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AGE DETERMINATIONS AND GEOLOGICAL STUDIES
K-Ar Isotopic Ages, Report 14

R.K. WANLESS, R.D. STEVENS
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Abstract

Two hundred and thirty 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 Geological Survey of Canada K-Ar age determinations by primary NTS quadrangle has been prepared.

Résumé

Les auteurs présentent 230 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 fourteenth report of potassium-argon age measurements completed in the Geochronological Laboratories of the Geological Survey of Canada. Two hundred and thirty determinations are reported, bringing the total number of published ages to 2463.

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
GSC 74-2, Report No. 12 – determinations 73-1 to 73-198
GSC 77-2, Report No. 13 – determinations 76-1 to 76-248
GSC 79-2, Report No. 14 – determinations 78-1 to 78-230

Determinations reported include 34 mineral pairs (25 biotite-hornblende and 9 biotite-muscovite), ranging in indicated age from 45.6 to 2654 Ma. The data obtained in various regions of Canada are presented in the accompanying figure and statistical information is summarized in the tables.

Twenty-one mineral pairs (62%) have ages that agree with the assigned 2σ error limits, whereas the remaining pairs have differences ranging as high as 93 per cent. The majority (76%) however have differences of less than 15 per cent. As indicated in K-Ar Report 13, when results for 58 mineral pairs were discussed, pairs with very large differences were excluded from the calculations because the minerals in those rocks did not crystallize at the same time or because one or another of the minerals in question suffered a net loss or gain of radiogenic argon at some period of its development.

Results for the 26 pairs having differences of less than 15 per cent have been plotted in Figure 1 and ratios of age differences have been calculated (Tables 1 and 2). Consideration of the weighted averages indicates some divergence from trends noted for the larger group considered in K-Ar Report 13. Although hornblende ages for the total group indicate a higher age than for the biotites, the weighted average (1.01) is markedly lower than that previously determined (1.05). This variance is attributable to the change in trend of the new results from British Columbia which have yielded generally higher biotite ages. This trend however is not apparent in samples from other regions of the country. A somewhat similar change is apparent in the biotite-muscovite comparison. The new pairs indicate higher biotite than muscovite ages in contrast to the generally accepted premise that muscovite retains radiogenic argon better than associated biotite.

The sampling is limited and while trends noted in K-Ar Report 13 are not as apparent, it is too early to draw conclusions from the data since in this new grouping several samples related to dyke intrusion and subsequent regional metamorphism were included. The rocks in question undoubtedly experienced multiple thermal events and consequent unpredictable effects on the radiogenic argon concentration. As additional analyses become available further comparisons will be made.

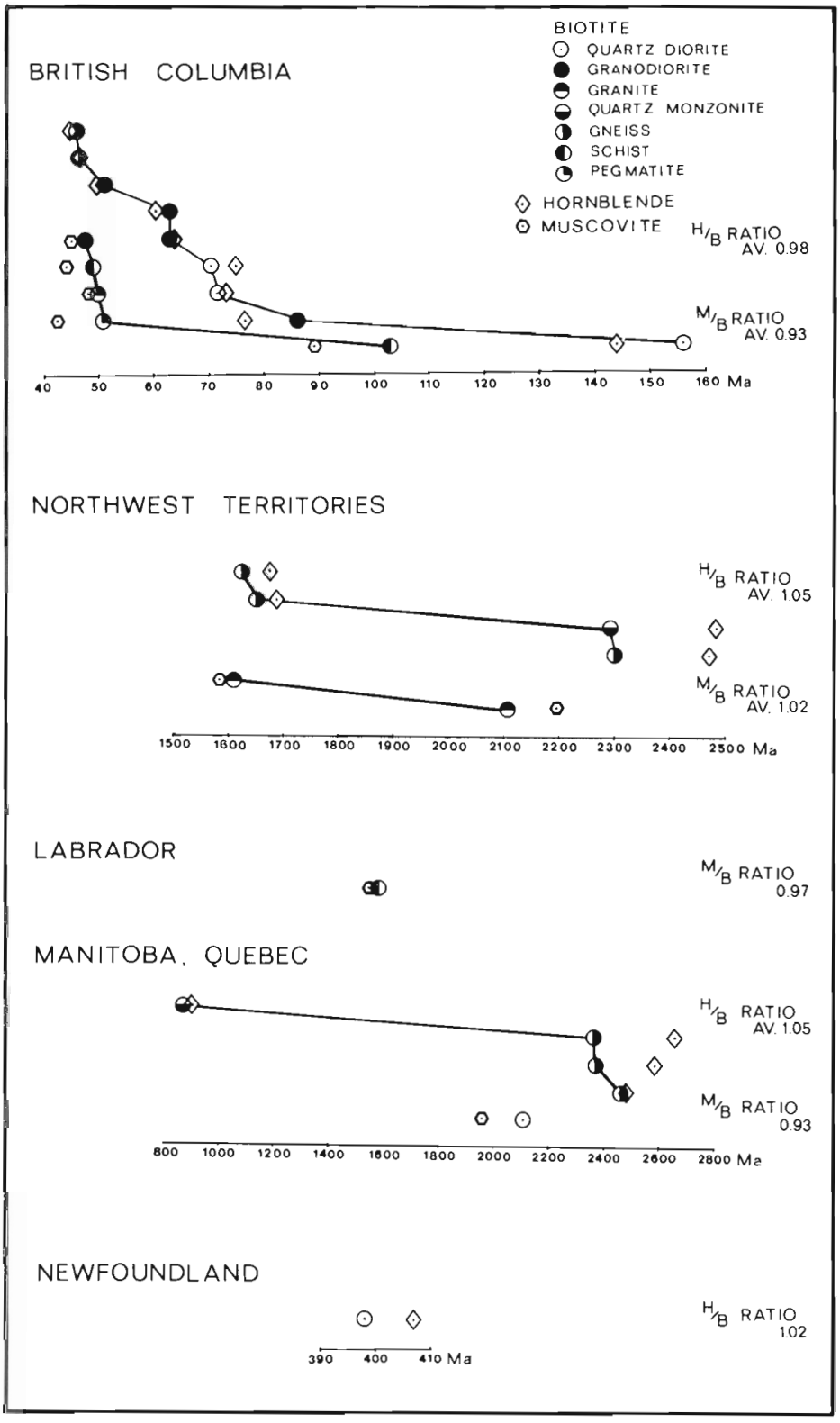

Figure 1. *Comparison of ages determined for biotite-hornblende and biotite-muscovite mineral pairs.*

Table 1

Comparison of biotite-hornblende age determinations

Region	No. of mineral pairs	No. of ages within 2σ limits	Frequency of highest age H	B	Average age ratio for pairs with age differences <15%	No. of sample pairs averaged	Range of biotite ages (Ma)
British Columbia	15	8	10	5	0.98	10	45.6 to 156
Northwest Territories	5	3	5	-	1.05	4	1626 to 2300
Manitoba, Quebec	4	3	4	-	1.05	3	868 to 2466
Newfoundland	1	1	1	-	1.02	1	398
Total	25	15	20	5		18	
Weighted average 1.01							

Table 2

Comparison of biotite-muscovite age determinations

Region	No. of mineral pairs	No. of ages within 2σ limits	Frequency of highest age M	B	Average age ratio for pairs with age differences <15%	No. of sample pairs averaged	Range of biotite ages (Ma)
British Columbia	5	2	-	5	0.93	4	47.8 to 103
Northwest Territories	2	2	1	1	1.02	2	1610 to 1209
Manitoba	1	1	-	1	0.93	1	2108
Labrador	1	1	-	1	0.97	1	1593
Total	9	6	1	8		8	
Weighted average 0.96							

Geological Time-Scales

The Phanerozoic time-scales of the Geological Society of London (1964) and Holmes (1959) are summarized in tabular form in Figure 2. 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 more current philosophical analysis of the concept of the geological time scale and a detailed discussion of some of its parts may be found in Cohee et al. (1978).

A revised time-scale, after Stockwell (1973), is given in Figure 3 for the Precambrian of the Canadian Shield.

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).

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 those adopted by the IUGS Subcommission on Geochronology at the 25th IGC in Sydney, Australia (Steiger and Jäger, 1977). They are as follows:

Potassium

$\lambda(^{40}K_{\beta-}) = 4.962 \times 10^{-10}/a^{-1}$

$\lambda(^{40}K_{e}) + \lambda'(^{40}K_{e}) = 0.581 \times 10^{-10}/a^{-1}$

$^{40}K = 0.01167$ atom%

Argon

atomic ratio $^{40}Ar/^{36}Ar$ atmospheric = 295.5

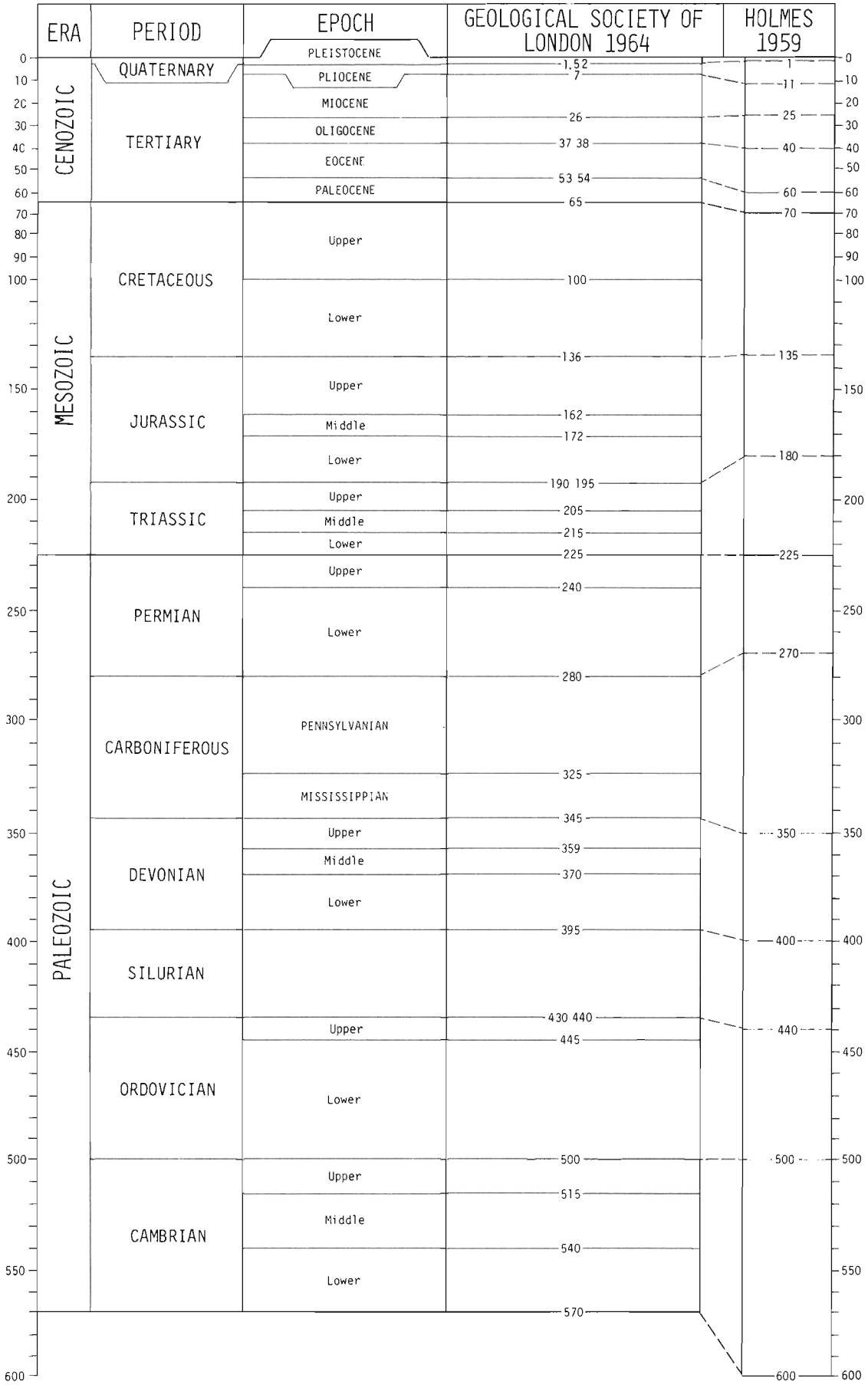

Figure 2. *Phanerozoic time-scale.*

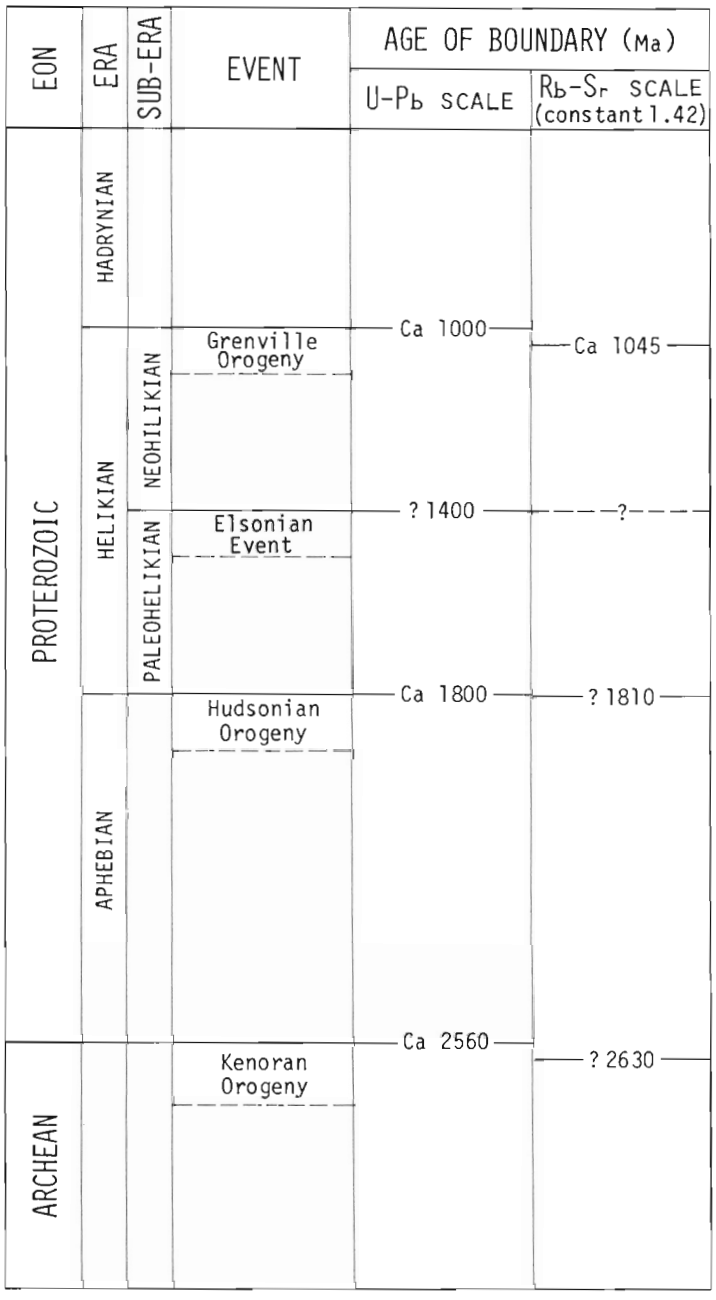

Figure 3. *Precambrian time-scale.*

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Wanless, R.K., Stevens, R.D., Lachance, G.R., and Edmonds, C.M.
1968: Age determinations and geological studies, K-Ar isotopic ages, Report 8; Geological Survey of Canada, Paper 67-2, Pt. A.

Errata

GSC Paper 64-17

Determination GSC 63-14:
NTS should read 116 N.

GSC Paper 65-17

Determination GSC 64-158:
NTS should read 12 I.

GSC Paper 77-2

p. 55, Delete 64-158 from 12 A
Enter 64-158 under 12 I.

p. 60, Delete 63-14 from 107 N
Enter 116 N with age determination 63-14.

British Columbia
(GSC 78-1 to GSC 78-99)

GSC 78-1 Biotite, K-Ar age **44.8 ± 2.4 Ma**

K = 7.19%, $^{40}Ar/^{40}K$ = 0.00264, radiogenic Ar = 71.4%.
Concentrate: Clean, unaltered, light brownish orange biotite with no visible contamination.

From gneiss (pyroxene-bearing phase)
(103 I) On Prince Rupert-Terrace road, about 1.6 km east of Kwinitsa, British Columbia, 54°19'N, 129°18'W. Map unit 1b, GSC Map 12-1966. Sample WN-20A-74, collected by R.K. Wanless and W.W. Hutchison.

See GSC 78-2 for description.

GSC 78-2 Biotite, K-Ar age **45.4 ± 2.4 Ma**

K = 7.49%, $^{40}Ar/^{40}K$ = 0.00267, radiogenic Ar = 74.9%.
Concentrate: Clean, unaltered, light brownish orange biotite with no visible contamination.

From gneiss (garnet-bearing phase)
(103 I) On Prince Rupert-Terrace road, about 1.6 km east of Kwinitsa, British Columbia, 54°19'N, 129°18'W. Map unit 1b, GSC Map 12-1966. Sample WN-20B-74, collected by R.K. Wanless and W.W. Hutchison.

These two determinations were made on biotite from a pyroxene-bearing phase (GSC 78-1) and a garnet-bearing phase (GSC 78-2) of the Kwinitsa Gneiss. For further discussion see Hutchison, W.W., Geology of Prince Rupert-Skeena, GSC Memoir 394 (in press).

GSC 78-3 Biotite, K-Ar age **46.4 ± 2.5 Ma**

K = 7.75%, $^{40}Ar/^{40}K$ = 0.00273, radiogenic Ar = 76.1%.
Concentrate: Clean, unaltered, light greenish-brown biotite with no visible contamination.

From gneiss
(103 I) 0.8 km west of bridge over Exchamsiks River on Prince Rupert-Terrace highway, British Columbia, 54°19.5'N, 129°17.5'W. Map unit 1, GSC Map 12-1966. Sample WN-21-74, collected by R.K. Wanless and W.W. Hutchison.

See GSC 78-4 for description.

GSC 78-4 Hornblende, K-Ar age **45.9 ± 3.0 Ma**

K = 1.06%, $^{40}Ar/^{40}K$ = 0.00270, radiogenic Ar = 63.4%.
Concentrate: Clean, unaltered, pleochroic, brown to green hornblende with no visible contamination.

From gneiss
(103 I) Details as for GSC 78-3.

This hornblende-biotite pair (GSC 78-3, 4) was obtained from gneiss of map unit 1, GSC Map 12-1966. For further discussion see Hutchison, W.W., Geology of Prince Rupert-Skeena, GSC Memoir 394 (in press).

GSC 78-5 Biotite, K-Ar age **46.6 ± 3.1 Ma**

K = 7.78%, $^{40}Ar/^{40}K$ = 0.00274, radiogenic Ar = 7.78%.
Concentrate: Clean, unaltered, dark greenish brown biotite with no visible contamination.

From quartz diorite
(103 I) 2.4 km east of Shames River, on Prince Rupert-Terrace highway, British Columbia, 54°20'N, 129°15'45"W. Map unit 1, GSC Map 12-1966. Sample WN-23-74, collected by R.K. Wanless and W.W. Hutchison.

The sample is from an "older" greenish grey quartz diorite. See Hutchison, W.W., Geology of Prince Rupert-Skeena, GSC Memoir 394 (in press).

GSC 78-6 Biotite, K-Ar age **46.6 ± 2.5 Ma**

K = 7.79%, $^{40}Ar/^{40}K$ = 0.00274, radiogenic Ar = 78.7%.
Concentrate: Clean, unaltered, light greenish brown biotite with no visible contamination.

From leucogneiss
(103 I) Top of Mt. Ponder (a little to west of summit), British Columbia, 54°42.5'N, 129°35'W. Map unit 1, GSC Map 12-1966. Sample WN-24-74, collected by R.K. Wanless and W.W. Hutchison.

See GSC 78-9 for description.

GSC 78-7 Hornblende, K-Ar age **46.9 ± 3.1 Ma**

K = 0.990%, $^{40}Ar/^{40}K$ = 0.00276, radiogenic Ar = 73.2%.
Concentrate: Clean, unaltered, pleochroic, brown to bluish green hornblende with no visible contamination.

From leucogneiss
(103 I) Details as for GSC 78-6.

See GSC 78-9 for description.

GSC 78-8 Biotite, K-Ar age **45.6 ± 2.4 Ma**

K = 7.11%, $^{40}Ar/^{40}K$ = 0.00268, radiogenic Ar = 73.6%.
Concentrate: Light brown biotite with approximately 4% chlorite alteration.

From leucogneiss
(103 I) South saddle of Red Cap Mountain, British Columbia, 54°42'N, 129°40'W. Map unit 1, GSC Map 12-1966. Sample WN-25-74, collected by R.K. Wanless and W.W. Hutchison.

See GSC 78-9 for description.

GSC 78-9 Biotite, K-Ar age **44.5 ± 2.4 Ma**

K = 7.13%, $^{40}Ar/^{40}K$ = 0.00262, radiogenic Ar = 76.2%.
Concentrate: Light brown biotite with approximately 4% chlorite as free contamination and as altered mica.

From leucogneiss
(103 I) At 4960 ft., north of headwaters of Carn Creek, British Columbia, 54°38'N, 129°37.5'W. Sample WN-26-74, collected by R.K. Wanless and W.W. Hutchison.

These four samples (GSC 78-6, 7, 8, 9) are from leucogneiss of map unit 1, although not of the most typical material. For further discussion see Hutchison, W.W., Geology of Prince Rupert-Skeena, GSC Memoir 394 (in press).

GSC 78-10 Whole-rock, K-Ar age **42.2 ± 5.6 Ma**

K = 2.10%, $^{40}Ar/^{40}K$ = 0.00248, radiogenic Ar = 81.5%.
Concentrate: Crushed whole-rock.

From basalt
(103 I) 0.8 km east of Exchamiks River, on south side of Prince Rupert-Terrace highway, British Columbia, 54°20'N, 129°17'W. See GSC Map 12-1966. Sample WN-22-74 collected by R.K. Wanless and W.W. Hutchison.

The sample was collected from the chilled margin of a vertical basaltic dyke cutting the gneiss represented by samples GSC 78-3 and 4.

For further discussion see Hutchison, W.W., Geology of Prince Rupert-Skeena, GSC Memoir 394 (in press).

GSC 78-11 Biotite, K-Ar age **145 ± 5 Ma**

K = 5.73%, $^{40}Ar/^{40}K$ = 0.00876, radiogenic Ar = 94.0%.
Concentrate: Impure, brownish orange biotite with approximately 15-20% chlorite alteration.

From gabbro
(93 M) On ridge crest 5 km east-southeast of Iktlaki Peak, Hazelton map area, British Columbia, 55°51.4'N, 126°05.5'W. Map unit C-4, GSC Open File 215. Sample 75WV-79-1, collected and interpreted by G.J. Woodsworth.

The sample is a medium grained massive gabbro composed of about 73% plagioclase, 16% clinopyroxene, 4% opaques, 4% biotite, 1% chlorite, 1% muscovite, 1% apatite. Biotite is slightly chloritized.

The sample is from a body of diorite and gabbro that cuts and is faulted against late Sinemurian (lower Jurassic) subaerial volcanics. A late Cretaceous to early Tertiary age was originally suggested for this body (GSC Open File 215); this date suggests a Late Jurassic age for the intrusion.

GSC 78-12 Biotite, K-Ar age **121 ± 4 Ma**

K = 7.08%, $^{40}Ar/^{40}K$ = 0.00726, radiogenic Ar = 90.7%.
Concentrate: Very light brown biotite with approximately 7% chlorite alteration.

From quartz diorite
(94 D) At elevation 5400 ft (1646 m), 1.5 km south of survey station 6798, west end of Ingenika Range, McConnell Creek map area, British Columbia, 56°40'N, 126°18'W. Map unit E of Richards (1976) and Woodsworth (1976), GSC Paper 76-1A. Sample 75WV-253-1, collected and interpreted by G.J. Woodsworth.

See GSC 78-13 for description and interpretation.

GSC 78-13 Hornblende, K-Ar age **142 ± 12 Ma**

K = 0.399%, $^{40}Ar/^{40}K$ = 0.00859, radiogenic Ar = 61.7%.
Concentrate: Fresh, pleochroic, yellowish brown to green hornblende with no visible contamination.

From quartz diorite
(94 D) Details as for GSC 78-12.

The sample is a medium grained, slightly porphyritic and faintly foliated quartz diorite with approximately 74% plagioclase, 13% quartz, 6% K-feldspar, 4% biotite, 1% hornblende, 1% chlorite and minor opaques, sphene, apatite and epidote. Biotite is partly chloritized.

The sample is from a quartz diorite body that intrudes Upper Triassic strata and is cut by the Ingenika Fault. The hornblende and biotite dates are highly discordant and a meaningful interpretation of the dates is not possible at this time.

GSC 78-14 Biotite, K-Ar age **156 ± 5 Ma**

K = 7.60%, $^{40}Ar/^{40}K$ = 0.00947, radiogenic Ar = 92.8%.
Concentrate: Relatively clean, very light brown biotite with approximately 1% chlorite alteration.

From diorite
(94 D) In small cirque at elevation 6000 ft (1830 m), 3 km west-northwest of summit of Fleet Peak, McConnell Creek map area, British Columbia, 56°47'N, 126°18'W. Map unit D of Richards (1976) and Woodsworth (1976) in GSC Paper 76-1A, p. 43-50. Sample 75WV-270-1 collected and interpreted by G.J. Woodsworth.

See GSC 78-15 for description and GSC 78-16 for interpretation.

GSC 78-15 Hornblende, K-Ar age **144 ± 8 Ma**

K = 0.643%, $^{40}Ar/^{40}K$ = 0.00873, radiogenic Ar = 60.0%.
Concentrate: Clean, unaltered, pleochroic, yellowish brown to green hornblende with no visible contamination.

From diorite
(94 D) Details as for GSC 78-14.

The sample is a medium grained, equigranular diorite, moderately foliated, composed of about 77% plagioclase, 14% biotite, 5% hornblende, 3% clinopyroxene and minor opaques, epidote, sericite, sphene and apatite. Clinopyroxene is rimmed and replaced by green hornblende.

See GSC 78-16 for interpretation.

GSC 78-16 Hornblende, K-Ar age **169 ± 7 Ma**

K - 0.97%, $^{40}Ar/^{40}K$ - 0.01028, radiogenic Ar = 85.9%.
Concentrate: Clean, unaltered, pleochroic, brownish yellow to green hornblende with no visible contamination.

From quartz monzodiorite
(94 D) At elevation 5900 ft (1799 m), 3 km west of survey point 6820 (Jensen Peak) and 5.5 km east-northeast of south end of Frederickson Lake, McConnell Creek map area, British Columbia, 56°56.5'N, 126°26'W. Map unit E of Richards (1976) and Woodsworth (1976) in GSC Paper 76-1A, p. 43-50. Sample 75WV-249-1, collected and interpreted by G.J. Woodsworth.

The sample is a medium grained, equigranular, massive, quartz monzodiorite composed of about 78% plagioclase, 11% microcline, 5% quartz, 3% hornblende, 1% biotite, 1% epidote and minor sphene, opaques, apatite. Hornblende is partly replaced by biotite and epidote.

Samples GSC 78-14 and GSC 78-15 are from the Fleet Peak pluton, a long, narrow dioritic to monzodioritic body. Most of the pluton is heavily chloritized and epidotized; the sample is from one of the few fresh areas in the pluton. GSC 78-16 is from the Jensen Peak pluton, a slightly miarolitic quartz monzodiorite body in fault contact with the Fleet Peak pluton. The Jensen Peak pluton is fresh and unfoliated; the 169 ± 7 Ma date may approximate the age of emplacement of the body.

The foliated and highly altered Fleet Peak pluton is similar in many ways to the Lower Jurassic Thane pluton in the Hogem Batholith, some 50 km to the southeast. The discordant age (156 ± 5 Ma on biotite and 144 ± 8 Ma on hornblende) may not indicate the time of emplacement of the Fleet Peak pluton: hornblende occurs as an alteration product of clinopyroxene, and biotite is slightly chloritized. The age of the pluton remains uncertain.

GSC 78-17 Whole-rock, K-Ar age **121 ± 9 Ma**

K = 2.76%, $^{40}Ar/^{40}K$ - 0.00729, radiogenic Ar = 93.2%.
Concentrate: Crushed whole-rock.

From siliceous semischist.
(93 O) Northwest side of Hart Highway, 5.4 km southwest of Caswell Creek, Pine Pass map area, British Columbia, 55°09.1'N, 122°48.3'W. Map unit 4, GSC Map 11-1961 (Muller, 1961). Sample GA-75-1, collected by H. Gabrielse and interpreted by C.J. Dodds.

The rock is a fresh, silvery-buff-grey quartz-muscovite semischist. A prograde metamorphic assemblage quartz-muscovite-chlorite is present; muscovite and chlorite are fairly fresh. Accessories include zoned tourmaline, apatite, and opaques. An excellent schistosity is displayed (imparted by muscovite and chlorite) which is deformed by two cleavages with associated fine crenulations. No new mineral growth has resulted from this latter deformation.

The specimen was collected from a road cut exposing a steeply southwest dipping sequence of interbedded sericitic and more resistant quartzitic grit which form part of the Upper Proterozoic Misinchinka Group.

See GSC 78-19 for interpretation.

GSC 78-18 Whole-rock, K-Ar age **118 ± 7 Ma**

K = 3.47%, $^{40}Ar/^{40}K$ = 0.00706, radiogenic Ar - 97.8%.
Concentrate: Crushed whole-rock.

From schist
(93 O) Northwest side of Hart Highway, 3.2 km southwest of Caswell Creek, Pine Pass map area, British Columbia, 55°10.3'N, 122°47.5'W. Map unit 4, GSC Map 11-1961 (Muller, 1961). Sample GA-75-2, collected by H. Gabrielse and interpreted by C.J. Dodds.

The rock is a fine grained, fresh, glossy, dark green-grey quartz-muscovite-chlorite-chloritoid schist. A prograde metamorphic assemblage quartz-muscovite-chlorite is present and is associated with the schistosity. An apparent overprinting of chlorite and chloritoid has occurred. A late pervasive cleavage together with two rather indistinct crenulations deform the schistosity. The micas are fairly fresh and are deformed only within cleavage planes. Sparse (1%) poikiloblastic chloritoid is present and is associated with a coarser generation of somewhat randomly oriented chlorite. The latter postdate the schistosity and apparently also the cleavage. Accessories include tourmaline, abundant opaques, and apatite.

The rock was obtained from a road cut exposing highly "cleaved" silvery grey weathering sericitic schist of the Upper Proterozoic Misinchinka Group.

See GSC 78-19 for interpretation.

GSC 78-19 Whole-rock, K-Ar age **119 ± 7 Ma**

K = 3.33%, $^{40}Ar/^{40}K$ - 0.00715, radiogenic Ar - 98.1%.
Concentrate: Crushed whole-rock.

From schist
(93 O) Road cut on northwest side of Hart Highway at Caswell Creek, Pine Pass map area, British Columbia, 55°11.4'N, 122°45.2'W. Map unit 4, GSC Map 11-1961 (Muller, 1961). Sample GA-75-3, collected by H. Gabrielse and interpreted by C.J. Dodds.

An isochron plot of the three samples (GSC 78-17, 18, 19) indicates an age of 116 Ma with no significant excess of radiogenic argon.

The rock is a fine grained, fresh, sheeny, darkish green-grey quartz-muscovite-chlorite-chloritoid schist and displays a good schistosity which is deformed by a pervasive cleavage and two poorly developed crenulations. The mineralogical, textural, and structural relationships within this rock are much the same as that of GSC 78-18. However, the metamorphic grade is, if anything, slightly higher. Chloritoid is more abundant (2-3%), slightly coarser grained, with little or no associated coarser chlorite. The micas are only mildly deformed having minor shreding only in cleavage planes. The chloritoid similarly overprints the crenulated schistosity and appears to postdate the cleavage.

The specimens were obtained from a road cut exposing intensely "cleaved" Misinchinka Group sericitic schists.

The above three samples were run for a dual purpose; (a) to corroborate a previous K-Ar determination on a biotite-muscovite pair from a schist collected close to the above localities (Muller, J.E., GSC Paper 63-17, p. 43-44), which yielded respectively ages of 143 and 136 Ma, (b) to ascertain if grade change within lithologically similar metamorphic rocks results in detectable changes in the K-Ar values. The cause of the disparity in the case of (a) is not

clear. The almost identical ages obtained suggest that little change in whole-rock K-Ar ages occurs with metamorphic grade increase, however, perhaps there was insufficient difference in grade in this sampling to show changes in the K-Ar values.

At present these metamorphic K-Ar ages are still among the oldest so far obtained from the Omineca-Crystalline and Metamorphic Belt. However, all other K-Ar ages from metamorphic rocks determined thus far from close proximity to the Rocky Mountain Trench have given early Tertiary ages. The occurrence of these older metamorphic ages within a belt yielding early Tertiary metamorphic ages remains enigmatic.

See further comments under GSC 78-35.

GSC 78-20 Biotite, K-Ar age **41.6 ± 2.2 Ma**

K = 7.50%, $^{40}Ar/^{40}K$ = 0.00225, radiogenic Ar = 78.2%.
Concentrate: Brown biotite with approximately 2% chlorite alteration.

From adamellite
(94 E) Cirque at the head of a northeast facing valley, about 3.4 km southeast of Warner Peak, Sifton Range, Toodoggone River map area, British Columbia, 57°38.9'N, 126°03.7'W. Sample GAA-75-86, collected by R.G. Anderson and interpreted by C.J. Dodds.

The rock is a medium grained, equigranular, homogeneous, greyish buff biotite adamellite. It consists of quartz (26.5%), plagioclase (28.5%), microcline (41.5%), biotite (2%), opaques (1%) and accessory apatite and allanite. The felsic minerals are evenly distributed. Both feldspars are fresh and generally subhedral. Microcline commonly contains stringy exsolved albite. Biotite ranges in size from 0.3 to 0.5 mm and is greenish brown in colour. Flakes are ragged, mildly bent and chloritized and inclusions (zircon) are few. Skeletal wedge-shaped opaque ore(s) and distinctly pleochroic, subhedral allanite occur as accessories.

The specimen was collected from the northern part of a granitic body outcropping in southeast Sifton Range and northwest Cormier Range. This stock discordantly intrudes structurally and metamorphically complex Proterozoic(?) and Lower Cambrian(?) gneisses, amphibolites, and quartz-rich schists.

The result agrees closely with a biotite age of 42 Ma obtained from a lithologically similar granitic body occurring in the Rocky Mountain Trench between Chowika and Police creeks (GSC Paper 77-2, p. 21, GSC 76-85). These bodies are currently considered to be right laterally offset segments of the same granitic intrusion.

GSC 78-21 Hornblende, K-Ar age **190 ± 8 Ma**

K = 0.851%, $^{40}Ar/^{40}K$ = 0.01162, radiogenic Ar = 83.6%.
Concentrate: Clean, unaltered, pleochroic, light brown to dark green hornblende with no visible contamination.

From quartz diorite
(94 E) Approximately 2.3 km west-southwest of Mt. Cushing, on east side of small valley with elongate lake, Toodoggone River map area, British Columbia, 57°36.2'N, 126°53.1'W. Sample GA-75-53, collected by H. Gabrielse and interpreted by C.J. Dodds.

This rock is a medium grained, foliated, homogeneous, darkish green-grey biotite-hornblende quartz diorite. It is fresh and composed of quartz (8%), plagioclase (calcic andesine) (59%), orthoclast (1.5%), biotite (8%), hornblende (18%), epidote (2%), opaques (1%), chlorite (1%) with accessory sphene. Plagioclase is sporadically saussuritized, orthoclase is fresh. Mafics occur in clotted aggregates. Biotite is dark brown, chloritized, and mildly deformed. Hornblende displays dark green (vague bluish tint) to yellow pleochroism, is subhedral to anhedral, variably sized (up to 5 mm) and fresh. It contains minor inclusions (quartz, opaques, and apatite). Epidote is plentiful, and chlorite occurs only as an alteration product of biotite.

The sample was collected from the Pitman Batholith, a large quartz diorite/diorite body outcropping throughout much of the north central part of Toodoggone River and south central part of Kechika map areas. Recent mapping has refined and reduced the areal extent of the Pitman Batholith. Previously published dates (Gabrielse, H., GSC 73-51, 73-52, in GSC Paper 74-2) referred to this batholith should not be listed under the Thudaka Batholith. (See also this publication, GSC 78-28). This is the only age determination from the Pitman Batholith.

See GSC 78-22 for interpretation.

GSC 78-22 Hornblende, K-Ar age **222 ± 10 Ma**

K = 0.47%, $^{40}Ar/^{40}K$ = 0.01371, radiogenic Ar = 88.2%.
Concentrate: Clean, unaltered, pleochroic, brown to green hornblende with a slight trace of chlorite contamination.

From porphyritic granodiorite
(94 E) North-facing cirque wall some 19.2 km northwest of Mt. Albert Dease, Toodoggone River map area, British Columbia, 57°52.1'N, 127°48.9'W. Sample GAD-75-153-1, collected and interpreted by C.J. Dodds.

The rock is a grey, medium grained, weakly foliated, porphyritic biotite-hornblende granodiorite. It consists of quartz (24%), plagioclase (oligoclase) (48%), orthoclase (19%), hornblende (4%), biotite (1%), chlorite (1%), opaques (1%), and accessory epidote, sphene and apatite. Phenocrysts are of orthoclase (4%), which are subhedral to anhedral, pink and up to 1 cm in size. The rock is typically hypidiomorphic-granular in texture and displays mild cataclastic deformation. Hornblende (faintly bluish green) occurs as fairly slender euhedral to subhedral prisms up to 2 mm in size (generally 0.5-1 mm). Impurities are scarce and chloritic alteration minor. Biotite (greenish brown) is strongly chloritized, ragged, sparse and up to 0.5 mm in size.

The specimen was collected from the central part of a porphyritic granodiorite batholith which intrudes Upper Paleozoic(?) low grade metasedimentary and metavolcanic rocks. This intrusion is lithologically similar to the Black Lake Batholith.

This age, and that of GSC 78-21 above, agree favourably with the previous K-Ar ages from Black Lake Batholith of 186 Ma (hornblende) and 189 and 200 Ma (biotite, hornblende pair), (Gabrielse, H., GSC 76-74, 75, and 76, in GSC Paper 77-2). Collectively, these intrusions are considered to be spatially related to volcanic rocks of the Takla and Hazelton groups. These latest Triassic, early Jurassic ages uphold this contention.

GSC 78-23 Biotite, K-Ar age **167 ± 6 Ma**

K = 6.60%, $^{40}Ar/^{40}K$ = 0.01018, radiogenic Ar = 95.1%.
Concentrate: Brown biotite with approximately 4% chlorite alteration.

From adamellite
(94 E) West-facing cirque wall 6.2 km north of Mt. Albert Dease, Toodoggone River map area, British Columbia, 57°47.7'N, 127°36.8'W. Sample GAD-75-151A-1, collected and interpreted by C.J. Dodds.

The rock is a fine- to medium-grained, pinkish-creamy-grey, equigranular, homogeneous hornblende-biotite adamellite. It is composed of quartz (30%), plagioclase (30%), orthoclase (34%), biotite (4%) and hornblende (2%) with accessory chlorite, apatite, and opaques. The rock is hypidiomorphic-granular in texture, and is undeformed and fresh. Biotite (deep orange-brown) is subhedral to anhedral, ranges in size from 0.2 to 1 mm, is slightly chloritized and contains few inclusions. Hornblende (bluish to yellowish green) occurs as slender subhedral prisms ranging in size from 0.5 to 2 mm, is mildly chloritized, and contains few inclusions.

The sample was obtained from the western extremity of a small stock intruding Takla volcanic rocks. This body is crudely oval-shaped and about 25 km in areal extent. The northern contact is faulted against Takla volcanic rocks. Elsewhere the contact zone appears more complex and is usually a gradational mix of fine grained equivalents of the "granite" and hornfelsed Takla volcanics. Throughout, the stock is cut by northwest-southeast and northeast-southwest trending basaltic dyke swarms. The dykes are post granite intrusions and are relatively unaltered.

The body forms part of a northwest-southeast trending belt of compositionally, texturally, and structurally similar intrusives occurring within the central Toodoggone River map area. The stocks intrude both Takla and "Toodoggone" volcanic rocks, but the current belief is that they are spatially related to the "Toodoggone" volcanic assemblage. This K-Ar age does not necessarily refute this concept as the time limits of this volcanic series are not fully known. The upper parts of the series may well be mid-Jurassic or even younger.

GSC 78-24 Hornblende, K-Ar age **182 ± 8 Ma**

K = 0.787%, $^{40}Ar/^{40}K$ = 0.01113, radiogenic Ar = 56.9%.
Concentrate: Clean, unaltered, pleochroic, brown to dark green hornblende with no visible contamination.

From dacitic crystal tuff
(94 E) Hill top, 10 km northwest of Drybrough Peak (6774), Toodoggone River map area, British Columbia, 57°16.5'N, 127°01'W. Sample GAD-76-82, collected and interpreted by C.J. Dodds.

The rock is a fresh, purplish grey quartz-plagioclase-hornblende dacitic crystal tuff(?). It consists of phenocrysts (clasts?) of quartz (4%), plagioclase (33%), hornblende (7%) with 1-2% coarse opaques, set in a very fine grained matrix (55%). Phenocrysts of quartz are subhedral (occasionally crudely bipyramidal and strongly embayed). Those of plagioclase are euhedral to subhedral and partially or occasionally completely altered to carbonate and sericite. Hornblende (deep olive green) is euhedral to subhedral, fresh, contains few inclusions and ranges in size up to 2 mm. The matrix is too fine grained and altered for accurate optical determination of the mineralogy.

This specimen was collected from a series of dark grey weathering quartz-plagioclase-hornblende rhyodacite/dacite porphyries forming part of the "Toodoggone" Volcanic Group.

This determination agrees well with previous K-Ar results from this volcanic series which gave hornblende ages of 179 and 186 Ma (respectively Gabrielse, H., GSC 76-77 in GSC Paper 77-2; and Carter, N.C., Geology Exploration and Mines in British Columbia; B.C. Dep. Mines Pet. Resource, 1971, p. 63.

GSC 78-25 Biotite, K-Ar age **37.8 ± 1.7 Ma**

K = 6.45%, $^{40}Ar/^{40}K$ = 0.00222, radiogenic Ar = 73.2%.
Concentrate: Light brownish orange biotite with approximately 7% chlorite alteration.

From lamprophyre (minette)
(94 E) Ridge crest, east flank of Sifton Range, 3.2 km north-northeast of Fox Peak, Toodoggone River map area, British Columbia, 57°47.9'N, 126°12.8'W. Sample GA-76-64, collected by H. Gabrielse and interpreted by C.J. Dodds.

The rock is a fresh, fine grained, medium grey minette and is finely speckled with very abundant biotite (30%). Biotite (dark orangish brown) is euhedral to subhedral, randomly oriented, only slightly and sporadically chloritized and ranges in size from 0.1 to 0.5 mm. It is set in a fine grained matrix containing abundant slender interlocking laths of K-feldspar, with scattered pools of quartz, calcite and fine aggregates of chlorite. Granular opaques, fine prisms of apatite, and anhedral sphene are plentiful. Rutile occurs sparsely as inclusions, where biotite is chloritized.

The sample was collected from a fresh lamprophyre dyke (about 10 m in width, vertical, strike 145°) which cuts complexly deformed amphibolitic rocks (age uncertain). Dykes of this type (predominantly minettes) occur commonly in an approximately northwest-southeast trending belt lying just west of the Rocky Mountain Trench within southeastern Kechika (94 L), northeastern Toodoggone River (94 E), and western and southwestern Ware (94 F) map areas. Maximum distribution of these dykes, however, coincides with Spinel Fault Zone which is located along the east side of a broad linear valley occupied by Stelkuz Creek to the southeast, Finlay River (Long and Cascade Canyon section), and Spinel Creek. This dyke zone can be farther traced northwestward through Spinel Lake and still farther through the Kechika Ranges just east of Johiah Lake.

This determination is consistent with earlier reported biotite ages of 49 and 37 Ma, and with a whole-rock age of 41.6 Ma from similar dykes (Gabrielse, H., GSC 73-55 and 56, in GSC Paper 74-2; and GSC 76-84, in GSC Paper 77-2). The intrusion of these dykes has been reported to coincide with a major period of block faulting in the Omineca Crystalline and Metamorphic Belt, but more specifically probably reflects the timing of much of the latest movement on the Spinel and Rocky Mountain Trench fault zones.

GSC 78-26 Biotite, K-Ar age **88.5 ± 3.3 Ma**

K = 7.68%, $^{40}Ar/^{40}K$ = 0.00530, radiogenic Ar = 90.1%.
Concentrate: Brownish orange biotite with approximately 3% chlorite alteration.

From granodiorite
(94 E) North-facing cirque wall some 7.2 km west-southwest of Oboe Lake, northern Thudaka Range, Toodoggone River map area, British Columbia, 57°55.4'N, 126°48.8'W. Sample GAD-75-133B-1, collected and interpreted by C.J. Dodds.

The rock is a coarse grained, fairly homogeneous, light creamy grey, foliated porphyritic biotite muscovite granodiorite. It consists of quartz (26%), plagioclase (oligoclase-43%), microcline (20%), biotite (5%), muscovite (6%) and accessory zircon, opaques, and apatite. Foliation appears to be largely the result of late or post crystalline cataclastic deformation. Felsic minerals are strained and fractured. Micas are ragged and somewhat bent. Muscovite commonly forms in seams, but also within cleavage traces of feldspars and in clotted aggregates. In part it is secondary and probably associated with the brittle deformation. Biotite (orange-brown) occurs in clotted aggregates. It is mildly chloritized, contains few inclusions (zircon) and ranges in size from 0.2 to 2 mm.

The sample is from the north central part of Thudaka Batholith. See GSC 78-28 for interpretation.

GSC 78-27 Biotite, K-Ar age **102 ± 10 Ma**

K = 7.79%, $^{40}Ar/^{40}K$ = 0.00609, radiogenic Ar = 92.2%.
Concentrate: Clean, unaltered, light brown biotite with no chlorite contamination.

From granodiorite
(94 L) Canyon of unnamed creek flowing from Lamarque Pass, 0.5 km from confluence with Jackstone Creek, Kechika map area, British Columbia, 58°13.8'N, 127°22.2'W. Map unit 12a, GSC Map 42-1962. Sample GA-76-79, collected by H. Gabrielse and interpreted by C.J. Dodds.

The rock is a fine- to medium-grained, fairly homogeneous, well foliated, rusty buffish grey, porphyritic, biotite granodiorite. It is composed of quartz (31%), plagioclase (43%), K-feldspar (10%), biotite (15%), with accessory chlorite, opaque ore(s), white mica, apatite and zircon. Phenocrysts are of orthoclase and are up to 2 cm in size. The foliation appears to be due to postcrystallization deformation. This has resulted in alignment and sporadic bending and shreading of biotite, development of sinuous shears, peripheral granulation of felsic minerals, and minor recrystallization of quartz. Biotite is dark greenish brown in colour. It is only slightly chloritized and contains few inclusions.

The sample is from the northernmost part of Thudaka Batholith within the Thudaka Fault zone. See GSC 78-28 for interpretation.

GSC 78-28 Muscovite, K-Ar age **86.8 ± 9.6 Ma**

K = 8.17%, $^{40}Ar/^{40}K$ = 0.00516, radiogenic Ar = 75.2%.
Concentrate: Clean, unaltered muscovite with no visible contamination.

From adamellite
(94 L) Ridge crest above 1980 m (6500 ft) south of Frog River, 7.1 km southwest of 7069 summit, Kechika map area, British Columbia, 58°06.7'N, 127°06.6'W. Map unit 12a, GSC Map 42-1962. Sample GAA-76-110A-2, collected by R. Anderson and interpreted by C.J. Dodds.

The rock is a fresh, light grey, medium grained, fairly homogeneous, unfoliated, porphyritic muscovite-biotite adamellite. It consists of quartz (29%), plagioclase (33%), microcline (26%), muscovite (5%), biotite (7%), with accessory chlorite, apatite, opaque ore(s), and zircon. Phenocrysts of microcline (1-2%) up to 1.5 cm in size are present. The rock is weakly deformed and unfoliated. The texture is typically hypidiomorphic-granular. Feldspars are relatively unaltered. Micas are somewhat clotted. Muscovite is fresh, up to 2 mm in size, somewhat deformed, with minor inclusions of opaque ore(s). Biotite (orange-brown) is sporadically chloritized, weakly deformed, with minor inclusions of fine zircon and opaque ore(s).

The sample was collected from an unfoliated part of Thudaka Batholith, close to the northern extremity of the body.

The Thudaka Batholith is generally a well foliated, porphyritic, two mica intrusion ranging in composition from quartz monzonite to granodiorite. It is currently considered to be a dextrally offset segment of the Cassiar Batholith, the movement having occurred along Thudaka Fault. The foliation (a prominent-structural element) is considered to be post intrusion and is progressively more marked close to the trace of the fault (western contact). Throughout the body, foliation appears to parallel the fault. All K-Ar ages for Thudaka Batholith are tabulated below. For comparison the K-Ar ages from Whudzi stock are also listed below. This stock which lies just south of the Thudaka Batholith, is compositionally and structurally similar to that body, and now is believed to be a dextrally offset part of that intrusion.

Summary of K-Ar Ages

Rock type	Sample No.	Mineral	Age (Ma)
Thudaka Batholith			
Foliated muscovite-biotite granodiorite*	GSC 73-51	biotite	86.8 ± 3.3
	GSC 73-52	muscovite	88.4 ± 4.2
Foliated biotite-muscovite granodiorite	GSC 78-26	biotite	88.5 ± 3.3
Foliated biotite granodiorite	GSC 78-27	biotite	102 ± 10
Unfoliated muscovite-biotite adamellite	GSC 78-28	muscovite	86.8 ± 9.6
Whudzi Stock			
Unfoliated muscovite-biotite quartz monzonite	GSC 76-80	biotite	94.2 ± 3.5
	GSC 76-81	muscovite	99.7 ± 3.7
Foliated biotite-muscovite quartz monzonite	GSC 76-82	biotite	90.9 ± 3.4
	GSC 76-83	muscovite	99.5 ± 3.7

*Previously listed as Pitman Batholith.

In general the ages agree favourably, but within the groupings for each intrusion the consistency is striking (except for GSC 78-27). Although geological data suggest post-intrusive deformation, possibly related to strike-slip movement along Thudaka Fault and related splay(s), this is not reflected in age differences between foliated (sheared) and unfoliated segments of either intrusion. Enigmatically, the most highly deformed part of the Thudaka Batholith sampled yielded the oldest age (viz. GSC 78-27).

Collectively these mid Cretaceous K-Ar ages are in accord with those previously determined from the Cassiar Batholith.

GSC 78-29 Hornblende, K-Ar age **57.7 ± 3.7 Ma**

$K = 0.570\%$, $^{40}Ar/^{40}K = 0.00341$, radiogenic Ar = 41.9%.
Concentrate: Clean, unaltered, pleochroic, light green to brown hornblende with no visible contamination.

From amphibolite
(94 E) Ridgetop on east flank of Sifton Range, 3.5 km east of Hedges Peak, Toodoggone River map area, British Columbia, 57°42.7'N, 126°05'W. Sample GAA-76-98-4, collected by R. Anderson and interpreted by C.J. Dodds.

The rock is a fresh, fine- to medium-grained, well-foliated, dark greenish grey amphibolite. It is composed of quartz (9%), plagioclase (14%), hornblende (72%), sphene (3%), opaque ore(s) (1%) and accessory apatite and biotite. Felsics are fairly undeformed; plagioclase is only incipiently saussuritized. Hornblende (olive green) is little altered or deformed, contains few inclusions, and ranges in size up to 2 mm. Opaque ores are disseminated; sphene commonly rims the ores. Biotite, dark brown in colour and partially chloritized, occurs sparsely.

The sample was collected from a sequence of amphibolite and quartzite.

See GSC 78-32 for further discussion.

GSC 78-30 Biotite, K-Ar age **51.0 ± 1.8 Ma**

$K = 7.53\%$, $^{40}Ar/^{40}K = 0.00301$, radiogenic Ar = 66.9%.
Concentrate: Clean, unaltered, light brown biotite with no chlorite contamination.

From pegmatite
(94 E) Ridge top on east flank of Sifton Range, 3.5 km easterly of Hedges Peak, Toodoggone River map area, British Columbia, 57°42.7'N, 126°05'W. Sample GAA-76-98-3, collected by R. Anderson and interpreted by C.J. Dodds.

See GSC 78-31 for description and GSC 78-32 for interpretation.

GSC 78-31 Muscovite, K-Ar ages $\begin{matrix}\mathbf{43.0 \pm 2.3}\\ \mathbf{43.2 \pm 2.4}\end{matrix}$ **Ma**

$K = 7.83\%$, $^{40}Ar/^{40}K = \begin{matrix}0.00253\\ 0.00254\end{matrix}$, radiogenic
$Ar = \begin{matrix}53.1\%\\ 48.1\%\end{matrix}$.
Concentrate: Clean, clear, unaltered muscovite with no visible contamination.

From pegmatite
(94 E) Details as for GSC 78-30.

The rock is a fresh, coarse grained, light creamy grey, biotite-muscovite pegmatite. Coarse "books" of muscovite are present and occur up to 1 cm in size. Swirling schlieren-like concentrations of biotite "invade" the pegmatite and could represent partially assimilated metasedimentary material. Biotite (orange-brown) is fresh, little deformed or chloritized, and contains few inclusions (predominantly zircon). Muscovite is fresh, fairly undeformed, and inclusion free.

The sample was obtained from a 1-2 m sill, which was probably intruded in the late stages of the major episode of regional metamorphism and associated deformation undergone by the host rocks. Host rocks are those sampled for GSC 78-29.

See GSC 78-32 for further discussion.

GSC 78-32 Hornblende, K-Ar age **60.2 ± 3.4 Ma**

$K = 0.554\%$, $^{40}Ar/^{40}K = 0.00356$, radiogenic Ar = 56.4%.
Concentrate: Clean, unaltered, pleochroic, light green to light brown hornblende with no visible contamination.

From amphibolite
(94 E) Ridge top on east flank of Sifton Range, 5 km due east of Fox Peak, Toodoggone River map area, British Columbia, 57°46.4'N, 126°08.9'W. Sample GAD-76-68-1, collected and interpreted by C.J. Dodds.

The rock is a coarse- to fine-grained, fresh, well foliated, dark grey green amphibolite. It is spotted with felsic-rich aggregates (probably retrograde garnet porphyroblasts) and consists of quartz (5%), plagioclase (23%), hornblende (58%), epidote (9%), sphene (4%) and accessory apatite and opaques. Hornblende (bluish green) is fairly fresh and undeformed, ranges up to 1 mm in size, and contains few inclusions. Petrographic evidence hints of two phases of regional metamorphism affecting these rocks, (1) amphibolite (±garnet), (2) upper greenschist. The latter gives rise to the now preserved assemblage of quartz-plagioclase-epidote-hornblende.

The above rocks (GSC 78-29, 30, 31, and 32) were sampled from a narrow, complexly deformed and regionally metamorphosed belt composed of amphibolite, marble, quartzite, schist, and gneiss which is intruded by a granitic stock (see GSC 78-20). The belt, which locally reaches kyanite grade, obliquely transects the western edge of the Rocky Mountain Trench with northeastern Toodoggone River (94 E) and central southwestern Ware (94 F) map areas. It is confined by Rocky Mountain Trench to the east and the Sifton Thrust and Spinel Fault Zone to the west and southwest. Current belief is that lithologically similar rocks occurring in Deserter's Range (in Fort Grahame map area) represent dextrally offset equivalents of these rocks.

See GSC 78-35 for interpretation.

GSC 78-33 Biotite, K-Ar age **49.2 ± 2.5 Ma**

$K = 6.87\%$, $^{40}Ar/^{40}K = 0.00290$, radiogenic Ar = 84.3%.
Concentrate: Clean, unaltered, light reddish brown biotite with no chlorite contamination.

From schist
(94 C) Northeast flanks of Butler Range, east of Flood Creek, 4.7 km northwest of Mount Ross, Fort Grahame map area, British Columbia, 56°41.3'N, 124°54.1'W. Sample GAD-76-66-1 collected and interpreted by C.J. Dodds.

See GSC 78-34 for description and GSC 78-35 for interpretation

GSC 78-34 Muscovite, K-Ar age **44.1 ± 1.9 Ma**

K = 8.29%, $^{40}Ar/^{40}K$ = 0.00259, radiogenic Ar = 60.8%.
Concentrate: Clean, clear, unaltered muscovite with no visible contamination.

From schist
(94 C) Details as for GSC 78-33.

The rock is a fairly fresh, fine- to medium-grained, silvery buff kyanite-garnet-muscovite-biotite quartz-rich schist. It displays a strong, finely crenulated schistosity, with prominent quartz rodding. The rock consists of quartz (48%), plagioclase (4%), garnet (5%), muscovite (27%), biotite (14%), chlorite (<1%), with accessory kyanite, opaques, apatite, tourmaline and zircon. The rock contains a prograde assemblage of quartz-kyanite-garnet-muscovite, biotite, but is somewhat cataclastically deformed (post metamorphism). Biotite (deep red-brown) is mildly chloritized and locally deformed; impurities are minor (zircon mainly) and size ranges up to 3 mm. Muscovite is interleafed with biotite and is fresh, only mildly deformed and occurs up to 3 mm in size.

See GSC 78-35 for further discussion and interpretation.

GSC 78-35 Muscovite, K-Ar age **46.9 ± 2.0 Ma**

K = 5.53%, $^{40}Ar/^{40}K$ = 0.00276, radiogenic Ar = 55.5%.
Concentrate: Clean, clear, unaltered muscovite with no visible contamination.

From gneiss
(94 C) Northeast flank of Butler Range, east of Flood Creek, 4.7 km northeast of Mount Ross, Mesilinka River map area, British Columbia, 56°41.3'N, 124°54.1'W. Sample GAD-76-66-2, collected and interpreted by C.J. Dodds.

The rock is a fresh, well-foliated, fine- to medium-grained, buff-grey quartz-rich garnet-muscovite-biotite gneiss. It is composed of quartz (61%), plagioclase (17%), muscovite (7%), biotite (11%), garnet (2%), opaques (1-2%), and accessory chlorite, fibrolite, tourmaline, apatite and zircon. A prograde assemblage quartz-plagioclase-muscovite-biotite-garnet-fibrolite is present, but the rock has undergone mild to moderate postmetamorphic cataclastic deformation. Muscovite is intergrown with biotite. Both micas are fresh, little altered and generally only mildly deformed.

Samples GSC 78-33, 34 and 35 were collected from sites only a few metres apart in the same sequence of interlayered schists and gneisses. These rocks form part of the complexly deformed and regionally metamorphosed Butler Range anticlinorium.

These K-Ar ages from Sifton and Butler ranges are tabulated as follows:

Summary of K-Ar Dates

Rock type	Sample No.	Mineral	Age (Ma)
Sifton Range			
Amphibolite	GSC 78-32	hornblende	60.2 ± 3.4
Amphibolite	GSC 78-29	hornblende	57.7 ± 3.7
Pegmatite	GSC 78-30	biotite	51.0 ± 1.8
	GSC 78-31	muscovite	43.0 ± 2.3
	" "	muscovite	43.2 ± 2.4
Butler Range			
Schist	GSC 78-33	biotite	49.2 ± 2.5
	GSC 78-34	muscovite	44.1 ± 1.9
Gneiss	GSC 78-35	muscovite	46.9 ± 2.0

These newly determined K-Ar ages listed above agree very favourably with previously reported results obtained from the Omineca Crystalline and Metamorphic Belt adjacent to the Rocky Mountain Trench, both from within Butler, Deserter's, and Wolverine Ranges (Dodds, C.J., GSC Paper 77-2, p. 21-22; Gabrielse, H., GSC Papers 74-2, p. 16-17, and 73-2, p. 24), and from further south (Muller, J.E., GSC Papers 71-2, p. 22-27; 63-17, p. 43-44; 62-17, p. 10-21; and 61-17, p. 14). Collectively these determinations reveal a relatively narrow belt occurring adjacent to and within the Rocky Mountain Trench, in which metamorphic, granitic (see GSC 78-20), and lamprophyre dyke (see GSC 78-25) rocks all yield early Tertiary K-Ar ages. This belt includes Sifton and Cormier ranges (east of the trench, and west and southwest of Sifton and Spinel faults), Deserter's Range (immediately east of the Trench), Butler Range (east of Mesilinka River), and Wolverine Range (west of the Trench). Unexplainably, metamorphic rocks (greenschist facies) of the Misinchinka Group outcropping close to the Rocky Mountain Trench (see GSC 78-17 to 19 inclusive, and Muller, J.E., GSC Paper 63-17, p. 42-43), yield latest Jurassic to Lower Cretaceous ages.

As concluded in earlier reports, the early Tertiary K-Ar ages probably reflect a period of major block faulting with local emplacement of high-level granitic intrusions and coeval(?) volcanism (with associated renewed heat flow, low grade metamorphism, and uplift). Whether the timing of dextral strike-slip movement of fault(s) in Rocky Mountain Trench and along Spinel Fault zone is also revealed by these ages, is uncertain.

Contrasting sharply with the above, mid to Lower Cretaceous metamorphic K-Ar ages have been obtained from somewhat similar complexly deformed and regionally metamorphosed Proterozoic rocks which occur farther west in Swannell Ranges. See GSC 78-42.

GSC 78-36 Biotite, K-Ar age **103 ± 4 Ma**

K = 7.15%, $^{40}Ar/^{40}K$ = 0.00616, radiogenic Ar = 81.0%.
Concentrate: Brownish-orange biotite with approximately 9% chlorite alteration.

From schist

(94 L) Ridge crest 7.2 km north-northeast of east end of Johiah Lake, Kechika map area, British Columbia, 58°06.1'N, 126°40.8'W. Map unit 2b, GSC Map 42-1962. Sample GAMa-76-52, collected by J.L. Mansy and interpreted by C.J. Dodds.

See GSC 78-37 for description and interpretation.

GSC 787-37 Muscovite, K-Ar age **89.7 ± 2.6 Ma**

$K = 8.18\%$, $^{40}Ar/^{40}K = 0.00534$, radiogenic Ar = 74.0%.
Concentrate: Clean, clear, unaltered muscovite with no visible contamination.

From schist

(94 L) Details as for GSC 78-36.

The rock is a rusty, buff weathering, fine- to medium-grained, muscovite-biotite quartz-rich schist. It displays an excellent schistosity and is composed of quartz (43%), plagioclase (6%), muscovite (20%), biotite (27%), chlorite (1%), opaques (2%) with accessory apatite, zircon, and tourmaline. The schistosity is deformed somewhat by a subparallel pervasive cleavage, resulting in fracturing of felsics, with some recrystallization of quartz and local shreading and alteration of micas. Muscovite is fairly fresh, contains few inclusions, and ranges in size up to 3 mm. Biotite (deep orange-brown), contains few impurities, is sporadically deformed and slightly chloritized, and ranges up to 1 mm in size.

The sample is from a complexly deformed and regionally metamorphosed (kyanite grade) sequence of schists and gneisses (Proterozoic(?) in age), which are locally intruded by pegmatite. These rocks are structurally and lithologically similar to those in northern Sifton Range (north and west of Sifton Thrust) and Butler Range to the southwest.

See GSC 78-42 for interpretation.

GSC 78-38 Muscovite, K-Ar age **100 ± 4 Ma**

$K = 8.80\%$, $^{40}Ar/^{40}K = 0.00600$, radiogenic Ar = 72.6%.
Concentrate: Clean, unaltered, clear muscovite with no visible contamination.

From pegmatite

(94 L) Ridge crest (7000'; 2134 m), 7.2 km north-northeast of east end of Johiah Lake, Kechika map area, British Columbia, 58°06.1'N, 126°40.8'W. Map unit 2b, GSC Map 42-1962. Sample GAMa-76-52A, collected by J.L. Mansy and interpreted by C.J. Dodds.

The rock is a coarse grained, creamy buff, brittly deformed tourmaline-muscovite pegmatite. It carries prominent books of muscovite up to 2 cm with sporadic coarse euhedral tourmaline. Brittle deformation results in fracturing and peripheral granulation of felsic minerals, bending of mica, and some recrystallization of quartz. Muscovite is fairly fresh, and somewhat deformed. Accessories include calcite, allanite, apatite, and opaques.

See GSC 78-37 for geological setting and GSC 78-42 for interpretation.

GSC 78-39 Biotite, K-Ar age **142 ± 5 Ma**

$K = 7.04\%$, $^{40}Ar/^{40}K = 0.00857$, radiogenic Ar = 93.2%.
Concentrate: Brownish orange biotite with approximately 9% chlorite alteration.

From semischist

(94 F) Ridge top approximately 15 km west-southwest of Mt. Russell, east flank of Swannell Ranges, Ware map area, British Columbia, 57°04.2'N, 125°58.8'W. Sample GAD-75-95A-1, collected and interpreted by C.J. Dodds.

The rock is a light to medium greenish grey, quartz-muscovite-chlorite-biotite semischist. It exhibits a weak schistosity and is spotted with fairly abundant somewhat randomly oriented porphyroblasts of biotite. Orange-brown biotite occurs as subidioblastic flakes up to 1.5 mm, and is fresh and only mildly deformed. It contains minor impurities which include fine graphite, minute zircon, and some quartz. Quartz is dominant over plagioclase, and accessories are tourmaline, apatite, zircon and opaques.

The sample was obtained from the east flank of the Swannell Anticlinorium, a broad asymmetrical structure involving regionally metamorphosed Proterozoic rocks. It was collected from close to the biotite isograd.

See GSC 78-42 for further discussion and interpretation.

GSC 78-40 Biotite, K-Ar age **101 ± 4 Ma**

$K = 7.21\%$, $^{40}Ar/^{40}K = 0.00601$, radiogenic Ar = 91.4%.
Concentrate: Somewhat impure, reddish-brown biotite with approximately 8% chlorite alteration.

From semischist

(94 E) Head of small valley on west flank of Swannell Ranges, some 12 km northeast of east end of Fredrickson Lake, Toodoggone River map area, British Columbia, 57°05.6'N, 126°16.4'W. Sample GA-76-89, collected and interpreted by C.J. Dodds.

The rock is a fresh, fine- to medium-grained quartz-plagioclase-zoisite-garnet-chlorite-biotite semischist, and is spotted with abundant light grey poikiloblasts of oligoclase (7%). It is composed of quartz (37%), plagioclase (oligoclase – 14%), biotite (36%), garnet (1%), zircon (1%), with accessory zoisite, chlorite, opaques, tourmaline and apatite. Biotite imparts a good schistosity. Matrix felsic minerals exhibit a good hornfelsic texture. Orange-brown biotite is fresh, little deformed or altered with only minor inclusions (mainly zircon).

This specimen was collected from the hornfelsed host rocks of the granitic dyke/sill sampled for GSC 78-41.

See GSC 78-42 for further discussion and interpretation.

GSC 78-41 Biotite, K-Ar age **96.2 ± 3.6 Ma**

$K = 7.10\%$, $^{40}Ar/^{40}K = 0.00574$, radiogenic Ar = 90.9%.
Concentrate: Brown biotite with less than 1% chlorite alteration.

From (meta)quartz monzonite

(94 E) Head of small valley, west flank of Swannell Ranges, some 12 km northeast of east end of Fredrickson Lake, Toodoggone River map area, British Columbia, 57°05.6'N, 126°16.4'W. Sample GA-76-89A, collected by H. Gabrielse and interpreted by C.J. Dodds.

The rock is a fresh, light creamy grey, medium grained, weakly to moderately foliated, but relatively homogeneous, metamorphosed muscovite-biotite quartz monzonite dyke or sill. It is composed of quartz (16%), plagioclase (40%), microcline (31%), biotite (7%), muscovite (2%), opaques (2%), calcite-ankerite (1%), with accessory chlorite, allanite, apatite, and zircon. The rock displays only mild cataclastic deformation and retains a hypidiomorphic granular texture. Biotite (dark brown) occurs in weakly aligned clotted aggregates. It is very fresh, little deformed, only slightly chloritized, up to 0.7 mm in size, and contains sparse inclusions (zircon predominantly). Muscovite is fresh, and only slightly deformed. Feldspars are surprisingly little altered. Pale straw yellow subhedral to anhedral accessory zircon occurs as inclusions in biotite or close to biotite flake clusters.

The sample was obtained from a folded and metamorphosed quartz monzonitic dyke or sill, some 15 m thick. This is one of a series of dykes or sills intruding complexly deformed and regionally metamorphosed Proterozoic clastic rocks in this immediate area. Metamorphic biotite is developed along axial planes of folds involving these intrusions, and appears to have resulted from a post-intrusion phase of regional metamorphism.

See GSC 78-42 for further discussion and interpretation.

GSC 78-42 Muscovite, K-Ar age **122 ± 4 Ma**

K = 8.06%, $^{40}Ar/^{40}K$ = 0.00734, radiogenic Ar = 80.8%.
Concentrate: Clean, clear, unaltered muscovite with no visible contamination.

From schist
(94 E) Head of small valley, west flank of Swannell Ranges, approximately 12 km northeast of Fredrikson Lake, Toodoggone River map area, British Columbia, 57°05.6'N, 126°16.4'W. Sample GA-76-89, collected by H. Gabrielse and interpreted by C.J. Dodds.

The rock is a fresh, pervasively cleaved, fine- to medium-grained, silvery-brownish-buff-grey quartz-plagioclase-garnet-biotite-muscovite schist. It consists of quartz (28%), plagioclase (8%), garnet (4%), biotite (23%), muscovite (33%), chlorite (2%), zircon (1%) with accessory tourmaline, apatite, and opaques. Micas impart an excellent schistosity which parallels the cleavage. Felsics are only slightly deformed and plagioclase little altered. Biotite (orange-brown) is mildly to moderately chloritized, and slightly deformed. Muscovite shows only slight deformation, is fairly fresh and ranges in size up to 0.8 mm. Small garnets are studded throughout.

This specimen was collected from the same sequence of rocks as sampled for GSC 78-40, but beyond the contact effects of that for GSC 78-41.

GSC 78-40, 41 and 42 were sampled from close to the axis of the Swannell Anticlinorium, a broad asymmetrical structure involving regionally metamorphosed and complexly deformed Proterozoic clastic rocks. Field evidence suggests the following sequence of events involving these rocks: (a) regional metamorphism (to kyanite grade at least) with associated isoclinal folding, (b) quartz monzonite dyke or sill intrusion plus local contact metamorphism, (c) development of major anticlinorium with less widespread metamorphism (garnet grade at least) with associated folding of the dykes and sills, coupled with new growth of biotite parallel with axial planes of second phase folds involving these intrusions.

All newly determined K-Ar ages described above from Kechika and Swannell Ranges are tabulated as follows:

Summary of K-Ar Ages

Rock type	Sample No.	Mineral	Age (Ma)
Kechika Ranges			
Schist	GSC 78-36	biotite	103 ± 4
	GSC 78-37	muscovite	89.7 ± 2.6
Pegmatite	GSC 78-38	muscovite	100 ± 4
Swannell Ranges			
Semischist	GSC 78-39	biotite	142 ± 5
Hornfelsed gneiss	GSC 78-40	biotite	101 ± 4
Meta granitic dyke/Sill	GSC 78-41	biotite	96.2 ± 3.6
Schist	GSC 78-42	muscovite	122 ± 4

The above ages agree favourably with previously published metamorphic K-Ar ages from the same belt (Dodds, C.J., GSC Paper 77-2, p. 19-20; and Irvine, T.N., GSC Paper 71-2, p. 11-12). These ages are also consistent with K-Ar ages from Whudzi and Thudaka intrusions (Dodds, C.J., GSC Paper 77-2, p. 20; and 78-28 this report). Collectively these results outline a belt giving early to mid-Cretaceous metamorphic and granitic K-Ar ages which contrasts markedly with the early Tertiary belt close to the Rocky Mountain Trench (see GSC 78-35, this report). Termination to the north of the latter belt is indicated by the K-Ar age data from northern Sifton and Kechika Ranges, and this may well coincide with the Sifton Thrust Fault. The K-Ar ages GSC 78-40, 41 from the granitic dyke or sill and host rock are strikingly similar to those from Whudzi Stock. However, the K-Ar ages GSC 78-39 and 42 from metamorphic rocks sampled at increased distances beyond the effects of these intrusions, yield progressively and distinctly older ages.

Geological evidence from within Omineca Mountains favours a major period of deformation and regional metamorphism during late Middle or early Upper Jurassic time. However, K-Ar ages from granitic and metamorphic rocks from Omineca Crystalline and Metamorphic Belt suggest:

(a) an early to mid-Cretaceous period of granitic intrusion, local metamorphism and deformation affecting at least the western part of the Belt.

(b) an early Tertiary period of block faulting, with associated local low grade metamorphism, granitic and lamprophyre dyke intrusion, and volcanism at the eastern edge of the belt adjacent to Rocky Mountain Trench.

This is in accord with conclusions of earlier reports (GSC Paper 77-2, p. 20-22).

GSC 78-43 Biotite, K-Ar age **41.3 ± 2.8 Ma**

K = 3.44%, $^{40}Ar/^{40}K$ = 0.00243, radiogenic Ar = 48.3%.
Concentrate: Somewhat impure, brownish orange biotite with a trace of hornblende and a fairly large component of possible verniculite.

From biotite lamprophyre dyke

(93 A) Boss Mountain molybdenum deposit, headwaters of Molybdenite Creek, northeast slope of Takomkane (Big Timothy) Mountain, British Columbia, 52°05'N, 120°55'W. Sample SVA75-7-26.8, collected and interpreted by A.E. Soregaroli, Western Mines Limited.

The sample is from a biotite lamprophyre dyke which has intruded the Takomkane Batholith near the Boss Mountain molybdenum deposit. Fragments of quartz-molybdenite veins and granodiorite occur within the dyke indicating a post-ore age for the dyke. The rock is characterized by brown biotite phenocrysts set in a mottled grey and white, fine grained matrix.

The date of 41.3 ± 2.8 Ma documents a heretofore unrecognized period of minor(?) magmatism in this part of British Columbia.

GSC 78-44 Biotite, K-Ar age **102 ± 5 Ma**

K = 7.84%, $^{40}Ar/^{40}K$ = 0.00608, radiogenic Ar = 84.3%.
Concentrate: Clean, unaltered, light brown biotite with no visible contamination.

From biotite quartz monzonite

(92 P) Anticlimax Molybdenum Prospect, Taweel Lake, 20.1 km north-northwest of Littlefort, British Columbia, 51°35'N, 120°18'W. Sample SVA75-7-13.8 collected and interpreted by A.E. Soregaroli, Western Mines Limited.

The sample is from an unaltered, medium grained, slightly porphyritic, leucocratic, biotite quartz monzonite. The rock is comprised of about 30 per cent subhedral quartz, 36 per cent perthitic potash feldspar, 27 per cent plagioclase, and 7 per cent euhedral brown biotite plus accessory apatite and zircon. Plagioclase cores are weakly altered to sericite and epidote.

The biotite quartz monzonite, one phase of the composite Anticlimax Stock, is cut by sporadic quartz-molybdenite-pyrite veinlets. Other more leucocratic phases of the stock are probably later differentiates related to the biotite quartz monzonite.

For interpretation see GSC 78-45.

GSC 78-45 Muscovite, K-Ar age **90.7 ± 3.3 Ma**

K = 8.67%, $^{40}Ar/^{40}K$ = 0.00540, radiogenic Ar = 87.7%.
Concentrate: Mainly clear, fresh and unaltered muscovite with no visible contamination.

From molybdenum prospect

(92 P) Anticlimax Molybdenum Prospect, Taweel Lake, 20.1 km north-northwest of Littlefort, British Columbia, 51°35'N, 120°18'W. Sample SVA75-7-13.24 collected and interpreted by A.E. Soregaroli, Western Mines Limited.

The sericite forms alteration envelopes bordering quartz-molybdenite-pyrite-wolframite veins in quartz monzonite host rock of the Anticlimax Stock.

The Anticlimax Stock is a composite intrusive body comprising at least four recognized phases ranging from biotite quartz monzonite to leucoquartz monzonite to quartz and quartz-feldspar porphyries and finally to a pegmatitic(?) phase. The oldest phase, the biotite quartz monzonite, was sampled (SVA75-7-13.8) for K-Ar dating and returned an age of 102 ± 5 Ma on magmatic biotite, thus dating the time of crystallization of this phase of the stock. The leucocratic nature of the other phases precluded comparative dating.

In an effort to establish the age of mineralization and concomitant sericite alteration and perhaps establish a genetic link with the Anticlimax Stock, samples of sericite alteration (SVA75-7-13.24) were collected for K-Ar dating. The age of 90.7 ± 3.3 Ma documents the age of alteration and the related mineralization. When we consider that at least two phases of the Anticlimax Stock crystallized after the biotite quartz monzonite phase, it is reasonable to consider the sericite age as valid and the alteration and associated molybdenum-tungsten mineralization as genetically related to the Anticlimax Stock.

GSC 78-46 Muscovite, K-Ar age **83.4 ± 4.2 Ma**

K = 9.04%, $^{40}Ar/^{40}K$ = 0.00496, radiogenic Ar = 76.7%.
Concentrate: Clean, clear, unaltered muscovite, with no visible contamination.

From granite

(92 G) 400 m northeast of the summit of Mount Donaldson (1433 m), British Columbia, 49°42'30"N, 123°27'03"W. Sample Rd76-46168, collected and interpreted by G.J. Woodsworth.

The sample is a fine grained, miarolitic, muscovite granite, composed of about 40% K-feldspar, 35% quartz, and 20% plagioclase. Muscovite forms small subhedral grains and clusters of grains scattered throughout.

This sample is from a small, high-level, muscovite granite stock that cuts granodiorite of the Coast Plutonic Complex. In many places the stock grades into pegmatite and contains small amounts of chalcopyrite in miarolitic cavities. About 25 km northwest of this sample, granodiorite of the Coast Plutonic Complex gives K-Ar dates of 88.3 ± 3.3 and 97.5 ± 4.5 Ma (GSC 76-46 and 47), significantly older than the date from the muscovite granite. Because of the seemingly high-level nature of this stock, the 83.4 ± 4.2 Ma date is taken to represent the time of emplacement of the granite and the age of the associated copper mineralization.

GSC 78-47 Hornblende, K-Ar age **75.9 ± 8.2 Ma**

K = 0.49%, $^{40}Ar/^{40}K$ = 0.00450, radiogenic Ar = 48.8%.
Concentrate: Relatively clean, unaltered, pleochroic, light to dark green hornblende, with a trace of chlorite contamination.

From granodiorite

(92 O) 4.5 km southeast of Mount McClure, British Columbia, 51°02'39"N, 123°26'58"W. Sample Rd76-46195, collected and interpreted by G.J. Woodsworth.

The sample is a medium grained, massive granodiorite, composed mostly of plagioclase with lesser amounts of quartz, K-feldspar and mafics. Hornblende is partly altered to actinolite, and biotite books are commonly partially chloritized. Minor constituents include epidote, apatite, opaques, sphene and zircon.

See GSC 78-49 for interpretation.

GSC 78-48 Biotite, K-Ar age **86.2 ± 3.1 Ma**

K = 7.29%, $^{40}Ar/^{40}K$ = 0.00513, radiogenic Ar = 87.3%.
Concentrate: Relatively clean, light brown biotite with approximately 1% chlorite alteration.

From granodiorite
(92 J) Roadcut, about 1.5 km northwest of mouth of Joffre Creek, Pemberton map area, British Columbia, 50°18.5'N, 122°40'W. Sample 75WV-264-1, collected and interpreted by G.J. Woodsworth.

See GSC 78-49 for description and interpretation.

GSC 78-49 Hornblende, K-Ar age **76.7 ± 3.9 Ma**

K = 0.77%, $^{40}Ar/^{40}K$ = 0.00455, radiogenic Ar = 58.9%.
Concentrate: Clean, unaltered, pleochroic brown to green hornblende, with no visible contamination.

From granodiorite
(92 J) Details as for GSC 78-48.

The sample is a medium- to coarse-grained, faintly foliated granodiorite composed of about 65% plagioclase, 7% quartz, 9% K-feldspar, 9% biotite, 8% hornblende, and minor epidote, sphene, chlorite and apatite. Mafics are only slightly chloritized; plagioclase is slightly sericitized.

Samples GSC 78-48 and 49 are from the Spetch Creek pluton, a large granodiorite body in the eastern part of the southern Coast Mountains. The hornblende age is similar to the 70 to 77.5 Ma ages obtained from the Scuzzy pluton to the southeast (GSC 72-5, 76-61, 76-62) and to ages obtained from quartz diorite 40 km to the northwest (See GSC 76-49 and 76-50). The biotite age is some 13% higher than the associated hornblende, possibly due to the biotite carrying excess argon. Sample GSC 78-47 is from a large body of granodiorite that forms part of the east edge of the Coast Plutonic Complex in Taseko Lakes map area. The date is identical, within the error limits, to the hornblende date from the Spetch Creek and Scuzzy plutons to the southeast. These three ages confirm that many plutons in the southern Coast Plutonic Complex northeast of Lillooet River give K-Ar ages of about 70 to 78 Ma. Some of these plutons are cut by plutons giving roughly 55 Ma ages (e.g. GSC 73-22, 23, 76-48). The K-Ar age pattern in the eastern part of the southern Coast Plutonic Complex is thus quite different from that in the Prince Rupert map area, where the eastern part of the Coast Plutonic Complex consistently gives 45 to 50 Ma ages.

GSC 78-50 Hornblende, K-Ar age **52.9 ± 14.9 Ma**

K = 0.129%, $^{40}Ar/^{40}K$ = 0.00312, radiogenic Ar = 18.0%.
Concentrate: Clean, unaltered, brown to light green hornblende, with no visible contamination.

From diorite
(92 J) From highway roadcut, about 3 km south of Pemberton junction, Pemberton map area, British Columbia, 50°18'05"N, 122°48'45"W. Sample WN-27-74, collected by R.K. Wanless and J.A. Roddick and interpreted by G.J. Woodsworth and J.A. Roddick.

The sample is from the Pemberton Complex, a heterogeneous unit of irregularly textured diorite, quartz diorite, and amphibolite. The specimen is a fine-grained gneissic diorite consisting largely of plagioclase and hornblende, with minor biotite and magnetite. Preliminary U-Pb dating of zircons from this sample suggest a Paleozoic age for the Pemberton Complex. The 53 Ma K-Ar age is younger than most other ages from the southern Coast Plutonic Complex. Ages (77, 86 Ma; GSC 78-48 and 49) from the Spetch Creek pluton east of the Pemberton Complex are significantly older than the 53 Ma age. The K-Ar pattern for the southern Coast Plutonic Complex is more complex than that in the Prince Rupert area, where the K-Ar ages young eastward in a systematic manner. The high error limits for this age reflect the low potassium and radiogenic argon contents of the sample.

GSC 78-51 Muscovite, K-Ar age **65.5 ± 2.6 Ma**

K = 8.44%, $^{40}Ar/^{40}K$ = 0.00387, radiogenic Ar = 65.0%.
Concentrate: Clean, mainly clear, fresh muscovite with no visible contamination.

From granitoid gneiss
(92 K) 1.7 km southeast of the junction of Sisyphus Creek and Southgate River, Bute Inlet map area, British Columbia, 50°55'24"N, 124°22'36"W. GSC Bulletin 295 (1979). Sample Rd76-46207, collected and interpreted by G.J. Woodsworth.

The sample is a fine- to medium-grained, folded gneiss with lenticular streaks of biotite. The rock is composed of about equal amounts of quartz, plagioclase and microcline with 4% biotite, 3% muscovite. Biotite is partly chloritized. Small rounded garnets form about 1% of the rock.

This sample is from the Central Gneiss Complex in the southern Coast Plutonic Complex. The gneiss is unconformably overlain by amphibolite grade metamorphic rocks, probably the lower Cretaceous Gambier Group. The age is slightly younger but in general agreement with 66 to 72 Ma ages obtained from the overlying Gambier Group rocks (GSC 73-24, 26) and the nearby Mount Gilbert pluton (GSC 73-20, 21). All these dates appear to indicate the cooling of the rocks after metamorphism and synchronous plutonism. The age of the Central Gneiss Complex in this area is not given by the K-Ar age and remains unknown.

GSC 78-52 Biotite, K-Ar age **70.6 ± 2.7 Ma**

K = 8.11%, $^{40}Ar/^{40}K$ = 0.00418, radiogenic Ar = 83.0%.
Concentrate: Clean, unaltered, light brown biotite with no chlorite contamination.

From quartz diorite
(92 K) From a road cut on east side of Elliott Creek, about 6 km north of its junction with Southgate River, Bute Inlet map area, British Columbia, 50°55'14"N, 124°38'04"W. Sample Rd76-46099, collected and interpreted by G.J. Woodsworth.

See GSC 78-53 for description and GSC 78-55 for interpretation.

GSC 78-53 Hornblende, K-Ar age **75.2 ± 6.0 Ma**

K = 0.76%, $^{40}Ar/^{40}K$ = 0.00446, radiogenic Ar = 66.1%.
Concentrate: Clean, unaltered, pleochroic, brown to dark green hornblende, with no visible contamination.

From quartz diorite
(92 K) Details as for GSC 78-52.

The sample is a medium grained, massive granodiorite composed of about 65% plagioclase, 15% quartz, 5% K-feldspar, 8% hornblende, 6% slightly chloritized biotite and minor amounts of epidote, sphene, opaques, apatite and sericite. Hornblende forms subhedral, slightly poikiloblastic grains that commonly contain clinopyroxene cores. Biotite is only very slightly chloritized and forms large, bent grains.

See GSC 78-55 for interpretation.

GSC 78-54 Biotite, K-Ar age **71.7 ± 2.7 Ma**

K = 7.24%, $^{40}Ar/^{40}K$ = 0.00425, radiogenic Ar = 89.0%.
Concentrate: Clean, unaltered, light brown biotite with no chlorite contamination.

From quartz diorite
(92 N) 5 km southwest of Whitemantle Mountain, Mount Waddington map area, British Columbia, 51°07'30"N, 125°16'36"W. Sample Rd76-16165, collected by J.A. Roddick and interpreted by G.J. Woodsworth.

See GSC 78-55 for description and interpretation.

GSC 78-55 Hornblende, K-Ar age **73.3 ± 7.0 Ma**

K = 0.60%, $^{40}Ar/^{40}K$ = 0.00435, radiogenic Ar = 58.4%.
Concentrate: Clean, unaltered, pleochroic, light green to brown hornblende, with no visible contamination.

From quartz diorite.
(92 N) Details as for GSC 78-54.

The sample is a well-foliated quartz diorite composed of about 75% plagioclase, 10% quartz, 10% hornblende, 4% biotite and minor amounts of sphene, epidote, opaques, sericite, chlorite and apatite. Hornblende forms subhedral grains up to 5 mm in length that contain numerous biotite, plagioclase, and opaque inclusions. Biotite is unaltered.

Samples GSC 78-52 and 53 are from the northwest part of the Mount Gilbert pluton, a large, elongate quartz diorite pluton near the axis of the southern Coast Plutonic Complex. The two dates are in good agreement with the 70.6 ± 3.4 Ma (hornblende) and 71.3 ± 2.7 Ma (biotite) dates from the Mount Gilbert pluton about 25 km east-southeast (GSC 73-20, 21).

Samples GSC 78-54 and 55 are from a heterogeneous body of diorite and quartz diorite that is the predominant unit in the south-central part of Mount Waddington map area. The ages are similar to the four ages from the Mount Gilbert pluton to the southeast and to a 73.2 ± 2.7 Ma age (GSC 76-20) from a quartz diorite pluton about 20 km to south-southwest. These dates establish the existence of a belt of 70 to 75 Ma ages southeast of the Central Gneiss Complex in the southern Coast Mountains.

GSC 78-56 Biotite, K-Ar age **46.8 ± 2.5 Ma**

K = 6.89%, $^{40}Ar/^{40}K$ = 0.00275, radiogenic Ar = 78.1%.
Concentrate: Relatively clean, light brown biotite with approximately 2% chlorite alteration.

From quartz diorite
(92 M) 2.5 km southwest of Jester Mountain, between Franklin and Corridor glaciers, Mount Waddington map area, British Columbia, 51°19'06"N, 125°18'54"W. Sample Rd76-46125, collected and interpreted by G.J. Woodsworth.

See GSC 78-57 for description and interpretation.

GSC 78-57 Hornblende, K-Ar age **55.7 ± 4.6 Ma**

K = 0.82%, $^{40}Ar/^{40}K$ = 0.00329, radiogenic Ar = 65.0%.
Concentrate: Clean, unaltered, pleochroic, light brown to green hornblende with no visible contamination.

From quartz diorite
(92 N) Details as for GSC 78-56.

The sample is a well-foliated quartz diorite with a faint augen texture composed of about 7% quartz, 4% biotite, 10% hornblende and 75% plagioclase, with minor chlorite, sericite, opaques, epidote and apatite. Plagioclase is bent and fractured. Hornblende occurs as large slightly poikiloblastic grains and as small granules. Biotite, slightly chloritized, forms mosaics of small unbent grains.

The sample is from a quartz diorite body that is in sharp (synplutonic fault?) contact with the west edge of an extensive body of Central Gneiss Complex. Ages from the Mount Gilbert pluton, a comparable distance southwest of the Central Gneiss Complex in Bute Inlet map area are about 71 Ma (GSC 73-20, 21). The northeast boundary of the belt of 70 to 75 Ma ages thus may not parallel the southwest margin of the Central Gneiss Complex throughout its length. The somewhat discordant biotite and hornblende ages from this sample may represent synplutonic faulting and recrystallization of the biotite, with resultant argon loss.

GSC 78-58 Biotite, K-Ar age **59.0 ± 2.4 Ma**

K = 7.35%, $^{40}Ar/^{40}K$ = 0.00348, radiogenic Ar = 88.4%.
Concentrate: Light brown biotite with approximately 6% chlorite alteration.

From granodiorite
(92 N) From summit of peak 1 km north of peak 7885' (2403 m), and 6 km south of Majestic Peak, Mount Waddington map area, British Columbia, 51°09'42"N, 124°22'18"W. Sample Rd76-16192, collected by J.A. Roddick and interpreted by G.J. Woodsworth.

The sample is a medium grained, massive granodiorite composed of about 63% plagioclase, 18% quartz, 5% K-feldspar, 13% biotite. Minor constituents include chlorite, sericite, opaques and apatite. Biotite forms subhedral grains that are commonly slightly bent and chloritized.

See GSC 78-59 for interpretation.

GSC 78-59 Biotite, K-Ar age **56.2 ± 2.4 Ma**

K = 7.78%, $^{40}Ar/^{40}K$ = 0.00332, radiogenic Ar = 86.5%.
Concentrate: Clean, unaltered, light greenish brown biotite with no chlorite contamination.

From granodiorite
(92 N) 6 km east of Mount Queen Bess, Mount Waddington map area, British Columbia, 51°15'14"N, 124°29'06"W. Sample Rd76-46719, collected and interpreted by G.J. Woodsworth.

The sample is a medium grained, massive granodiorite with conspicuous biotite books, composed of about 65% plagioclase, 4% K-feldspar, 20% quartz, 7% biotite, 3% hornblende, and minor sphene, epidote, sericite, opaques and apatite.

Samples GSC 78-58 and 59 are from large granodiorite to quartz diorite plutons that form the eastern part of the Coast Plutonic Complex in this area. These plutons are northeast of the belt of 70 to 75 Ma ages, near the axis of the Coast Plutonic Complex (see GSC 78-55). Together with the 55 Ma ages from the Bishop River pluton (GSC 73-22, 23) these dates indicate an extensive area of plutons giving 55 to 60 Ma ages from the eastern part of the Coast Plutonic Complex in this area.

GSC 78-60 Biotite, K-Ar age **49.9 ± 2.4 Ma**

K = 7.77%, $^{40}Ar/^{40}K$ = 0.00294, radiogenic Ar = 80.6%.
Concentrate: Clean, unaltered, light brown biotite with no chlorite contamination.

From granitoid gneiss
(92 N) From just above Highway 20, 5.9 km east of main bridge across Klinaklini River and about 11 km west of Tatla Lake post office, British Columbia, 51°55'39"N, 124°45'34"W. Sample Rd76-46726-2, collected and interpreted by G.J. Woodsworth.

The sample is from the felsic part of a banded gneiss. Plagioclase (65%) forms anhedral, equant grains with weak zoning. Quartz (30%) is highly strained. Brown biotite (3%) is fresh and commonly bent. Epidote, muscovite, and zircon are minor constituents.

The sample is from a complex area of intensely deformed gneisses lying northeast of the Yalakom Fault. These gneisses are similar to the Central Gneiss Complex of the southern Coast Plutonic Complex but lie well to the northeast. Overburden obscures the relationships between these gneisses and nearby unmetamorphosed Mesozoic and Tertiary strata. It is unlikely that this 50 Ma age represents the time of formation of the gneisses, as they are isoclinally folded and metamorphosed to amphibolite facies. More probably, the age represents an Eocene cooling event, possibly related to uplift of the Coast Mountains.

GSC 78-61 Biotite, K-Ar age **65.9 ± 2.6 Ma**

K = 7.45%, $^{40}Ar/^{40}K$ = 0.00390, radiogenic Ar = 85.6%.
Concentrate: Clean, unaltered, very light brown biotite, with no chlorite contamination.

From quartz diorite
(92 N) 10 km east of the mouth of Success Creek, Mount Waddington map area, British Columbia, 51°54'34"N, 125°33'30"W. Sample Rd76-560090, collected by R.G. Anderson and interpreted by G.J. Woodsworth.

See GSC 78-61 for description and GSC 78-64 for interpretation.

GSC 78-62 Hornblende, K-Ar age **121 ± 12 Ma**

K = 0.45%, $^{40}Ar/^{40}K$ = 0.00730, radiogenic Ar = 67.2%.
Concentrate: Clean, unaltered, pleochroic, brown to dark green hornblende, with no visible contamination.

From quartz diorite
(92 N) Details as for GSC 78-61.

The sample is a medium grained, faintly foliated quartz diorite, composed of about 70% plagioclase, 7% quartz, 12% hornblende, 8% biotite and minor amounts of epidote, sphene, apatite and opaques. Hornblende forms subhedral grains that are partly replaced by biotite. Biotite is only very slightly chloritized.

See GSC 78-64 for interpretation.

GSC 78-63 Biotite, K-Ar age **56.0 ± 1.8 Ma**

K = 7.45%, $^{40}Ar/^{40}K$ = 0.00331, radiogenic Ar = 77.1%.
Concentrate: Relatively clean, unaltered, light brown biotite, with less than 1% chlorite contamination.

From quartz diorite
(92 N) Ridge crest 6.5 km S12°W of Monarch Mountain, British Columbia, 51°50'31"N, 125°53'34"W. Sample Rd76-46137, collected and interpreted by G.J. Woodsworth.

See GSC 78-63 for description and interpretation.

GSC 78-64 Hornblende, K-Ar age **73.5 ± 6.3 Ma**

K = 0.68%, $^{40}Ar/^{40}K$ = 0.00436, radiogenic Ar = 58.8%.
Concentrate: Clean, unaltered, pleochroic, light brown to green hornblende, with no visible contamination.

From quartz diorite
(92 N) Details as for GSC 78-63.

The sample is a moderately foliated, medium grained quartz diorite composed of about 75% plagioclase (fresh, weakly zoned, and slightly bent), 5% quartz, 10% hornblende, 7% biotite, and minor epidote, chlorite, opaques, and apatite. Hornblende is slightly altered to biotite, epidote, and opaques. Biotite forms large, bent grains that are commonly slightly chloritized.

Determinations GSC 78-63 and 64 are from a northwest trending body of quartz diorite in the eastern part of the Coast Plutonic Complex. To the east the pluton is in contact with Lower Cretaceous strata, but the nature of the contact is not known. The biotite and hornblende ages are markedly discordant. The hornblende age is similar to a 70 ± 14 Ma biotite age (GSC 65-28) from a small pluton about 45 km northwest and to 72 and 73 Ma ages (GSC 78-54 and 55) from a pluton about 100 km southeast.

GSC 78-61 and 62 are from a heterogeneous quartz diorite body in the eastern Coast Plutonic Complex. The pluton is flanked on the west by a wide zone of migmatite, quartz diorite, greenstone, and mylonitized equivalents. The ages from this sample are the most highly discordant yet encountered in the Coast Plutonic Complex. The presence of two discordant samples in roughly the same

part of the Coast Plutonic Complex is surely no coincidence, but the data are too sparse to permit interpretation. It is clear, however, that the belt of concordant 55 to 60 Ma ages to the southeast does not continue into the northwest part of Mount Waddington map area.

GSC 78-65 Biotite, K-Ar age **47.5 ± 2.5 Ma**

K = 7.46%, $^{40}Ar/^{40}K$ = 0.00279, radiogenic Ar = 76.5%.
Concentrate: Clean, unaltered, light brown biotite, with no visible contamination.

(103 I) From quartz diorite gneiss
Ridge crest 4 km southeast of Morin Peak, Prince Rupert map area, British Columbia, 54°30'31"N, 129°17'21"W. Sample Rd72-3-9-3, collected by W.W. Hutchison and interpreted by G.J. Woodsworth.

The sample is a coarse grained quartz diorite gneiss. Modal composition is plagioclase, 53.4%; quartz 34.4%; biotite 9.5%; K-feldspar 0.7%; hornblende 0.2%; apatite 0.9%; opaques 0.9%; zircon, trace.

The sample is from the Central Gneiss Complex, in the eastern part of the axis of the Coast Plutonic Complex. U-Pb ages on zircons from this sample range from 70 to 76 Ma (R.K. Wanless, personal communication, 1974). The K-Ar age is yet another of a large number of 43 to 50 Ma ages that have been obtained from the Prince Rupert map area that may reflect mid-Tertiary uplift and cooling.

GSC 78-66 Biotite, K-Ar age **51.4 ± 2.4 Ma**

K = 6.94%, $^{40}Ar/^{40}K$ = 0.00303, radiogenic Ar = 74.8%.
Concentrate: Greenish brown biotite with about 5% chlorite alteration.

(93 E) From granodiorite
Ridge crest 10 km east-northeast of Queen Point on Gardner Canal, Whitesail Lake map area, British Columbia, 53°20'40"N, 127°47'38"W. Sample 77WV-261, collected and interpreted by G.J. Woodsworth.

See GSC 78-67 for description and GSC 78-68 for interpretation.

GSC 78-67 Hornblende, K-Ar age **50.0 ± 2.9 Ma**

K = 0.849%, $^{40}Ar/^{40}K$ = 0.00295, radiogenic Ar = 61.2%.
Concentrate: Clean, unaltered, pleochroic, brown to green hornblende with no visible contamination.

(93 E) From granodiorite
Details as for GSC 78-66.

The sample is a grey unfoliated granodiorite consisting of large K-feldspar megacrysts (20%) in a medium grained matrix of plagioclase (60%), quartz (10%), K-feldspar (3%), biotite (5%), hornblende (1%), 1% epidote, sphene, opaques, and apatite. Biotite forms ragged, 1 to 2 mm long, grains that are slightly chloritized. Hornblende forms anhedral to subhedral grains up to 1 mm across.

See GSC 78-68 for interpretation.

GSC 78-68 Biotite, K-Ar age **52.7 ± 2.3 Ma**

K = 7.59%, $^{40}Ar/^{40}K$ = 0.00311, radiogenic Ar = 64.1%.
Concentrate: Greenish brown biotite with about 2% chlorite alteration.

(93 E) From quartz monzodiorite
6 km east of junction of Tezwa River and Kalitan Creek, Whitesail Lake map area, British Columbia, 53°03'15"N, 127°42'59"W. Sample 77WV-340, collected and interpreted by G.J. Woodsworth.

The sample is a medium grained, grey quartz monzodiorite composed of about 70% plagioclase, 15% K-feldspar (large, slightly perthitic anhedral), 7% quartz, 6% biotite, and minor myrmekite, allanite, sphene, opaques, and apatite. Biotite is fresh and occurs as ragged grains and clots of grains.

GSC 78-66 and 67 are from a large granodiorite pluton that seems to have been folded and recrystallized simultaneously with the Central Gneiss Complex. Sample GSC 78-68 is from a lithologically similar pluton about 35 km to the south. The eastern part of this pluton intrudes older plutons and Central Gneiss Complex; the western part of the pluton is intimately associated with the Central Gneiss Complex. These ages are reconnaissance determinations in an area with no previous geochronological information. The ages are similar to the 49 ± 4 Ma age (GSC 67-25) obtained from quartz diorite about 40 km to the west, and indicate that the extensive K-Ar "plateau" of 45 to 55 Ma ages in Prince Rupert and Douglas Channel map-areas extends into southestern Whitesail Lake map area.

GSC 78-69 Biotite, K-Ar age **73.5 ± 2.2 Ma**

K = 7.39%, $^{40}Ar/^{40}K$ = 0.00436, radiogenic Ar = 47.5%.
Concentrate: Brown biotite, with about 4% chlorite alteration.

(93 E) From diorite
From bank of Horetzky Creek, 300 m downstream from outlet of Siffleur Lake, Whitesail Lake map area, British Columbia, 53°36'14"N, 127°46'27"W. Sample 77WV-94, collected and interpreted by G.J. Woodsworth.

The sample is a fine grained, unfoliated, grey diorite composed largely of about 85% strongly zoned, subhedral plagioclase, 3% quartz, 3% K-feldspar, 5% biotite, and about 4% clinopyroxene (partly altered to actinolite). Biotite forms anhedral grains that are slightly altered to chlorite.

The specimen is from the Horetzky Dyke, an east-west trending quartz diorite body that cuts the Central Gneiss Complex and Tahtsa Complex near the east margin of the Coast Plutonic Complex. The pluton is a fairly high-level body and the K-Ar age is probably close to the time of intrusion. If so, then metamorphism and folding of the Central Gneiss Complex in this area is pre-Tertiary in age.

GSC 78-70 Biotite, K-Ar age **58.8 ± 1.8 Ma**

K = 6.95%, $^{40}Ar/^{40}K$ = 0.00347, radiogenic Ar = 79.6%.
Concentrate: Light brown biotite with about 9% chlorite alteration.

From granodiorite
(93 E) 4 km southwest of the west end of Lindquist Lake, Whitesail Lake map area, British Columbia, 53°18'50"N, 127°20'19"W. Sample 77WV-300, collected and interpreted by G.J. Woodsworth.

The sample is a coarse grained unfoliated granodiorite consisting of about 35% plagioclase, 35% quartz, 23% K-feldspar (large, equant, perthitic grains), 6% biotite, and 1% muscovite, epidote, opaques, and apatite. Biotite forms ragged grains about 2 mm long that are about 1% altered to chlorite.

The sample is from a large body of granodiorite that forms part of the eastern edge of the Coast Plutonic Complex. Stratigraphic relations suggest a late Cretaceous or Tertiary age for the granodiorite; the K-Ar age is in accord with this suggestion.

GSC 78-71 Biotite, K-Ar age **48.9 ± 2.5 Ma**

K = 7.81%, $^{40}Ar/^{40}K$ = 0.00288, radiogenic Ar = 58.6%.
Concentrate: Clean, unaltered, light brown biotite, with no chlorite contamination.

From granite
(93 E) 1.5 km south of junction of Gamsby River and Sias Creek, Whitesail Lake map area, British Columbia, 53°21'40"N, 127°27'00"W. Sample 77WV-229, collected and interpreted by G.J. Woodsworth.

The rock is a light pink, medium grained miarolitic quartz monzonite, composed of about 30% plagioclase, 30% K-feldspar, 37% quartz, 3% biotite, and minor magnetite and apatite. Biotite forms irregular grains up to 2 mm across; some are slightly chloritized. Epitaxial muscovite partly rims some biotite grains.

The sample is from a high-level miarolitic granite stock that cuts the granodiorite of GSC 78-70 (59 Ma on biotite). The 49 Ma age probably represents the time of intrusion of the stock and suggests correlation with the Nanika intrusions to the north.

GSC 78-72 Biotite, K-Ar age **57.9 ± 1.9 Ma**

K = 5.38%, $^{40}Ar/^{40}K$ = 0.00342, radiogenic Ar = 68.3%.
Concentrate: Brownish orange biotite, with about 7% chlorite alteration.

From granite
(93 E) 11 km northwest of west end of Troitsa Lake, Whitesail Lake map area, British Columbia, 53°36'N, 127°28'W. Sample BOLOM 77WV-351, collected by T.A. Richards and interpreted by G.J. Woodsworth.

The sample is an altered, miarolitic feldspar porphyry, consisting of plagioclase, biotite, and hornblende, phenocrysts in a fine grained pink granophyric matrix. About 50 per cent of the small euhedral biotite phenocrysts are altered to chlorite.

The sample is from the Mount Bolom stock, a high-level, miarolitic, porphyritic granite that cuts Upper Cretaceous strata just east of the Coast Plutonic Complex. The age probably represents the time of intrusion of the stock and suggests correlation with the Eocene Nanika intrusions.

GSC 78-73 Biotite, K-Ar age **63.2 ± 2.5 Ma**

K = 7.47%, $^{40}Ar/^{40}K$ = 0.00373, radiogenic Ar = 85.8%.
Concentrate: Clean, unaltered, light brown biotite with no chlorite contamination.

From granodiorite
(93 M) 1.6 km northwest of Thoen Peak, head of Suskwa River, Hazelton map area, British Columbia, 55°24'N, 127°02.5'W. Sample 87D-74RW, collected and interpreted by T.A. Richards.

See GSC 78-74 for description, and GSC 78-79 for interpretation.

GSC 78-74 Hornblende, K-Ar age **60.8 ± 8.2 Ma**

K = 0.38%, $^{40}Ar/^{40}K$ = 0.00359, radiogenic Ar = 52.6%.
Concentrate: Clean, unaltered, pleochroic, light brown to light green hornblende with no visible contamination.

From granodiorite
(93 M) Details as for GSC 78-73.

The sample is a mesocratic, medium- to fine-grained subporphyritic biotite-hornblende granodiorite. The rock is very fresh, and is largely composed of subhedral zoned plagioclase, granular quartz and K-feldspar. The biotite (5%) is clean and fresh. The hornblende (3%) is fresh; some grains have clinopyroxene cores.

See GSC 78-79 for interpretation.

GSC 78-75 Biotite, K-Ar age **63.5 ± 2.5 Ma**

K = 6.90%, $^{40}Ar/^{40}K$ = 0.00375, radiogenic Ar = 86.3%.
Concentrate: Light brown biotite with approximately 3% chlorite alteration.

From granodiorite
(93 M) Natlan Peak, 32.2 km northeast of Hazelton, Hazelton map area, British Columbia, 55°24.5'N, 127°17'W. Sample Mt. Natlan-76RW, collected and interpreted by T.A. Richards.

See GSC 78-76 for description and GSC 78-79 for interpretation.

GSC 78-76 Hornblende, K-Ar age **64.1 ± 4.9 Ma**

K = 0.40%, $^{40}Ar/^{40}K$ = 0.00379, radiogenic Ar = 47.6%.
Concentrate: Clean, unaltered, pleochroic, light green to light brown hornblende with no visible contamination.

From granodiorite
(93 M) Details as for GSC 78-75.

The sample is a coarse- to medium-grained pyritic biotite-hornblende granodiorite, with deuteric alteration related to sulphide mineralization. The biotite (5%) is chloritized and the hornblende (5%) is fresh.

See GSC 78-79 for interpretation.

GSC 78-77 Hornblende, K-Ar age **72.3 ± 7.4 Ma**

K = 0.52%, $^{40}Ar/^{40}K$ = 0.00429, radiogenic Ar = 50.2%.
Concentrate: Clean, unaltered, pleochroic, light green to light brown hornblende with no visible contamination.

From diorite
(93 M) 16.1 km northeast of Hazelton, on top of Nine Mile Mountain, Hazelton map area, British Columbia, 55°21'N, 127°29'W. Sample Nine Mile-RW, collected and interpreted by T.A. Richards.

The sample is a medium grained hornblende diorite. Hornblende is fresh.

See GSC 78-79 for interpretation.

GSC 78-78 Biotite, K-Ar age **70.2 ± 2.2 Ma**

K = 6.79%, $^{40}Ar/^{40}K$ = 0.00416, radiogenic Ar = 88.7%.
Concentrate: Clean, unaltered, brownish orange biotite with no chlorite alteration.

From dacite porphyry
(93 M) 12.9 km east-southeast from Skeena Crossing at 5000 ft. elevation, southwestern part of Rocher Deboule Range, Hazelton map area, British Columbia, 55°03'N, 127°38'W. Sample 50-76RW, collected and interpreted by T.A. Richards.

The sample is a light green, aphanitic, biotite-feldspar dacite porphyry with a trachytic texture. Biotite (3%) forms fresh, round phenocrysts.

See GSC 78-79 for interpretation.

GSC 78-79 Biotite, K-Ar age **72.1 ± 2.2 Ma**

K = 6.87%, $^{40}Ar/^{40}K$ = 0.00427, radiogenic Ar = 88.7%.
Concentrate: Clean, unaltered, brownish orange biotite with no chlorite contamination.

From dacite porphyry
(93 M) Immediately north of Juniper Creek, at 1372 m elevation, along west ridges of Rocher Deboule Range, Hazelton map area, British Columbia, 55°08'N, 127°42.5'W. Sample 38-76RW, collected and interpreted by T.A. Richards.

The sample is a pale beige biotite-feldspar dacite porphyry from a biotite porphyry breccia. Plagioclase is slightly sericitized. Biotite is generally fresh but is slightly oxidized around the edges.

Determinations GSC 78-73 through 77 are from three of a swarm of high-level intrusive bodies that extends for nearly 400 km along the Intermontane belt. The K-Ar ages (61 to 72 Ma) from the three stocks described here are consistent with other ages from the Bulkley Intrusions (60 to 80 Ma) and probably represent the time of emplacement of the stocks.

Determinations GSC 78-78 and 79 are from acidic volcanics of the Brian Boru Formation in the Rocher Deboule Range. The volcanics are cut by the Rocher Deboule stock, a high-level granodiorite body that has given a 70 Ma K-Ar date. The two K-Ar ages from the Brian Boru volcanics are equivalent within the error limits and indicate a late Cretaceous age for this formation. The similarity in age between the volcanics and the Rocher Deboule stock strongly suggests that the two are coeval, a relationship that is not clearly evident in the field. The dates establish correlation of the Brian Boru volcanics with the Kasalka volcanics in Whitesail Lake map area.

GSC 78-80 Biotite, K-Ar age **50.7 ± 2.3 Ma**

K = 7.58%, $^{40}Ar/^{40}K$ = 0.00299, radiogenic Ar = 83.7%.
Concentrate: Clean, unaltered, light greenish brown biotite with no chlorite contamination.

From quartz monzonite
(93 M) South of Kisegas Peak, north of Babine River, southern Atna Range, Hazelton map area, British Columbia, 55°46'N, 127°20'W. Sample Kisegas-RW, collected and interpreted by T.A. Richards.

The sample is a leucocratic, medium grained biotite quartz monzonite with conspicuous K-feldspar megacrysts. Biotite is partly chloritized.

The sample is from a porphyry molybdenum prospect that intrudes Upper Jurassic Bowser Lake sediments. The stock is one of a number of acidic, molybdenite-bearing intrusions along the east margin of Coast Plutonic Complex, all of which give roughly 50 Ma ages.

GSC 78-81 Muscovite, K-Ar age **117 ± 4 Ma**

K = 7.39%, $^{40}Ar/^{40}K$ = 0.00703, radiogenic Ar = 89.9%.
Concentrate: Clean, clear, unaltered, very fine grained muscovite with no visible contamination.

From granite
(93 K) From quarry where Babine Lake road crosses Pinkut Creek, Fort Fraser map area, British Columbia, 54°24'N, 125°25'W. Sample Pinkut Creek, collected and interpreted by T.A. Richards.

The sample is a coarse grained leucocratic muscovite granite. Muscovite (5%) is fresh. Biotite is slightly bent and quartz and feldspars show incipient cataclasis.

The sample is from a complex of granitic and granitoid rocks from the eastern margin of the Hazelton basin. These rocks are unlike most high-level stocks characteristic of the Intermontane Belt. The K-Ar age does not support the hypothesis that these rocks form the basement to the western Intermontane belt, but it is not clear just what the age represents.

GSC 78-82 Biotite, K-Ar age **47.8 ± 3.1 Ma**

K = 6.65%, $^{40}Ar/^{40}K$ = 0.00281, radiogenic Ar = 67.8%.
Concentrate: Somewhat impure brownish orange biotite with approximately 9-10% chlorite alteration.

From granodiorite-quartz monzonite
(82 E) 2.6 km northeast of south end of Vaseaux Lake, east of Highway 97, Okanagan Valley, British Columbia, 49°17.5'N, 119°30'W. Sample OKANAGAN GN, collected and interpreted by A.V. Okulitch.

See GSC 78-83 for description and interpretation.

GSC 78-83 Muscovite, K-Ar age **45.5 ± 3.0 Ma**

K = 8.67%, $^{40}Ar/^{40}K$ = 0.00268, radiogenic Ar = 68.3%.
Concentrate: Relatively clean, unaltered clear muscovite with a slight trace of chlorite contamination.

From granodiorite-quartz monzonite
(82 E) Details as for GSC 78-82.

Gneissic leucocratic granodiorite intrudes metasediments of the Okanagan Complex and is pre- or syntectonic with second phase structures in this area. Related plutons are found along the east side of the Okanagan Valley from Kelowna to Colville, Washington. Near the 49th parallel, one such body intrudes metasediments correlated with the Carboniferous to (?) lower Triassic Anarchist Group (Ryan, 1973). Phase 2 deformation is likely a mid-Jurassic event. The probable age of this intrusion is therefore Permo-Triassic but it has suffered both late Jurassic (circa 150 Ma) and Eocene heating which has reset the Rb-Sr and K-Ar systems.

See GSC 78-88 for further discussion and GSC 78-94 for literature references.

GSC 78-84 Biotite, K-Ar age **45.6 ± 2.4 Ma**

K = 6.62%, $^{40}Ar/^{40}K$ = 0.00269, radiogenic Ar = 85.1%.
Concentrate: Dark brown biotite with approximately 15% chlorite alteration.

From gneiss
(82 E) Highway 3, east of Osoyoos Lake at Anarchist Mountain lookout, British Columbia, 49°00'40"N, 119°24'15"W. Sample ANARCHIST GNEISS, collected and interpreted by A.V. Okulitch.

See GSC 78-85 for description and interpretation.

GSC 78-85 Hornblende, K-Ar age **63.5 ± 4.8 Ma**

K = 0.95%, $^{40}Ar/^{40}K$ = 0.00376, radiogenic Ar = 42.6%.
Concentrate: Clean, unaltered, pleochroic, light brown to dark green hornblende with no visible contamination.

From gneiss
(82 E) Details as for GSC 78-84.

Results are typical of K-Ar analyses in the metamorphic complex and indicate either early Tertiary metamorphism or uplift and cooling or both. Some Tertiary plutonism may have local effects. Other work in the region (Ryan, 1973) with the Rb-Sr system indicates mid-Jurassic (140 Ma) metamorphism. On regional geological grounds, the Anarchist orthogneiss could be Permo-Triassic in age.

See GSC 78-94 for literature references.

GSC 78-86 Biotite, K-Ar age **47.8 ± 3.2 Ma**

K = 6.85%, $^{40}Ar/^{40}K$ = 0.00282, radiogenic Ar = 79.0%.
Concentrate: Light brown biotite with approximately 9% chlorite alteration.

From granitoid gneiss
(82 E) Kettle River valley, 3.2 km south of Winnifred Creek, about 61 km due east of Kelowna, British Columbia, 49°53'N, 118°41.5'W. Sample MONASHEE-I, collected and interpreted by A.V. Okulitch.

See GSC 78-87 for interpretation.

GSC 78-87 Biotite, K-Ar age **47.6 ± 2.5 Ma**

K = 6.57%, $^{40}Ar/^{40}K$ = 0.00280, radiogenic Ar = 77.6%.
Concentrate: Somewhat impure, brown biotite with approximately 9% chlorite alteration.

From "augen" granite
(82 E) At bridge over Kettle River, 4.2 km south of Mohr Creek, British Columbia, 49°48'N, 118°42.5'W. Sample MONASHEE II, collected and interpreted by A.V. Okulitch.

Foliated granite to granodiorite with K-feldspar augen and laced with pegmatite intruded the Okanagan Complex prior to much of the penetrative, mid-Jurassic deformation and metamorphism. Its minimum age is therefore Early Jurassic (circa 185 Ma) but could be Permo-Triassic or older. The evident pervasive effects of later events makes determination of the intrusive age improbable.

See GSC 78-88 for further discussion.

GSC 78-88 Hornblende, K-Ar age **55.5 ± 2.9 Ma**

K = 1.24%, $^{40}Ar/^{40}K$ = 0.00328, radiogenic Ar = 74.1%.
Concentrate: Clean, unaltered, pleochroic, olive-green to light brown hornblende with no visible contamination.

From granodiorite gneiss
(82 F) About 1.6 km east-northeast of Upper Little Slocan Lake, on southern flank of Valhalla gneiss dome, about 14.5 km southwest of Slocan, British Columbia, 49°41.3'N, 117°37.9'W. Sample VALHALLA-3, collected and interpreted by A.V. Okulitch.

Veined augen gneiss in the core of Valhalla gneiss dome (Reesor, 1965) was possibly intruded during Jura-Cretaceous orogenic events but detailed mapping south of the dome (Simony, 1976) suggests that extensively metamorphosed and injected upper Palaeozoic sediments form at least part of this unit. Its intrusive character is therefore in doubt and its K-Ar "age" likely reflects the influence of possibly coeval syenitic intrusions (Little, 1957; Reesor, 1965).

These seven age determinations are from rocks of the Okanagan Metamorphic Complex. Orthogneiss and foliated intrusive rocks from the Okanagan Metamorphic Complex range in age from Precambrian to Cretaceous on the basis of speculative interpretation of field data but records only an early Tertiary thermal or cooling event spanning about 10 Ma (55 to 45 Ma). Discussion of this pervasive resetting of the K-Ar isotopic system has been made previously (Okulitch, 1975) and little additional information has been subsequently obtained to explain it. Prevailing hypotheses include uplift and cooling of a metamorphic terrane created during Middle Jurassic orogenic events, extensive metamorphism associated with Eocene intrusive and extrusive rocks and Tertiary, very

low grade, regional metamorphism and metasomatism. Detailed studies (Ryan, 1973; Solberg, 1977) indicate that the Rb-Sr system was similarly affected. An hypothesis combining uplift and cooling with local thermal effects of exposed and subjacent igneous rocks is a plausible compromise.

See GSC 78-94 for literature references.

GSC 78-89 Biotite, K-Ar age **47.6 ± 2.5 Ma**

K = 6.93%, $^{40}Ar/^{40}K$ = 0.00280, radiogenic Ar = 82.8%.
Concentrate: Light brown biotite with approximately 4% chlorite alteration.

From gneiss
(82 L) Shuswap Range, southwest of Queest Mountain, 0.8 km by road east of Sim Creek and 10.1 km north-northeast of Sicamous, British Columbia, 50°55.2'N, 119°55.6'W. Sample 125CAa73-3, collected and interpreted by A.V. Okulitch.

See GSC 78-90 for further information.

GSC 78-90 Hornblende, K-Ar age **92.1 ± 4.2 Ma**

K = 1.40%, $^{40}Ar/^{40}K$ = 0.00549, radiogenic Ar = 76.5%.
Concentrate: Clean, unaltered, pleochroic, light to dark green hornblende with no visible contamination.

From gneiss
(82 L) Details as for GSC 78-89.

Granodioritic gneiss that forms part of an elongate, sill-like pluton that intruded metasediments of probable early Paleozoic age. The pluton extends for 50 km west from the Shuswap Complex north of Shuswap Lake and a related body lies east of the complex near Revelstoke (R.K. Wanless, personal communication, 1975). The Pb-U system in zircons records the intrusive age of 372 Ma (Late Devonian) (Okulitch and Wanless, 1975). Later thermal events (regional metamorphism in the Middle Jurassic, contact metamorphism possibly in the Cretaceous and uplift and cooling in the early Tertiary) produced open behaviour in the Rb-Sr system (W. Slawson, personal communication, 1975), annealed fission tracks in zircons to give circa 50 Ma dates (C. Naeser, personal communication, 1976) and set the K-Ar system at about 45 to 50 Ma ago.

See GSC 78-94 for literature references.

GSC 78-91 Hornblende, K-Ar age **107 ± 5 Ma**

K = 0.877%, $^{40}Ar/^{40}K$ = 0.00638, radiogenic Ar = 74.7%.
Concentrate: Clean, unaltered, pleochroic, light brown to light green hornblende with no visible contamination.

From granodiorite gneiss
(82 M) 6.4 km south of the North Thompson River, 32 km east southeast of Vavenby, British Columbia, 51°36.6'N, 119°26.0'W. Map unit 1, Adams Lake map (R.B. Campbell, 1965). Sample 141CAa74-1, collected and interpreted by A.V. Okulitch.

See GSC 78-93 for description and interpretation.

GSC 78-92 Biotite, K-Ar age **54.4 ± 2.3 Ma**

K = 7.15%, $^{40}Ar/^{40}K$ = 0.00321, radiogenic Ar = 81.3%.
Concentrate: Brown biotite with approximately 4% chlorite alteration.

From granite to granodiorite gneiss
(82 M) On Highway 5, 27.4 km east of Vavenby, British Columbia, 51°40.4'N, 119°26.7'W. Map unit 1, Adams Lake map area (Campbell, R.B., 1963). Sample 169CAa74, collected and interpreted by A.V. Okulitch.

See GSC 78-93 for description and interpretation.

GSC 78-93 Biotite, K-Ar age **57.5 ± 2.4 Ma**

K = 7.95%, $^{40}Ar/^{40}K$ = 0.00339, radiogenic Ar = 83.1%.
Concentrate: Clean, unaltered, brownish orange biotite with no visible contamination.

From granite
(83 D) On Highway 5, 9.3 km south of Blue River bridge, British Columbia, 52°03'N, 119°20'W. Map unit 10 (within unit 2A), GSC Map 15-1967 (Canoe River; R.B. Campbell). Sample 393CAa74, collected and interpreted by A.V. Okulitch.

Granodioritic orthogneiss from the western margin of the Shuswap Complex north of Adams Lake near the North Thompson River is of pre-late Jurassic age. Field relationships providing better age limits are unavailable as these plutons are isolated by faults or lie within undated country rocks. Samples GSC 78-91 and 78-92 bear some similarity to Devonian intrusive rocks near Adams Lake (Okulitch and Wanless, 1975). Resetting of the K-Ar system at about 55 Ma is typical for most gneissic rocks within the complex and has been discussed above in relation to the Okanagan Complex. The late Cretaceous (107 ± 5 Ma) date obtained from sample GSC 78-91 may have been caused by thermal effects of nearby Cretaceous plutons (Campbell and Tipper, 1971) but in view of the known pervasive effects of Tertiary resetting, must be considered a minimum date.

See GSC 78-94 for literature references.

GSC 78-94 Hornblende, K-Ar age **143 ± 6 Ma**

K = 0.860%, $^{40}Ar/^{40}K$ = 0.00862, radiogenic Ar = 82.4%.
Concentrate: Clean, unaltered, pleochroic, yellowish brown to green hornblende with no visible contamination.

From nepheline syenite gneiss
(82 M) At 2439 m (8000 ft.) altitude, 275 m west of summit of Mount Copeland, approximately 19.3 km northwest of Revelstoke, British Columbia, 51°07 1/2'N, 118°25 1/2'W. Sample WN-4-74, collected and interpreted by R.K. Wanless and A.V. Okulitch.

A small pluton of syenite gneiss lies on the south flank of Frenchman's Cap gneiss dome where it intruded metasediments of possible early Cambrian age (Fyles, 1970). Having apparently participated in all phases of deformation, the earliest of which, on the basis of regionally acquired field relations and radiometric data, may be Ordovician in age (P.B. Read, personal communication, 1976), the pluton is presumed to be of early Paleozoic age. In view of some uncertainty as to the age of the intruded rocks, it may be older. The date of 143 ± 6 Ma reflects effects of

Jura-Cretaceous metamorphism but in view of the common Tertiary resetting described previously, must be considered a minimum age for that event.

References

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GSC 78-95 Biotite, K-Ar age **51.0 ± 2.4 Ma**

K = 6.43%, $^{40}Ar/^{40}K$ = 0.00301, radiogenic Ar = 90.5%.
Concentrate: Brownish orange biotite, with approximately 15% chlorite alteration.

(82 F) From uraniferous pegmatite
9.7 km south of Castlegar, two miles upstream on north side of China Creek, south central British Columbia, 49°14'0"N, 117°42'30"W. Sample 82F-770064, collected and interpreted by D.R. Boyle.

The rock is a coarse grained biotite-muscovite-garnet-smoky quartz-plagioclase pegmatite containing uraninite and secondary uranium minerals (uranophane). Pegmatite body intrudes layered granitoid gneisses of the Shuswap Metamorphic Complex.

See GSC 78-99 for interpretation.

GSC 78-96 Biotite, K-Ar age **54.7 ± 1.9 Ma**

K = 5.07%, $^{40}Ar/^{40}K$ = 0.00323, radiogenic Ar = 85.7%.
Concentrate: Brownish orange biotite with approximately 15% chlorite alteration.

(82 F) From uraniferous pegmatite
10 km south of Castlegar, two miles upstream on south side of China Creek, south central British Columbia, 49°13'0"N, 117°42'0"W. Sample 82F-770145, collected and interpreted by D.R. Boyle.

Details as for GSC 78-95.

See GSC 78-99 for interpretation.

GSC 78-97 Biotite, K-Ar age **50.0 ± 2.4 Ma**

K = 6.37%, $^{40}Ar/^{40}K$ = 0.00294, radiogenic Ar = 88.5%.
Concentrate: Brownish orange biotite with approximately 10% chlorite alteration.

(82 E) From uraniferous pegmatite
11.3 km north of Grand Forks, British Columbia, 49°07'0"N, 118°22'40"W. Sample 82E-770065, collected and interpreted by D.R. Boyle.

The rock is coarse grained, biotite-muscovite-garnet-smoky quartz-plagioclase pegmatite containing uraninite and secondary uranium minerals. Pegmatite body intrudes biotite schists and gneisses of the Shuswap Metamorphic Complex.

See GSC 78-99 for interpretation.

GSC 78-98 Biotite, K-Ar age **50.0 ± 2.4 Ma**

K = 7.68%, $^{40}Ar/^{40}K$ = 0.00294, radiogenic Ar = 61.5%.
Concentrate: Clean, unaltered, biotite with no visible chlorite contamination.

(82 L) From uraniferous pegmatite
32 km east of Vernon, British Columbia on the north side of Blue Springs Creek, 50°15'0"N, 118°45'30"W. Sample 82-LPG-1-A, collected and interpreted by D.R. Boyle.

The rock is a coarse grained, muscovite-biotite-garnet-smoky quartz-plagioclase pegmatite containing monazite and secondary uranium minerals. Pegmatite body intrudes granitoid gneisses of the Monashee Group, Shuswap Metamorphic Complex.

See GSC 78-99 for interpretation.

GSC 78-99 Muscovite, K-Ar age **48.9 ± 2.5 Ma**

K = 7.60%, $^{40}Ar/^{40}K$ = 0.00288, radiogenic Ar = 64.1%.
Concentrate: Clean, brownish stained muscovite with no visible contamination.

From uraniferous pegmatite
(82 L) Details as for GSC 78-98.

Samples GSC 78-95, 96, 97, 98, and 99 were taken from uraniferous pegmatites in south central British Columbia. These bodies have a remarkably similar mineralogical composition and texture to uranium-producing pegmatites in the northern part of Washington state. Age determinations for the British Columbia pegmatites and those of the Daybreak and Atomic Silver mines of Washington are summarized below.

Sample No.	Location	Mineral	Age (Ma)
GSC 78-95	China Creek, B.C.	Biotite	51.0 ± 2.4
GSC 78-96	Grand Forks, B.C.	Biotite	54.7 ± 1.9
GSC 78-97	China Creek, B.C.	Biotite	50.0 ± 2.4
GSC 78-98	Blue Springs, B.C.	Biotite	50.0 ± 2.4
GSC 78-99	Blue Springs, B.C.	Muscovite	48.9 ± 2.5
PG-1A	Daybreak Mine, Wash.	Muscovite	60.1 ± 1.9
PG-2A	Atomic Silver Mine, Wash.	Muscovite	53.3 ± 1.9

All of the data fall within a 11 Ma interval (49-60 Ma) and good correlation exists between ages for biotite-muscovite pairs (Blue Springs) and biotites from spatially related but separate pegmatites (China Creek). These rocks are very coarse grained pegmatites consisting of plagioclase, smoky quartz, garnet and variable amounts of muscovite and biotite; border phases tend to be biotite rich while internal zones are generally muscovite rich. Some pegmatites contain uraninite associated with books of mica (China Creek and Grand Forks); all bodies contain secondary uranium minerals (autunite or uranophane). Monazite is present in the Blue Springs pegmatite. All of the British Columbia pegmatites occur in the Shuswap Metamorphic Complex, in areas also containing Cretaceous to middle Tertiary intrusive phases. The Blue Springs pegmatite is a large discordant body whereas the China Creek and Grand Forks pegmatite swarms appear to be concordant within the Shuswap gneisses. The Daybreak and Atomic Silver pegmatites in northern Washington occur within intrusive rocks of monzonitic composition. Although distinct similarities exist between mineralogy, uranium content and age of the British Columbia and Washington pegmatites the possibility of resetting of K-Ar ages for the south central British Columbia pegmatites by a well documented Tertiary thermal event (45-50 Ma) must be considered (Ross, 1973; Medford, 1975). Resetting of K-Ar ages in the Shuswap Metamorphic Complex by Tertiary volcanic events has also been documented (Mathews, 1976; Okulitch, 1978). It would appear therefore that without supplementary measurements (i.e. U-Pb dating of uraninites or zircons) it is not possible to delimit the presence of an uraniferous pegmatite province in south central British Columbia and northern Washington consisting of a single generation of pegmatites.

References

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GSC 78-100 Biotite, K-Ar age **63.5 ± 3.1 Ma**

K = 6.45%, $^{40}Ar/^{40}K$ = 0.00375, radiogenic Ar = 72.3%.
Concentrate: Clean, unaltered, brown biotite with no visible contamination.

From andesite
(115 I) Bottom end of Granite Canyon, Pelly River, Yukon, 62°43'30"N, 136°13'W. Sample TO74-74A, collected and interpreted by D. Tempelman-Kluit.

The fresh basalt sampled was correlated (Bostock, 1936) with the Carmacks Group on lithologic grounds and because the age of that group is improperly known the sample was dated. The rock also resembles basalt in the lower Mount Nansen Group and because its 63.5 Ma age is close to the 55 ± Ma age of plutonic and volcanic rocks from the Mount Nansen Group, it may be better correlated with that group. On the other hand it is surprising to fine Mount Nansen ages so far northeast, only 30 km southwest of the Tintina Fault. The nearest occurrences of Mount Nansen Group are 80 km farther southwest. Most likely this basalt is equivalent to that at Solitary Mountain and Boswell River in northeast and southeast Laberge map area. It may also represent a suite of volcanics distinct from both the Mount Nansen and Carmacks groups.

Reference

Bostock, H.S.
1936: Carmacks District, Yukon; Geological Survey of Canada Memoir 189, p. 67.

GSC 78-101 Whole-rock, K-Ar age **189 ± 22 Ma**

K = 0.94%, $^{40}Ar/^{40}K$ = 0.01159, radiogenic Ar = 94.3%.
Concentrate: Crushed whole-rock.

From acid tuff
(105 F) Ridge between Seagull Creek and McConnell River, 10.2 km bearing 343° from mouth of White Creek, Yukon, 61°33'N, 132°34'W. Sample TO75-33-2, collected and interpreted by D. Tempelman-Kluit.

This sample of Mississippian acid to intermediate volcanic rock was taken to test whether its K-Ar apparent age reflects the stratigraphic age of the rocks or a younger thermal event. The 189 Ma date is far too young for the Mississippian time of extrusion of the volcanics, but too old for the 90 Ma thermal event that has regionally reset most rocks in this district. The apparent age therefore may reflect partial thermal resetting of the volcanics by the 90 Ma event or an older thermal event not previously recognized. This possible later event may be the regional thrusting and folding which occurred during the Jura-Cretaceous. If so, the 189 Ma age may pinpoint the time of this event.

GSC 78-102 Biotite, K-Ar age **76.7 ± 3.4 Ma**

K = 7.08%, $^{40}Ar/^{40}K$ = 0.00456, radiogenic Ar = 75.3%.
Concentrate: Dark brown biotite with approximately 4% chlorite alteration.

From quartz monzonite
(105 F) Top of ridge, 1.8 km south-southwest of 6943 peak, Yukon, 61°26.5'N, 133°53'W. Sample TO75-26-7, collected and interpreted by D. Tempelman-Kluit.

See GSC 78-109 for discussion and interpretation.

GSC 78-103 Biotite, K-Ar age **88.1 ± 3.2 Ma**

K = 7.63%, $^{40}Ar/^{40}K$ = 0.00524, radiogenic Ar = 90.9%.
Concentrate: Relatively clean, fresh, light brown biotite with approximately 1% chloritization.

From quartz monzonite
(105 F) Top of ridge, 8.6 km north-northwest (325°) from junction of Sheep Creek and Big Salmon River, Yukon, 61°28'15"N, 133°34'W. Sample TO75-25-11, collected and interpreted by D. Tempelman-Kluit.

See GSC 78-109 for discussion and interpretation.

GSC 78-104 Biotite, K-Ar age **91.2 ± 3.3 Ma**

K = 6.98%, $^{40}Ar/^{40}K$ = 0.00544, radiogenic Ar = 88.8%.
Concentrate: Brownish orange biotite with approximately 6% chlorite alteration.

From quartz monzonite
(105 F) Top of ridge, 9.3 km bearing 176° from Pass Peak, Yukon, 61°29'N, 132°49'W. Sample TO75-19-9, collected and interpreted by D. Tempelman-Kluit.

See GSC 78-109 for discussion and interpretation.

GSC 78-105 Biotite, K-Ar age **96.0 ± 3.5 Ma**

K = 6.98%, $^{40}Ar/^{40}K$ = 0.00573, radiogenic Ar = 83.5%.
Concentrate: Dark brown biotite with approximately 6% chlorite alteration.

From quartz monzonite
(105 F) Hilltop 4.5 km west of junction of Seagull Creek and McConnell River, Yukon, 61°23.5'N, 132°36'W. Sample TO75-20-3, collected and interpreted by D. Tempelman-Kluit.

See GSC 78-109 for discussion and interpretation.

GSC 78-106 Biotite, K-Ar age **86.4 ± 3.2 Ma**

K = 7.56%, $^{40}Ar/^{40}K$ = 0.00514, radiogenic Ar = 89.7%.
Concentrate: Clean, unaltered, brown biotite with no visible contamination.

From quartz monzonite
(105 F) Ridge 9.6 km east-northeast (64°) from junction of Rose River and Big Creek, Yukon, 61°15 1/2'N, 132°50.5'W. Sample TOC75-17b, collected by G. Cavey and interpreted by D. Tempelman-Kluit.

See GSC 78-109 for discussion and interpretation.

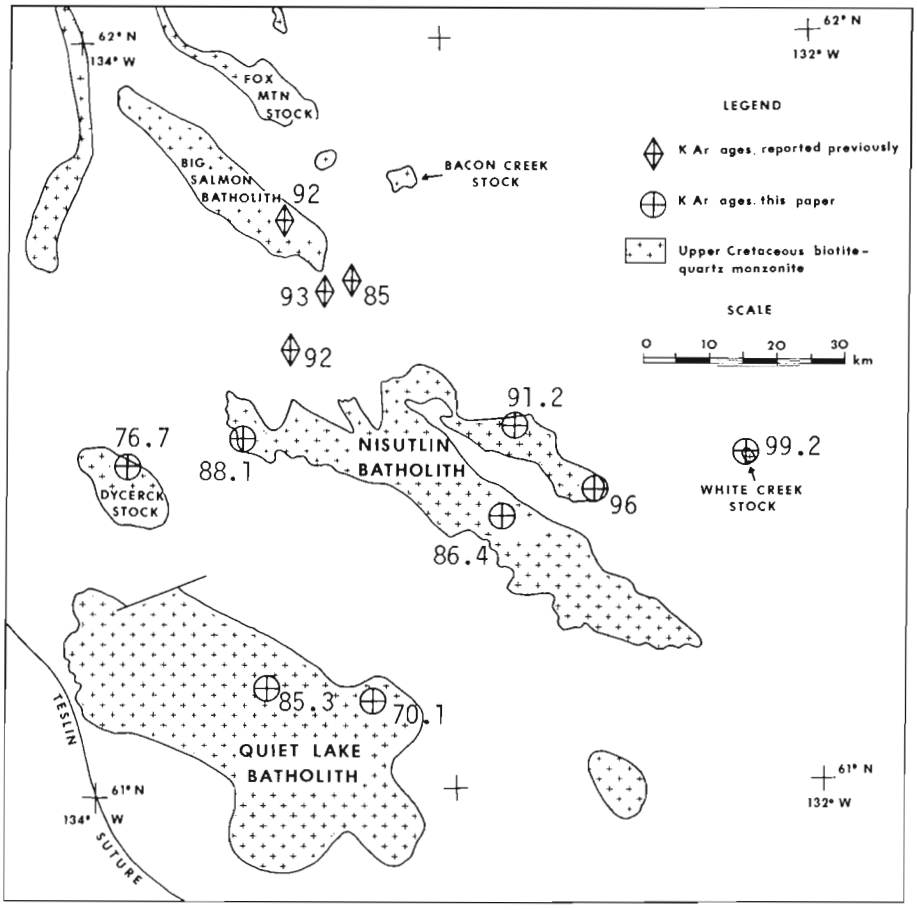

Figure 4. Quartz monzonite and related plutons, central Yukon.

GSC 78-107 Biotite, K-Ar age **85.3 ± 3.1 Ma**

K = 7.42%, $^{40}Ar/^{40}K$ = 0.00508, radiogenic Ar = 84.7%.
Concentrate: Greenish-brown biotite with approximately 5% chlorite alteration.

From granodiorite
(105 F) On ridge 7.3 km southeast (128°) from 7134 peak, south of Gray Creek, Yukon, 61°08'N, 133°30.5'W. Sample TO75-31-17, collected and interpreted by D. Tempelman-Kluit.

See GSC 78-109 for discussion and interpretation.

GSC 78-108 Biotite, K-Ar age **70.1 ± 2.6 Ma**

K = 7.55%, $^{40}Ar/^{40}K$ = 0.00415, radiogenic Ar = 68.7%.
Concentrate: Clean, fresh and unaltered, brownish orange biotite with no visible contamination.

From quartz monzonite
(105 F) Dropoff Mountain, Yukon, 61°07'N, 133°13'30"W. Sample TO75-27-9, collected and interpreted by D. Tempelman-Kluit.

See GSC 78-109 for discussion and interpretation.

GSC 78-109 Biotite, K-Ar age **99.2 ± 3.6 Ma**

K = 6.47%, $^{40}Ar/^{40}K$ = 0.00593, radiogenic Ar = 87.5%.
Concentrate: Brownish orange, considerably altered biotite with 15% chlorite as both an alteration product and as free flakes.

From quartz monzonite
(105 F) Ridge 10 km north-northeast (16°) from Mt. Hogg, Yukon, 61°26'N, 132°11'W. Sample TO75-17-3, collected and interpreted by D. Tempelman-Kluit.

The samples are of quartz monzonite and related rocks which form concordant and discordant plutons that intrude strata as young as Mississippian in a large area in central Yukon (Fig. 3). The samples resemble other quartz monzonites which occur widely in northeastern Yukon and British Columbia that have given K-Ar ages between 70 and 110 Ma. Although the samples reported here are lithologically similar, their apparent ages range widely and they evidently cooled during an interval from 100 to 70 Ma ago. Systematic variation in the apparent ages is not detectable from the widely spaced sampling done to date. The ages are consistent with four others reported earlier for samples from similar plutonic rocks and regionally metamorphosed rocks (see Fig. 4).

Rock Association	Age (Ma)		
Regionally metamorphosed rocks	85	GSC 65-37	Adjusted for
	93	GSC 65-36	25th IGC
	92	GSC 65-34	Constants
Big Salmon Batholith	92	GSC 65-35	
Dycer Creek Stock	76.7	GSC 78-102	
Nisutlin Batholith	88.1	GSC 78-103	
	91.2	GSC 78-104	
	96.0	GSC 78-105	
	86.4	GSC 78-106	
Quiet Lake Batholith	85.3	GSC 78-107	
	70.1	GSC 78-108	
White Creek Stock	99.2	GSC 78-109	

Whether the wide range in ages reflects not only a long cooling interval but also a long intrusive history is unknown.

The 10 Ma range in the four ages from the apparently homogeneous Nisutlin Batholith suggests that this pluton is a long-lived multiple intrusion. The 15 Ma difference in ages of the two samples from the heterogeneous Quiet Lake Batholith also suggest it is a multiple intrusion emplaced during a considerable time span.

GSC 78-110 Hornblende, K-Ar age **372 ± 15 Ma**

K = 1.69%, $^{40}Ar/^{40}K$ = 0.02398, radiogenic Ar = 93.6%.
Concentrate: Relatively clean, unaltered, pleochroic, brown to green hornblende with less than 1% chlorite contamination.
From coarse grained syenodiorite
(116 O) Unnamed hill north of Porcupine River, 25 km east-northeast of the village of Old Crow, Yukon, 67°36'N, 139°15'W. Sample 998NC2, collected and interpreted by D.K. Norris.

The stock is an isolated occurrence of limited areal extent and very poor exposure between the Kaltag-Porcupine and Yukon Faults, on the north flank of the Aklavik Arch, GSC locality C-27134. Highly sheared, basic intrusions are strung out along the Kaltag-Porcupine Fault adjacent to the stock. Scattered outcrops of Lower Paleozoic carbonates and Upper Mesozoic clastics occur in the immediate area but their contact relations with the stock are not visible.

The stock differs significantly in mineralogy from the neighbouring Mount Schaeffer (Baadsgaard et al., 1961) and the Old Crow (Wanless et al., 1965) granitic stocks from which Devonian and younger isotopic ages have been obtained.

References

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GSC 78-111 Muscovite, K-Ar age **1673 ± 42 Ma**

K = 8.87%, $^{40}Ar/^{40}K$ = 0.1602, radiogenic Ar = 98.7%.
Concentrate: Clean, clear, unaltered muscovite with no visible contamination.

From syenite
(77 E) Outcrop near small lake 16 km north of Washburn Lake and 88.5 km northwest of Cambridge Bay, Victoria Island, District of Franklin, 70°15'N, 107°35'W. Sample WG-1, collected by K. Bond (Uranex Exploration) and interpreted by Walter Gibbins (DINA).

The rock is a coarse- to very coarse-grained fresh and unaltered syenite. This syenite is overlain by Paleozoic carbonates and late Proterozoic diabase sills. Nearby sediments may be of Hadrynian and/or Aphebian age (Young and Jefferson, 1975), but critical contacts have not been located or examined.

The Hudsonian age extends the Churchill Province to Victoria Island, over 160 km northwest of previously reported limits. This area is within 160 km of both the Minto Inlier and Coppermine Homocline of the Bear Province. Any proposed boundary between the Bear and Churchill provinces will have to be defined and delineated by geophysical methods.

The relative age of nearby Proterozoic sediments is controversial (Young and Jefferson, 1975, p. 1737) and unless a relationship can be established with the syenite they are likely to remain so.

Reference

Young, G.M. and Jefferson, C.W.
1975: Late Precambrian Shallow Water Deposits, Banks and Victoria Islands, Arctic Archipelago; Canadian Journal of Earth Sciences, v. 12, p. 1734-1748.

GSC 78-112 Biotite, K-Ar age **1689 ± 42 Ma**

K = 7.45%, $^{40}Ar/^{40}K$ = 0.1625, radiogenic Ar = 99.4%.
Concentrate: Clean, unaltered, brownish orange biotite with no visible contamination.

From charnockitic gneiss
(58 B) Between Bellot Strait and Macgregor Laird Lake, Somerset Island, District of Franklin, 72°02'N, 94°43'W. Sample 76-DV-279-A, collected by C.D.S. de Vries and R.D. Stevens, interpreted by C.D.S. de Vries (University of Calgary).

The sample is from a foliated hypersthene and biotite bearing quartzo-feldspathic gneiss. The foliation is parallel to axial planes of F3 mesoscopic folds in adjacent mafic bands and is marked by flattened quartz, elongated hypersthene and weakly oriented biotite. The K-Ar age probably dates uplift and cooling of the rock after F3 deformation and high grade metamorphism.

GSC 78-113 Biotite, K-Ar age **1742 ± 42 Ma**

K = 7.24%, $^{40}Ar/^{40}K$ = 0.1704, radiogenic Ar = 99.5%.
Concentrate: Relatively clean and fresh, brownish orange biotite with approximately 1% chlorite alteration.

From garnet-sillimanite paragneiss
(58 B) Approximately 2 km east of Mount Walker, southern Somerset Island, District of Franklin, 72°04'N, 94°16'W. Sample 76-DV-274-C, collected and interpreted by C.D.S. de Vries (University of Calgary).

The sample is a well-foliated sillimanite-garnet-biotite-potash feldspar-plagioclase-quartz gneiss. These metasediments show evidence of both F 1 and F 3 deformation. Garnet porphyroblasts are distinctly flattened in S 1 surfaces, sillimanite forms L 3 lineations, and biotite has been observed to be either parallel to S 1 surfaces, or S 3 surfaces, suggesting that biotite recrystallized during the last phase of deformation.

It may be concluded that the 1742 Ma age represents uplift and cooling after the high grade metamorphic event and F 3 deformation.

GSC 78-114 Hornblende, K-Ar age **1942 ± 126 Ma**

K = 0.47%, $^{40}Ar/^{40}K$ = 0.2028, radiogenic Ar = 97.5%.
Concentrate: Clean, unaltered, nonpleochroic, very light green amphibole with no visible contamination.

From metabasite
(58 B) Between Macgregor Laird Lake and Bellot Strait, about 8 km east-northeast of Leask Point, Somerset Island, District of Franklin, 72°00'30"N, 94°57'W. Sample 76-DV-279-b5, collected by C.D.S. de Vries and R.D. Stevens, interpreted by C.D.S. de Vries.

See GSC 78-116 for description and interpretation.

GSC 78-115 Hornblende, K-Ar age **2126 ± 150 Ma**

K = 0.39%, $^{40}Ar/^{40}K$ = 0.2358, radiogenic Ar = 96.8%.
Concentrate: Clean, unaltered, pleochroic, light brown to dark brown hornblende with no visible contamination.

From metabasite
(58 B) Between Macgregor Laird Lake and Bellot Strait, about 8 km east-northeast of Leask Point, Somerset Island, District of Franklin, 72°00'30"N, 94°57'W. Sample 76-DV-279-b6, collected by C.D.S. de Vries and R.D. Stevens, interpreted by C.D.S. de Vries.

See GSC 78-116 for description and interpretation.

GSC 78-116 Hornblende, K-Ar age **2009 ± 176 Ma**

K = 0.30%, $^{40}Ar/^{40}K$ = 0.2144, radiogenic Ar = 95.1%.
Concentrate: Clean, unaltered, pleochroic, light brown to dark brown hornblende with no visible contamination.

From metabasite
(58 B) Between Macgregor Laird Lake and Bellot Strait, about 8 km east-northeast of Leask Point, Somerset Island, District of Franklin, 72°00.5'N, 94°57'W. Sample 76-DV-279-b12, collected by C.D.S. de Vries and R.D. Stevens, interpreted by C.D.S. de Vries (University of Calgary).

All three samples are from an approximately 70 m thick metabasite sheet which has been metamorphosed under conditions of the granulite facies. A distinct mineralogical and textural change is observed from the rim of the unit, which is a medium grained, diopside-hypersthene-plagioclase (An 85)-hornblende gneiss to a very coarse grained, massive hornblendite core, mainly composed of green pleochroic hornblende with minor amounts of plagioclase (An 95), hypersthene and hercynitic spinel. Textural and petrological features indicate that amphiboles and pyroxenes formed as an equilibrium assemblage under granulite facies conditions.

The metabasite sheet has been affected by both F 1 and F 3 deformation (Kerr and de Vries, 1977). C-axes of hornblendes form a weak lineation approximately parallel to F 3 hinges. Since amphiboles and pyroxenes appear to form equilibrium textures, the granulite facies event probably occurred late in the tectonic history, i.e. syntectonic with F 3 deformation.

The K-Ar dates on the three hornblende concentrates cluster around 2000 Ma, which may tentatively be taken as the minimum age of the granulite facies metamorphic event and F 3 deformation. It can be noted that all other K-Ar dates available from the Precambrian metamorphic rocks of the Boothia-Somerset region (Blackadar, 1967) give younger apparent ages ranging from about 1740 to 1635 Ma. All these younger ages are from biotite concentrates perhaps reflecting the lower blocking temperature for argon in biotite.

References

Blackadar, R.G.
1967: Precambrian geology of Boothia Peninsula, Somerset Island, and Prince of Wales Island, District of Franklin; Geological Survey of Canada, Bulletin 151.

Kerr, J.Wm. and de Vries, C.D.S.
1977: Structural geology of Somerset Island and Boothia Peninsula, District of Franklin; in Report of Activities, Part A, Geological Survey of Canada, Paper 77-1A.

GSC 78-117 Biotite, K-Ar age **1654 ± 40 Ma**

K = 7.47%, $^{40}Ar/^{40}K$ = 0.1573, radiogenic Ar = 99.5%.
Concentrate: Relatively clean, unaltered, light green biotite with approximately 1% chlorite contamination.

From gneiss
(47 D) Igloolik map-area, District of Franklin, 69°05'N, 83°17'W. Sample WN-53-75, collected and interpreted by R.K. Wanless and M. Schau.

See GSC 78-118 for description and interpretation.

GSC 78-118 Hornblende, K-Ar age **1688 ± 50 Ma**

K = 1.23%, $^{40}Ar/^{40}K$ = 0.1623, radiogenic Ar = 99.3%.
Concentrate: Clean, unaltered, pleochroic, brown to dark green hornblende with no visible contamination.

From gneiss
(47 D) Details as for GSC 78-117.

The biotite and hornblende have approximately the same age which is near that of the "Hudsonian event". Usually concordant numbers from different minerals are taken to signify that the minerals formed at this time. The geological evidence is that these gneisses and the contained minerals had a long history and the latest (conical) folding may be reflected by these numbers. A zircon age from this gneiss is discordant but intersects concordia near 2605 Ma (R.K. Wanless, personal communication).

GSC 78-119 Biotite, K-Ar age **1610 ± 40 Ma**

K = 6.93%, $^{40}Ar/^{40}K$ = 0.1510, radiogenic Ar = 99.5%.
Concentrate: Moderately altered brown biotite with approximately 8% chloritization.

From "granite"
(47 A) Approximately 26 km west-northwest of Hall Lake, District of Franklin, 68°56'N, 83°54'W. Sample WN-51-74, collected by R.K. Wanless and M. Schau.

See GSC 78-120 for interpretation.

GSC 78-120 Muscovite, K-Ar age **1588 ± 49 Ma**

K = 8.51%, $^{40}Ar/^{40}K$ = 0.1480, radiogenic Ar = 99.2%.
Concentrate: Clean, unaltered, slightly yellow-stained muscovite with no visible contamination.

From "granite"
(47 A) Details as for GSC 78-119.

Muscovite and biotite from this pluton of the Hall Lake Plutonic Complex give a minimum date probably associated with the "Hudsonian Event".

GSC 78-121 Biotite, K-Ar age **1630 ± 40 Ma**

K = 7.60%, $^{40}Ar/^{40}K$ = 0.1539, radiogenic Ar = 99.7%.
Concentrate: Somewhat altered brown biotite with approximately 7% chlorite.

From acid volcanic rock
(47 A) Approximately 26 km west-northwest of Hall Lake, District of Franklin, 68°56'N, 83°54'W. Sample WN-52-74, collected and interpreted by R.K. Wanless and M. Schau.

This biotite, from an acid volcanic rock of Prince Albert Group, gives a "Hudsonian" date. It is in part chloritized. The rocks are interpreted to be Archean on geological grounds.

GSC 78-122 Hornblende, K-Ar age **1839 ± 52 Ma**

K = 1.09%, $^{40}Ar/^{40}K$ = 0.1856, radiogenic Ar = 99.4%.
Concentrate: Clean, unaltered, slightly pleochroic, dark brown hornblende with no visible contamination.

From gneiss
(26 B) 49.9 km west of Littlecoat Channel, Baffin Island, District of Franklin, 64°29'N, 66°44'W. Map unit 8, GSC Map 17-1966. Sample TA-65-T230, collected by R.G. Blackadar and interpreted by C.H. Stockwell.

This hornblende is from a medium grained, black, hornblende-pyroxene gneiss with interlayers of grey material. Fresh hornblende is the most plentiful mineral present; the other minerals include pyroxene, quartz, plagioclase, and accessory apatite and opaque material.

Because hornblende, as a rule, retains argon at a high temperature the determined age is probably close to the time of crystallization of the hornblende and to the time of metamorphism.

GSC 78-123 Hornblende, K-Ar age **1670 ± 49 Ma**

K = 0.432%, $^{40}Ar/^{40}K$ = 0.1597, radiogenic Ar = 97.5%.
Concentrate: Clean, unaltered, pleochroic, brownish green to light brown hornblende with no contamination.

From amphibolite
(25 P) Beekman Peninsula, 4.8 km northwest of Winton Bay, Baffin Island, District of Franklin, 63°26'N, 64°42'W. Map unit 5, GSC Map 18-1966. Sample SR-65-216A, collected by R.G. Blackadar and interpreted by C.H. Stockwell.

Medium grained, black amphibolite with inconspicuous foliation and lineation. Over half of the rock consists of fresh hornblende, the remainder being plagioclase and quartz.

Because of the generally good retention of argon in hornblende at high temperature, the determined age is probably not much younger than the time of crystallization of the hornblende and the time of metamorphism.

GSC 78-124 Biotite, K-Ar age **2109 ± 47 Ma**

K = 7.35%, $^{40}Ar/^{40}K$ = 0.2326, radiogenic Ar = 99.7%.
Concentrate: Light brown biotite with approximately 15% chlorite alteration.

From granite
(85 I) 4.5 km northeast of the mouth of François River, District of Mackenzie, 62°06'10"N, 112°51'51"W. Map unit Agr, GSC Paper 78-1A, Fig. 26.1. Sample 77DM126a, collected and interpreted by A. Davidson.

See GSC 78-125 for description, and GSC 78-131 for interpretation.

GSC 78-125 Muscovite, K-Ar age **2201 ± 48 Ma**

K = 8.74%, $^{40}Ar/^{40}K$ = 0.2502, radiogenic Ar = 99.4%.
Concentrate: Clean, fresh, clear muscovite with no visible contamination.

From granite
(85 I) Details as for GSC 78-124.

The rock is massive, homogeneous, pale grey, medium- to coarse-grained, inequigranular two-mica granite, with scattered, randomly oriented, tabular megacrysts of white microcline. It is composed of approximately 30% each of sodic oligoclase, microcline and quartz, 7% muscovite, 3% biotite and a trace of blue-green apatite.

See GSC 78-131 for interpretation.

GSC 78-126 Hornblende, K-Ar age **2127 ± 79 Ma**

K = 0.99%, $^{40}Ar/^{40}K$ = 0.2359, radiometric Ar = 99.4%.
Concentrate: Clean, unaltered, brown to green pleochroic hornblende with no visible contamination.

From quartz syenite
(85 I) 1.75 km east of the west end of Whiteman Lake, south shore, District of Mackenzie, 62°08'11"N, 112°45'09"W. Map unit 2a, GSC Paper 78-1A, Fig. 26.1. Sample 77DM81, collected and interpreted by A. Davidson.

The rock is massive, homogeneous, medium grained, equigranular, greenish-buff biotite-hornblende quartz syenite. The sample was collected at the lake shoreline where the rock is fresh. The same rock back from the shore is characteristically brown-weathering and crumbly. This sample is composed of perthitic feldspar (72%), quartz (14%), hornblende (10%), biotite (2%), altered fayalite (2%) and traces of zircon. The larger perthite grains commonly have sodic oligoclase cores.

See GSC 78-131 for interpretation.

GSC 78-127 Biotite, K-Ar age **2166 ± 47 Ma**

K = 7.13%, $^{40}Ar/^{40}K$ = 0.2434, radiogenic Ar = 99.8%.
Concentrate: Clean, unaltered, yellow to dark brown pleochroic biotite, with no chlorite contamination.

From granite
(85 I) Southernmost bay of small lake, 0.5 km north of Mad Lake, District of Mackenzie, 62°07'33"N, 112°44'27"W. Map unit 4, GSC Paper 78-1A, Fig. 26.1. Sample 77DM135, collected and interpreted by A. Davidson.

The rock is massive, homogeneous, sub-porphyritic, medium- to fine-grained, pink hornblende-biotite granite; 2 to 4 mm perthitic K-feldspar phenocrysts and rare, rounded quartz phenocrysts are scattered evenly throughout a granular matrix consisting of approximately equal parts of quartz, albite and weakly perthitic microcline. Evenly distributed, 1 to 2 mm, anhedral grains of hornblende (4%) and biotite (8%), both with pale yellow to brown pleochroism, give the rock a peppery texture. Fluorite is accessory.

See GSC 78-131 for interpretation.

GSC 78-128 Riebeckite, K-Ar age **2133 ± 112 Ma**

K = 0.57%, $^{40}Ar/^{40}K$ = 0.2370, radiogenic Ar = 99.2%.
Concentrate: Clean, unaltered, greenish brown to dark green to almost opaque indigo blue pleochroic riebeckite, with no visible contamination.

From peralkaline granite
(85 I) From large boulder at the northeast shore of Mad Lake, District of Mackenzie, 62°07'12"N, 112°44'53"W. Representative of granite exposed for 11 km east-northeast from this locality, up direction of glacial transport. Map unit 5, GSC Paper 78-1A, Fig. 26.1. Sample 77DM132c, collected and interpreted by A. Davidson.

The rock is massive, homogeneous, coarse grained, equigranular, greenish buff riebeckite perthite granite. It is composed of euhedral perthite (64%) with composition approximately Ab:Or = 60:40, with interstitial riebeckite (10%), enigmatite (2%), quartz (23%) and fluorite (1%), with traces of metamict zircon and secondary astrophyllite and acmite. This sample, taken from a glacially transported boulder, is the freshest representative of this map unit (Grace Lake Granite) encountered; in outcrop, the granite is normally reddened, somewhat friable, and the riebeckite is at least partly altered to hematite, albite, biotite and fluorite.

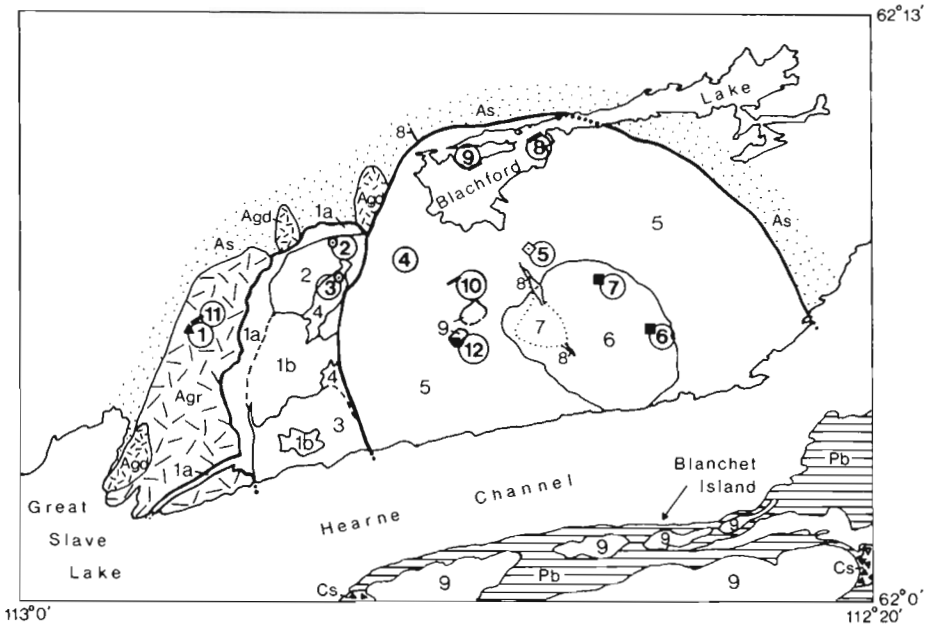
See GSC 78-131 for interpretation.

GSC 78-129 Biotite, K-Ar age **3240 ± 59 Ma**

K = 6.39%, $^{40}Ar/^{40}K$ = 0.5268, radiogenic Ar = 99.6%.
Concentrate: Fresh, clean, brownish orange biotite, with no chlorite contamination.

From hornfels
(85 I) 3 km due north of Hearne Channel and 7.5 km southeast of Blachford Lake, District of Mackenzie, 62°06'06"N, 112°30'24"W. Xenolith of map unit As in map unit 6, GSC Paper 78-1A, Fig. 26.1. Sample 71DM37Δ2, collected and interpreted by A. Davidson.

See GSC 78-131 for description and interpretation.



Legend for Fig. 5, and summary of K-Ar age determinations

MAP-UNIT	ROCK UNIT OR TYPE	LOCATION	K-Ar NO.		K-Ar AGE
9	Diorite to granodiorite stocks, diorite laccoliths on Blanchet Island	12	GSC 78-136	Bi	1864 ± 43
			GSC 72-44	Hb	1705 ± 58
			GSC 67-77	Bi	1795 ± 55
	GREAT SLAVE SUPERGROUP (Cs, Pb)				
Cs	Stark Formation				
Pb	Pethei Group				
	.....unconformity?.....				
	East-northeast-trending diabase dykes	11	GSC 78-135	WR	1693 ± 67
		10	GSC 78-134	WR	1807 ± 74
		9	GSC 78-133	WR	1791 ± 73
		8	GSC 78-132	WR	1767 ± 104
	BLACHFORD LAKE COMPLEX (1a, b - 7, 8)				
7,8	Alteration, veining and Nb-U-REE mineralization				
6	Thor Lake Syenite	7	GSC 78-131	Bi	2064 ± 46
			GSC 78-130	WR	2150 ± 58
		6	GSC 78-129	Bi	3240 ± 59
5	Grace Lake Granite	5	GSC 76-188	Hb	2057 ± 56
		4	GSC 78-128	Hb	2133 ± 112
4	Mad Lake Granite	3	GSC 78-127	Bi	2166 ± 47
3	Hearne Channel Granite				
2	Whiteman Lake Quartz Syenite	2	GSC 78-126	Hb	2127 ± 79
1a,b	Caribou Lake Gabbro				
Agr	Two-mica granite	1	GSC 78-125	Mu	2201 ± 48
			GSC 78-124	Bi	2109 ± 47
Agd	Biotite granodiorite				(≥ 2500)[1]
	YELLOWKNIFE SUPERGROUP				
As	Metagreywacke-siltstone, knotted schist				

[1] Note: A diabase sill emplaced in biotite granodiorite (Agd) 20 km west-southwest of the west contact of the Blachford Lake complex has been dated at 2487 ± 64 Ma (GSC 76-184, whole-rock K-Ar).

Figure 5. *Geological map of Blachford Lake Complex.*

GSC 78-130 Whole-rock, K-Ar age **2150 ± 58 Ma**

K = 1.80%, $^{40}Ar/^{40}K$ = 0.2404, radiogenic Ar = 99.5%.
Concentrate: Crushed whole-rock.

From hornfels
(85 I) 6 km due north of Hearne Channel and 6.5 km south-southeast of the narrowest part of Blachford Lake, District of Mackenzie, 62°07'26"N, 112°33'42"W. Xenolith of map unit As in map unit 6, GSC Paper 78-1A, Fig. 26.1. Sample 71DM4d, collected and interpreted by A. Davidson.

See GSC 78-131 for description and interpretation.

GSC 78-131 Biotite, K-Ar age **2064 ± 46 Ma**

K = 7.47%, $^{40}Ar/^{40}K$ = 0.2243, radiogenic Ar = 99.9%.
Concentrate: Clean, unaltered, brownish-orange biotite, with no chlorite contamination.

From hornfels
(85 I) Details as for GSC 78-130.

Both hornfels samples were collected from large, angular blocks of metasediment incorporated in peralkaline syenite. Sample GSC 78-129 was taken from the centre of one of several angular xenoliths of size ranging from 1 to 10 m. Sample GSC 78-130 was collected a few metres from the west edge of a very large block at least 100 m in diameter. These hornfelses are very fine grained, tough, splintery, medium to dark grey, and contain millimetre-size biotite metacrysts. Colour and composition layering reflect original bedding in these hornfelsed metagreywacke-siltstones. Thin sections reveal the presence of cordierite, hypersthene and green spinel in addition to biotite, set in a matrix of very fine plagioclase and quartz that locally displays a granophyre-like texture, perhaps indicative of partial melting.

Age determinations GSC 78-124 to 131 are aimed at confirming the age of the Blachford Lake Complex suggested by the previously determined K-Ar age of 2057 ± 56 Ma (GSC 76-188; Wanless et al., 1978, p. 39), obtained from riebeckite extracted from the Grace Lake Granite (map unit 8a, Davidson, 1972; map unit 6, Davidson, 1978, and this report, Fig. 5). This age is unusually young compared with ages (2.4 to 2.7 Ga) of other granitoid plutonic rocks in the southern Slave Province. Combined with distinctive chemistry and structural form of the Blachford Lake complex, it indicates a relationship to the early development of the Athapuscow aulacogen (Hoffman, 1973), situated in the east arm of Great Slave Lake, rather than to the late Archean Kenoran Orogeny of the Slave Province. The age determinations interpreted here are located on Fig. 5, points 1 to 4, 6 and 7; point 5 is the previously determined riebeckite age. The ages are summarized in legend for Fig. 5.

Contact relationships observed in the field give unequivocal proof of the sequence of intrusion of the four main phases of the Blachford Lake complex, which are: 1) Caribou Lake Gabbro (map units 1a and 1b, Fig. 5), 2) Whiteman Lake Quartz Syenite (map unit 2), 3) Hearne Channel and Mad Lake Granites (map units 3 and 4), and 4) Grace Lake Granite (map unit 5) and Thor Lake Syenite (map unit 6). As well as confirming the age reported earlier, it was hoped that it would be possible to demonstrate a sequence of absolute ages in accord with the observed geologic age relationships. The age determinations reported above do, broadly, confirm a mid-Aphebian age (2100 Ma) for the Blachford lake complex, but meaningful age distinctions between the Whiteman Lake Quartz Syenite, Mad Lake Granite, Grace Lake Granite, and Thor Lake Syenite are not apparent, suggesting that the various plutonic phases were emplaced essentially coevally.

An anomalously old age, 3240 ± 59 Ma (GSC 78-129), was obtained from biotite from a hornfelsed metasedimentary xenolith within the Thor Lake Syenite. The Yellowknife Supergroup metasedimentary rocks from which this and other xenoliths were presumably derived, are known to have been metamorphosed in late Archean time. This age must therefore be interpreted as due to excess radiogenic argon in the biotite. Another sample of hornfels from a large block incorporated in the Thor Lake Syenite gave whole-rock (GSC 78-130) and biotite (GSC 78-131) ages of 2150 ± 58 Ma and 2064 ± 46 Ma respectively, indicating a weak concentration of radiogenic argon in the rock relative to biotite. Both these ages are likely close to the age of crystallization of the Thor Lake Syenite, and are compatible with the ages obtained from minerals in the comagmatic Grace Lake Granite and the coeval but geologically older Mad Lake Granite and Whiteman Lake Quartz Syenite. An Rb-Sr isochron age for the Whiteman Lake Quartz Syenite has been determined at 2081 ± 42 Ma (R.K. Wanless, personal communication, 1978).

The two-mica granite that forms the country rock to the earliest intrusive phase (Caribou Lake Gabbro) of the Blachford Lake complex is considered to belong to the suite of Kenoran plutonic rocks so widespread in the southern Slave Province, and thus to be late Archean in age. It is texturally and compositionally indistinguishable from certain other plutons in the region (e.g., the two-mica granite at Morose Lake, Davidson, 1972, Fig. 2, map unit 9), and quite different in the same respects to all phases of the Blachford Lake complex. Moreover, it is mildly sheared and altered (pink to red in colour with chloritized biotite and sericitized feldspar) in northeast-trending zones that are truncated by the Caribou Lake Gabbro, and between which it is massive, white to pale grey, and apparently unaltered. It is noticeably metamorphosed only within a few tens of metres of the gabbro contact. In an attempt to confirm the suggested Archean age, massive, pale grey granite was sampled a full 2 km west of the essentially vertical gabbro contact, in the hope that this would be far enough removed from the thermal effects of the Blachford Lake complex for the micas, particularly the muscovite, to retain an Archean age. The biotite (GSC 78-124) and muscovite (GSC 78-125) ages, respectively 2109 ± 47 Ma and 2201 ± 48 Ma, suggest that, if it is Archean, this granite has indeed been affected by a later thermal event. 35 m west of the sample site the granite is cut by a 3 m wide, north-northeast-trending, vertical dyke of purplish pink rhyolite. 150 m north of the sample site, both rhyolite and granite are cut by a northeast-trending, vertical diabase dyke at least 25 m wide. Whether this local intrusive activity or whether the Blachford lake complex itself has caused up-dating, or whether the two-mica granite is in fact post-Archean, has not been resolved. An attempt to extract zircon from this rock for U-Pb dating was unsuccessful.

See GSC 78-136 for additional discussion and literature references.

GSC 78-132 Whole-rock, K-Ar age **1767 ± 104 Ma**

K = 0.56%, $^{40}Ar/^{40}K$ = 0.1743, radiogenic Ar = 98.7%.
Concentrate: Crushed whole-rock.

From diabase
(85 I) Small island 0.5 km southwest of the narrowest part of Blachford Lake, District of Mackenzie, 62°10'37"N, 112°35'35"W. Sample FY76-23-04, collected by R.A. Frith, interpreted by A. Davidson.

The rock is a very fine grained, uniform, dark grey diabase. The sample was taken from drillcore obtained 30 cm from the contact of an east-northeast-trending dyke, at least 5 m wide, that cuts the Grace Lake Granite of the Blachford Lake Complex.

See GSC 78-136 for interpretation.

GSC 78-133 Whole-rock, K-Ar age **1791 ± 73 Ma**

K = 0.99%, $^{40}Ar/^{40}K$ = 0.1780, radiogenic Ar = 99.4%.
Concentrate: Crushed whole-rock.

From diabase
(85 I) East shore of island 3 km west-southwest of the narrowest part of Blachford Lake, District of Mackenzie, 62°09'50"N, 112°37'57"W. Sample FY76-27-08, collected by R.A. Frith, interpreted by A. Davidson.

The rock is a very fine grained, uniform, dark grey diabase. The sample was taken from drill-core obtained 10 cm from the contact of an east-northeast-trending dyke, 20 m wide, that cuts the Grace Lake Granite of the Blachford Lake Complex.

See GSC 78-136 for interpretation.

GSC 78-134 Whole-rock, K-Ar age $\frac{1807 \pm 74}{1808 \pm 75}$ **Ma**

K = 1.04%, $^{40}Ar/^{40}K = \frac{0.1806}{0.1807}$, radiogenic Ar = $\frac{56.9\%}{74.0\%}$.

Concentrate: Crushed whole-rock.

From diabase
(85 I) 4 km east of Mad Lake, 2.5 km south of Blachford Lake, District of Mackenzie, 62°07'12"N, 112°39'33"W. Sample 71DMR6Δ9b, collected by P.L. Reeves, interpreted by A. Davidson.

The rock is black, aphanitic basalt with fresh, evenly distributed plagioclase micro-phenocrysts. The sample was collected from one of several narrow dykelets up to 10 cm wide that cut an east-northeast-trending diabase dyke emplaced within the Grace Lake Granite of the Blachford Lake Complex.

See GSC 78-136 for interpretation.

GSC 78-135 Whole-rock, K-Ar age **1693 ± 67 Ma**

K = 0.91%, $^{40}Ar/^{40}K$ = 0.1632, radiogenic Ar = 97.5%.
Concentrate: Crushed whole-rock.

From diabase
(85 I) 4.6 km northeast of the mouth of François River, District of Mackenzie, 62°06'13"N, 112°51'47"W. Sample 77DM126c, collected and interpreted by A. Davidson.

The rock is fine grained, massive, dark grey diabase, collected 25 cm from the southeast contact of a northeast-trending dyke, at least 25 m wide, that cuts pale grey two-mica granite and also a rhyolite dyke within the granite. The diabase has ophitic texture, and contains fresh augite, plagioclase and magnetite in an impalpable groundmass, likely recrystallized glass, containing tiny plagioclase laths. Calcite and chlorite-epidote alteration are not present.

See GSC 78-136 for interpretation.

GSC 78-136 Biotite, K-Ar age **1864 ± 43 Ma**

K = 7.14%, $^{40}Ar/^{40}K$ = 0.1897, radiogenic Ar = 99.7%.
Concentrate: Dark brown biotite with approximately 3% chlorite alteration.

From granodiorite
(85 I) 4 km north of Hearne Channel and 5 km south of the southwest bay of Blachford Lake, District of Mackenzie, 62°05'50"N, 112°39'35"W. Map-unit 9b, GSC Paper 78-1A, Fig. 26.1. Sample 77DM161, collected and interpreted by A. Davidson.

The rock is a pale pink, fine grained, equigranular, massive, homogeneous biotite granodiorite. It contains euhedral, zoned plagioclase (42%), subhedral quartz (25%) and anhedral, weakly perthitic orthoclase (23%), with 10% brown biotite and traces of magnetite, apatite and sphene. Calcic cores of plagioclase grains are clouded and some biotite grains are partly altered to chlorite. The sample was collected from the southwest part of one of two small stocks of variable composition (augite-hornblende diorite, biotite-hornblende quartz diorite, biotite granodiorite) that intrude the Grace Lake Granite of the Blachford Lake Complex and also the east-northeast-trending diabase dykes within the granite.

All the ages determined for the east-northeast-trending diabase dykes are younger, as they should be, than all the ages determined for rocks of the Blachford Lake Complex in which they were emplaced. All of their determined ages, however, are somewhat younger than the 1864 ± 43 Ma age (GSC 78-136) obtained for the small plutons (Fig. 5, map unit 9) that cut them. Three explanations are possible: 1) the biotite extracted from map unit 9 contains excess radiogenic argon and therefore gives too old an age; 2) the fine grained and chilled diabases have not remained entirely closed systems and have lost some radiogenic argon, resulting in ages that are too young; and 3) there is more than one period, or perhaps a continuum, of diabase dyke intrusion spanning the time of emplacement of map unit 9. It should be noted that none of the diabase ages were obtained from the same dykes that are known to be cut by map unit 9; samples of those dykes proved to be too altered to provide material suitable for dating. It is also noted that GSC 78-134, apart from yielding the oldest diabase age, 1807 ± 74 Ma was obtained from a small dykelet within a larger dyke of unknown older age. It is just possible, therefore, that, fortuitously, only dykes of a younger set were dated and, again fortuitously, only dykes of an older set are present in the vicinity of the stocks of map unit 9. Considerations set out below make this interpretation highly unlikely.

The rock types present in the small, post-diabase stocks are texturally and compositionally indistinguishable from those of quartz diorite laccoliths exposed on Blanchet Island, 9 km to the south, and from similar intrusions elsewhere in the east arm of Great Slave Lake, and the two have been tentatively correlated (Davidson, 1978, p. 126). Two K-Ar ages, one from Blanchet Island (GSC 72-44) and one from a small island in Hearne Channel (GSC 67-77), just east of the map area of Fig. 5, are listed in the map legend for comparison. In addition, the laccoliths have given a Rb-Sr whole-rock isochron age of 1811 ± 78 Ma (Wanless, R.K., 1979, personal communication). These laccoliths are known to postdate the Great Slave Supergroup, within the lower part of which are volcanic rocks (Seton Formation, Kahochella Group; Hoffman, 1968), dated by Rb-Sr isochrons at 1832 ± 10 Ma (Baadsgaard et al., 1973) and 1805 ± 17 Ma (Wanless, 1978, personal communication), using $^{87}Rb = 1.42 \times 10^{-11}a$. If those isochron ages reflect the real

age of the Seton Formation volcanic rocks, i.e., between 1850 and 1800 Ma, and the correlation between the quartz diorite laccoliths and the small stocks of map unit 9 is correct, then the biotite dated at 1864 ± 43 Ma (GSC 78-136) contains some excess radiogenic argon, and the determined age for map unit 9 is therefore too old, perhaps by as much as 100 Ma. If, however, they reflect an isotope equilibrating event, then this argument may not apply. Alternatively, it is quite possible that the Rb-Sr ages obtained for the Seton volcanic rocks are themselves the result of such an event. Stratigraphic position of the Seton Formation within the Great Slave Supergroup and subsequent regional structural history before emplacement of the laccoliths (Hoffman et al., 1977) require that Seton volcanism occurred at some appreciable time before laccolith emplacement, perhaps of the order of a few tens of millions of years.

So far as is known, swarms of east-northeast-trending diabase dykes intrude neither the quartz diorite laccoliths in the east arm of Great Slave Lake, nor any part of the Great Slave Supergroup within which the laccoliths lie. Thus it is not likely that this period of dyke intrusion spans the time of emplacement of the quartz diorite laccoliths and stocks (alternative 3 above). However, Great Slave Supergroup sediments are not known to occur in that part of the area north of Hearne Channel underlain by the Blachford Lake Complex and the east-northeast diabase dykes that cut it, so their mutual age relationship cannot be directly established. Diabase dykes with the same east-northeast trend are present in the basement to the Great Slave Lake and also in the Simpson Islands where they are unconformably overlain by the Hornby Channel Formation, the basal unit of the Great Slave Supergroup at that locality (Hoffman et al., 1977); these dykes have not been dated. Some, however, are known to intrude a large alkaline gabbro dyke (Burwash and Cavell, in press; Badham, 1979), emplaced in the Simpson Islands basement block, and for which biotite K-Ar ages of 2170 Ma (GSC 62-93) and 2200 Ma (Burwash and Baadsgaard, 1962) have been obtained. Although it cannot be tacitly assumed that diabase dyke swarms with similar trends, even in the same region, have the same age (Leech, 1966), geologic considerations suggest that there was a major period of diabase dyke emplacement in this area between the time of intrusion of the Blachford Lake Complex about 2100 Ma ago and the beginning of Great Slave Supergroup, perhaps 1900 Ma or more ago. If this is so, then the ages reported for the east-northeast-trending diabase dykes that cut the Blachford Lake Complex are younger than their real ages, suggesting that the diabases have lost radiogenic argon, either by slow leakage or during some later, pervasive regional event, perhaps related to deformation in the Athapuscow aulacogen. If studies establish an event within this region such as could be held responsible for single and isochron whole-rock ages being too young and minerals ages being either too young or too old, then all these age determinations will have to be very carefully reappraised. Evidence that the east-northeast-trending diabases are "leaky" with respect to argon has been presented. Baadsgaard et al. (1973, p. 1581) admit that the Seton Formation isochron age could be either the age of extrusion or of spilitization; why not an age related to altogether younger alteration? – all the quartz diorite laccolithic rocks in the same region are altered, some intensely so. Such an event need neither have affected the whole region, nor have been all-pervasive within the region affected, nor have exerted equal influence on the different isotope systems. The problem will be to identify those ages that reflect an original crystallizing event versus those that are partly or wholly reset.

References

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GSC 78-137 Muscovite, K-Ar age **1775 ± 42 Ma**

K = 8.16%, $^{40}Ar/^{40}K$ = 0.1755, radiogenic Ar - 99.8%.
Concentrate: Fine grained, slightly yellow-stained muscovite with approximately 6% chlorite contamination.

From sandstone
(85 H) Fort Resolution, District of Mackenzie, 61°48'N, 113°01'W. Map unit 1Awi, GSC Map 1370A, Douglas and Norris, 1973. Sample FYT-WIS-11, collected and interpreted by R.A. Frith.

The Wilson Island Group is of early Proterozoic age. It underlies the Great Slave Supergroup, estimated to be 2000 Ma (Baadsgaard et al., 1973) at the base. This date on muscovite from Wilson Island Sandstone reflects a thermal event that affected these rocks at about this time.

Reference

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GSC 78-138 Muscovite, K-Ar age **1742 ± 44 Ma**

K = 9.01%, $^{40}Ar/^{40}K$ = 0.1704, radiogenic Ar - 99.1%.
Concentrate: Clean, clear, fresh and unaltered muscovite with no visible contamination.

From veins in metarhyolite
(85 H) Fort Resolution, south shore of Great Slave Lake, District of Mackenzie, 61°46'N, 113°09'W. Map unit 1Awi, GSC Map 1370A, Douglas and Norris, 1973. Sample FYT-WIV, collected and interpreted by R.A. Frith.

The Wilson Island Group is early Proterozoic in age bracketed by the age of the late Archeozoic granites (2500 Ma) and the lowermost Great Slave Supergroup (estimated at 2000 Ma, Baadsgaard et al., 1973).

The 1742 ± 44 Ma is a K-Ar age from a pegmatite that intrudes basic volcanics of the Wilson Island Group. The Great Slave Supergroup which unconformably overlies the Wilson Island Group does not contain pegmatites of this sort and it is reasonable to assume that the pegmatite formed during the regional metamorphic episode that affected the Wilson Island Group, but not the Great Slave Supergroup. However, the age is evidently too young for either group, which suggests that the date represents an Hudsonian up-date.

GSC 78-139 Muscovite, K-Ar age **2374 ± 54 Ma**

K = 8.39%, $^{40}Ar/^{40}K$ = 0.2860, radiogenic Ar = 99.3%.
Concentrate: Clean, unaltered, clear muscovite with no visible contamination.

From pegmatite
(76 F) Island in Nose Lake, District of Mackenzie, 65°24'N, 108°51'W. Map unit 8, Frith and Hill in GSC Paper 75-1C, p. 368. Sample T8008b, collected and interpreted by R.A. Frith.

Muscovite-microcline-quartz-tourmaline pegmatite cuts both Yellowknife Supergroup metasediments and volcanic rocks. Inclusions in the pegmatite are oriented east-southeast in common with the regional foliation, but the pegmatite is unaffected, indicating it postdated the foliation. The pegmatite is common in the southern half of Nose-Beechy Lake map area where it is invariably hosted by the Yellowknife Supergroup. The pegmatite probably formed in situ from the metasediments, but may have formed as a late stage residue from the granitoid intrusions which also postdate the regional foliation.

GSC 78-140 Whole-rock, K-Ar age **1461 ± 64 Ma**

K = 0.97%, $^{40}Ar/^{40}K$ = 0.1307, radiogenic Ar = 98.5%.
Concentrate: Crushed whole-rock.

From basalt
(76 J) Southeast of Bathurst Inlet, District of Mackenzie, 66°11'N, 107°02'W. Map unit B-3b, GSC Open File 342 and GSC Paper 76-1A. Sample FYT-BL-1, collected and interpreted by R.A. Frith.

The Brown Sound Formation lies about 610 m from the top of the Goulburn Group. Amygdaloidal basalt makes up part of the formation and it is cut by felsic dykes which were dated as whole-rocks, yielding an age of 1461 ± 64 Ma. The value is undoubtedly too young but it provides the only minimum age on record for the Goulburn Group. Radiogenic argon probably escaped from the feldspar present in the rock. Uranium from amygdules in the host rock may provide an alternate material for dating a minimum age for the rock and an age of mineralization.

See also GSC 78-141.

GSC 78-141 Whole-rock, K-Ar age **1320 ± 61 Ma**

K = 0.91%, $^{40}Ar/^{40}K$ = 0.1130, radiogenic Ar = 98.6%.
Concentrate: Crushed whole-rock.

From basalt
(76 J) Southeast of Bathurst Inlet, District of Mackenzie, 66°11'N, 107°02'W. Map unit B-3b, GSC Open File 342 and GSC Paper 76-1A. Sample FYT-BL-2, collected and interpreted by R.A. Frith.

A felsic dyke cuts amygdaloidal basalt of the Brown Sound Formation, Goulburn Group. The 1461 ± 64 Ma determination (GSC 78-140) provides a minimum age for this formation (~700 m from the top of the ~7000 m thick group). ^{40}Ar leakage is probable as the age of the Goulburn is probably between 2000 and 1800 Ma, in common with the age of the Great Slave Supergroup. (Laboratory Note:- GSC 78-141 has suffered somewhat greater argon loss than GSC 78-140. This kind of disparity is to be expected in attempting to date felsic whole-rock material by the K-Ar method).

GSC 78-142 Biotite, K-Ar age **1626 ± 40 Ma**

K = 6.28%, $^{40}Ar/^{40}K$ = 0.1533, radiogenic Ar = 99.4%.
Concentrate: Brown biotite with approximately 10% chlorite alteration.

From granodiorite gneiss
(65 C) Approximately 33 km east of the south end of Kasba Lake, and 3.5 km north of the Manitoba boundary, in District of Keewatin, 60°01'50"N, 101°19'50"W. See GSC Map 24-1970, accompanying Paper 70-45. Sample WN-25-75, collected by R.K. Wanless and interpreted by K.E. Eade and R.K. Wanless.

The sample is grey biotite-hornblende granodiorite gneiss (Map unit 4, GSC Map 24-1970), with good foliation due to compositional layering in layers up to 5 cm. The rock is medium grained, granitic textured, and is composed of quartz, plagioclase (oligoclase), biotite, hornblende, minor microcline and accessory minerals apatite, zircon and opaques. Minor bands or veins of pink granodiorite to quartz monzonite (Map unit 6, GSC Map 24-1970) cut and partially assimilate the grey gneiss.

For interpretation see GSC 78-143.

GSC 78-143 Hornblende, K-Ar age **1676 ± 49 Ma**

K = 0.91%, $^{40}Ar/^{40}K$ = 0.1606, radiogenic Ar = 98.6%.
Concentrate: Clean, unaltered, pleochroic, brown to green hornblende with no visible contamination.

From granodiorite gneiss
(65 C) Details as for GSC 78-142.

The K-Ar ages are interpreted to mean that the hornblende passed its argon blocking temperature 1767 ± 49 Ma ago and the biotite passed its argon blocking temperature 1626 ± 40 Ma ago, near the end of the metamorphic event associated with the Hudsonian orogeny. However, the rocks themselves are considered to have crystallized much earlier, during the Archean, and these ages record the younger metamorphic event in this region. Preliminary Pb-U analysis of zircon from this rock has confirmed the Archean age assignment.

GSC 78-144 Whole-rock, K-Ar age $\frac{\mathbf{1483 \pm 46}}{\mathbf{1451 \pm 45}}$ **Ma**

K = 0.51%, $^{40}Ar/^{40}K = \frac{0.1337}{0.1295}$, radiogenic
Ar = $\frac{97.8\%}{97.5\%}$.
Concentrate: Crushed whole-rock.

From gabbro
(65 J) 6.4 km west of the southwest end of Tulemalu Lake, District of Keewatin, 62°47'N, 99°52'W. Sample EA-47A-76, collected and interpreted by K.E. Eade.

This is the fine grained chilled margin of a diabase dyke, approximately 11 m wide, dipping vertically, and trending 050°. Some cleavage is evident parallel to the strike, with quartz veins filling some cleavage fractures. The rock is composed of phenocrysts of lath-like plagioclase, epidote, chlorite, and opaques in a very fine grained, felted groundmass of plagioclase, chlorite, carbonate, epidote and opaque. The feldspars are partially altered to clinozoisite and/or epidote and epidote and chlorite are secondary after pyroxene and/or amphibole. In general the rock is strongly altered.

The ages of 1483 ± 46 Ma and 1451 ± 45 Ma are considered to be young, probably due to loss of radiogenic argon resulting from the extensive alteration of the rock, and they do not bear any relationship to the age of emplacement of the dyke.

GSC 78-145 Biotite, K-Ar age **1687 ± 41 Ma**

K = 7.15%, $^{40}Ar/^{40}K$ = 0.1623, radiogenic Ar = 99.3%.
Concentrate: Clean, fresh and unaltered, very light brown mica (possibly phlogopite) with no chlorite contamination.

From lamprophyre
(65 J) Island near west shore, northeastern arm of Angikuni Lake, District of Keewatin, 62°16'15"N, 99°49'30"W. Sample EA-457-76, collected by M. Raudsepp and interpreted by K.E. Eade.

The sample is from a lamprophyre dyke, approximately 1 m wide, dipping 70°, and trending 010°, cutting metagabbro, which in turn cuts granodiorite gneiss. The contacts of the lamprophyre with metagabbro are sharp, with no visible contact effects on the metagabbro. The lamprophyre does not show any chilling effects at the margins. Minor shears at 160°-240° result in small offsets of the lamprophyre-metagabbro contact. Prominent cleavage at 90° in the metagabbro does not cut the lamprophyre. The lamprophyre contains elliptical granodiorite gneiss xenoliths 2 to 10 cm long, with long axis oriented parallel to the dyke contacts. Biotite phenocrysts compose approximately 25% of the rock, with carbonate, plagioclase, potassic feldspar and augite, other major constituents, and minor quartz and opaques.

The lamprophyre dyke is considered to be part of the intrusive suite associated with the Martell syenite of the Dubawnt Group and 1687 ± 41 Ma is a minimum age for intrusion of the dyke. Previous K-Ar work on Martell syenite samples yielded 1715 Ma (GSC 65-74) and 1605 Ma (GSC 66-93). A Rb-Sr isochron on Dubawnt Group volcanic rocks gives an age of 1786 ± 4 Ma, Donaldson (1972). In the same paper Donaldson suggests a mean K-Ar age for Dubawnt igneous rocks of 1698 ± 45 Ma. Hence the 1687 ± 41 Ma age determined on this sample is in the expected range.

Reference

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GSC 78-146 Whole-rock, K-Ar age **2549 ± 265 Ma**

K = 0.24%, $^{40}Ar/^{40}K$ = 0.3258, radiogenic Ar = 98.6%.
Concentrate: Crushed whole-rock.

From chilled diabase
(65 J) Approximately 19.3 km east of Angikuni Lake, District of Keewatin, 62°08'35"N, 99°20'30"W. Sample WN-219-76, collected and interpreted by R.K. Wanless and K.E. Eade.

The sample was taken from the chilled margin of a dyke 25 m wide, dipping vertically, trending 100°, and cutting migmatized paragneiss. The chilled diabase consists of microphenocrysts of feldspar laths, and grains of pyroxene and amphibole, in a fine groundmass of the same minerals, along with opaques. The pyroxene is partially altered to amphibole and chlorite.

The age determined on this sample (2549 ± 265 Ma) is probably too old and the sample may contain excess argon. The extreme lower limit of the determination could fall within the range suggested by determinations on similar east-trending dykes.

GSC 78-147 Whole-rock, K-Ar age **1869 ± 220 Ma**

K = 0.29%, $^{40}Ar/^{40}K$ = 0.1905, radiogenic Ar = 99.0%.
Concentrate: Crushed whole-rock.

From diabase
(65 J) Approximately 22.5 km east of Angikuni Lake, District of Keewatin, 62°20'57"N, 99°08'07"W. Sample WN-221-76, collected and interpreted by R.K. Wanless and K.E. Eade.

The sample was taken from the chilled margin at the south contact of a dyke 25 m wide, vertically dipping, trending 105°, cutting pink to grey foliated quartz monzonite to granodiorite. The very fine grained diabase is composed of microphenocrysts of feldspar laths, grains of pyroxene and amphibole, in a fine groundmass of the same minerals along with opaques. Pyroxene is slightly altered to amphibole and chlorite.

For interpretation see GSC 78-151.

GSC 78-148 Whole-rock, K-Ar age **1999 ± 213 Ma**

K = 0.40%, $^{40}Ar/^{40}K$ = 0.2127, radiogenic Ar = 98.3%.
Concentrate: Crushed whole-rock.

From gabbro
(65 J) Approximately 22.5 km east of Angikuni Lake, District of Keewatin, 62°20'57"N, 99°08'07"W. Sample WN-224-76, collected and interpreted by R.K. Wanless and K.E. Eade.

This sample is from the chilled south margin of a dyke 22 m wide, vertically dipping, and trending 105°, cutting pink to grey foliated quartz monzonite to granodiorite. This dyke is 150 m north of, and parallel to, the diabase dyke GSC 78-147 (2735). The chilled phase of the dyke is the same as for GSC 78-147.

For interpretation see GSC 78-151.

GSC 78-149 Hornblende, K-Ar age **2270 ± 100 Ma**

K = 0.73%, $^{40}Ar/^{40}K$ = 0.2642, radiogenic Ar = 98.2%.
Concentrate: Clean, unaltered, pleochroic, light brown to green hornblende with no visible contamination.

From quartz monzonite-granodiorite
(65 J) Approximately 22.5 km east of Angikuni Lake, District of Keewatin, 62°20'57"N, 99°08'07"W. Sample WN-222-76, collected by R.K. Wanless and interpreted by K.E. Eade.

This sample of quartz monzonite to granodiorite is from the south contact of the diabase (GSC 78-147). The pink to grey medium grained quartz monzonite to granodiorite has some foliation and is composed of quartz, plagioclase, microcline, hornblende, and biotite, with accessory apatite, sphene, zircon and opaque.

For interpretation see GSC 78-151.

GSC 78-150 Hornblende, K-Ar age **2429 ± 203 Ma**

K = 0.69%, $^{40}Ar/^{40}K$ = 0.2980, radiogenic Ar = 99.1%.
Concentrate: Clean, unaltered, pleochroic, light brown to green hornblende with no visible contamination.

From granodiorite
(65 J) Approximately 22.5 km east of Angikuni Lake, District of Keewatin, 62°20'57"N, 99°08'07"W. Sample WN-223-76, collected and interpreted by R.K. Wanless and K.E. Eade.

This sample of quartz monzonite to granodiorite is the same as GSC 78-149 but is from approximately 2 m from the diabase dyke. The rock is similar in all respects to GSC 78-149.

For interpretation see GSC 78-151.

GSC 78-151 Hornblende, K-Ar age **2242 ± 114 Ma**

K = 0.60%, $^{40}Ar/^{40}K$ = 0.2584, radiogenic Ar = 99.0%.
Concentrate: Clean, unaltered, pleochroic, brown to green hornblende with no visible contamination.

From foliated granodiorite
(65 J) Approximately 22.5 km east of Angikuni Lake, District of Keewatin, 62°20'57"N, 99°08'07"W. Sample WN-225-76, collected by R.K. Wanless and interpreted by K.E. Eade.

This sample is from quartz monzonite to granodiorite at the contact with the diabase (GSC 78-148). The rock is the same as GSC 78-149 and GSC 78-150 from approximately 150 m to the south.

Two parallel east-trending (105°) diabase dykes cut a small pluton of foliated quartz monzonite to granodiorite. The dykes are undeformed and unmetamorphosed. The whole-rock ages on chilled margins of the dykes, 1869 ± 220 Ma (GSC 78-147) and 1999 ± 213 Ma (GSC 78-148) are minimum ages of intrusion of the dykes and the samples may have suffered some argon loss. The chilled margin of a similar east-trending dyke gives a whole rock age of 1955 ± 54 Ma (GSC 78-152) but biotite from the country rock at the contact of that dyke, presumably reset by intrusion of the dyke, gives an age of 2118 ± 47 Ma (GSC 78-153) and this is regarded as closer to the age of intrusion of the east-trending dykes.

Results on hornblende from the quartz monzonite to granodiorite cut by the dykes, show some variation, 2270 ± 100 Ma (GSC 78-149), 2429 ± 203 Ma (GSC 78-150), and 2242 ± 114 Ma (GSC 78-151). The pluton of quartz monzonite to granodiorite would appear to be slightly younger than the quartz monzonite bands and stringers cutting the granodiorite gneiss in this region, which has a hornblende age of 2485 ± 62 Ma (GSC 78-157). This slight difference in age could be related to a slower cooling of the pluton and a slight delay in reaching the argon blocking temperature of the hornblende in the pluton. It seems likely that both the pluton and the bands of quartz monzonite are related to the Kenoran Orogeny and are cut by the early Aphebian diabase dykes.

GSC 78-152 Whole-rock, K-Ar age **1955 ± 106 Ma**

K = 0.592%, $^{40}Ar/^{40}K$ = 0.2050, radiogenic Ar = 98.8%.
Concentrate: Crushed whole-rock.

From diabase
(65 J) 43 km southwest of mouth of Kazan River on Yathkyed Lake, District of Keewatin, 62°18'00"N, 98°35'50"W. Sample EA-400-75, collected by G. Stott and interpreted by K.E. Eade.

The sample was taken from a chilled margin of a 16 m wide, vertically dipping dyke, trending 100°, cutting grey granodiorite gneiss that is intruded by veins of pink quartz monzonite. The chilled phase of the diabase is composed of microphenocrysts of feldspar laths and granular to bladed pyroxene and amphibole in a groundmass consisting of tiny feldspar laths, pyroxene, amphibole and opaques. The pyroxene is partially altered to amphibole and chlorite and the plagioclase to clinozoisite.

For interpretation see GSC 78-157.

GSC 78-153 Biotite, K-Ar age **2118 ± 47 Ma**

K = 6.45%, $^{40}Ar/^{40}K$ = 0.2342, radiogenic Ar = 99.7%.
Concentrate: Dark brown biotite with approximately 8% chlorite alteration.

From granodiorite gneiss
(65 J) 43 km southwest of mouth of Kazan River on Yathkyed Lake, District of Keewatin, 62°18'00"N, 98°35'50"W. Sample EA-1329-75, collected by G. Stott and interpreted by K.E. Eade.

See GSC 78-154 for description and GSC 78-157 for interpretation.

GSC 78-154 Hornblende, K-Ar age **2471 ± 62 Ma**

K = 0.977%, $^{40}Ar/^{40}K$ = 0.3076, radiogenic Ar = 99.2%.
Concentrate: Clean, unaltered, pleochroic brown to dark green hornblende with no visible contamination.

From granodiorite gneiss
(65 J) Details as for GSC 78-153.

This sample of granodiorite gneiss is from the contact with the diabase of GSC 78-152. The grey granodiorite gneiss is medium- to coarse-grained, whitish weathering, with discontinuous streaky gneissosity marked by mineral segregations. The rock is composed of quartz, oligoclase, biotite and hornblende with accessory opaque, apatite, sphene and zircon. Both biotite and hornblende are slightly chloritized.

For interpretation see GSC 78-157.

GSC 78-155 Hornblende, K-Ar age **2431 ± 61 Ma**

K = 1.02%, $^{40}Ar/^{40}K$ = 0.2986, radiogenic Ar = 99.5%.
Concentrate: Clean, unaltered, pleochroic, brown to green hornblende with no visible contamination.

From granodiorite gneiss
(65 J) 43 km southwest of mouth of Kazan River on Yathkyed Lake, District of Keewatin, 62°18'00"N, 98°35'50"W. Sample EA-1327-75, collected by G. Stott and interpreted by K.E. Eade.

From granodiorite gneiss, similar to GSC 78-153 but located 6 m from the contact with the gabbro dyke. The rock is the same as GSC 78-153 except here all the biotite is strongly chloritized.

For interpretation see GSC 78-157.

GSC 78-156 Biotite, K-Ar age **2293 ± 51 Ma**

K = 6.46%, $^{40}Ar/^{40}K$ = 0.2688, radiogenic Ar = 99.8%.
Concentrate: Light brownish biotite with approximately 9% chlorite alteration.

From coarse quartz monzonite
(65 J) 43 km southwest of mouth of Kazan River on Yathkyed Lake, District of Keewatin, 62°18'00"N, 98°35'50"W. Sample EA-1328-75, collected by G. Stott and interpreted by K.E. Eade.

The sample is from pink, medium- to coarse-grained or pegmatitic biotite hornblende quartz monzonite, in veins cutting grey granodiorite gneiss, 5.5 m from the contact of the diabase dyke GSC 78-152. The quartz monzonite occurs both as veins almost conformable to the gneissosity of the granodiorite gneiss and as pervasive interlayers within the gneiss. It is composed of quartz, plagioclase, microcline, biotite and hornblende with accessory apatite, sphene, opaque and zircon. The minerals are unaltered in comparison to those of the granodiorite gneiss.

See GSC 78-157 for interpretation.

GSC 78-157 Hornblende, K-Ar age **2485 ± 62 Ma**

K = 0.965%, $^{40}Ar/^{40}K$ = 0.3109, radiogenic Ar = 99.5%.
Concentrate: Clean, unaltered, pleochroic, light brown to green hornblende with no visible contamination.

From coarse quartz monzonite vein
(65 J) Details as for GSC 78-156.

As previously reported (Eade, 1976) both granodiorite gneiss and the pink quartz monzonite cutting it, are deformed by dominant early northeast trending folds and by slightly younger southeast trending flexures. The east trending diabase dykes post-date the deformations. The 1955 ± Ma age (GSC 78-152) is a minimum age for the intrusion of the diabase dyke and is considered to be too young. Assuming that the biotite in the granodiorite gneiss at the contact with the dyke was reset by the intrusion, the 2118 ± 47 Ma age (GSC 78-153) may actually be close to the age of the dyke intrusion and the chilled margin sample may have suffered some loss of radiogenic argon. The hornblende in the granodiorite gneiss at the dyke contact has presumably not been reset by the dyke intrusion and the 2471 ± 62 Ma age (GSC 78-154) is considered to be a minimum age for the formation of the granodiorite gneiss. The 2431 ± 61 Ma age (GSC 78-155) on hornblende from the granodiorite gneiss some 6 m from the contact of the dyke is in the same general range but this rock is altered (biotite is completely chloritized) and the age is slightly young. Hornblende from a quartz monzonite vein cutting the granodiorite gneiss gives an age of 2485 ± 62 Ma (GSC 78-157) and the granodiorite

K-Ar age determinations for east trending dykes and adjacent country rocks

Location	Sample	Number	Age (Ma)
Approximately 19 km east of Angikuni Lake	Whole-rock from chilled margin of dyke trending 100°	GSC 78-146	2549 ± 265
Approximately 22 km east of Angikuni Lake	Whole-rock from chilled margin of dyke trending 105°	GSC 78-147	1869 ± 220
"	"	GSC 78-148	1999 ± 213
"	Hornblende from quartz monzonite-granodiorite at south contact of dyke GSC 78-147	GSC 78-149	2270 ± 100
"	Hornblende from quartz monzonite-granodiorite 2 m from south contact of dyke GSC 78-147	GSC 78-150	2429 ± 203
"	Hornblende from foliated granodiorite at contact with dyke GSC 78-148	GSC 78-151	2242 ± 114
43 km southwest of mouth of Kazan River on Yathkyed Lake	Whole-rock from chilled margin of dyke trending 100°	GSC 78-152	1955 ± 106
"	Biotite from granodiorite gneiss at contact with dyke sample GSC 78-152	GSC 78-153	2118 ± 47
"	Hornblende as above	GSC 78-154	2471 ± 62
"	Hornblende from granodiorite 6 m from contact of dyke sample GSC 78-152	GSC 78-155	2431 ± 61
"	Biotite from pink quartz monzonite cutting granodiorite gneiss sample GSC 78-153 and 5.5 m from contact of dyke sample GSC 78-152	GSC 78-156	2293 ± 51
"	Hornblende as above	GSC 78-157	2485 ± 62

gneiss must be older than that age. Hornblende in the quartz monzonite passed its argon blocking temperature 2485 ± 62 Ma ago shortly after crystallization of the quartz monzonite and biotite from the same rock passed its argon blocking temperature 2293 ± 51 Ma ago (GSC 78-156).

The granodiorite gneiss may well be an orthogneiss, developed from an earlier plutonic granodiorite, at the time of the intrusion of the quartz monzonite and the accompanying deformation during the Kenoran Orogeny. The post-deformational gabbro dyke is of early Aphebian age.

It is particularly interesting that the northeast trending folding in this area developed during the Kenoran Orogeny. Aphebian age Hurwitz Group rocks in the Kognak River area to the southeast (Eade, 1974) have a similar trend of folding resulting from deformation during the Hudsonian Orogeny. Hence the Hudsonian deformational trends are similar to and superimposed on the earlier Kenoran deformation.

References

Eade, K.E.

1974: Geology of the Kognak River map-area, District of Keewatin; Geological Survey of Canada, Memoir 377.

1976: Geology of the Tulemalu Lake map-area, District of Keewatin; in Report of Activities, Part A, Geological Survey of Canada, Paper 76-1A, p. 379-381.

GSC 78-158 Biotite, K-Ar age **2300 ± 53 Ma**

K = 7.36%, $^{40}Ar/^{40}K$ = 0.2703, radiogenic Ar = 99.9%.
Concentrate: Brown biotite with approximately 2% chlorite alteration.

From granodiorite gneiss
(65 J) Approximately 40 km east of Angikuni Lake, District of Keewatin, 62°17'53'N, 98°44'58"W. Sample WN-214-76, collected and interpreted by R.K. Wanless and K.E. Eade.

The whitish weathering grey granodiorite gneiss is medium grained with a streaky gneissosity marked by mineral segregations. Quartz, oligoclase and biotite are the major components, with some hornblende, and accessory apatite, zircon and opaques. There is minor chloritization of the biotite and hornblende.

This age, 2300 ± 53 Ma on biotite from the granodiorite gneiss can be compared with hornblende ages from the same rock, 2471 ± 62 Ma (GSC 78-154), 2431 ± 61 Ma (GSC 78-155) and 2473 ± 184 Ma (GSC 78-159). The age indicates the time the biotite of the granodiorite gneiss passed its argon blocking temperature, and as in other cases, at a time later than hornblende passed its argon blocking temperature. Biotite from quartz monzonite that cuts the granodiorite gneiss in this region gives a very similar age, 2293 ± 51 Ma (GSC 78-156).

GSC 78-159 Hornblende, K-Ar age **2473 ± 184 Ma**

K = 0.96%, $^{40}Ar/^{40}K$ = 0.3080, radiogenic Ar = 99.9%.
Concentrate: Clean, unaltered, pleochroic, brown to green hornblende with no visible contamination.

From granodiorite gneiss
(65 J) 43 km southwest of mouth of Kazan River at Yathkyed Lake, District of Keewatin, 62°18'00"N, 98°35'50"W. Sample WN-212-76, collected and interpreted by R.K. Wanless and K.E. Eade.

The sample is taken from the granodiorite gneiss at the same location as GSC 78-153, where it is cut by the diabase dyke (GSC 78-152). For description of the granodiorite gneiss, see GSC 78-153.

The hornblende age, 2473 ± 184 Ma is similar to the hornblende ages, 2431 ± 61 Ma (GSC 78-155) and 2471 ± 62 Ma (GSC 78-154), both from granodiorite gneiss close to east-trending diabase dykes. The ages are considered to be indicative of the age of formation of the granodiorite gneiss, which may be an orthogneiss developed from an earlier plutonic granodiorite.

GSC 78-160 Whole-rock, K-Ar age **2275 ± 59 Ma**

K = 0.59%, $^{40}Ar/^{40}K$ = 0.2650, radiogenic Ar = 98.8%.
Concentrate: Crushed whole-rock.

From diabase
(65 J) Approximately 0.8 km east of Kazan River, some 21 km south of its entrance into Yathkyed Lake, District of Keewatin, 62°25'45"N, 98°13'00"W. Sample EA-65A-75, collected and interpreted by K.E. Eade.

The sample is from the chilled margin of a diabase dyke 23 m wide, trending 090°, and dipping vertically, cutting migmatite. The margin of the dyke is composed of tiny phenocrysts of plagioclase laths, pyroxene and amphibole in a very fine groundmass of plagioclase, pyroxene, amphibole and opaques.

For interpretation, see GSC 78-161.

GSC 78-161 Whole-rock, K-Ar age **2230 ± 59 Ma**

K = 0.60, $^{40}Ar/^{40}K$ = 0.2559, radiogenic Ar = 99.4%.
Concentrate: Crushed whole-rock.

From diabase
(65 J) Approximately 3.2 km south of the major bend of the Kazan River, District of Keewatin, 62°12'20"N, 98°17'20"W. Sample EA-76A-75, collected and interpreted by K.E. Eade.

The sample is from the chilled margin of a diabase dyke 30 m wide, trending 110°, dipping vertically, cutting migmatized paragneiss. The chilled margin of the diabase is composed of phenocrysts of fine lath-like plagioclase, pyroxene, and amphibole, in a fine groundmass of feldspar, pyroxene, amphibole and opaques.

The ages of 2275 ± 59 Ma (GSC 78-160) and 2230 ± 59 Ma (GSC 78-161) on the east trending diabase dykes are older than the indicated age 1955 ± 106 Ma (GSC 78-152) for a similar dyke and biotite at its contact, 2118 ± 47 Ma (GSC 78-153). It is possible that two sets of east-trending dykes with slightly different orientation and age exist in the region but it seems more likely that all three dykes belong to the same set and that the age of 2275 ± 59 Ma is the preferred age of the dyke set.

GSC 78-162 Hornblende, K-Ar age **1891 ± 169 Ma**

K = 0.79%, $^{40}Ar/^{40}K$ = 0.1942, radiogenic Ar = 99.2%.
Concentrate: Clean, unaltered, pleochroic, brown to dark green hornblende with no visible contamination.

From metagabbro
(65 J) Island in Angikuni Lake, District of Keewatin, 62°16'03"N, 99°44'30"W. Sample WN-215-76, collected and interpreted by R.K. Wanless and K.E. Eade.

The sample was taken from the chilled margin of a dyke approximately 30 m wide, dipping vertically, and trending 040°, cutting migmatized paragneiss. The gabbro has been metamorphosed and recrystallized and consists of plagioclase and amphibole.

For interpretation see GSC 78-167.

GSC 78-163 Whole-rock, K-Ar age **1814 ± 165 Ma**

K = 0.80%, $^{40}Ar/^{40}K$ = 0.1816, radiogenic Ar = 99.2%.
Concentrate: Crushed whole-rock.

From metagabbro
(65 J) Details as for GSC 78-162.

GSC 78-164 Hornblende, K-Ar age **1925 ± 157 Ma**

K = 0.34%, $^{40}Ar/^{40}K$ = 0.1999, radiogenic Ar = 95.8%.
Concentrate: Very fine grained, nonpleochroic, hornblende with a slight trace of chlorite contamination.

From metagabbro
(65 J) Approximately 13 km east of Angikuni Lake, District of Keewatin, 62°09'39"N, 99°29'22"W. Sample WN-217-76, collected and interpreted by R.K. Wanless and K.E. Eade.

The sample was taken from the chilled margin of a dyke 60 m wide, vertically dipping, trending 040°, cutting migmatized paragneiss. The metagabbro has been recrystallized but the chilled margin is very fine grained with fine feldspar laths in a groundmass of hornblende with minor chlorite and opaques.

For interpretation see GSC 78-167.

GSC 78-165 Whole-rock, K-Ar age **2067 ± 226 Ma**

K = 0.32%, $^{40}Ar/^{40}K$ = 0.2248, radiogenic Ar = 97.0%.
Concentrate: Crushed whole-rock.

From metagabbro
(65 J) Details as for GSC 78-164.

For interpretation see GSC 78-167.

GSC 78-166 Biotite, K-Ar age **1779 ± 42 Ma**

K = 5.23%, $^{40}Ar/^{40}K$ = 0.1762, radiogenic Ar = 99.9%.
Concentrate: Impure, light brown biotite with approximately 25-30% chlorite contamination both as free flakes and as an alteration product of the mica.

From migmatized paragneiss
(65 J) Island in Angikuni Lake, District of Keewatin, 62°16'03"N, 99°44'30"W. Sample WN-216-76, collected and interpreted by K.E. Eade and R.K. Wanless.

The sample of migmatized paragneiss is from the contact with the metagabbro dyke (GSC 78-163). The medium- to coarse-grained biotite-rich dark grey paleosome is interlayered with white, quartz-feldspar leucosome and both are cut by pink bands and segregations of quartz monzonite.

For interpretation see GSC 78-167.

GSC 78-167 Biotite, K-Ar age **1939 ± 34 Ma**

K = 5.53%, $^{40}Ar/^{40}K$ = 0.2023, radiogenic Ar = 98.9%.
Concentrate: Light brown biotite with approximately 3% chlorite alteration.

From granodiorite gneiss
(65 J) About 12.9 km east of Angikuni Lake, District of Keewatin, 62°09'39"N, 99°29'22"W. Sample WN-218-76, collected by R.K. Wanless and interpreted by K.E. Eade.

This biotite sample is from the migmatized paragneiss 1.5 km from its contact with the metagabbro dyke (GSC 78-165). The migmatized paragneiss consists of interlayered medium grained, dark grey, biotite-rich paleosome and medium- to coarse-grained white leucosome.

The northeast trending metagabbro dykes apparently postdate the deformation of the migmatized paragneiss but the dyke rocks have been metamorphosed and recrystallized, unlike the east-trending dykes. It must be assumed that the ages on the northeast trending dykes reflect the age of metamorphism and not the age of intrusion. However, it is possible that metamorphism followed closely the intrusion of the dykes. Samples from the island in Angikuni Lake, show consistently younger ages than the equivalent samples from 12 km east of the lake. A major northeast trending zone of faulting and shearing passes through Angikuni Lake close to the sample location and it is possible tectonism may have reset the K-Ar systems in the island samples.

All the determinations must be regarded as minimum ages of the metamorphism that affected these rocks. The two groups of samples show some consistency, suggesting there is a metamorphic event, perhaps only of local significance, that postdates the Kenoran orogeny. However, as this event does not affect the east trending diabase dykes, it predates their intrusion. The ages determined here for the metamorphism are probably too young and the event may have an age around 2300 Ma.

GSC 78-168 Muscovite, K-Ar age **1616 ± 49 Ma**

K = 5.84%, $^{40}Ar/^{40}K$ = 0.1520, radiogenic Ar = 99.5%.
Concentrate: Clean, very fine grained, clear muscovite with no visible chlorite. Some of the mica flakes are yellow-stained.

Comparison of K-Ar determination for samples from Island in Angikuni Lake and area 12 km east of Angikuni Lake

Location	Sample	Number	Age (Ma)
Island in Angikuni Lake	Hornblende from chilled margin of dyke trending 040°	GSC 78-162	1891 ± 169
"	Whole-rock from above	GSC 78-163	1814 ± 165
"	Biotite from paragneiss at contact of above dyke	GSC 78-166	1779 ± 42
Approximately 12 km east of Angikuni Lake	Hornblende from chilled margin of dyke trending 040°	GSC 78-164	1925 ± 157
"	Whole-rock from above	GSC 78-165	2067 ± 226
"	Biotite from granodiorite gneiss at contact of above dyke	GSC 78-167	1939 ± 34

From sheared acid volcanic tuff

(65 I) 30 km southwest from the south end of Tyrrell Arm, Yathkyed Lake, District of Keewatin, 62°13'45"N, 97°50'10"W. Sample EA-1814-73, collected and interpreted by K.E. Eade.

The sample is from sheared volcanic tuff, acid to intermediate in composition. The fine grained rock is composed of quartz, potassic feldspar, plagioclase, abundant white mica, with minor biotite, epidote and pyrite. As the potassium content is remarkably low it is likely both muscovite and paragonite are present in the concentrate.

The age, 1616 ± 49 Ma probably represents the metamorphic and deformational event associated with the Hudsonian Orogeny. As the age appears to be somewhat young, it is likely there has been some radiogenic argon loss from the strongly deformed rock.

GSC 78-169 Biotite, K-Ar age **2425 ± 54 Ma**

K = 7.83%, $^{40}Ar/^{40}K$ = 0.2972, radiogenic Ar = 99.4%.
Concentrate: Clean, unaltered, light brownish orange biotite with no visible contamination.

From pyroxene-bearing nebulitic granodiorite gneiss

(65 I) East side of the large island in the southeast part of Yathkyed Lake, District of Keewatin, 62°05'17"N, 97°45'54"W. Sample WN-18-75, collected by R.K. Wanless and interpreted by K.E. Eade and R.K. Wanless.

This biotite is from a foliated dark grey, medium grained, granulitic gneiss containing some nebulitic mafic-rich wisps. The rock is composed of quartz, potassic feldspar, plagioclase, hypersthene and biotite, with minor hornblende and accessory zircon, apatite and opaque.

The K-Ar age is interpreted to mean that the biotite passed its argon blocking temperature 2425 ± 54 Ma ago in the waning stages of the Kenoran Orogeny. This might be shortly after the crystallization of the rock but it is more likely the record of a metamorphic event affecting an older rock.

This age is of particular interest in that the record of this Kenoran event is preserved by the biotite. Elsewhere in this general region only the younger metamorphism associated with the Hudsonian Orogeny is recorded in the biotite. Preliminary Pb-U analysis of zircon from this rock has yielded a concordant group of ages indicating an age of 2640 Ma.

GSC 78-170 Biotite, K-Ar age **1593 ± 39 Ma**

K = 6.37%, $^{40}Ar/^{40}K$ = 0.1487, radiogenic Ar = 99.5%.
Concentrate: Unaltered, very light brown biotite with approximately 2% amphibole impurity.

From amphibolite

(56 K) On hillock approximately 0.4 km from lake, Hayes River region, District of Keewatin, 66°34'03"N, 92°42'40"W. Sample SMA3-0126B, collected and interpreted by M. Schau.

See GSC 78-172 for description, interpretation and an "isochron" age of 1563 Ma.

GSC 78-171 Hornblende, K-Ar age **1828 ± 116 Ma**

K = 0.202%, $^{40}Ar/^{40}K$ = 0.1839, radiogenic Ar = 94.1%.
Concentrate: Clean, unaltered, non-pleochroic amphibole (actinolite) with no visible contamination.

From amphibolite

(56 K) Details as for GSC 78-170.

See GSC 78-172 for description, interpretation and an "isochron" age of 1563 Ma.

GSC 78-172 Whole-rock, K-Ar age **1633 ± 79 Ma**

K = 2.87%, $^{40}Ar/^{40}K$ = 0.1544, radiogenic Ar = 98.9%.
Concentrate: Crushed whole-rock.

From amphibolite

(56 K) Details as for GSC 78-170.

A plot of these three samples on a $^{40}Ar/^{36}Ar$ vs $^{40}K/^{36}K$ diagram gives an "isochron" age of 1563 Ma and indicates an initial $^{40}Ar/^{40}K$ ratio of 1650, considerably higher than the normal atmospheric value of 296.

The biotite, amphibole and whole-rock give dates which when considered together can be interpreted as giving the latest closing of the Ar diffusion system. The "isochron" age gives an age of cessation of cooling of about 1563 Ma. The individual mineral dates therefore reflect partial retention of argon. The amphibole is thus a mixed date which is older than the biotite mixed date. The unit, part of the Prince Albert Group, is thought to be Archean.

GSC 78-173 Sanidine, K-Ar age **78.1 ± 2.3 Ma**

K = 7.37%, $^{40}Ar/^{40}K$ = 0.00464, radiogenic Ar = 96.7%.
Concentrate: Clean feldspar with minor traces of quartz and chlorite contamination.

From bentonite
(83 F) Northeast of Forestry Trunk Road in lsd 11-25-47-20 W5. Northeast side of an old strip mine pit (Sterling-Coal Valley Mining Ltd. Pit No. 5) between former mining towns of Coal Valley and Foothills, Alberta, approx. 53°02'N, 116°45'W. Sample STERCO SAND, submitted and interpreted by J.R. McLean.

This sample is of a prominent bentonite bed, immediately above a sequence of bedded volcanic cherts (Jerzykiewicz and McLean, 1977). The location is the hanging wall of a northeast-dipping thrust fault which forms the abrupt northeast termination on the Mynheer coal "pod" (Alexander, 1977). The throw on the fault is unknown and, thus, the exact stratigraphic location of the sample is unknown. However, the succession with which this sample is associated is known to be latest Cretaceous to earliest Tertiary in age (about 65 Ma), and thus the age determination is believed to be too old. If the age determination were correct, it would indicate a juxtaposition of late Santonian (Upper Cretaceous) and Paleocene sediments with an implied throw of several thousand feet on the fault. There is no supporting evidence for this at the present time.

References

Alexander, F.J.
1977: The structural geology of the Mynheer "A" zone, Coal Valley, Alberta; unpublished M.Sc. thesis, University of Alberta.

Jerzykiewicz, T. and McLean, J.R.
1977: Bedded volcanic chert near Coalspur, Central Foothills, Alberta; in Geological Survey of Canada, Paper 77-1B, p. 149-155.

GSC 78-174 Whole-rock, K-Ar age **949 ± 33 Ma**

K = 1.01%, $^{40}Ar/^{40}K$ = 0.07252, radiogenic Ar = 96.3%.
Concentrate: Crushed whole-rock.

From gabbro
(74 K) Northeast side of Douglas River, south and slightly outside of the Carswell structure, Saskatchewan, 58°16'25"N, 109°33'20"W. Sample LPT-1, collected and interpreted by L.P. Tremblay.

The sample is from a gabbro dyke that cuts the Athabasca Formation a short distance to the south of the external rim of the area affected by the Carswell structure. At the sample location the Athabasca Formation is probably about 1220 m thick as indicated by deep drilling a short distance to the east of the Carswell structure. This age indicates that most of the sandstones of the Athabasca Formation are at least older than 949 ± 33 Ma. However, this date is probably low as some of the minerals of the gabbro are in part altered to chlorite. This dyke trends about west-northwest. It probably correlates in time with the Mackenzie dyke trend. It probably also indicates that igneous activities and hydrothermal events were still going on in the area, for a long period of time, after the deposition of the Athabasca Formation, that is, later than about 1350 ± 50 Ma (Ramoekers, Saskatchewan Geological Survey, Summary of Investigations 1976, p. 118). This date marks approximately the time of intrusion of the gabbro.

GSC 78-175 Whole-rock, K-Ar age **1128 ± 450 Ma**

K = 0.013%, $^{40}Ar/^{40}K$ = 0.09110, radiogenic Ar = 52.3%.
Concentrate: Crushed whole-rock.

From "chloritic schist"
(74 K) Approximately 915 m east of the northeast end of Cluff Lake, Saskatchewan, 58°21'45"N, 109°31'10"W. Sample LPT-2 collected and interpreted by L.P. Tremblay.

The sample is from a chlorite schist in the immediate vicinity of and apparently host to the D orebody northeast of Cluff Lake within the Carswell structure on the Amok property. This rock as mapped by the company's geologists was regarded as being a red siltstone forming a small basin at the base of the Athabasca Formation overlying unconformably basement gneisses and this red siltstone is assumed now to be completely altered to chlorite schist. The writer would like to refer to this altered rock as possibly an altered amphibolite or basic volcanic rock that could have been a part of the basement succession. Although this sample was highly altered to chlorite, it was used for age determination as no other more suitable material was available. The date may not be too reliable because of the extremely low K-content of the sample (note error limits), however it appears fine as it is very close to the age (1100 Ma) of the pitchblende reported from the D orebody in the Cluff Lake area (K. Tapaninen, Paper to CIM Meeting Edmonton Oct. 26, 1975). It suggests that some hydrothermal events possibly responsible for the chlorite alteration of the samples were going on when the uranium mineralization took place in the area.

GSC 78-176 Whole-rock, K-Ar age **1735 ± 51 Ma**

K = 1.08%, $^{40}Ar/^{40}K$ = 0.1694, radiogenic Ar = 99.5%.
Concentrate: Crushed whole-rock.

From basalt
(74 N) About 61 m from the Fay Winze Station on the 32nd level, about 1570 m below surface, Eldorado Mine, Beaverlodge, Saskatchewan, 59°33'30"N, 108°28'W. Map unit 27, GSC Memoir 367. Sample LPT-4, collected and interpreted by L.P. Tremblay.

The sample comes from a basalt dyke related to the late gabbro dykes of the Beaverlodge area. The dyke dips 70°N, trends northwesterly and is up to 0.6 m thick. It cuts rocks resembling Foot Bay gneiss of the Tazin Group. This gneiss is a cataclastic, garnetiferous, quartzo-feldspathic biotite-hornblende bearing rock that strikes east-west and dips 20° to 30°S in the vicinity of the dyke.

The dyke is fine grained and dense appearing. It is closely jointed in three directions: parallel, at right angles and diagonal to trend of dyke and although it is fresh looking it is in part altered to chlorite and/or serpentine along some joint planes, possibly as a result of movement on those planes. As seen in thin section the dyke is composed of feldspar laths scattered in a mass of mafic minerals, now altered to amphibole, chlorite and opaques.

The close jointing suggests that the dyke has been affected by the late movement on the St. Louis fault. No uranium mineralization was noted in the immediate vicinity of the dyke but specularite in tiny grains was observed within the dyke chilled margins.

Although the dyke shows some alteration in thin sections, the date is believed to be reliable and to indicate the time of intrusion of the basalt.

GSC 78-177 Biotite, K-Ar age **2398 ± 52 Ma**

K = 7.54%, $^{40}Ar/^{40}K$ = 0.2913, radiogenic Ar = 99.8%.
Concentrate: Relatively clean, greenish brown biotite with less than 1% chlorite contamination.

From paragneiss
(53 E) Long Bay, Bigstone Lake, Manitoba, 53°43'29"N, 95°49'10"W. Sample EE74-269B, collected and interpreted by I.F. Ermanovics.

See GSC 78-181 for description and interpretation, and GSC 78-195 for further discussion.

GSC 78-178 Biotite, K-Ar age **2375 ± 51 Ma**

K = 7.74%, $^{40}Ar/^{40}K$ = 0.2862, radiogenic Ar = 99.8%.
Concentrate: Clean, unaltered, light greenish brown biotite with no visible contamination.

From orthogneiss
(53 E) Long Bay, Bigstone Lake, Manitoba, 53°43'29"N, 95°49'10"W. Sample EE74-269A, collected and interpreted by I.F. Ermanovics.

See GSC 78-181 for description and interpretation, and GSC 78-195 for further discussion.

GSC 78-179 Hornblende, K-Ar age **2584 ± 63 Ma**

K = 1.22%, $^{40}Ar/^{40}K$ = 0.3342, radiogenic Ar = 99.8%.
Concentrate: Clean, unaltered, pleochroic, brown to green hornblende with no visible contamination.

From orthogneiss
(53 E) Details as for GSC 78-178.

See GSC 78-181 for description and interpretation, and GSC 78-195 for further discussion.

GSC 78-180 Biotite, K-Ar age **2466 ± 53 Ma**

K = 7.67%, $^{40}Ar/^{40}K$ = 0.3065, radiogenic Ar = 99.8%.
Concentrate: Clean, unaltered, light greenish brown biotite with no visible contamination.

From orthogneiss
(53 E) Long Bay, Bigstone Lake, Manitoba, 53°43'40"N, 95°49'40"W. Sample EE74-273, collected and interpreted by I.F. Ermanovics.

See GSC 78-181 for description and interpretation, and GSC 78-195 for further discussion.

GSC 78-181 Hornblende, K-Ar age **2480 ± 61 Ma**

K = 0.943%, $^{40}Ar/^{40}K$ = 0.3097, radiogenic Ar = 99.4%.
Concentrate: Clean, unaltered, pleochroic, brown to green hornblende with no visible contamination.

From orthogneiss
(53 E) Details as for GSC 78-180.

Rocks from which these minerals derive comprise layered, metatonalite gneisses which appear to have a regionally discordant structural trend with respect to the fold axes of supracrustal rocks of Bigstone Lake (Park and Ermanovics, 1978). Biotite ages show comparable "younging" as in the Cobham River-Azure Lake schist belt. A U-Pb concordia intercept age on zircon from sample GSC 78-180 and GSC 78-181 yields an age of 2804 Ma (R.K. Wanless, personal communication, 1977).

See GSC 78-195 for additional discussion.

GSC 78-182 Biotite, K-Ar age **2008 ± 46 Ma**

K = 6.74%, $^{40}Ar/^{40}K$ = 0.2142, radiogenic Ar = 99.9%.
Concentrate: Light brown biotite with approximately 10% chlorite alteration.

From quartz diorite cobbles and boulders
(53 E) Island 1.6 km west-northwest of Cochrane Island, Island Lake, Manitoba, 53°57'45"N, 94°46'35"W. Map unit 3, Manitoba Mines Branch Publication 59-3. Sample EE74-364, collected and interpreted by I.F. Ermanovics.

See GSC 78-185 for description and interpretation, and GSC 78-195 for further discussion.

GSC 78-183 Biotite, K-Ar age **2215 ± 91 Ma**

K = 7.48%, $^{40}Ar/^{40}K$ = 0.2529, radiogenic Ar = 99.9%.
Concentrate: Greenish biotite with approximately 3% chlorite alteration.

From quartz diorite
(53 E) North shore of Cochrane Bay, Island Lake, Manitoba, 53°58'00"N, 94°39'30"W. Map unit 8, Manitoba Mines Branch Publication 59-3. Sample EE74-372, collected and interpreted by I.F. Ermanovics.

See GSC 78-185 for description and interpretation, and GSC 78-195 for further discussion.

GSC 78-184 Hornblende, K-Ar age $\begin{matrix}3137 \pm 68\\3154 \pm 68\end{matrix}$ **Ma**

K = 0.335%, $^{40}Ar/^{40}K = \begin{matrix}0.4916\\0.4974\end{matrix}$, radiogenic Ar = $\begin{matrix}97.8\%\\99.2\%\end{matrix}$.
Concentrate: Clean, unaltered, pleochroic, light brown to green hornblende with no visible contamination.

From tonalite orthogneiss
(53 E) Stevenson Lake, Manitoba, 53°54'20"N, 95°58'45"W. Sample EE74-001, collected and interpreted by I.F. Ermanovics.

See GSC 78-185 for description and interpretation, and GSC 78-195 for further discussion.

GSC 78-185 Hornblende, K-Ar age **2579 ± 62 Ma**

K = 0.390%, $^{40}Ar/^{40}K$ = 0.3329, radiogenic Ar = 98.9%.
Concentrate: Pleochroic, light green to light brown hornblende with a trace of chlorite contamination.

From conglomerate boulders

(53 E) East end of Collins Bay, Island Lake, Manitoba, 53°58'13"N, 94°54'05"W. Sample EE74-342, collected and interpreted by I.F. Ermanovics.

These rocks are metatonalites and occur adjacent to a thin, greenstone schist belt which extends from Ponask Lake to Stevenson Lake to Collins Bay, where the succession thickens at Island Lake. Just west of Collins Bay the Island Lake conglomerate lies unconformably on metamorphosed granodiorite and tonalite forming the basal member of the Island Lake succession (Herd and Ermanovics, 1975). Samples GSC 78-182, 183 and 185 derive from the basal conglomerate above the unconformity and judging from hornblende and biotite ages, argon appears to have been significantly affected to produce younger ages in biotites. U-Pb concordia intercept ages on zircons from GSC 78-183 and 182 yield 2765 Ma and 2757 Ma respectively (R.K. Wanless, personal communication, 1978).

The old hornblende ages are difficult to explain. Sample GSC 78-184 is one of the least deformed metatonalites in the area and is thought to underlie the Hayes River Group. Consequently, that these represent the age of the pre-unconformity rock (in the absence of other data) cannot be precluded.

See GSC 78-195 for further discussion.

GSC 78-186 Biotite, K-Ar age **2430 ± 52 Ma**

K = 7.18%, $^{40}Ar/^{40}K$ = 0.2983, radiogenic Ar = 99.9%.
Concentrate: Light brown biotite with approximately 3% chlorite alteration.

From quartz diorite

(62 P) 9.3 km southeast of Rice River estuary, opposite Black Island, Lake Winnipeg, Manitoba, 51°16'50"N, 96°20'45"W. Map unit 11b, GSC Paper 69-42. Sample EE74-BLI-3, collected and interpreted by I.F. Ermanovics.

This K-Ar age was obtained from a meta-tonalite whose U-Pb zircon age is ca. 2.9 Ga (Krogh et al., 1974). The age reflects fairly the Kenoran epiorogenic period and is in keeping with similar K-Ar ages in the area – e.g. GSC 72-69, GSC 72-70, GSC 61-128, GSC 61-129.

See GSC 78-195 for further discussion.

GSC 78-187 Whole-rock, K-Ar age **3161 ± 69 Ma**

K = 0.571%, $^{40}Ar/^{40}K$ = 0.4996, radiogenic Ar = 99.6%.
Concentrate: Crushed whole-rock.

From diabase

(63 H) Shoal in southern part of Playgreen lake, Manitoba, 53°48'45"N, 98°02'30"W. Map unit 10, GSC Paper 72-29. Sample EE720208, collected and interpreted by I.F. Ermanovics.

Whole-rock diabase GSC 76-201 yielded two similar ages at 2997 ± 67 Ma and 2974 ± 68 Ma. A plot of $^{40}Ar/^{36}Ar$ vs $^{40}K/^{36}Ar$ for all three ages does not indicate excess radiogenic argon despite their apparently anomalously high values. The dykes are definitely not Kenoran and were probably emplaced in Aphebian or more recent times (Ermanovics and Fahrig, 1975).

See GSC 78-195 for further discussion.

GSC 78-188 Biotite, K-Ar age **2373 ± 52 Ma**

K = 7.82%, $^{40}Ar/^{40}K$ = 0.2867, radiogenic Ar = 99.6%.
Concentrate: Clean, unaltered, light green biotite with no visible contamination.

From meta-quartz diorite

(63 I) Cross Lake area, Manitoba, 54°39'00"N, 97°48'30"W. Sample EE-75-073, collected by I.F. Ermanovics and R.K. Herd, interpreted by I.F. Ermanovics.

See GSC 78-190 for description and interpretation, and GSC 78-195 for further discussion.

GSC 78-189 Biotite, K-Ar age **2108 ± 49 Ma**

K = 7.92%, $^{40}Ar/^{40}K$ = 0.2324, radiogenic Ar = 99.7%.
Concentrate: Clean, unaltered, greenish brown biotite with no visible contamination.

From metaquartz diorite

(63 I) Cross Lake area, Manitoba, 54°38'45"N, 97°48'45"W. Sample EE-75-072, collected by I.F. Ermanovics and R.K. Herd, interpreted by I.F. Ermanovics.

See GSC 78-190 for description and interpretation, and GSC 78-195 for further discussion.

GSC 78-190 Muscovite, K-Ar age **1959 ± 46 Ma**

K = 7.97%, $^{40}Ar/^{40}K$ = 0.7057, radiogenic Ar = 99.2%.
Concentrate: Clean, mainly clear, fresh muscovite with no visible contamination.

From meta-quartz diorite

(63 I) Details as for GSC 78-184.

These samples derive from the meta-tonalite from below the unconformity at Cross Lake described by Rousell (1965) and depicted in Ermanovics and Davison (1976, p. 339). GSC 78-189 and GSC 78-190 are fresh materials from a lineated metatonalite 24 m from the unconformity. GSC 78-188 is more leucocratic, was collected 12 m from the unconformity and most closely resembles the boulders of the overlying conglomerate. Feldspars in both rocks are fresh and sporadic garnets are present in hand specimens in both samples. A U/Pb concordia intercept age on zircon from GSC 78-189, 190 is 2712 Ma (Wanless, R.K., personal communication, 1977).

Rocks GSC 78-189 and 190 are thought to be the result of reheating, judging from the fresh nature of the mineralogy, and lineated, granoblastic metamorphic texture. The reason that biotite in sample GSC 78-188 appears not to have been similarly affected is not clear, but may be related to its leucocratic and less deformed state. In any event, these mineral ages imply post-Kenoran events, as yet, not understood. The younger ages are comparable to those reported for GSC 60-84, GSC 65-96, GSC 63-101 and GSC 63-102.

See GSC 78-195 for further discussion.

GSC 78-191 Biotite, K-Ar age **2370 ± 53 Ma**

K = 7.69%, $^{40}Ar/^{40}K$ = 0.2852, radiogenic Ar = 99.8%.
Concentrate: Relatively pure, light brown biotite with approximately 2% chlorite alteration.

From paragneiss
(53 E) North shore of Warrington Lake, Manitoba, 53°00'50"N, 94°53'00"W. Sample EE74-326, collected and interpreted by I.F. Ermanovics.

See GSC 78-195 for description, interpretation and general discussion.

GSC 78-192 Biotite, K-Ar age **2389 ± 53 Ma**

K = 8.20%, $^{40}Ar/^{40}K$ = 0.2892, radiogenic Ar = 99.8%.
Concentrate: Clean, unaltered, pale brown biotite with no visible contamination.

From paragneiss
(53 E) Island in Azure Lake, Ontario, 53°05'31"N, 94°39'45"W. Sample EE74-302, collected and interpreted by I.F. Ermanovics.

See GSC 78-195 for description, interpretation and general discussion.

GSC 78-193 Biotite, K-Ar age **2245 ± 50 Ma**

K = 7.54%, $^{40}Ar/^{40}K$ = 0.2590, radiogenic Ar = 99.6%.
Concentrate: Mostly fresh, brown to greenish brown biotite with approximately 2% chlorite alteration.

From tonalite gneiss
(53 E) East end of Azure Lake, Ontario, 53°05'31"N, 94°39'15"W. Sample EEH-74-608, collected and interpreted by I.F. Ermanovics.

See GSC 78-195 for description, interpretation and general discussion.

GSC 78-194 Biotite, K-Ar age **2364 ± 53 Ma**

K = 7.34%, $^{40}Ar/^{40}K$ = 0.2838, radiogenic Ar = 99.8%.
Concentrate: Clean, unaltered, light brown biotite with no visible contamination.

From tonalitic orthogneiss
(53 E) North shore of Warrington Lake, Manitoba, 53°00'50"N, 94°52'20"W. Sample EE74-325, collected and interpreted by I.F. Ermanovics.

See GSC 78-195 for description, interpretation and general discussion.

GSC 78-195 Hornblende, K-Ar age **2654 ± 64 Ma**

K = 0.695%, $^{40}Ar/^{40}K$ = 0.3515, radiogenic Ar = 99.5%.
Concentrate: Clean, unaltered, pleochroic, brown to green hornblende with no visible contamination.

From tonalitic orthogneiss
(53 E) Details as for GSC 78-194.

Rocks from which these five samples derive constitute the southern limit of the Cross Lake (Sachigo) subprovince. Paragneisses GSC 78-192 and 193, part of the Cobham River-Azure Lake supracrustal outliers, are intruded by metatonalites (GSC 78-191, 194 and 195). The hornblende age reflects fairly the age of Kenoran metamorphism. However, the biotites of all rocks from within the schist belt indicate post-Kenoran, isotopic readjustment to a younger age. Although this isotopic readjustment is less than in rocks farther north, it nevertheless represents a significant difference and was unexpected at this latitude. Rocks 56 km to the south, GSC 70-77 and GSC 60-86, yield K/Ar biotite ages of 2431 Ma and 2582 Ma respectively.

Reset ages occurring in the Sachigo subprovince, but not in the Berens subprovince to the south, may be a significant criterion in the tectonic evolution of these subprovinces.

General discussion and summary:

From latitude 53° in Manitoba, biotites in Archean rocks show progressive K-Ar 'younging' northward. South of this latitude K-Ar hornblende is older than K-Ar biotite by about 80 Ma, especially in schists. Hornblende in plutonic rocks intruding these schists generally yield K-Ar ages of ca. 2600 Ma, as do some biotites.

North of latitude 53° reset biotite ages are first seen in schist belts (ages of ca. 2300 Ma) and then in plutonic rocks, until near the Pikwitonei granulite domain K-Ar ages of 1800 and 2000 Ma become fairly general in all types of rocks. Hornblendes show 'resetting' to ca. 2400 Ma and in one case to 1800 Ma.

South of latitude 53° K-Ar biotite ages cluster around 2400 Ma, and this may be taken to reflect Kenoran epiorogeny. However, north of latitude 53° progressive resetting of biotite ages to 1800 Ma may reflect the beginning of Aphebian tectonics of Archean rocks in the Superior Province (Sachigo or Cross Lake subprovince) in Manitoba. Evidence for this idea comes from the observation that ages in schist belts are rejuvenated more than in subjacent plutons. Plutonic rocks must have been cool and rigid to transmit stresses to schist belts which recrystallized micas or remobilized argon. Farther north, closer to the Kenoran-Proterozoic junction (Nelson Front) plutonic rocks become similarly affected, presumably during higher temperatures. That argon rejuvenation of Archean rocks was controlled by the Hudsonian Orogeny is demonstrated by the observation that K-Ar ages are not younger than 1800 Ma.

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GSC 78-196 Biotite, K-Ar age **886 ± 25 Ma**

K = 7.54%, $^{40}Ar/^{40}K$ = 0.06647, radiogenic Ar = 98.8%.
Concentrate: Clean, unaltered, brown biotite with no chlorite contamination.

From monzonite
(31 G) About 830 m west of Quinville Corners, Quebec, 45°33'N, 75°42'W. Sample 361A, collected and interpreted by D.D. Hogarth and K.L. Currie.

This specimen was collected from a north-south trending monzonite dyke which post-tectonically cuts calc-gneisses, calc-silicate rocks and quartzites. The vertical dyke, 15 m wide in its widest part, exhibits a well developed igneous texture with euhedral perthite laths randomly oriented, and displays a well developed chilled margin. Although the dyke clearly postdates Grenville Orogeny, the determination shows that it is of Precambrian age. Similar dykes are found over a considerable area, and they may be related to syenites exposed near Buckingham, 24 km to the east.

GSC 78-197 Whole-rock, K-Ar age **1624 ± 48 Ma**

K = 0.514%, $^{40}Ar/^{40}K$ = 0.1531, radiogenic Ar = 98.2%.
Concentrate: Crushed whole-rock.

From basalt
(34 B) Richmond Gulf area, Quebec, 56.2°N, 74.5°W. Sample CD 730113, collected and interpreted by E.J. Schwarz.

See GSC 78-198 for description and interpretation.

GSC 78-198 Whole-rock, K-Ar age **1625 ± 109 Ma**

K = 0.159%, $^{40}Ar/^{40}K$ = 0.1532, radiogenic Ar = 96.1%.
Concentrate: Crushed whole-rock.

From basalt
(34 B) Richmond Gulf area, Quebec, 56.2°N, 75.5°W. Sample CD 730602, collected and interpreted by E.J. Schwarz.

These samples are Proterozoic komatiites from Smith Island. The komatiites and komatiitic basalts are from a thick volcanic series which overlies Archean basement in northern Quebec.

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GSC 78-199 Biotite, K-Ar age **859 ± 25 Ma**

K = 7.85%, $^{40}Ar/^{40}K$ = 0.06396, radiogenic Ar = 98.7%.
Concentrate: Clean, unaltered, brown biotite with no visible contamination.

From carbonatite
(32 H) On point at narrows in Lac à la Truite, about 56.3 km north-northwest of Girardville, Quebec, 49°29'N, 72°48'W. Sample LPT-3, collected and interpreted by L.P. Tremblay.

This sample came from a recently discovered alkaline complex in Quebec, the Crevier carbonatite. This complex is at the junction of the belt of alkaline rocks along the northern flank of the Grenville Province with the Saguenay Branch of the Ottawa-St. Lawrence alkaline belt (K.L. Currie, GSC Bulletin 239). The complex is mainly syenitic in composition; and biotite syenite and aegirite syenite are important rock types of this complex. The carbonate core is strongly foliated and all the rocks of the complex are gneissic to strongly gneissic. The sample came from the carbonate core and contained about 30 per cent fresh large biotite flakes.

This date suggests that the Crevier carbonatite belongs to the alkaline belt along the northern flank of the Grenville Province and not to that of the Ottawa-St. Lawrence Graben system. It corresponds to the metamorphism associated with the Grenville Orogeny, which dates between 900 and 1000 Ma and which has affected the Crevier Complex and the rocks of the alkaline belt along the Grenville Front but not those along the Ottawa-St. Lawrence system. These are much younger being between 560 and 200 Ma.

GSC 78-200 Muscovite, K-Ar age **367 ± 12 Ma**

K = 8.08%, $^{40}Ar/^{40}K$ = 0.02364, radiogenic Ar = 96.6%.
Concentrate: Clean, clear, unaltered muscovite with no visible contamination.

From schist
(31 H) Roadcut on Knowlton-South Bolton highway at junction with road to Bolton Glen, 3.8 km southeast of Knowlton, Quebec, 45°12'20"N, 72°28'00"W. Sutton schist (unpublished Bolton Glen Formation). Sample PB76-89-S1, collected and interpreted by M.J. Rickard (Australian National University).

The schist consists of quartz (45%), muscovite (45%), albite (5%) and chlorite, calcite and opaques (5%), and is interlayered with schistose quartzite and quartz veinlets. A strong early schistosity parallels lithological layering and a crenulation cleavage in the hinge planes of early cross-folds. Muscovite with interlayered chlorite occurs as straight crystals along the layering and in the early cross-folds. Late crenulation microfolds are only weakly developed and a few muscovite crystals lie athwart the dominant schistosity. Untwinned albite porphyroblasts contain inclusion trails of the early cross-folds and include some late microfolds.

See GSC 78-201 for further discussion.

GSC 78-201 Muscovite, K-Ar age **380 ± 13 Ma**

K = 7.55%, $^{40}Ar/^{40}K$ = 0.02455, radiogenic Ar = 94.4%.
Concentrate: Clean, clear, unaltered muscovite with no visible contamination.

From schist
(31 H) Roadcut on Knowlton-South Bolton highway, 200 m north of Sallys Pond, 7.3 km southeast of Knowlton, Quebec, 45°10'50"N, 72°26'40"W. Sutton schist (unpublished Sallys Pond Formation). Sample PB76-88-S2a, collected and interpreted by M.J. Rickard (Australian National University).

The schist consists of albite (35%), muscovite (35%), chlorite (25%) and quartz (5%). Thin quartzite interlayers show well developed late crenulation cleavage. Only a trace of early folds remains. Muscovite appears in bunches of straight recrystallized crystals defining the late folds and a new growth in the late cleavage. Most chlorite forms discrete layers parallel to the late cleavage. Near-euhedral albite porphyroblasts include late folds and have prism faces oriented in the late cleavage planes.

The two K-Ar ages were determined on metamorphic muscovites from the Sutton schist within the core of the Sutton Anticline. The objectives were to date muscovite growths related to the late crenulation cleavage and to test whether mica fabrics controlled by early folds and schistosity have been completely degassed. At the same time these dates provide a check on the 440 Ma age (about 449 Ma using modern constants in the calculations) on metamorphic muscovites in the same metamorphic zone some 18 km to the southwest reported 15 years ago (GSC 61-182, 183 in Lowdon et al., 1963, p. 104-105).

The muscovite in rock with early folds (GSC 78-200) yielded an age of 367 ± 12 Ma and the late muscovite (GSC 78-201) an age of 380 ± 13 Ma. Within experimental error limits, the two ages are the same, average 373 ± 13 Ma, late Devonian, and correspond to the time of the Acadian Orogeny.

Since these muscovite dates are minimum ages and there is no structural control on the relationship between the late folding in the Sutton Anticline and the folding in the Siluro-Devonian in the Lake Memphremagog area some 13 km to the east, it is yet possible that the late folding is Acadian or Taconic and metamorphic muscovites cooled through the argon blocking temperature during the Acadian. Similarly, the early folding may be Acadian or Taconic insofar as these K-Ar ages bear upon the question. The ages of deformation and muscovite growth are far from clear because other Ordovician to Silurian ages have been obtained from Sutton schists and their equivalents (Harper, 1968; St. Julien and Hubert, 1975; Knight, 1976).

The previously determined 420 and 440 Ma ages must be ignored. They are probably of inferior analytical quality arising from either poor potassium analyses of insensitivity of a mass spectrometer in use at the time (Wanless et al., 1973, p. 79-82). The conclusions made by Rickard (1965) based on these two ages, that the late deformation and metamorphism are Taconic, are rendered doubtful.

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GSC 78-202 Hornblende, K-Ar age **919 ± 41 Ma**

K = 1.16%, $^{40}Ar/^{40}K$ = 0.06959, radiogenic Ar = 98.3%.
Concentrate: Clean, unaltered, pleochroic, brown to green hornblende with no visible contamination.

From adamellite gneiss
(12 M) West side of plateau to west of Aguanus River Valley, Quebec, 51°24'42"N, 62°47'04"W. Map unit 3a, GSC Map 77-1a (Bourne et al., 1976). Sample BRA-76-1305, collected and interpreted by J.H. Bourne.

The sample was collected from a metamorphosed adamellite unit which surrounds the Romaine River anorthosite mass. The hornblende is likely of metamorphic origin, formed by the breakdown of primary orthopyroxene.

The date obtained is in no way related to the formation of the adamellite. It represents the date of the well known cratonization of the Grenville Province. The date presumably represents the time at which the metamorphic temperatures fell below the 'blocking temperature' of hornblende (roughly 600°C).

GSC 78-203 Biotite, K-Ar age **868 ± 25 Ma**

K = 7.35%, $^{40}Ar/^{40}K$ = 0.06478, radiogenic Ar = 98.4%.
Concentrate: Very light brown biotite with approximately 8% chlorite alteration.

From adamellite
(12 M) Shore of Lac la Galissonniere, Duplessis County, Quebec, 51°25'52"N, 62°00'58"W. Map unit 8, GSC Paper 77-1. Sample BRA-76-28, collected and interpreted by J.H. Bourne.

See GSC 78-204 for description and interpretation.

GSC 78-204 Hornblende, K-Ar age **900 ± 41 Ma**

K = 1.09%, $^{40}Ar/^{40}K$ = 0.06777, radiogenic Ar = 97.5%.
Concentrate: Fresh, pleochroic, olive-green to dark green hornblende with less than 1% biotite contamination.

From adamellite

(12 M) Details as for GSC 78-203.

The values of 868 ± 25 Ma (biotite) and 900 ± 41 Ma (hornblende) are only slightly younger than other K-Ar age determinations from this same general area. These data therefore support the field interpretation of this and related monzonite bodies as being late syn- to post-tectonic.

These monzonite masses are associated with strong positive aeromagnetic anomalies, and are commonly circular in form. This distinctive trait enables them to be followed into adjoining areas. The total area underlain by the rocks of this unit in the eastern Grenville Province may be seen to be quite substantial and indicates that this late syn-to post-tectonic event was of considerable importance in the development of this area.

GSC 78-205 Biotite, K-Ar age **963 ± 27 Ma**

K = 7.77%, $^{40}Ar/^{40}K$ = 0.07390, radiogenic Ar = 98.8%.
Concentrate: Clean, unaltered, light brown biotite with no chlorite contamination.

From gneiss

(12 M) Shore of Lac Mabille, Duplessis County, Quebec, 51°59'40"N, 62°56'46"W. Sample BRA-76-182, collected and interpreted by J.H. Bourne.

The rock type dated consists of an extremely variably and highly inhomogeneous gneiss unit. Evidence for an event of partial melting is widespread. The origin of the unit is not clear, however several metasedimentary horizons were recognized in the field. The age determination of 963 ± 27 Ma can only be interpreted as a cooling age related to post-tectonic uplift (?), and similar to many other ages from this part of the Grenville Province. However this particular value is interesting in that it lies close to a K-Ar value of 847 Ma reported in Wanless et al. (1968; GSC Paper 67-2, p. 135; K-Ar report 8; determination GSC 66-167). In the compilation of the 'thermochron' map of the Grenville Province, Harper and later workers have found it necessary to displace all their 'chrontours' to the north around this point. Examination of I.M. Stevenson's original field maps and the now available aeromagnetic maps of the region show that the samples dated were taken from an area where a circular aeromagnetic anomaly is located identical to the anomaly associated with GSC 78-203 and 204 discussed in this report. The writer disagrees with the interpretation of 66-167 that the young age from the granite indicates the granite was emplaced prior to the close of the Grenville Orogeny. Rather the young age indicates the granite may be post-Grenville in age. The fact that most K-Ar ages on biotite from this same area are 100 Ma older supports this interpretation. The large "wow" in the contours on the 'thermochron' map near the eastern end of the Grenville Province is therefore seen to be invalid, the 847 Ma is not a cooling but an intrusive age, and the 'chrontours' are more nearly parallel to the Grenville Front in this area, as they are elsewhere in the Grenville Province.

GSC 78-206 Biotite, K-Ar age **1042 ± 29 Ma**

K = 7.24%, $^{40}Ar/^{40}K$ = 0.08194, radiogenic Ar = 99.3%.
Concentrate: Clean, unaltered, brownish orange biotite with no visible contamination.

From "granitic" boulder

(11 N) Top-central surface of "kame moraine", north-central Coffin Island, Magdalen Islands, Quebec, 47°33.9'N, 61°30.4'W. Sample PC 13/74, collected and interpreted by V.K. Prest.

See GSC 78-208 for comments and interpretation.

GSC 78-207 Biotite, K-Ar age **1083 ± 29 Ma**

K = 7.09%, $^{40}Ar/^{40}K$ = 0.08622, radiogenic Ar = 99.1%.
Concentrate: Clean, unaltered, dark brown biotite with no visible contamination.

From "gneiss" boulder

(11 N) Bouldery mantle overlying "kame moraine" on southeastern end of Coffin Island, Magdalen Islands, Quebec, 47°32.8'N, 61°32.8'W. Sample PC 12/74, collected and interpreted by V.K. Prest.

See GSC 78-208 for comments and interpretation.

GSC 78-208 Biotite, K-Ar age **663 ± 26 Ma**

K = 6.88%, $^{40}Ar/^{40}K$ = 0.04651, radiogenic Ar = 74.6%.
Concentrate: Clean, unaltered, dark brown biotite with no chlorite contamination.

From "granite" boulder

(11 N) Western end of Brion Island, Magdalen Islands, Gulf of St. Lawrence, Quebec, 47°47.1'N, 61°30.1'W. Sample PC 2/76, collected and interpreted by V.K. Prest.

The granitic boulders (GSC 78-206, 207 and 208) from the northern part of the Magdalen Islands group were collected from below a former water plain (with a maximum altitude of about 30 to 35 m), and are hence considered to have been ice-rafted into position. They are associated with a bouldery gravel mantle that overlies stratified sand and silt or rests directly on bedrock. Though deposited from floating ice, and associated with a great variety of basic igneous rocks, it is important to try and identify a source area. The ages of all three boulders indicate Precambrian-age source rocks. This rules out Cape Breton Island, only 100 km to the southeast, and (together with the abundance of ultrabasic rocks) suggests a Newfoundland source more than 200 km to the northeast. This is substantiated by the frequent occurrences of red hematitized, jasper-like pebbles and cobbles in the ice-rafted drift that are diagnostic of a red, cobbly conglomerate from off the west side of Port au Port Peninsula.

Prince Edward Island
(GSC 78-209)

GSC 78-209 Biotite, K-Ar age **357 ± 12 Ma**

K = 7.38%, $^{40}Ar/^{40}K$ = 0.02294, radiogenic Ar = 95.7%.
Concentrate: Clean, unaltered, light greenish brown biotite with no chlorite contamination.

From granitic boulder
(11 E) Boulder till of sea cliff, southeastern Prince Edward Island, 46°00.7'N, 62°27.2'W. Sample PC 80/76, collected and interpreted by V.K. Prest.

This is a date on a glacial erratic (a small granitic boulder) first seen at the top of a 9 m shoreline cliff of clayey till in a small cove. A chip specimen was collected at that time. The boulder was collected in toto from the beach when it was rediscovered (with its unmistakable specimen-scar) in 1976. It was hoped that an age determination might substantiate other evidence which indicates that the till here was deposited by ice flowing northward from Nova Scotia. Though the age of this boulder is somewhat younger than most of the other Devonian-age (New Brunswick) boulders found on Prince Edward Island, it is not diagnostic of a Nova Scotian, Cobequid Mountain source as opposed to a New Brunswick highlands source. It does, however, add to the known granitoid and gneissic erratics on Prince Edward Island that are clearly unrelated to the Laurentide Ice Sheet.

Nova Scotia
(GSC 78-210 to GSC 78-212)

GSC 78-210 Biotite, K-Ar age **363 ± 9 Ma**

K = 7.18%, $^{40}Ar/^{40}K$ = 0.02338, radiogenic Ar = 97.4%.
Concentrate: Relatively clean, brown biotite with less than 1% chlorite contamination.

From granodiorite/quartz monzonite
(11 K) East end of cliff at Grande Falaise, near Jerome Brook, Nova Scotia, 46°40.5'N, 60°57.8'W. Sample CP76-Z1, collected and interpreted by K.L. Currie.

The northern peninsula of Cape Breton Island is interpreted as a Precambrian block marginally veneered by Paleozoic and Mesozoic sedimentary rocks, and intruded by Devonian and younger granitoid rocks (Neale, 1956; MacLaren, 1956; Currie, 1976). The correct identification of Precambrian plutons, as opposed to Devonian plutons depends on a combination of field mapping and radiometric dating. The Corney Brook complex, from which this specimen is taken, is a polydeformed biotite-hornblende granodiorite. The specimen was taken from a remobilized pegmatitic portion underlying unconformably the Jumping Brook complex (Currie, 1976), which is in turn unconformably overlain by the Horton Group of Mississippian age. All of the rocks were shattered and partially re-welded subsequent to the Mississippian. The age of formation of the granite is therefore Precambrian on geologic grounds. The Devonian age returned from the biotite is presumed to date the Acadian orogeny, which profoundly affected both the Corney Brook complex and the Jumping Brook complex.

References

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GSC 78-211 Whole-rock, K-Ar age **354 ± 36 Ma**

K = 0.43%, $^{40}Ar/^{40}K$ = 0.02272, radiogenic Ar = 83.0%.
Concentrate: Crushed whole-rock.

From diabase
(11 F) Midsection of deep canal cut at St. Peters, Cape Breton Island, Nova Scotia, 45°39'10"N, 60°52'11"W. Map unit 10, GSC Map 1083A (L.J. Weeks, 1964). Sample GCA23-1, collected and interpreted by H.H.J. Geldsetzer.

The sample is from a dark greenish-grey fine- to medium-grained diabase which represents one of a series of intrusive bodies trending northeast and southwest from St. Peters, Cape Breton Island, over a distance of about 25 km (Weeks, 1964). The diabase intrudes sediments of the Horton and Windsor groups (Weeks, 1964) which are of Tournaisian and Late Viséan age respectively. The Viséan-Namurian boundary is placed at 320 Ma, a date which could be regarded as the maximum age of the diabase.

Comparable dates in Cape Breton Island are the Rb-Sr dates of 371 Ma and 370 Ma (recalculated using Rb decay constant of $1.42 \times 10^{-11} a^{-1}$) for volcanics of the Fisset Brook Formation (Cormier and Kelly, 1964) which, however, underlies the Horton and Windsor groups. Small diabase dykes in the Antigonish Highlands about 100 km to the east are thought to be in part of post-Devonian age (Benson, 1974).

References

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GSC 78-212 Whole-rock, K-Ar age **127 ± 15 Ma**

K = 1.14%, $^{40}Ar/^{40}K$ = 0.00761, radiogenic Ar = 97.6%.
Concentrate: Crushed whole-rock.

From diabase drill core
(11 J) Scatarie Bank, offshore Nova Scotia, 46°02.4'N, 58°50.9'W. Sampled by Bedford Institute electric drill in 221 m of water. Sample HN-73-006-73-2-355, collected and interpreted by L.H. King.

The diabase occurs on a local topographic high on the eastern flank of Scatarie Bank and was taken from a 4.5 m core obtained with the Bedford Institute of Oceanography electric drill. The sample yielded a K-Ar whole-rock date of 127 ± 15 Ma, i.e., about early Cretaceous.

The sample site is 45 km north of the Orpheus Basin, part of the Glooscap Fault System. The origin of the diabase may be related to motion along a fault zone during Cretaceous time. Folded Cretaceous beds in the Orpheus Basin (King and MacLean, 1976) provide evidence for such motion; however, much of the folding probably occurred in late Cretaceous to early Tertiary time. Alternately, the diabase may be related to activity responsible for the widespread occurrence of local sites of igneous activity in eastern Canada during Cretaceous time. Poole et al. (1970) discussed the occurrence of lamprophyre dykes from Notre Dame Bay, Newfoundland with an average of 133 Ma, a diabase dyke on Anticosti Island with a date of 138 Ma, and samples of the Monteregian intrusives of Quebec with ages ranging from 84 to 123 Ma with many in the 100-115 Ma range. Of possible significance are the alkaline granites of the White Mountain magma series of northern New Hampshire and southern Maine with an age range of 110 to 185 Ma (Lyons and Faul, 1968).

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Newfoundland-Labrador
(GSC 78-213 to GSC 78-230)

GSC 78-213 Biotite, K-Ar age **1913 ± 44 Ma**

K = 7.32%, $^{40}Ar/^{40}K$ = 0.1979, radiogenic Ar = 99.4%.
Concentrate: Light orange-brown biotite with approximately 6% chlorite alteration.

(14 L) From paragneiss
Promontory on north shore of Bears Gut at east end of the fiord, Labrador, Newfoundland, 58°44'09"N, 62°56'05"W. Map unit 4, GSC Map 6-1974. Sample MZ-72-22-3, collected and interpreted by W.C. Morgan.

See GSC 78-227 for description.

GSC 78-214 Biotite, K-Ar age **2006 ± 46 Ma**

K = 6.93%, $^{40}Ar/^{40}K$ = 0.2138, radiogenic Ar = 99.5%.
Concentrate: Clean, unaltered biotite with no visible contamination.

(14 L) From granite pegmatite
Duncan Point, 3 km southeast of Bell Inlet, Labrador, Newfoundland. Map unit Apm, GSC Map 1469A. Sample MZ-72-375, collected and interpreted by W.C. Morgan.

See GSC 78-227 for description.

GSC 78-215 Whole-rock, K-Ar age **2576 ± 141 Ma**

K = 0.136%, $^{40}Ar/^{40}K$ = 0.3322, radiogenic Ar = 98.0%.
Concentrate: Crushed whole-rock.

(14 L) From diabase
4 km south of Rowsell Head, Labrador, Newfoundland, 58°57'15"N, 63°09'55"W. Map unit Adb, GSC Map 1469A. Sample MZ-71-252-1, collected and interpreted by W.C. Morgan.

See GSC 78-227 for description.

GSC 78-216 Whole-rock, K-Ar age **2426 ± 61 Ma**

K = 0.484%, $^{40}Ar/^{40}K$ = 0.2974, radiogenic Ar = 99.2%.
Concentrate: Crushed whole-rock.

(14 L) From diabase
1 km southeast of the east end of Bell Inlet, Labrador, Newfoundland, 58°51'45"N, 63°00'45"W. Map unit Adb, GSC Map 1469A. Sample MZ-71-207-3, collected and interpreted by W.C. Morgan.

See GSC 78-227 for description.

GSC 78-217 Whole-rock, K-Ar age **2161 ± 57 Ma**

K = 0.768%, $^{40}Ar/^{40}K$ = 0.2425, radiogenic Ar = 99.5%.
Concentrate: Crushed whole-rock.

(14 L) From diabase
1 km south of the west end of Bell Inlet, Labrador, Newfoundland, 58°51'08"N, 63°03'50"W. Map unit Adb, GSC Map 1469A. Sample MZ-72-13-3, collected and interpreted by W.C. Morgan.

See GSC 78-227 for description.

GSC 78-218 Hornblende, K-Ar age **1728 ± 50 Ma**

K = 1.18%, $^{40}Ar/^{40}K$ = 0.1684, radiogenic Ar = 99.7%.
Concentrate: Clean, unaltered, dark brown hornblende, with no visible impurities.

(14 L) From granulite
3.5 km east of the north end of North Arm, Saglek Fiord, Labrador, Newfoundland, 58°32'35"N, 63°24'10"W. Map unit 9, GSC Map 6-1974. Sample MZ-72-200-3, collected and interpreted by W.C. Morgan.

See GSC 78-227 for description.

GSC 78-219 Whole-rock, K-Ar age **2738 ± 66 Ma**

K = 0.854%, $^{40}Ar/^{40}K$ = 0.3734, radiogenic Ar = 99.5%.
Concentrate: Crushed whole-rock.

(14 L) From pseudotachylite
7.5 km northeast of the north end of North Arm, Saglek Fiord, Labrador, Newfoundland, 58°36'12"N, 62°23'10"W. Map unit 9, GSC Map 6-1974. Sample MZ-72-216-1, collected and interpreted by W.C. Morgan.

See GSC 78-227 for description.

GSC 78-220 Hornblende, K-Ar age **2011 ± 54 Ma**

K = 0.458%, $^{40}Ar/^{40}K$ = 0.2148, radiogenic Ar = 98.1%.
Concentrate: Clean, unaltered, pleochroic, light brown to bluish green hornblende with no visible contamination.

(14 L) From metadiabase
3.5 km southwest of the west end of Ramah Bay, Labrador, Newfoundland, 58°50'35"N, 63°22'50"W. Map unit Adb, GSC Map 1469A. Sample MZ-71-310-2, collected and interpreted by W.C. Morgan.

See GSC 78-227 for description.

GSC 78-221 Whole-rock, K-Ar age **2166 ± 57 Ma**

K = 0.568%, $^{40}Ar/^{40}K$ = 0.2434, radiogenic Ar = 99.2%.
Concentrate: Crushed whole-rock.

(14 L) From metadiabase
Details as for GSC 78-220. Sample MZ-71-310-1.

See GSC 78-227 for description.

GSC 78-222 Whole-rock, K-Ar age **2359 ± 136 Ma**

K = 0.179%, $^{40}Ar/^{40}K$ = 0.2827, radiogenic Ar = 98.3%.
Concentrate: Crushed whole-rock.

From diabase
(14 L) 6.5 km south-southwest of the west end of Ramah Bay, Labrador, Newfoundland, 58°48'35"N, 63°22'45"W. Map unit Hdb, GSC Map 1469A. Sample MZE-72-64-2, collected by M.E. Cherry and interpreted by W.C. Morgan.

See GSC 78-227 for description.

GSC 78-223 Whole-rock, K-Ar age **1303 ± 41 Ma**

K = 0.828%, $^{40}Ar/^{40}K$ = 0.1110, radiogenic Ar = 98.9%.
Concentrate: Crushed whole-rock.

From diabase
(14 L) Details as for GSC 78-222. Sample MZE-72-64-7(3).

See GSC 78-227 for description.

GSC 78-224 Muscovite, K-Ar age **1222 ± 32 Ma**

K = 6.36%, $^{40}Ar/^{40}K$ = 0.1015, radiogenic Ar = 99.7%.
Concentrate: Silvery coloured muscovite with approximately 10% chlorite contamination. Most of the muscovite flakes have a striated appearance and some contain black inclusions.

From schist
(14 L) Southeast side of Ramah Bay, Labrador, Newfoundland, 58°50'30"N, 63°11'40"W. Map unit ARH-U, GSC Map 1469A. Sample MZ-71-66-1, collected and interpreted by W.C. Morgan.

See GSC 78-227 for description.

GSC 78-225 Biotite, K-Ar age **1593 ± 39 Ma**

K = 7.69%, $^{40}Ar/^{40}K$ = 0.1487, radiogenic Ar = 99.1%.
Concentrate: Clean, unaltered, light brownish biotite with no visible contamination.

From schist
(14 L) 6.5 km south-southwest of the south end of Pangertok Inlet, Saglek Fiord, Labrador, Newfoundland, 58°18'45"N, 63°13'40"W. Map unit ARS, GSC Map 1431A. Sample MZC-72-605, collected by M.P. Cecile and interpreted by W.C. Morgan.

See GSC 78-227 for description.

GSC 78-226 Muscovite, K-Ar age **1550 ± 39 Ma**

K = 8.09%, $^{40}Ar/^{40}K$ = 0.1427, radiogenic Ar = 99.2%.
Concentrate: Mainly clear muscovite but with some yellowish stain, and with approximately 3% chlorite contamination.

From schist
(14 L) Details as for GSC 78-225.

See GSC 78-227 for description.

GSC 78-227 Whole-rock, K-Ar age **2597 ± 296 Ma**

K = 0.010%, $^{40}Ar/^{40}K$ = 0.3375, radiogenic Ar = 66.0%.
Concentrate: Crushed whole-rock.

From diabase
(14 L) South side of Ramah Bay, Labrador, Newfoundland, 58°51'00"N, 63°16'20"W. Map unit ARdb, GSC Map 1469A. Sample MZ-71-146-2, collected and interpreted by W.C. Morgan.

These samples were submitted as part of an overall study of the Ramah Group and basement rocks along the Nain-Churchill Structural Province contact (Taylor, 1971) in the Nachvak Fiord-Saglek Fiord area. The samples are derived from three geological units (Morgan, 1975) and are described separately as follows: basement rocks in the Hudsonian foreland (Nain Structural Province), reworked basement rocks in the Hudsonian mobile belt (Churchill Structural Province) and the Ramah Group.

Basement rocks in the Hudsonian foreland

This unit consists of a variety of north-trending Archean gneisses cut by an intense west-trending Aphebian diabase dyke swarm. The dykes do not cut the Ramah Group which lies to the west and, together with adjacent gneisses, form a regolith at the base of that group.

Sample GSC 78-213 is biotite from a psammitic garnet-biotite paragneiss that locally contains sillimanite and graphite. The paragneiss is cut by the west-trending diabase dyke swarm but its age is younger than those determined from many of the dykes. The age of 1913 ± 44 Ma may be related to a thermal event associated with the Hudsonian orogeny. A similar biotite age of 2006 ± 46 Ma (GSC 78-214) was obtained from a white, coarse grained to pegmatitic garnet-biotite granite that extensively veins and intrudes the gneisses but is cut by the diabase dykes.

Samples GSC 78-216 and 215 gave whole-rock ages of 2426 ± 61 Ma and 2576 ± 141 Ma respectively. They are massive, altered, aphanitic olivine diabase dykes that consist of relict olivine, augite, pigeonite and plagioclase (An_{50}) in a matrix of green hornblende, brown hornblende, biotite, chlorite and magnetite. Specimen GSC 78-217, representative of a closely spaced swarm of interconnected feldsparphyric diabase dykes in which the mafic minerals are completely altered to hornblende, chlorite and epidote, gave a younger age of 2161 ± 57 Ma.

Reworked basement rocks in the Hudsonian mobile belt

The reworked basement unit lies west of the Ramah Group and consists of essentially the same rock types as the Archean block to the east. A characteristic feature of the reworked block is the widespread evidence of cataclastic events of more than one age. The entire block is bounded by a major fault system along its east side. Northeast- to north-trending foliated metadiabase and amphibolite dykes in this unit are considered to be reworked equivalents of the post-orogenic west-trending massive diabase intrusions to the east. Deformation, metamorphism, and change in attitude of the dykes are attributed to the Hudsonian orogeny.

The hornblende age reported for sample GSC 78-218 of 1728 ± 50 Ma from a garnet-hypersthene-diopside-hornblende granulite is a metamorphic age related to the Hudsonian orogeny.

The significance of a whole-rock age of 2738 ± 66 Ma from specimen GSC 78-219, pseudotachylite from the east of this block, is uncertain. Outcrops in the vicinity of the sample have been interpreted as Archean rocks,

re-metamorphosed to granulite facies in the Aphebian and later mylonitized and cut by pseudotachylite veins. This extensive zone of intense cataclasis is interpreted as a Labrador continuation of the Greenland Nagssugtoqidian boundary (Morgan, 1975). The age can also be interpreted in the light of detailed work on the Nagssugtoqidian boundary (Watterson, 1974) which has shown that the main Nagssugtoqidian deformation is pre-dyke in age.

Samples GSC 78-220 and 221 are from the core and chilled margin of a northeast-trending, foliated amphibolite dyke. They gave a hornblende age of 2011 ± 54 Ma and a whole-rock age of 2166 ± 57 Ma respectively.

Sample GSC 78-222, from the chilled margin of a 12 m thick, north-trending, dark green, slightly altered diabase dyke with a weak foliation in the core zone has given a whole-rock age of 2359 ± 136 Ma. Unlike the amphibolite dykes, this post-Kenoran diabase has been only slightly modified by Hudsonian events.

A one metre wide massive, unaltered, west-northwest trending, dark grey aphanitic diabase cuts across and chills against the above metadiabase. Its whole-rock age of 1303 ± 41 Ma from sample GSC 78-223 is interpreted as evidence of a Helikian phase of diabase dyke intrusion. Dykes with similar ages occurring elsewhere in Labrador and near Ungava Bay have been reported by Taylor (1970), GSC 73-172.

The Ramah Group

This group is a sequence of dominantly sedimentary rocks, deformed by open to subisoclinal overturned folds and metamorphosed to greenschist and amphibolite facies. Along its eastern margin the base of the Ramah Group rests with a profound angular unconformity on Archean rocks that are cut by an Aphebian diabase dyke swarm. The western contact of the Ramah Group fold-belt is marked by west dipping thrusts and by faults.

The group is intruded by a series of pre- to early syntectonic diabase sills that range in thickness to a maximum of about one hundred metres. The sills are massive, with fine grained to aphanitic margins and medium- to coarse-grained interiors, and are altered. One thick sill is locally differentiated with an ultramafic core. Sample GSC 78-227, a highly altered diabase, yielding an age of 2597 ± 296 Ma has a very low potassium content (0.010% K) and excess radiogenic argon in the sample could account for the anomalously great age.

Sample GSC 78-224 is a very fine grained chloritoid-muscovite schist from a phyllite band in quartzite of Rowsell Harbour Formation which forms the basal part of the group (Knight and Morgan, 1976). The age obtained, 1222 ± 32 Ma, may relate to an uplift event or to an Elsonian thermal event. The figure corresponds to a K-Ar whole-rock age of 1180 ± 60 Ma derived from the volcanic member of Rowsell Harbour Formation on the north side of Ramah Bay (GSC 67-132; Wanless et al., 1969). This volcanic member gave a Rb-Sr whole-rock errorchron age of 1959 Ma ($\lambda = 1.42 \times 10^{-11} a^{-1}$) interpreted as a metamorphic age caused by the Hudsonian orogeny (Morgan, 1978).

The biotite-muscovite mineral pair (GSC 78-220, 221) giving ages of 1593 ± 39 Ma and 1550 ± 39 Ma respectively, are from a sillimanite-biotite-muscovite schist affected by a Hudsonian thermal event.

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GSC 78-228 Biotite, K-Ar age **919 ± 26 Ma**

$K = 7.91\%$, $^{40}Ar/^{40}K = 0.06961$, radiogenic Ar = 98.9%.
Concentrate: Clean, unaltered, light green biotite with no chlorite contamination.

From mafic dyke
(13 J) Michelin deposit, about 64 km southwest of Makkovik, Labrador, Newfoundland, 54°35.5'N, 59°58.7'W. Sample SSG-177a-75, collected and interpreted by S.S. Gandhi.

The sample is from the "calcite-biotite member", a thin rock unit, less than 0.3 m thick and traceable for about 30 m or so. It is concordant to the bedding (or flow margins) and schistosity (both striking about N70°E and dipping about 55° to the south) of an acidic volcanic sequence. The rock is well foliated, and consists of biotite (30%) and calcite (10%). The dyke has local bifurcations that indicate intrusive character; this is supported by fine grained margins that appear to be chilled margins. Foliation is parallel to the regional schistosity in the country rock. The 'calcite-biotite member' cuts through the uranium-bearing mineralized zone, but in itself is not mineralized. It thus appears to be pre-metamorphic but post-mineralization.

The metamorphism and deformation in the country rock is believed to be Hudsonian (or 1600 Ma) which is supported by K-Ar age determinations on post-tectonic granites of the region. The country rock, which also hosts the disseminated uranium mineralization, is part of Aphebian Aillik Group, and consists predominantly of acidic volcanics and tuffs.

The age of 919 ± 26 Ma is too young for the 'Hudsonian' deformation. It is 'Grenville' age. The 'Grenville Front' is not exposed in the region, but it is believed to be within 16 km south of the Michelin deposit. It is probable that the 'Grenville' event had an effect on the Michelin area, but the precise nature of the effect is not known. It may have caused some movement along shear planes and old faults, and could have produced some low temperature thermal effects. It appears that this was sufficient to reset the K-Ar clock in the 'calcite-biotite member' which is a type of rock that would be relatively susceptible to such an event.

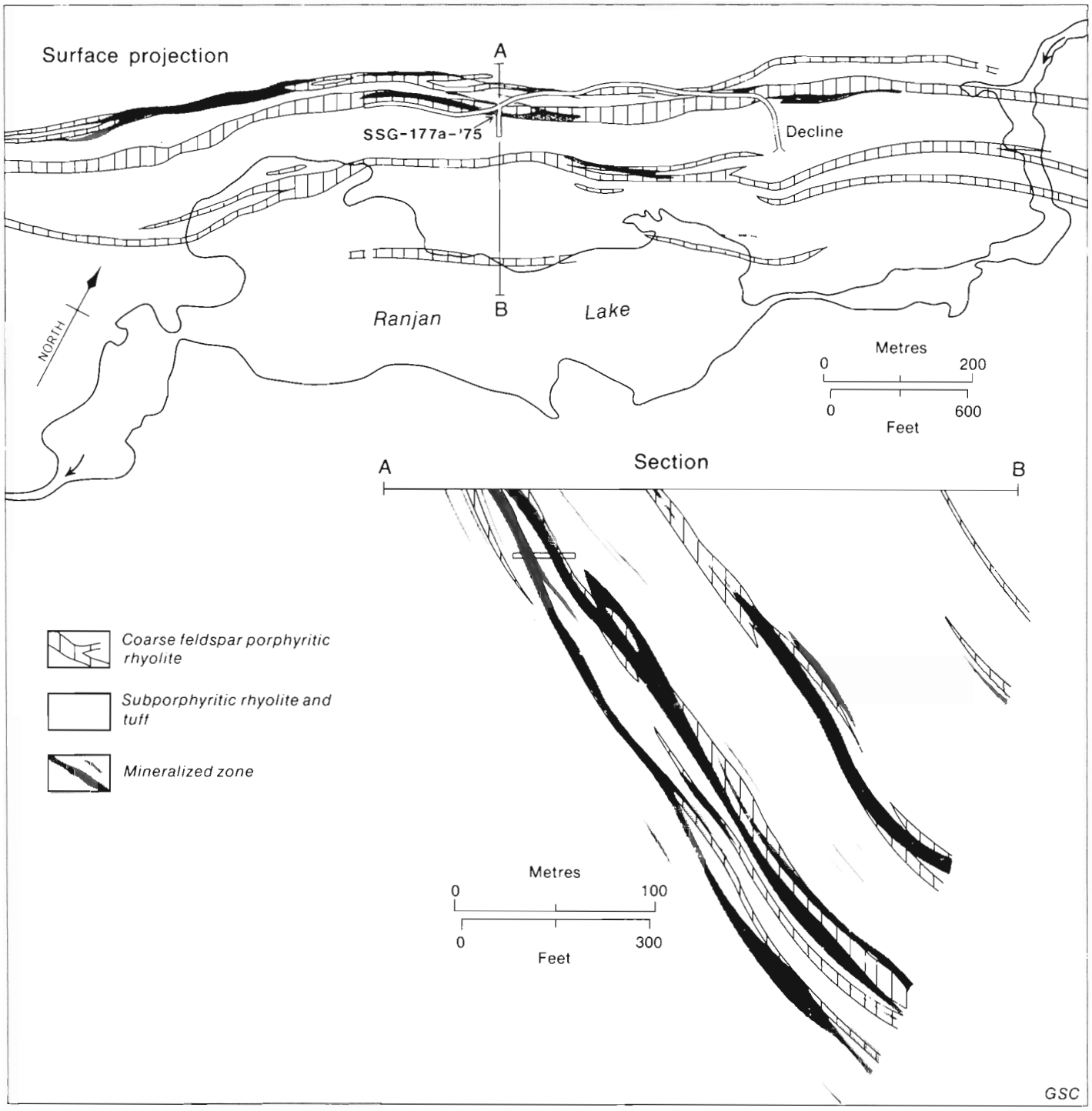

Figure 6. *Surface projection and cross-section of Michelin uranium deposit, Labrador.*

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GSC 78-229 Biotite, K-Ar age **398 ± 13 Ma**

K = 7.45%, $^{40}Ar/^{40}K$ = 0.02587, radiogenic Ar = 98.1%.
Concentrate: Light brown biotite with approximately 3% chlorite alteration.

From quartz diorite
(2 E) Twillick Point, Rocky Bay, Newfoundland, 49°26'N, 54°14'W. Map unit 15, Pickerill, Pajari, Currie and Bergo, GSC Paper 78-1A. Sample 77012, collected by G. Pajari and interpreted by K.L. Currie.

See GSC 78-230 for description and interpretation.

GSC 78-230 Hornblende, K-Ar age **407 ± 51 Ma**

K = 0.31%, $^{40}Ar/^{40}K$ = 0.02654, radiogenic Ar = 76.9%.
Concentrate: Relatively clean, unaltered, pleochroic, brown to green hornblende with a trace of chlorite contamination.

From quartz diorite
(2 E) Details as for GSC 78-229.

This specimen was collected from the Rocky Bay pluton, a massive, unaltered, homogeneous quartz diorite characterized by large, poikilitic biotite flakes. Like the related Frederickton pluton, the Rocky Bay shows a foliated margin approaching granodiorite in composition. An earlier measurement gave an age of 398 ± 15 Ma for the foliated margin of the Frederickton pluton (GSC 64-159), but it seemed possible that the massive central phase was younger. The two new ages are essentially concordant with the older one, and show that the whole of the Rocky Bay-Frederickton mass is essentially of the same age, and lies relatively early in the development of the igneous rocks of the Carmanville area. In particular it is clearly older than the Aspen Cove (360 ± 14 Ma, GSC 63-183) or Deadman's Bay plutons (335 ± 14 Ma, GSC 63-184). These ages accord with current geological mapping in this region (Currie and Pajari, 1977; Currie and Pajari, 1978), but conflict drastically with the views of Kennedy and McGonigal (1972) who believed the Rocky Bay pluton to be the youngest igneous rock in the region.

References

Currie, K.L. and Pajari, G.E.
1977: Igneous and metamorphic rocks between Rocky Bay and Ragged Harbour, Northeastern Newfoundland; in Report of Activities, Part A, Geological Survey of Canada, Paper 77-1A, p. 341-346.

1978: The Gander Lake and Davidsville Groups of northeastern Newfoundland – a reconsideration; Canadian Journal of Earth Sciences, v. 15, p. 721-733.

Kennedy, M.J. and McGonigal, M.H.
1972: The Gander Lake and Davidsville Groups of northeastern Newfoundland, New data and tectonic implications; Canadian Journal of Earth Sciences, v. 9, p. 453-459.

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 77-2, Report No. 13 – determinations 76-1 to 76-248
GSC 79-2, Report No. 14 – determinations 78-1 to 78-230

GSC Age Determinations Listed by N.T.S. Co-ordinates

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