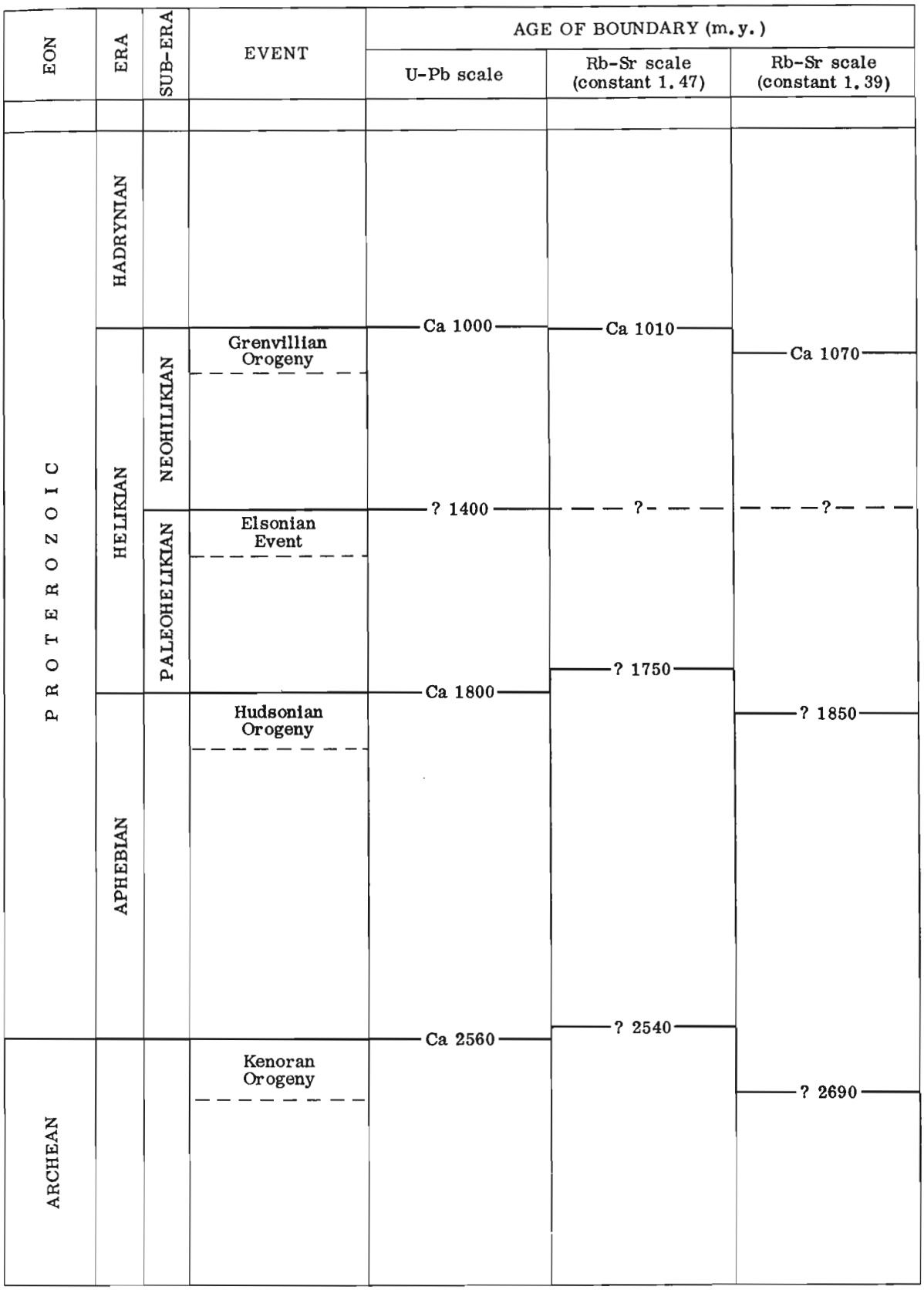

Figure 2. Precambrian time-scale, with modifications from Stockwell, 1973.

Radio-frequency induction heating was employed to fuse the samples in vacuo. A precisely determined quantity of enriched argon-38 was added to the liberated gas which was then purified by passage through cold-traps, hot copper oxide, and over a titanium sponge getter. Isotopic analyses were carried out in modified A.E.I. MS-10 mass spectrometers operated in the static mode.

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

Constants Employed in Age Calculations

The constants employed to calculate the ages are as follows: $\lambda_\beta = 4.72 \times 10^{-10} yr^{-1}$; $\lambda_\varepsilon = 0.585 \times 10^{-10}$ yr^{-1}; ^{40}K atomic abundance = 1.19×10^{-4}.

Geological Time-Scales

The Phanerozoic time-scales of the Geological Society of London (1964) and Holmes (1959) are summarized in tabular form in Figure 1. For appropriate stage and series names the reader is referred to the Geological Society of London publications 'The Phanerozoic Time-Scale' p. 260-262 and 'The Phanerozoic Time-Scale - A Supplement' page 7.

A revised time-scale, after Stockwell (1973), is given in Figure 2 for the Precambrian of the Canadian Shield. Stockwell has prepared the following explanatory notes. As in earlier publications, the close of orogeny* is chosen as the boundary between time-units of Eon, Era, and Sub-Era rank but a distinction is now made between orogenic ages and immediately following cooling ages. Precision in estimating individual age determinations is impossible because of very large analytical errors, uncertainty in decay constants, and the generally obscure effect of geological factors but, in an effort to minimize or cancel out the analytical uncertainties, average values are used here, the averages being for clusters of similar ages as determined by each method on each mineral or rock-type within a structural province chosen as a type region. On this basis, boundaries between the named time-units are placed within a narrow time interval between the latest phase of orogeny and the earliest stage of the immediately following cooling period. The latest orogenic phase is given best by U-Pb methods (and with some exceptions by the Rb-Sr whole-rock isochron method) on late orogenic granitic rocks or pegmatite, while the earliest datable stage of subsequent cooling is given by K-Ar ages on orogenic amphibole and by Rb-Sr ages on orogenic muscovite.

A good example is found in the Grenville structural province which is the type region for the Grenvillian Orogeny, for the post-Grenvillian cooling period, and for the boundary between the Neohelikian and the Hadrynian. In this province, the boundary is estimated, in round numbers, at 1000 m.y., on the U-Pb scale. It is placed within a narrow time-range between the latest phase of the orogeny, which is given by a cluster of 29 Pb^{207}/Pb^{206} ages of pegmatite averaging 1011 m.y. old (and of 16 concordant and concordia ages on pegmatite averaging 1035 m.y.), and the earliest stage of the post-Grenvillian cooling period which is given by a cluster of 22 K-Ar ages on orogenic amphiboles averaging 963 m.y. Incidentally, the peak of igneous activity within the Grenvillian Orogeny is indicated by granitic intrusions clustering around an average of 1074 m.y. by the 207-206 method, and of 1104 m.y. by the concordant and concordia methods. A late stage of the cooling period is indicated by a cluster of 98 K-Ar ages on biotite averaging 924 m.y. and an intermediate stage, by a cluster of 29 K-Ar ages on muscovites averaging 943 m.y.

The presently estimated isotopic age of each boundary is subject to change as more dates become available and as their interpretation is improved, but such changes will not alter the nomenclature nor definition of the time-units because these are based on rocks in type regions. In most regions of the Shield the boundaries set apart very important episodes in earth history for they lie along contacts between deeply eroded basement and unconformably overlying sedimentary and volcanic sequences.

*The term "orogeny" is used here to denote a process of mountain-building accompanied by important folding that affected large segments of the crust and was commonly associated with virtually contemporaneous regional metamorphism and the emplacement of granitic bodies and pegmatite. The term "orogenic materials" is used to denote those minerals and rocks that formed in conjunction with this process.

References

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1968: Age determinations and geological studies, K-Ar isotopic ages, Report 8; Geol. Surv. Can., Paper 67-2, Pt. A.

Wanless, R.K., Stevens, R.D. and Loveridge, W.D.
1970: Anomalous parent-daughter isotopic relationships in rocks adjacent to the Grenville Front near Chibougamau, Quebec; Eclogae geol. Helv., v. 63/1, p. 345-364.

ERRATA

G.S.C. Paper 64-17

Determination GSC 63-51:
Co-ordinates should read 64°06'N, 115°22'W.

G.S.C. Paper 73-2

Determination GSC 72-69:
Location should read 3 miles northwest of Shallow Lake.

Determination GSC 72-76:
Location should read 16 miles north-northwest of Weaver Lake.

British Columbia
(GSC 73-1 to GSC 73-56)

GSC 73- 1 Hornblende, K-Ar age 148 ± 7 m.y.

K = 0.373%, $^{40}Ar/^{40}K$ = 0.0090, radiogenic Ar = 67.1%.
Concentrate: Clean, fresh and unaltered, pleochroic, olive-green to bluish green hornblende with approximately 2% chlorite contamination.

From quartz diorite
(102 I) Southwest coast of Lanz Island, off northwest tip of Vancouver Island, British Columbia, 50°48'20"N, 128°41'20"W. Map-unit Jg, Alert Bay - Cape Scott map-area. Sample MEKA 68-4, collected and interpreted by J.E. Muller.

The rock is medium-grained, dark-coloured quartz diorite with 56.5% plagioclase with oscillatory zoning (An_{27} to An_{45}), 20.3% quartz, 16.0% green hornblende, 5.7% biotite and minor muscovite, chlorite, epidote and opaques. Crystalline rocks of Scott Islands, at the northwest tip of Vancouver Island, are considered to be part of the Westcoast Crystalline Complex (Muller *et al.*, 1974), but they grade into granodiorite which on adjacent Cox Island is in intrusive contact with Lower Jurassic Sinemurian sediments. Although the Crystalline Complex may be originally of Paleozoic age the K-Ar age shows it was recrystallized in Jurassic time. The age of 148 m.y. (Upper Jurassic, Kimmeridgian) is within the known K-Ar age range of the Island Intrusions (*see* GSC 73-17).

Reference

Muller, J.E., Northcote, K.E. and Carlisle, D.
1974: Geology and mineral deposits of Alert Bay - Cape Scott map-areas, Vancouver Island, British Columbia; Geol. Surv. Can., Paper 74-8.

GSC 73- 2 Whole-rock, K-Ar age 7.6 ± 0.7 m.y.

K = 0.640%, $^{40}Ar/^{40}K$ = 0.00048, radiogenic Ar = 39.8%.
Concentrate: Crushed whole-rock.

From basalt
(92 L) Near top of Twin Peaks (Point 3865), 12.9 km southwest of Port McNeill, Vancouver Island, British Columbia, 50°30'30"N, 127°14'55"W. Map-unit Tv, Alert Bay - Cape Scott map-area, Geol. Surv. Can. Paper 74-8. Sample MEKA 69-6B, collected and interpreted by J.E. Muller.

The rock is a fine-grained, medium brown, microporphyritic basalt with platy jointing that in outcrop could be mistaken for a metasedimentary rock. It contains labradorite phenocrysts, 1-3 mm in length, that include grains of diopside and magnetite, in a trachytic-textured matrix of labradorite laths up to 0.3 mm in size, diopside, and magnetite.

See GSC 73-3 for interpretation.

GSC 73- 3 Whole-rock, K-Ar age 7.9 ± 0.8 m.y.

K = 0.956%, $^{40}Ar/^{40}K$ = 0.00046, radiogenic Ar = 39.1%.
Concentrate: Crushed whole-rock.

From basalt
(92 L) Spur off Rayonnier Co. centre main road, west of Twin Peaks, 4.4 km south of O'Connor Lake, Vancouver Island, British Columbia, 50°30'05"N, 127°15'45"W. Alert Bay - Cape Scott map-area, Geol. Surv. Can. Paper 74-8. Sample MEKA 69-3 (69-227F), collected and interpreted by J.E. Muller.

The rock is a fine-grained, dark-grey basalt with microphenocrysts of labradorite to 1 mm in length in a fine subtrachytic matrix of labradorite, diopside and magnetite.

GSC 73-2 and GSC 73-3 are two whole-rock samples from basalt from Twin Peaks, south of Port McNeill, northern Vancouver Island. There are a few other isolated buttes of probable Tertiary volcanic rocks, as well as the rocks of Haddington Island. On Twin Peaks lava flows and poorly consolidated tuffs and volcanic conglomerates occur. No detailed mapping has been carried out in the only partly logged-off area. The two closely similar dates are the only positive evidence that volcanism was active in late Tertiary, early Pliocene time. Basaltic volcanics of similar age are also known from Tow Hill at the north end of Queen Charlotte Islands, and from islands and Shell Oil drill holes in Hecate Strait.

References

Muller, J.E., Northcote, K.E. and Carlisle, D.
1974: Geology and mineral deposits of Alert Bay - Cape Scott map-areas, Vancouver Island, British Columbia; Geol. Surv. Can., Paper 74-8.

Sutherland Brown, A.
1968: Geology of the Queen Charlotte Islands, British Columbia; B.C. Dept. Mines Pet. Resour., Bull. 54.

GSC 73- 4 Hornblende, K-Ar age 42.1 ± 7.0 m.y.

K = 0.204%, $^{40}Ar/^{40}K$ = 0.0025, radiogenic Ar = 17.4%.
Concentrate: Relatively clean, unaltered, pleochroic brown to green hornblende with less than 1% chlorite contamination.

From hornblende-plagioclase porphyry
(92 E) Near portal of old Indian Chief mine, west side of Stewardson Inlet, Vancouver Island, British Columbia, 49°26'50"N, 126°18'35"W. Nootka Sound map (in prep.). Sample MEKA 71-5, collected and interpreted by J.E. Muller.

The rock is from a dyke of medium-grained, light-coloured porphyry with 30.8% plagioclase phenocrysts, 4.8% hornblende phenocrysts up to (5 mm) in 59.2% fine-grained (0.01 mm) quartz-feldspar matrix. There is minor leucoxene, apatite, pyroxene and biotite. The dyke intrudes skarnified bedded carbonate believed to be of Paleozoic age.

See GSC 73-9 for interpretation.

GSC 73- 5 Hornblende, K-Ar age 32.5 ± 3.9 m.y.

K = 0.480%, $^{40}Ar/^{40}K$ = 0.0019, radiogenic Ar = 30.1%.
Concentrate: Pleochroic, light green to bluish green hornblende with approximately 2% attached biotite contamination.

From granodiorite
(92 B) West side of small bay on west coast of Sydney Inlet, at bearing N30°E from Starling Point, Vancouver Island, British Columbia, 49°24'25"N, 126°16'25"W. Map-unit Jg, Nootka Sound map (in prep.). Sample MEKA 71-1, collected and interpreted by J.E. Muller.

See GSC 73-6 for description and GSC 73-9 for interpretation.

GSC 73- 6 Biotite, K-Ar age 36.6 ± 2.1 m.y.

K = 6.92%, $^{40}Ar/^{40}K$ = 0.0022, radiogenic Ar = 70.0%.
Concentrate: Clean, fresh, light brownish biotite with no visible impurities.

From granodiorite
(92 B) Details as for GSC 73-5.

The rock is medium-grained, medium-coloured granodiorite with very slight foliation and contains 39.9% plagioclase of average composition An_{30}, 12.9% perthitic potash feldspar, 38.2% quartz, 6.8% biotite, 2.0% hornblende and minor epidote, white mica, chlorite and apatite. The rock contained flakes of molybdenite and some azurite on hairline fractures.

See GSC 73-9 for interpretation.

GSC 73- 7 Biotite, K-Ar age 35.1 ± 2.1 m.y.

K = 4.98%, $^{40}Ar/^{40}K$ = 0.0021, radiogenic Ar = 54.5%.
Concentrate: Relatively clean, reddish brown biotite with approximately 2% attached chlorite contamination.

From quartz monzonite
(92 E) South side of bay on Flores Island, west side and opposite north end of Openit Peninsula, Vancouver Island, British Columbia, 49°22'25"N, 126°13'50"W. Nootka Sound map (in prep.). Sample MEKA 71-3, collected and interpreted by J.E. Muller.

The rock is fine- to medium-grained, light-coloured quartz monzonite with 33.7% zoned plagioclase (An_{40} - An_{20}) 26.1% potassium feldspar, 36.5% quartz, 2.5% biotite, 0.5% hornblende and epidote and opaque minerals. The texture is generally aplitic, and it contains graphic quartz-feldspar intergrowths.

See GSC 73-9 for interpretation.

GSC 73- 8 Hornblende, K-Ar age $\frac{62.7 \pm 4 \text{ m.y.}}{68.7 \pm 4 \text{ m.y.}}$

K = $\frac{0.396\%}{0.361\%}$, $^{40}Ar/^{40}K$ = $\frac{0.0037}{0.0041}$, radiogenic Ar = 48.7%.
Concentrate: Relatively clean, unaltered, pleochroic olive-brown to green hornblende with less than 2% biotite contamination.

From granodiorite
(92 F) Highway cut at sharp corner 2.4 km south of Kennedy Lake, Alberni-Tofino highway, British Columbia, 49°00'50"N, 125°34'05"W. Map-unit 21, Alberni map-area, Geol. Surv. Can. Paper 68-50. Sample MEKA 72-3, collected and interpreted by J.E. Muller.

See GSC 73-9 for description and interpretation.

GSC 73- 9 Biotite, K-Ar age 44.5 ± 2.3 m.y.

K = 7.17%, $^{40}Ar/^{40}K$ = 0.0026, radiogenic Ar = 78.8%.
Concentrate: Clean, unaltered, orange biotite with no visible contamination.

From granodiorite
(92 F) Details as for GSC 73-8.

The rock is fine-grained, medium-coloured granodiorite with 50.2% plagioclase, 27.8% quartz, 14.4% potash feldspar, 4.0% biotite, 2.4% hornblende and chlorite, zircon and opaque minerals. Subhedral plagioclase, orthoclase and mafic minerals are "cemented" by a granulose matrix of quartz and alkali feldspar.

The new identification of additional small Tertiary plutons along the west coast of Vancouver Island warrants a summary of all such plutons now known. Before this information became available they had already been shown provisionally on the geological reconnaissance map of Vancouver Island (Muller, 1971). From west to east they are:

Sydney Inlet Pluton (new)	Age (m.y.)
GSC 73-4 Dacite porphyry, hornblende	42.1 ± 7
GSC 73-6 Granodiorite, biotite	36.6 ± 2.1
GSC 73-5 " hornblende	32.5 ± 3.9
GSC 73-7 Quartz monzonite, biotite	35.1 ± 2.1
Catface Pluton	
GSC 65-11 Quartz diorite, biotite	48 ± 12
Tofino Pluton	
GSC 66-31 Granodiorite, biotite	50 ± 5
South Kennedy Lake Pluton (new)	
GSC 73-9 Granodiorite, biotite	44.5 ± 2.3
GSC 73-8 " hornblende	65.7 ± 4
East Kennedy Lake Pluton (?)	
GSC 72-19 Post-ore dyke, biotite	47 ± 3
GSC 66-32 Quartz monzonite, biotite	59 ± 3

Tertiary plutons are generally northwesterly-elongated small bodies of light-coloured granitic rocks, in some places porphyritic and apparently of epizonal character. They may feather out into dacite porphyry dykes and sills. They range in composition from quartz diorite to quartz monzonite and dacite porphyry and, apart from the general unaltered character, they are not easily distinguished from similar Jurassic high-level plutons. Isotopic age determination is therefore required for their identification. Except for the Zeballos Pluton they occur near the west coast of the island and a relationship to the early Tertiary faulting that juxtaposed older rocks and the Pacific Rim Complex (Muller, 1973) could be suggested. They are not known to intrude Eocene to Oligocene sediments anywhere. The age-range is now 59 to 32 m.y. (Paleocene to Middle Oligocene). The Sydney Inlet Pluton yielded a concordant biotite-hornblende pair, but the pair for the Kennedy Lake Pluton is discordant. More determinations will be necessary to determine whether two plutonic periods are involved in that body. The age range of the plutons overlaps the Carmanah Formation exposed along the coast to the southwest of the intrusions and it appears that plutonism and deposition of these sediments occurred concurrently.

References

Carson, D.J.T.
1973: The plutonic rocks of Vancouver Island; Geol. Surv. Can., Paper 72-44.

Carson, D.J.T., Muller, J.E., Wanless, R.K. and Stevens, R.D.
1971: Age of the contact metasomatic copper and iron deposits, Vancouver and Texada Islands, British Columbia; Geol. Surv. Can., Paper 71-36.

Muller, J.E.
1971: Geological reconnaissance map of Vancouver Island and Gulf Islands; Geol. Surv. Can., Open File 61.

1973: Geology of Pacific Rim National Park; Geol. Surv. Can., *in* Paper 73-1, p. 29-37.

GSC 73- 10 Hornblende, K-Ar age 192 ± 9 m.y.

K = 0.970%, $^{40}Ar/^{40}K$ = 0.0118, radiogenic Ar = 89.8%.
Concentrate: Relatively clean, unaltered, pleochroic brown to dark green hornblende with less than 2% chlorite contamination.

From amphibolized basalt
(92 F) South side of Grice Bay, opposite Indian Island, British Columbia, 49°06'55"N, 125°47'55"W. Map-unit A, Alberni map-area, Geol. Surv. Can. Paper 68-50. Sample MEKA 72-2, collected and interpreted by J.E. Muller.

The rock is fine-grained, dark greenish black, well-lineated amphibolite, consisting of equigranular hornblende 54%, biotite 12% and plagioclase 29%. It forms a crosscutting dyke in well-foliated plagioclase-quartz-biotite gneiss of the Westcoast Crystalline Complex. Intrusion of the dyke was almost certainly related to the widespread Late Triassic Karmutsen basaltic volcanism, which post-dated the emplacement, but pre-dated the Jurassic metamorphism of the Westcoast Complex. The K-Ar age of the dyke is inter-

preted as indicating the time of recrystallization of the dyke from basalt to amphibolite in the very early part of the protracted Jurassic plutonic period that on Vancouver Island according to present dates lasted from 180 to 140 m.y. ago (*see* comments for GSC 73-17). From the gneissic host rock of the dyke no K-Ar date could be obtained but zircons extracted from it yielded a very satisfactory concordant age-triplet: $^{206}Pb/^{238}U$ = 265 m.y.; $^{207}Pb/^{235}U$ = 263 m.y.; $^{207}Pb/^{206}Pb$ = 244 m.y. (Muller *et al.*, 1974). The dates confirm the inference that the Westcoast Complex is at least in part derived from late Paleozoic rocks. Jurassic plutonism apparently did not affect the zircon age, although it metamorphosed the basalt dyke to amphibolite.

Reference

Muller, J.E., Wanless, R.K. and Loveridge, W.D. 1974: A Paleozoic zircon age of the Westcoast Crystalline Complex of Vancouver Island, British Columbia; Can. J. Earth Sci., v. 11, no. 12, in press.

GSC 73- 11 Hornblende, K-Ar age 160 ± 7 m.y.

K = 0.511%, $^{40}Ar/^{40}K$ = 0.0097, radiogenic Ar = 73.0%.
Concentrate: Clean, unaltered, pleochroic, brown to green hornblende with no visible impurities.

From quartz diorite
(92 L) Road-cut 0.72 km north-northeast of west tip of Tlowils Lake, Vancouver Island, British Columbia, 50°16'03"N, 126°00'13"W. *See* Alert Bay - Cape Scott map-area, Geol. Surv. Can. Paper 74-8. Sample MEKA 71-8, collected by D. Carlisle and interpreted by J.E. Muller.

See GSC 73-12 for description and GSC 73-17 for interpretation.

GSC 73- 12 Biotite, K-Ar age 155 ± 6 m.y.

K = 6.56%, $^{40}Ar/^{40}K$ = 0.0094, radiogenic Ar = 92.0%.
Concentrate: Clean, unaltered, dark brown biotite with no visible impurities.

From quartz diorite
(92 L) Details as for GSC 73-11.

The rock is medium-grained, dark-coloured quartz diorite with 56.7% plagioclase, 3.5% potash feldspar, 11.2% quartz, 3.1% graphic intergrowths of quartz and feldspar, 3.7% biotite, 5.5% hornblende, 13.7% hypersthene - diallage, and 2.6% opaques. Hypersthene is optically continuous with clinopyroxene blebs and is rimmed by hornblende.

See GSC 73-17 for interpretation.

GSC 73- 13 Hornblende, K-Ar age 159 ± 7 m.y.

K = 0.375%, $^{40}Ar/^{40}K$ = 0.0097, radiogenic Ar = 64.1%.
Concentrate: Pleochroic, olive-green to bluish green hornblende with a trace of biotite and approximately 5% chlorite contamination.

From diorite
(92 K) About 1.6 km west of bay on road along creek entering Salmon Bay, Vancouver Island, British Columbia, 50°22'35"N, 125°58'50"W. Sample MEKA 71-7, collected and interpreted by J.E. Muller.

This rock is a medium-grained, dark-coloured, non-foliated diorite with 46% plagioclase phenocrysts and 34% plagioclase matrix, 10.6% biotite, 6.5% hornblende and minor opaque minerals and chlorite.

See GSC 73-17 for interpretation.

GSC 73- 14 Biotite, K-Ar age 146 ± 7 m.y.

K = 6.79%, $^{40}Ar/^{40}K$ = 0.0089, radiogenic Ar = 88.9%.
Concentrate: Greenish brown biotite with approximately 10% chloritization.

From granodiorite
(92 K) Road-cut 1.2 km N20°E from north tip of Pye Lake, Vancouver Island, British Columbia, 50°18'47"N, 125°35'04"W. *See* Bute Inlet map (in prep.). Sample MEKA 71-9, collected by D. Carlisle and interpreted by J.E. Muller.

See GSC 73-15 for description and GSC 73-17 for interpretation.

GSC 73- 15 Hornblende, K-Ar age 142 ± 7 m.y.

K = 0.294%, $^{40}Ar/^{40}K$ = 0.0086, radiogenic Ar = 53.7%.
Concentrate: Relatively clean, pleochroic, brownish green to dark green hornblende with less than 1% chlorite contamination.

From granodiorite
(92 K) Details as for GSC 73-14.

The rock is medium-grained, medium-coloured, unfoliated granodiorite and the thin section shows 48.6% plagioclase, 9.6% potash feldspar, 31.4% quartz, 3.6% biotite, 3.8% hornblende, 2.2% chlorite, 0.2% epidote and 0.6% magnetite.

See GSC 73-17 for interpretation.

GSC 73-16 Hornblende, K-Ar age 112 ± 5 m.y.

K = 0.520%, $^{40}Ar/^{40}K$ = 0.0068, radiogenic Ar = 65.5%.
Concentrate: Clean, unaltered, pleochroic, brown to green hornblende with no visible contamination.

From granodiorite
(92 K) South side of minor point, Rock Bay steamer landing, Vancouver Island, British Columbia, 50° 19'56"N, 125°29'05"W. Blue Inlet map (in prep.). Sample MEKA 71-10, collected by D. Carlisle and interpreted by J.E. Muller.

See GSC 73-17 for description and interpretation.

GSC 73-17 Biotite, K-Ar age 105 ± 10 m.y.

K = 7.37%, $^{40}Ar/^{40}K$ = 0.0063, radiogenic Ar = 86.4%.
Concentrate: Clean, unaltered, light brownish biotite with less than 1% hornblende contamination.

From granodiorite
(92 K) Details as for GSC 73-16.

The rock is medium-grained, medium-coloured granodiorite with 45.0% plagioclase with discontinuous normal zoning (An_{60} to An_{20}), 14.0% microperthite, 23.6% quartz, 5.7% biotite, 7.8% hornblende, 0.9% pyroxene and minor chlorite and sphene.

Three samples for age determination collected by D. Carlisle from Bute Inlet map-area and one sample from just west of the border with Alert Bay map-area yielded good hornblende-biotite pairs. They indicate that plutonic rocks on the northeastern part of Vancouver Island near Johnstone Strait are like the bulk of granitic rocks farther south and west, all forming part of the Jurassic Island Intrusions.

From west to east they are as follows:

Adam River Batholith		Age (m.y.)
GSC 73-12	Quartz diorite, biotite	155 ± 6
GSC 73-11	" " hornblende	160 ± 7
GSC 73-13	Diorite, hornblende	159 ± 7
Pye Lake Intrusion		
GSC 73-14	Granodiorite, biotite	146 ± 7
GSC 73-15	" hornblende	142 ± 7
Rock Bay Intrusion		
GSC 73-17	Granodiorite, biotite	105 ± 10
GSC 73-16	" hornblende	112 ± 5

The fairly concordant dates vary from 160 m.y. to 142 m.y. for the samples from Adam River Batholith and Pye Lake Intrusion. They are generally within the Jurassic Period according to the Geological Society of London (1964) time-scale and within the 180 - 140 m.y. age-range previously determined for Island Intrusions. But they are in the younger part of the spectrum, mostly Late Jurassic time.

On Vancouver Island intrusive contact relations have thus far not been found with any but Pleinsbachian (183 m.y.) or possibly Toarcian (178 m.y.) Lower Jurassic sediments. Known Upper Jurassic sediments on the west coast of Vancouver Island carry, to the writer's knowledge, only volcanic debris and it is conceivable that plutonism was still active in Late Jurassic time.

The 105 and 112 m.y. K-Ar ages for the Rock Bay intrusive body would correlate to Lower Cretaceous Aptian to Albian time. To the northwest, in Quatsino Sound area, a conglomerate carrying boulders of granitic rocks is probably of Albian age. Taking the datings by microflora and by isotopes at face value one would have to conclude that crystallization of parts of the Island Intrusions occurred almost simultaneously with erosion of other parts. This could be due to a progressive northeastward "younging" of the several parallel batholithic zones of Vancouver Island. The Early Cretaceous age of the Rock Bay sample is similar to ages obtained for small plutons on the northeast coast of Texada Island.

GSC 73-18 Hornblende, K-Ar age 158 ± 7 m.y.

K = 0.563%, $^{40}Ar/^{40}K$ = 0.0096, radiogenic Ar = 74.7%.
Concentrate: Pleochroic brown to green hornblende with approximately 1% contamination by both biotite and chlorite.

From granodiorite
(92 B) Road-cut on logging road along Holt Creek, Vancouver Island, British Columbia, 48°43'55"N, 123°50'10"W. Map-unit 6 (Saanich Granodiorite), Geol. Surv. Can. Map 42A (1918). Sample MEKA 70-11, collected and interpreted by J.E. Muller.

The rock is medium-grained, medium-coloured, slightly foliated granodiorite with 50.2% plagioclase, 10.8% potash feldspar, 21.5% quartz, 25% biotite, 13.6% hornblende, 0.6% sphene, 0.6% epidote and 0.6% opaque minerals.

See GSC 73-19 for interpretation.

GSC 73- 19 Hornblende, K-Ar age 141 ± 6 m.y.

K = 0.537%, $^{40}Ar/^{40}K$ = 0.0086, radiogenic Ar = 75.1%.
Concentrate: Clean, unaltered, pleochroic, brownish green to dark green hornblende with no visible contamination.

From granodiorite
(92 B) Quarry on logging road on north slope of Koksilah Ridge, near Duncan, Vancouver Island, British Columbia, 48°42'45"N, 123°46'00"W. Map-unit 6, Geol. Surv. Can. Map 42A, Duncan sheet. Sample MEKA 70-13, collected and interpreted by J.E. Muller.

The rock is medium-grained, medium-coloured granodiorite with 51.0% plagioclase, 16.0% potash feldspar, 22.7% quartz, 0.3% biotite, 7.7% hornblende and accessory sphene, epidote, chlorite and opaques. Like GSC 73-18 it is from a small granitic body south of Duncan, B.C.

Two determinations were made on hornblende from granodiorite samples from the intrusive body south of Duncan. They establish that intrusions in the southeast part of Vancouver Island are, like the rest of the Island Intrusions, of Jurassic age. Throughout the island, the ages range from 180 m.y., or Early Jurassic, Sinemurian to Pliensbachian, to 140 m.y. or Middle Jurassic, Callovian. The beginning of this time span coincides with the widespread volcanism that produced the Bonanza Volcanics, but the end appears to coincide with the beginning of classic sedimentation of debris from the volcanics. The ages obtained indicate that the Duncan granitic body is a relatively young one in the group of Island Intrusions.

GSC 73- 20 Hornblende, K-Ar age 70.6 ± 3.4 m.y.

K = 0.682%, $^{40}Ar/^{40}K$ = 0.0042, radiogenic Ar = 57.5%.
Concentrate: Pleochroic, yellow-brown to dark green hornblende with approximately 2% biotite contamination.

From quartz diorite
(92 K) 3.2 km west of Mt. Gilbert, British Columbia, 50°51'54"N, 124°19'01"W. Map-unit 2, Bute Inlet map (Hutchison and Roddick, in prep.), Mt. Gilbert pluton. Sample Rd 71-40206-1, collected and interpreted by G.J. Woodsworth.

See GSC 73-21 for description and GSC 73-27 for interpretation.

GSC 73- 21 Biotite, K-Ar age 71.3 ± 2.7 m.y.

K = 7.62%, $^{40}Ar/^{40}K$ = 0.0043, radiogenic Ar = 77.7%.
Concentrate: Clean, fresh, light greenish biotite with no visible contamination.

From quartz diorite
(92 K) Details as for GSC 73-20.

The sample is a medium-grained, moderately foliated quartz diorite consisting of 49% subhedral plagioclase (slight normal zoning, average composition about An_{35}), 20% quartz, 15% biotite (grains cluster in clots having a crude foliation; slightly chloritized), 14% fresh, poikilitic hornblende, and 2% combined opaques, sphene, epidote, and K-feldspar.

See GSC 73-27 for interpretation.

GSC 73- 22 Biotite, K-Ar age 55.4 ± 2.5 m.y.

K = 7.17%, $^{40}Ar/^{40}K$ = 0.0033, radiogenic Ar = 74.7%.
Concentrate: Impure, light green biotite with approximately 14% chloritization.

From granodiorite
(92 K) Road-cut on south side of Bishop River, 2 km east of junction with Charon Creek, British Columbia, 50°59'05"N, 124°14'54"W. Map-unit P-3, Bute Inlet map (Hutchison and Roddick, in prep.), Styx Creek pluton. Sample Rd 71-40157-1, collected and interpreted by G.J. Woodsworth.

See GSC 73-23 for description and GSC 73-27 for interpretation.

GSC 73- 23 Hornblende, K-Ar age 55.3 ± 3.3 m.y.

K = 0.672%, $^{40}Ar/^{40}K$ = 0.0033, radiogenic Ar = 57.0%.
Concentrate: Impure, pleochroic, brownish green to bluish green hornblende with approximately 5% biotite and a trace of chlorite contamination.

From granodiorite
(92 K) Details as for GSC 73-22.

The sample is a medium-grained, massive granodiorite composed of 25% plagioclase (oscillatory-normal zoning from An_{30} to An_{22}), 27% quartz, 14%

interstitial K-feldspar, 5% slightly chloritized biotite (contains epidote and sphene inclusions), 0.2% ragged hornblende grains, and 2% combined sphene, epidote, and opaques.

See GSC 73-27 for interpretation.

GSC 73- 24 Muscovite, K-Ar age $\frac{68.3 \pm 3.4 \text{ m.y.}}{66.2 \pm 3.3 \text{ m.y.}}$.

K = 6.43%, $^{40}Ar/^{40}K = \frac{0.0041}{0.0039}$, radiogenic Ar = $\frac{77.8\%}{68.9\%}$.
Concentrate: Impure, limonite-stained muscovite with approximately 10% chlorite impurity.

From quartz-muscovite schist
(92 K) 4.8 km east of Mt. Raleigh, British Columbia, 50°54'55"N, 124°15'01"W. Map-unit 2, Bute Inlet map (W.W. Hutchison and Roddick, in prep.). *See* also unit 5 of Mt. Raleigh group. Sample Rd 71-40207-1, collected and interpreted by G.J. Woodsworth.

The sample is a well-foliated quartz-muscovite schist. Muscovite (40%) occurs both as platy 1 mm-long grains oriented parallel to the foliation and as very fine-grained, randomly-oriented shimmer aggregates that form irregular layers and clots. Quartz (55%) occurs as anhedral, roughly equant grains. Minor chlorite, opaques, and limonitic and jarositic stain complete the rock.

See GSC 73-27 for interpretation.

GSC 73- 25 Hornblende, K-Ar age 68.4 ± 3.3 m.y.

K = 0.414%, $^{40}Ar/^{40}K = 0.0041$, radiogenic Ar = 54.4%.
Concentrate: Relatively clean, unaltered, pleochroic, light to dark brown hornblende with less than 1% chlorite contamination.

From lamprophyre
(92 K) One mile northeast of Mt. Raleigh, British Columbia, 50°54'55"N, 124°15'01"W. *See* Bute Inlet map (W.W. Hutchison and J.A. Roddick, in prep.). Sample Rd 71-40207-2, collected and interpreted by G.J. Woodsworth.

From the centre of a 6-foot-thick lamprophyre dyke cutting the muscovite schist of GSC 73-24.

The sample is a grey-brown fine- to medium-grained lamprophyre consisting of euhedral hornblende phenocrysts (40%) in a fine-grained matrix of subhedral plagioclase (approximately An_{23}) and minor opaques and zeolites. Hornblende is commonly zoned, either with several oscillations or with an inner lighter core in sharp contact with an outer darker rim. Some hornblende grains contain cores of feldspar, fine-grained opaques, and feebly birefringent material.

See GSC 73-27 for interpretation.

GSC 73- 26 Hornblende, K-Ar age 71.6 ± 8.6 m.y.

K = 0.086%, $^{40}Ar/^{40}K = 0.0043$, radiogenic Ar = 19.9%.
Concentrate: Clean, unaltered, pleochroic, olive-green to bluish green hornblende with no visible impurities.

From amphibolite
(92 K) 2.1 km northwest of summit of Mt. Raleigh, British Columbia, 50°55'16"N, 124°17'38"W. *See* Bute Inlet map (W.W. Hutchison and J.A. Roddick, in prep.), and unit 6 of Mt. Raleigh group. Sample Rd 70-30502-2, collected by W.W. Hutchison and interpreted by G.J. Woodsworth.

The amphibolite is black, fine-grained, and strongly lineated. Hornblende (55%) forms fresh subhedral to euhedral grains up to 10 mm in length. Plagioclase (40%) occurs as anhedral unzoned grains interstitial to hornblende and as larger subhedral grains that may be relict phenocrysts. Opaques (1%) are small and anhedral. Quartz-rich pods and bands contain plagioclase with minor garnet and epidote.

See GSC 73-27 for interpretation.

GSC 73- 27 Biotite, K-Ar age 57.5 ± 2.6 m.y.

K = 7.92%, $^{40}Ar/^{40}K = 0.0034$, radiogenic Ar = 83.0%.
Concentrate: Clean, fresh, dark green biotite with a slight trace of chlorite contamination.

From quartz diorite
(92 K) 1.9 km northeast of snout of Ramose Glacier, British Columbia, 50°58'50"N, 124°05'18"W. Map-unit P-3, Bute Inlet map (W.W. Hutchison and J.A. Roddick, in prep.); Styx Creek pluton. Sample Rd 70-10399-1, collected by J.A. Roddick and interpreted by G.J. Woodsworth.

The rock is a medium-grained, fresh, massive quartz diorite composed of 43% plagioclase (oscillatory-normal zoning ranging from An_{29} to An_{22}), 38% quartz, 3% K-feldspar, 11% biotite (slightly chlori-

tized), and 5% combined hornblende, sphene, epidote, and opaques. Biotite occurs both as large, subhedral, poikilitic books and as much smaller anhedral grains.

Apparent K-Ar ages from the Mt. Gilbert pluton (71 ± 3 m.y. on both biotite and hornblende), amphibolite (72 ± 9 m.y.) and muscovite schist (67 ± 3 m.y.) from metamorphic rocks of the Mt. Raleigh Group, and a lamprophyre dyke (68 ± 3 m.y.) cutting the Mt. Raleigh Group cluster around 70 m.y. and are equivalent within the stated error limits. The Styx Creek pluton gives significantly younger apparent ages of 55 ± 3 m.y. (biotite), 57 ± 3 m.y. (biotite), and 55 ± 3 m.y. (hornblende). Field work suggests:

1. emplacement of the Mt. Gilbert pluton occurred synchronously with metamorphism of the Mt. Raleigh Group;
2. the lamprophyre dykes have been intruded prior to the emplacement of the Styx Creek pluton; and
3. the Styx Creek pluton was emplaced later.

The K-Ar ages are consistent with these observations.

The 70 m.y. dates appear to reflect the age of metamorphism of the Mt. Raleigh Group and the emplacement of the Mt. Gilbert pluton, rather than later rapid uplift of both the pluton and metamorphic rocks. The date from the lamprophyre dyke seems to give the age of emplacement of the dyke, and suggests that the dyke may be related to the intrusion of the Mt. Gilbert pluton. In any case, the 56 m.y. ages appear to date the emplacement of the Styx Creek pluton.

GSC 73- 28 Hornblende, K-ar age 44.4 ± 3.2 m.y.

K = 0.387%, $^{40}Ar/^{40}K$ = 0.0026, radiogenic Ar = 35.2%.
Concentrate: Relatively clean, unaltered, pleochroic olive-brown to light green hornblende with a slight trace of biotite and quartz.

From quartz diorite
(93 L) West of Pillar Peak, British Columbia, 54°14'N, 128°00'W. Sample AgD 71-26TD, collected and interpreted by H.W. Tipper.

See GSC 73-29 for description and interpretation.

GSC 73- 29 Biotite, K-Ar age 48.6 ± 2.8 m.y.

K = 7.33%, $^{40}Ar/^{40}K$ = 0.0029, radiogenic Ar = 77.2%.
Concentrate: Clean, fresh, light brown biotite with no visible contamination.

From quartz diorite
(93 L) Details as for GSC 73-28.

The rock is medium-grained mesocratic to leucocratic quartz diorite from a stock on the eastern margin of the Coast Plutonic Complex. The ages obtained are compatible with ages obtained previously along the eastern margin of the Coast Plutonic Complex to the north and south.

GSC 73- 30 Hornblende, K-Ar age 49.9 ± 3 m.y.

K = 0.739%, $^{40}Ar/^{40}K$ = 0.0030, radiogenic Ar = 60.2%.
Concentrate: Pleochroic, light brown to bluish green hornblende with approximately 2% biotite contamination.

From quartz diorite
(93 L) 6.4 km south of Pillar Peak, British Columbia, 54°11'N, 127°54'W. Sample AgD 71-24TD, collected and interpreted by H.W. Tipper.

See GSC 73-31 for description and interpretation.

GSC 73- 31 Biotite, K-Ar age 42.9 ± 2.2 m.y.

K = 7.70%, $^{40}Ar/^{40}K$ = 0.0025, radiogenic Ar = 80.9%.
Concentrate: Greenish biotite with approximately 4% chlorite alteration.

From quartz diorite
(93 L) Details as for GSC 73-30.

The rock is a medium- to coarse-grained, nonporphyritic biotite-hornblende quartz diorite from a stock on the eastern margin of the Coast Plutonic Complex. The ages obtained are compatible with ages obtained previously along the eastern margin of the Coast Plutonic Complex to the north and south.

GSC 73- 32 Biotite, K-Ar age 44.4 ± 2.4 m.y.

K = 7.56%, $^{40}Ar/^{40}K$ = 0.0026, radiogenic Ar = 73.2%.
Concentrate: Light greenish brown biotite with approximately 5% chlorite alteration.

From quartz diorite
(93 L) At head of Serb Creek, Hawson Range, British Columbia, 54°39'N, 127°50'W. Sample AgD 71-25TD, collected and interpreted by H.W. Tipper.

The rock is a coarse- to medium-grained quartz diorite.

The batholith from which the material was obtained is considered from field evidence to be a young body satellitic to the Coast Plutonic belt. The radiometric age supports an early Tertiary age.

GSC 73- 33 Hornblende, K-Ar age 48.9 ± 2.2 m.y.

K = 0.445%, $^{40}Ar/^{40}K$ = 0.0029, radiogenic Ar = 52.3%.
Concentrate: Relatively clean, unaltered, pleochroic olive-brown to bluish green hornblende with a slight trace of biotite and quartz.

From granodiorite
(93 L) 9.7 km north of Top Lake, Telkwa Pass, British Columbia, 54°39'N, 127°41'W. Sample AgD 70-8TD, collected and interpreted by H.W. Tipper.

See GSC 73-34 for description and interpretation.

GSC 73- 34 Biotite, K-Ar age 48.0 ± 2.4 m.y.

K = 7.50%, $^{40}Ar/^{40}K$ = 0.0028, radiogenic Ar = 78.1%.
Concentrate: Clean, fresh, light brown biotite with no visible contamination.

From granodiorite
(93 L) Details as for GSC 73-33.

The rock is a grey, coarse-grained granodiorite.

The intrusion from which this sample was obtained is a satellitic body at the east margin of the Coast Plutonic Complex. The ages obtained are compatible with ages obtained elsewhere on this margin of the Complex.

GSC 73- 35 Hornblende, K-Ar age $\frac{189 \pm 8 \text{ m.y.}}{206 \pm 9 \text{ m.y.}}$

K = 0.360%, $^{40}Ar/^{40}K = \frac{0.0116}{0.0127}$, radiogenic Ar = $\frac{72.5\%}{55\%}$.
Concentrate: Relatively clean, pleochroic, light green to brown hornblende with approximately 5% chlorite alteration.

From altered quartz diorite
(93 L) South side of east end of Talkwa Pass, British Columbia, 54°33'N, 127°42'W. Sample AgD 71-27TD, collected and interpreted by H.W. Tipper.

The sample is a sub-porphyritic to medium-grained quartz diorite from a batholith that intrudes lower Jurassic (upper Sinemurian) volcanic rocks dated paleontologically. The batholith is apparently older than lowest middle Jurassic or highest lower Jurassic and is considered to be genetically related to the upper Sinemurian volcanics it intrudes.

The age proposed by the Geological Society of London for Upper Sinemurian epoch would be about 185 m.y. The two ages determined for this sample are older than the proposed age for Upper Sinemurian but the first determination is within the limits suggested for the determination. The age determination confirms the field interpretation of the age of the batholith and tends to support the contention of a genetic relation to the volcanics.

GSC 73- 36 Biotite, K-Ar age 45.6 ± 3 m.y.

K = 5.75%, $^{40}Ar/^{40}K$ = 0.0027, radiogenic Ar = 70.7%.
Concentrate: Brown biotite with a slight trace of hornblende contamination. Many of the mica flakes have a blistered texture.

From tuff
(93 L) 16 km northeast of Top Falls, Telkwa Pass, British Columbia, 54°39'N, 127° 36'W. Sample AgD 70-9TD, collected and interpreted by H.W. Tipper.

The rock is a grey, plagioclase-biotite volcanic tuff.

From field evidence the tuff is believed to be early Tertiary in age, correlative with the Ootsa Lake Group of Eocene age. The radiometric age confirms this.

GSC 73- 37 Hornblende, K-Ar age 45.3 ± 2.7 m.y.

K = 0.671%, $^{40}Ar/^{40}K$ = 0.0027, radiogenic Ar = 67.7%.
Concentrate: Clean, unaltered, pleochroic, light brown to dark brown hornblende with no visible impurities.

From hornblende-feldspar porphyry
(93 L) 12.9 km north of Saturday Lake, British Columbia, 54°56'N, 126°26'W. Sample AgD 70-21TD, collected and interpreted by H.W. Tipper.

The material dated is from a small stock that intrudes early Tertiary volcanic rocks correlative (?) with the Ootsa Lake Group and possibly is genetically related. The radiometric age obtained confirms this early Tertiary age.

GSC 73- 38 Hornblende, K-Ar age 173 ± 8 m.y.

K = 0.821%, $^{40}Ar/^{40}K$ = 0.0159, radiogenic Ar = 78.5%.
Concentrate: Clean, unaltered, pleochroic, brown to dark green hornblende with no visible contamination.

From tuff
(93 L) 6.4 km south of mouth of Howson Creek, British Columbia, 54°35'N, 127°21'W. Sample AgD 70-7TD, collected and interpreted by H.W. Tipper.

The rock is a grey, medium-grained, feldspar-hornblende tuff from a bed of volcanic tuff in the Lower Jurassic part of the Hazelton Group. Paleontologically the rocks are dated as Upper Sinemurian in age and the radiometric age tends to support the paleontology.

GSC 73- 39 Hornblende, K-Ar age 49.0 ± 3 m.y.

K = 0.661%, $^{40}Ar/^{40}K$ = 0.0029, radiogenic Ar = 54.2%.
Concentrate: Clean, slightly pleochroic, light brownish green hornblende with no visible contamination.

From hornblende-feldspar porphyry
(93 L) 6.4 km northwest of Saturday Lake, British Columbia, 54°54'N, 126°26'W. Sample AgD 70-1TD, collected and interpreted by H.W. Tipper.

See GSC 73-40 for description and interpretation.

GSC 73- 40 Biotite, K-Ar age 48.9 ± 3 m.y.

K = 6.49%, $^{40}Ar/^{40}K$ = 0.0029, radiogenic Ar = 77.1%.
Concentrate: Clean, unaltered, brown biotite with no visible contamination.

From hornblende-feldspar porphyry
(93 L) Details as for GSC 73-39.

The rock is a grey, medium-grained, hornblende-biotite-feldspar porphyry from a small stock intruding Lower Jurassic Hazelton Group sediments. This and similar stocks in the area are considreed to be genetically related to early Tertiary (Eocene) acidic volcanic rocks. The age determination would support this relationship.

GSC 73- 41 Biotite, K-Ar age 54.9 ± 2.4 m.y.

K = 7.76%, $^{40}Ar/^{40}K$ = 0.0033, radiogenic Ar = 76%.
Concentrate: Brownish coloured biotite with approximately 5% chlorite alteration.

From quartz diorite
(93 L) 4.8 km east of Goosly Lake, British Columbia, 54°10'N, 126°18'W. Sample AgD 70-20TD, collected and interpreted by H.W. Tipper.

The sample is from a medium-grained quartz diorite stock which intrudes Lower Cretaceous sediments and volcanics and is considered on field evidence to be of early Tertiary age. The radiometric age corroborates this.

GSC 73- 42 Biotite, K-Ar age 44 ± 2 m.y.

K = 7.38%, $^{40}Ar/^{40}K$ = 0.0026, radiogenic Ar = 76.7%.
Concentrate: Clean, fresh, orange coloured biotite with no visible contamination.

From quartz diorite
(93 L) At fire lookout, 6.4 km east of Goosly Lake, British Columbia, 54°10'N, 126° 16'W. Sample AgD 70-18TD, collected and interpreted by H.W. Tipper.

The rock is medium-grained, dull grey quartz diorite from a small pluton intruding early Tertiary volcanics. The radiometric age is compatible with field evidence and corroborates ages on nearby plutons.

GSC 73- 43 Biotite, K-Ar age 44.3 ± 2 m.y.

K = 6.99%, $^{40}Ar/^{40}K$ = 0.0026, radiogenic Ar = 81.2%.
Concentrate: Clean, fresh, olive-brown biotite with no visible contamination.

From plagioclase-biotite porphyry
(93 L) Bear Island, Babine Lake, British Columbia, 54°56'N, 126°15'W. Sample AgD 70-17TD, collected and interpreted by H.W. Tipper.

The rock is a buff-grey, plagioclase-biotite porphyry.

The stock from which the material was obtained is similar to other stocks and plugs in the area (Babine Feldspar Porphyries) that are considered on field evidence and radiometric ages by other laboratories to be of early Tertiary age. This radiometric age confirms a early Tertiary age.

GSC 73- 44 Hornblende, K-Ar age 195 ± 8 m.y.

K = 0.493%, $^{40}Ar/^{40}K$ = 0.0120, radiogenic Ar = 82.4%.
Concentrate: Clean, unaltered, pleochroic, brown to bluish green hornblende with a very slight trace of chlorite contamination.

From quartz monzonite
(93 L) South of Mahtzehtzel Mt., British Columbia, 54°36'N, 126°08'W. Sample AgD 71-30TD, collected and interpreted by H.W. Tipper.

The rock is a medium- to coarse-grained quartz monzonite phase of the Topley Intrusions which cut Lower Jurassic (Upper Sinemurian) volcanic rocks to which they are thought to be genetically related. The age determination confirms an early Jurassic (quite possibly Sinemurian) age for the intrusions.

GSC 73- 45 Hornblende, K-Ar age 205 ± 9 m.y.

K = 0.547%, $^{40}Ar/^{40}K$ = 0.0127, radiogenic Ar = 83.4%.
Concentrate: Clean, unaltered, pleochroic, brown to light green hornblende with no visible contamination.

From porphyritic monzonite
(93 L) Small island 8 km north of Topley Landing, British Columbia, 54°52'N, 126°07'W. Sample AgD 70-13TD, collected and interpreted by H.W. Tipper.

The rock is a very coarse grained, slightly foliated, porphyritic monzonite from a phase of the Topley Intrusions which intrudes Hazelton Group volcanics of Lower Jurassic (Upper Sinemurian) age. The age determination, 205 ± 9 m.y., suggests an Upper Triassic age but based on field observations this is too old. Either the assumed age for Upper Sinemurian rocks is incorrect or the age determination is incorrect for unexplained reasons. However, the age determination confirms that the Topley Intrusions are at least Lower Jurassic in age.

GSC 73- 46 Hornblende, K-Ar age $\frac{64.7 \pm 2.4 \text{ m.y.}}{64.9 \pm 2.2 \text{ m.y.}}$.

K = 0.729%, $^{40}Ar/^{40}K = \frac{0.00385}{0.00386}$, radiogenic Ar = $\frac{62.2\%}{71.6\%}$.
Concentrate: Clean, pleochroic olive-brown to bluish green hornblende with no visible alteration or contamination.

From garnet amphibolite
(94 C) Ridge-crest, Butler Range, Omineca Mountains, British Columbia, 56°22'N, 124°39'W. Sample GACa 70-143-3, collected by K.V. Campbell and interpreted by H. Gabrielse.

The rock is a homogeneous, melanocratic garnet amphibolite of medium to coarse grain consisting of about 60% amphibole, 15% plagioclase An_{40}, 15% quartz and 10% garnet. For further discussion and interpretation *see* summary following GSC 73-50.

GSC 73- 47 Hornblende, K-Ar age $\frac{53.9 \pm 3 \text{ m.y.}}{53.7 \pm 2.4 \text{ m.y.}}$.

K = 1.52%, $^{40}Ar/^{40}K = \frac{0.00320}{0.00319}$, radiogenic Ar = $\frac{76\%}{80.7\%}$.
Concentrate: Fresh, pleochroic olive-green to bluish green hornblende with approximately 10% free chlorite contamination.

From schistose amphibolite
(94 C) Ridge-crest, Butler Range, Omineca Mountains, British Columbia, 56°22'N, 124°39'W. Sample GACa 70-143-2, collected by K.V. Campbell and interpreted by H. Gabrielse.

See GSC 73-48 for description and GSC 73-50 for interpretation.

GSC 73- 48 Biotite, K-Ar age 40.5 ± 2.2 m.y.

K = 7.31%, $^{40}Ar/^{40}K$ = 0.0024, radiogenic Ar = 82.9%.
Concentrate: Fresh, unaltered brownish biotite with approximately 10% free chlorite contamination.

From schistose amphibolite
(94 C) Details as for GSC 73-47.

The rock is a mesocratic to melanocratic, medium-grained, homogeneous schistose amphibolite containing a few scattered poikiloblastic garnets. It contains about 40% amphibole, 25% biotite, 10 - 15% sodic andesine and 15 - 30% quartz. For further discussion and interpretation *see* GSC 73-50.

GSC 73- 49 Hornblende, K-Ar age $\frac{45.4 \pm 1.9 \text{ m.y.}}{47.9 \pm 2.0 \text{ m.y.}}$.

K = 0.477%, $^{40}Ar/^{40}K = \frac{0.00269}{0.00284}$, radiogenic Ar = $\frac{37.7\%}{31.9\%}$.
Concentrate: Fresh, unaltered, pleochroic blue-green to olive-green hornblende with approximately 2% free biotite contamination.

From schist/amphibolite
(94 C) Ridge-crest south of Ivor Creek, northern Rocky Mountains, British Columbia, 56°52½'N, 124°48'W. Sample GACa 70-144-2, collected by K.V. Campbell and interpreted by H. Gabrielse.

See GSC 73-50 for description and interpretation.

GSC 73- 50 Biotite, K-Ar age 40.8 ± 1.9 m.y.

K = 7.48%, $^{40}Ar/^{40}K$ = 0.00241, radiogenic Ar = 69%.
Concentrate: Light brown biotite with approximately 8% chloritization.

From schist/amphibolite
(94 C) Details as for GSC 73-49.

The rock is a melanocratic biotite-quartz amphibole schist or amphibole of fine grain containing 25-40% poikilitic amphibole, 10-15% biotite, and 20-25% quartz.

The samples listed below were obtained from regionally metamorphosed terranes in Omineca and northern Rocky Mountains flanking northern Rocky Mountain Trench. These terranes, comprising the Ingenika Group west of the Trench and the Missinchinka Group to the east consist of variably metamorphosed Upper Proterozoic, mainly clastic rocks.

The ages are similar to those previously obtained for regionally metamorphosed rocks, pegmatites and small granitic bodies within the Wolverine Complex and Ingenika Group (*see* discussion by Muller in Geol. Surv. Can., Paper 71-2). It now seems clear that these ages reflect a major episode of block faulting accompanied by local volcanism and high-level granitic intrusion. They clearly post-date regional metamorphism as determined by stratigraphic and structural means.

Summary of K-Ar age determination data

Sample No.	Mineral	Age (m.y.)
GSC 73-46	Hornblende	64.7 ± 2.4 64.9 ± 2.2
GSC 73-47	Hornblende	53.9 ± 3 53.7 ± 2.4
GSC 73-48	Biotite	40.5 ± 2.2
GSC 73-49	Hornblende	45.4 ± 1.9 47.9 ± 2.0
GSC 73-50	Biotite	40.8 ± 1.9

GSC 73- 51 Biotite, K-Ar age 86.8 ± 3.3 m.y.

K = 8.10%, $^{40}Ar/^{40}K$ = 0.0052, radiogenic Ar = 81.7%.
Concentrate: Clean, fresh, light green biotite with no visible alteration or contamination.

From granodiorite
(94 E) Thudaka Range, 6.4 km due west of north end of Oboe Lake, British Columbia, 58° 00'N, 126°48'W. *See* Toodoggone River E½ map (in prep.). Sample GAD-71-47, collected by C.J. Dodds and interpreted by H. Gabrielse.

See GSC 73-52 for description and interpretation.

GSC 73- 52 Muscovite, K-Ar age 88.4 ± 4.2 m.y.

K = 9.00%, $^{40}Ar/^{40}K$ = 0.0053, radiogenic Ar = 74.2%.
Concentrate: Clean, fresh, clear muscovite with no visible alteration or contamination.

From granodiorite
(94 E) Details as for GSC 73-51.

The sample of megacrystic, muscovite-biotite granodiorite is considered to be typical of the eastern part of the Pitman Batholith. The granitic rock is comparable to that of parts of the Cassiar Batholith farther northwest, particularly the border phases which are also cataclastic in many places. The ages are generally consistent with those obtained from similar granitic rocks in the Cassiar region.

GSC 73- 53 Muscovite, K-Ar age 94.9 ± 3.5 m.y.

K = 8.47%, $^{40}Ar/^{40}K$ = 0.0057, radiogenic Ar = 80.7%.
Concentrate: Clean, fresh, mainly clear muscovite with no visible impurities, but with yellow stain on a few of the mica flakes.

From quartz monzonite
(94 F) 4.8 km west-northwest of Prairie Mt., south end of Cormier Range, British Columbia, 57°27'N, 125°47'W. Sample GA-71-41(a), collected and interpreted by H. Gabrielse.

See GSC 73-54 for description and interpretation.

GSC 73- 54 Muscovite, K-Ar age 104 ± 4 m.y.

K = 8.41%, $^{40}Ar/^{40}K$ = 0.0063, radiogenic Ar = 76.5%.
Concentrate: Relatively clean, clear muscovite with approximately 4% chlorite contamination.

From quartz monzonite
(94 F) 4.8 km west-northwest of Prairie Mt., south end of Cormier Range, British Columbia, 57°27'N, 125°47'W. Sample GA-71-41(b), collected and interpreted by H. Gabrielse.

The samples are from boulders of muscovite-quartz monzonite that occur in basalt conglomerate of the Sifton Formation. The ages of about 95 and 104 m.y. thus give a maximum age of the Sifton Formation in this area.

GSC 73- 55 Biotite, K-Ar age 49.0 ± 2.3 m.y.

K = 7.79%, $^{40}Ar/^{40}K$ = 0.0029, radiogenic Ar = 60.4%.
Concentrate: Clean, fresh, light orange biotite with no visible impurities or alteration.

From lamprophyre
(94 F) Just above north bank of Finlay River, approximately 8 km upstream from Ware, British Columbia, 57°25'N, 125°47'W. Sample GA-71-92A, collected and interpreted by H. Gabrielse.

See GSC 73-56 for description and interpretation.

GSC 73- 56 Biotite, K-Ar age 37 ± 2.2 m.y.

K = 7.71%, $^{40}Ar/^{40}K$ = 0.0022, radiogenic Ar = 64.9%.
Concentrate: Clean, fresh, reddish orange biotite with no visible alteration or contamination.

From lamprophyre
(94 F) North side of Finlay River, about 14.5 km west-northwest of Ware, British Columbia, 57°27'N, 125°52'W. Sample GAD 71-48, collected by C.J. Dodds and interpreted by H. Gabrielse.

The rock, a dark greenish grey lamprophyre (minette), is typical of many dykes that cut Upper Cretaceous - Lower Tertiary rocks of the Sifton Formation. The age is therefore consistent with field data and provides a minimum age for at least the lower part of the Sifton Formation.

GSC 73- 57 Hornblende, K-Ar age 341 ± 14 m.y.

K = 0.510%, $^{40}Ar/^{40}K$ = 0.0219, radiogenic Ar = 87.4%.
Concentrate: Relatively clean, unaltered, pleochroic, yellow-brown to green hornblende with trace impurities of chlorite and quartz.

From granite
(117 A) Mt. Sedgwick, Yukon Territory, 68° 50.6'N, 139°04'W. N.A.P.L. vertical air photograph A13470-156; co-ordinates (Norris, 1972): X = +1.99 cm, Y = -0.35 cm. Map-unit A, Geol. Surv. Can. Map 10-1963. Sample 525NC, collected and interpreted by D.K. Norris.

See GSC 73-58 for description and interpretation.

GSC 73- 58 Biotite, K-Ar age 312 ± 11 m.y.

K = 7.28%, $^{40}Ar/^{40}K$ = 0.0199, radiogenic Ar = 95.8%.
Concentrate: Light brown biotite with approximately 10% chlorite alteration.

From granite
(117 A) Details as for GSC 73-57.

The rock from which the mineral concentrates were obtained is a light grey, coarse-grained biotite - hornblende granite with occasional feldspar phenocrysts up to 1 cm long.

The Mt. Sedgwick stock occurs near the southeastern extremity of Romanzof Uplift (Norris, 1973) in the northernmost part of the Cordilleran Orogenic System in Canada. It intrudes highly deformed slaty argillites, quartzites and limestones of the Precambrian (?) Neruokpuk Formation. The northeasterly transgressive Mississippian and Pennsylvanian Kekiktuk and Kayak Formations, and Lisburne Group (Bamber and Waterhouse, 1973) overlie the Neruokpuk with spectacular angular unconformity, as seen for example on the left bank of the lower Malcolm River (Norris, 1973). Locally the Kekiktuk appears to be in depositional contact with the granite. Thus a minimum age for the intrusion (and for the deformation of the Neruokpuk) should be the age of the Kekiktuk (∿330 m.y.).

The Mt. Sedgwick stock is one of a suite of acid igneous intrusions known to occur in northern Yukon Territory and adjacent Alaska. The ages of these intrusions and their timing relative to the deformation of their host rock are of fundamental importance to a meaningful interpretation of the geological history of the northern Cordillera. The fact that the stocks are numerous, that they are individually of small areal extent, that they appear to be only mildly deformed, and that their host is of very low grade (greenschist facies) metamorphism would suggest that they were intruded after the principal deformation of the Neruokpuk Formation.

Published radiometric ages for the Mt. Sedgwick stock range from 95 m.y. (Baadsgaard *et al.*, 1961) to 355 m.y. (Wanless *et al.*, 1964), and for the suite from 95 m.y. (Baadsgaard *et al.*, 1961) to 431 m.y. (Reiser, 1970). Thus the hornblende and biotite radiometric ages of 341 and 312 m.y., respectively, in this latest sample favour an older rather than a younger age within these ranges. The hornblende number, moreover, is compatible with the age of and contact relations with the Kekiktuk Formation.

Compounding the difficulties of interpretation because of poor exposure is the hydrothermal alteration of the granite bodies. All are altered to varying degrees. Yellow stain of the fresh surface is common, and chloritization and sericitization is abundant in thin section. If these stocks in northern Yukon Territory and northeastern Alaska form a genetically related, coeval suite, however, the writer favours the value of 431 m.y. for the Romanzof Granite (Reiser, 1970) as the minimum age of these intrusions. Thus they may be no younger than Ordovician, and the age and principal deformation of their host, the Neruokpuk Formation (sensu stricto) (Leffingwell, 1919), is correspondingly older, perhaps even Precambrian (Norris, 1973).

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GSC 73- 59 Muscovite, K-Ar age 108 ± 4 m.y.

K = 6.44%, $^{40}Ar/^{40}K$ = 0.0065, radiogenic Ar = 83%.
Concentrate: Relatively clean, clear muscovite with approximately 5% chlorite and a trace of quartz impurity.

From schist
(105 B) On Little Moose River, 11.3 km north-northeast of east end of Meister Lake, Yukon Territory, 60°25'00"N, 130°15'30"W. Map-unit 1a, Geol. Surv. Can. Map 10-1960. Sample 5-2-7/F-PB, collected by W. H. Fritz and interpreted by W. H. Poole.

See GSC 73-60 for description and GSC 73-63 for interpretation.

GSC 73- 60 Biotite, K-Ar age 92 ± 6 m.y.

K = 6.93%, $^{40}Ar/^{40}K$ = 0.0055, radiogenic Ar = 79%.
Concentrate: Impure, altered, light brownish orange biotite with about 25% chloritic alteration products and about 2% muscovite impurity.

From schist
(105 B) Details as for GSC 73-59.

The biotite and muscovite concentrates were prepared from a light brown-grey, garnetiferous muscovite-biotite schist of medium grain size. In thin section, the quartz is slightly strained and both biotite and muscovite are fresh and undeformed.

See GSC 73-63 for interpretation.

GSC 73- 61 Muscovite, K-Ar age 78 ± 4 m.y.

K = 9.40%, $^{40}Ar/^{40}K$ = 0.0047, radiogenic Ar = 73%.
Concentrate: Relatively clean, clear muscovite with about 5% chlorite impurity. Some of the mica flakes are slightly yellow stained.

From gneiss
(105 B) Ridge-top, 17.7 km north-northwest of west end of Meister Lake, Yukon Territory, 60°29'00"N, 130°30'00"W. Map-unit 1c, Geol. Surv. Can. Map 10-1960. Sample 5-7-5/F-PB, collected by W. H. Fritz and interpreted by W. H. Poole.

See GSC 73-62 for description and GSC 73-63 for interpretation.

GSC 73- 62 Biotite, K-Ar age 144 ± 8 m.y.

K = 6.95%, $^{40}Ar/^{40}K$ = 0.0088, radiogenic Ar = 80%.
Concentrate: Brownish orange biotite with approximately 10% chlorite alteration.

From schist
(105 B) Details as for GSC 73-61.

The biotite and muscovite concentrates were prepared from a light brown-grey, medium-grained mica-quartz schist. In thin section, about 75% of the rock is quartz (anhedral, slightly strained). Nearly 10% is feldspar and about 1% garnet porphyroblasts. Muscovite and biotite each make up less than 10% of the rock; the muscovite is fresh, straight and 1 to 3 mm in diameter, while the biotite is red-brown, fresh, clear, unaltered and in part intergrown with muscovite.

See GSC 73-63 for interpretation.

GSC 73- 63 Muscovite, K-Ar age 73 ± 3 m.y.

K = 8.23%, $^{40}Ar/^{40}K$ = 0.0044, radiogenic Ar = 75%.
Concentrate: Clean, mostly clear muscovite with some slight yellow staining.

From pegmatite
(105 B) Ridge crest 21 km due south of mouth of Cabin Creek, Yukon Territory, 60°32'30"N, 130°16'00"W. Map-unit 1c, Geol. Surv. Can. Map 10-1960. Sample 5-9-3/C-PB, collected by R. L. Christie and interpreted by W. H. Poole.

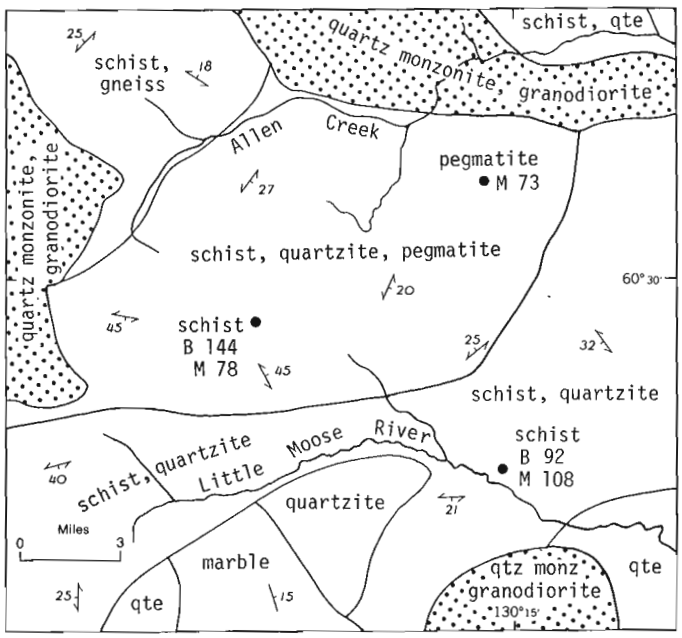

Figure 3. K-Ar dates and generalized geology, east-central Wolf Lake map-area, Yukon Territory. Geology from Geological Survey of Canada Map 10-1960.

The pegmatite is white and very coarse grained with perthite crystals as much as several inches across. Quartz and plagioclase (albite-oligoclase) are minor; quartz in thin section is coarsely mortared and slightly strained. About 5% of the thin section studied consists of muscovite in very coarse crystals, some of them bent on kink bands. Biotite and sericite each make up less than one per cent of the rock.

These five K-Ar dates were obtained in an attempt to determine the age of regional metamorphism and accompanying pegmatite emplacement in several hundred square miles of east-central Wolf Lake map-area (Poole *et al.*, 1960). The metamorphic terrane lies along the northern and eastern edges of the northern end of the Cassiar Batholith. In east-central Wolf Lake map-area, from where these samples came (Fig. 3), the metamorphic terrane bulges eastward to the Liard River across the regional northwest trend. The protolith of the metamorphic rocks is almost assuredly Lower Cambrian quartzite and slate. The Cassiar Batholith and associated intrusions to the east were emplaced during the Cretaceous.

The five dates range from Late Jurassic to Late Cretaceous, at the outside extremes from 73 to 144 m.y. A much closer grouping was expected because only the one metamorphic episode has been identified. The biotite dates of 92 and 144, plus a biotite date on schist of 98 m.y. (GSC 60-30 *in* Geol. Surv. Can., Paper 61-17, p. 17-18) collected within the same terrane roughly 24 km to the northwest, suggest that the 144 m.y. date is anomalously high for unknown reasons, and the correct date lies in the 90-100 m.y. range, i.e. mid-Cretaceous or early late Cretaceous. The three muscovite dates, on the other hand, seem not to support this conclusion. The dates on the zone of schist, quartzite and pegmatite of 78 and 73 m.y. are concordant but the schist outside and to the southeast of this zone yielded 108 m.y. This last date could be regarded as anomalously high, and accordingly a muscovite date in the 70-80 m.y. range is accepted as the "best". Thus at the end of the analysis, we have a best guess of 90-100 m.y. biotites in the same terrane as "younger" 70-80 m.y. muscovites. Hardly a reasonable model.

Several explanations are possible to account for the scatter of the dates. Perhaps the metamorphism in the terrane is not a single event of uniform origin and age as supposed. Perhaps, if these K-Ar dates are "uplift" dates, the rate of uplift (and cooling) differed from place to place. The pattern of dates does not support this model; within the area of Figure 3, biotite dates increase northeasterly and muscovite dates increase southeasterly. Perhaps one or two of the dates has greater than expected analytical error, e.g. the biotite dates of 144 m.y. (GSC 73-62) and muscovite date of 108 m.y. (GSC 73-59). These possibilities cannot be appraised satisfactorily. In short, no clear explanation of the scatter of dates is apparent. The granites surely have not caused the regional metamorphism and are younger. The metamorphism could indeed be early Mesozoic, and the K-Ar dates reflect uplift in mid-Cretaceous.

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GSC 73- 64 Biotite, K-Ar age 345 ± 15 m.y.

K = 7.85%, $^{40}Ar/^{40}K$ = 0.0222, radiogenic Ar = 94%.
Concentrate: Relatively pure, greenish brown biotite with less than 10% free chlorite contamination. Some of the mica flakes have split edges.

From quartz monzonite
(340 F) On coast, 14.5 km southeast of Cape Woods, northern Ellesmere Island, District of Franklin, 82°09'N, 86°25'W. Map-unit Aa, Geol. Surv. Can. Map 16-1956. Sample CBF-66-251, collected and interpreted by T. Frisch.

The biotite comes from a little-deformed rock of the Phillips Inlet intrusion, a quartz monzonitic stock (Frisch, in press). The rock has a generally granitic texture but large perthite crystals (3 to 10 mm) are commonly bordered by fine-grained, myrmekite-rich material, which may have recrystallized after crushing during a late stage of crystallization. Biotite is abundant and rather fresh, being only locally altered to chlorite.

This date agrees, within error limits, with that obtained on biotite (GSC 63-22) from gneissic, intrusive granitic rock on the north shore of Phillips Inlet, 16 km southeast of the present locality (Wanless *et al.*, 1965, p. 27). Although this intrusion is much larger and, aside from marginal cataclasis, undeformed, the age determined indicates that it does not appear to post-date the several smaller, foliate intrusions mapped by Trettin (1971) in the Phillips Inlet area. While not necessarily indicating the age of intrusion, this determination strongly suggests emplacement of the Phillips Inlet stock in Middle or Late Devonian time, probably coeval with regional metamorphism in this part of northwestern Ellesmere Island (Trettin, 1971). In other areas of Ellesmere, major regional plutonism, both acid and basic, occurred in the Early Devonian, according to K-Ar determinations on biotite (Frisch, 1974).

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GSC 73- 65 Biotite, K-Ar age $\frac{177 \pm 8 \text{ m.y.}}{189 \pm 9 \text{ m.y.}}$

K = 7.67%, $^{40}Ar/^{40}K = \frac{0.0109}{0.0116}$, radiogenic Ar = $\frac{90\%}{88\%}$.
Concentrate: Relatively pure, light brown biotite with less than 5% chlorite as flake edge alteration. A trace of quartz is present as an impurity.

From augen gneiss
(340 F) 14.5 km south of Hansen Point, northern Ellesmere Island, District of Franklin, 82°24'N, 82°35'W. Map-unit 1, Geol. Surv. Can. Map 16-1956. Sample CBF-66-249, collected and interpreted by T. Frisch.

The biotite is from a well-foliated, granitic augen gneiss with biotite and muscovite. The augen are of both plagioclase and microcline perthite. The biotite is pale yellow to dark brown and fairly fresh but is in places intergrown with sphene and epidote and altered along cleavages to an isotropic material. The muscovite appears to be an alteration product of biotite. The augen gneiss is a major rock-type in the amphibolite-facies metamorphic complex exposed along the eastern shore of Yelverton Inlet.

Both determinations were made on the same concentrate at two different times (1968 and 1971). The Jurassic date obtained is exceedingly difficult to interpret, as geological evidence clearly indicates no metamorphism younger than Devonian or Mississippian in northern Ellesmere Island. Apparently, severe argon loss has occurred, due to unknown causes.

GSC 73- 66 Biotite, K-Ar age 1623 ± 40 m.y.

K = 7.55%, $^{40}Ar/^{40}K$ = 0.1506, radiogenic Ar = 98.9%.
Concentrate: Clean, fresh and unaltered, light brownish olive biotite with no visible contamination.

From gneiss
(37 B) Drillhole, Rowley Island airstrip, District of Franklin, 69°03'58.48"N, 79°03'48.32"W. Sample M-0-4, collected and interpreted by H.P. Trettin.

The specimen is from the bottom of a diamond-drill hole (Aquitaine *et al.* Rowley M-04 well) at the airstrip of a former DEW site on Rowley Island in the structurally deeper part of Foxe Basin. This drillhole, which was cored from 123 m to the bottom, penetrates 512 m of Silurian, Ordovician, and possibly Cambrian strata and 20 m of underlying Precambrian biotite gneiss. The upper 9 m or so of the Precambrian core is visibly altered, but in the remaining parts alteration is more subtle. The rock analyzed consists mainly of quartz, K-feldspar, plagioclase (probably calcic oligoclase), and biotite, with minor amounts of muscovite, sericite, epidote, and zircon. Myrmekitic and perthitic intergrowths are common. The biotite is mostly fresh but altered, to a minor extent, by chlorite. Sericite and epidote alteration are common in the plagioclase.

The age determination (1623 ± 40 m.y.) conforms with other apparent ages from the Churchill Province and suggests recrystallization or argon-loss during the "Hudsonian orogeny". The relatively young age within the broad group of "Hudsonian" K-Ar ages may be due to a moderate amount of alteration related to weathering at the sub-Paleozoic nonconformity.

GSC 73- 67 Actinolite, K-Ar age 438 ± 20 m.y.

K = 0.59%, $^{40}Ar/^{40}K$ = 0.0288, radiogenic Ar = 77%.
Concentrate: Relatively clean, faintly pleochroic, light green actinolite occurring as long prismatic crystals. There is about 2% biotite impurity in the sample.

From amphibolite
(37 G) Between Fish and McOuat lakes, No. 4 Deposit area of Mary River region, Baffin Island, District of Franklin, 71°27'N, 79°54'W. Sample JD-24B-1965, collected and interpreted by G.D. Jackson.

The sample is amphibolite from the central part of a pillow in a metamorphosed mafic flow overlying iron-formation of the Mary River Group (Jackson, 1966; Jackson and Taylor, 1970). The sample was taken a few hundred feet south by east from sample JD-323-1965 (GSC 67-61) for which K-Ar ages of 1005 ± 40 m.y. and 963 ± 39 m.y. were determined for the contained hornblende (Jackson, 1970).

Both sample JD-24B and JD-323 are from the same formation, which is of pre-Hudsonian age. Samples of metamorphosed sedimentary and volcanic rocks of the Mary River Group yielded an Rb-Sr isochron age of about 1900 m.y. (*See* discussion of Fryer's work in Jackson and Taylor, op. cit.).

A large diabase dyke dated at 566 m.y. (GSC 67-59) outcrops within 200 feet of the sample location. This dyke follows a major break at this locality, known as the Central Borden Fault zone, along which lower Paleozoic strata have been displaced during recurrent movement. Tourmaline-rich dykelets and highly leached iron-formation in the area suggest that thermal activity related to the diabase emplacement may have extended for some distance from the dyke boundaries. The K-Ar clock for sample JD-24B was probably re-set during the dyke emplacement, whereas the K-Ar clock for sample JD-323, for which an older age was determined, was only partially re-set.

References

Jackson, G.D.
1966: Geology and mineral possibilities of the Mary River region, northern Baffin Island; Can. Min. J., v. 87, p. 57-61.

1970: G.S.C. 67-61, *in* Age determinations and geological studies by R.K. Wanless, R.D. Stevens, G.R. Lachance and R.N. Delabio; Geol. Surv. Can., Paper 69-2A, p. 35.

Jackson, G.D. and Taylor, F.C.
1972: Correlation of major Aphebian rock units in the northern Canadian Shield; Can. J. Earth Sci., v. 9, no. 12, p. 1650-1669.

GSC 73- 68 Biotite, K-Ar age 1710 ± 52 m.y.

K = 8.23%, $^{40}Ar/^{40}K$ = 0.1627, radiogenic Ar = 99%.
Concentrate: Light orange coloured biotite of somewhat variable colour intensity. No impurities were detected. Some of the mica flakes have split edges.

From mafic band in granitoid gneiss
(38 B) About 6.4 km north of the southern side of Bylot Island, District of Franklin, 72° 58'N, 77°17'W. Sample JD-183/2-68, collected and interpreted by G.D. Jackson.

The sample is from a metamorphosed mafic sill within layered migmatites in granulite facies terrain (*see* Geol. Surv. Can., Paper 74-25, in press). The rock is dark greenish black, massive, medium-grained and equigranular. It contains 40% labradorite, 35% clinopyroxene, 15% hypersthene, 9% reddish-brown biotite and small amounts of magnetite, apatite, brownish green hornblende and zircon. The biotite is typical of that found in many granulite terrains, but has crystallized later than the pyroxenes and hornblende, possibly when metamorphism began to wane. The age obtained is considered to be a minimum age for the last major metamorphic event at the close of Aphebian time.

GSC 73- 69 Whole-rock, K-Ar age $\frac{487 \pm 25 \text{ m.y.}}{492 \pm 19 \text{ m.y.}}$

K = 0.629%, $^{40}Ar/^{40}K = \frac{0.0325}{0.0329}$, radiogenic Ar = $\frac{44.0\%}{55.0\%}$.
Concentrate: Crushed whole-rock.

From gabbro
(48 A) Northern Baffin Island, District of Franklin, 73°02'N, 85°05'W. Map-unit 9, Geol. Surv. Can. Map 55-6. Sample R-31-4/2-1954, collected by R.G. Blackadar and interpreted by G.D. Jackson.

See GSC 73-70 for description and interpretation.

GSC 73- 70 Whole-rock, K-Ar age $\frac{549 \pm 26 \text{ m.y.}}{546 \pm 26 \text{ m.y.}}$

K = 0.62%, $^{40}Ar/^{40}K = \frac{0.0373}{0.0370}$, radiogenic Ar = $\frac{71\%}{72\%}$.
Concentrate: Crushed whole-rock.

From gabbro
(48 C) Northern Baffin Island, District of Franklin, 73°02'N, 85°05'W. Map-unit 9, Geol. Surv. Can. Map 55-6. Sample R-31-4-1954, collected by R.G. Blackadar and interpreted by G.D. Jackson.

The sample is dark, mottled, medium-grained massive gabbro from the central zone of a gabbro dyke. It contains plagioclase, clinopyroxene, olivine, magnetite-ilmenite, micrographic quartz-feldspar intergrowth, hornblende, biotite, apatite and a trace of chlorite.

This sample is from a dyke that probably belongs to the Franklin swarm (Fahrig, 1971). It was originally dated at 1140 m.y. about 10 years ago (Fahrig, 1965). Sample GSC 73-69 is from the same dyke at the same locality. Because the new dates for these two samples are reproducible, it is suggested that the 1140 m.y. age be dropped. The reason for the difference is not known, but there may have been undetected excess argon in the earlier analysis. The differences in the ages recently determined for the two samples may reflect a chemical inhomogeneity of the dyke. The new ages may be somewhat too young for the age of intrusion because dykes are not known to intrude the lower Paleozoic strata in this region.

References

Fahrig, W.F.
1965: G.S.C. 63-20; *in* Age determinations and geological studies by R.K. Wanless, R.D. Stevens, G.R. Lachance and J.Y.H. Rimsaite; Geol. Surv. Can., Paper 64-17, Part 1, p. 25.

Fahrig, W.F., Irving, E. and Jackson, G.D.
1971: Paleomagnetism of the Franklin diabases; Can. J. Earth Sci., v. 8, no. 4, p. 455-467.

GSC 73- 71 Whole-rock, K-Ar age 522 ± 65 m.y.

K = 0.296%, $^{40}Ar/^{40}K = 0.0352$, radiogenic Ar = 16.7%.
Concentrate: Crushed whole-rock.

From gabbro
(37 A) Baffin Island, District of Franklin, 73° 02'N, 85°05'W. Map-unit 9, Geol. Surv. Can. Map 55-6. Sample R-31-40/2-1954, collected by R.G. Blackadar and interpreted by G.D. Jackson.

See GSC 73-72 for description and interpretation.

GSC 73- 72 Whole-rock, K-Ar age $\frac{674 \pm 30 \text{ m.y.}}{661 \pm 30 \text{ m.y.}}$

K = 0.34%, $^{40}Ar/^{40}K = \frac{0.0474}{0.0463}$, radiogenic Ar = $\frac{76\%}{74\%}$.
Concentrate: Crushed whole-rock.

From gabbro
(48 C) Northern Baffin Island, District of Franklin, 73°02'N, 85°05'W. Map-unit 9, Geol. Surv. Can. Map 55-6. Sample R-31-40-1954, collected by R.G. Blackadar and interpreted by G.D. Jackson.

Samples GSC 73-71 and GSC 73-72 are dark greenish black fine-grained equigranular massive gabbro. They contain plagioclase, clinopyroxene, magnetite-ilmenite, hornblende, biotite, olivine and a trace of chlorite.

They are from near the contact of a 122-m-wide dyke that occurs at the same locality as the dyke from which samples GSC 73-69 and GSC 73-70 were obtained. Sample 73-72 was originally dated at 915 m.y. (GSC 63-19). This old date should be dropped in favour of

the more recent dates which probably approximate the age of intrusion and suggest that this dyke is part of the Franklin Swarm (Fahrig *et al.*, 1971). The different ages obtained for the two samples may reflect inhomogeneities in the dyke composition.

Reference

Fahrig, W. F., Irving, E. and Jackson, G. D.
1971: Paleomagnetism of the Franklin diabases; Can. J. Earth Sci., v. 8, no. 4, p. 455-467.

GSC 73- 73 Biotite, K-Ar age 1696 ± 42 m.y.

K = 7.80%, $^{40}Ar/^{40}K$ = 0.1609, radiogenic Ar = 99.4%.
Concentrate: Clean, fresh, unaltered, light greenish biotite with no visible contamination.
From gneiss
(26 B) 6.4 km east of Chidliak Bay, Baffin Island, District of Franklin, 64°49'N, 66°34'W. Map-unit 11, Geol. Surv. Can. Map 17-1966. Sample TA-65-T241, collected by R. G. Blackadar and interpreted by C. H. Stockwell.

Medium-grained, grey biotite gneiss. Biotite is plentiful and, in some layers, occurs with hornblende. Both minerals are fresh. Other constituents include plagioclase and quartz.

The sample is from the Churchill Structural Province and the age agrees with other K-Ar biotite ages from this province and is classed as an early Paleohelikian (post-Hudsonian) cooling age.

GSC 73- 74 Biotite, K-Ar age 87 ± 4 m.y.

K = 7.34%, $^{40}Ar/^{40}K$ = 0.0052, radiogenic Ar = 70%.
Concentrate: Moderately altered light brown biotite with about 10% chloritization. There is also about 2% muscovite impurity. Many of the biotite flakes contain pleochroic haloes.

From granodiorite
(105 O) 240 m southwest of "Cirque Lake", about 8 km south of MacMillan Pass, District of Mackenzie, 63°17'N, 130°08.3'W. Sample FJ68-320-2, collected and interpreted by D.C. Findlay.

The sample is granodiorite from a stock that outcrops near a small cirque lake about 610 m northeast of the main mineralized zone of the Mactung tungsten deposit (Amax Inc.) about 5 miles south of MacMillan Pass on the Yukon-Northwest Territories boundary. Pyrrhotite-scheelite mineralization occurs in skarn bands formed in (?) Cambrian sediments near the contact of the stock (Findlay, 1969). The Cretaceous K-Ar age is generally consistent with other K-Ar ages obtained from granodioritic rocks in the Yukon-Northwest Territories border region.

Reference

Findlay, D.C.
1969: Mineral Industry of Yukon Territory and southwest District of Mackenzie, N.W.T., 1968. Geol. Surv. Can., Paper 69-55, p. 52-53.

GSC 73- 75 Whole-rock, K-Ar age 1739 ± 51 m.y.

K = 1.75%, $^{40}Ar/^{40}K$ = 0.1671, radiogenic Ar = 99.3%.
Concentrate: Crushed whole-rock.

From quartz-feldspar porphyry
(76 E) Approximately 2.4 km west of the northwest end of Finger Lake, Contwoyto Lake area, District of Mackenzie, 65°42'40"N, 111°15'25"W. *See* Geol. Surv. Can. Map 12-1965. Sample T100-64, collected and interpreted by L.P. Tremblay.

This porphyry is not metamorphosed and was not found in the Contwoyto Lake area in rocks more metamorphosed than the almandine zone of regional metamorphism. If it formed later than the regional metamorphism it is possibly related to similar rocks in the Bear Province. If it is early and was not affected by the regional metamorphism because of its location and its composition, its date could either be an updated one or a true one. In this instance this date is assumed to be related to that of the rocks of the Bear Province and to represent a late porphyry intrusion of Hudsonian age in the Slave Province.

GSC 73- 76 Whole-rock, K-Ar age 1390 ± 50 m.y.

K = 0.968%, $^{40}Ar/^{40}K$ = 0.1205, radiogenic Ar = 97%.
Concentrate: Crushed whole-rock.

From diabase
(75 K) Nonacho Lake area, District of Mackenzie, 62°00'N, 109°32'30"W. *See* diabase dykes, Geol. Surv. Can. Map 1123A. Sample MC98B-70, collected and interpreted by J.C. McGlynn.

See GSC 73-77 for description and interpretation.

GSC 73- 77 Whole-rock, K-Ar age 1480 ± 53 m.y.

K = 3.06%, $^{40}Ar/^{40}K$ = 0.1315, radiogenic Ar = 99%.
Concentrate: Crushed whole-rock.

From diabase
(75 F) Nonacho Lake area, District of Mackenzie, 61°30'40"N, 109°27'36"W. *See* diabase dykes, Geol. Surv. Can. Map 526A. Sample MCP4-70, collected and interpreted by J.C. McGlynn.

These are samples of chilled margins of diabase dykes that strike at 340°, dip vertically and cut sediment of the Nonacho group and granitic gneisses of the basement of these sediments. The chilled phase of the diabase is composed of laths of plagioclase and grains of pyroxene and olivine in a groundmass consisting of tiny laths of plagioclase and pyroxene embedded in black semi-opaque material. The date is a reasonable one and gives a minimum age for the Nonacho sediments and for folding and at least some faulting of these rocks.

For more detailed interpretations of ages of these dykes that include ^{40}Ar-^{39}Ar ages the reader is referred to McGlynn *et al.* (1974).

Reference

McGlynn, J.C., Hanson, G.N., Irving, E. and Park, J.K.
1974: Paleomagnetism and age of Nonacho Group sandstones and associated Sparrow dikes, District of Mackenzie; Can. J. Earth Sci., v. 11, p. 30-42.

GSC 73- 78 Whole-rock, K-Ar age $\frac{3512 \pm 168 \text{ m.y.}}{3525 \pm 172 \text{ m.y.}}$

K = 0.19%, $^{40}Ar/^{40}K = \frac{0.6000}{0.6047}$, radiogenic Ar = $\frac{99\%}{82\%}$.
Concentrate: Crushed whole-rock.

From diabase
(75 O) West of Smart Lake, District of Mackenzie, 63°30'N, 106°59'W. Map-unit 7, Geol. Surv. Can. Map 4-1971 (Artillery Lake), Geol. Surv. Can., Paper 71-38. Sample FD69-3008, collected and interpreted by J.A. Fraser.

The sample was taken from the chilled margin of a dyke that discordantly intrudes migmatite of the Churchill Province. The dyke is 18 m wide, strikes N30E, and is steeply inclined. It is composed of dark grey, brownish weathering, fine-grained, massive diabase comprising fairly fresh labradorite (60%), clinopyroxene with associated traces of hornblende and biotite (37%), and opaque minerals (3%). The texture is characterized by phenocrysts of zoned plagioclase up to 2 mm long set in an ophitic groundmass of plagioclase and pyroxene. For interpretation *see* GSC 73-79.

GSC 73- 79 Whole-rock, K-Ar age 3470 ± 161 m.y.

K = 0.147%, $^{40}Ar/^{40}K$ = 0.5842, radiogenic Ar = 99%.
Concentrate: Crushed whole-rock.

From diabase
(75 O) West of Smart Lake, District of Mackenzie, 63°30.5'N, 106°58'W. Map-unit 7, Geol. Surv. Can. Map 4-1971 (Artillery Lake), Geol. Surv. Can., Paper 71-38. Sample FD69-3004, collected and interpreted by J.A. Fraser.

The sample is a grey, grey-weathering, medium-grained, massive diabase from a dyke that intrudes porphyritic granite of the Churchill Province. The dyke is exposed for more than 60 m along strike and 15 m across strike, trends 045 degrees and, although contacts with wall rocks are not exposed, is inferred to dip steeply. The diabase consists of laths of unaltered labradorite (50%) up to 2 mm long, crystals of clinopyroxene (45%) 2 mm across rimmed by uralitic hornblende (2%), magnetite (3%), traces of olivine, and a few crystals of pyrite. The texture is diabasic to ophitic.

Three dyke sets are exposed in the Artillery Lake map-area. Dykes of easterly trend have given a K-Ar age of 1765 m.y. (GSC 72-49). They are rich in hornblende and are commonly strongly foliated. Northerly trending, typically massive dykes have yielded a K-Ar age of 1560 m.y. (GSC 70-74). The latter dykes and those of northeasterly trend, represented by samples GSC 73-78 and GSC 73-79, clearly post-date country gneisses and granites which are probably Archean, and apparently also post-date the well-developed foliation and cataclasis, presumably of Aphebian age, which are characteristic of the Churchill Province in this region. The northeasterly trending dykes are tentatively considered to be Helikian. No explanation other than the presence of excess radiogenic argon can be offered at present for the anomalously high ages obtained. It should be noted that the two sample localities may both lie on segments of the same dyke. Dykes of the north-northwest trending Mackenzie swarm, known to be about 1200 m.y. old, are not exposed in this area but their presence can be inferred from linear magnetic anomalies which are distinctly more continuous than anomalies associated with dykes of the other swarms.

GSC 73- 80 Hornblende, K-Ar age 1541 ± 44 m.y.

K = 0.685%, $^{40}Ar/^{40}K$ = 0.1395, radiogenic Ar = 96.8%.
Concentrate: Clean, slightly pleochroic, light green hornblende with an insignificant trace of chlorite impurity.

From paragneiss
(86 F) Small island in Eyston Lake, District of Mackenzie, 65°08'10"N, 116°28'40"W. Map-unit B, Geol. Surv. Can. Map 1014A. Sample SH-53-59, collected and interpreted by C.H. Stockwell.

The paragneiss is a dark grey, rather fine-grained rock with a well-developed foliation. It consists of abundant hornblende with lesser amounts of biotite and plagioclase and a little apatite and zircon. The hornblende is fresh, the biotite is slightly altered to chlorite, and the plagioclase is mostly sericitized.

The sample is from the Wopmay Belt of the Bear Structural Province. The age obtained on the hornblende is somewhat younger than the prevalent K-Ar ages for this sub-province and falls in the middle Paleohelikian, considerably younger than the late Aphebian Hudsonian Orogeny of the type region. It is interesting to note, however, that the age correlates quite well with K-Ar ages on both hornblende and biotite from granitic rocks of the Echo Bay area, some 80 miles to the northwest. From these rocks Robinson and Morton (1972) obtained four ages on hornblende ranging from 1570 ± 40 to 1690 ± 40 m.y. and on biotite from the same samples ranging from 1620 ± 20 to 1700 ± 20 m.y. The same rocks also yielded a Paleohelikian Rb-Sr whole-rock isochron date of 1670 ± 30 m.y. (λ Rb 1.47). These granitic rocks form a part of the very large Great Bear Batholith which,

according to Fraser *et al.* (1972), was shallowly emplaced and roofed by comagmatic volcanics and derived sediments, and the country rocks are not regionally metamorphosed. Thus the Great Bear batholith is nonorogenic and in part at least is post-Hudsonian. Being shallowly emplaced, it cooled quickly and this conclusion is independently confirmed by the essential agreement between the biotite and hornblende ages. It is concluded that the paragneiss of the present sample (hornblende 1541 ± 44 m.y.) was last metamorphosed at the time of emplacement and virtually contemporaneous cooling of the Great Bear batholith in mid-Paleohelikian time. It should be noted that Jory (1964) obtained a concordia age of 1820 ± 30 m.y. on zircon from granitic rocks in the Echo Bay area, which age is late Aphebian, indicating that the Great Bear batholith had a long history of emplacement.

References

Fraser, J.A., Hoffmann, P.F., Irvine, T.N. and Mursky, G.
1972: The Bear Province. *In* Variations in Tectonic Styles in Canada; Geol. Assoc. Can., Special Paper No. 11, p. 453-503.

Jory, L.T.
1964: Mineralogical and isotopic relations in the Port Radium pitchblende deposits, Great Bear Lake, Canada; unpubl. Ph.D. thesis, Cal. Inst. Tech., Pasadena, Cal.

Robinson, B.W. and Morton, R.D.
1972: The geology and geochronology of the Echo Bay area, Northwest Territories, Canada; Can. J. Earth Sci., v. 9, p. 158-171.

GSC 73- 81 Hornblende, K-Ar age 1689 ± 50 m.y.

$K = 0.906\%$, $^{40}Ar/^{40}K = 0.1598$, radiogenic Ar = 99%.
Concentrate: Relatively clean, unaltered, pleochroic light green to bluish green hornblende with trace amounts of biotite and chlorite contamination.

From schist
(75 D) South shore of Thekulthili Lake, District of Mackenzie, 60°56'20"N, 110°17'20"W. Map-unit 3, Geol. Surv. Can. Map 607A. Sample SH-41-59, collected and interpreted by C.H. Stockwell.

This hornblende was separated from the same sample as the biotite of GSC 60-55 (1730 m.y.).

For description *see* GSC 60-55 (Lowdon, 1961), and for interpretation *see* GSC 73-83.

Reference

Lowdon, J.A.
1961: Age determinations by the Geological Survey of Canada; Geol. Surv. Can., Paper 61-17.

GSC 73- 82 Hornblende, K-Ar age 2064 ± 54 m.y.

$K = 1.20\%$, $^{40}Ar/^{40}K = 0.2193$, radiogenic Ar = 99.1%.
Concentrate: Clean, fresh, pleochroic light brown to dark green hornblende with a trace (less than 1%) of free biotite contamination.

From granitic gneiss
(75 O) North shore of large island in Wholdaia Lake, District of Mackenzie, 60°35'40"N, 103°50'00"W. Map-unit 4, Geol. Surv. Can. Map 7-1956. Sample SH-94-59, collected and interpreted by C.H. Stockwell.

This hornblende was separated from the same sample as the biotite of GSC 61-83 (1830 m.y.). For description *see* GSC 61-83 (Lowdon *et al.*, 1963). For interpretation *see* GSC 73-83.

GSC 73- 83 Hornblende, K-Ar age $\frac{*(2088 \pm 56)}{2041 \pm 56}$ m.y.

$K = \frac{*(1.31)}{1.44\%}$, $^{40}Ar/^{40}K = \frac{*(0.2234)}{0.2153}$, radiogenic Ar = 99.4%.
Concentrate: Relatively clean, unaltered, pleochroic olive-brown to dark bluish green hornblende with approximately 2% free biotite contamination.

From gneissic monzonite
(75 B) South shore of Spitfire Lake, District of Mackenzie, 60°53'N, 107°40'W. Map-unit 2, Geol. Surv. Can. Map 55-10. Sample SH-90-59, collected and interpreted by C.H. Stockwell.

*Adjusted for 2% biotite impurity.

This hornblende was separated from the same sample as the biotite of GSC 60-56 (1910 m.y.). For description *see* GSC 60-56 (Lowdon, 1961).

This hornblende age, together with those of GSC 73-81 and GSC 73-82 and their associated biotite ages from the same samples, are listed as follows:

Rock type	No.	Biotite age, m.y.	No.	Hornblende age, m.y.
Schist	GSC 60-55	1730	GSC 73-81	1689 ± 50
Granitic gneiss	GSC 61-83	1830	GSC 73-82	2064 ± 54
Gneissic monzonite	GSC 60-56	1910	GSC 73-83	2088 ± 55

All three pairs are from a region north and northeast of Lake Athabasca, which region forms a part of a much larger area in the western part of the Churchill Structural Province, where a considerable number of pre-Hudsonian (pre-late Aphebian) ages have been found (Wanless, 1970), strongly suggesting the presence there of a pre-Hudsonian orogenic belt, probably re-worked in part during the Hudsonian.

The two older hornblende ages listed above, confirm the suggestion that an older orogeny is present. These ages are middle Aphebian and because of the high-temperature retentivity of argon by hornblende, approach most closely the age of primary crystallization. The corresponding biotite ages from the same samples, some 200 to 300 m.y. younger, reflect the low-temperature retentivity of argon and indicate either an exceptionally long post-orogenic cooling period, or a low-temperature overprint due to re-burial or to partial loss of argon due to heat from the Hudsonian orogeny.

The third biotite-hornblende pair listed above is from a layer of schist enclosed in crushed granitic gneiss and both the biotite and hornblende ages, which agree with one another, date this late deformation or quick cooling as early Paleohelikian (post-Hudsonian). The schist is from the Tazin Group and the K-Ar dates give a minimum for the time of deposition of the group.

References

Lowdon, J.A., Stockwell, C.H., Tipper, H.W. and Wanless, R.K.
1963: Age determinations and geological studies; Geol. Surv. Can., Paper 62-17.

Wanless, R.K.
1970: Isotopic age map of Canada; Geol. Surv. Can., Map 1256A.

District of Keewatin
(GSC 73-84 to GSC 73-91)

GSC 73- 84 Biotite, K-Ar age 2071 ± 47 m.y.

K = 7.63%, $^{40}Ar/^{40}K$ = 0.2204, radiogenic Ar = 99.5%.
Concentrate: Fresh and unaltered brownish biotite with approximately 2% free hornblende contamination.

From lamprophyre
(56 D) Vicinity of Kaminak Lake, District of Keewatin, 62°16¾'N, 94°24"W. Sample FA-71082, collected and interpreted by W.F. Fahrig.

The biotite was obtained from a lamprophyre dyke in the Kaminak Lake area. These dykes have been described as post-tectonic by Davidson (1970) inasmuch as they are undeformed and cut folded Hurwitz (Aphebian) strata. On the basis of a K-Ar age of 1690 ± 55 obtained on biotite from the lamprophyre, he suggested that they might be related to Hurwitz igneous activity. They are known to cut metamorphosed Kaminak diabases and some samples appear in thin section to have undergone low-grade regional metamorphism (K.L. Currie, pers. comm.). If the K-Ar age of 2071 ± 47 m.y. is the minimum age of intrusion it is significantly greater than the age of Hurwitz volcanism (1808 ± 35 m.y.) reported by Wanless and Eade (in prep.) or of Dubawnt volcanism which is 1725 ± 4 m.y. Donaldson (1972) (λ Rb = 1.47). It is proposed in explanation that the 2071 m.y. K-Ar age for the biotite of the lamprophyre is anomalously high because of the presence of excess argon. This area is underlain by Archean gneisses from which argon in large quantities would be released during the Hudsonian Orogeny. It is quite possible that the mildly heated, biotite-rich lamprophyre absorbed significant quantities of fugitive argon during this episode.

References

Davidson, A.
1970: Precambrian geology, Kaminak Lake map-area, District of Keewatin; Geol. Surv. Can., Paper 69-51.

Donaldson, J.A.
1972: Dubawnt Volcanics, *in* Wanless, R.K. and Loveridge, W.D.; Rubidium-strontium isotopic age studies, report 1, Geol. Surv. Can., Paper 72-23, p. 25-31.

Wanless, R.K. and Eade, K.E.
1975: Geochronology of Archean and Proterozoic rocks in the southern District of Keewatin; Can. Jour. Earth Sci. (in press).

GSC 73- 85 Hornblende, K-Ar age 1634 ± 48 m.y.

K = 0.907%, $^{40}Ar/^{40}K$ = 0.1521, radiogenic Ar = 98.7%.
Concentrate: Relatively clean, unaltered, pleochroic light green to dark green hornblende with less than 1% chlorite and biotite contamination.

From paragneiss
(55 N) 9.6 km northeast of McManaman Lake, District of Keewatin, 63°23'40"N, 92°01'00"W. Map-unit 6, Geol. Surv. Can. Map 55-17. Sample SH-107-59, collected and interpreted by C.H. Stockwell.

From same sample as GSC 61-103 (K-Ar biotite age 1695 ± 90 m.y.).

For description *see* GSC 61-103 (Lowdon *et al.*, 1963).

The ages obtained on the hornblende and biotite are indistinguishable within the limits of analytical error. Both fall within the Paleohelikian sub-Era and might be expected to be cooling ages following the close of the Hudsonian orogeny.

The sample is from the Churchill Structural Province just south of Chesterfield Inlet.

Reference

Lowdon, J.A., Stockwell, C.H., Tipper, H.W. and Wanless, R.K.
1963: Age determinations and geological studies, Report 3; Geol. Surv. Can., Paper 62-17, p. 60.

GSC 73- 86 Biotite, K-Ar age 1650 ± 54 m.y.

K = 7.56%, $^{40}Ar/^{40}K$ = 0.1540, radiogenic Ar = 99%.
Concentrate: Light brown coloured biotite with about 4% chlorite alteration.

From paragneiss
(46 C) South of Salmon Pond, Southampton Island, District of Keewatin, 64°10'N, 84°53'W. Map-unit 3, Geol. Surv. Can. Map 1404A (in press). Sample HF-21C-1969, collected and interpreted by W.W. Heywood.

This rock is a fine- to medium-grained, leucocratic paragneiss containing discontinuous mafic-rich layers composed of biotite and hornblende with minor quartz and plagioclase.

See GSC 73-91 for interpretation.

GSC 73- 87 Biotite, K-Ar age 1610 ± 52 m.y.

K = 7.72%, $^{40}Ar/^{40}K$ = 0.1485, radiogenic Ar = 98%.
Concentrate: Relatively clean, light orange-brown biotite with about 2% chlorite alteration.

From gneiss
(46 B) Western side of Porsild Mountains, Southampton Island, District of Keewatin, 64° 47½'N, 83°25'W. Map-unit 4, Geol. Surv. Can. Map 1404A (in press). Sample HF-1-68, collected and interpreted by W.W. Heywood.

The rock is a medium-grained, dark olive-green, equigranular pyroxene gneiss. It is well foliated and locally the layers are intensely contorted.

See GSC 73-91 for interpretation.

GSC 73- 88 Biotite, K-Ar age 1595 ± 52 m.y.

K = 8.07%, $^{40}Ar/^{40}K$ = 0.1469, radiogenic Ar = 98%.
Concentrate: Relatively clean, light brownish biotite with no chlorite impurity.

From gneiss
(46 A) East side of Southampton Island, District of Keewatin, 64°14'N, 81°57'W. Map-unit 3, Geol. Surv. Can. Map 1404A (in press). Sample HF-3-68, collected and interpreted by W.W. Heywood.

This rock is a grey, porphyroblastic biotite gneiss. K-feldspar porphyroblasts occur in a foliated, medium-grained matrix.

See GSC 73-91 for interpretation.

GSC 73- 89 Biotite, K-Ar age 1615 ± 52 m.y.

K = 7.93%, $^{40}Ar/^{40}K$ = 0.1495, radiogenic Ar = 99%.
Concentrate: Relatively clean, brownish coloured biotite with a trace of free chlorite contamination.

From gneiss
(46 A) Cape Fisher area, Southampton Island, District of Keewatin, 64°30'N, 81°53'W. Map-unit 4, Geol. Surv. Can. Map 1404A (in press). Sample HF-95, collected and interpreted by W.W. Heywood.

This rock is moderately well layered, medium- to coarse-grained, equigranular hornblende-biotite gneiss.

See GSC 73-91 for interpretation.

GSC 73- 90 Biotite, K-Ar age 1610 ± 52 m.y.

K = 7.71%, $^{40}Ar/^{40}K$ = 0.1487, radiogenic Ar = 99%.
Concentrate: Relatively clean, light brown coloured biotite with about 2% chlorite contamination.

From pegmatite
(46 A) Gore Point, Bell Peninsula, Southampton Island, District of Keewatin, 64°04'N, 81°19'W. Map-unit 3, Geol. Surv. Can. Map 1404A (in press). Sample HF-202-69, collected and interpreted by W.W. Heywood.

The rock is from a massive, medium- to coarse-grained subhorizontal sheet of pink biotite pegmatitic granodiorite. It contains altered and granitized mafic gneiss inclusions.

See GSC 73-91 for interpretation.

GSC 73- 91 Biotite, K-Ar age 1590 ± 52 m.y.

K = 7.83%, $^{40}Ar/^{40}K$ = 0.1462, radiogenic Ar = 98%.
Concentrate: Relatively clean, olive-brown biotite with less than 2% hornblende contamination.

From paragneiss
(45 P) Small lake west of Seashore Point, Bell Peninsula of Southampton Island, District of Keewatin, 63°46'N, 80°15'W. Map-unit 3, Geol. Surv. Can. Map 1404A (in press). Sample HF-4-68, collected and interpreted by W.W. Heywood.

This sample was taken from well layered, medium-grained, inequigranular hornblende-biotite paragneiss. Layers are continuous over the outcrop and range from 4 mm to 2 cm thick.

These ages (GSC 73-86 through GSC 73-91) are representative of metamorphic and intrusive rocks of Southampton Island. They all fall within a very limited range and are probably regional cooling ages following the close of the Hudsonian orogeny.

Reference

Heywood, W.W. and Sanford, B.V.
The geology of Southampton, Coats and Mansel Islands, District of Keewatin, Northwest Territories; Geol. Surv. Can., Mem. and Map 1404A. (in press)

Saskatchewan
(GSC 73-92 to GSC 73-102)

GSC 73- 92 Biotite, K-Ar age 1770 ± 65 m.y.

K = 7.30%, $^{40}Ar/^{40}K$ = 0.1720, radiogenic Ar = 99%.
Concentrate: Impure, buff, olive-green biotite with needle-like inclusions. There is about 20% free chlorite and less than 1% hornblende contamination.

From quartz diorite
(63 K) Drill cuttings from hole 0.4 km north of Highway 35, Saskatchewan, 54°43¾'N, 101°59¾'W. Map-unit 14, Geol. Rept. No. 6, Sask. Res. Council, 1964. Sample JXWS-3760-3770 composite, collected and interpreted by D.C. Findlay.

The sample is a drill-cutting composite of quartz diorite from a depth of 3760 to 3770 feet (1150 m) in the Reynard Lake pluton near Creighton, Saskatchewan.

See GSC 73-94 for interpretation.

GSC 73- 93 Biotite, K-Ar age 1645 ± 50 m.y.

K = 6.71%, $^{40}Ar/^{40}K$ = 0.1535, radiogenic Ar = 99%.
Concentrate: Relatively clean, slightly altered, khaki biotite with 2% chlorite alteration and 5% hornblende impurity. About 50% of the flakes contain oriented needle-like inclusions and 5% contain opaque blebs.

From quartz diorite
(63 K) 0.4 km north of Highway 35, Saskatchewan, 54°43.75'N, 101°59.75'W. Map-unit 14, Plate 1, Geol. Rept. No. 6, Sask. Res. Council 1964. Sample JXWS-7380-7480, collected and interpreted by D.C. Findlay.

The sample is a drill-cutting composite of mafic quartz diorite from a depth of 7420 to 7480 feet (2280 m) in the Reynard Lake pluton.

See GSC 73-94 for interpretation.

GSC 73- 94 Biotite, K-Ar age 1585 ± 50 m.y.

K = 7.59%, $^{40}Ar/^{40}K$ = 0.1453, radiogenic Ar = 99%.
Concentrate: Impure olive-green biotite with about 10% hornblende contamination and traces of muscovite and quartz. All biotite flakes contain oriented needle-like inclusions. Total chlorite content is 1%.

From quartz diorite
(63 K) Drill cuttings from hole 0.4 km north of Highway 35, Saskatchewan, 54°43¾'N, 101°59¾'W. Map-unit 14, Plate 1, Geol. Rept. No. 6, Sask. Res. Council 1964. Sample JXWS-10020-60, collected and interpreted by D.C. Findlay.

Sample is a drill-cutting composite of mafic quartz diorite from a depth of 10 020-10 060 feet (3067 m) in the Reynard Lake pluton.

During the winter of 1965-66 a 10 000-foot, large-diameter borehole was drilled at the Joint Experimental Weather Station near Creighton, Sask. The borehole site lies about ¼ mile north of Highway 35, at 54°43.75'N, 101°59.75'W. The site is near the centre of the zoned granodiorite-quartz diorite Reynard Lake pluton, described by Smith (1964) and Byers and Dahlstrom (1954).

Composite cutting samples obtained from three depths within the borehole yielded K-Ar ages ranging from 1585 ± 50 m.y. at the bottom of the hole (10 020-10 060 feet), through an intermediate age of 1645 ± 50 m.y. at a depth of 7 420-7 480 feet, to a slightly older age of 1770 ± 65 m.y. at a relatively shallow depth (3 760-3 770 feet).

These ages, coupled with a previous GSC surface K-Ar age (GSC 61-112) of 1705 m.y. obtained at Reynard Lake, about 3.2 km south of the drill site (Lowdon *et al.*, 1963, p. 66) suggest the possibility of an apparent decrease in K-Ar age with depth in the Reynard Lake mass, presumably attributable to argon loss related to heating effects. However, it may be noted that the JXWS borehole showed a relatively low bottom-hole temperature (about 95°F) in comparison with projected temperatures (120-140°F) derived from Shield heat-flow data and thermal gradients.

For the present, the systematic age variations shown by these samples may be merely fortuitous. Additional age determinations would be necessary to ascertain if the variation pattern is real.

References

Byers, A.R. and Dahlstrom, C.D.A.
1954: Geology and Mineral Deposits of the Amisk-Wildnest Lakes area, Saskatchewan; Sask. Dept. Mines Resour., Geol. Br., Rept. no. 14.

Smith, J.R.
1964: Distribution of Nickel, Copper and Zinc in bedrock of the East Amisk area, Saskatchewan; Sask. Res. Council, Geol. Div., Rept. no. 6.

GSC 73- 95 Hornblende, K-Ar age 1707 ± 50 m.y.

K = 1.02%, $^{40}Ar/^{40}K$ = 0.1625, radiogenic Ar = 98.7%.
Concentrate: Clean, fresh, pleochroic light brown to dark green hornblende with no visible impurities.

From paragneiss in granitic gneiss
(63 M) Reindeer River, 19.3 km north of Atik Falls, Saskatchewan, 55°47'05"N, 103° 06'20"W. Map-unit 3, Geol. Surv. Can. Map 1-1958. Sample SH-128-59, collected and interpreted by C.H. Stockwell.

See GSC 73-96 for description and GSC 73-104 for interpretation.

GSC 73- 96 Biotite, K-Ar age 1514 ± 38 m.y.

K = 7.89%, $^{40}Ar/^{40}K$ = 0.1359, radiogenic Ar = 99.2%.
Concentrate: Clean, fresh, light brownish biotite with no visible impurities.

From paragneiss in granitic gneiss
(63 M) Details as for GSC 73-95.

The sample from which the biotite and hornblende were separated is a dark grey, medium-grained paragneiss composed of quartz, oligoclase, hornblende, biotite and a little muscovite. All of the minerals are fresh. As seen on the outcrop, the paragneiss forms layers in granitic gneiss and both are much contorted and closely folded. The paragneiss forms part of the Kisseynew Gneiss.

See GSC 73-104 for interpretation.

GSC 73- 97 Hornblende, K-Ar age 1659 ± 110 m.y.

K = 0.270%, $^{40}Ar/^{40}K$ = 0.1555, radiogenic Ar = 94%.
Concentrate: Clean, unaltered, pleochroic olive-green to light brown hornblende with no visible contamination.

From schist
(73 P) Northeast end of point northeast of Bear Island, Lac la Ronge, Saskatchewan, 55° 17'30"N, 104°54'40"W. Map-unit 2, Geol. Surv. Can. Map 592A. Sample SH-36-59, collected and interpreted by C.H. Stockwell.

This sample is a fine-grained, dark greenish grey, hornblende schist containing in addition to abundant hornblende, some quartz, plagioclase and a little biotite with accessory magnetite and apatite. Cleavage parallels the bedding and both are drag-folded; small crenulations may be seen on the bedding-cleavage planes.

For interpretation see GSC 73-104.

GSC 73- 98 Hornblende, K-Ar age 1693 ± 50 m.y.

K = 0.973%, $^{40}Ar/^{40}K$ = 0.1604, radiogenic Ar = 98.7%.
Concentrate: Clean, unaltered, pleochroic light brown to light green hornblende with a trace (less than 1%) of free biotite contamination.

From paragneiss
(63 L) Island in Wildnest Lake, Saskatchewan, 54°58'45"N, 102°20'50"W. Map-unit 6b, Geol. Surv. Can. Map 314A. Sample SH-130-59, collected and interpreted by C.H. Stockwell.

The paragneiss is a dark grey, medium-grained rock composed of quartz, oligoclase, biotite, hornblende, and accessory apatite. All the minerals are fresh. The sample is from the Kisseynew Gneiss.

For interpretation of age see GSC 73-104.

GSC 73- 99 Biotite, K-Ar age 1603 ± 40 m.y.

K = 6.96%, $^{40}Ar/^{40}K$ = 0.1479, radiogenic Ar = 98.6%.
Concentrate: Light brown biotite with approximately 9% chlorite alteration.

From gneiss
(64 D) Small island south of Edgar Island, Reindeer Lake, Saskatchewan, 56°58'30"N, 102°20'20"W. Map-unit 4, Geol. Surv. Can. Map 527A. Sample SH-32-59, collected and interpreted by C.H. Stockwell.

See GSC 73-100 for description and GSC 73-104 for interpretation.

GSC 73-100 Hornblende, K-Ar age 1594 ± 44 m.y.

K = 0.652%, $^{40}Ar/^{40}K$ = 0.1465, radiogenic Ar = 98.3%.
Concentrate: Clean, unaltered, pleochroic, light brown to light green hornblende with no visible contamination.

From gneiss
(64 D) Details as for GSC 73-99.

The sample from which the biotite and hornblende were separated is a fine-grained, grey gneiss composed of quartz, andesine, hornblende, biotite and accessory apatite. All the minerals are fresh. The gneiss occurs as layers from 1 inch to 2 feet (2.5 cm to 61 cm) wide within white granitic gneiss and pegmatite.

For interpretation of these ages see GSC 73-104.

GSC 73-101 Biotite, K-Ar age 1672 ± 41 m.y.

K = 6.99%, $^{40}Ar/^{40}K$ = 0.1574, radiogenic Ar = 99.2%.
Concentrate: Clean, brown biotite with less than 2% hornblende contamination.

From diorite
(63 L) East shore, 1.2 km from south end of Neagle Lake, Saskatchewan, 54°45'45"N, 102°22'25"W. Map-unit 17a, Sask. Dept. Mineral Res. Map 14a. Sample SH-132 59, collected and interpreted by C.H. Stockwell.

See GSC 73-104 for description and interpretation.

GSC 73-102 Hornblende, K-Ar age 1842 ± 51 m.y.

K = 0.438%, $^{40}Ar/^{40}K$ = 0.1826, radiogenic Ar = 98.4%.
Concentrate: Clean, pleochroic, brown to dark green hornblende with a slight trace of chlorite contamination.

From diorite
(63 L) Details as for GSC 73-101.

This is a dark grey, medium-grained, massive diorite composed of fresh hornblende, biotite and andesine with a little epidote and accessory sphene and apatite. The diorite forms a stock intruding the Amisk Group of volcanic and sedimentary rocks. According to Byers and Dahlstrom (1954) the diorite is a post-tectonic intrusion. It is cut by a few stringers of granite.

Biotite from the same body of diorite yielded a K-Ar age of 1730 m.y. (*see* GSC 60-72, Lowdon, 1961).

See GSC 73-104 for interpretation.

Manitoba
(GSC 73-103 to GSC 73-106)

GSC 73-103 Hornblende, K-Ar age 1675 ± 111 m.y.

$K = 0.240\%$, $^{40}Ar/^{40}K = 0.1578$, radiogenic Ar = 95.4%.
Concentrate: Clean, slightly pleochroic, light green hornblende with a slight trace of chlorite contamination.

From hornblende schist
(63 J) Southeast shore of Dion Lake, Manitoba, 54°49'35"N, 99°30'15"W. Map-unit 1, Geol. Surv. Can. Map 987A. Sample SH-143-59, collected and interpreted by C.H. Stockwell.

This is a dark green, coarse-grained, hornblende schist composed of hornblende, biotite, andesine and a little quartz, with accessory magnetite, sphene, and apatite. On the outcrop the schist is cut by dykes of pegmatite. The schist constitutes part of the Amisk Group.

For interpretation of age see GSC 73-104.

GSC 73-104 Hornblende, K-Ar age 1664 ± 49 m.y. / 1704 ± 50 m.y.

$K = \frac{0.869\%}{0.723\%}$, $^{40}Ar/^{40}K = \frac{0.1562}{0.1620}$, radiogenic Ar = 98.3%.
Concentrate: Relatively clean, fresh, pleochroic olive-brown to dark bluish green hornblende with approximately 2% biotite contamination as free flakes.

From granitic gneiss
(63 O) Southeast shore of Halfway Lake, 0.8 km northwest of Lyddal, Manitoba, 55°01'50"N, 98°26'20"W. Map-unit 5, Geol. Surv. Can. Map 54-13. Sample SH-156-59, collected and interpreted by C.H. Stockwell.

The hornblende is from the same rock as biotite GSC 60-79 (1675 ± 90 m.y.) (Lowdon, 1961), which should be consulted for a description of the rock.

This sample and others discussed below are from the southern part of the Churchill Structural Province southwest of the town of Churchill, Manitoba. A recapitulation of the age determinations is given as follows, arranged in order of increasing ages on hornblende:

Rock type	No.	Hornblende, m.y.	No.	Biotite, m.y.
Gneiss	GSC 73-100	1594 ± 44	GSC 73-99	1603 ± 40
Schist	GSC 73-97	1659 ± 110		
Schist	GSC 73-103	1675 ± 111		
Paragneiss	GSC 73-98	1693 ± 50		
Granitic gneiss	GSC 73-104	1704 ± 50	GSC 60-79	1657 ± 90
Paragneiss	GSC 73-95	1707 ± 50	GSC 73-96	1514 ± 38
Diorite	GSC 73-102	1842 ± 51	GSC 73-101	1672 ± 41
Quartz diorite			GSC 60-72	1730 ± 90

Allowing for analytical errors, the ages could range throughout the Paleohelikian and into the late Aphebian, but a more probable picture is given by taking averages which calculate to 1639 m.y. for biotite and 1696 m.y. for hornblende which are middle to early Paleohelikian. As hornblende retains radiogenic argon at a higher temperature than does biotite, the age obtained on hornblende approaches more closely to the time of crystallization of the rocks, which was probably during the late Aphebian Hudsonian orogeny. This compares with an Rb-Sr whole-rock isochron age of 1705 ± 14 m.y. ($\lambda Rb = 1.47$) for the time of emplacement of the Annabel Lake pluton (Mukherjee *et al.*, 1971). The post-Hudsonian cooling interval between the hornblende blocking temperature and the biotite blocking temperature averaged 57 m.y.

The ages obtained on hornblende at 1675 ± 111 m.y. (GSC 73-103) and 1842 ± 51 m.y. (GSC 73-102) are minima for the time of deposition of the Amisk Group, and those at 1693 ± 50 (GSC 73-98) and 1707 ± 50 (GSC 73-95) are minima for the time of deposition of the Kisseynew Gneiss.

References

Byers, A.R. and Dahlstrom, C.D.A.
1954: Geology and mineral deposits of the Amisk-Wildnest Lakes area, Saskatchewan; Sask. Dept. Mineral Resour. Rept. no. 14.

Lowdon, J.A.
1961: Age determinations by the Geological Survey of Canada; Geol. Surv. Can., Paper 61-17.

Mukherjee, A.C., Stauffer, M.R. and Baadsgaard, H.
1971: The Hudsonian Orogeny near Flin Flon, Manitoba; A tentative interpretation of Rb-Sr and K-Ar ages; Can. J. Earth Sci., v. 8, p. 939-946.

GSC 73-105 Hornblende, K-Ar age $\frac{1007 \pm 34 \text{ m.y.}}{965 \pm 32 \text{ m.y.}}$ $\frac{985 \pm 34 \text{ m.y.}}{0.0779}$

K = 1.07%, $^{40}Ar/^{40}K$ = 0.0737, radiogenic
98.4% 0.0757
Ar = 98.2%.
96.3%

Concentrate: Clean, pleochroic, olive-blende with no visible impurity.

From "granite"

(63 K) 0.8 km southeast of south end of Cliff Lake, Manitoba, 54°47'30"N, 101°49'37"W. Map-unit 9, Geol. Surv. Can. Map 1078A. Sample SH-23-63, collected by W.F. Fahrig and interpreted by C.H. Stockwell.

The sample is a massive, dark grey granitic rock with poorly developed phenocrysts of altered feldspar. The rock is composed of quartz, feldspar, plentiful hornblende and a little biotite. The feldspar is heavily clouded with alteration products but the hornblende is relatively fresh.

This is from the Flin Flon area of the southern part of the Churchill Structural Province and it has been named the Cliff Lake Granite. It intrudes the Amisk Group but its relationship to the Missi Group is controversial; Stockwell (1960) presented lithological and structural evidence that the Cliff Lake granite porphyry was overlain unconformably by the Missi but Stauffer and Mukherjee (1971) gave structural evidence indicating that it may be younger than the Missi.

Available K-Ar dates do not solve the problem. A K-Ar age for muscovite of 1620 ± 90 m.y. (GSC 63-106, Wanless *et al.*, 1965) is suspect because the muscovite separate was badly contaminated with impurities and the present average age of 986 ± 28 m.y. on hornblende is so radically different that it is undoubtedly anomalous.

References

Stauffer, M.R. and Mukherjee, A.
1971: Superimposed deformations in the Missi metasedimentary rocks near Flin Flon, Manitoba; Can. J. Earth Sci., v. 8, p. 217-242.

Stockwell, C.H.
1960: Flin Flon-Mandy area, Manitoba and Saskatchewan; Geol. Surv. Can., Map 1078A.

Wanless, R.K., Stevens, R.D., Lachance, G.R. and Rimsaite, R.Y.H.
1965: Age determinations and geological studies; Geol. Surv. Can., Paper 64-17 (Pt. 1).

GSC 73-106 Hornblende, K-Ar age 2597 ± 64 m.y.

K = 0.424%, $^{40}Ar/^{40}K$ = 0.3269, radiogenic Ar = 98%.
Concentrate: Clean, pleochroic, olive-brown to bluish green hornblende with no visible contamination.

From granodiorite

(52 L) Island in southwest part of Halfway Lake, Manitoba, 50°54'50"N, 95°23'45"W. Map-unit 9, Geol. Surv. Can. Map 809A. Sample SH-43-63, collected by W.F. Fahrig and interpreted by C.H. Stockwell.

The hornblende is from a sample of medium-grained, massive, pinkish grey granodiorite composed of quartz, oligoclase, hornblende and biotite. The feldspar is much sericitized and clouded and much of the biotite is altered to chlorite and epidote but the hornblende is fresh.

The sample is from the Cat Lake subprovince of the Superior Structural Province. It is from a batholith, here informally called the Faraway batholith, which intrudes rocks of the Rice Lake Group along partly concordant but mainly discordant contacts. There are two other determinations on materials from this batholith, one yielding a K-Ar age of 2670 ± 130 m.y. on biotite (GSC No. 60-89, Lowdon, 1961) and the other yielding an Rb-Sr whole rock-mineral isochron age of 2515 ± 120 m.y. ($\lambda Rb = 1.47$) (Turek and Peterman, 1971). Considering the large analytical errors and the unreliability of such determinations for obtaining the age of primary crystallization, as contrasted with the ability of hornblende to retain argon except at high temperatures, the hornblende age at 2597 ± 64 m.y. probably approaches most closely the time of primary crystallization of the Faraway batholith. Allowing for the analytical error the hornblende passed its argon blocking temperature in the late Archean or early Aphebian and the batholith undoubtedly crystallized in the Archean.

References

Lowdon, J.A.
1961: Age determinations by the Geological Survey of Canada; Geol. Surv. Can., Paper 61-17.

Turek, A. and Peterman, Z.E.
1971: Advances in the geochronology of the Rice Lake-Beresford Lake area, southeastern Manitoba; Can. J. Earth Sci., v. 8, p. 572-579.

GSC 73-107 Hornblende, K-Ar age $\frac{2475 \pm 61 \text{ m.y.}}{2453 \pm 60 \text{ m.y.}}$

K = 0.681%, $^{40}Ar/^{40}K = \frac{0.2995}{0.2947}$, radiogenic Ar = $\frac{99.4\%}{99\%}$.
Concentrate: Clean, unaltered, pleochroic, olive-brown to bluish green hornblende with no visible impurities.

From gneiss
(52 F) 12.2 km east of railway underpass, Highway 17, northeast of Kenora, Ontario, 49°52'00"N, 93°52'00"W. Sample SH-51-60, collected and interpreted by C.H. Stockwell.

See GSC 73-108 for description and interpretation.

GSC 73-108 Biotite, K-Ar age $\frac{2296 \pm 50 \text{ m.y.}}{2263 \pm 50 \text{ m.y.}}$

K = 7.70%, $^{40}Ar/^{40}K = \frac{0.2624}{0.2559}$, radiogenic Ar = $\frac{99.8\%}{99.7\%}$.
Concentrate: Clean, unaltered, light brownish coloured biotite with no visible contamination.

From gneiss
(52 F) Details as for GSC 73-107.

The rock is a very dark grey, medium-grained gneiss, probably a metavolcanic rock. It consists of plagioclase, quartz, biotite and hornblende. All the minerals are fresh. The gneiss is cut by dykelets of red granite. The sample is from the Wabigoon subprovince of the Superior Structural Province.

Both of these ages are cooling ages, but that obtained on hornblende, because of its higher blocking temperature, approaches more closely the time of metamorphism. Allowing for analytical errors, the biotite passed its blocking temperature during the Aphebian while the hornblende passed its blocking temperature somewhat earlier, during the early Aphebian, suggesting that the metamorphism is probably Archean.

GSC 73-109 Hornblende, K-Ar age 2603 ± 62 m.y.

K = 0.849%, $^{40}Ar/^{40}K$ = 0.3282, radiogenic Ar = 98.7%.
Concentrate: Clean, pleochroic, bluish green to olive-green hornblende with no visible alteration or contamination.

From quartz diorite
(42 M) South shore, 9.6 km east of outlet of Eahamet Lake, Ontario, 51°29'30"N, 87°46'45"W. Map-unit 5c, Ont. Dept. Mines Map 51b. Sample PC-33-61 collected by V.K. Prest, interpreted by C.H. Stockwell.

See GSC 73-110 for description and interpretation.

GSC 73-110 Biotite, K-Ar age 2442 ± 53 m.y.

K = 7.92%, $^{40}Ar/^{40}K$ = 0.2925, radiogenic Ar = 99.7%.
Concentrate: Clean, light greenish biotite with no visible alteration or contamination.

From quartz diorite
(42 M) Details as for GSC 73-109.

The biotite and hornblende are from a medium-grained, massive, grey, quartz diorite composed of quartz, andesine, microcline, biotite, hornblende and minor epidote, apatite, sphene and zircon. The biotite and hornblende are unaltered. The quartz diorite is mapped as a "younger intrusion".

The sample is from the Cat Lake subprovince of the Superior Structural Province. Both ages are interpreted as cooling ages, but the hornblende, because of its higher blocking temperature, approaches more nearly the time of primary crystallization of the rock. Allowing for the analytical error, the hornblende passed its blocking temperature in the early Aphebian or late Archean and the quartz diorite is undoubtedly Archean.

GSC 73-111 Hornblende, K-Ar age 2510 ± 62 m.y.

K = 0.861%, $^{40}Ar/^{40}K$ = 0.3071, radiogenic Ar = 99.5%.
Concentrate: Clean, unaltered, pleochroic, olive-brown to bluish green hornblende with a very slight trace of biotite impurity.

From granodiorite
(42 C) Highway 17, 1.6 km east of Highway 614, Longlac area, Ontario, 48°42'15"N, 85°50'30"W. Sample SH-37-60, collected and interpreted by C.H. Stockwell.

See GSC 73-112 for description and interpretation.

GSC 73-112 Biotite, K-Ar age 2362 ± 52 m.y.

K = 7.81%, $^{40}Ar/^{40}K$ = 0.2758, radiogenic Ar = 99.7%.
Concentrate: Clean, unaltered, light greenish biotite with no visible contamination. Some of the mica flakes have split edges.

From granodiorite
(42 C) Details as for GSC 73-111.

This is a light grey, massive granodiorite composed of quartz, oligoclase, microcline, myrmekite, biotite and plentiful hornblende, with accessory sphene. The plagioclase is somewhat sericitized, but the biotite and hornblende are fresh.

The sample is from the Wawa subprovince of the Superior Structural Province. The biotite age (2362 ± 52 m.y.) and the hornblende age (2510 ± 62 m.y.) are cooling ages, but that of the latter approaches more closely the time of primary crystallization of the rock. Both minerals, on cooling, passed their respective blocking temperature during the early Aphebian, suggesting that the granodiorite was emplaced and was crystallized during the late Archean Kenoran orogeny.

GSC 73-113 Hornblende, K-Ar age 2554 ± 61 m.y.

K = 0.716%, $^{40}Ar/^{40}K$ = 0.3170, radiogenic Ar = 99.6%.
Concentrate: Relatively clean, fresh, pleochroic light green to bluish green hornblende with a slight trace of biotite contamination.

From granodiorite
(42 E) Road-cut on Highway 11, 3.4 km west of bridge at Longlac, Ontario, 49°46'55"N, 86°35'30"W. *See* Ont. Dept. Mines Map 46b. Sample SH-32-60, collected and interpreted by C.H. Stockwell.

See GSC 73-114 for description and interpretation.

GSC 73-114 Biotite, K-Ar age 2181 ± 48 m.y.

K = 8.01%, $^{40}Ar/^{40}K$ = 0.2405, radiogenic Ar = 99.7%.
Concentrate: Light green biotite with approximately 12% chlorite alteration. Some of the mica flakes have split edges.

From granodiorite
(42 F) Details as for GSC 73-113.

The rock is a medium-grained, pinkish-grey, somewhat foliated, granodiorite composed of quartz, plagioclase, microcline, myrmekite, hornblende, biotite and a little epidote, apatite, zircon and sphene. The plagioclase is considerably altered to sericite but the other minerals are fresh.

The sample is from the Wabigoon subprovince of the Superior Structural Province. Allowing for analytical error, the hornblende, on cooling, passed its blocking temperature during the early Aphebian or late Archean and, as the blocking temperature is not much lower than the temperature of crystallization, this indicates that the granodiorite crystallized during the Archean, probably during the Kenoran orogeny. The difference between the hornblende and biotite ages is much greater than normally found during a simple post-orogenic cooling interval, suggesting that the biotite age may have resulted from a rise in temperature due to re-burial or to some other thermal event of too low a temperature to affect the hornblende. It is quite possible that during this supposed event the biotite lost only part of its argon, in which case the age obtained has no chronological significance.

GSC 73-115 Hornblende, K-Ar age $\frac{2595 \pm 140 \text{ m.y.}}{2612 \pm 141 \text{ m.y.}}$

K = 0.183%, $^{40}Ar/^{40}K = \frac{0.3264}{0.3303}$, radiogenic Ar = $\frac{97.4\%}{95.2\%}$
Concentrate: Relatively clean concentrate of fresh, pleochroic, olive-brown to light bluish green hornblende with only a slight trace of biotite contamination.

From paragneiss
(42 F) Road-cut on Highway 11, 1.6 km west of Pagwachuan, Ontario, 49°46'00"N, 85° 15'00"W. Map-unit 2b, Ont. Dept. Mines Map 51H. Sample SH-29-60, collected and interpreted by C.H. Stockwell.

See GSC 73-116 for description and interpretation.

GSC 73-116 Biotite, K-Ar age 2230 ± 49 m.y.

K = 7.74%, $^{40}Ar/^{40}K$ = 0.2496, radiogenic Ar = 99.7%.
Concentrate: Somewhat altered, brownish orange biotite with approximately 10% chloritization.

From paragneiss
(42 F) Details as for GSC 73-115.

The sample is of dark grey, fine-grained paragneiss composed of quartz, feldspar, biotite, hornblende, accessory apatite, and rare zircon. All the minerals are fresh.

The sample is from the Quetico subprovince of the Superior Structural Province. The ages obtained on the biotite and hornblende are cooling ages, but those obtained on hornblende, because of its higher blocking temperature, approach more closely the time of metamorphism. Allowing for analytical errors, the biotite passed its blocking temperature in the Aphebian and the hornblende passed its blocking temperature somewhat earlier, namely, in the early Aphebian or late Archean, suggesting that the metamorphism is probably Archean.

At the same locality, the paragneiss is cut by a dyke of pegmatite which represents one point on an Rb-Sr whole-rock isochron for pegmatite and granite of the Quetico Belt. This yielded an age of 2612 ± 77 m.y. (λRb = 1.47) for the time of emplacement (Wanless and Loveridge, 1972), placing the pegmatite in the late Archean Kenoran orogeny. This agrees well with the hornblende age determination given above and suggests that the metamorphism of the paragneiss also took place during the Kenoran.

Reference

Wanless, R.K. and Loveridge, W.D.
1972: Rubidium-strontium isotopic age studies, Report 1; Geol. Surv. Can., Paper 72-23.

GSC 73-117 Hornblende, K-Ar age 2806 ± 66 m.y.

K = 0.914%, $^{40}Ar/^{40}K$ = 0.3783, radiogenic Ar = 99.4%.
Concentrate: Pleochroic light green to bluish green, fresh hornblende with a trace of biotite impurity.

From granodiorite
(42 C) Road-cut on Highway 17, 5.6 km east of White River, Ontario, 48°34'40"N, 85°12'40"W. Sample SH-35-60, collected and interpreted by C.H. Stockwell.

See GSC 73-118 for description and GSC 73-119 for interpretation.

GSC 73-118 Biotite, K-Ar age $\frac{2169 \pm 59 \text{ m.y.}}{2130 \pm 48 \text{ m.y.}}$.

K = 7.63%, $^{40}Ar/^{40}K = \frac{0.2382}{0.2310}$, radiogenic Ar = $\frac{99.7\%}{99.5\%}$.
Concentrate: Light greenish biotite with approximately 10% chlorite alteration and about 2% free hornblende contamination.

From granodiorite
(42 C) Details as for GSC 73-117.

The granodiorite is a medium-grained, grey, massive rock composed of quartz, oligoclase, microcline, hornblende and biotite, with accessory apatite. All of the minerals are fresh. The granodiorite is cut in many directions by numerous dykes of biotite-bearing pink pegmatite.

See GSC 73-119 for interpretation.

GSC 73-119 Hornblende, K-Ar age 2968 ± 68 m.y.

K = 0.622%, $^{40}Ar/^{40}K$ = 0.4219, radiogenic Ar = 99.2%.
Concentrate: Clean, unaltered, pleochroic, olive-brown to dark green hornblende with a slight trace of chlorite contamination.

From granodiorite
(42 D) Road-cut on Highway 17, 10.6 km west of bridge over Pays Plat River, Rossport area, Ontario, 48°54'20"N, 87°41'00"W. Map-unit 6, Geol. Surv. Can. Map 308A. Sample SH-39-60, collected and interpreted by C.H. Stockwell.

This is a medium-grained, somewhat foliated, red granodiorite with plentiful hornblende and biotite in roughly parallel crystals. The hornblende is fresh, but much of the biotite is interleaved with chlorite or is mixed with epidote. Oligoclase is considerably altered to sericite and predominates over microcline, which is fresh. Quartz is plentiful and accessories include apatite and magnetite. The rock is cut by stringers of pink pegmatite. This granodiorite seems to be representative of a large area of pink granitic rocks that extends from Schreiber nearly to Nipigon, a distance of 64 km.

The granodiorite of this sample, and of samples GSC 73-118 (biotite 2150 m.y.) and GSC 73-117 (hornblende 2806 ± 65 m.y.) lie within the Wawa subprovince of the Superior Structural Province. The hornblende ages are much older than the commonly found post-Kenoran hornblende cooling ages. Two explanations for these two old ages are possible. One is that the hornblende contains excess argon and, if so, the ages are meaningless. The other is that the ages represent normal post-orogenic cooling ages and, if so, the presence here of a pre-Kenoran orogeny is indicated. The biotite age (2150 m.y.) is middle Aphebian and is much younger than the normal early Aphebian, post-Kenoran cooling ages for this mineral. Accordingly, it is suggested that the region may have been reheated in post-Kenoran time so that, on cooling, the biotite passed its argon blocking temperature during the middle Aphebian to produce this young overprint-

ing or, alternatively, the biotite may have lost only part of its accumulated argon and, if so, the age obtained is chronologically meaningless.

GSC 73-120 Hornblende, K-Ar age $\frac{(2442 \pm 60 \text{ m.y.})^*}{2394 \pm 60 \text{ m.y.}}$

$K = \frac{(0.614\%)}{0.771\%}^*$, $^{40}Ar/^{40}K = \frac{(0.2925)^*}{0.2823}$, radiogenic Ar = 99.3%.
Concentrate: Relatively clean, fresh, pleochroic light brown to dark green hornblende with less than 2% biotite contamination.

From granitic gneiss
(42 C) Road-cut on Highway 17 at south end of Fungus Lake, Ontario, 48°18'00"N, 84° 59'00"W. Sample SH-86-60, collected and interpreted by C.H. Stockwell.

*Adjusted for 2% biotite impurity.

This is a medium-grained, grey, granitic gneiss composed of quartz, oligoclase, microcline, biotite, hornblende and a little epidote, apatite and sphene. The oligoclase is partly altered to sericite and much of the biotite is gone to chlorite but the hornblende is relatively fresh. The granitic gneiss is crossed by joints along which there is a development of epidote and red alterations which were not included in the sample.

The sample is from the Wawa subprovince of the Superior Structural Province. The hornblende, on cooling, passed its argon blocking temperature during the early Aphebian, suggesting that the gneiss crystallized during the late Archean kenoran orogeny.

GSC 73-121 Hornblende, K-Ar age $\frac{(2314 \pm 60 \text{ m.y.})^*}{2299 \pm 60 \text{ m.y.}}$

$K = \frac{(0.633)^*}{0.712\%}$, $^{40}Ar/^{40}K = \frac{(0.2660)^*}{0.2630}$, radiogenic Ar = 99.6%.
Concentrate: Clean, unaltered, light brown to bluish green hornblende with a trace of biotite contamination.

From paragneiss
(42 F) Railway-cut 0.32 km west of Hornepayne station, Ontario, 49°13'40"N, 84°47'20"W. Sample SH-27-60, collected and interpreted by C.H. Stockwell.

*Adjusted for 1% biotite impurity.

See GSC 73-122 for description and interpretation.

GSC 73-122 Biotite, K-Ar age 2446 ± 53 m.y.

K = 7.86%, $^{40}Ar/^{40}K$ = 0.2934, radiogenic Ar = 99.7%.
Concentrate: Clean, fresh, light brown biotite with no visible alteration or contamination.

From paragneiss
(42 F) Details as for GSC 73-121.

The rock is a dark grey, well-foliated, fine-grained paragneiss composed of quartz, albite, biotite, hornblende, and a little microcline and accessory apatite. All the minerals are unaltered. The paragneiss is a component of migmatite in which stringers of white granitic material parallel the foliation of the paragneiss.

The sample is from the Quetico subprovince of the Superior Structural Province, for which subprovince the average of thirteen K-Ar biotite ages is 2496 m.y. which agrees quite closely with the biotite age (2446 ± 53 m.y.) of the present sample, so that this age is considered to be a normal post-orogenic cooling age for biotite. The hornblende age (2299 ± 60 m.y.) however, is much younger and is anomalous in view of the commonly found relationship of argon retentivity which is hornblende > biotite. The cause of the anomaly is unknown.

GSC 73-123 Hornblende, K-Ar age $\frac{(2527 \pm 65 \text{ m.y.})^*}{2450 \pm 65 \text{ m.y.}}$

$K = \frac{(0.990\%)^*}{1.14\%}$, $^{40}Ar/^{40}K = \frac{(0.3110)^*}{0.2942}$, radiogenic Ar = 99.8%.
Concentrate: Relatively clean, pleochroic, olive-brown to bluish green hornblende with approximately 2% biotite contamination.

From granite gneiss
(42 H) Road-cut on Highway 11 at east end of bridge over Mattagami River, Smooth Rock Falls, Ontario, 49°16'20"N, 81°38' 40"W. Sample SH-23-60, collected and interpreted by C.H. Stockwell.

*Adjusted for 2% biotite impurity.

See GSC 73-124 for description and interpretation.

GSC 73-124 Biotite, K-Ar age 2272 ± 62 m.y.

K = 7.32%, $^{40}Ar/^{40}K$ = 0.2576, radiogenic Ar = 98%.
Concentrate: Somewhat altered, brownish coloured biotite with about 8% chloritization.

From granite gneiss
(42 H) Details as for GSC 73-123.

This is a well-foliated, grey, granitic gneiss consisting of quartz, feldspar, hornblende, biotite, epidote and accessory apatite. The feldspar is somewhat sericitized but the hornblende is fresh. Some of the biotite crystals are fresh, but others are partly or completely altered to chlorite. The rock is probably intrusive because it encloses long shreds and angular blocks of hornblende gneiss (probably metavolcanics). The granitic gneiss is cut along and across its foliation by stringers of white and pink granitic materials. The rock lies within the Opatica subprovince of the Superior Structural Province.

The biotite age at 2272 ± 62 m.y. and the hornblende age at 2527 ± 65 m.y. are cooling ages, but that obtained on the hornblende, because of its higher blocking temperature, approaches more closely the time of crystallization. The biotite passed its blocking temperature toward the middle Aphebian, while the hornblende passed its blocking temperature during the early Aphebian, suggesting that the rock crystallized during the late Archean Kenoran orogeny.

GSC 73-125 Muscovite, K-Ar age 1180 ± 40 m.y.

K = 8.79%, $^{40}Ar/^{40}K$ = .0962, radiogenic Ar = 99%.
Concentrate: Clean, clear muscovite.

From "granite"
(41 H) Coast of Georgian Bay, near Killarney, Ontario, 45°58'N, 81°28'W. Map-unit 4a, Geol. Surv. Can. Map 221A, and map-unit 9d (Grenville), Geol. Surv. Can. Map 21-1968. Sample CFCC-216, collected by R.T. Cannon and interpreted by M.J. Frarey.

The rock is a syenitic granite phase of the "Killarney Granite". It is fine- to medium-grained, foliated, pink, and in part porphyritic.

The age probably represents a post-granite metamorphic-deformational event at the Grenville Front. Note agreement with GSC 73-126, a sample from a metaquartzite xenolith in similar adjacent granite.

GSC 73-126 Impure muscovite, K-Ar age 1180 ± 40 m.y.

K = 7.00%, $^{40}Ar/^{40}K$ = 0.0961, radiogenic Ar = 99%.
Concentrate: Impure sericite concentrate with about 30% quartz. Most mica flakes have both inclusions and attached fragments of quartz and some contain very pale green prismatic inclusions (? apatite).

From schist
(41 I) North shore of Georgian Bay, Ontario, 46°01'N, 81°26'W. Map-unit Co2, Geol. Surv. Can. Map 220A, and map-unit 2 (Grenville), Geol. Surv. Can. Map 21-1968. Sample CFCC-62, collected by R.T. Cannon and interpreted by M.J. Frarey.

The rock is a glassy, schistose, metamorphosed orthoquartzite consisting of quartz, sericite, minor feldspar and accessories. It forms a large xenolith in granite.

The age is taken as that of crystallization of sericite during a deformational event at the Grenville Front.

GSC 73-127 Muscovite, K-Ar age 1215 ± 45 m.y.

K = 8.43%, $^{40}Ar/^{40}K$ = 0.0999, radiogenic Ar = 98%.
Concentrate: Relatively clean, clear muscovite with less than 1% biotite and traces of chlorite and hornblende.

From granite
(41 I) North of central part of Balsam Lake, Goschen Tp., Ontario, 46°09'40"N, 81° 13'20"W. Map-unit 4b, Geol. Surv. Can. Map 220A, and map-unit 14 (Southern Province), Geol. Surv. Can. Map 21-1968. Sample FC-29-65, collected and interpreted by M.J. Frarey.

The rock is a grey muscovite granite intruding Huronian Gowganda Formation.

The muscovite is probably a primary constituent of the granite and the age represents the time of granite crystallization or a modified age resulting from deformation subsequently in the Grenville Front zone three miles to the east.

GSC 73-128 Muscovite, K-Ar age 1215 ± 40 m.y.

K = 8.17%, $^{40}Ar/^{40}K$ = 0.0997, radiogenic Ar = 99%.
Concentrate: Relatively clean, clear muscovite with 5% quartz and 2% biotite impurity. About 30% of the flakes carry a light yellow stain.

From schist
(41 I) Reef (Shoal) Lake, Ontario, 46°15'N, 81°12"W. Map-unit B1, Geol. Surv. Can. Map 220A, and map-unit 3 (Southern Province) Geol. Surv. Can. Map 21-1968. Sample FAD-192b, collected by A. Davidson and interpreted by M.J. Frarey.

The rock is a mica schist (metasediment) intercalated with Huronian quartzite a few miles west of the Grenville Front.

The age is interpreted as that of a metamorphic-igneous event that affected the area or a modified age of such an event resulting from subsequent Grenville Front deformation. Note agreement with GSC 73-127 from a granite body in a similar tectonic location a few miles to the south.

GSC 73-129 Biotite, K-Ar age 965 ± 35 m.y.

K = 7.82%, $^{40}Ar/^{40}K$ = 0.0737, radiogenic Ar = 99%.
Concentrate: Relatively clean, unaltered olive-green biotite with about 3% hornblende contamination.

From granite
(41 I) 1000 feet northeast of northeast corner of main body, Bell Lake, Ontario, 46°08'40"N, 81°10'30"W. Map-unit 4b, Geol. Surv. Can. Map 220A, and map-unit 7a (Grenville), Geol. Surv. Can. Map 21-1968. Sample FAD-368-65, collected by A. Davidson and interpreted by M.J. Frarey.

The sample is from the Bell Lake Granite, a coarse-grained, pink, porphyritic (K-feldspar) biotitic granite.

The granite body forms part of a series of granite intrusions along the Grenville Front. An isochron obtained from Front granites not far southwest indicates an intrusive age of 1581 ± 47 m.y. (Wanless and Loveridge, 1972) and the Bell Lake body probably is of similar age. The biotite age is interpreted as that of a metamorphic event during the culmination or close of the Grenville orogeny.

Reference

Wanless, R.K. and Loveridge, W.D.
1972: Rubidium-strontium age studies, report 1; Geol. Surv. Can., Paper 72-23, p. 45-48.

GSC 73-130 Hornblende, K-Ar age 2466 ± 59 m.y.

K = 0.749%, $^{40}Ar/^{40}K$ = 0.2975, radiogenic Ar = 96%.
Concentrate: Fresh, pleochroic, light brown to dark green hornblende with less than 2% biotite contamination.

From "granite"
(31 L) Road-cut on Highway 11, near north end of Angus Lake, Ontario, 46°55'40"N, 79°45'00"W. See map-unit 4, plate 2, W.G.Q. Johnson, Geol. Soc. Amer. Bull., v. 65, no. 11, 1954. Sample SH-6-60, collected and interpreted by C.H. Stockwell.

This hornblende is from a massive, medium-grained, grey granitic rock composed mainly of feldspar, hornblende and biotite. The hornblende is fresh, but the biotite is much altered to chlorite and the feldspar to sericite and zoisite. The rock is criss-crossed by dykes of lighter grey to pink aplitic granite and both kinds of grey rock form inclusions in the pink. The sample is from the Abitibi Belt of the Superior Structural Province, and is representative of Johnston's (1954) chlorite zone about three miles northwest of the Grenville Front. The rock is overlain unconformably by the Gowganda Formation.

The K-Ar age is interpreted to mean that the hornblende passed its argon blocking temperature 2466 ± 59 m.y. ago, shortly after the time of crystallization of the rock. This was during the early Aphebian, suggesting that the rock crystallized during the late Archean Kenoran Orogeny. The hornblende age is a maximum for the time of deposition of the Gowganda Formation.

Reference

Johnston, W.G.Q.
1954: Geology of the Temiskaming-Grenville contact southeast of Lake Temagami, Northern Ontario, Canada; Geol. Soc. Amer. Bull., v. 65, p. 1047-1074.

GSC 73-131 Hornblende, K-Ar age 884 ± 31 m.y.

K = 0.486%, $^{40}Ar/^{40}K$ = 0.0660, radiogenic Ar = 94.7%.
Concentrate: Clean, unaltered, pleochroic olive-green to bluish green hornblende with no visible contamination.

From banded gneiss
(31 L) On Highway 11, 4.8 km north of North Bay, Ontario, 46°21'20"N, 79°28'20"W. Sample SH-3-60, collected and interpreted by C.H. Stockwell.

This is the same sample as GSC 62-115 which yielded a K-Ar age of 940 ± 60 m.y. on biotite (Leech *et al.*, 1963). For description of the gneiss *see* GSC 62-115.

The sample was collected from the Central Gneiss Belt (Wynne-Edwards, 1972) which is a subprovince of the Grenville Structural Province. The ages obtained (on hornblende 884 ± 31 m.y. and on biotite 940 ± 60 m.y.) are early Hadrynian and both are interpreted as cooling ages. Normally, it would be expected that the hornblende, because of its higher blocking temperature, would give a slightly older cooling age

than co-existing biotite, but in this case, taking the analytical errors into consideration, the two ages are indistinguishable. There is some uncertainty regarding their time of crystallization which could be either during the late Neohelikian Grenvillian orogeny or earlier. The former, however, seems more likely because of the nearby Grenvillian age of 1160 m.y. which is a ^{207}Pb-^{206}Pb age obtained on sphene from granitic gneiss and thought to be a metamorphic age (Tilton and Grünenfelder, 1968).

References

Leech, G.B., Lowdon, J.A., Stockwell, C.H. and Wanless, R.K.
1963: Age determinations and geological studies; Geol. Surv. Can., Paper 63-17.

Tilton, G.R. and Grünenfelder, M.
1968: Sphene: uranium-lead ages; Science, v. 159, p. 1458-1461.

GSC 73-132 Hornblende, K-Ar age $\frac{(973 \pm 33 \text{ m.y.})^*}{965 \pm 33 \text{ m.y.}}$

$K = \frac{(1.26\%)^*}{1642\%}$, $^{40}Ar/^{40}K = \frac{(0.0745)^*}{0.0737}$, radiogenic Ar = 98.7%.
Concentrate: Clean, unaltered, pleochroic light brown to dark green hornblende with less than 2% biotite contamination.

From migmatite
(31 L) Mattawa area, Ontario, 46°18'20"N, 78° 44'20"W. *See* Ont. Dept. Mines Map 53D. Sample SH-1-60, collected and interpreted by C.H. Stockwell.

*Adjusted for 2% biotite impurity.

See GSC 73-133 for description and interpretation.

GSC 73-133 Biotite, K-Ar age $\frac{1598 \pm 40 \text{ m.y.}}{1644 \pm 40 \text{ m.y.}}$

$K = 7.91\%$, $^{40}Ar/^{40}K = \frac{0.1472}{0.1535}$, radiogenic Ar $= \frac{99\%}{98.7\%}$.
Concentrate: Clean, unaltered, light brown biotite with no visible alteration. The concentrate contains less than 1% hornblende contamination and some of the mica flakes have red hematite inclusions.

From migmatite
(31 L) Details as for GSC 73-132.

The migmatite is a rock in which pale pink granitic layers alternate with dark grey mafic layers. The rock is composed of abundant quartz and orthoclase with lesser amounts of plagioclase, hornblende and biotite. Apatite is accessory. All the minerals are fresh.

The sample is from the Central Gneiss Belt (Wynne-Edwards, 1972) of the Grenville Structural Province and the hornblende age is normal for the post-Grenvillian cooling period of this province. It falls in the early Hadrynian and because of the high blocking temperature of hornblende is only slightly younger than the time of crystallization which, probably, was during the late Neohelikian Grenvillian orogeny.

The ages obtained on biotite (GSC 73-133, 1598 ± 40 and 1644 ± 40 m.y.) from the same sample are clearly anomalous for the reason that this mineral, because of its low blocking temperature, normally gives a younger age than co-existing hornblende. The anomalously old ages obtained may be due to excess argon and, if so, are chronologically meaningless.

Reference

Wynne-Edwards, H.R.
1972: The Grenville Province. *In* Variations in tectonic styles in Canada; Geol. Assoc. Can., Special Paper No. 11, p. 263-334.

GSC 73-134 Hornblende, K-Ar age 838 ± 29 m.y.

K = 0.672%, $^{40}Ar/^{40}K$ = 0.0618, radiogenic Ar = 95%.
Concentrate: Pleochroic, light green to olive-brown hornblende with slight biotite and quartz contamination.

From granite
(31 C) Road-cut on Highway 7, 9.2 km east of Marmora, Ontario, 44°29'40"N, 77°34' 15"W. Map-unit 8a, Geol. Surv. Can. Map 560A. Sample SH-7-63, collected and interpreted by C.H. Stockwell.

The granite from which this hornblende was separated is a massive, medium-grained grey rock composed of quartz, perthite, alkali amphibole, biotite, zircon and fluorite. The sample is from the Deloro stock which intrudes rocks of the Grenville and Hastings Groups.

The age of 838 ± 29 m.y. compares with two K-Ar ages on riebeckite previously reported from the same stock, one at 875 m.y. (GSC 63-115, Wanless *et al.*, 1965) and the other at 989 ± 30 m.y. (Macintyre *et al.*, 1967). All are early Hadrynian cooling ages and, being on amphibole, approach quite closely the time

of primary crystallization as given by an Rb-Sr whole-rock isochron age of 1059 ± 46 m.y. (λRb = 1.47) (Wanless and Loveridge, 1972) which indicates that the stock was emplaced during the Grenvillian orogeny of late Neohelikian age.

References

Macintyre, R.M., York, D. and Moorhouse, W.W.
1967: Potassium-argon age determinations in the Madoc-Bancroft area in the Grenville Province of the Canadian Shield; Can. J. Earth Sci., v. 4, p. 815-828.

Wanless, R.K., Stevens, R.D., Lachance, G.R. and Rimsaite, R.Y.H.
1965: Age determinations and geological studies; Geol. Surv. Can., Paper 64-17 (Pt. 1).

Wanless, R.K. and Loveridge, W.D.
1972: Rubidium-strontium isochron age studies, Report 1; Geol. Surv. Can., Paper 72-23.

GSC 73-135 Whole-rock, K-Ar age 851 ± 30 m.y.

K = 0.961%, $^{40}Ar/^{40}K$ = 0.0629, radiogenic Ar = 98.9%.
Concentrate: Crushed whole-rock.
From diabase
(31 C) North of Kingston, Ontario, 44°20'N, 76° 27'W. *See* Geol. Surv. Can. Map 27-1962. Sample K-4-1, collected by E. Irving and interpreted by W.F. Fahrig.

This sample is from the chilled margin of a north-trending diabase dyke. The paleomagnetic pole for this dyke (Park and Irving, 1972) is similar to that for the Franklin dykes which are thought to be about 700 m.y. old (Fahrig *et al.*, 1971). The present age of 851 ± 30 m.y. is significantly greater, but the pole for these north-trending dykes is a 'virtual pole', and probably does not adequately average paleosecular variation at the time of intrusion.

References

Fahrig, W.F., Irving, E. and Jackson, G.D.
1971: Paleomagnetism of the Franklin diabases; Can. J. Earth Sci., v. 8, p. 455-467.

Park, J.K. and Irving, E.
1972: Magnetism of dikes of the Frontenac axis; Can. J. Earth Sci., v. 9, p. 763-765.

GSC 73-136 Hornblende, K-Ar age 2236 ± 58 m.y.

K = 0.772%, $^{40}Ar/^{40}K$ = 0.2507, radiogenic Ar = 99%.
Concentrate: Pleochroic, light green to olive-brown hornblende with approximately 3% attached biotite contamination.

From meta-tuff
(32 F) Road-cut on Senneterre-Chibougamau highway 4.2 km north of railway crossing, Quebec, 49°31'50"N, 76°09'10"W. *See* Que. Dept. Mines Map 1258. Sample SH-17-60, collected and interpreted by C.H. Stockwell.

This is a fine-grained, massive, dark grey meta-tuff with a clastic texture. The rock is composed of angular fragments of quartz, feldspar and felsite in a matrix of quartz, plagioclase, pale brown biotite and green hornblende. The biotite and hornblende are fresh and are interpreted to be metamorphic. The sample is from the Abitibi Belt, which is a subprovince of the Superior Structural Province.

The K-Ar age of 2236 ± 58 m.y. on the hornblende is interpreted to be a cooling age, which, because of the high-temperature retentivity of argon in this mineral, is normally not much younger than the time of crystallization. This might suggest an Aphebian age for the metamorphism, but as there is no geological evidence suggesting such a young metamorphism, the isotopic age more probably resulted from re-heating of the rock, suggesting a possible affinity with the Chibougamau Lake pluton which gave K-Ar biotite ages of 2020 ± 70 and 2045 ± 70 m.y. (GSC 67-113, Wanless *et al.*, 1970).

Reference

Wanless, R.K., Stevens, R.D., Lachance, G.R. and Delabio, R.N.
1970: Age determinations and geological studies; Geol. Surv. Can., Paper 69-2A.

GSC 73-137 Hornblende, K-Ar age 1087 ± 36 m.y.

K = 0.332%, $^{40}Ar/^{40}K$ = 0.0860, radiogenic Ar = 89%.
Concentrate: Clean, unaltered, pleochroic light green to bluish green hornblende with no visible contamination.

From schist
(32 G) Chibougamau highway, 0.16 km north of bridge over Lac Dufresne, Quebec, 49° 34'50"N, 74°15'35"W. Map-unit 5a, Que. Dept. Mines Map 1236. Sample SH-56a-62, collected and interpreted by C.H. Stockwell.

This is a fine-grained, dark green, hornblende schist composed of quartz, feldspar, abundant hornblende and a little carbonate, epidote, and pyrite.

The sample is from a zone of schists within the Grenville Front which forms the northwest boundary of the Grenville Front Tectonic Zone of Wynne-Edwards (1972). The schist probably formed by metamorphism of nearby Archean greenstones of the Superior Province and the age obtained on the hornblende, because of the high blocking temperature for this mineral, probably approaches closely the time of formation of the schist and of the Grenville Front at this locality. The age, at 1087 ± 36 m.y., is late Neohelikian, which is somewhat older than the usual post-Grenvillian cooling age of this mineral so that the Grenville Front at this locality may have formed during an early stage of the Grenvillian orogeny.

Reference

Wynne-Edwards, H.R.
1972: The Grenville Province. *In* variations in tectonic styles in Canada; Geol. Assoc. Can., Special Paper No. 11, p. 263-334.

GSC 73-138 Hornblende, K-Ar age 921 ± 32 m.y.

K = 1.48%, $^{40}Ar/^{40}K$ = 0.0695, radiogenic Ar = 99%.
Concentrate: Clean, unaltered, pleochroic, light brown to dark green hornblende with no visible contamination.

From orthogneiss
(32 G) On west side of Chibougamau highway at Mile 107.6, Ducharme Tp., Quebec, 49° 26'28"N, 74°08'58"W. *See* Que. Dept. Mines prelim. map 1069. Sample SH-7-59, collected and interpreted by C.H. Stockwell.

The hornblende is from the same sample as the biotite of GSC 62-150 which gave a K-Ar age of 1105 ± 60 m.y. (Leech *et al.*, 1963). For rock description *see* GSC 62-150.

The sample is from a locality 14.5 km southeast of the Grenville Front and is within the Grenville Front Tectonic Zone of Wynne-Edwards (1972). The age obtained on the biotite (1105 ± 60 m.y.) is regarded as anomalous due to excess argon and is geochronologically meaningless. That on the hornblende (921 ± 32 m.y.) is early Hadrynian and is normal for the

post-Grenvillian cooling period for this mineral, but it is uncertain whether the hornblende crystallized during the Grenvillian orogeny or was merely heated during that time. The latter explanation seems more probable because the orthogneiss has been dated by the Rb-Sr whole-rock isochron method at 2855 ± 146 m.y. (λRb = 1.47) (Frith, 1971), and the same author has concluded that the northwestern limit of the Grenvillian orogeny is some 48 km southeast of the Grenville Front. That is to say, the limit of the Grenvillian orogeny does not necessarily coincide with the Grenville Front which, at this locality, appears to have formed initially in the Archean.

References

Frith, R.A.
1971: Rb-Sr isotopic studies of the Grenville Structural Province in the Chibougamau and Lac St. Jean area; unpubl. Ph.D. thesis, Dept. Geol. Sci., McGill Univ., Montreal.

Leech, G.B., Lowdon, J.A., Stockwell, C.H. and Wanless, R.K.
1963: Age determinations and geological studies; Geol. Surv. Can., Paper 63-17.

GSC 73-139 Hornblende, K-Ar age 1639 ± 109 m.y.

K = 0.247%, $^{40}Ar/^{40}K$ = 0.1528, radiogenic Ar = 93%.
Concentrate: Clean, unaltered, pleochroic olive-green to bluish green hornblende with no visible contamination.

From hornblende schist
(25 E) Hudson Bay Co. Post, Wakeham Bay, Quebec, 61°36'N, 71°57'W. Map-unit 3a, Geol. Surv. Can. Map 13-1960. Sample SH-99-60, collected by V.W. Sims and interpreted by C.H. Stockwell.

This is a dark green, coarse-grained, hornblende schist with pronounced cleavage and lineation. In addition to hornblende, which is unaltered, the rock contains quartz and very minor amounts of biotite and chlorite.

It lies within the Cape Smith Fold Belt, which is a subprovince of the Churchill Structural Province.

For interpretation see GSC 73-143.

GSC 73-140 Hornblende, K-Ar age 1584 ± 48 m.y.

K = 1.31%, $^{40}Ar/^{40}K$ = 0.1452, radiogenic Ar = 99%.
Concentrate: Clean, unaltered, pleochroic olive-brown to bluish green hornblende with no visible contamination.

From mafic gneiss
(35 H) 13 km southwest of Fisher Bay, Quebec, 61°42'N, 72°26'W. Map-unit 2, Geol. Surv. Can. Map 13-1960. Sample KG-105-59, collected by R. Kretz and interpreted by C.H. Stockwell.

See GSC 73-141 for description and GSC 73-143 for interpretation.

GSC 73-141 Biotite, K-Ar age 1639 ± 40 m.y.

K = 8.18%, $^{40}Ar/^{40}K$ = 0.1528, radiogenic Ar = 99%.
Concentrate: Clean, unaltered, light brownish biotite with no visible contamination.

From mafic gneiss
(35 H) Details as for GSC 73-140.

The rock from which these two minerals were separated is a black, medium-grained, mafic gneiss with compositional foliation and strong lineation. Hornblende constitutes more than half of the rock and a little biotite is also present. Both minerals are fresh.

The sample is from the Churchill Structural Province just north of the Cape Smith Fold Belt.

For interpretation of age see GSC 73-143.

GSC 73-142 Biotite, K-Ar age 1628 ± 41 m.y.

K = 7.96%, $^{40}Ar/^{40}K$ = 0.1513, radiogenic Ar = 98%.
Concentrate: Relatively clean, fresh, dark olive-buff biotite with less than 2% hornblende contamination.

From mafic gneiss
(35 G) 19 km south of Deception Bay, Quebec, 61°59'N, 74°43'W. Map-unit 2, Geol. Surv. Can. Map 13-1960. Sample KG-35-59, collected by R. Kretz and interpreted by C.H. Stockwell.

See GSC 73-143 for description and interpretation.

GSC 73-143 Hornblende, K-Ar age 1658 ± 48 m.y.

K = 0.463%, $^{40}Ar/^{40}K$ = 0.1555, radiogenic Ar = 96%.

Concentrate: Clean, fresh, pleochroic light bluish green to olive-green hornblende with no visible contamination.

From mafic gneiss
(35 G) Details as for GSC 73-142.

The rock from which these two minerals were separated is a dark grey, medium-grained, mafic gneiss with distinct foliation and lineation. Hornblende constitutes more than half of the rock and some biotite is also present. Both minerals are unaltered. The sample is from the Churchill Structural Province at a point north of the Cape Smith Fold Belt.

The five age determinations from rocks of the Cape Smith Belt and from the Churchill Structural Province just north of it, are tabulated as follows:

Rock type	No.	Biotite age	No.	Hornblende age, m.y.
Schist			GSC 73-139	1639±109
Gneiss	GSC 73-141	1639 ± 40	GSC 73-140	1584±48
Gneiss	GSC 73-142	1628 ± 41	GSC 73-143	1658±48

As can be seen, all the ages are much the same and, because of overlapping analytical errors, are indistinguishable from one another, even though the argon blocking temperature for hornblende is much higher than for biotite. This is interpreted to be the result of quick cooling, the cooling interval being too short to be measurable by the K-Ar method.

GSC 73-144 Biotite, K-Ar age 877 ± 24 m.y.

K = 7.79%, $^{40}Ar/^{40}K$ = 0.0653, radiogenic Ar = 98%.
Concentrate: Clean, unaltered, brownish orange biotite.

From altered anorthosite
(22 D) Road-cut just east of bridge over Shipshaw River, Quebec, 48°30'20"N, 71°16'30"W. Map-unit 1, Que. Dept. Mines Map 1175. Sample SH-47-62, collected and interpreted by C.H. Stockwell.

See GSC 73-145 for description and interpretation.

GSC 73-145 Hornblende, K-Ar age 986 ± 30 m.y.

K = 1.08%, $^{40}Ar/^{40}K$ = 0.0758, radiogenic Ar = 97%.
Concentrate: Clean, unaltered, pleochroic dark green to olive green hornblende with no visible contamination.

From altered anorthosite
(22 D) Details as for GSC 73-144.

This sample is of anorthosite partly altered to coarse-grained biotite and hornblende which occur in patches extending outwards for 5 to 7.5 cm from both walls of a pegmatite dyke about 15 cm wide. The sample from the alteration zone contains somewhat sericitized plagioclase along with hornblende and biotite which are fresh, although the biotite crystals are somewhat bent and broken.

The sample is from the Central Granulite Terrain (Wynne-Edwards, 1972) which is a subprovince of the Grenville Structural Province. Both the ages (986 ± 30 m.y. on hornblende and 877 ± 24 m.y. on coexisting biotite) are early Hadrynian cooling ages and that on the hornblende, because of the higher blocking temperature for this mineral, approaches more closely the time of crystallization, which was undoubtedly at the time of intrusion of the pegmatite which, in turn, was probably emplaced during the Grenvillian orogeny of late Neohelikian age. The age obtained on the hornblende is a minimum for the anorthosite.

Reference

Wynne-Edwards, H.R.
1972: The Canadian Grenville Province. *In* Variations in tectonic styles in Canada; Geol. Assoc. Can., Specila Paper No. 11, p. 263-334.

GSC 73-146 Biotite, K-Ar age 1411 ± 35 m.y.

K = 7.78%, $^{40}Ar/^{40}K$ = 0.1228, radiogenic Ar = 98%.
Concentrate: Clean, unaltered, light brown biotite with no visible contamination.

From migmatite
(24 H) North shore of unnamed lake between George River and Tunulih River, Quebec, 57°52'30"N, 65°55'45"W. Map-unit 11, Geol. Surv. Can. Map 8-1970. Sample SH-5-62, collected and interpreted by C.H. Stockwell.

See GSC 73-147 for description and interpretation.

GSC 73-147 Hornblende, K-Ar age 1678 ± 50 m.y.

K = 1.27%, $^{40}Ar/^{40}K$ = 0.1583, radiogenic Ar = 97%.
Concentrate: Relatively clean, fresh, pleochroic, olive-brown to dark green hornblende with only a slight trace of biotite.

From migmatite
(24 H) Details as for GSC 73-146.

The migmatite is a dark grey, medium-grained rock composed of quartz, plagioclase, biotite, hornblende, and a little apatite, epidote and sphene. The minerals are fresh. The rock has a contorted gneissic structure which is cut parallel with, and across, the foliation planes by lenses and stringers of pink pegmatite.

The sample is from the Churchill Structural Province east of the Labrador Fold Belt. The age obtained on hornblende (1678 ± 50 m.y.) because of its high blocking temperature, no doubt approaches the time of metamorphism more closely than that obtained on biotite (1411 ± 35 m.y.). The hornblende age is Paleohelikian, suggesting that the metamorphism is Hudsonian (late Aphebian). The difference between the cooling age of hornblende and that of biotite is much greater than normally found as a result of simple post-orogenic cooling, which suggests that the biotite age is an overprint resulting from some other thermal event.

GSC 73-148 Hornblende, K-Ar age 1351 ± 42 m.y.

K = 1.85%, $^{40}Ar/^{40}K$ = 0.1155, radiogenic Ar = 99.3%.
Concentrate: Relatively clean, unaltered, pleochroic light brown to dark green hornblende with approximately 2% free biotite contamination.

From charnockitic gneiss
(24 P) Northeast shore of Edward Lake, Quebec, 59°53'30"N, 65°02'00"W. Map-unit 20, Geol. Surv. Can. Map 13-1968. Sample SH-12-62, collected and interpreted by C.H. Stockwell.

This hornblende is from the same sample that gave a biotite K-Ar age of 1590 ± 90 m.y. (GSC 62-132) to which the reader is referred for a petrographic description (*in* Leech *et al.*, 1963). The great difference between the hornblende and biotite ages from the same sample suggests that one or the other is anomalous. It seems probable that the hornblende age is the more reliable because of its more recent determination, analytical techniques having improved. Because of the high blocking temperatures of hornblende its determined cooling age is thought to approach closely its age of crystallization.

Reference

Leech, G.B., Lowdon, J.A., Stockwell, C.H. and Wanless, R.K.
1963: Age determinations and geological studies; Geol. Surv. Can., Paper 63-17.

GSC 73-149 Whole-rock, K-Ar age 1873 ± 53 m.y.

K = 0.437%, $^{40}Ar/^{40}K$ = 0.1876, radiogenic Ar = 95.7%.
Concentrate: Crushed whole-rock.

From lamprophyre
(24 C) Outcrop in stream valley, east of unnamed lake, Quebec, 56°41'N, 68°48'W. Map-unit 11, Lac Patu map (Que. Dept. Nat. Resour., in press). Sample 19A9, collected and interpreted by B. Dressler (Que. Dept. Nat. Resour.).

The dated lamprophyre outcrops in an area underlain by iron-rich argillites and siltstone of the Ruth Formation and by rocks of the Sokoman Formation (= iron-formation) of the Labrador Trough.

The rock is massive, fine- to medium-grained, and dark greenish grey. In thin section, it is composed of serpentinized olivine, chloritized pyroxene, and phlogopite-biotite set in a fine-grained groundmass of garnet (probably andradite), chlorite minerals and opaque minerals. Apatite and sphene occur as minor constituents. The ore minerals are ilmenite, magnetite, pyrite, chalcopyrite, awaruite and hematite.

Rocks cropping out close to the lamprophyre are heavily faulted. Their structure is more or less independent of the general north-northwest trend, showing, for instance, high-angle cross-faults.

The lamprophyre is probably associated with carbonatites, olivine-melilitite tuffs and carbonatite breccias found a few miles to the south and southeast (Dimroth, 1970, Dressler, in press).

The tectonic appearance and radiometric age of the rock prove the deposition and deformation of the iron-formation of the Labrador Trough to be older than 1873 ± 53 m.y. The obtained age, however, is surprisingly old, since it is older than the common Hudsonian 1600 m.y. age.

However, it coincides very well with an age determination by Fryer (1972), who dated the iron-formation at 1870 ± 50 m.y.

References

Dimroth, Erich
1970: Meimechites and Carbonites of the Castignon Lake Complex, New Quebec; Neues Jahrb. Mineral. Abh., v. 112, no. 3, p. 239-278.

Dressler, Burkhard
Geology of the Patu Lake area; Quebec Dept. Nat. Resour.; Prel. Report 603 (in press).

Fryer, B.J.
1972: Age determination in the Circum-Ungava Geosyncline and the Evolution of Precambrian Banded iron-formation; Can. J. Earth Sci., v. 9, no. 6, p. 652-663.

GSC 73-150 Biotite, K-Ar age 1016 ± 28 m.y.

K = 7.58%, $^{40}Ar/^{40}K$ = 0.0788, radiogenic Ar = 99.2%.
Concentrate: Relatively clean, light greenish brown biotite with no visible alteration but with a trace of hornblende contamination.

From gneiss or migmatite
(23 B) Approximately 3 km east of north end of lake to east of Lac Gentilhomme, Quebec, 52°38'N, 66°48'W. Sample JD-182A-63, collected and interpreted by G.D. Jackson.

See GSC 73-151 for description and GSC 73-162 for interpretation.

GSC 73-151 Hornblende, K-Ar age 985 ± 34 m.y.

K = 1.27%, $^{40}Ar/^{40}K$ = 0.0757, radiogenic Ar = 98.0%.
Concentrate: Unaltered, pleochroic, greenish brown to bluish green hornblende with approximately 2% biotite contamination.

From gneiss or migmatite
(23 B) Details as for GSC 73-150.

The sample is from migmatized Kaniapiskau Supergroup sedimentary rocks that may belong to the Katso Formation.

The sample is fine- to medium-grained, inequigranular, poikiloblastic, anhedral and thinly banded. It contains 26% quartz, 29% oligoclase, 20% brown biotite, 12% blue-green hornblende, 8% pistacite, 3% apatite, 2% orthoclase and traces of zircon, pyrrhotite, allanite and kaolinite.

For interpretation see GSC 73-162.

GSC 73-152 Biotite, K-Ar age 1051 ± 29 m.y.

K = 6.35%, $^{40}Ar/^{40}K$ = 0.0823, radiogenic Ar = 98.6%.
Concentrate: Fresh and unaltered, reddish brown biotite with no visible contamination.

From amphibolite
(23 B) Large outcrop area 0.48 km east of Moisie River, Quebec, 52°18'30"N, 66°46'W. Sample JDS-189B/6-63, collected by Ian Semple and interpreted by G.D. Jackson.

See GSC 73-153 for description and GSC 73-162 for interpretation.

GSC 73-153 Hornblende, K-Ar age 831 ± 29 m.y.

K = 1.44%, $^{40}Ar/^{40}K$ = 0.0611, radiogenic Ar = 97.5%.
Concentrate: Clean, fresh and unaltered, pleochroic, greenish brown to light brown hornblende with no visible contamination.

From amphibolite
(23 B) Details as for GSC 73-152.

The sample is from an amphibolite band in a hybrid area that also contains segregated paragneisses, pegmatites and granitic intrusions. The sample is fine-grained, inequigranular, poikiloblastic, finely foliated and lineated. It contains 35% oligoclase-andesine, 40% brownish green hornblende, 14% deep reddish brown biotite, 5% pale pink garnet, 2% apatite, 2% magnetite and traces of leucoxene, sphene, zircon, pyrrhotite, goethite, carbonate, muscovite, and clinopyroxene. The clinopyroxene is relict and partially replaced by hornblende. The plagioclase is partly altered. The amphibolite resembles that derived from basic metavolcanic rocks and is probably part of the Kaniapiskau Supergroup.

For interpretation see GSC 73-162.

GSC 73-154 Hornblende, K-Ar age 927 ± 32 m.y.

K = 1.37%, $^{40}Ar/^{40}K$ = 0.0701, radiogenic Ar = 97.2%.
Concentrate: Clean, unaltered, pleochroic, olive-brown to dark green hornblende with no visible contamination.

From metadiorite
(23 B) West of Rivière la Ronde, Quebec, 52° 06'N, 66°55'30"W. Sample JD-339C/63, collected and interpreted by G. D. Jackson.

The sample is from a massive uniform body that has been mylonitized and recrystallized into a strongly lineated rock. The body is considered to be an intrusion that is related to the Shabogamo gabbros and gabbroic anorthosites, although it could be metavolcanic. The sample is fine-grained, inequigranular and poikiloblastic. It contains 25% antiperthitic oligoclase, 18% greenish brown hornblende, 13% garnet, 6% clinopyroxene, 8% dark brownish red biotite, 5% antiperthite, 8% orthoclase, 4% magnetite-ilmenite, 3% clinozoisite, and lesser amounts of apatite, myrmekite, scapolite, pyrrhotite, calcite, zircon and allanite. Hornblende rims occur around the pyroxene and clinozoisite has developed from plagioclase and clinopyroxene.

For interpretation see GSC 73-162.

GSC 73-155 Whole-rock, K-Ar age 954 ± 33 m.y.

K = 0.451%, $^{40}Ar/^{40}K$ = 0.0727, radiogenic Ar = 97.2%.
Concentrate: Crushed whole-rock.

From basic dyke
(22 D) 6.4 km northeast of St. Henri-de-Taillon, Quebec, 48°42'N, 71°48'W. Sample FP72-3605, collected and interpreted by W. F. Fahrig.

The sample was collected from 0.9-m-thick north-dipping, basic dyke. The dyke strikes 150° and cuts the Lac St. Jean anorthosite. It is megascopically fresh and exhibits a chilled, undisturbed contact with the anorthosite country rock. In thin section the rock appears unaltered, consisting chiefly of plagioclase, olivine, iron-ores and biotite. Larger blocky plagioclase phenocrysts show fine oscillatory zoning.

This age is considered to be the minimum age of intrusion of the dyke. Previous experience with whole-rock K-Ar dating of basic intrusions suggests that the ages tend to be at least 10% less than their true ages. This dyke is likely to be at least 1100 m.y. old. The anorthosite cut by the dyke was intruded and cooled prior to dyke intrusion, so it is presumably still older.

GSC 73-156 Whole-rock, K-Ar age 3520 ± 72 m.y.

K = 0.440%, $^{40}Ar/^{40}K$ = 0.6031, radiogenic Ar = 99.0%.
Concentrate: Crushed whole-rock.

From gabbro
(23 H) Gabbro Lake, Quebec, 53°37'N, 65°17'W. Map-unit 8, Geol. Surv. Can. Map 17-1961. Sample FA-710442, collected and interpreted by W. F. Fahrig.

The sample is fresh gabbro from one of the Shabogamo gabbro intrusions (Fahrig, 1967; Wynne-Edwards; 1961; Fahrig *et al.*, 1974). The gabbros intrude quartzite that lies unconformably on strata of the Kaniapiskau Supergroup. Shabogamo gabbros to the south of the collecting sites were metamorphosed and deformed during the Grenvillian Orogeny. The intrusions are therefore Helikian and the whole-rock age must reflect the presence of excess argon. It is noteworthy that the gabbro occurs near the Grenville Front where excess argon has previously been reported and explained (Stockwell, 1963; Wanless *et al.*, 1970).

References

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1967: Shabogamo Lake map-area, Newfoundland-Labrador and Quebec; Geol. Surv. Can., Mem. 354.

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Stockwell, C. H.
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1970: Anomalous parent daughter isotopic relationship in rocks adjacent to the Grenville Front near Chibougamau, Quebec; Eclogae Geol. Helv., v. 63/1, p. 345-364.

Wynne-Edwards, H. R.
1961: Ossokmanuan Lake (west half), Newfoundland; Geol. Surv. Can., Prelim. Map 17-1961.

GSC 73-157 Biotite, K-Ar age 1410 ± 43 m.y.

K = 6.28%, $^{40}Ar/^{40}K$ = 0.1227, radiogenic Ar = 99.1%.
Concentrate: Impure, thick, brown biotite with less than 5% attached hornblende impurity.

From amphibolite
(24 H) George River area, Quebec, 57°34'N, 65°39'W. Sample RM69-94A, collected by E. W. Reinhardt and interpreted by F. C. Taylor.

This sample is from a biotite amphibolite that forms about 70% of a mixed, contorted pegmatite-granitic gneiss-amphibolite terrain forming part of the Churchill Province. The age, 1410 ± 43 m.y. is young for this region as most other ages are in the order of 1700 to 1800 m.y. (e.g. *see* GSC 73-158). The amphibolite in parts of the outcrop is cataclastic and the younger age may reflect this deformation.

GSC 73-158 Hornblende, K-Ar age 1859 ± 52 m.y.

K = 0.558%, $^{40}Ar/^{40}K$ = 0.1854, radiogenic Ar = 97.7%.
Concentrate: Clean, pleochroic, dark green to brownish yellow hornblende with no visible contamination.

From amphibolite
(24 A) Near George River, Quebec, 56°18'N, 64°41'W. *See* Geol. Surv. Can. Map 8-1970. Sample TA 69-1A, collected and interpreted by F.C. Taylor.

This sample is from a dark green, medium-grained, equigranular, banded biotite amphibolite that occurs in a moderately mylonitized zone near the George River. The age is a metamorphic one and is undoubtedly related to the Hudsonian orogeny which left its imprint on the rocks to the east of the Labrador Trough.

GSC 73-159 Whole-rock, K-Ar age 1420 ± 43 m.y.

K = 0.473%, $^{40}Ar/^{40}K$ = 0.1239, radiogenic Ar = 97.1%.
Concentrate: Crushed whole-rock.

From diabase
(23 P) Near south shore of Lake Mistinibi, Quebec, 55°56'N, 64°08'W. Map-unit 24, Geol. Surv. Can., Paper 71-48. Sample TA 537B, collected and interpreted by F.C. Taylor.

This sample is from the chill zone of a 3-m-thick vertical diabase dyke that strikes N25E. This dyke intrudes garnetiferous paragneiss that is probably metamorphosed Kaniapiskau Supergroup strata. The age provides an approximation of the time of intrusion of the dyke and a minimum age for the time of metamorphism. Compare with GSC 73-174.

GSC 73-160 Hornblende, K-Ar age 1536 ± 46 m.y.

K = 1.08%, $^{40}Ar/^{40}K$ = 0.1388, radiogenic Ar = 98.4%.
Concentrate: Clean, fresh and unaltered, pleochroic, yellow-brown to dark green hornblende with no visible contamination.

From amphibolite
(24 A) Northern Quebec, 56°35'N, 64°01'W. *See* Geol. Surv. Can. Map 8-1970. Sample RM 69-49A, collected by E.W. Reinhardt and interpreted by F.C. Taylor.

This sample is from a fine-grained, dark grey-green, thinly laminated amphibolite that is associated with concordant bands of hornblende-biotite granite that in places is slightly pegmatitic. It lies about 140 km east of the Labrador Trough. The age probably represents the minimum age of the metamorphism in this area. As the sample is from rocks close to a large post-tectonic adamellite intrusive, it may have been somewhat updated.

GSC 73-161 Hornblende, K-Ar age 904 ± 31 m.y.

K = 1.26%, $^{40}Ar/^{40}K$ = 0.0678, radiogenic Ar = 98.3%.
Concentrate: Fresh, unaltered, pleochroic, olive-green to light green hornblende with less than 2% biotite contamination.

From gneiss
(23 B) North tip of point on east side of Wahnahnish Lake, Labrador, Newfoundland, 52° 51'30"N, 66°50'W. Sample JD-78/2-63, collected and interpreted by G.D. Jackson.

See GSC 73-162 for description and interpretation.

GSC 73-162 Biotite, K-Ar age 908 ± 26 m.y.

K = 6.78%, $^{40}Ar/^{40}K$ = 0.0683, radiogenic Ar = 98.9%.
Concentrate: Fresh, light brown biotite with no visible alteration, but containing approximately 5% hornblende contamination.

From gneiss
(23 B) Details as for GSC 73-161.

The sample is from a hornblende-rich zone in quartz-biotite feldspar metasedimentary gneiss in the Katsao Formation of the Kaniapiskau Supergroup. The sample is fine-grained, inequigranular, poikiloblastic and xenoblastic, and locally crushed. It contains 32% green hornblende, 15% andesine, 13% brown biotite, 12% diopside, 12% microcline, 7% quartz, 4% calcite; minor apatite, leucoxene, pistacite and pyrrhotite, and traces of sphene, ilmenite, zircon and muscovite.

Proterozoic rocks within the area have been highly deformed regionally at least twice, about earlier northeasterly-trending axes and later northwesterly-trending axes. Metamorphic grade ranges from lower amphibolite into granulite facies.

The present metamorphism either accompanied the later deformation or post-dates it and has largely masked any earlier metamorphism(s). The dates are similar to K-Ar ages determined throughout the Grenville Province and while they provide a minimum age for the metamorphism, they probably date more closely a time of epeirogenic uplift. It is perhaps interesting that for this and the associated samples the hornblende gives younger ages than the biotite. (*See* GSC 73-150 to 154).

GSC 73-163 Hornblende, K-Ar age 2048 ± 54 m.y.

K = 0.520%, $^{40}Ar/^{40}K$ = 0.2165, radiogenic Ar = 97.6%.
Concentrate: Clean, unaltered, pleochroic, light brown to dark green hornblende with no visible contamination.

From amphibolite
(13 L) Island in southeast part of Fraser Lake, Labrador, Newfoundland, 54°23'N, 63° 39'W. Map-unit 1, Geol. Surv. Can. Map 19-1968. Sample EC71-105, collected and interpreted by R.F. Emslie.

The amphibolite is a dark grey, medium-grained, foliated rock consisting of black hornblende with lesser amounts of white-weathering feldspar and sparse, scattered pale pink garnets. As seen in thin section the rock is granoblastic and fairly equigranular. Hornblende constitutes about 60-70 per cent of the rock, is pleochroic from deep olive-green to pale yellowish green, fresh and relatively free of inclusions. Most of the remainder of the rock is sericitized plagioclase. Small amounts of sphene, clinopyroxene, apatite and opaques are present.

The amphibolite is a layer or lens within the basement gneiss complex surrounding the Michikamau anorthositic intrusion. The sampling locality is about 4 km from the contact of the intrusion. The K-Ar date is believed to provide an estimate of the minimum age of the gneiss complex. It appears to predate the Hudsonian Orogeny and may possibly be an Archean relic only partially affected by Hudsonian events and/or thermal effects accompanying emplacement of the Michikamau intrusion (*see* GSC 73-164).

GSC 73-164 Hornblende, K-Ar age 1479 ± 101 m.y.

K = 0.224%, $^{40}Ar/^{40}K$ = 0.1314, radiogenic Ar = 94.7%.
Concentrate: Clean, unaltered, pleochroic, brown to yellow-brown hornblende with no visible contamination.

From gabbro
(13 L) Island in Contact Lake, Labrador, Newfoundland, 54°13'N, 63°48'W. Map-unit 4, Geol. Surv. Can. Map 19-1968 (R.F. Emslie). Sample EC63-385, collected and interpreted by R.F. Emslie.

The rock is a fine-grained, dark brownish grey hornblende gabbro, equigranular with dark, subparallel, hornblende-rich streaks. As seen in thin section the texture is fine-grained granular. The rock consists of about 25% brown hornblende, 25% clinopyroxene, the remainder being plagioclase, accessory apatite and opaques. The hornblende is pleochroic from dark brown to pale yellow-brown. All of the minerals are fresh.

The hornblende gabbro is a marginal facies of the Michikamau anorthositic intrusion. The intrusion is unmetamorphosed and the hornblende is believed to date the time of cooling of the intrusion. The hornblende age is a closer approximation to the time of intrusion of the Michikamau pluton than the K-Ar biotite age of 1400 ± 50 m.y. obtained on primary biotite from olivine-bearing anorthosite of the Michikamau intrusion (*see* GSC 63-164 *in* Wanless *et al.*, 1965). The K-Ar age of the hornblende agrees, within the large analytical uncertainty, with the nearly concordant U-Pb ages of zircons from adamellite of the Michikamau intrusion which average about 1460 m.y. as determined by Krogh and Davis (1973).

References

Krogh, T.E. and Davis, G.L.
1973: The significance of inherited zircons on the age and origin of igneous rocks - an investigation of the ages of the Labrador adamellites; Carnegie Inst. Wash., Yearb., v. 72, p. 610-613.

Wanless, R.K., Stevens, R.D., Lachance, G.R. and Rimsaite, J.Y.H.
1965: Age determinations and geological studies; Geol. Surv. Can., Paper 64-17 (Pt. 1).

GSC 73-165 Hornblende, K-Ar age 1205 ± 40 m.y.

K = 1.21%, $^{40}Ar/^{40}K$ = 0.0987, radiogenic Ar = 95.5%.
Concentrate: Clean, unaltered, pleochroic dark brown to dark green hornblende with no biotite or chlorite contamination.

From quartz monzonite
(14 E) South shore of lake just northwest of Umiakovik Lake, Labrador, Newfoundland, 57°24'00"N, 62°56'00"W. Map-unit 15, Geol. Surv. Can. Map 8-1970. Sample SH-19-62, collected and interpreted by C.H. Stockwell.

This hornblende is from the same sample that yielded a K-Ar biotite age of 1275 ± 75 m.y. (GSC 62-172, *in* Leech *et al.*, 1963) and the reader is referred to that paper for a description of the rock. Taking the analytical errors into consideration both ages are the same. Both are probably post-crystallization cooling ages but that of hornblende, because of its high blocking temperature is normally closer to the time of primary crystallization of the rock. This large body of massive rock from which the sample was collected cuts surrounding gneisses discordantly and is apparently about the same age as a small body of adamellite on Dog Island (56°39'N, 61°09'W) as mapped by Taylor (1970) and for which Krogh and Davies (1973) obtained a virtually concordant U-Pb age on zircon at 1293 m.y. Accordingly, these two intrusions are appreciably younger than the Michikamau adamellite giving an average U-Pb zircon concordant age of 1458 m.y. and the Harp Lake adamellite giving a U-Pb concordia intercept age of 1450 m.y. (as determined by Krogh and Davies, 1973).

References

Krogh, T.E. and Davis, G.L.
1973: The significance of inherited zircons on the age and origin of igneous rocks -- an investigation of the ages of the Labrador adamellites; Carnegie Inst. Wash., Yearb., v. 72, p. 610-613.

Leech, G.B., Lowdon, J.A., Stockwell, C.H. and Wanless, R.K.
1963: Age determinations and geological studies; Geol. Surv. Can., Paper 63-17.

Taylor, F.C.
1970: Reconnaissance geology of a part of the Precambrian Shield, northeastern Quebec and northern Labrador, Part II; Geol. Surv. Can., Paper 70-24, with Map 70-24.

GSC 73-166 Hornblende, K-Ar age 1301 ± 41 m.y.

K = 1.04%, $^{40}Ar/^{40}K$ = 0.1096, radiogenic Ar = 98.7%.
Concentrate: Clean, unaltered, pleochroic light brown to dark green hornblende with no visible impurities.

From adamellite
(14 D) Island in Hawk Lake, Labrador, Newfoundland, 56°02'30"N, 63°34'00"W. Map-unit 15, Geol. Surv. Can. Map 8-1970. Sample SH-29-62, collected and interpreted by C.H. Stockwell.

This age determination of 1301 ± 31 m.y. is a rerun of the hornblende of GSC 63-175 which yielded a K-Ar age of 1325 m.y. and to which the reader is referred for a description of the adamellite (*in* Wanless *et al.*, 1965). The re-run was undertaken using a

more accurate method of determining the small amount of potassium present, so that the 1301 ± 31 m.y. age is regarded as more reliable.

The sample is from a large discordant body of massive, unmetamorphosed adamellite just northwest of the Harp Lake Complex. It has been called the Mistastin pluton by March and Crocket (1974). Two other age determinations are available from this pluton. One is a K-Ar age on biotite yielding 1340 ± 50 m.y. (GSC 63-174, in Wanless *et al.*, 1965) which is about the same as the hornblende determination, and the other is Rb-Sr whole-rock isochron on adamellite giving 1270 ± 15 m.y. ($Rb\lambda = 1.47$) or 1346 ± 15 m.y. ($Rb\lambda = 1.39$) as determined by Marchand and Crocket (1974). Because the K-Ar ages on hornblende and biotite are probably somewhat younger than the time of primary crystallization the Rb-Sr age of 1346 ± 15 using $Rb\lambda = 1.39$ seems better. It may be noted that this Rb-Sr age is virtually the same as that for the Seal Group volcanics at 1278 ± 92 m.y. ($Rb\lambda = 1.47$) or 1350 ± 92 ($Rb\lambda = 1.39$) as determined by R.K. Wanless (pers. comm.) indicating that the Mistastin pluton was emplaced at or near the time of the Seal Group volcanism. Both events are Neohelikian in age.

References

Marchand, M. and Crocket, J.H.
1974: The Mistastin Lake pluton and meteorite crater, northern Labrador; Geol. Assoc. Can. and Mineral. Assoc. Can. Annual meeting 1974, abstract, p. 58-59.

Wanless, R.K., Stevens, R.D., Lachance, G.R. and Rimsaite, J.Y.H.
1965: Age determinations and geological studies; Geol. Surv. Can., Paper 64-17 (Pt. 1).

GSC 73-167 Hornblende, K-Ar age 1401 ± 43 m.y.

K = 1.12%, $^{40}Ar/^{40}K = 0.1215$, radiogenic Ar = 99.0%.
Concentrate: Clean, unaltered, pleochroic, olive-brown to bluish green hornblende with no visible contamination.

From gneiss
(13 L) 0.8 km north of Shipiskan Lake, Labrador, Newfoundland, 54°39'45"N, 62°18'00"W. Map-unit A3, Geol. Surv. Can. Map 53-14. Sample SH-24a-62, collected and interpreted by C.H. Stockwell.

This age determination of 1401 ± 43 m.y. is a re-run of the hornblende of GSC 63-177 which yielded a K-Ar age of 1350 m.y. and to which the reader is referred for a description of the gneiss (*in* Wanless *et al.*, 1965). The re-run was undertaken using a more accurate method of determining the small amount of potassium present, so that the 1401 ± 43 m.y. age is regarded as more reliable. This age is regarded as being either close to the time of metamorphism of the gneiss or of up-dating in a thermal aureole extending outwards from the contact of the Harp Lake Complex of anorthosite and adamellite. The sample was taken from a point 13 km south of the Harp Lake contact but the outward extent of the thermal aureole of sufficiently high temperature to pass the blocking temperature of hornblende is unknown.

From the same outcrop a paragneiss gave a K-Ar determination on biotite at 1430 ± 80 m.y. (GSC 62-177 in Leech *et al.*, 1963) which also could be either post-crystallization cooling age younger than the time of metamorphic crystallization or an effect of the thermal aureole.

Taking analytical errors into consideration both of the K-Ar ages are close to the time of primary crystallization of the Harp Lake adamellite, which has a U-Pb concordia intercept age for zircon at 1450 m.y. as determined by Krogh and Davis (1973).

All of these rocks are in the Nain Province (Western Nain subprovince) of Stockwell (in prep.) and are unconformably overlain by sediments and volcanics of the Seal Group of the Grenville Province so that the above age determinations are maxima for the time of beginning of deposition of the Seal Group. This agrees with the Rb-Sr whole-rock isochron age of 1278 ± 92 m.y. ($Rb\lambda = 1.47$) for volcanics of the Seal Group as determined by R.K. Wanless (pers. comm.).

References

Krogh, T.E. and Davis, G.L.
1973: The significance of inherited zircons on the age and origin of igneous rocks -- an investigation of the ages of the Labrador adamellites; Carnegie Inst. Wash., Yearb., v. 72, p. 610-613.

Leech, G.B., Lowdon, J.A., Stockwell, C.H. and Wanless, R.K.
1963: Age determinations and geological studies; Geol. Surv. Can., Paper 63-17.

Wanless, R.K., Stevens, R.D., Lachance, G.R. and Rimsaite, J.Y.H.
1965: Age determinations and geological studies; Geol. Surv. Can., Paper 64-17 (Pt. 1).

GSC 73-168 Biotite, K-Ar age 1437 ± 36 m.y.

K = 7.70%, $^{40}Ar/^{40}K = 0.1261$, radiogenic Ar = 99%.
Concentrate: Relatively clean, unaltered, light brown biotite with approximately 4% free chlorite contamination.

From granite
(13 K) Central Labrador, Newfoundland, 54°32' 00"N, 60°27'30"W. Map-unit A, Geol. Surv. Can. Map 53-14, and map-unit 9, Geol. Surv. Can. Open File 42, 1970. Sample SH-27-62, collected and interpreted by C.H. Stockwell.

See GSC 73-169 for description and interpretation.

GSC 73-169 Hornblende, K-Ar age $\frac{(1645 \pm 46 \text{ m.y.})^*}{1574 \pm 46 \text{ m.y.}}$

$K = \frac{(0.682\%)^*}{0.836\%}$, $^{40}Ar/^{40}K = \frac{(0.1536)^*}{0.1440}$,
radiogenic Ar = 98%.
Concentrate: Clean, fresh, pleochroic bluish green to light brown hornblende with approximately 2% free biotite contamination.

From granite
(13 K) Details as for GSC 73-168.

*Adjusted for 2% biotite impurity.

This hornblende is from the same sample as the biotite GSC 73-168 which yielded an age of 1437 ± 36 m.y. The rock from which this pair of minerals was separated is a massive, grey granite composed of quartz, plagioclase, microcline, biotite, hornblende and accessory magnetite and sphene. The plagioclase is much clouded with alteration products but the other minerals are fresh. The granite intrudes the Aillik Group and is in faulted contact with the Upper Croteau Group (Williams, 1970).

The biotite and hornblende age determinations are thought to be post-crystallization cooling ages but that for the hornblende, because of its higher blocking temperature, approaches more closely the time of primary crystallization of the granite. The hornblende age lies within the range of hornblende post-Hudsonian cooling ages for the type area (the Churchill Province) indicating that the granite may have been emplaced during the Hudsonian orogeny. This provides a minimum age for the Aillik Group and if so, places the group in the Aphebian, it being assumed that the group is not Archean. It is interesting to note that the Upper Croteau Group volcanics have given an Rb-Sr whole-rock isochron date of 1474 ± 42 m.y. ($Rb\lambda = 1.47$) as determined by Wanless and Loveridge (1972) who regard the age as a reasonable estimate for the time of volcanism, thus confirming the conclusion of Williams (1970), based on geological evidence, that the Upper Croteau is younger than the granite as well as being younger than the Aillik Group. According to the revised time scale (Stockwell, 1973) the Aillik Group is probably Aphebian, the Upper Croteau is Paleohelikian and the Seal Group is Neohelikian.

References

Stockwell, C.H.
1973: Revised Precambrian time scale for the Canadian Shield; Geol. Surv. Can., Paper 72-52.

Wanless, R.K. and Loveridge, W.D.
1972: Rubidium-strontium isotopic age studies, Report 1; Geol. Surv. Can., Paper 72-23.

Williams, F.M.G.
1970: Snegamook Lake map-area, east half, Newfoundland; Geol. Surv. Can., Open File 42.

GSC 73-170 Whole-rock, K-Ar age 3777 ± 76 m.y.

K = 0.679%, $^{40}Ar/^{40}K = 0.7071$, radiogenic Ar = 99%.
Concentrate: Crushed whole-rock.

From diabase
(14 M) Northeast side of Whale Island, Labrador, Newfoundland, 59°27'N, 63°40'W. *See* Geol. Surv. Can. Map 13-1968. Sample TA67-T394A, collected and interpreted by F.C. Taylor.

Sample is from the chill zone of an east striking, 1.2-m-thick diabase dyke cutting Proterozoic granulite.

For interpretation see GSC 73-171.

GSC 73-171 Whole-rock, K-Ar age 4494 ± 82 m.y.

K = 0.237%, $^{40}Ar/^{40}K = 1.0847$, radiogenic Ar = 99%.
Concentrate: Crushed whole-rock.

From diabase
(14 L) Saglek Bay area, Labrador, Newfoundland, 58°27'N, 63°02'W. *See* Geol. Surv. Can. Map 8-1970. Sample TA69-217C, collected and interpreted by F.C. Taylor.

Sample is from the chill zone of an east-northeast striking, 15-m-thick, dark grey diabase dyke cutting Archean gneisses containing amphibolite layers.

This sample and GSC 73-170 contain excess argon and the ages are therefore spurious. It is of interest that some of the diabase dykes on the west coast of Greenland (Bridgwater, 1970) also contain excess argon and return ages well in excess of their host rocks.

Reference

Bridgwater, D.
1970: A compilation of K/Ar age determinations on rocks from Greenland carried out in 1969; Gronlands Geol. Under. Rapp. Nr. 28, p. 47-55.

GSC 73-172 Whole-rock, K-Ar age 1199 ± 40 m.y.

K = 1.05%, $^{40}Ar/^{40}K$ = 0.0980, radiogenic Ar = 99%.
Concentrate: Crushed whole-rock.

From diabase
(14 E) South of North River, Labrador, Newfoundland, 57°12'N, 63°38'W. *See* Geol. Surv. Can. Map 8-1970. Sample RM69-288D, collected by E.W. Reinhardt and interpreted by F.C. Taylor.

This sample is from a northeast striking, vertical, 1.2 metre thick diabase dyke. The sample is from the chill zone and abuts the granulite host rock.

The age, 1199 ± 40, is similar to that obtained on a group of nearly flat-lying diabases near Ungava Bay, GSC 67-115 (Taylor, 1970) and another dyke south of the Korok River, GSC 67-116 (Fahrig, 1970). This sample suggests that this swarm of dykes extends much farther south than previously known.

References

Fahrig, W.F.
1970: *In* age determinations and geological studies; K-Ar isotopic ages report 9; Geol. Surv. Can., Paper 64-2A, p. 64.

Taylor, F.C.
1970: Reference as above.

GSC 73-173 Whole-rock, K-Ar age 2483 ± 66 m.y.

K = 1.92%, $^{40}Ar/^{40}K$ = 0.3013, radiogenic Ar = 99.8%.
Concentrate: Crushed whole-rock.

From diabase
(14 M) Nachvak Fiord area, Labrador, Newfoundland, 59°10'N, 63°32'W. *See* Geol. Surv. Can. Map 13-1968. Sample TA67-T345B, collected and interpreted by F.C. Taylor.

This sample is from the chill zone of a 9-m-thick, vertical diabase dyke that strikes N85E. The age is considered to be the approximate age of the intrusion and representative of many of the east-trending dykes present in the Archean rocks in this part of Labrador.

GSC 73-174 Whole-rock, K-Ar age 1392 ± 44 m.y.

K = 1.00%, $^{40}Ar/^{40}K$ = 0.1205, radiogenic Ar = 98.6%.
Concentrate: Crushed whole-rock.

From diabase
(13 M) 5 km north of major river along northern edge of Harp Lake anorthosite pluton, Labrador, Newfoundland, 55°28'N, 62° 35'W. Map-unit 24, Geol. Surv. Can. Paper 71-48. Sample TA693B, collected and interpreted by F.C. Taylor.

This sample is from the chill zone of a vertical, 12 metre-thick diabase dyke that strikes N170E. It cuts hornblende- and pyroxene-bearing paragneiss. The age provides the approximate age of intrusion of the dyke and a minimum age for the metamorphism of the country rock. Compare with GSC 73-159.

GSC 73-175 Hornblende, K-Ar age 2546 ± 62 m.y.

K = 0.662%, $^{40}Ar/^{40}K$ = 0.3154, radiogenic Ar = 98.8%.
Concentrate: Clean, fresh and unaltered, pleochroic brown to green hornblende with no visible contamination.

From amphibolite
(14 L) Maidmounts Island, Labrador, Newfoundland, 58°23'N, 62°34'W. *See* Geol. Surv. Can. Map 8-1970. Sample RM-220B, collected by E.W. Reinhardt and interpreted by F.C. Taylor.

This sample is from a medium-grained, grey-green amphibolite lying in the Nain Structural Province. This amphibolite forms part of a migmatite terrane that is characterized by many schlieren of biotite and hornblende in the granitic fraction. The age of 2546 ± 62 m.y. confirms an Archean age for this rock which is presumably a product of the Kenoran orogeny.

GSC 73-176 Whole-rock, K-Ar age 1748 ± 50 m.y.

K = 0.419%, $^{40}Ar/^{40}K$ = 0.1685, radiogenic Ar = 97.0%.
Concentrate: Crushed whole-rock.

From diabase
(13 N) 20 km north of northeast end of Harp Lake, Labrador, Newfoundland, 55°22'N, 61° 25'W. Map-unit 24, Geol. Surv. Can. Paper 71-48. Sample TA960A, collected and interpreted by F.C. Taylor.

This sample is from the chill zone of a vertical diabase dyke that strikes N155E. The dyke, which is 18 metres thick, cuts a massive, medium-grained, pink syenite which is probably of Archean age and part of the large area of Archean rocks making up the Nain Province in this part of Labrador. The age, 1748 ± 50 m.y. is believed to be the age of intrusion of the dyke.

GSC 73-177 Whole-rock, K-Ar age 1248 ± 40 m.y.

K = 0.658%, $^{40}Ar/^{40}K$ = 0.1035, radiogenic Ar = 96.9%.

From mafic volcanic rock
(13 N) Eighteen kilometres north of northeast end of Harp Lake, Labrador, Newfoundland, 55°22'N, 61°31'W. Map-unit 4, Geol. Surv. Can. Paper 71-48. Sample TA961, collected and interpreted by F.C. Taylor.

This sample is from a small area of mafic volcanic rock that lies within Archean migmatites. The rock is chiefly medium grey-green, equigranular and fine-grained but locally 6 mm clusters of plagioclase crystals occur. In part the rock is fragmental, probably a flow breccia, with fragments of mafic rock up to 60 cm long. Minor amounts of calcite are present locally.

The age, 1248 ± 40 m.y. shows that this volcanic rock is much younger than the Archean terrane in which it lies. It may be part of the Croteau Group, which lies 100 km to the south, dated by the Rb-Sr technique at 1474 ± 42 m.y. (Wanless and Loveridge, 1972). It is more likely however that it forms part of the Seal Lake Group of volcanic rocks that occur in the same region as the Croteau Group and which have been recently dated at 1278 ± 92 m.y. (pers. comm., R.K. Wanless, Rb-Sr isochron).

Reference

Wanless, R.K. and Loveridge, W.D.
1972: Rubidium-strontium isochron age studies, Report 1; Geol. Surv. Can., Paper 72-23, p. 57.

GSC 73-178 Hornblende, K-Ar age 2511 ± 61 m.y.

K = 0.942%, $^{40}Ar/^{40}K$ = 0.3073, radiogenic Ar = 99.9%.
Concentrate: Clean, unaltered, pleochroic, yellow-brown to dark green hornblende with no visible contamination.

From amphibolite
(13 N) 12 km south of mouth of Hunt River, Labrador, Newfoundland, 55°29'N, 60°34'W. Map-unit 3, Geol. Surv. Can. Paper 71-48. Sample TA482G, collected and interpreted by F.C. Taylor.

This sample is from an amphibolite associated with dolomite, quartz-feldspar paragneiss and a group of ultrabasic rocks lying within the migmatite terrane which is part of the Hopedale Gneiss. The age of 2511 ± 61 m.y. suggests that these rocks are possibly Archean in age and of similar age to the Hopedale Gneiss which in this general area has K-Ar ages of 2400 to 2600 m.y. (*see* GSC 62-178 and 63-172). The discovery of spinifex texture in the ultrabasic rocks by K.D. Collerson of Memorial University (oral comm.) would tend to confirm an Archean age for these rocks as this texture is supposedly an Archean characteristic.

GSC 73-179 Whole-rock, K-Ar age 1125 ± 37 m.y.

K = 0.578%, $^{40}Ar/^{40}K$ = 0.0900, radiogenic Ar = 99.2%.
Concentrate: Crushed whole-rock.

From diabase
(13 N) Entrance to Tooktoosner Bay, Labrador, Newfoundland, 55°27'N, 60°18'W. Map-unit 24, Geol. Surv. Can. Map 71-48. Sample TA898A, collected and interpreted by F.C. Taylor.

This sample is from a northeast-striking, vertical diabase dyke cutting Archean migmatite that is part of the Hopedale Gneiss. At this point the dyke is 60-m-thick. It can be traced for about 24 km along strike so that it is one of the most prominent dykes in the area. The age of 1125 ± 37 m.y. is assumed to be the age of intrusion of the dyke.

This sample shows good agreement with GSC 73-185 from a dyke of similar orientation from Blackstones Island which is 40 km east of the present locality. This latter age is 1144 ± 33 m.y. and it appears that this swarm of dykes is of Neohelikian age.

GSC 73-180 Whole-rock, K-Ar age 846 ± 30 m.y.

K = 1.59%, $^{40}Ar/^{40}K$ = 0.0625, radiogenic Ar = 99.5%.
Concentrate: Crushed whole-rock.

From diabase
(13 O) Large island in Bay of Islands, Labrador, Newfoundland, 55°12'N, 59°43'W. Map-unit 24, Geol. Surv. Can. Paper 71-48. Sample TA778B, collected and interpreted by F. C. Taylor.

See GSC 73-181 for description and interpretation.

GSC 73-181 Whole-rock, K-Ar age 934 ± 33 m.y.

K = 1.73%, $^{40}Ar/^{40}K$ = 0.0708, radiogenic Ar = 98.3%.
Concentrate: Crushed whole-rock.

From diabase
(13 O) Large island in Bay of Islands, Labrador, Newfoundland, 55°12'N, 59°43'W. Map-unit 24, Geol. Surv. Can. Paper 71-48. Sample TA778A, collected and interpreted by F. C. Taylor.

These two samples *see* GSC 73-180 and 181 are from the contact zones of two intersecting dykes intruding granodiorite that is probably 1600 m.y. old (*see* GSC 73-188). The older strikes N025E and the younger between N070E and N110E. The older dyke, which is 12-m-thick, is strongly porphyritic, whereas the younger, which is 3-m-thick, shows only scattered plagioclase crystals.

These determinations give an approximation of the time of intrusion. Although the older dyke is similar lithologically and roughly in orientation to GSC 73-182, there is an age difference of 360 m.y., suggesting at least two ages of porphyritic diabase.

GSC 73-182 Whole-rock, K-Ar age 1294 ± 41 m.y.

K = 1.14%, $^{40}Ar/^{40}K$ = 0.1088, radiogenic Ar = 96.5%.
Concentrate: Crushed whole-rock.

From diabase
(14 C) North shore of Kuivik Island, Labrador, Newfoundland, 56°17'N, 61°30'W. Map-unit 16, Geol. Surv. Can. Paper 70-24. Sample TA473B, collected and interpreted by F. C. Taylor.

This sample is from the chilled margin of a north-striking, vertical diabase dyke that is 18 m thick. The dyke cuts a light pink, medium-grained biotite granodiorite that is part of the adamellite-anorthosite suite of post-tectonic intrusive rocks common in Labrador. Locally, this dyke is porphyritic with plagioclase crystals up to 8 cm long. The age, 1294 ± 41 m.y., is the approximate age of intrusion of the dyke and also provides a minimum age for the granodiorite and adamellite. Porphyritic diabases are fairly common along the Labrador coast (*see* also GSC 73-180 and 181).

GSC 73-183 Hornblende, K-Ar age 1999 ± 54 m.y.

K = 1.09%, $^{40}Ar/^{40}K$ = 0.2081, radiogenic Ar = 99.7%.
Concentrate: Relatively clean, unaltered, pleochroic green to brown hornblende with a slight trace of chlorite contamination.

From amphibolite
(13 N) 8 km west of mouth of Hunt River, Labrador, Newfoundland, 55°36'N, 60°47'W. Map-unit 1, Geol. Surv. Can. Paper 71-48. Sample BT238, collected by A. J. Baer and interpreted by F. C. Taylor.

This sample is from a dark green, medium-grained, equigranular, foliated garnet-bearing amphibolite. The major rock-unit in the area of the sample is Archean migmatite. The outcrop is cut by several thin (1 to 2 m thick) diabase dykes striking N125E.

The age, 1999 ± 54 m.y., is younger than anticipated for rocks in this region and may be a minimum figure only.

GSC 73-184 Whole-rock, K-Ar age 1195 ± 88 m.y.

K = 0.288%, $^{40}Ar/^{40}K$ = 0.0976, radiogenic Ar = 97.5%.
Concentrate: Crushed whole-rock.

From diabase
(13 N) 12 km west of Comma Island, Labrador, Newfoundland, 55°19'N, 60°34'W. Map-unit 24, Geol. Surv. Can. Paper 71-48. Sample TA798A, collected and interpreted by F. C. Taylor.

This sample is from the chill zone of a vertical, 50-metre-thick diabase dyke that strikes N070E and cuts Archean migmatite. The age provides the approximate age of intrusion of this dyke. Compare with GSC 73-185.

GSC 73-185 Whole-rock, K-Ar age 1144 ± 33 m.y.

K = 0.623%, $^{40}Ar/^{40}K$ = 0.0920, radiogenic Ar = 98.4%.
Concentrate: Crushed whole-rock.

From diabase
(13 O) Blackstones Island, Labrador, Newfoundland, 55°30'N, 59°42'W. Map-unit 24, Geol. Surv. Can. Paper 71-48. Sample TA892A, collected and interpreted by F. C. Taylor.

This sample is from the chill zone of a 12-metre-thick vertical diabase dyke striking northeast. It cuts Archean migmatite and forms part of a northeast-striking swarm of diabase dykes. The contact shows extensive baking and is bleached for about 0.3 metre.

The age gives the approximate age of intrusion of the dyke. Compare with GSC 73-184.

GSC 73-186 Whole-rock, K-Ar age 824 ± 29 m.y.

K = 1.58%, $^{40}Ar/^{40}K$ = 0.0649, radiogenic Ar = 98.7%.
Concentrate: Crushed whole-rock.

From diabase
(13 O) Head of Bay of Islands, Labrador, Newfoundland, 55°08'N, 59°56'W. Map-unit 24, Geol. Surv. Can. Paper 71-48. Sample TA774A, collected and interpreted by F. C. Taylor.

This sample is from an east-striking diabase dyke, one of a swarm of porphyritic dykes, present along the coast of Labrador at this latitude. This particular dyke is 18 m thick and intrudes a pink, massive, biotite granodiorite. The age 824 ± 29 m.y. is assumed to be the age of the intrusion.

GSC 73-187 Muscovite, K-Ar age 1586 ± 39 m.y.

K = 8.77%, $^{40}Ar/^{40}K$ = 0.1454, radiogenic Ar = 98.9%.
Concentrate: Clean, fresh, clear muscovite. Many of the mica flakes have split edges, but there is no visible contamination.

From granite
(13 O) Ironbound Islands*, Labrador, Newfoundland, 55°08'N, 58°48'W. Map-unit 11, Geol. Surv. Can. Paper 71-48. Sample TA465, collected and interpreted by F. C. Taylor.

See GSC 73-188 for description and interpretation.

*Location shown as Western Island on recent Geol. Surv. Can. Map 9-1971.

GSC 73-188 Biotite, K-Ar age 1591 ± 40 m.y.

K = 8.08%, $^{40}Ar/^{40}K$ = 0.1461, radiogenic Ar = 99.6%.
Concentrate: Light green biotite with approximately 3% chloritization and less than 1% muscovite contamination.

From granite
(13 O) Details as for GSC 73-187.

These samples are from a muscovite-biotite granite that shows intrusive relationships with a well-banded silicic tuff forming part of the Aillik Group. The granite is a medium-grained, variously massive to foliated, equigranular, medium-pink rock. These two ages agree very well with other K-Ar biotite ages from the same area. Gandhi *et al.* (1969) reported 1600 ± 34 m.y. for a sample from the Strawberry granite located 15 km to the west of the present locality and Stockwell and King (1963) reported an age of 1645 m.y. (GSC 62-179) on a sample from the east shore of Aillik Bay 25 km to the west-northwest.

It is concluded from these ages that intrusive granites in the Makkovik subprovince were emplaced in the early Paleohelikian sub-era.

References

Gandhi, S. S., Grasty, R. L. and Grieve, R. A. F.
1969: The geology and geochronology of the Makkovik Bay area, Labrador; Can. J. Earth Sci., v. 6, p. 1019-1035.

Stockwell, C. H. and King, A. F.
1963: *In* age determinations and geological studies; Geol. Surv. Can., Paper 63-17, p. 115.

GSC 73-189 Hornblende, K-Ar age 1617 ± 48 m.y.

K = 0.406%, $^{40}Ar/^{40}K$ = 0.1498, radiogenic Ar = 96.2%.
Concentrate: Clean, fresh and unaltered, pleochroic, light brown to light bluish green hornblende.

From schist
(13 O) Beach, above high tide, east side of Ford's Bight, Labrador, Newfoundland, 55°05'N, 59°05'W. Sample GX-2-73(1) collected by R. McWhae (Eastcan Exploration Ltd.), submitted by A. C. Grant (Atlantic Geoscience Centre).

The rock is a small fragment of moderately foliated, equigranular, hornblende-chlorite-plagioclase

schist with large poikiloblastic, colourless pyroxenes. The chlorite pseudomorphs appear to represent original biotite and are strongly aligned, giving rise to the distinct foliation of the rock in thin section. No unaltered biotite remains, but the hornblende is very fresh.

See GSC 73-190 for interpretation.

GSC 73-190 Whole-rock, K-Ar age 129 ± 6 m.y.

K = 1.84%, $^{40}Ar/^{40}K$ = 0.0078, radiogenic Ar = 76.2%.
Concentrate: Crushed whole-rock.

From basalt
(13 O) Beach above high tide, east side of Ford's Bight, Labrador, Newfoundland, 55°05'N, 59°05'W. Sample GX-2-73(4), collected by R. McWhae (Eastcan Exploration Ltd.), submitted by A.C. Grant (Atlantic Geoscience Centre).

Small fragment of fine-grained, heavily altered "basalt" consisting of laths of plagioclase, phenocrysts of orthopyroxene, and carbonate-zeolite-filled cavities in a groundmass of very fine magnetite, feldspar, brown chlorite/biotite, and carbonate.

The basaltic sample (GSC 73-190) is from a poor exposure several feet wide in an area mapped as Aphebian Aillik-equivalent metasediments. The 1617 ± 48 m.y. age obtained from the metasediments (GSC 73-189) is rather young for Aphebian, but is not out of line with the general run of metamorphic ages in the Nain Province.

The basaltic rock (perhaps a dyke), is closely associated with a marine "volcanic conglomerate" which has been assigned as Jurassic in age on the basis of micro-fossils in the calcite cement (N.J. McMillan, Aquitaine Oil Co.). The age of 129 ± 6 m.y., together with a previously determined 145 ± 6 m.y. date by Geochron Laboratories, confirms that Upper Jurassic to Lower Cretaceous igneous activity occurred in this area.

GSC 73-191 Whole-rock, K-Ar age $\frac{915 \pm 32 \text{ m.y.}}{926 \pm 32 \text{ m.y.}}$

K = 1.68%, $^{40}Ar/^{40}K = \frac{0.0689}{0.0700}$, radiogenic Ar = $\frac{99\%}{97\%}$.
Concentrate: Crushed whole-rock.

From mafic dyke
(12 P) On coast 4.8 km southwest of Barge Bay, Labrador, Newfoundland, 51°47'N, 56°14'30"W. Sample BK-71-71Δ2, collected and interpreted by H.H. Bostock.

The sample is a dark grey, fine-grained mafic rock with plagioclase phenocrysts up to 3 mm long forming 5% of the rock.

See GSC 73-192 for interpretation.

GSC 73-192 Whole-rock, K-Ar age $\frac{566 \pm 22 \text{ m.y.}}{553 \pm 21 \text{ m.y.}}$

K = 4.08%, $^{40}Ar/^{40}K = \frac{0.0386}{0.0376}$, radiogenic Ar = $\frac{99\%}{96\%}$.
Concentrate: Crushed whole-rock.

From mafic dyke
(2 M) On coast 4.8 km southeast of Henley Harbour, Labrador, Newfoundland, 51°57'N, 55°54'W. Sample BK-71-77Δ3B, collected and interpreted by H.H. Bostock.

The sample is a dark purple, fine-grained, equigranular mafic rock.

The samples dated represent two east-west striking minor mafic dykes intrusive into Grenville gneisses on the north shore of the Strait of Belle Isle. The apparently older (most westerly) dyke contains fine-grained amphibole in a matrix between feldspar laths, whereas the other, apparently younger (more easterly) dyke contains chlorite but is otherwise of similar texture.

The dykes are probably of the same late Grenville age but have had different late Grenville metamorphic histories. The two dates fall within the range found by Grasty *et al.* (1969) for late dykes on the east coast of Labrador near the Grenville front.

Reference

Grasty, R.L., Rucklidge, J.C. and Elders, W.A.
1969: New K-Ar age determinations on rocks from the east coast of Labrador; Can. J. Earth Sci., v. 6, p. 340-344.

GSC 73-193 Whole-rock, K-Ar age 411 ± 17 m.y.

K = 0.533%, $^{40}Ar/^{40}K$ = 0.0269, radiogenic Ar = 95%.
Concentrate: Crushed whole-rock.

From basalt
(2 M) 0.3 km southeast of Henley Harbour, Labrador, Newfoundland, 51°59'N, 55°51'W. Sample BK-71-82Δ1B, collected and interpreted by H.H. Bostock.

The sample is a dark grey, fine-grained basalt with plagioclase phenocrysts up to 3 mm long forming 2% of the rock.

See GSC 73-196 for interpretation.

GSC 73-194 Whole-rock, K-Ar age 421 ± 17 m.y.

K = 0.558%, $^{40}Ar/^{40}K$ = 0.0276, radiogenic Ar = 95%.
Concentrate: Crushed whole-rock.

From basalt
(2 M) 0.3 km southeast of Henley Harbour, Labrador, Newfoundland, 51°59'N, 55° 51'W. Sample BK-71-82Δ1A, collected and interpreted by H.H. Bostock.

The rock is a dark grey and purple, fine-grained, equigranular basalt.

See GSC 73-196 for interpretation.

GSC 73-195 Whole-rock, K-Ar age 427 ± 17 m.y.

K = 0.689%, $^{40}Ar/^{40}K$ = 0.0280, radiogenic Ar = 95%.
Concentrate: Crushed whole-rock.

From basalt
(12 I) Ridge west of Horse Chops Ridge, Newfoundland, 50°55'15"N, 56°20'06"W. Sample BKW-70-252, collected by R. Waitt and interpreted by H.H. Bostock.

The sample is a dark grey, fine-grained basalt with phenocrysts up to 2 mm long forming 2% of the rock.

See GSC 73-196 for interpretation.

GSC 73-196 Whole-rock, K-Ar age 413 ± 16 m.y.

K = 1.22%, $^{40}Ar/^{40}K$ = 0.0270, radiogenic Ar = 95%.
Concentrate: Crushed whole-rock.

From basalt
(12 I) Creek bottom, 1.2 km northwest of Horse Chops Ridge, Newfoundland, 50°56'16"N, 56°20'32"W. Sample BKW-70-262, collected by R. Waitt and interpreted by H.H. Bostock.

The rock is a dark green, fine-grained basalt with 2% feldspar phenocrysts up to 3 mm long.

Four samples, dated by the K-Ar whole-rock method, are from basalt flows of the Lighthouse Cove Formation. Two, GSC 73-193 and 73-194, are from lower and upper parts respectively of the basalt flow at Henley Harbour; and two, GSC 73-195 and 73-196, are from basalt flows at the north end of the Long Range Grenville Inlier. The basalt consists primarily of clinopyroxene and intermediate plagioclase with minor opaque minerals and trace quartz. Plagioclase is typically slightly porphyritic or glomerocrystic. Small amounts of chlorite appear to have formed from interstitial glass. The basalts are unfoliated and apparently unaltered although cores of some plagioclase crystals are sericitized. They occur to the west of visible Paleozoic metamorphism in the Grenville gneisses.

The K-Ar dates provided by these flows are essentially the same, averaging 418 m.y. This date falls within the error limit of an earlier date obtained by the K-Ar whole-rock method of 375 ± 100 m.y. on the Table Head flow (Wanless *et al.*, 1965), but is at least 100 m.y. too young in view of the fossil age (about 540 m.y.; *see* Palmer *in* North, 1971) of the Devils Cove and Forteau Formations which overlie the Lighthouse Cove basalts at Canada Bay. Moreover, this age is essentially the same as a K-Ar biotite age of 434 ± 18 m.y. (Wanless *et al.*, 1973) from the gneisses near Fourche Point that is thought to reflect uplift presumably at the end of Ordovician orogeny. Thus, even though the flows dated are from areas west of visible late metamorphism, it seems likely that the flow dates reflect uplift rather than the age of effusion.

References

North, F.K.
1971: The Cambrian of Canada and Alaska: *in* Cambrian of the New World; ed. C.K. Holland, Wiley Interscience.

Wanless, R.K., Stevens, R.D., Lachance, G.R. and Rimsaite, J.Y.H.
1965: Age determinations and geological studies, K-Ar isotopic ages report 5; Geol. Surv. Can., Paper 64-17 (Pt. 1), p. 111.

Wanless, R.K., Stevens, R.D., Lachance, G.R. and Delabio, R.N.
1973: Age determinations and geological studies, K-Ar isotopic ages, report 11; Geol. Surv. Can., Paper 73-2, p. 105.

GSC 73-197 Hornblende, K-Ar age 401 ± 16 m.y.

K = 0.964%, $^{40}Ar/^{40}K$ = 0.0262, radiogenic Ar = 95.9%.
Concentrate: Clean, unaltered, slightly pleochroic, dark green hornblende with no visible contamination.

From granite
(12 A) 0.6 km northeast of Hinds Lake, Red Indian Lake area, Newfoundland, 48°59'30"N, 56°56'30"W. Map-unit 14, Geol. Surv. Can. Map 1196A. Sample AA-1a-58-2, collected and interpreted by F.D. Anderson.

The specimen is from a medium- to coarse-grained, salmon pink, hornblende granite.

See GSC 73-198 for interpretation.

GSC 73-198 Biotite, K-Ar age 398 ± 16 m.y.

K = 6.97%, $^{40}Ar/^{40}K$ = 0.0259, radiogenic Ar = 95.2%.
Concentrate: Somewhat altered, brown biotite with approximately 10% chloritization.

From granitic gneiss

(12 A) 2.5 km east of Hinds Lake, Red Indian Lake area, Newfoundland, 48°59'00"N, 56°52'30"W. Map-unit 14, Geol. Surv. Can. Map 1196A. Sample AA1a-60-1, collected and interpreted by F.D. Anderson.

The specimen is from a fine-grained, grey, granitic gneiss xenolith in hornblende granite.

The specimens (GSC 73-197 and 198) are from a granitic batholith in west-central Newfoundland from which an anomalous date of 484 m.y. had been reported (GSC 61-203). The present reported ages of 401 ± 16 m.y. for the granite and 398 ± 16 for an enclosed gneiss are for practical purposes the same, and date the age of granitic intrusion as Devonian in agreement with field evidence.

References

Neale, E.R.W. and Nash, W.A.
1963: Sandy Lake (East Half), Newfoundland; Geol. Surv. Can., Paper 62-18.

Williams, H.
1970: Red Indian Lake; Geol. Surv. Can., Map 1196A.

APPENDIX

The numbers listed below refer to the individual sample determination numbers, e.g. (GSC) 62-189, published in the G.S.C. Age Reports listed below:

GSC 60-17, Report No. 1 - determinations 59-1 to 59- 98
GSC 61-17, Report No. 2 - determinations 60-1 to 60-152
GSC 62-17, Report No. 3 - determinations 61-1 to 61-204
GSC 63-17, Report No. 4 - determinations 62-1 to 62-190
GSC 64-17, Report No. 5 - determinations 63-1 to 63-184
GSC 65-17, Report No. 6 - determinations 64-1 to 64-165
GSC 66-17, Report No. 7 - determinations 65-1 to 65-153
GSC 67-2A, Report No. 8 - determinations 66-1 to 66-176
GSC 69-2A, Report No. 9 - determinations 67-1 to 67-146
GSC 71- 2, Report No. 10 - determinations 70-1 to 70-156
GSC 73- 2, Report No. 11 - determinations 72-1 to 72-163
GSC 74- 2, Report No. 12 - determinations 73-1 to 73-198

GSC Age Determinations Listed by N.T.S. Co-ordinates

1-M 62-189, 190; 63-136, 137; 66-170, 171; 70-145, 146, 147, 152.

1-N 65-150; 70-156.

2-C 70-155.

2-D 59-94, 95, 96, 97, 98; 60-151, 152; 63-182; 65-142, 143; 66-172; 70-153, 154.

2-E 62-187, 188; 63-168, 169, 170, 171, 183, 184; 64-159; 65-144, 145, 146, 147, 148, 149, 67-144; 70-151.

2-F 70-148.

2-L 72-158, 159.

2-M 66-173; 73-192, 193, 194.

3-D 63-161.

10-N 72-163.

11-D 70-122, 123.

11-E 66-156, 157, 158; 70-124, 125.

11-F 62-168, 169.

11-K 66-159, 160, 161.

11-L 65-133, 134, 135; 66-163; 70-128, 129, 130; 72-124, 125, 126.

11-O 61-202; 63-162; 65-138, 139, 140, 141; 66-168.

11-P 67-143.

12-A 64-158; 67-142; 70-120, 121; 72-160, 161; 73-197, 198.

12-B 60-147, 199; 62-186; 63-166, 167.

12-E 65-129; 66-153; 70-102, 103, 104, 105; 72-95.

12-H 60-148; 61-203, 204; 70-143, 144, 149.

12-I 60-149; 61-200, 201; 66-169; 70-150; 72-153, 154, 155, 156, 157; 73-195, 196.

12-L 60-133, 134, 143.

12-O 60-135.

12-P 73-191.

13-C 66-167; 67-138.

13-D 60-132.

13-E 64-160; 70-133.

13-F 60-145; 67-136, 137.

13-H 60-146; 67-141.

13-I 70-138, 142; 72-140, 150.

13-J 70-134, 135, 136, 137; 72-139.

13-K 60-144; 61-196; 62-183, 184, 185; 63-178, 179; 72-141, 142, 143; 73-168, 169.

13-L 61-197; 62-177; 63-148, 163, 177; 64-157; 65-151; 73-163, 164, 167.

13-M 63-174; 64-162; 70-131, 132; 73-174.

13-N 62-178; 63-172; 73-176, 177, 178, 179, 183, 184.

13-O 62-179, 180, 181, 182; 67-133, 134, 135; 70-140, 141; 72-144, 145, 146, 147, 148, 149, 151, 152; 73-180, 181, 185, 186, 187, 188, 189, 190.

14-C 72-138; 73-182.

14-D 60-143; 63-175; 65-122, 152; 73-166.

14-E 61-195; 62-172; 63-181; 64-164; 65-153; 66-166; 72-134; 73-165, 172.

14-F 62-171; 63-180; 64-163; 72-135, 136, 137.

14-L 63-173, 176; 64-165; 67-130, 131, 132, 140; 73-171, 175.

14-M 67-129; 72-133; 73-170, 173.

20-I 72-162.

20-P 61-194; 62-167.

21-A 59-93; 62-163, 164, 165, 166; 65-132; 66-155.

21-B 61-193; 62-161, 162.

21-E 59-89, 90, 91; 60-117, 118; 64-132; 66-142; 72-103, 104, 105.

21-G 60-136; 62-159; 63-155; 66-154; 67-128; 70-108, 109, 110; 72-111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123.

21-H 62-160; 64-156; 65-131; 72-127, 128, 129, 130.

21-I 64-154; 70-127.

21-J 61-187, 188, 189, 190, 191, 192; 62-155, 156, 157, 158; 63-156, 157, 158, 159; 65-130; 70-111, 115, 116, 117, 118, 119; 72-107, 108, 109, 110.

21-L 62-119, 120, 121; 64-128; 67-120.

21-M 59-86, 87; 60-114; 62-145.

21-O 64-155; 70-112; 72-106.

21-P 70-113, 114.

22-A 62-122; 64-131; 65-125, 126, 127, 128; 66-152; 70-106, 107; 72-97, 99, 100, 101, 102.

22-B 61-184, 185, 186; 70-101; 72-96.

22-D 60-113, 115; 73-144, 145, 155.

22-F 60-116; 62-144; 66-146.

22-H 72-98.

22-K 61-163.

22-N 64-127; 66-144, 145.

22-P 61-166; 62-142.

23-A 67-119.

23-B 59-88; 62-140, 141; 66-147, 148, 149, 150; 73-150, 151, 152, 153, 154, 161, 162.

23-C 61-164, 165, 171.

23-D 63-138, 152.

23-F 64-144.

23-G 60-137, 138, 139, 140; 61-198.

23-H 62-173, 174, 175, 176; 64-161; 66-165; 73-156.

23-I 59-64; 60-129, 141, 142; 63-164, 165.

23-J 62-123; 66-164.

23-O 59-63; 60-128; 62-139.

23-P 60-131; 61-181; 65-120, 121; 70-100; 73-159.

24-A 60-130; 72-93, 132; 73-158, 160.

24-B 63-134, 135; 67-117; 70-98, 99.

24-C 60-126, 127; 73-149.

24-D 62-124.

24-F 59-65; 62-136.

24-G 62-137; 67-118.

24-H 62-138; 66-151; 73-146, 147, 157.

24-I 64-124; 65-123; 67-116; 72-94.

24-J 62-134, 135; 67-115.

24-K 63-132.

24-L 61-175.

24-M 61-176, 178; 62-125.

24-N 61-179, 180.

24-P 62-132, 133, 170; 67-139; 70-139; 72-131; 73-148.

25-A 67-64, 114.

25-C 64-136, 137.

25-D 66-143.

25-E 73-139.

25-I 66-70.

25-K 61-52.

26-B 59-37, 38; 73-73.

26-C 66-69.

26-F 66-68.

27-C 61-50, 51; 64-36; 70-65; 72-37, 38.

27-D 70-66, 67.

27-F 70-64.

27-G 70-68.

31-C 59-57; 63-115; 64-119, 122; 65-111; 73-134, 135.

31-D 62-116, 117, 118.

31-E 59-44, 45, 48, 49, 50.

31-F 59-51, 52, 53, 54, 55, 56; 61-161; 65-113; 66-134; 70-84; 72-86, 87.

31-G 60-112; 63-133; 64-125, 126; 65-112; 67-127; 70-85, 86, 87, 88, 89, 90, 91; 72-88.

31-H 59-92; 61-182, 183; 66-141.

31-J 63-139, 140; 65-114, 115, 116, 117; 66-137, 138.

31-L 61-159, 160; 62-114, 115; 73-130, 131, 132, 133.

31-M 59-76, 77, 78; 61-157; 65-110; 70-83.

31-N 59-79, 80, 81, 82, 83, 84, 85.

31-O 65-118, 119.

31-P 60-111.

32-A 60-110.

32-B 70-92, 93, 94, 95; 72-89.

32-C 59-67, 68, 69, 70, 71, 72, 73, 75; 60-106; 64-129; 67-124; 72-90.

32-D 59-66, 74; 61-167, 168; 63-149, 150; 64-85; 66-130, 132, 133; 67-121, 122.

32-E 66-131.

32-F 61-169; 67-123; 73-136.

32-G 60-107, 108; 61-162; 62-146, 147, 148, 149, 150, 153, 154; 63-136, 137, 141, 142, 143, 144, 145, 146, 147; 64-145, 146, 147, 148, 149, 150, 151, 152; 66-139; 67-113, 126; 72-91; 73-137, 138.

32-H 60-109; 62-151, 152; 64-153.

32-L 61-170.

32-O 64-143; 67-125.

32-P 66-140; 70-96, 97.

33-A 59-62.

33-F 60-120.

33-H 59-61.

33-I 59-60.

33-J 60-119.

33-N 59-58, 59.

34-B 63-153, 154; 64-141.

34-C 64-135.

34-D 63-93; 65-85, 86, 87.

34-F 64-134.

34-G 61-172.

34-I 62-130, 131.

34-J 61-173.

34-L 60-121.

34-M 65-83, 84; 66-95.

34-O 61-177; 64-142.

34-P 61-174; 62-126, 127, 128, 129.

35-A 60-124; 64-138, 139.

35-C 64-133, 140.

35-F 60-122.

35-G 65-124; 66-135, 136; 73-142, 143.

35-H 60-125; 73-140, 141.

35-J 60-123.

36-C 59-36.

36-H 66-67.

37-A 70-57, 60, 61; 73-71.

37-B 73-66.

37-E 70-55; 72-35.

37-F 62-86; 64-34, 35; 70-51.

37-G 67-55, 56, 57, 58, 59, 60, 61, 62, 63; 70-54; 72-34; 73-67.

37-H 70-56, 62, 63, 75; 72-36.

38-A 70-58, 59.

38-B 70-53; 73-68.

38-C 70-52.

39-B 61-49.

40-G 63-111, 112.

41-H 59-46, 47; 61-158; 62-113; 73-125.

41-I 59-43; 61-149, 150; 62-106, 107, 108, 109; 63-117; 66-118, 119, 120, 121, 122; 73-126, 127, 128, 129.

41-J 59-42; 60-105; 61-145, 146, 147, 148; 62-105, 111, 112; 63-128, 129; 64-89, 111; 65-107, 108; 66-114, 115, 116, 117; 67-110, 111, 112.

41-K 65-105.

41-N 61-142; 63-122; 64-84; 65-106; 66-113.

41-O 61-143, 144; 64-103, 104, 112; 65-109.

41-P 61-151, 152, 156; 64-100, 107; 70-81, 82.

42-A 60-104; 63-118, 119, 130.

42-C 62-110; 73-111, 112, 120; 73-117, 118.

42-D 63-123; 64-116, 118; 67-104; 72-82, 83; 73-119.

42-E 61-140; 64-115; 73-113.

42-F 60-102; 64-102, 105; 73-114, 115, 116, 121, 122.

42-G 60-103; 63-113, 114; 66-123, 124.

42-H 73-123, 124.

42-I 66-125, 126, 127, 128, 129; 72-85.

42-L 64-86, 87, 88, 92, 93, 94, 95, 96, 97, 98, 99, 114; 65-104; 66-111, 112.

42-M 60-100; 62-103, 104; 63-120, 121; 73-109, 110.

43-E 60-101.

43-G 67-106, 107; 70-80.

43-K 70-79.

44-P 64-72.

45-P 73-91.

46-A 73-88, 89, 90.

46-B 65-77; 73-87.

46-C 73-86.

46-E 65-79.

46-F 65-78.

46-J 65-52.

46-K 65-53.

46-L 65-57; 67-90.

46-M 65-54, 58; 73-109, 110.

46-N 65-55, 59.

46-P 64-28; 73-91.

47-A 67-54.

47-B 65-56.

47-F 64-30, 33; 66-66.

48-A 64-29; 73-69.

48-B 62-85; 64-32.

48-C 63-19, 20; 73-70, 72.

48-D 64-31.

52-A 60-99; 61-138; 64-101, 113; 67-98, 99, 100, 102, 103, 105; 72-81.

52-B 60-98; 61-132, 133; 63-116.

52-C 60-95; 61-131; 62-102.

52-D 66-110; 67-108.

52-E 60-93, 94; 61-130; 66-107.

52-F 60-92; 64-106, 108; 73-107, 108.

52-H 61-139; 67-97, 101.

52-I 64-120.

52-K 61-134, 135; 64-90, 91.

52-L 59-41; 60-89, 90; 73-106.

52-M 60-87, 88; 70-76; 72-71.

52-N 60-91.

52-O 61-136.

53-A 65-103.

53-B 63-110.

53-C 60-97; 62-101; 64-117.

53-D 60-86; 70-77; 72-72, 73, 75.

53-G 61-137.

53-J 60-96.

53-K 67-96.

53-L 64-78; 67-95.

53-M 62-100; 66-108; 72-74, 77.

53-N 66-109; 70-78.

54-D 60-80; 61-122; 66-106.

54-F 61-123.

54-L 67-92, 93.

55-E 60-64; 72-67.

55-K 61-105.

55-L 60-61; 66-94; 67-87, 88, 89; 72-51, 52, 53, 54, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66.

55-M 61-102; 62-96; 65-73, 74; 66-93.

55-N 61-103; 73-85.

56-B 65-76.

56-C 59-33.

56-D 64-74; 73-84.

56-G 65-80.

56-J 61-93, 94.

56-K 61-92.

56-M 61-91.

56-O 61-97.

56-P 65-81, 82.

57-A 61-96.

57-C 61-95; 63-92.

57-F 67-53.

57-G 63-17.

58-B 63-18.

58-C 72-33.

62-P 61-128, 129.

63-A 72-76.

63-H 60-85.

63-I 60-84; 61-124, 125, 127; 64-79.

63-J 61-119, 120; 63-99, 100, 101, 102, 103, 104, 105; 64-80, 81, 82, 83; 65-96, 97, 98; 67-94; 73-103.

63-K 60-73, 74; 61-112, 118; 63-96, 106, 108; 73-92, 93, 94, 105.

63-L 60-72; 73-98, 101, 102.

63-M 60-71; 73-95, 96.

63-O 60-79; 65-99, 100; 73-104.

63-P 60-83; 61-121, 126; 65-101, 102; 66-100, 101, 102, 103, 104, 105.

64-A 60-81, 82.

64-C 60-75, 76, 77; 61-116, 117; 62-99; 63-107.

64-D 73-99, 100.

64-E 67-91.

64-G 61-115.

64-H 59-40.

64-I 60-78; 63-109; 64-77.

64-L 60-67.

64-N 61-113; 62-98.

64-P 61-114.

65-A 59-34.

65-C 60-63.

65-D 61-83.

65-F 64-73.

65-G 60-62; 61-106; 64-71; 65-71, 72, 66-91.

65-H 64-70.

65-J 59-35; 61-104.

65-K 61-101; 62-97.

65-N 60-60.

65-O 61-100; 62-95.

65-P 66-92.

66-A 61-98, 99; 65-75.

66-D 63-44; 66-89.

66-E 61-86.

66-H 59-32.

66-J 61-89, 90.

66-L 63-65.

66-M 64-63; 65-69, 70; 66-90.

66-N 61-87, 88.

68-H 65-60, 61.

69-F 62-87A, 87B.

73-O 60-69.

73-P 60-70; 73-97.

74-A 61-111.

74-B 60-68.

74-E 61-107.

74-K 66-99.

74-M 63-94.

74-N 59-39; 60-65; 61-108; 63-97, 98; 64-76; 65-95; 66-96, 97, 98; 72-68.

74-O 60-66.

74-P 61-109, 110.

75-A 62-94.

75-B 60-56; 73-83.

75-D 60-53, 54, 55; 65-62; 66-82, 84; 73-81.

75-E 61-76, 79, 80; 63-45; 65-63; 66-78, 79, 81, 83, 85, 86; 67-78.

75-F 61-81; 73-77.

75-I 59-27; 63-82.

75-J 59-28; 60-57.

75-K 61-78, 82; 63-80, 81; 70-73.

75-L 60-50, 51, 52; 61-69; 63-83; 66-80; 67-76, 85.

75-M 63-43, 84, 85, 86, 87.

75-N 61-70, 71; 63-58, 59.

75-O 59-22; 60-58; 61-84; 72-49, 50; 73-78, 79, 82.

75-P 59-29; 66-88.

76-A 59-30.

76-B 60-59.

76-C 66-87.

76-D 63-53; 67-84; 70-70.

76-E 63-64, 70; 67-71, 86; 73-75.

76-F 63-73; 73-77.

76-G 59-23, 24, 25, 26; 63-25, 26, 27; 64-37, 38, 39, 40, 41.

76-H 59-31.

76-I 61-85; 63-62, 74, 75; 64-62.

76-J 64-48, 49, 50, 52, 53.

76-K 61-74, 75; 73-76.

76-L 63-63, 76.

76-M 63-67, 68, 69; 64-51; 67-83.

76-N 63-60, 66, 78.

76-O 63-61, 71, 72; 70-74.

76-P 63-46, 79.

77-A 64-67.

77-G 61-53.

78-B 62-83, 84.

82-D 66-47.

82-E 60-20; 66-45, 46.

82-F 59-1, 2, 3, 4, 5, 6; 60-2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 21, 22; 61-9, 10, 11, 12, 13, 14, 15, 16, 17, 25, 26, 27; 62-1, 2, 3, 4, 5, 6, 7, 8, 12, 26, 27, 28, 29, 30, 31, 32, 39, 40, 41, 42, 43; 63-13; 66-51, 52, 53, 54, 55.

82-G 62-38; 63-75; 64-75; 65-1, 2, 3, 4, 5, 6, 7, 33, 88, 89, 90, 91, 92; 66-56, 57.

82-J 65-93.

82-K 60-18, 19; 61-18, 19, 20; 62-9, 10, 11, 13, 14, 15, 16, 17, 18, 33, 34; 63-10, 11, 12; 64-21, 23; 66-48, 49, 50.

82-L 60-1; 61-1, 2, 3, 4, 5, 6, 7, 8; 62-35, 36, 37, 44, 45, 46, 47, 48; 66-43, 44.

82-M 63-1, 8; 64-15, 16, 17, 18, 22; 72-30, 31.

82-N 59-7, 8; 61-21, 22, 23, 24, 28; 63-19, 20, 21, 22, 23, 24, 25, 49, 50, 51, 52, 53, 54; 64-19, 20, 21; 70-5.

83-D 64-4, 13, 14; 65-24, 94; 67-43, 44; 70-16, 17, 18.

85-H 61-77; 62-93; 67-72, 73, 74, 75; 72-44, 45, 46, 47.

85-I 61-67, 68; 63-24; 67-77.

85-J 60-49; 61-64, 66; 63-54, 55; 67-82; 70-69.

85-N 60-45, 46, 47; 61-57, 59; 62-90, 91.

85-O 61-60, 61, 62, 63, 65, 73; 62-92; 63-28, 29, 52.

85-P 61-72.

86-A 59-16, 17, 18, 19, 20, 21.

86-B 60-43, 44, 48; 63-30, 31, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 51.

86-C 60-40, 41, 42; 61-56, 58; 62-89; 64-42, 43, 45, 46, 64, 66; 67-81.

86-E 72-39.

86-F 63-32, 50; 64-65; 73-80.

86-G 61-55; 64-47, 59, 60, 61; 65-67; 66-73.

86-H 63-48; 65-64, 65, 66, 68; 66-74, 75, 76, 77; 67-68, 69, 70; 70-71, 72; 72-43.

86-J 60-38, 39; 63-89, 90.

86-K 67-67, 80; 72-41.

86-L 72-40.

86-M 63-47; 64-54.

86-N 60-37; 66-71, 72; 67-79; 72-42.

86-O 63-88, 91; 64-44, 55, 57, 58, 68, 69.

86-P 63-49.

87-D 64-56.

88-N 63-77.

92-B 65-13; 66-34; 73-5; 73-6, 18, 19.

92-C 70-36.

92-E 73-4, 7.

92-F 64-2, 3, 130; 65-11, 17, 18; 66-29, 30, 31, 32, 33; 67-39; 72-9, 10, 11, 12, 13, 14, 19, 20, 21; 73-8, 9, 10.

92-H 62-55, 56, 57; 65-8, 9, 10; 66-42; 72-3, 4, 5, 6, 7, 8.

92-I 61-29; 62-58, 59, 60, 61, 62, 63; 66-37, 38, 39, 40, 41; 72-22.

92-K 73-13, 14, 15, 16, 17, 20, 21, 22, 23, 24, 25, 26, 27.

92-L 65-12, 14, 15; 66-27, 28; 72-17, 18, 26; 73-2, 3, 11, 12.

92-M 72-15, 16.

92-O 63-7, 9; 65-27; 67-42.

92-P 65-22, 23, 25, 26; 66-35, 36.

93-A 62-64; 63-6.

93-B 66-26.

93-D 64-10; 65-19, 28; 66-20; 67-29, 30; 70-7, 8.

93-F 61-34.

93-G 66-21, 22, 23, 24, 25; 67-41.

93-J 67-40.

93-K 61-35, 36, 37.

93-L 67-35, 36, 37, 38; 73-28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45.

93-O 60-23, 24; 61-30, 31, 32, 33; 62-65, 66, 67; 70-37, 38, 39, 40, 41, 42, 43, 44.

94-C 66-18, 19; 70-11, 12, 13, 14, 15; 72-27, 28, 29; 73-46, 47, 48, 49, 50.

94-D 70-10.

94-E 70-9; 73-51, 52.

94-F 73-53, 54, 55, 56.

94-L 62-68, 69.

95-E 62-88.

95-G 60-35.

96-P 61-54.

97-A 60-36; 63-56.

97-D 63-57.

102-I 73-1.

103-A 64-7, 8; 66-16, 17; 67-26, 27, 28, 31, 32, 33, 34; 70-6.

103-B 66-14; 67-18, 19, 20.

103-F 67-16, 17; 70-1, 2.

103-G 64-5, 6; 70-3.

103-H 64-11, 12; 66-10, 11, 12, 13; 67-22, 23, 24, 25.

103-I 65-29, 30, 32; 66-6, 7, 15.

103-J 65-31; 66-5, 8, 9; 67-21.

103-P 64-9.

104-I 62-71; 67-15; 70-27, 28, 29, 30, 31, 32.

104-J 60-25; 62-70; 70-21, 22, 25, 26, 33, 34, 35.

104-K 62-75, 76, 77.

104-M 60-26, 27, 34; 61-38, 39, 46, 47.

104-N 70-19.

104-O 62-72, 73; 66-1, 2, 3; 67-1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14; 70-4, 20, 23, 24.

104-P 62-74; 64-1.

105-B 59-14; 60-28, 30; 61-45; 70-48, 49, 50; 73-59, 60, 61, 62, 63.

105-C 59-9; 61-42.

105-D 59-10.

105-E 66-60.

105-F 65-34, 35, 36, 37.

105-G 60-29; 65-45.

105-H 67-49.

105-I 67-65, 66.

105-J 61-43.

105-K 61-44; 65-38, 39, 40, 41, 42, 43, 44; 67-47, 48; 70-45, 46.

105-M 62-81; 65-46, 48, 49.

105-O 73-74.

106-D 62-78, 80; 65-47.

107-N 63-14.

115-G 59-11, 12, 13; 60-32.

115-H 60-31; 61-41.

115-J 64-24, 25; 67-45, 46.

115-O 60-33; 64-26, 27.

115-P 65-50; 70-47.

116-A 62-79.

116-B 66-58, 59.

116-C 61-40; 62-82.

117-A 63-15, 16; 73-57, 58.

117-C 65-51.

120-E 66-65.

120-G 59-15; 66-61, 62.

120-N 66-63.

340-E 67-50, 51, 52.

340-F 63-22; 73-64, 65.

560-A 63-21.

560-D 61-48; 63-23.

560-N 66-64.

Mid Atlantic Ridge
66-174, 175, 176; 67-145, 146.