GEOLOGICAL SURVEY OF CANADA
COMMISSION GÉOLOGIQUE DU CANADA

PAPER 82-2

AGE DETERMINATIONS AND GEOLOGICAL STUDIES

K-Ar Isotopic Ages, Report 16

R.D. STEVENS
R.N. DELABIO
G.R. LACHANCE

Canada

1982

PAPER 82-2

AGE DETERMINATIONS AND GEOLOGICAL STUDIES

K-Ar Isotopic Ages, Report 16

R.D. STEVENS
R.N. DELABIO
G.R. LACHANCE

1982

Available in Canada through

authorized bookstore agents
and other bookstores

or by mail from

Canadian Government Publishing Centre
Supply and Services Canada
Hull, Québec, Canada K1A 0S9

and from

Geological Survey of Canada
601 Booth Street
Ottawa, Canada K1A 0E8

A deposit copy of this publication is also available
for reference in public libraries across Canada

Cat. No. M44-82/2E Canada: $4.00
ISBN 0-660-11293-O Other countries: $4.80

Price subject to change without notice

CONTENTS

AGE DETERMINATIONS AND GEOLOGICAL STUDIES
K-Ar Isotopic Ages, Report 16

Abstract

Two hundred and twenty-six potassium-argon age determinations carried out by the Geological Survey of Canada 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 where possible. The experimental procedures employed are described in brief outline and the constants used in the calculation of ages are listed. Three geological time-scales are reproduced in tabular form for ready reference and an index of all Geological Survey of Canada K-Ar age determinations published in this format has been prepared using NTS quadrangles as the primary reference.

Résumé

Les auteurs présentent 226 datations au potassium-argon effectuées par la Commission géologique du Canada. 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. Trois 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 sixteenth report of potassium-argon age measurements completed in the Geochronological Laboratories of the Geological Survey of Canada. Two hundred and twenty-six determinations are reported, bringing the total number of published ages to 2897 in this series.

Since the reports have not always followed the same numerical sequence, the list following identifies the complete series:-

	Determinations
GSC Paper 60-17, Report 1	59-1 to 59-98
GSC Paper 61-17, Report 2	60-1 to 60-152
GSC Paper 62-17, Report 3	61-1 to 61-204
GSC Paper 63-17, Report 4	62-1 to 62-190
GSC Paper 64-17, Report 5	63-1 to 63-184
GSC Paper 65-17, Report 6	64-1 to 64-165
GSC Paper 66-17, Report 7	65-1 to 65-153
GSC Paper 67-2A, Report 8	66-1 to 66-176
GSC Paper 69-2A, Report 9	67-1 to 67-146
GSC Paper 71-2, Report 10	70-1 to 70-156
GSC Paper 73-2, Report 11	72-1 to 72-163
GSC Paper 74-2, Report 12	73-1 to 73-198
GSC Paper 77-2, Report 13	76-1 to 76-248
GSC Paper 79-2, Report 14	78-1 to 78-230
GSC Paper 81-2, Report 15	80-1 to 80-208
GSC Paper 82-2, Report 16	81-1 to 81-226 (this report)

Geological Time Scales

The Phanerozoic portion of a time scale chart prepared by Izett et al. (1980) at the request of the Geologic Names Committee for use by members of the United States Geological Survey is reproduced for quick reference as Figure 1. Another current 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) and Armstrong (1978).

A revised time scale, after Stockwell (1982), is reproduced as Figure 2 for the Precambrian of the Canadian Shield, and a proposed time scale by Harrison and Peterman (1980) for the Precambrian of the United States and Mexico is reproduced as Figure 3.

Experimental Procedures

The concentration of potassium in most samples was routinely determined using X-ray fluorescence methods (Lachance, in Wanless et al., 1965, p. 4-7); the reliability of this technique has been demonstrated by Wanless et al. (1966, Table 1, p. 2). In cases where the quantity of available sample was too small for XRF 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) but have been upgraded to reflect significantly improved analytical conditions of recent years. The absolute error on potassium determination is now taken as ±0.02 for X-ray fluorescence and ±0.012 for isotopic dilution. 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 ICG in Sydney, Australia (Steiger and Jager, 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

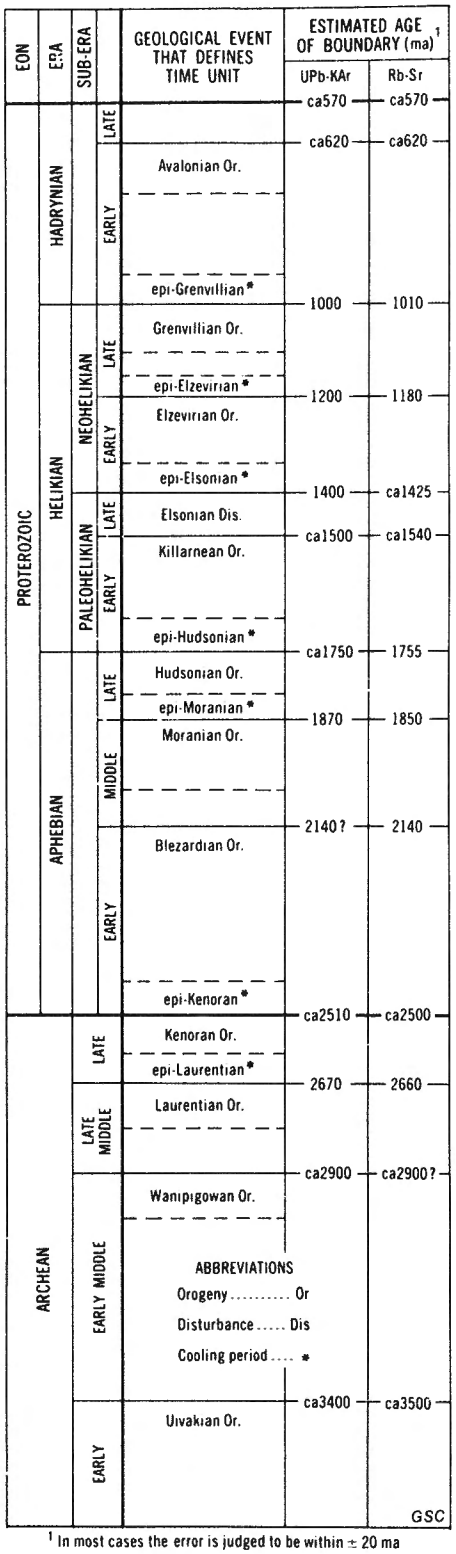
atomic ratio $^{40}Ar/^{36}Ar$ atmospheric = 295.5

MAJOR GEOCHRONOLOGIC AND CHRONOSTRATIGRAPHIC UNITS

Subdivisions in use by the U.S. Geological Survey (and their map symbols)					Age estimates[1] of boundaries in million years (m.y.)	
Phanerozoic Eon or Eonothem	Cenozoic Era or Erathem (Cz)	Quaternary Period or System (Q)		Holocene Epoch or Series	0.010	
				Pleistocene Epoch or Series	2	(1.7-2.2)
		Tertiary Period or System (T)	Neogene Subperiod or Subsystem (N)	Pliocene Epoch or Series	5	(4.9-5.3)
				Miocene Epoch or Series	24	(23-26)
			Paleogene Subperiod or Subsystem (Pε)	Oligocene Epoch or Series	38	(34-38)
				Eocene Epoch or Series	55	(54-56)
				Paleocene Epoch or Series	63	(63-66)
	Mesozoic Era or Erathem (Mz)	Cretaceous Period or System (K)		Late Cretaceous Epoch or Upper Cretaceous Series	96	(95-97)
				Early Cretaceous Epoch or Lower Cretaceous Series	138	(135-141)
		Jurassic Period or System (J)			205	(200-215)
		Triassic Period or System (T)			∿240	
	Paleozoic Era or Erathem (Pz)	Permian Period or System (P)			290	(290-305)
		Carboniferous Periods or Systems (C)	Pennsylvanian Period or System (P)		∿330	
			Missippian Period or System (M)		360	(360-365)
		Devonian Period or System (D)			410	(405-415)
		Silurian Period or System (S)			435	(435-440)
		Ordovician Period or System (O)			500	(495-510)
		Cambrian Period or System (C)			∿570	

[1] Ranges reflect uncertainties of isotopic and biostratigraphic age assignments. Age of boundaries not closely bracketed by existing data shown by ∿. Decay constants and isotope ratios employed are cited in Steiger and Jager (1977).

Figure 1. *Phanerozoic time scale (from Izett et al.; Geologic Names Committee, 1980 edition).*



[1] In most cases the error is judged to be within ± 20 ma

Figure 2. *Precambrian time scale (Stockwell, 1982).*

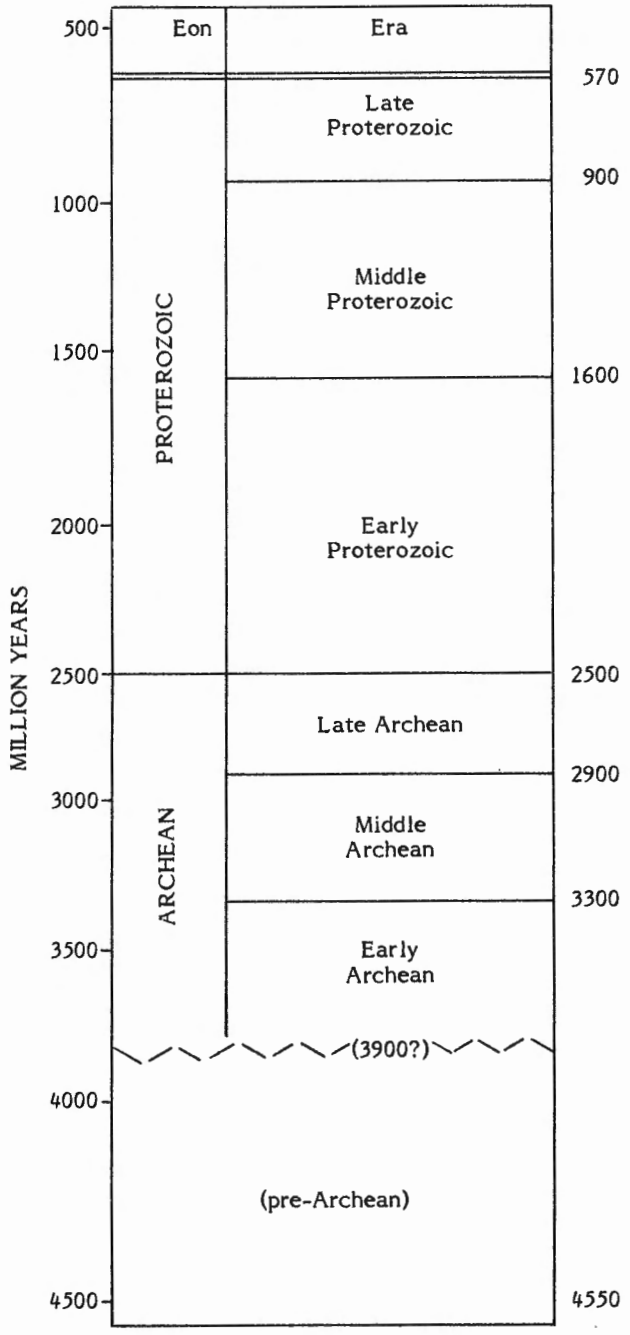


Figure 3. *Proposed chronometric time scale for the Precambrian of the United States and Mexico by the Working Group on the Precambrian for the United States and Mexico (Harrison and Peterman, 1980).*

REFERENCES

Armstrong, R.L.
1978: Pre-Cenozoic Phanerozoic time-scale – computer file of critical dates and consequences of new and in-progress decay constant revisions; in Contributions to the geologic time scale, Cohee, Glaessner and Hedberg editors, American Association of Petroleum Geologists, Studies in Geology, No. 6, p. 73-91.

Cohee, G.V., Glaessner, M.F., and Hedberg, H.D.
1978: Contributions to the Geologic Time Scale, Studies in Geology, No. 6; American Association of Petroleum Geologists, p. 1-388.

Harrison, J.E. and Peterman, Z.E.
1980: North American Commission on Stratigraphic Nomenclature, Note 52 – A preliminary proposal for a chronometric time scale for the Precambrian of the United States and Mexico; Geological Society of America, Bulletin, v. 91, Part I, p. 377-380.

Holmes, A.
1959: A revised geological time-scale; Transactions Edinburgh Geological Society, v. 17, Pt. 3, p. 183-216.

Izett, G.A., Lanphere, M.A., MacLachlan, M.E., Naesser, C.W., Obradovich, J.D., Peterman, Z.E., Rubin, M., Stern, T.W., and Zartman, R.E.
1980: Major geochronologic and chronostratigraphic units; in Isochron West, No. 28, August 1980, New Mexico Bureau of Mines and Mineral Resources.

Steiger, R.H. and Jager, E.
1977: Subcommission on Geochronology: Convention on the use of decay constants in Geo- and Cosmochronology; Earth and Planetary Science Letters, v. 36, p. 359-362.

Stockwell, C.H.
1982: Proposals for time classification and correlation of Precambrian rocks and events in Canada and adjacent areas of the Canadian Shield. Part I – A time classification of Precambrian rocks and events; Geological Survey of Canada, Paper 80-19.

Wanless, R.K., Stevens, R.D., Lachance, G.R., and Rimsaite, J.Y.H.
1965: Age determinations and geological studies, Pt. 1 – Isotopic ages, Report 5; Geological Survey of Canada, Paper 64-17, p. 1-126.

1966: Age determinations and geological studies, K-Ar isotopic ages, Report 6; Geological Survey of Canada, Paper 65-17.

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.

ISOTOPIC AGES, REPORT 16

British Columbia
(GSC 81-1 to GSC 81-34)

GSC 81-1 Biotite, K-Ar age **161 ± 6 Ma**

K = 6.51%, $^{40}Ar/^{40}K$ = 0.00979, radiogenic Ar = 96.4%.
Concentrate: Relatively clean, fresh and unaltered brown biotite with a slight trace of chlorite contamination.

From quartz diorite
(104 N) At elevation 4500 ft. (1370 m), southeast side of Nakina River canyon, British Columbia, 59°00'30"N, 132°58'W. Map-unit 12b, GSC Memoir 307; map-unit 9 in Terry, GSC Paper 77-1A. Sample C76-165 collected by J. Terry and described by J.W.H. Monger.

See GSC 81-2 for description.

GSC 81-2 Hornblende, K-Ar age **150 ± 17 Ma**

K = 0.40%, $^{40}Ar/^{40}K$ = 0.00908, radiogenic Ar = 76.3%.
Concentrate: Clean, fresh and unaltered, pleochroic, brown to light green hornblende with no visible contamination.

From quartz diorite
(104 N) Details as for GSC 81-1.

This quartz diorite intrusion (Nakina River stock of Aitken, G.S.C. Memoir 307, p. 57) lies entirely within and clearly intrudes the Nahlin ultramafic body, itself an assemblage of peridotite, minor gabbro, trondhjemite and diabase. The specimen consists of feldspar (50-60%), hornblende (~15%), biotite (~15%) and quartz. The feldspar forms interlocking subhedral stubby laths of calcic plagioclase which is locally saussuritic. The hornblende is euhedral to subhedral and altered in part to biotite.

GSC 81-3 Biotite, K-Ar age **202 ± 7 Ma**

K = 7.05%, $^{40}Ar/^{40}K$ = 0.01215, radiogenic Ar = 92.9%.
Concentrate: Relatively clean, very light brown biotite with approximately 1% chlorite alteration.

From pyroxenite
(104 G) Stikine Canyon, British Columbia, 58°00'N, 131°05'W. Sample SE 331973, collected and described by J.G. Souther.

The sample is from a coarse grained, black, magnetite-rich pyroxenite with biotite phenocrysts up to 1.75 cm in diameter, anhedral grains of clinopyroxene, rounded grains of magnetite and apatite, and interstitial biotite. The pyroxenite forms a marginal, basic phase of the Tahltan Syenite Stock, one of a series of cupriferous syenite bodies that are commonly associated with upper Triassic augite andesite volcanic rocks in the Stikine region.

GSC 81-4 Biotite, K-Ar age **180 ± 5 Ma**

K = 7.20%, $^{40}Ar/^{40}K$ = 0.01098, radiogenic Ar = 95.4%.
Concentrate: Dark brown biotite with approximately 9% chlorite alteration.

From granite
(104 I) 3 km west of peak 7174', northwestern Three Sisters Range, Cry Lake map area, British Columbia, 58°10'43"N, 129°33'00"W; see Anderson 1979, Figure 2, map unit 4d. Sample AN-78-528-3, collected and interpreted by R.G. Anderson.

The sample is a massive, white weathering medium-grained, equigranular granite containing 42 per cent andesine, 29 per cent alkali feldspar, 20 per cent quartz, 7 per cent biotite and 2 per cent accessory minerals (magnetite, titanite, apatite and zircon). Chlorite and sausserite form minor (<1 per cent) alteration products of biotite and plagioclase; alkali feldspar is slightly to moderately turbid. It is typical of the potassic marginal phase of the Three Sisters Pluton.

For interpretation see GSC 81-16.

GSC 81-5 Hornblende, K-Ar age $\frac{172}{170} \pm \frac{13}{16}$ **Ma**

K = 0.52%, $^{40}Ar/^{40}K = \frac{0.01050}{0.01033}$, radiogenic Ar = $\frac{54.3}{19.1}$%.
Concentrate: Clean, unaltered, pleochroic, light green to light brown hornblende with no visible contamination.

From diorite
(104 I) 16 km southeast of Cake Hill, east of Beggerlay Creek, in western Three Sisters Range, Cry Lake map area, British Columbia, 58°04'44"N, 129°26'15"W; see Anderson 1979, Figure 2, map unit 4b. Sample AN-79-661-3 collected and interpreted by R.G. Anderson.

The rock is a fresh, massive, "salt-and-pepper" weathering, medium-grained, seriate, equant hornblende porphyry diorite, a variety of the mafic phase of the Three Sisters Pluton. It contains 45 per cent andesine-labradorite, 3 per cent quartz, 1 per cent alkali feldspar, 45 per cent hornblende and 6 per cent accessory minerals (magnetite, biotite, titanite, augite, apatite and zircon). The unit is characterized by rare augite cores in the hornblende and uncommon irregular labradorite to bytownite cores in the more sodic plagioclase. Chlorite and epidote alteration of hornblende and biotite are rare; sausserite alteration products are rarely observed in plagioclase.

For interpretation see GSC 81-16.

GSC 81-6 Hornblende, K-Ar age **218 ± 29 Ma**

K = 0.29%, $^{40}Ar/^{40}K$ = 0.01348, radiogenic Ar = 39.1%.
Concentrate: Pleochroic, light green to yellowish brown hornblende with a trace of chlorite and biotite contamination.

From gabbro
(104 H) 4 km southeast of confluence of Moose Creek and Beggerlay Creek, 12.5 km northeast of the confluence of Klappan and Stikine Rivers, Spatsizi map area, British Columbia, 57°58'04"N, 129°28'00"W; see Anderson 1979, Figure 2, map unit 2. Sample AN-79-717-1 collected and interpreted by R.G. Anderson.

The sample is typical of the moderately to highly altered, massive hornblende diorite and gabbro which makes up the Beggerlay Creek Pluton. The rock is massive, medium to coarse-grained and equigranular. It is composed of 45 per cent labradorite, 16 per cent clinopyroxene, 14 per cent hornblende, 11 per cent biotite and 12 per cent accessory minerals (magnetite, apatite and ± actinolite ± magnetite ± serpentine aggregates pseudomorphing olivine(?)). Secondary chlorite and white mica alterations (2 per cent of the rock) of the ferromagnesian minerals and plagioclase respectively are widespread and distinctive of the Beggerlay Creek Pluton. Also characteristic are the clinopyroxene cores in anhedral hornblende and late, coarse poikiloblastic(?) plates of biotite.

For interpretation see GSC 81-16.

GSC 81-7 Hornblende, K-Ar age **197 ± 18 Ma**

K = 0.43%, $^{40}Ar/^{40}K$ = 0.01210, radiogenic Ar = 75.3%.
Concentrate: Clean, unaltered, pleochroic, dark green to yellowish brown hornblende with no visible contamination.

From granodiorite
(104 J) 2 km southwest of peak 5999', near Pallen Creek, in north central Hotailuh Range, Dease Lake map area, British Columbia, 58°14'00"N, 130°15'00"W; see Gabrielse 1980 and Anderson 1980, p. 37. Sample AN-79-635-1 collected and interpreted by R.G. Anderson.

Fresh, pinkish cream weathering, massive, medium-grained, seriate granodiorite, which underlies much of the Pallen Creek Pluton, is represented by this sample. Distinctive of this phase are uncommon, slightly coarser grained alkali feldspar megacrysts. Approximately 50 per cent andesine, 24 per cent quartz, 19 per cent alkali feldspar, 4 per cent biotite, 2 per cent hornblende and 1 per cent accessory minerals (magnetite, titanite, apatite, zircon and allanite) make up the rock. A trace of chlorite (after the ferromagnesian minerals) and sausserite (after plagioclase) is present.

The subhedral alkali feldspar megacrysts are highly turbid imparting a reddish colour to the rock.

For interpretation see GSC 81-16.

GSC 81-8 Whole rock, K-Ar age **150 ± 4 Ma**

K = 2.38%, $^{40}Ar/^{40}K$ = 0.00909, radiogenic Ar = 94.2%.
Concentrate: Crushed whole rock.

From fine-grained quartz diorite
(104 I) 16 km southeast of peak 7174', southeastern Three Sisters Range, Cry Lake map area, British Columbia, 58°03'40"N, 129°19'30"W; see Anderson 1979, Figure 2, map unit 4a. Sample AN-79-719-1 collected and interpreted by R.G. Anderson.

The fine-grained phase of the Three Sisters Pluton is characterized by fresh, light grey to white weathering massive quartz diorite to monzodiorite such as the sample which was dated. The fine-grained, equigranular and locally diabasic texture is distinctive and prohibits mineral separation. The rock consists of 64 per cent labradorite, 8 per cent quartz, 4 per cent alkali feldspar, 19 per cent hornblende, 2 per cent biotite, 1 per cent augite and 2 per cent magnetite. Ragged augite cores in hornblende and bytownite cores in labradorite are typical of this phase (and other coeval phases of the Three Sisters Pluton) but are much finer grained than in other phases. Alteration of plagioclase to epidote and hornblende and biotite to chlorite is widespread but of variable degree.

For interpretation see GSC 81-16.

GSC 81-9 Hornblende, K-Ar age **230 ± 10 Ma**

K = 1.00%, $^{40}Ar/^{40}K$ = 0.01428, radiogenic Ar = 89.9%.
Concentrate: Unaltered, pleochroic, brown to dark green hornblende with no visible contamination.

From hornblendite
(104 I) 3 km south-southwest from south end of Upper Gnat Lake, eastern end of Hotailuh Range, Cry Lake map area, British Columbia, 58°11'00"N, 129°51'30"W; see Anderson 1979, Figure 2, map unit 3. Sample AN-79-607-1 collected and interpreted by R.G. Anderson.

One of the lithologies characteristic of the Gnat Lakes Ultramafite is dark greenish grey weathering, massive, medium- to coarse-grained, equigranular hornblendite represented by this sample. The rock is fairly fresh and contains 69 per cent hornblende, 3 per cent augite, 4 per cent magnetite, 4 per cent plagioclase and <1 per cent accessory minerals (titanite and apatite). Euhedral magnetite and apatite and subhedral titanite are distinctive of the Gnat Lakes Ultramafite. Plagioclase (labradorite?) occurs as distinctive, highly altered grains interstitial to hornblende. Chlorite alteration of hornblende is rare.

For interpretation see GSC 81-16.

GSC 81-10 Hornblende, K-Ar age **227 ± 14 Ma**

K = 0.67%, $^{40}Ar/^{40}K$ = 0.01407, radiogenic Ar = 70.5%.
Concentrate: Clean, unaltered, pleochroic, light brown to dark green hornblende with no visible contamination.

From hornblende clinopyroxenite
(104 I) Same location and co-ordinates as GSC 81-9. Sample AN-79-609-2 collected and interpreted by R.G. Anderson.

This sample is representative of the dark greenish grey weathering, massive, medium- to coarse-grained and equigranular hornblende clinopyroxenite of the Gnat Lakes Ultramafite. It comprises 56 per cent hornblende, 27 per cent augite, 11 per cent magnetite and 1 per cent accessory minerals (titanite and apatite). Euhedral magnetite and apatite and subhedral titanite are characteristic. Augite is typically slightly to moderately uralitized by the surrounding anhedral hornblende which accounts for the higher modal proportions of the latter in the clinopyroxenite. About 4 per cent of the rock is composed of epidote and chlorite alteration of the hornblende.

For interpretation see GSC 81-16.

GSC 81-11 Hornblende, K-Ar age **280 ± 19 Ma**

K = 0.340%, $^{40}Ar/^{40}K$ = 0.01757, radiogenic Ar = 50.7%.
Concentrate: Pleochroic, brown to dark brown hornblende with a trace of chlorite contamination.

From hornblende-augite porphyry dyke
(104 I) 5 km south-southeast of Horn Mountain, Cry Lake map area, British Columbia, 58°13'14"N, 129°34'00"W. Sample AN-79-698-3, collected and interpreted by R.G. Anderson.

See GSC 81-12 for description and GSC 81-16 for interpretation.

GSC 81-12 Hornblende, K-Ar age **170 ± 11 Ma**

K = 0.62%, $^{40}Ar/^{40}K$ = 0.01036, radiogenic Ar = 73.8%.
Concentrate: Clean, unaltered, pleochroic, light green to dark brown hornblende with a trace of chlorite contamination.

From hornblende-augite porphyry dyke
(104 I) 5 km south-southeast of Horn Mountain, northern Three Sisters Range, Cry Lake map area, British Columbia, 58°13'14"N, 129°34'00"W (see Anderson 1979, Figure 1). Sample AN-79-698-3 collected and interpreted by R.G. Anderson.

This rock is typical of the uncommon augite-bearing porphyritic dykes which intrude members of the Triassic plutonic suite and Upper Triassic volcanics; atypical are the hornblende phenocrysts. Euhedral hornblende (about 15 per cent), augite (about 7 per cent) and magnetite (about 5 per cent) phenocrysts are set in a groundmass consisting of finer-grained subhedral to anhedral plagioclase, magnetite, hornblende, carbonate amygdules and the alteration products epidote, carbonate and chlorite.

For interpretation see GSC 81-16.

GSC 81-13 Hornblende, K-Ar age **142 ± 53 Ma**

K = 0.065%, $^{40}Ar/^{40}K$ = 0.00857, radiogenic Ar = 9.3%.
Concentrate: Clean, unaltered, pleochroic, light green to brown hornblende with no visible contamination.

From leucocratic granodiorite
(104 I) 18 km southwest of peak 7174', Three Sisters Range, Cry Lake map area, British Columbia, 58°02'23"N, 129°18'45"W. Sample AN-79-718-1, collected and interpreted by R.G. Anderson and H. Gabrielse.

See GSC 81-14 for description and GSC 81-16 for interpretation.

GSC 81-14 Hornblende, K-Ar age **185 ± 28 Ma**

K = 0.156%, $^{40}Ar/^{40}K$ = 0.01130, radiogenic Ar = 42.0%.
Concentrate: Clean, unaltered, pleochroic, light green to bluish green hornblende with no visible contamination.

From leucocratic granodiorite
(104 I) 18 km southwest of peak 7174', southeastern Three Sisters Range, Cry Lake map area, British Columbia, 58°02'23"N, 129°18'45"W; see Anderson 1979, Figure 2, map unit 4e. Sample AN-79-718-1 collected and interpreted by R.G. Anderson.

This rock is the typical white weathering, massive, medium-grained and equigranular, distinctively leucocratic granodiorite of the leucocratic phase of the Three Sisters Pluton. Approximately 46 per cent albite, 25 per cent quartz, 23 per cent perthitic alkali feldspar, 3 per cent hornblende and <1 per cent accessory minerals (apatite and titanite) make up the rock. Opaque minerals are conspicuously absent. Epidote and chlorite make up about 2 per cent of the rock and form minor alteration products of hornblende; some euhedral to subhedral epidote may be primary and is distinctive of this phase.

For interpretation see GSC 81-16.

GSC 81-15 Biotite, K-Ar age **188 ± 4 Ma**

K = 6.61%, $^{40}Ar/^{40}K$ = 0.01154, radiogenic Ar = 93.0%.
Concentrate: Relatively clean, unaltered, light brown biotite with a trace of chlorite contamination.

From granodiorite
(104 J) 3.2 km southwest of peak 5213', western Hotailuh Range, Dease Lake map area, British Columbia, 58°14'00"N, 130°25'30"W; see Anderson 1980. Sample AN-79-716-1 collected and interpreted by R.G. Anderson.

The sample is typical of the Tanzilla Pluton: white weathering, slightly heterogeneous (rare mafic inclusions), massive, medium-grained and equigranular. About 54 per cent labradorite, 20 per cent quartz, 9 per cent alkali feldspar, 8 per cent biotite, 7 per cent hornblende and 2 per cent accessory minerals (magnetite, titanite and apatite) make up the rock. Minor alteration of the ferromagnesian minerals to chlorite and calcite and of plagioclase to white mica and sausserite is visible. Irregular, more calcic plagioclase cores in labradorite are very rare.

See GSC 81-16 for description and interpretation.

GSC 81-16 Hornblende, K-Ar age **171 ± 14 Ma**

K = 0.50%, $^{40}Ar/^{40}K$ = 0.01039, radiogenic Ar = 65.1%.
Concentrate: Relatively clean, unaltered, pleochroic, light brown to green hornblende with a trace of chlorite contamination.

From granodiorite
(104 J) Details as for GSC 81-15.

This report summarizes the K-Ar isotopic dating (37 determinations) of the Hotailuh Batholith and surrounding satellitic plutons. This work was done in conjunction with the early reconnaissance mapping of the area (Gabrielse, 1962; Gabrielse et al., 1962; Wanless et al., 1972, p. 17-21) and later, more detailed mapping (Anderson, 1978, 1979 and 1980; Gabrielse, 1979, 1980; Stevens et al., 1982). The early work established two groups of ages, 213-217 Ma and 139-166 Ma (uncorrected for revised decay constants). The batholith was believed to be uniform in composition, intrusive into the Upper Triassic Stuhini Group and the source for granitic detritus in nearby Lower Jurassic conglomerates (Wanless et al., 1972, p. 21; Gabrielse and Reesor, 1974). Detailed work was undertaken in order to determine the relationships between plutons within the Hotailuh Batholith and between the country rock and the batholithic and satellitic plutons. The geological relationships provide geological constraints on interpretation of the K-Ar geochronology of the Upper Triassic plutons and Lower to Upper Jurassic plutons summarized in Table 1 and Figures 4 and 5.

The Triassic plutonic suite consists of four plutons intruded in the following order (oldest to youngest): Stikine Pluton (consisting of intensely foliated hornblende diorite); Cake Hill Pluton (composed of moderately foliated hornblende granodiorite, quartz monzodiorite and quartz monzonite); Gnat Lakes Ultramafite (composed of hornblende clinopyroxenite and hornblendite); and Beggerlay Creek

Pluton (comprising altered hornblende diorite and gabbro). The Upper Triassic Stuhini Group in part nonconformably overlies and commonly contains fragments of the Cake Hill Pluton in its basal members. Augite- and augite-bladed plagioclase porphyry dykes, believed to be comagmatic with some of the flows in the Stuhini Group, intrude the Cake Hill Pluton, Gnat Lakes Ultramafite and Beggerlay Creek Pluton. Only the Beggerlay Creek Pluton demonstrably intrudes and metamorphoses the Stuhini Group. The country rock intruded by other plutons was apparently covered by younger volcanics and sediments or uplifted and eroded during emplacement and uplift of the two plutonic suites. Poorly preserved ammonites collected from the Stuhini Group around the Hotailuh Batholith suggest a possible to probable Triassic age (H.W. Tipper, personal communication 1977, 1979); elsewhere it is known to be of Carnian-Norian age (Souther, 1971a; Monger, 1980).

Potassium-argon isotopic ages for the Triassic plutonic suite range from 143 ± 6 Ma (GSC 70-28) to 230 ± 10 Ma (GSC 81-9; Table 1 and Figures 4a and 5a). In general, they agree well with the upper stratigraphic constraint on the age of intrusion but only crudely conform to the relative order of pluton emplacement. Interpretation of the 222 ± 11 Ma (GSC 70-34) isotopic age for the Stikine Pluton is poorly constrained because its relationship with the Stuhini Group is poorly known. Also, the petrography of sample GSC 70-34, bears marked similarities to the Cake Hill Pluton rather than the Stikine Pluton. More work is warranted to determine the isotopic age of the Stikine Pluton.

The older isotopic ages for the Cake Hill Pluton, 218 ± 11 Ma (GSC 70-33), 220 ± 11 Ma (GSC 70-33) and 227 ± 14 Ma (GSC 80-5) are internally consistent. Parts of the pluton uplifted and unroofed during the Late Triassic to provide a source area for some of the Stuhini Group volcaniclastics might be expected to yield slightly older isotopic ages than areas of the pluton later unroofed and presently exposed. Nonetheless the oldest isotopic age provides a minimum estimate for the emplacement of the Cake Hill Pluton because it is intruded by the Gnat Lakes Ultramafites, dated at 227-230 Ma. Estimates of the isotopic age of the Carnian-Norian boundary at 225 Ma by Armstrong (1978, 1981) and 220 ± 8 Ma by Odin (1981; see Figure 5a) are remarkably consistent with the isotopic dating of and the stratigraphic constraints on the emplacement of the Cake Hill Pluton. The analytical uncertainty (2σ) in the Late Triassic ages for the Cake Hill Pluton, the fact that the K-Ar isotopic ages are cooling ages and the uncertainty in the isotopic age of the Carnian-Norian boundary demonstrated by Odin (1981) permit sufficient time for the Cake Hill Pluton to be intruded, uplifted and unroofed as a source area for sediments in the Upper Triassic Stuhini Group. The Jurassic isotopic ages of 151 ± 8 Ma (GSC 70-27) and 143 ± 6 Ma (GSC 70-28) were determined from drill core samples of a pendant of intruded and metamorphosed Cake Hill Pluton in the Three Sisters Pluton (Souther, 1971b) and are clearly reset ages.

The Gnat Lakes Ultramafite is dated at 227 ± 14 Ma (GSC 81-10) and 230 ± 10 Ma (GSC 81-9). As with the Cake Hill Pluton, these isotopic ages are consistent with the stratigraphic constraints on its emplacement age. The Gnat Lakes Ultramafite is lithologically and petrographically similar to phases of other Upper Triassic, Alaskan-type ultramafic bodies (e.g. Irvine, 1976; T.N. Irvine, personal communication, 1979) which are believed to be comagmatic with the augite porphyry flows of the Upper Triassic Takla Group (Irvine, 1976). Wong and Godwin (1980) dated pegmatitic hornblende segregations in the Wrede Creek (Alaskan-type) ultramafite in the McConnell Creek map area (94D) at 225 ± 8 Ma which compare closely with isotopic ages determined from the Gnat Lakes Ultramafite.

One K-Ar isotopic age, 218 ± 29 Ma (GSC 81-6) was determined for the Beggerlay Creek Pluton. The low potassium content of the analyzed amphibole separate contributes to the large (2σ) analytical uncertainty in the age. Nevertheless, it is consistent with the intrusive relationship of the Beggerlay Creek Pluton with the Stuhini Group. If the date approximates the emplacement age of the pluton, it constrains the period of extrusion and deposition of part of the Stuhini Group to 9 million years between the time of incorporation of Cake Hill Pluton fragments into the basal Stuhini Group (post 227 ± 14 Ma; GSC 80-5) and the intrusion of the Beggerlay Creek Pluton into part of the volcanic pile (pre 218 ± 29 Ma; GSC 81-6). This age bracket is remarkably similar to the isotopic age of the Carnian-Norian boundary proposed by Armstrong (1981).

It was hoped that the isotopic age of the hornblende-augite porphyry dyke in the Cake Hill Pluton would provide a corroboration of the isotopic age brackets for the Upper Triassic Stuhini Group. However, two K-Ar isotopic dates determined from two different samples of the same dyke, 280 ± 19 Ma (GSC 81-11) and 170 ± 11 Ma (GSC 81-12), are probably not significant (Table 1). They are highly discordant and the older date is inconsistent with the presumed age (~230-?240 Ma) of the Cake Hill Pluton which it intrudes. The older date may represent effects of excess Ar in the system; the Middle Jurassic isotopic date probably records resetting of the isotopic system during intrusion of the Jurassic plutonic suite.

Batholithic (Figure 5b; see Anderson 1978, 1979) and satellitic (Figure 5c; see Anderson, 1980) members of the Jurassic plutonic suite were mapped in detail. Two types of plutons occur. One type, exemplified by the McBride River Pluton and parts of the Snowdrift Creek Pluton, is homogeneous, contains rare mafic inclusions, is massive to faintly foliated and is composed of siliceous hornblende-biotite granodiorite or tonalite. The other type, seen in the Three Sisters, Pallen Creek, Tanzilla and parts of the Snowdrift Creek Plutons, is a heterogeneous, composite variety with uncommon to common mafic inclusions, rare foliation, and an expanded compositional spectrum. The Three Sisters Pluton exemplifies this second type. It is composed of five phases whose intraplutonic intrusive relations establish an overall mafic to felsic intrusive sequence (oldest to youngest): fine-grained phase (fine-grained augite-hornblende quartz monzodiorite, quartz diorite and monzodiorite); mafic phase (several varieties of (biotite-) hornblende diorite and gabbro); central phase (heterogeneous biotite-hornblende monzodiorite, quartz monzodiorite and granodiorite); potassic marginal phase (hornblende-biotite granite, quartz syenite, quartz monzonite and syenite); and leucocratic phase (distinctive leucocratic (epidote-) hornblende quartz diorite, granodiorite and diorite). Two or more varieties of these lithologies are present in other plutons of this type.

The Jurassic plutonic suite intrudes the Upper Triassic Stuhini Group and metamorphoses the carbonates, sandstones and shales of the Lower Jurassic sediments which fringe parts of the northern and eastern margins of the Hotailuh Batholith. The latter unit is abundantly fossiliferous and is dated at Early to Late Toarcian (Henderson and Perry, 1981; Anderson, 1980). This places a lower stratigraphic constraint on the emplacement age of parts of the Jurassic plutonic suite of 188 Ma (base of the Toarcian) according to Armstrong (1981; Figure 5b). The Snowdrift Creek Pluton intrudes Pleinsbachian sediments (Stevens et al., 1982) and therefore must have been emplaced post 188-197 Ma (Armstrong, 1981; Figure 5c). There is no geological constraint on the upper stratigraphic age of emplacement of the Jurassic plutonic suite.

Table 1

Compilation of K-Ar isotopic age determinations for the Hotailuh Batholith and satellitic plutons

Pluton or Phase	Determination Number and Reference	Sample No.	Age[1] (Ma)	Mineral
		TRIASSIC PLUTONIC SUITE		
Stikine Pluton	GSC 70-34[2]	GA-67-98C	222 ± 11	hornblende
			222 ± 11	hornblende
Cake Hill Pluton	GSC 70-27[2]	GA-1390	151 ± 8	hornblende
	GSC 70-28[2]		143 ± 6	biotite
Cake Hill Pluton	GSC 70-33[2]	GAD67-132-1	220 ± 11	hornblende
			218 ± 11	hornblende
Cake Hill Pluton	GSC 80-5[2]	An-77-276	227 ± 14	hornblende
Gnat Lakes Ultramafite	GSC 81-9[4]	An-79-607-1	230 ± 10	hornblende
Gnat Lakes Ultramafite	GSC 81-10[4]	An-79-609-2	227 ± 14	hornblende
Beggerlay Creek Pluton	GSC 81-6[4]	An-79-717-1	218 ± 29	hornblende
		TRIASSIC AND JURASSIC VOLCANICS		
Augite hornblende porphyry dyke	GSC 81-11[4] and 12	An-79-698-3	280 ± 19	hornblende
			170 ± 11	hornblende
		JURASSIC PLUTONIC SUITE		
Three Sisters Pluton fine-grained phase	GSC 81-8[4]	An-79-719-1	150 ± 4	whole rock
mafic phase	GSC 80-8[3]	An-78-542-1	183 ± 14	hornblende
mafic phase	GSC 80-9[3]	An-78-523-1	179 ± 6	biotite
	GSC 80-10[3]		189 ± 14	hornblende
mafic phase	GSC 81-5[4]	An-79-661-3	172 ± 13	hornblende
			170 ± 16	hornblende
central phase	GSC 70-30[2,5]	GAD67-132-3	159 ± 8	hornblende
central phase	GSC 70-31[2]	GAD67-132-2	167 ± 9	hornblende
	GSC 70-32[2]		167 ± 7	biotite
central phase	GSC 80-4[3]	An-77-345	170 ± 11	hornblende
potassic marginal phase	GSC 70-29[2]	GA2/9/61-2A	170 ± 8	hornblende
potassic marginal phase	GSC 80-2[3]	An-77-356	176 ± 5	biotite
	GSC 80-3[3]		169 ± 11	hornblende
potassic marginal phase	GSC 80-7[3]	An-78-505-5	208 ± 15	hornblende
potassic marginal phase	GSC 81-4[4]	An-78-528-3	180 ± 5	biotite
leucocratic phase	GSC 81-13[4] and 14	An-79-718-1	142 ± 53	hornblende
McBride River Pluton	GSC 80-11[3]	An-78-467	186 ± 13	hornblende
Snowdrift Creek Pluton	GSC 80-1[3]	An-77-329	147 ± 5	biotite
Pallen Creek Pluton	GSC 70-25[2]	GA-67-97	165 ± 8	hornblende
	GSC 70-26[2]		145 ± 7	biotite
Pallen Creek Pluton	GSC 81-7[4]	An-79-635-1	197 ± 18	hornblende
Tanzilla Pluton	GSC 81-16[4]	An-79-716	171 ± 14	hornblende
	GSC 81-15[4]	An-79-716	188 ± 4	biotite

[1] All K-Ar isotopic ages are consistent with the decay constants recommended by Steiger and Jager (1977).
[2] Reported in Wanless et al. (1972, p. 17-21).
[3] Reported in Stevens et al. (1982).
[4] This report.
[5] Location corrected to 8.5 km east southeast of peak 7174', eastern Three Sisters Range, Cry Lake map area, British Columbia, 58°08'36"N, 129°31'00"W (H. Gabrielse personal communication, 1977; see Anderson, Figure 2, map-unit 4c).

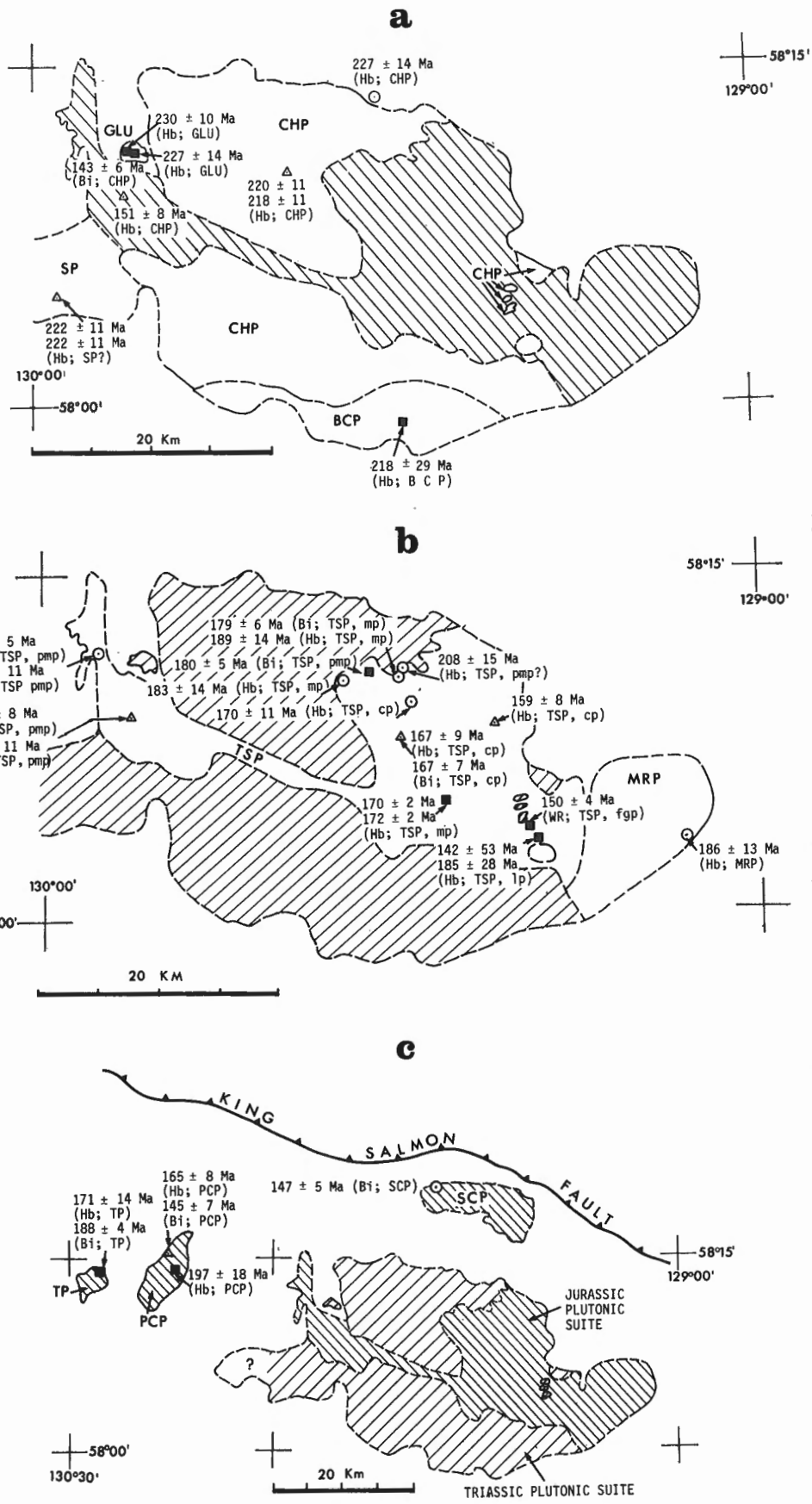


Figure 4

Distribution of K-Ar dates for (a) Triassic plutonic suite; (b) Jurassic plutonic suite (batholithic plutons); and (c) Jurassic plutonic suite (satellitic plutons). Shaded squares represent new K-Ar isotopic ages given in this report; open symbols represent K-Ar isotopic ages already reported (Table 1); for triangles see Wanless et al., 1972, p. 17-21 and for circles see Stevens et al., 1982. Abbreviations for Triassic plutonic suite are: BCP = Beggerlay Creek Pluton; CHP = Cake Hill Pluton; GLU = Gnat Lakes Ultramafite; SP = Stikine Pluton. Abbreviations for the Jurassic plutonic suite (batholithic plutons) are: MRP = McBride River Pluton; TSP = Three Sisters Pluton (cp = central phase; fgp = fine-grained phase; lp = leucocratic phase; mp = mafic phase; pmp = potassic marginal phase). Abbreviations for the Jurassic plutonic suite (satellitic plutons) are: PCP = Pallen Creek Pluton; SCP = Snowdrift Creek Pluton; TP = Tanzilla Pluton. Parenthesized abbreviations refer to material (Bi = biotite; Hb = hornblende; WR = whole rock) and pluton or phase dated.

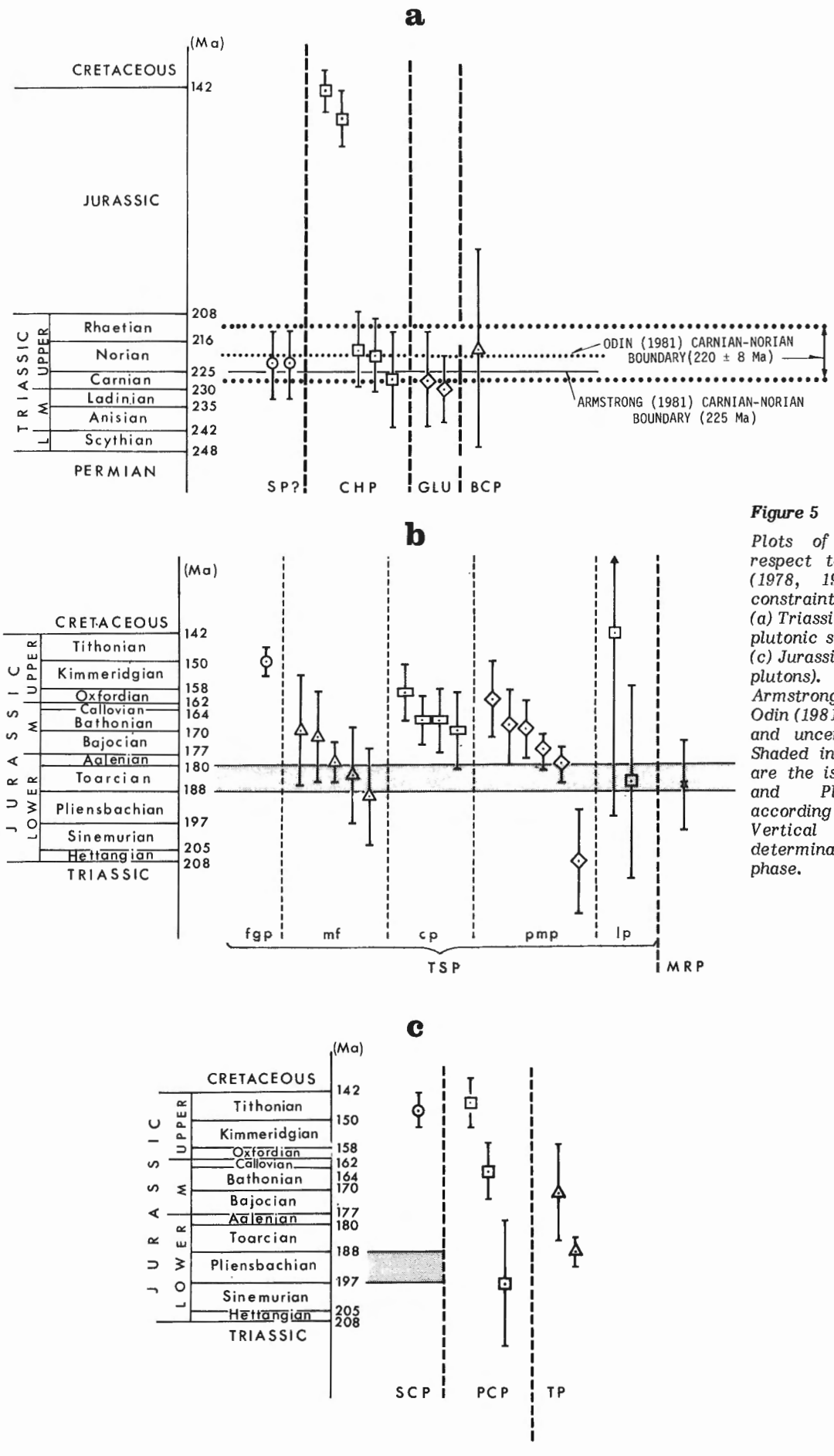


Figure 5

Plots of K-Ar isotopic ages with respect to time scale of Armstrong (1978, 1981) and the stratigraphic constraints on the emplacement age of: (a) Triassic plutonic suite; (b) Jurassic plutonic suite (batholithic plutons); and (c) Jurassic plutonic suite (satellitic plutons). Carnian-Norian boundary of Armstrong (1981; solid line) and Odin (1981; dotted lines show estimate and uncertainty) given in Figure 2a. Shaded intervals of Figures 2b and 2c are the isotopic ages for the Toarcian and Pleinsbachian, respectively, according to Armstrong (1981). Vertical dashed lines separate determinations for each pluton or phase.

Potassium-argon isotopic ages for the Jurassic plutonic suite range from 142 ± 53 Ma (GSC 81-13) to 208 ± 15 Ma (GSC 80-7; see Table 1). However, intrusion of most of the Jurassic pluton suite is considered to have occurred between 180 Ma and 188 Ma. The interval includes most of the oldest isotopic ages from plutons and phases in the Jurassic plutonic suite within the 2σ analytical uncertainty. Nevertheless, a few intraphase discordant K-Ar dates exist (e.g. 161 ± 11 Ma (GSC 70-29) and 180 ± 5 Ma (GSC 81-4) for the potassic marginal phase). In the eastern outcrops of the Three Sisters Pluton, there is a broad decrease in K-Ar isotopic age from the northwest (208 Ma, 179-189 Ma) to the east and southeast (142-159 Ma; Figure 4b). This change is seen within phases (e.g. mafic and central phases) and apparently does not reflect their sequential intrusion. It may be due to a prolonged cooling of the Three Sisters Pluton (between approximately 188-150 Ma) or, more likely, a late (~150 Ma), low temperature hydrothermal alteration which selectively reset the K-Ar isotopic system in samples closest to the present margins of the pluton. This is also detected in the west (Figures 4b, 4c) where barely unroofed exposures of the Three Sisters Pluton, potassic marginal phase, Pallen Creek Pluton and Tanzilla Pluton are characterized by highly discordant mineral pairs (e.g. Pallen Creek Pluton: GSC 70-25; 70-26 and GSC 81-7) or anomalously younger hornblende ages compared to coexisting biotites (e.g. Three Sisters Pluton, potassic marginal phase (GSC 80-2, 80-3) and Tanzilla Pluton (GSC 81-15 and 16). This 150-155 Ma "event" may be related to the intrusion of the Snowdrift Creek Pluton if the single mineral K-Ar age of 147 ± 5 Ma (GSC 80-1) reflects its emplacement age; however, parts of it have marked lithological, petrographic and geochemical similarities with the McBride River Pluton dated at 186 ± 13 Ma (GSC 80-11). Accurate isotopic dating of the intrusion age of the Snowdrift Creek Pluton is also important in constraining the age of earliest formation of structures related to the King Salmon Fault which the pluton truncates (H. Gabrielse, personal communication, 1980).

The anomalously old isotopic age of 208 ± 15 Ma (GSC 80-7) for the potassic marginal phase of the Three Sisters Pluton may reflect excess argon through incorporation of the older Cake Hill Pluton as evidenced by petrographic similarities of the sample to the Cake Hill Pluton and uncommon inclusions of the Cake Hill Pluton in the potassic marginal phase near the sample location. Sample GSC 70-29 from the central phase of the Three Sisters Pluton also has more petrographic similarity to the Cake Hill Pluton than the distinctive central phase. Finally, the large analytical uncertainties in K-Ar isotopic ages for the leucocratic phase of the Three Sisters Pluton (GSC 81-13 and 14) reflect the K-poor nature of the amphiboles and show the need for more dating of this phase.

Potassium-argon isotopic dating indicates two main periods of plutonism in and around the Hotailuh Batholith: an episode in the Late (to Middle?) Triassic (K-Ar ages between 218-230 Ma); and an episode in the Early to Late Jurassic (K-Ar ages between 142-188 Ma). The K-Ar isotopic systems of the Jurassic plutonic suite may have been affected by a late, low temperature, hydrothermal disturbance around 150 Ma which partially to totally reset some samples. Stratigraphic and isotopic dating of the emplacement of most of the Jurassic plutonic suite between 180-188 Ma compares closely in age with Jurassic plutonism and volcanism along the northeastern margin of the Bowser Basin (Gabrielse et al., 1980).

Generally, the K-Ar isotopic dating of the Hotailuh Batholith agrees well with the stratigraphic constraints on the emplacement of the two plutonic suites. It may place brackets on the isotopic age of the Stuhini Group volcanism (between 218 and 227 Ma) centered at the batholith. The K-Ar isotopic ages reported here provide the framework for further geochronological studies of the Hotailuh Batholith.

References

Anderson, R.G.
1978: Preliminary report on the Hotailuh Batholith: its distribution, age and contact relationships in the Cry Lake, Spatsizi and Dease Lake map-areas, north-central British Columbia; in Current Research, Part A, Geological Survey of Canada, Paper 78-1A, p. 29-31.

1979: Distribution and emplacement history of plutons within the Hotailuh Batholith in the Cry Lake and Spatsizi map-areas, north-central British Columbia; in Current Research, Part A, Geological Survey of Canada, Paper 79-1A, p. 393-395.

1980: Satellitic stocks, volcanic and sedimentary stratigraphy, and structure around the northern and western margins of the Hotailuh Batholith, north-central British Columbia; in Current Research, Part A, Geological Survey of Canada, Paper 80-1A, p. 37-40.

Armstrong, R.L.
1978: Pre-Cenozoic Phanerozoic time-scale --computer file of critical dates and consequences of new and in-progress decay-constant revisions; American Association of Petroleum Geologists, Studies in Geology, no. 6, p. 73-91.

1981: Late Triassic-Early Jurassic time scale calibration in British Columbia, Canada; in Odin, G.S., editor, 1981, Numerical dating of the Stratigraphic Column. (in press)

Gabrielse, H.
1962: Cry Lake; Geological Survey of Canada, Map 29-1962.

1979: Geological map of Cry Lake map area; Geological Survey of Canada, Open File 610.

1980: Dease Lake map area; Geological Survey of Canada, Open File 707.

Gabrielse, H. and Reesor, J.E.
1974: The nature and setting of granitic plutons in the central and eastern parts of the Canadian Cordillera; Pacific Geology, v. 8, p. 109-138.

Gabrielse, H., Souther, J.G., and Roots, E.F.
1962: Dease Lake; Geological Survey of Canada, Map 21-1962.

Gabrielse, H., Wanless, R.K., Armstrong, R.L., and Erdman, L.R.
1980: Isotopic dating of Early Jurassic volcanism and plutonism in north-central British Columbia; in Current Research, Part A, Geological Survey of Canada, Paper 80-1A, p. 27-32.

Henderson, C.M. and Perry, D.G.
1981: A Lower Jurassic heteroporid cryozoan and associated biota, Turnagain Lake, British Columbia; Canadian Journal of Earth Sciences, v. 18, p. 457-468.

Irvine, T.N.
1976: Studies of Cordilleran gabbroic and ultramafic intrusions, British Columbia. Part 2: Alaskan ultramafic-gabbroic bodies in the Aiken Lake, McConnell Creek and Toodoggone map-areas; in Report of Activities, Part A, Geological Survey of Canada, Paper 76-1A, p. 76-81.

Monger, J.W.H.
1980: Upper Triassic stratigraphy, Dease Lake and Tulsequah map areas, northwestern British Columbia; in Current Research, Part B, Geological Survey of Canada, Paper 80-1B, p. 1-9.

Odin, G.S.
1982: Numerical Dating in Stratigraphy, J. Wiley & Sons Ltd.

Souther, J.G.
1971a: Geology and mineral deposits of the Tulsequah map-area, British Columbia; Geological Survey of Canada, Memoir 362, 84 p.

1971b: Log of drill hole no. 2, NTS 104 I, British Columbia; Geological Survey of Canada, Open File 56.

Steiger, R.H. and Jager, E.
1977: Subcommission of Geochronology: Convention on the use of decay constants in geo- and cosmochronology; Earth and Planetary Science Letters, v. 36, p. 359-362.

Stevens, R.D., Delabio, R.N., and Lachance, G.R.
1982: Age determinations and geological studies. Geological Survey of Canada, Paper 81-2.

Wanless, R.K., Stevens, R.D., Lachance, G.R., and Delabio, R.N.
1972: Age determinations and geological studies; Geological Survey of Canada, Paper 71-2, p. 17-21.

Wong, R.H. and Godwin, C.I.
1980: K/Ar determinations, Wrede Creek zoned ultramafic complex (94D/9E); in Geological Fieldwork, 1979, British Columbia Ministry of Energy, Mines and Petroleum Resources, Paper 1980-1, p. 156-157.

GSC 81-17 Biotite, K-Ar age **53.3 ± 1.4 Ma**

K = 7.02%, $^{40}Ar/^{40}K$ = 0.00314, radiogenic Ar = 70.6%.
Concentrate: Clean, unaltered, dark brown biotite with no detected chlorite.

From gneiss
(94 E) Ridge crest about 3.3 km northeast of Warner Peak in southern Sifton Range, Toodoggone map area, British Columbia, 57°41'15"N, 126°05'30"W. Sample GA79-67, collected and interpreted by H. Gabrielse.

The rock is a medium to coarse grained, well layered and foliated grey granitic gneiss locally with conspicuous augen of potash feldspar. It comprises more than 40 per cent quartz, more than 30 per cent feldspar, 10 per cent biotite and 5 per cent amphibole. All minerals are fresh. Zircon is a common accessory mineral.

The K-Ar age is in general agreement with several ages obtained on various other lithologies nearby. These include amphibolite (GSC 78-25; 37.8 ± 1.7 Ma); amphibolite (GSC 78-30; 51.0 ± 1.8 Ma); and granite (GSC 78-20; 40.6 Ma). These ages appear to reflect a thermal event of Eocene age that affected rocks in many of the metamorphic complexes along the Omineca Crystalline Belt.

GSC 81-18 Muscovite, K-Ar age $\frac{44.9}{40.0} \pm \frac{2.0}{1.9}$ **Ma**

K = 4.34%, $^{40}Ar/^{40}K = \frac{0.00264}{0.00235}$, radiogenic Ar = $\frac{56.0}{14.3}$%.

From schist
(94 E) Saddle on ridge crest, approximately 4 km northeast of north end of Spinel Lake, Toodoggone map area, British Columbia, 57°55'42"N, 126°22'30"W. Sample GA79-67b, collected and interpreted by H. Gabrielse.

Rock is a kyanite-staurolite-garnet-mica schist intercalated with quartzite and pebble conglomerate. The texture is crystalloblastic medium grained. Thin-sections are characterized by deformed kyanite crystals and helicitic garnets.

The muscovite is anomalous in having low potassium content and low radiogenic argon. An earlier sample yielded no detectable radiogenic argon. The K-Ar ages are similar to those from the southern part of the Sifton Range (See note on GSC 81-17).

GSC 81-19 Biotite, K-Ar age **78.4 ± 1.7 Ma**

K = 7.58%, $^{40}Ar/^{40}K$ = 0.00466, radiogenic Ar = 71.2%.
Concentrate: Clean, unaltered, dark greenish brown biotite with no detected chlorite.

From granite
(104 I) On west side of mountain between Eagle and Little Eagle Rivers, about 10 km northest of Fish Lake, Cry Lake map area, British Columbia, 58°35'N, 129°39'W. Sample GA79-102B, collected and interpreted by H. Gabrielse.

The rock is a blocky, leucocratic, medium grained miarolitic biotite granite characterized by rusty and deeply weathered surface. It contains about 40 per cent patchy perthitic potash feldspar locally forming megacrysts to 5 mm, less than 20% oligoclase-andesine, about 25 per cent quartz and 5% fairly fresh biotite.

See GSC 81-20 for interpretation.

GSC 81-20 Hornblende, K-Ar age **73.5 ± 4.2 Ma**

K = 0.80%, $^{40}Ar/^{40}K$ = 0.00436, radiogenic Ar = 31.2%.
Concentrate: Pleochroic brown to dark green hornblende with a trace of biotite contamination.

From granite/quartz monzonite
(104 J) On ridge crest approximately 1.6 km southeast of Snow Peak, Dease Lake map area, British Columbia, 58°27'N, 130°26'15"W. Sample GA79-103, collected and interpreted by H. Gabrielse.

Rock is a leucocratic medium grained biotite-hornblende quartz monzonite with well developed beta quartz crystals. It comprises 30 per cent potash feldspar, 30 per cent plagioclase (An_{40}) which is partly sericitized and strongly zoned, 5 per cent biotite and 5 per cent hornblende both slightly chloritized but mainly fresh, and 20 per cent quartz.

The sample is from a stock that has intruded and metamorphosed folded and cleaved Lower Jurassic sediments. The K-Ar age and that of GSC 81-19 (78.4 ± 1.7 Ma) represent a plutonic episode that has produced a number of stocks and small batholiths in the Jenning's River (104 O) and McDame (104 P) map areas to the north. All seem to post-date contractional and strike-slip displacements in the region.

GSC 81-21 Hornblende, K-Ar age $\frac{137}{137} \pm \frac{12}{12}$ **Ma**

K = 0.45%, $^{40}Ar/^{40}K = \frac{0.00827}{0.00827}$, radiogenic Ar = $\frac{62.6}{54.5}$%.

Concentrate: Unaltered, pleochroic, light brown to dark green hornblende with a trace of chlorite contamination.

From quartz monzonite

(104 I) About 5 km west of Four Mile River on east side of ridge, approximately 16 km north-northwest of Dark Mountain, Cry Lake map area, British Columbia, 58°43'N, 129°30'15"W. Sample GA79-81, collected and interpreted by H. Gabrielse.

The rock is a pink weathering hornblende quartz monzonite of medium grain size locally containing megacrysts of potash feldspar. It comprises about 35 per cent plagioclase (An_{34}) which is partly altered to sericite; 35 per cent potash feldspar; and 10 per cent hornblende in some places much altered to chlorite but in others completely fresh. Sphene is abundant.

The quartz monzonite is intrusive into hornblende diorite or granodiorite (see GSC 81-22) forming a batholith of early Jurassic age. Similar plutons elsewhere in the region have given somewhat older ages (ca. 150-160 Ma). Considering the rather large limits of error in these determinations little importance can be placed on their significance at present.

GSC 81-22 Hornblende, K-Ar age **206 ± 11 Ma**

K = 0.82%, $^{40}Ar/^{40}K$ = 0.01270, radiogenic Ar = 85.1%.

Concentrate: Pleochroic, light brown to dark green hornblende with a trace of biotite and chlorite contamination.

From granodiorite

(104 I) Low, timbered knobs 2 km west of Eagle River and 10 km east-northeast of north end of Halfmoon Lake, Cry Lake map area, British Columbia, 58°43'30"N, 129°46'45"W. Sample GA79-102A, collected and interpreted by H. Gabrielse.

Rock is a leucocratic to mesocratic medium to coarse grained hornblende quartz granodiorite to diorite. It comprises 40 per cent strongly sericitized plagioclase; 10 per cent potash feldspar, locally megacrystic; more than 25 per cent quartz and 20 per cent hornblende which is generally fresh.

The batholith underlain by these rocks is separated from the Cassiar batholith (mid Cretaceous quartz monzonite to granite) by the Kutcho fault. The lithology is identical with that of the early Jurassic plutons in Toodoggone River (94 E) map area. It is clear that early Jurassic plutonism was widespread along the eastern margin of the Intermontane Belt.

GSC 81-23 Biotite, K-Ar age **43.7 ± 2.3 Ma**

K = 7.05%, $^{40}Ar/^{40}K$ = 0.00257, radiogenic Ar = 79.4%.

Concentrate: Greenish brown biotite with approximately 6% chlorite alteration.

From quartz diorite

(103 I) 2 km west-northwest of Mt. Suden, Prince Rupert map area, British Columbia, 54°32'10"N, 129°34'41"W. Map unit D, G.S.C. map 1472A. Sample WN-36-75, collected by R.K. Wanless and W.W. Hutchison.

See GSC 81-24 for description.

GSC 81-24 Hornblende, K-Ar age **50.3 ± 2.9 Ma**

K = 0.774%, $^{40}Ar/^{40}K$ = 0.00296, radiogenic Ar = 56.0%.

Concentrate: Clean, unaltered, pleochroic brown to dark green hornblende with no visible contamination.

From quartz diorite

(103 I) Details as for GSC 81-23.

The sample is a quartz diorite from near the north end of the Kasiks pluton, a dioritic body associated with the Central Gneiss Complex.

GSC 81-25 Biotite, K-Ar age **51.4 ± 2.4 Ma**

K = 7.25%, $^{40}Ar/^{40}K$ = 0.00303, radiogenic Ar = 74.2%.

Concentrate: Relatively clean, unaltered, light brown biotite with a slight trace of chlorite contamination.

From gneiss

(103 I) 1.5 km east of Mt. Campagnolo, Prince Rupert map area, British Columbia, 54°31'12"N, 129°43'39"W. Map unit 1a, GSC map 1472A. Sample WN-35-75, collected by R.K. Wanless and W.W. Hutchison.

See GSC 81-26 for description.

GSC 81-26 Hornblende, K-Ar age **54.1 ± 3.1 Ma**

K = 0.827%, $^{40}Ar/^{40}K$ = 0.00319, radiogenic Ar = 69.4%.

Concentrate: Clean, unaltered, pleochroic, brown to dark green hornblende with no visible contamination.

From gneiss

(103 I) Details as for GSC 81-25.

The sample is a coarse grained, grey gneiss from the Central Gneiss Complex. Biotite and hornblende are fresh and unaltered.

GSC 81-27 Biotite, K-Ar age **42.0 ± 2.2 Ma**

K = 6.48%, $^{40}Ar/^{40}K$ = 0.00247, radiogenic Ar = 65.9%.

Concentrate: Brownish orange biotite with approximately 4% chlorite alteration.

From garnet-bearing granulite

(103 I) Large quarry about 1 km east of Kwinitsa, Prince Rupert map area, British Columbia, 54°13'41"N, 129°32'13"W. Map unit 1b, G.S.C. map 1472A. Sample WN-37-75(A), collected by R.K. Wanless and W.W. Hutchison.

See GSC 81-29 for description.

GSC 81-28 Hornblende, K-Ar age **52.3 ± 9.2 Ma**

K = 0.78%, $^{40}Ar/^{40}K$ = 0.00308, radiogenic Ar = 57.1%.
Concentrate: Clean, unaltered, pleochroic very light brown to dark brown hornblende with no visible contamination.

From garnet-bearing granulite.
(103 I) Details as for GSC 81-27.

See GSC 81-29 for description.

GSC 81-29 Biotite, K-Ar age **43.9 ± 2.3 Ma**

K = 5.16%, $^{40}Ar/^{40}K$ = 0.00258, radiogenic Ar = 53.5%.
Concentrate: Clean, unaltered, brownish orange biotite with no visible contamination.

From biotite-hornblende gneiss
(103 I) About 1 km east of Kwinitsa, Prince Rupert map area, British Columbia, 54°13'41"N, 129°32'13"W. Map unit 1b, G.S.C. map 1472A. Sample WN-37-75(B), collected by R.K. Wanless and W.W. Hutchison.

GSC 81-27, 28 and 29 are from the same locality, which is the locality where GSC 78-1 (44.8 ± 2.4, biotite) and GSC 78-2 (45.4 ± 2.4, biotite) were collected. GSC 81-27 and 28 are from a sample of garnet-orthopyroxene granulite; GSC 81-29 is from a hornblende-biotite-garnet gneiss. Both rocks were fresh and unaltered.

GSC 81-30 Biotite, K-Ar age **46.9 ± 2.5 Ma**

K = 7.49%, $^{40}Ar/^{40}K$ = 0.00276, radiogenic Ar = 79.2%.
Concentrate: Brown biotite with approximately 2% chlorite alteration.

From gneiss
(103 I) About 6 km southeast of Morin Peak, Prince Rupert map area, British Columbia, 54°28'17"N, 129°15'39"W. Map unit 1b, G.S.C. map 1472A. Sample WN-33-75, collected by R.K. Wanless and W.W. Hutchison.

This sample is from leucogneiss of the Central Gneiss Complex. The rock is fresh and unaltered.

GSC 81-31 Biotite, K-Ar age **48.9 ± 2.6 Ma**

K = 7.36%, $^{40}Ar/^{40}K$ = 0.00288, radiogenic Ar = 66.4%.
Concentrate: Dark brown biotite with approximately 2% chlorite alteration.

From gneiss
(103 I) About 8 km south of Amoth Lake, Prince Rupert map area, British Columbia, 54°40'44"N, 129°35'49"W. Map unit 1a, G.S.C. map 1472A. Sample WN-34-75 collected by R.K. Wanless and W.W. Hutchison.

This sample is a fine grained leucogneiss from the Central Gneiss Complex. The rock is fresh and unaltered.

GSC 81-32 Hornblende, K-Ar age **421 ± 11 Ma**

K = 1.75%, $^{40}Ar/^{40}K$ = 0.02754, radiogenic Ar = 90.4%.
Concentrate: Clean, unaltered, pleochroic light brown to dark green hornblende with no visible contamination.

From syenite
(82 N) Ice River Complex, Yoho National Park, British Columbia, 51°08'N, 116°26'W. Sample ICE RIV., collected and interpreted by Wm.C. Gussow.

This represents the first dating of hornblende from the Ice River Complex. Published K-Ar dates on other material range from 220-390 Ma. Currie (1975), based on age dating of biotite, concluded that emplacement occurred in Late Paleozoic time (Devonian-Carboniferous), roughly 245 Ma ago. My interpretation of the field evidence indicated that it is Precambrian basement, so material was collected for possible zircon age determination. There was no zircon, but the syenite contained abundant excellent hornblende which yielded an age nearly twice that of Currie's biotite age. This would: 1) imply a late Ordovician or older time of emplacement, or 2) indicate the last major heating of the rocks. At best, the dates give only the minimum age of the rocks and may have been reset by a later thermal event.

Reference

Currie, K.L.
1975: The geology and petrology of the Ice River alkaline complex, British Columbia; Geological Survey of Canada, Bulletin 245, p. 1-68.

GSC 81-33 Muscovite, K-Ar age **48 ± 4 Ma**

K = 8.30%, $^{40}Ar/^{40}K$ = 0.00281, radiogenic Ar = 54%.
Concentrate: Clean, clear muscovite with no visible contamination.

From quartz monzonite
(82 L) On Branch 1 off Fisher Road, British Columbia, 50°10'N, 118°01'W. Map-unit 1, GSC Map 1059A. Sample 530aRA-1-70, collected by J.E. Reesor.

See GSC 81-34 for description.

GSC 81-34 Biotite, K-Ar age **46 ± 3 Ma**

K = 7.77%, $^{40}Ar/^{40}K$ = 0.00272, radiogenic Ar = 67%.
Concentrate: Clean, orange coloured biotite with no visible contamination or alteration.

From quartz monzonite
(82 L) Details as for GSC 81-33.

This rock is a faintly foliated, medium to fine grained, light grey muscovite biotite quartz monzonite occurring as lenticular and irregular masses in Shuswap metasedimentary gneisses.

GSC 81-35 Biotite, K-Ar age **95.6 ± 2.8 Ma**

K = 6.33%, $^{40}Ar/^{40}K$ = 0.00570, radiogenic Ar = 88.9%.
Concentrate: Light brown biotite with approximately 3% chlorite alteration.

From molybdenite-bearing quartz veinlet stockwork
(105 C) Red Mountain molybdenum deposit, 75 km east-northeast of Whitehorse, Yukon 60°59'16"N, 134°44'30"W. Sample SYA79-56 from Amoco Canada Petroleum Company Limited drill hole 78-4 at a depth of 430-440 m. Collected and interpreted by W.D. Sinclair.

The biotite appears to be hydrothermal in origin. It is medium to coarse grained, light to dark brown and occurs as "books" up to 1 mm thick in quartz veinlets. Molybdenite, pyrite and gypsum are also present in the veinlets.

The Red Mountain deposit consists of a stockwork zone of molybdenum-bearing fractures and quartz veinlets superimposed on a small intrusion of quartz monzonite porphyry and surrounding hornfels. Crosscutting relationships indicate that mineralization occurred in several successive stages. Hydrothermal biotite alteration of the wallrocks is associated with some of the stages and, in places, biotite formed in the quartz veinlets. The age of the biotite from these quartz veinlets (95.6 ± 2.8 Ma) also represents the age of the associated molybdenite mineralization.

This age is slightly older than the ages of 85 ± 3.1 Ma and 70.1 ± 2.6 Ma reported by Tempelman-Kluit (in Wanless et al., 1979) for the Quiet Lake Batholith of quartz monzonite to granodiorite which outcrops a few kilometres to the northeast. The small intrusion of quartz monzonite porphyry and associated molybdenum mineralization at Red Mountain probably represent an older phase of activity related to this intrusion. This is supported by the date of 87.4 ± 1.9 Ma for a quartz monzonite porphyry dyke that cuts the mineralized stockwork (GSC 81-36).

Reference

Wanless, R.K., Stevens, R.D., Lachance, G.R., and Delabio, R.N.
1979: Age determinations and geological studies, K-Ar isotopic ages, Report 14; Geological Survey of Canada, Paper 79-2, 67 p.

GSC 81-36 Phlogopite, K-Ar age **87.4 ± 1.9 Ma**

K = 7.31%, $^{40}Ar/^{40}K$ = 0.00521, radiogenic Ar = 84.1%.
Concentrate: Relatively clean, very light brown phlogopite with approximately 2% chlorite alteration.

From quartz monzonite porphyry
(105 C) Red Mountain molybdenum deposit, 75 km east-northeast of Whitehorse, Yukon 60°59'17"N, 134°44'30"W. Sample SYA80-33 from Amoco Canada Petroleum Company Limited drill hole 79-7 at a depth of 692-699.5 m. Collected and interpreted by W.D. Sinclair.

The quartz monzonite porphyry consists of approximately 50% pink K-feldspar phenocrysts, 10% quartz phenocrysts and 3% biotite phenocrysts in an aphanitic quartzo-feldspathic matrix. The biotite occurs as light to medium brown, ragged, anhedral grains up to 2 mm across. It is partly sericitized, up to 15% in places, but otherwise unaltered.

The sample is from a quartz monzonite porphyry dyke about 20 m wide that cuts the Red Mountain molybdenum deposit. The age of this dyke (87.4 ± 1.9 Ma) is comparable to one of the ages (85 ± 3.1 Ma) for the nearby Quiet Lake Batholith reported by Tempelman-Kluit (in Wanless et al., 1979). The dyke appears to be related to a post-mineral quartz monzonite porphyry intrusion which is compositionally similar to the mineralized quartz monzonite porphyry stock. This supports the contention that the Red Mountain deposit may be genetically related to an earlier phase of intrusive activity associated with the Quiet Lake Batholith.

Reference

Wanless, R.K., Stevens, R.D., Lachance, G.R., and Delabio, R.N.
1979: Age determinations and geological studies, K-Ar isotopic ages, Report 14; Geological Survey of Canada, Paper 79-2, 67 p.

GSC 81-37 Biotite, K-Ar age **70.5 ± 2.2 Ma**

K = 6.33%, $^{40}Ar/^{40}K$ = 0.00418, radiogenic Ar = 88.7%.
Concentrate: Brown biotite with approximately 2% chlorite alteration.

From feldspar porphyry
(115 I) Rusk Creek prospect, 1500 m west of Nansen Creek on the southeast flank of Mount Nansen, Yukon, 62°04'26"N, 137°15'19"W. Sample SYA79-58 from Cyprus Exploration Company Limited drill core CD-16 at a depth of 168.5-170 m. Sample collected and interpreted by W.D. Sinclair.

The feldspar porphyry consists of approximately 35% plagioclase (An_{42}) phenocrysts, 5% quartz phenocrysts and 3% biotite phenocrysts in a fine-grained, dark green matrix of quartz, K-feldspar and chlorite. Minor chlorite, epidote, carbonate and magnetite are also present. Biotite is light to dark brown and appears fresh although it contains abundant magnetite inclusions and some inclusions of chalcopyrite, apatite and zircon.

The feldspar porphyry belongs to the Mount Nansen Group of intermediate to felsic volcanic rocks and appears to be part of massive andesite flows mapped by Sawyer and Dickenson (1976). In the vicinity of the sample location, the feldspar porphyry is cut by scattered quartz veinlets weakly mineralized with chalcopyrite and molybdenite. Consequently, the age of 70.5 ± 2.2 Ma may represent a thermal event associated with this mineralization. However, the age is comparable to other K-Ar age determinations of Mount Nansen Group volcanic rocks that are also about 70 Ma (D.J. Tempelman-Kluit, personal communication, 1980). Thus the age reported here appears to support a Late Cretaceous age for the Mount Nansen Group. This is in contrast to the Late Jurassic-Early Cretaceous age suggested by Bostock (1936) and the Eocene age of 58 Ma reported by

Tempelman-Kluit (1976). The mineralization itself has not been dated radiometrically. However, it appears to be associated with subvolcanic intrusions related to the Mount Nansen Group volcanic rocks and is likely very similar in age.

References

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

Sawyer, J.P.B. and Dickenson, R.A.
1976: Mount Nansen in Porphyry Deposits of the Canadian Cordillera; CIM Special Volume 15, p. 336-343.

Tempelman-Kluit, D.J.
1976: The Yukon Crystalline Terrane: enigma in the Canadian Cordillera; Geological Society of America Bulletin, v. 87, p. 1343-1357.

GSC 81-38 Biotite, K-Ar age **97.1 ± 3.6 Ma**

K = 7.38%, $^{40}Ar/^{40}K$ = 0.00580, radiogenic Ar = 93.8%.
Concentrate: Clean, unaltered, dark brown biotite with no detected chlorite.

From biotite quartz monzonite porphyry
(105 M) Two Buttes (west side), 6.3 km west of Fraser Falls on the Stewart River and approximately 30 km west-southwest of Mayo, Yukon, 63°29'11"N, 135°22'12"W. Sample SYA79-72, collected and interpreted by W.D. Sinclair.

The rock is from the marginal, fine grained phase of a porphyritic biotite quartz monzonite plug. The sample consists of 30% plagioclase phenocrysts, 5% quartz phenocrysts, 5% biotite phenocrysts and 2% hornblende phenocrysts in a very fine-grained matrix of quartz, K-feldspar and minor amounts of calcite and epidote. Apatite and zircon occur as accessory minerals. The biotite is dark brown and ranges from unaltered to chloritized to various degrees.

For interpretation see SYA79-86 (GSC 81-41).

GSC 81-39 Biotite, K-Ar age **98.1 ± 3.6 Ma**

K = 7.16%, $^{40}Ar/^{40}K$ = 0.00586, radiogenic Ar = 92.5%.
Concentrate: Clean, unaltered, light brown biotite with no detected chlorite.

From granodiorite porphyry
(116 A) North side of peak 5864, 5 km west of Hamilton Creek, Yukon, 64°09'36"N, 137°37'27"W. Sample SYA79-79, collected and interpreted by W.D. Sinclair.

The rock is from one of several small bodies that intrude Ordovician to Silurian chert and argillite. The sample consists of 60% phenocrysts of plagioclase (andesine), biotite, orthoclase, hornblende, some clinopyroxene and a few rounded quartz grains in a fine grained matrix of orthoclase, plagioclase, quartz and minor biotite. Biotite is light brown and ranges from 0.3 to 1 mm in size. Some grains are chloritized (up to 20%) but most are clean and relatively unaltered.

For interpretation see SYA79-86 (GSC 81-41).

GSC 81-40 Biotite, K-Ar age **99.3 ± 3.7 Ma**

K = 6.26%, $^{40}Ar/^{40}K$ = 0.00593, radiogenic Ar = 83.6%.
Concentrate: Light brown biotite with approximately 10% chlorite alteration.

From porphyritic quartz monzonite
(115 P) South side of Scheelite Dome, 19.5 km north-northwest of Mayo, Yukon, 63°46'37"N, 136°15'36"W. Sample SYA79-84, from a large, angular block of float, collected and interpreted by W.D. Sinclair.

The specimen consists of approximately 35% plagioclase (andesine), 30% quartz, 20% orthoclase, 10% biotite, 2% hornblende, and 1% clinopyroxene. Epidote, calcite, chlorite and sericite together total 2%. Accessory minerals are sphene, apatite, zircon, allanite and traces of

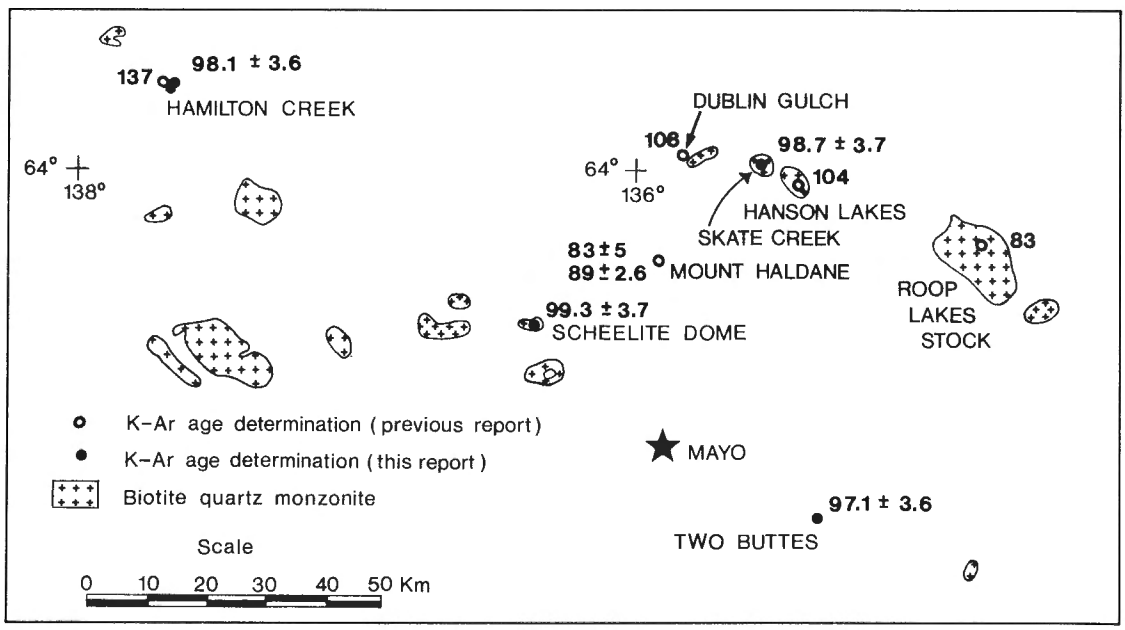


Figure 6. *Biotite quartz monzonite and related plutons in the Mayo area, Yukon.*

disseminated pyrite. Biotite occurs as light brown grains from 1 to 3 mm in size and relatively unaltered except for some chloritization in places.

The rock is from a small stock that has intruded metasedimentary rocks of probable late Proterozoic age (Kuran et al., 1982). Scheelite and chalcopyrite occur in skarn developed in limy beds adjacent to the stock and scheelite occurs locally in quartz veinlets in the stock itself. Both types of mineralization are probably related to the emplacement of the pluton which occurred at 99.3 ± 3.7 according to the age of the biotite reported here. In contrast, Kuran et al. (1982) reported a K-Ar age determination of 90.4 ± 2.9 Ma from the same stock. This suggests that the quartz monzonite may have been emplaced in several stages over a period spanning at least 10 Ma.

For further interpretation see SYA79-86 (GSC 81-41).

GSC 81-41 Biotite, K-Ar age **98.9 ± 3.7 Ma**

K = 6.59%, $^{40}Ar/^{40}K$ = 0.00591, radiogenic Ar = 91.0%.
Concentrate: Light brown biotite with approximately 15% chlorite contamination.

From biotite quartz monzonite
(106 D) Bulldozer trench near top of ridge at headwaters of Skate Creek, 10 km west of Hansen Lakes, Yukon, 64°03'01"N, 135°33'44"W. Sample SYA79-86, collected and interpreted by W.D. Sinclair.

The specimen consists of 35% plagioclase (andesine), 25% orthoclase, 25% quartz, 10% biotite, 3% hornblende and 2% chlorite, calcite, and sericite combined. Accessory minerals are sphene, apatite and zircon. Biotite is light brown and ranges from 1 to 3 mm in size. It contains inclusions of apatite and zircon and is chloritized in places along cleavage planes but many grains are relatively unaltered.

The four samples reported here are of biotite quartz monzonite and related rocks that form small discordant stocks in the Mayo area (Fig. 6). The ages agree very closely and indicate a mid-Cretaceous age of emplacement. Previously reported K-Ar age determinations from plutonic rocks in the Mayo show a much greater variation as shown in the following list, which also includes the ages in this report:

Sample	Location	Age (Ma)
GSC 62-78	Hanson Lakes[1]	104 ± 8[6]
GSC 62-79	Hamilton Creek[1]	137 ± 11[6]
GSC 62-80	Dublin Gulch[1]	108 ± 9[6]
GSC 62-81	Roop Lakes[1]	83 ± 7[6]
GSC 65-49	Mount Haldane[2]	83 ± 5[6]
GSC 80-74	Mount Haldane[3]	89 ± 2.6
GS 101	Scheelite Dome[4]	90.4 ± 2.9
GSC 81-38	Two Buttes[5]	97.1 ± 3.6
GSC 81-39	Hamilton Creek[5]	98.1 ± 3.6
GSC 81-40	Scheelite Dome[5]	99.3 ± 3.7
GSC 81-41	Skate Creek[5]	98.9 ± 3.9

[1] Leech et al. (1963)

[2] Wanless et al. (1967)

[3] Stevens et al. (1982)

[4] Kuran et al. (1982)

[5] this report

[6] These ages have been recalculated using the 25th IGC constants of Steiger and Jager, 1977.

The range of ages, from 83 to 108 Ma, suggests that intrusive activity occurred intermittently over a span of at least 15 Ma and, according to Sinclair et al. (1980), may be as much as 20 Ma. The 137 Ma age for one Hamilton Creek sample (GSC 62-79) appears anomalous and may be in error. The Hamilton Creek sample analyzed for this report (GSC 81-39) gave a mid-Cretaceous age of 98.1 + 3.6 Ma, consistent with other plutons in the area.

References

Kuran, V.M., Godwin, C.I., and Armstrong, R.L.
1982: Geology and geochronometry of the Scheelite Dome tungsten-bearing skarn property, Yukon Territory; Canadian Institute of Mining and Metallurgy Bulletin, v. 75, no. 838, p. 137-142.

Leech, G.B., Lowdon, J.A., Stockwell, C.H., and Wanless, R.K.
1963: Age determinations and geological studies (including isotopic ages – Report 4); Geological Survey of Canada, Paper 63-17, 140 p.

Sinclair, A.J., Tessari, O.J., and Harakal, J.E.
1980: Age of Ag-Pb-Zn mineralization, Keno Hill – Galena Hill area, Yukon Territory; Canadian Journal of Earth Sciences, v. 17, p. 1100-1103.

Steiger, R.H. and Jager, E.
1977: Subcommission on geochronology: Convention on the use of decay constants in geo- and cosmochronology; Earth and Planetary Science Letters, 36, p. 359-362.

Stevens, R.D., Lachance, G.R., and Delabio, R.N.
1982: Age determinations and geological studies, K-Ar isotopic ages, Report 15; Geological Survey of Canada, Paper 81-2.

Wanless, R.K., Stevens, R.D., Lachance, G.R., and Edmonds, C.M.
1967: Age determinations and geological studies, K-Ar isotopic ages, Report 7; Geological Survey of Canada, Paper 66-17, 120 p.

GSC 81-42 Whole rock, K-Ar age **83.4 ± 2.1 Ma**

K = 3.03%, $^{40}Ar/^{40}K$ = 0.00496, radiogenic Ar = 94.4%.
Concentrate: Crushed whole rock.

From porphyry
(105 E) 2½ km north of Hootalinqua, Yukon, 61°36'30"N, 134°54'W. Sample TO79-22-1, collected and interpreted by D.J. Tempelman-Kluit.

About two kilometres north of Hootalinqua is a cliff of red weathering nearly flat lying volcanic breccia with angular volcanic bombs and blocks in a muddy matrix. This is part of an extensive unit of volcanics that is unnamed but which extends northwest from here for about 50 km. The blocks, all of the same volcanics, were sampled. They are pink feldspar biotite porphyry with an aphanitic felsic groundmass. Biotite flakes are fresh, slightly resorbed and pleochroic in browns.

The age of the rocks is unknown, but the unit was correlated with the Carmacks Group. The age determined on the whole rock is almost certainly an unmodified extrusive age that indicates it is Upper Cretaceous, but considerably older than any of the Carmacks Group. These volcanics should be considered as a distinct unit. Similar volcanics in the southeast corner of Laberge map area near Baker Lake have given an age of 80.8 Ma (GSC 81-43). Other volcanics that are now considered equivalent are on the west side of Open Creek and on and around Solitary Mountain in Laberge

map area. These volcanics occur as small accumulations of generally acid to intermediate rocks, that are more colourful than the Carmacks or Mount Nansen Groups, and judging from the age determinations, between them in age.

GSC 81-43 Whole rock, K-Ar age **80.0 ± 2.3 Ma**

K = 2.19%, $^{40}Ar/^{40}K$ = 0.00476, radiogenic Ar = 66.1%.
Concentrate: Crushed whole rock.

From felsic volcanic rock
(105 E) 10 km east-northeast of Roaring Bull Rapids, Teslin River, Yukon, 61°07'00"N, 134°06'00"W. Sample TO79-14-12, collected and interpreted by D.J. Tempelman-Kluit.

North of Baker Lake in the southeast corner of Laberge map area are colourful felsic volcanic rocks that are correlated with those on Solitary Mountain and those on the west side of Open Creek. The sample was taken to date these rocks for which stratigraphic relations do not limit the age closely. A related sample, GSC 81-42, comes from similar rocks near Hootalinqua. The sample is of fresh, mauve coloured, faintly banded, aphanitic dacite with 1 or 2% scattered tiny shiny brown biotite flakes and a few anhedral plagioclase phenocrysts.

The whole rock date is probably the extrusive age of the volcanics as they are unaltered; it indicates the rock is Upper Cretaceous. Because of their freshness these volcanics were considered younger than the Carmacks Group, but this idea is wrong.

GSC 81-44 Biotite, K-Ar age **118 ± 3 Ma**

K = 5.94%, $^{40}Ar/^{40}K$ = 0.00707, radiogenic Ar = 95.3%.
Concentrate: Light brown biotite with approximately 9% chlorite alteration.

From granodiorite
(105 E) 6 km southeast of Mount Laurier, Yukon, 61°01'30"N, 134°40'30"W. Sample TO79-40-3, collected and interpreted by D.J. Tempelman-Kluit.

The dated specimen is of a fresh, medium- to fine-grained, equigranular biotite hornblende granodiorite that lacks a planar fabric. It is part of a large intrusion centred on McClintock Lakes and astride the Whitehorse-Laberge map areas boundary. This granitic rock probably inrudes dense dark aphanitic volcanics on Teslin Mountain, which have been correlated with the Mount Nansen Group. The rock was dated to determine the age of the intrusion. Its 118 Ma age is probably close to the intrusive age of the rock as it is fresh, indicating the intrusion is Lower Cretaceous. The date corresponds with others of 92.1, 105, 109, 109, 108 and 116 Ma determined by Morrison et al. (1979) for like intrusions in Whitehorse map area. The date also implies that the volcanics on Teslin Mountain are not coeval with the volcanics of the Miners Range, but that they are equivalent to the volcanics in the Dawson Range near Mt. Nansen.

Reference

Morrison, G.W., Godwin, C.I., and Armstrong, R.L.
1979: Interpretation of isotopic ages and Sr^{87}/Sr^{86} initial ratios for plutonic rocks in the Whitehorse map-area, Yukon; Canadian Journal of Earth Sciences, v. 16, no. 10, p. 1988-1997.

GSC 81-45 Whole rock, K-Ar age **64.0 ± 2.1 Ma**

K = 1.84%, $^{40}Ar/^{40}K$ = 0.00379, radiogenic Ar = 83.1%.
Concentrate: Crushed whole rock.

From aphanitic volcanic rock
(105 E) Carmacks road, 4 km southwest of Twin Lakes, Yukon, 62°40'00"N, 135°58'W. Sample TO79-5-8, collected and interpreted by D.J. Tempelman-Kluit.

This sample is of a reddish weathering, aphanitic, medium grey volcanic rock of intermediate composition whose age and affinity were not known because it occurs in an isolated area and is lithologically unlike other strata. The whole rock date determined shows it is Upper Cretaceous and because the date is close to those obtained for the Carmacks Group (see samples GSC 81-46, 47, 49 and 50) this isolated exposure is considered to be coeval with that unit.

GSC 81-46 Biotite, K-Ar age **68.2 ± 1.6 Ma**

K = 7.37%, $^{40}Ar/^{40}K$ = 0.00404, radiogenic Ar = 82.2%.
Concentrate: Clean, unaltered, light brown biotite with no detected chlorite.

From granite
(115 I) Main ridge of Prospector Mountain, Yukon, 62°26'30"N, 137°48'W. Sample TO79-34-12, collected and interpreted by D.J. Tempelman-Kluit.

This sample from Prospector Mountain is of medium-grained, equigranular, pale mauve coloured granite with euhedral thick tablets of mauve plagioclase that give the rock the texture of a crowded porphyry. The rock is the same as that collected from Mt. Pitts (GSC 81-47). Interstitial anhedral K-feldspar and quartz are in roughly equal proportions. Hornblende occurs as fresh subhedral, stubby prisms with many fresh biotite flakes as inclusions. The granite intrudes the Carmacks Group and the association is so intimate as to suggest a cogenetic relationship. The upper contact of the intrusion conforms with the depositional layering of the Carmacks Group and these strata are arched gently over the intrusion. Volcanic rocks near the intrusion are baked. Because of its upper contact relations, its texture and its composition, the granite may be a laccolith in the Carmacks Group implying that there should be a flat base to the intrusion; this has not been seen.

The Upper Cretaceous date from the biotite of this rock supports the idea that the intrusion is coeval with the Carmacks Group as it coincides with the age of that unit determined from samples GSC 81-47, 49, 50 and 51. The date probably reflects cooling following emplacement and has not been affected by younger thermal events.

GSC 81-47 Biotite, K-Ar age **71.7 ± 1.7 Ma**

K = 5.58%, $^{40}Ar/^{40}K$ = 0.00425, radiogenic Ar = 81.4%.
Concentrate: Reddish brown biotite with approximately 2% chlorite alteration.

From granite
(115 I) On Mount Pitts, Yukon, 62°33'30"N, 137°38'W. Sample TO79-28-14, collected and interpreted by D.J. Tempelman-Kluit.

This sample is a fine-grained equigranular biotite granite with a mauvish cast and a crowded porphyry texture from Mt. Pitts. The rock contains plagioclase, K-feldspar, quartz, biotite and hornblende in order of importance; the biotite is pleochroic in browns as ragged flakes that are

locally chloritized and the hornblende is more altered. The rock is similar to that collected from Prospector Mountain (GSC 81-46) and the date determined from the biotite matches the Prospector Mountain date. Ideas for the relations of the Prospector Mountain granite may also apply to these rocks.

On Mount Pitts this Upper Cretaceous granite intrudes the Carmacks Group as at Prospector Mountain.

GSC 81-48 Whole rock, K-Ar age **116 ± 3 Ma**

K = 4.60%, $^{40}Ar/^{40}K$ = 0.00699, radiogenic Ar = 92.7%.
Concentrate: Crushed whole rock.

From aphanitic volcanic rock
(105 E) Top of Packers Mountain, Yukon, 61°50'00"N, 135°32'W. Sample TO79-19-5, collected and interpreted by D.J. Tempelman-Kluit.

This sample from Packers Mountain is of light grey, aphanitic felsic volcanics that are locally flow banded. Similar rocks underlie a large part of north central Laberge map area, and were correlated speculatively with the Carmacks Group. Their age is unknown although they apparently overlie the Lower Jurassic Laberge Group.

The whole rock age of 116 Ma determined for this sample is considered close to the extrusive age and it indicates this rock is Lower Cretaceous and the time equivalent of granodiorite in Carmacks (sample GSC 81-56) and Laberge (sample GSC 81-44) map areas.

GSC 81-49 Hornblende, K-Ar age **74.4 ± 3.0 Ma**

K = 1.25%, $^{40}Ar/^{40}K$ = 0.00441, radiogenic Ar = 84.0%.
Concentrate: Clean, unaltered, pleochroic, light brown to dark brown hornblende with no visible contamination.

From porphyry
(115 I) 2½ km west of peak 4325, Macmillan Range, Yukon, 62°56'00"N, 136°11'30"W. Sample TOR79-23-9, collected and interpreted by D.J. Tempelman-Kluit.

The rock sampled is from the northeast corner of Carmacks map area, from volcanics tentatively correlated with the Carmacks Group and the sample was taken to test that assignment. It is a pink hornblende porphyry with an aphanitic pink groundmass of fresh felted plagioclase tablets about 0.1 mm long. The hornblendes are pleochroic in browns and fresh and occur as euhedral stubby prisms to 1 mm long and rimmed by a thin rind of opaques.

Hornblende was dated and indicates the rock is Upper Cretaceous. This is most probably the age of extrusion of the volcanics or close to it as there is no evidence of younger thermal events in this region. The date confirms the tentative correlation with the Carmacks Group, which has given dates of about 70 Ma.

GSC 81-50 Biotite, K-Ar age **65.8 ± 1.6 Ma**

K = 5.99%, $^{40}Ar/^{40}K$ = 0.00390, radiogenic Ar = 19.5%.
Concentrate: Clean, unaltered, light brown biotite with no detected chlorite.

From basalt
(115 I) 10.5 km south of Mount Pitts, northern Carmacks map area, Yukon, 62°28'30"N, 137°38'W. Sample TO79-28-13, collected and interpreted by D.J. Tempelman-Kluit.

See GSC 81-51 for description and interpretation. Note that the radiogenic argon content of GSC 81-50 is abnormally low so that the calculated age should be taken with some reservation.

GSC 81-51 Hornblende, K-Ar age **78.4 ± 3.2 Ma**

K = 1.23%, $^{40}Ar/^{40}K$ = 0.00466, radiogenic Ar = 75.8%.
Concentrate: Clean, unaltered, pleochroic, brown to dark green hornblende with no visible contamination.

From basalt
(115 I) Details as for GSC 81-50.

This sample is of a small plug, a few hundred metres across, that invades the Carmacks Group on the south side of Mt. Pitts and north of Big Creek. This plug is probably a Carmacks Group feeder and its relations imply that it is coeval with that unit. The rock is a chocolate brown weathering, blue grey aphanitic basalt with small fresh, prominent, shiny black hornblendes and fresh brown biotites about 1 mm across. Both minerals were dated; the hornblende gave 78.4 Ma while the biotite was dated as 65.8 Ma. Although this is a spread of nearly 13 Ma the dates corroborate others for the Carmacks Group that indicate it is Upper Cretaceous (e.g. GSC 82-47 and 49). The reason for the difference in the age of the two minerals is not known, but it may be that the hornblende age is closer to the age of intrusion of the plug, while the biotite age may be partly reset by an event of which there is no other evidence.

GSC 81-52 Hornblende, K-Ar age **56.5 ± 3.0 Ma**

K = 1.05%, $^{40}Ar/^{40}K$ = 0.00333, radiogenic Ar = 61.6%.
Concentrate: Fresh, pleochroic, light to dark brown hornblende with a trace of biotite contamination.

From porphyritic felsite
(105 E) Top of Bunker Hill, Yukon, 61°20'00"N, 135°46'30"W. Sample TO79-4-1b, collected and interpreted by D.J. Tempelman-Kluit.

Bunker Hill is a small plug of aphanitic felsite about 500 m across. It intrudes the Lower Jurassic Laberge Group. The felsite is light grey and has a quartzo-feldspathic groundmass with euhedral white albite tablets and euhedral stubby, dark green hornblendes and biotite flakes.

It was unknown if this intrusion, one of several in southwestern Laberge map area, is roughly coeval with the Laberge Group or if it is younger. The Eocene date determined for hornblende from the sample shows that the rock post-dates the Laberge Group and that these intrusions are a younger set. They resemble those of the Mount Nansen Group, but that unit has been dated about 10 or 15 Ma older in the Miners Range. The Bunker Hill date may be interpreted to mean that the Miners Range volcanics range into the Eocene and that these rocks were extruded over a time span of 20 Ma between 75 and 55 Ma ago.

GSC 81-53 Hornblende, K-Ar age **200 ± 9 Ma**

K = 0.647%, $^{40}Ar/^{40}K$ = 0.01229, radiogenic Ar = 66.3%.
Concentrate: Clean, unaltered, pleochroic, dark brown to dark green hornblende with no visible contamination.

From crystal tuff
(105 E) 2 km north of Ottawa Mountain, Yukon, 61°18'00"N, 135°50'20"W. Sample TOE79-7-4, collected and interpreted by D.J. Tempelman-Kluit.

See GSC 81-55 for description and interpretation.

GSC 81-54 Hornblende, K-Ar age **187 ± 10 Ma**

K = 0.80%, $^{40}Ar/^{40}K$ = 0.01144, radiogenic Ar = 89.2%.
Concentrate: Clean, unaltered, pleochroic, brown to dark green hornblende with no visible contamination.

From crystal tuff
(105 E) 8½ km west-southwest of Packers Mountain, Yukon, 61°47'00"N, 135°38'W. Sample TO79-17-5, collected and interpreted by D.J. Tempelman-Kluit.

See GSC 81-55 for description and interpretation.

GSC 81-55 Hornblende, K-Ar age **209 ± 9 Ma**

K = 0.625%, $^{40}Ar/^{40}K$ = 0.01288, radiogenic Ar = 86.9%.
Concentrate: Clean, unaltered, pleochroic, brown to dark green hornblende with no visible contamination.

From crystal tuff
(105 E) Packers Mountain area, Yukon, 61°49'30"N, 135°41'30"W. Sample TO79-16-3, collected and interpreted by D.J. Tempelman-Kluit.

Three samples of the Nordenskiold Dacite were taken from separate localities in Laberge map area to date this unit which was named by Bostock and Lees (1938). The rocks are medium grey, homogeneous, acid to intermediate, massive volcanics that weather resistantly. They are interlayered with sandstones of the Laberge Group or Upper Lewes River Group and it was not known if the rocks are the same age as their host or whether they are younger sills.

Sample GSC 81-55 is a crystal tuff with fresh, broken biotite, hornblende, feldspar and quartz crystals. In the field the rock looks remarkably like a sandstone, but contains large rounded bombs and blocks of volcanics that are nearly indistinguishable from the matrix. Sample GSC 81-54 is of the same sort of rock with large rounded volcanic clasts in a crystal tuff matrix. The third sample (GSC 81-53) is like the other two, but lacks large volcanic clasts.

The three ages determined are all on hornblendes and as these are fresh they are considered to approximate the age of extrusion. The ages overlap at about 200 Ma within their limits of error and the Nordenskiold Dacite is therefore probably Upper Triassic. If the variation in the ages is real it may range into Lower Jurassic. The volcaniclastics are therefore coeval with the enclosing sandstone which must be Upper Triassic also. The sandstone is lithologically indistinguishable from that of the Lower Jurassic Laberge Group and identical sandstone therefore occurs in both the Lewes River and Laberge Groups.

Reference

Bostock, H.S. and Lees, E.J.
1938: Laberge map-area, Yukon; Geological Survey of Canada, Memoir 217.

GSC 81-56 Hornblende, K-Ar age **110 ± 8 Ma**

K = 0.60%, $^{40}Ar/^{40}K$ = 0.00656, radiogenic Ar = 46.0%.
Concentrate: Clean, unaltered, pleochroic, light green to light brown hornblende with no visible contamination.

From granodiorite
(115 I) 12 km west-northwest of Victoria Mountain, Yukon, 62°14'00"N, 137°14'30"W. Sample TOE79-40-18, collected and interpreted by D.J. Tempelman-Kluit.

A fresh, equigranular, medium-grained, hornblende biotite granodiorite without planar fabric was selected for dating from near Bow Creek as a lithologically representative sample of extensive granitic rocks in southwestern Carmacks map area. The rock is hypidiomorphic and granular with fresh anhedral oligoclase and quartz, about 5% euhedral fresh dark green hornblende and slightly chloritized subhedral biotite. The rock unit extends westward into the Klotassin district of Snag map area where it has given dates between 90 and 110 Ma (Tempelman-Kluit and Wanless, 1975).

The date determined for hornblende from this rock is 110 Ma and because it is a fresh rock the date is considered close to the emplacement age of the intrusion. The date is no surprise and corresponds with others in the region; it supports the idea of extensive mid-Cretaceous plutonics in central Yukon Crystalline Terrane.

Reference

Tempelman-Kluit, D.J. and Wanless, R.K.
1975: Potassium-argon age determinations of metamorphic and plutonic rocks in the Yukon Crystalline Terrane; Canadian Journal of Earth Sciences, v. 12, no. 11, p. 1895-1909.

GSC 81-57 Whole rock, K-Ar age **109 ± 3 Ma**

K = 3.12%, $^{40}Ar/^{40}K$ = 0.00650, radiogenic Ar = 94.5%.
Concentrate: Crushed whole rock.

From felsic volcanic rock
(115 I) On Klaza Mountain, Yukon, 62°16'30"N, 137°30'W. Sample TO79-31-16, collected and interpreted by D.J. Tempelman-Kluit.

A fresh felsic volcanic with an aphanitic, mauve-grey groundmass and a few scattered white K-feldspar and clear quartz phenocrysts was selected for dating from the top of Klaza Mountain. Volcanics on the ridge from Klaza Mountain southeast to Victoria Mountain and Mount Nansen in the Dawson Range have been called the Mount Nansen Group because of their lithologic similarity, but the age of these rocks was unknown. Rocks in the Miners Range which were considered equivalents of the Mount Nansen Group were recently dated by Grond (1980) who showed that these rocks are Upper Cretaceous.

The age of 109 Ma (Lower Cretaceous) corresponds with that of the granitic rocks through which these volcanics are intruded (GSC 81-56) and also with the volcanics of Packers Mountain (GSC 81-48). However it is about 40 Ma older than the date obtained by Grond for the Miners Range volcanics. This indicates that the volcanics in the Miners Range are incorrectly correlated with the Mount Nansen Group. The Mount Nansen Group is therefore Lower Cretaceous and is more restricted than was thought before. It should not include the intermediate volcanics that lie underneath the Carmacks basalt. These rocks in east central Snag and west central Carmacks map areas around Apex and Prospector

Mountain and the volcanics around Mt. Pitts beneath the basaltic Carmacks Group are not the Mount Nansen Group, but a lithologically distinct lower part of Carmacks Group and the same age as these rocks, Upper Cretaceous. Volcanics in the Miners Range are properly correlated with the Carmacks Group, not the Mount Nansen as the author has done in the past.

The intermediate volcanics of Packers Mountain and Teslin Mountain are time equivalent with those in the Mount Nansen district and are therefore considered Mount Nansen Group equivalents.

It appears therefore that there are two lithologically similar volcanic units in this part of Yukon. One, which is Lower Cretaceous (circa. 110 Ma), includes volcanics from Mount Nansen to Klaza Mountain as well as those on Prospector and Teslin Mountain and possibly others. It is the Mount Nansen Group. The second, around Apex and Prospector Mountains and in the Miners Range is the lower part of the Carmacks Group from which it is lithologically distinct because it is more felsic, but with which it is intercalated and coeval. These rocks are Upper Cretaceous.

Reference

Grond, H.C.
1980: New K-Ar dates and geochemistry from Mount Nansen Volcanics, Yukon; Unpublished B.Sc. thesis, University of British Columbia.

GSC 81-58 Hornblende, K-Ar age **199 ± 32 Ma**

K = 0.24%, $^{40}Ar/^{40}K$ = 0.01225, radiogenic Ar = 66.8%.
Concentrate: Clean, unaltered, pleochroic, brown to dark green hornblende with no visible contamination.

From intermediate volcanic rock
(105 E) 1 km west of Fyfe Lake, Laberge map area, Yukon, 61°52'00"N, 135°09'30"W. Sample TOE79-24-10, collected and interpreted by D.J. Tempelman-Kluit.

The dated sample is a medium khaki aphanitic fresh volcanic of intermediate composition with scattered fresh prismatic black hornblende crystals to 2 mm long. It is part of the extensive volcanics in north central Laberge map area that was considered to be all part of one unit correlated with the Carmacks Group. This date (199 ± 32 Ma) and those on two other samples (GSC 81-42: 83.4 Ma; GSC 81-48: 116 Ma) show that this idea needs revision. The volcanics are not all the same age although they are lithologically alike and all of intermediate character. The age determined for this sample shows that some of the volcanics are Upper Triassic while the others are Lower Cretaceous and Upper Cretaceous and the area will need to be carefully examined to see if these rocks can be separately mapped. If this volcanic rock is coeval with the Lewes River Group as its age suggests it extends the area of that unit considerably further east than was thought.

GSC 81-59 Biotite, K-Ar age **181 ± 4 Ma**

K = 6.14%, $^{40}Ar/^{40}K$ = 0.01105, radiogenic Ar = 94.5%.
Concentrate: Clean, unaltered, light brown biotite with no detected chlorite.

From porphyry
(105 E) 13½ km northwest of Teslin Crossing, Yukon, 61°18'N, 134°49'30"W. Sample TO79-8-6, collected and interpreted by D.J. Tempelman-Kluit.

See GSC 81-61 for description and interpretation.

GSC 81-60 Biotite, K-Ar age **173 ± 4 Ma**

K = 6.17%, $^{40}Ar/^{40}K$ = 0.01053, radiogenic Ar = 16.6%.
Concentrate: Clean, unaltered, very small concentrate of light brown biotite with no detected chlorite.

From syenite
(105 E) 13½ km northwest of Teslin Crossing, Yukon, 61°18'00"N, 134°49'30"W. Sample TO79-8-6A, collected and interpreted by D.J. Tempelman-Kluit.

See GSC 81-61 for description and interpretation.

GSC 81-61 Hornblende, K-Ar age **186 ± 5 Ma**

K = 1.14%, $^{40}Ar/^{40}K$ = 0.01140, radiogenic Ar = 91.0%.
Concentrate: Clean, unaltered, pleochroic, light green to brown hornblende with no visible contamination.

From porphyry
(105 E) 8 km northwest of Teslin Crossing, Yukon, 61°16'30"N, 134°45'W. Sample TO79-10-4, collected and interpreted by D.J. Tempelman-Kluit.

All three samples are from a small oval shaped intrusion about 10 km in long dimension near Teslin Crossing and referred to as the Teslin Crossing Stock. The stock intrudes slate and sandstone of the Lower Jurassic Laberge Group and as it is lithologically different from dated rocks its age was not known and it was not clear if the intrusion is coeval with its host or much younger.

Sample GSC 81-59 is of a rusty weathering biotite feldspar porphyry dyke that cuts the stock. It has 5 mm thick tabular K-feldspars and fresh anhedral biotite about 0.3 mm across in an aphanitic quartzo-feldspathic groundmass that is weakly saussuritized. Nearby sample GSC 81-60 is of syenite of the stock itself. It is pinkish, medium- to fine-grained with anhedral perthitic K-feldspar and much less plagioclase and quartz. The main mafic is fresh augite which makes up 5% of the rock but there is also a little biotite. The third sample (GSC 81-61) is of fresh crowded hornblende feldspar porphyry that makes up the stock at this location. It's groundmass is a microcrystalline quartz feldspar mixture and it has euhedral feldspar, hornblende and biotite phenocrysts to 3 mm across.

The ages determined are in fairly close agreement and approximate the time of intrusion of this stock as Lower or Middle Jurassic. They indicate that the Teslin Crossing stock is coeval with the Laberge Group and somewhat younger than the Nordenskiold Dacite although it may be cogenetic with it. The Teslin Crossing stock is related to northwest trending feldspar porphyry dykes that run diagonally through central Laberge map area. One of these dykes was dated at 164 Ma with sample GSC 81-62.

GSC 81-62 Hornblende, K-Ar age **164 ± 10 Ma**

K = 0.66%, $^{40}Ar/^{40}K$ = 0.00999, radiogenic Ar = 83.4%.
Concentrate: Clean, unaltered, pleochroic, brown to green hornblende with no visible contamination.

From porphyry
(105 E) 12½ km south-southeast of Hootalinqua, Yukon, 61°28'30"N, 134°50'W. Sample TO79-15-5, collected and interpreted by D.J. Tempelman-Kluit.

In central Laberge map area is a swarm of northeast trending porphyry dykes that cut the Laberge and Lewes River Groups, but not the Tantalus Formation. The porphyries are like those of the Teslin Crossing Stock and they were thought coeval. They weather a rusty colour and have a mauve, aphanitic to very fine crystalline quartzo-feldspathic groundmass with euhedral fresh hornblendes to ½ mm and white equant euhedral K-feldspars to 5 mm.

The date of 164 Ma determined from the fresh hornblende of this rock is probably the intrusive age of the rock making this dyke Middle Jurassic and somewhat younger than the Teslin Crossing stock. The age overlaps with one of those of the Teslin Crossing stock within its error limits. This indicates that the dyke and others like it are broadly time equivalent to the Laberge Group and that they are a late expression of volcanism associated with that unit that began with the Nordenskiold Dacite. Thus, although volcanics are not an important part of the stratigraphic section of the Laberge Group there is evidence of considerable volcanic activity during its deposition.

GSC 81-63 Hornblende, K-Ar age **185 ± 8 Ma**

K = 0.95%, $^{40}Ar/^{40}K$ = 0.01133, radiogenic Ar = 70.1%.
Concentrate: Clean, unaltered, pleochroic, brown to green hornblende with no visible contamination.

From granodiorite/quartz diorite
(105 E) On north side of Lokken Creek, 3 km above its mouth, Walsh Creek area, Yukon, 61°55'30"N, 134°35'00"W. Sample TO79-23-3, collected and interpreted by D.J. Tempelman-Kluit.

A sample was collected from a poorly exposed intrusion in the western part of the Teslin Suture Zone to determine its age. Stratigraphic limits on the Lokken Batholith are broad and its relations to the sheared rocks of Teslin Suture Zone unclear although it appears to be a pluton that was only involved marginally in the shearing and it has escaped from this event largely unscathed.

The sample is of massive coarse-grained equigranular mesocratic hornblende granodiorite to quartz diorite that is beautifully fresh. It has a weak planar fabric defined by aligned hornblendes. The hornblende is as euhedral stubby prisms that enclose small biotite flakes. Sphene is a prominent accessory mineral. The rock looks like much of the Klotassin Batholith in Snag map area which has given ages in two ranges, namely ± 170 Ma and ± 100 Ma.

The rock is fresh and the date of 185 Ma (Lower Jurassic) is probably close to the last thermal event. This may have been the shearing in the Teslin Suture Zone. It is not known how much time separated shearing and the emplacement of the batholith so that the date may represent a partially or totally reset age. Considering how close the date is to older dates determined for the Kotassin and to the time of shearing in Teslin Suture Zone determined from ductile deformed rocks in Finlayson Lake map area as about 200-180 Ma, it approximates the time of strain more closely than the time of intrusion. Intrusion is most likely older and may be represented by the 216 Ma date determined for sample GSC 81-64 from a lithologically similar intrusion outside the Teslin Suture Zone.

GSC 81-64 Hornblende, K-Ar age **216 ± 14 Ma**

K = 0.62%, $^{40}Ar/^{40}K$ = 0.01333, radiogenic Ar = 65.9%.
Concentrate: Clean, unaltered, pleochroic, yellowish brown to dark green hornblende with no visible contamination.

From quartz diorite
(105 E) 5 km west of the mouth of Headless Creek, Yukon, 61°49'00"N, 134°47'00"W. Sample TO79-20-2, collected and interpreted by D.J. Tempelman-Kluit.

In north central Laberge map area is basalt and andesite that is Pennsylvanian and which probably ranges into the Permian and Triassic. These volcanics are intruded at one place by a stock of fresh, medium-grained, equigranular, light grey, homogeneous hornblende quartz diorite. The rocks are 10 or 15 km west of the western edge of Teslin Suture Zone. Xenoliths and dark mafic clots with sharp boundaries are common and the quartz diorite lacks fabrics, but local layering in it represents partly digested mafic schlieren. The rock is made up of euhedral fresh hornblende intergrown with subhedral tabular plagioclase and much less quartz. Zircon is a prominent accessory mineral.

The date determined from the fresh hornblende of the quartz diorite is considered to approximate the intrusive age of the rock as there is no evidence of younger thermal events. The intrusion is therefore most probably Middle Triassic. It may represent an example of the kind of rock that was sheared in the Teslin Suture Zone to produce the "Klotassin Suite" and sample GSC 81-63 may be such a sheared product. The intrusion is most likely a subvolcanic part of the Lewes River Group, which includes Triassic volcanic rocks. So far this intrusion is the only one like it in the region and it is surprising considering the extensive Triassic volcanics that there are not other examples.

GSC 81-65 Hornblende, K-Ar age **152 ± 7 Ma**

K = 0.92%, $^{40}Ar/^{40}K$ = 0.00919, radiogenic Ar = 86.7%.
Concentrate: Clean, unaltered, pleochroic, light green to dark green hornblende with no visible contamination.

From syenite
(115 I) 10 km east-northeast of Klaza Mountain, Yukon, 62°18'00"N, 137°19'30"W. Sample TOC79-18-9, collected and interpreted by D.J. Tempelman-Kluit.

See GSC 81-66 for description and interpretation.

GSC 81-66 Hornblende, K-Ar age **184 ± 7 Ma**

K = 1.18%, $^{40}Ar/^{40}K$ = 0.01124, radiogenic Ar = 86.7%.
Concentrate: Clean, unaltered, pleochroic, dark brown to dark green hornblende with no visible contamination.

From syenite
(115 I) 4½ km north-northwest of Klaza Mountain, Yukon, 62°18'00"N, 137°32'00"W. Sample TO79-31-18, collected and interpreted by D.J. Tempelman-Kluit.

South of Big Creek in central Carmacks map area is an extensive, distinctive, homogeneous, coarse-grained porphyritic syenite that is intruded by mid-Cretaceous biotite hornblende granodiorite, cut by numerous Mount Nansen Group dykes and plugs and overlain by the Carmacks Group. Similar syenite is a marginal phase of the Granite Mountain Batholith and the two may be coeval.

Euhedral dark green hornblende to 5 or 10 mm across, the only mafic, makes up as much as a quarter of the rock's volume. Thick tablets of pink K-feldspar, several centimetres across, constitute most of the remainder. The texture varies from porphyritic to coarse-grained equigranular. Sphene is an abundant accessory mineral.

Quartz and albite form graphic intergrowths along the rims of K-feldspars. Locally the rock has sufficient quartz to approach granite composition. The rocks are locally foliated and elsewhere they are saussuritized, but the foliation is not as penetratively developed as in the Granite Mountain Batholith.

Both dates were determined on fresh, clean hornblende and the difference in the ages implies that one sample (GSC 81-65) was altered and its age partly reset. Whether the other sample was also altered, but reset less or whether it represents the intrusive age is not clear. The relations of the syenite to the Granite Mountain Batholith suggests that the 184 Ma age is close to the intrusive age and the syenite was therefore most likely intruded in the Early Jurassic. Possibly the alteration of the other sample may be related to intrusion of Mount Nansen Group dykes which are plentiful in this area.

GSC 81-67 Biotite, K-Ar age **204 ± 4 Ma**

K = 7.10%, $^{40}Ar/^{40}K$ = 0.01253, radiogenic Ar = 95.5%.
Concentrate: Clean, unaltered, greenish brown biotite with no detected chlorite.

From quartz monzonite
(115 I) 2 km east of Granite Canyon on Pelly River, Yukon, 62°50'30"N, 136°11'30"W. Sample TO79-25-5, collected and interpreted by D.J. Tempelman-Kluit.

This sample, from near the centre of the Tatlmain Batholith in northeastern Carmacks map area, was taken to date this large intrusion which has not hitherto been dated. The rock is a coarse-grained (with huge, 5-10 cm, megacrysts of K-feldspar) biotite quartz monzonite that is representative of this homogeneous batholith. It lacks fabric or layering but has a few rounded mafic inclusions and has roughly equal proportions of grey quartz, white plagioclase and pinkish K-feldspar with 5 or 10% biotite. The rock lacks intergranular cement and breaks down to gruss readily.

The rock looks like the Coffee Creek Granite of Snag map area, which is mid-Cretaceous, and like some mid-Cretaceous quartz monzonite batholiths in the Pelly Mountains and an age near 100 Ma was expected on this basis. The age of 204 Ma (Upper Triassic) determined on the biotite is therefore a surprise. There is no stratigraphic evidence to narrowly limit the age of the batholith; it intrudes Upper Paleozoic strata of Teslin Suture Zone that have been strongly sheared during the Upper Triassic and Lower Jurassic and is older than the Carmacks Group, dated as 74.4 Ma nearby. The Upper Triassic age may be the time of intrusion of the rocks, or may reflect thermal resetting during the shearing mentioned above. In the second case the intrusive age may be older.

The Tatlmain Batholith may be equivalent to strongly sheared quartz monzonite of Simpson Allochthon in Finlayson Lake map area on the opposite side of the Tintina Trench. That rock's hornblende was dated as 316 Ma (GSC 80-85), but its mica gave an age of 201 Ma (GSC 80-84), close to that of Tatlmain Batholith.

GSC 81-68 Biotite, K-Ar age **160 ± 3 Ma**

K = 6.84%, $^{40}Ar/^{40}K$ = 0.00972, radiogenic Ar = 79.7%.
Concentrate: Greenish biotite with approximately 10% chlorite alteration and less than 2% hornblende contamination.

From porphyritic granite-granodiorite
(115 I) 11 km north of Tatchun Lake, Yukon, 62°23'N, 136°06'30"W. Sample TOE79-35-10, collected by P. Erdmer and interpreted by D.J. Tempelman-Kluit.

See GSC 81-71 for description and interpretation.

GSC 81-69 Hornblende, K-Ar age **162 ± 8 Ma**

K = 0.89%, $^{40}Ar/^{40}K$ = 0.00982, radiogenic Ar = 43.1%.
Concentrate: Unaltered, pleochroic, brown to green hornblende with minor sphene contamination.

From porphyritic granite-granodiorite
(115 I) Details as for GSC 81-68.

See GSC 81-71 for description and interpretation.

GSC 81-70 Biotite, K-Ar age **144 ± 3 Ma**

K = 7.68%, $^{40}Ar/^{40}K$ = 0.00874, radiogenic Ar = 90.8%.
Concentrate: Clean, unaltered, greenish biotite with no detected chlorite.

From granodiorite
(115 I) South of Tatlmain Lake, 1 km southeast of Peak 4402', Yukon, 62°32'30"N, 136°20'00"W. Sample TO79-25-2, collected and interpreted by D.J. Tempelman-Kluit.

See GSC 81-71 for description and interpretation.

GSC 81-71 Hornblende, K-Ar age **142 ± 10 Ma**

K = 0.57%, $^{40}Ar/^{40}K$ = 0.00856, radiogenic Ar = 69.1%.
Concentrate: Clean, unaltered, pleochroic, yellowish brown to green hornblende with no visible contamination.

From granodiorite
(115 I) On Big Creek, 7½ km above mouth of Dark Creek, Yukon, 62°26'30"N, 137°03'W. Sample TO79-30-14, collected and interpreted by D.J. Tempelman-Kluit.

Two samples were collected from the Tatchun Batholith in Carmacks map area to determine the age of this hitherto undated intrusion in the Yukon Cataclastic Complex which has been involved in the ductile deformation. A third sample was collected from the lithologically similar Granite Mountain Batholith. The Tatchun Batholith is of hornblende biotite granodiorite that is generally, but not everywhere foliated. Generally the rocks are mesocratic and porphyritic with late pinkish K-feldspar megacrysts that make up 20% of the rock and a medium-grained granitic texture. The batholith is heterogeneous, with mafic screens and schlieren of amphibolite and some zones that are so strongly sheared as to make the rocks gneissic. Elsewhere the rocks nearly lack fabrics. Both samples from Tatchun Batholith are of strongly foliated porphyritic hornblende biotite granodiorite to quartz monzonite: in one only the biotite was dated, but in the other both minerals were determined.

Granite Mountain Batholith (GSC 81-71) is lithologically like Tatchun Batholith with the same variation in gneissosity, mafic screens and megacrysts. The sample from this intrusion is a well foliated mesocratic biotite hornblende granodiorite without phenocrysts.

The biotite and hornblende in all the samples is fresh and the dates determined from them represent the last thermal episode that affected the rocks. This may be the

strain that imposed the penetrative fabric or it may be the time of formation of the megacrysts: it is not the crystallization age of the rocks. The strain and megacryst events may be parts of one episode with the megacrysts the last stage. The ages differ by about 20 Ma and the strain and/or megacryst event is probably best approximated by the 144 Ma and 142 Ma determinations with the 160 and 162 Ma ages representing partly reset ages closer to the intrusive age of the rocks. This indicates Latest Jurassic strain of these rocks.

An age of 174 ± 6 Ma (GSC 80-73) was determined earlier for biotite from the northern extension of the Granite Mountain Batholith and a concordant U/Pb determination on zircon from this locality gave 192 Ma (Earliest Jurassic).

Apparently the Tatchun and Granite Mountain Batholiths were intruded in the Late Triassic or Early Jurassic and were variously but penetratively strained during the Jurassic. Whether the strain was a single or multistage episode or whether it was long or short lived is not known but common K-A ages about 160 and 140 Ma in these types of rocks may imply two stages. The Tatchun and Granite Mountain Batholiths are part of the Klotassin Suite and are like the northwestern Klotassin Batholith.

GSC 81-72 Biotite, K-Ar age **108 ± 5 Ma**

K = 5.33%, $^{40}Ar/^{40}K$ = 0.00644, radiogenic Ar = 90.7%.
Concentrate: Brown biotite with approximately 5% chlorite alteration and 5% hornblende impurity.

From amphibolite
(115 F&G) Approximately 6.4 km northwest of head of Koidern Creek and 3.2 km east of head of Moose Creek, Kluane Ranges, Yukon, 61°47.9'N, 140°25.2'W. Map-unit 17, GSC Map 1177A. Sample WN-136-74, collected by R.D. Stevens and J.W.H. Monger.

This amphibolite was thought to represent metamorphosed Triassic(?) volcanics. The date is a minimum age for metamorphism.

GSC 81-73 Biotite, K-Ar age **112 ± 4 Ma**

K = 6.88%, $^{40}Ar/^{40}K$ = 0.00670, radiogenic Ar = 79.2%.
Concentrate: Light brown biotite with approximately 6% chlorite alteration.

From granite
(115 F&G) Southwest side of Kluane Ranges, approximately 5.2 km north-northwest of Tepee Lake, Yukon, 61°38.5'N, 140°13.6'W. Map-unit 18, GSC Map 1177A. Sample WN-135-74, collected by R.D. Stevens and J.W.H. Monger.

See GSC 81-74 for description.

GSC 81-74 Hornblende, K-Ar age **115 ± 5 Ma**

K = 0.799%, $^{40}Ar/^{40}K$ = 0.00693, radiogenic Ar = 65.1%.
Concentrate: Clean, unaltered, pleochroic, brown to green hornblende with no visible contamination.

From granite
(115 F&G) Details as for GSC 81-73.

The sample is of hornblende biotite granodiorite from the Kluane Range intrusions. The 112-115 Ma dates represent a minimum age of emplacement.

GSC 81-75 Biotite, K-Ar age **114 ± 4 Ma**

K = 5.95%, $^{40}Ar/^{40}K$ = 0.00687, radiogenic Ar = 91.1%.
Concentrate: Somewhat impure brown biotite with approximately 7% chlorite alteration.

From granodiorite
(115 F&G) At elevation 5800 ft. (1768 m), top of rounded knoll 5¼ km north-northwest of Teepee Lake, Kluane Lake map area, Yukon, 61°38'30"N, 140°14'15"W. Map-unit 18, Map 1177A, GSC Memoir 340 (Muller, J.E., 1957). Sample MV-74-102, collected by J.W.H. Monger.

See GSC 81-76 for description.

GSC 81-76 Hornblende, K-Ar age **143 ± 6 Ma**

K = 0.337%, $^{40}Ar/^{40}K$ = 0.00866, radiogenic Ar = 70.1%.
Concentrate: Clean, unaltered, pleochroic, light to dark green hornblende with no visible contamination.

From granodiorite
(115 F&G) Details as for GSC 81-75.

The rock is a medium grained, light grey hornblende biotite granodiorite from a belt of granitic rocks (ranging from diorite to "leucogranite") intruding Permo-Pennsylvanian and upper Triassic "greenstones" and limestone. Rocks as young as late Jurassic-early Cretaceous are metamorphosed in this belt.

The specimen is non-foliated, non-porphyritic, but with occasional small clots of dark minerals most visible on weathered surfaces. It consists mainly of slightly to moderately sericitized plagioclase (commonly with normal and oscillatory zoning), anhedral slightly strained quartz, lesser sericitized potash feldspar, fresh weakly pleochroic green hornblende, moderately chloritized brown biotite, and accessory opaques, apatite, sphene, epidote and zircon.

GSC 81-77 Whole rock, K-Ar age $\frac{6.4}{6.5} \pm \frac{0.8}{0.6}$ **Ma**

K = 3.27%, $^{40}Ar/^{40}K = \frac{0.000374}{0.000377}$, radiogenic Ar = $\frac{57.3}{73.2}$%.
Concentrate: Crushed whole rock.

From felsite
(115 F&G) North side of north branch of glacier on east side of Mt. Constantine, head of Count Creek, St. Elias Mountains, Yukon, 61°26.1'N, 140°29.7'W. Map-unit 23a, GSC Map 1177A. Sample WN-124-74, collected by J.G. Souther and R.D. Stevens.

The rock is a fine grained, non-porphyritic felsite from a large dome intruding youngest Wrangell lavas. Intrusion was thought to be younger than or contemporaneous with faulting in this region. The specimen used was a micrographic quartz trachyte in which the feldspar has been heavily kaolinized and which carries abundant interstitial carbonate. Both of these features render whole rock age determination highly suspect.

GSC 81-78 Whole rock, K-Ar age **16.3 ± 1.4 Ma**

K = 2.95%, $^{40}Ar/^{40}K$ = 0.000951, radiogenic Ar = 81.7%.
Concentrate: Crushed whole rock.

From "felsite"

(115 F&G) Creek on east side of Donjek Range approximately 2.4 km west of Duke River, 6.4 km below confluence with Grizzly Creek, Yukon, 61°11.7'N, 139°10.6'W. Map-unit 23a, GSC Map 1177A. Sample WN-127-74, collected by J.G. Souther and R.D. Stevens.

The specimen is of microporphyritic trachyte in which original mafic minerals have been totally altered to dusty iron oxides and chlorite. It was collected from a felsite intruding Tertiary lavas and sediments. The altered nature of the specimen renders whole rock age determination highly suspect.

GSC 81-79 Whole rock, K-Ar age **13.6 ± 1.2 Ma**

K = 3.10%, $^{40}Ar/^{40}K$ = 0.000792, radiogenic Ar = 85.9%.
Concentrate: Crushed whole rock.

From "felsite"

(115 F&G) On ridge north of Cement Creek, approximately 11 km west of confluence with Donjek River, St. Elias Mountains, Yukon, 61°25.1'N, 139°51.3'W. Map-unit 23a, GSC Map 1177A. Sample WN-122-74, collected by R.D. Stevens and J.G. Souther.

The specimen is a pale buff-brown to grey felsitic rock with biotite phenocrysts. Iron oxides and carbonate replace original ferromagneisan minerals. It intrudes Wrangell lavas of Tertiary age. The altered nature of this rock renders whole rock age determination highly suspect

GSC 81-80 Whole rock, K-Ar age **14.6 ± 1.3 Ma**

K = 3.41%, $^{40}Ar/^{40}K$ = 0.000853, radiogenic Ar = 82.3%.
Concentrate: Crushed whole rock.

From "felsite"

(115 F&G) West side of Kluane Range, above Duke River approximately 2 2/3 km east-northeast of its confluence with Grizzly Creek, Yukon, 61°11.7'N, 139°01'W. Map-unit 23a, GSC Map 1177A. Sample WN-125-74, collected by R.D. Stevens and J.G. Souther.

This felsitic rock forms a dome intruding Wrangell lavas and Tertiary sediments of the Amphitheatre Formation. It is a quartz trachyte with small phenocrysts of reasonably fresh brown biotite in a heavily altered groundmass. The altered nature of this rock renders whole rock age determination highly suspect.

GSC 81-81 Whole rock, K-Ar age **15.5 ± 1.4 Ma**

K = 3.64%, $^{40}Ar/^{40}K$ = 0.000904, radiogenic Ar = 88.4%.
Concentrate: Crushed whole rock.

From "felsite"

(115 F&G) In creek on east side of Donjek Range approximately 2.4 km west of Duke River 6.4 km below its confluence with Grizzly Creek, Kluane map area, Yukon, 61°11.7'N, 139°10.6'W. Map-unit 23a, GSC Map 1177A. Sample WN-126-74, collected by R.D. Stevens and J.G. Souther.

See GSC 81-82 for description.

GSC 81-82 Biotite, K-Ar age **20.0 ± 1.8 Ma**

K = 6.46%, $^{40}Ar/^{40}K$ = 0.00117, radiogenic Ar = 53.0%.
Concentrate: Clean, unaltered, reddish orange biotite with no visible contamination.

From "felsite"

(115 F&G) Details as for GSC 81-81.

The sample is from a felsite intruding Tertiary lavas and sediments. It is a microporphyritic trachyte with phenocrysts of altered, deep brown to red-brown biotite and very fresh orthoclase.

GSC 81-83 Biotite, K-Ar age **52.8 ± 2.2 Ma**

K = 6.50%, $^{40}Ar/^{40}K$ = 0.00311, radiogenic Ar = 80.3%.
Concentrate: Clean, unaltered, very dark brown biotite with no visible contamination.

From "felsite"

(115 F&G) Ridge-side north of Cement Creek, approximately 11.3 km west of confluence with Donjek River, St. Elias Mountains, Yukon, 61°25.3'N, 139°51.4'W. Map-unit 23a, GSC Map 1177A. Sample WN-123-74, collected by R.D. Stevens and J.G. Souther.

The sample was collected from a felsite thought to cut Tertiary Wrangell lavas and to be the youngest volcanic event in the area. The rock is a pale buff-brown to grey felsite with small biotite phenocrysts in a somewhat altered feldspathic groundmass. The determined age is at variance with the perceived field relationships and is therefore suspect though analytically satisfactory.

GSC 81-84 Whole rock, K-Ar age $\frac{13.1}{10.8} \pm \frac{2.0}{1.9}$ **Ma**

K = 0.804%, $^{40}Ar/^{40}K = \frac{0.000768}{0.000630}$, radiogenic Ar = $\frac{16.9}{7.8}$%.
Concentrate: Crushed whole rock.

From basalt

(115 B&C) East side of Chalcedony Mountain, approximately 8.4 km west of junction of Kuskawulsh and Dusty Rivers, Yukon, 60°40'N, 138°05.5'W. Sample WN-128-74, collected by J.G. Souther and R.D. Stevens.

The sample is from a fresh, massive basalt with occasional feldspar phenocrysts. It is from the base of the Wrangell basalts of the Dezadeash pile. The specimen used is a carbonate-rich basaltic rock with interstitial opaque glass. Its feldspars are quite fresh, suggesting that the carbonate is not due to alteration. The low radiogenic argon content obtained in both extractions dictates caution in accepting the calculated age determinations.

GSC 81-85 Whole rock, K-Ar age **13.5 ± 1.2 Ma**

K = 2.33%, $^{40}Ar/^{40}K$ = 0.000787, radiogenic Ar = 32.4%.
Concentrate: Crushed whole rock.

From volcanic glass

(115 B&C) On mountain-side north of Felsite Creek, approximately 10.5 km above (west of) its junction with Dusty River, Yukon, 60°35.3'N, 138°12.4'W. Sample WN-130-74, collected by J.G. Souther and R.D. Stevens.

The specimen is of glass from a volcanic neck sampled on a reconnaissance age determination program in this area.

GSC 81-86 Biotite, K-Ar age **144 ± 5 Ma**

K = 7.80%, $^{40}Ar/^{40}K$ = 0.00869, radiogenic Ar = 93.6%.
Concentrate: Clean, unaltered, light greenish brown biotite with no visible contamination.

From granite/granodiorite
(115 B&C) Near head of creek between Chalcedony and Hoodoo Mountains, 13.7 km above its junction with Kuskawulsh River, Yukon, 60°38.8'N, 138°15.1'W. Sample WN-129-74, collected by R.D. Stevens and J.G. Souther.

See also GSC 81-87.

GSC 81-87 Hornblende, K-Ar age **141 ± 6 Ma**

K = 1.07%, $^{40}Ar/^{40}K$ = 0.00851, radiogenic Ar = 91.0%.
Concentrate: Clean, unaltered, pleochroic, brown to green hornblende with no visible contamination.

From granite/granodiorite
(115 B&C) Details as for GSC 81-86.

The specimen is from a slightly gneissic granitoid sampled on a reconnaissance age determination program in this area.

GSC 81-88 Muscovite/chlorite, K-Ar age **54.7 ± 2.3 Ma**

K = 5.69%, $^{40}Ar/^{40}K$ = 0.00323, radiogenic Ar = 71.1%.
Concentrate: Very impure, discoloured muscovite with 25% chlorite contamination.

From schist
(115 F&G) South side of hill top approximately 2 km from east shore of Kluane Lake, opposite Destruction Bay, Kluane Lake sheet, Yukon, 61°15.0'N, 138°35.5'W. Map-unit 2, GSC Map 1177A. Sample WN-133-74, collected by R.D. Stevens and G.H. Eisbacher.

The muscovite concentrate was obtained from a sample of Kluane schist and approximately dates the metamorphism of this rock, though the low potassium content of the mica and its impure nature suggest considerable caution in using this determination. Also see GSC 81-89.

GSC 81-89 Biotite, K-Ar age **52.8 ± 2.2 Ma**

K = 6.62%, $^{40}Ar/^{40}K$ = 0.00311, radiogenic Ar = 68.8%.
Concentrate: Brownish orange biotite with approximately 2% chlorite alteration.

From schist
(115 F&G) Near elevation 5809 ft. (1771 m), mountain top east of junction of Talbot Arm and Kluane Lake, Yukon, 61°21.2'N, 138°36.5'W. Map-unit 1, GSC Map 1177A. Sample WN-131-74, collected by R.D. Stevens and G.H. Eisbacher.

This sample was also of Kluane schist, but in this case muscovite was too rare to permit the preparation of an adequate concentrate. The date approximates the time of metamorphism.

GSC 81-90 Biotite, K-Ar age **54.1 ± 2.4 Ma**

K = 6.74%, $^{40}Ar/^{40}K$ = 0.00319, radiogenic Ar = 76.1%.
Concentrate: Brownish orange biotite with approximately 2% chlorite alteration.

From granite
(115 F&G) On mountain side east of lower reach of Talbot Arm, Kluane Lake, Yukon, 61°23.3'N, 138°31.2'W. Map-unit 5, GSC Map 1177A. Sample WN-134-74, collected by R.D. Stevens and G.H. Eisbacher.

This specimen was collected from granite of the Ruby Range batholith and represents a cooling age subsequent to emplacement or metamorphism.

District of Franklin
(GSC 81-91 to GSC 81-140)

GSC 81-91 Whole rock, K-Ar age **626 ± 19 Ma**

K = 8.00%, $^{40}Ar/^{40}K$ = 0.04352, radiogenic Ar = 99.7%.
Concentrate: Crushed whole rock.

From basalt
(39 H) 6 km west of Cape Camperdown, south shore of Bache Peninsula, east coast of Ellesmere Island, District of Franklin, 79°02'N, 74°52'W. Sample FS-77-303, collected and interpreted by T. Frisch.

See GSC 81-94 for description and interpretation.

GSC 81-92 Whole rock, K-Ar age **1463 ± 77 Ma**

K = 0.72%, $^{40}Ar/^{40}K$ = 0.1310, radiogenic Ar = 98.7%.
Concentrate: Crushed whole rock.

From gabbro
(39 H) 6 km west of Cape Camperdown, south shore of Bache Peninsula, east coast of Ellesmere Island, District of Franklin, 79°02'N, 74°52'W. Sample FS-77-306A, collected and interpreted by T. Frisch.

See GSC 81-94 for description and interpretation.

GSC 81-93 Whole rock, K-Ar age **1369 ± 66 Ma**

K = 0.82%, $^{40}Ar/^{40}K$ = 0.1369, radiogenic Ar = 98.1%.
Concentrate: Crushed whole rock.

From gabbro
(39 H) 6 km west of Cape Camperdown, south shore of Bache Peninsula, east coast of Ellesmere Island, District of Franklin, 79°02'N, 74°52'W. Sample FS-77-306B, collected and interpreted by T. Frisch.

See GSC 81-94 for description and interpretation.

GSC 81-94 Whole rock, K-Ar age **1197 ± 33 Ma**

K = 3.11%, $^{40}Ar/^{40}K$ = 0.09870, radiogenic Ar = 99.3%.
Concentrate: Crushed whole rock.

From basalt
(39 H) 6 km west of Cape Camperdown, south shore of Bache Peninsula, Ellesmere Island, District of Franklin, 79°02'N, 74°52'W. Sample FS-77-304, collected and interpreted by T. Frisch.

These rocks were collected from two sills in a clastic sequence overlying basement and underlying lower Paleozoic strata on Bache Peninsula, eastern Ellesmere Island (Christie, 1967, Pl. II). Both sills are strongly altered and, particularly along the contacts, heavily frost-shattered, so that fresh samples of chilled margins in situ were not obtainable. GSC 81-91 is from the upper chilled margin of the lower sill in Christie's (1967) Plate II and is an extremely altered rock, anomalously high in K_2O. The age obtained, 626 Ma, also anomalous, is omitted from further discussion. GSC 81-94 comes from near the lower margin of the same sill. GSC 81-92 and 93 are both from near the chilled margin of the upper sill and the ages agree within error limits. The ages of 1200 to 1400 Ma confirm a Precambrian age for the Rensselaer Bay Formation, which the sills intrude. However, in view of the altered state of the samples, the results are not interpreted as indicating conclusively that the Bache Peninsula sills are significantly older than those in the Thule Group.

Reference

Christie, R.L.
1967: Bache Peninsula, Ellesmere Island, Arctic Archipelago; Geological Survey of Canada, Memoir 347, 63 p.

GSC 81-95 Whole rock, K-Ar age **576 ± 33 Ma**

K = 0.86%, $^{40}Ar/^{40}K$ = 0.03942, radiogenic Ar = 97.5%.
Concentrate: Crushed whole rock.

From diabase
(39 B) 2 km southwest of Clarence Head, southeast coast of Ellesmere Island, District of Franklin, 76°47'N, 77°49'W. Sample FS-77-115 collected and interpreted by T. Frisch.

See GSC 81-97 for description and interpretation.

GSC 81-96 Whole rock, K-Ar age **580 ± 36 Ma**

K = 0.75%, $^{40}Ar/^{40}K$ = 0.03974, radiogenic Ar = 95.6%.
Concentrate: Crushed whole rock.

From diabase
(39 E&F) North shore of Goding Bay, east of Sparks Glacier, east coast of Ellesmere Island, District of Franklin, 78°01'N, 76°07'W. Sample FS-77-127 collected and interpreted by T. Frisch.

See GSC 81-97 for description and interpretation.

GSC 81-97 Whole rock, K-Ar age **791 ± 60 Ma**

K = 0.56%, $^{40}Ar/^{40}K$ = 0.05767, radiogenic Ar = 97.4%.
Concentrate: Crushed whole rock.

From diabase
(39 E&F) North shore of Goding Bay, east of Sparks Glacier, east coast of Ellesmere Island, District of Franklin, 78°01'N, 76°07'W. Sample FS-77-137 collected and interpreted by T. Frisch.

GSC 81-95, 96 and 97 refer to samples from diabase dykes cutting basement and Thule Group. All three samples were relatively fresh and the ages obtained are probably valid indicators of the time of intrusion.

Field observations suggested that dykes were concentrated in areas where Thule Group rocks were exposed and thus were another manifestation of basaltic igneous activity related to deposition of the Thule Group. Their K-Ar ages clearly indicate, however, that the dykes are much younger (Hadrynian) than the Thule Group basalts (Neohelikian).

GSC 81-98 Whole rock, K-Ar age **1065 ± 73 Ma**

K = 0.55%, $^{40}Ar/^{40}K$ = 0.08429, radiogenic Ar = 98.5%.
Concentrate: Crushed whole rock.

From basalt
(39 B) 2 km southwest of Clarence Head, southeast coast of Ellesmere Island, District of Franklin, 76°47'N, 77°49'W. Sample FS-77-100, collected and interpreted by T. Frisch.

See GSC 81-101 for description and interpretation.

GSC 81-99 Whole rock, K-Ar age **978 ± 46 Ma**

K = 1.00%, $^{40}Ar/^{40}K$ = 0.07539, radiogenic Ar = 98.8%.
Concentrate: Crushed whole rock.

From diabase
(39 B) 2 km southwest of Clarence Head, southeast coast of Ellesmere Island, District of Franklin, 76°47'N, 77°49'W. Sample FS-77-121, collected and inter-preted by T. Frisch.

See GSC 81-101 for description and interpretation.

GSC 81-100 Whole rock, K-Ar age **1284 ± 37 Ma**

K = 2.86%, $^{40}Ar/^{40}K$ = 0.1087, radiogenic Ar = 99.3%.
Concentrate: Crushed whole rock.

From diabase
(39 E&F) 4 km west of Gale Point, north shore of Cadogan Inlet, east coast of Ellesmere Island, District of Franklin, 78°12'N, 75°42'W. Sample FS-77-243, collected and interpreted by T. Frisch.

See GSC 81-101 for description and interpretation.

GSC 81-101 Whole rock, K-Ar age **1173 ± 43 Ma**

K = 1.45%, $^{40}Ar/^{40}K$ = 0.09596, radiogenic Ar = 98.8%.
Concentrate: Crushed whole rock.

From diabase
(39 E&F) 4 km west of Gale Point, north shore of Cadogan Inlet, east coast of Ellesmere Island, District of Franklin, 78°12'N, 75°42'W. Sample FS-77-250, collected and interpreted by T. Frisch.

GSC 81-98, 99, 100 and 101 refer to samples from the Thule Group, a Proterozoic sequence of predominantly clastic sedimentary rocks that overlie crystalline basement on the southeastern coast of Ellesmere Island (Christie, 1972, Frisch and Christie, 1982). Basalt lava and sills of tholeiitic composition are found mainly in the lower part of the sequence and are considered to be at least broadly coeval with deposition of the sediments. The samples were taken from the chill zones of four igneous bodies.

GSC 81-99 is from either a lava or sill; the other three samples are from sills. All the samples are altered to some degree, the mafic silicates generally showing the greatest alteration. In GSC 81-100, however, plagioclase is heavily altered as well. For this reason, the age obtained, 1284 ± 37 Ma, is not considered valid.

The other three ages agree, or nearly agree, within error limits and their average, 1100 Ma (to the nearest 100 Ma), is thought to be a reliable indication of the age of basaltic igneous activity during formation of the Thule Group. On this basis, the Thule Group on Ellesmere Island is considered to be 1000 to 1200 Ma old. Ages obtained from basalt sills in equivalent rocks in northwestern Greenland (type locality of the Thule Group) fall in the range 1070 to 1190 Ma.

References

Christie, R.L.
1972: Central Stable Region; p. 40-87 in Guidebook to Excursion A66, The Canadian Arctic Islands and the Mackenzie region, D.J. Glass (Ed.); XXIV International Geological Congress, Montreal, 146 p.

Frisch, T. and Christie, R.L.
1982: Stratigraphy of the Proterozoic Thule Group, southeastern Ellesmere Island, Arctic Archipelago; Geological Survey of Canada, Paper 81-19.

GSC 81-102 Whole rock, K-Ar age **115 ± 5 Ma**

K = 0.913, $^{40}Ar/^{40}K$ = 0.00690, radiogenic Ar = 90.0%.
Concentrate: Crushed whole rock.

From basic dyke
(59 B) 12.9 km south-southwest of mouth of Lyall River, north western Grinnell Peninsula of Devon Island, District of Franklin, 76°53'54"N, 95°24'47"W. Sample K1-72-268bL, collected and described by J. William Kerr.

The specimen is from the chilled margin of a basic dyke which cuts through Ordovician and Pennsylvanian rocks. See GSC 81-103 for description.

GSC 81-103 Whole rock, K-Ar age **117 ± 5 Ma**

K = 0.777%, $^{40}Ar/^{40}K$ = 0.00700, radiogenic Ar = 52.3%.
Concentrate: Crushed whole rock.

From diabase
(59 B) 7.2 km southwest of mouth of Lyall River, northwestern Grinnell Peninsula, Devon Island, District of Franklin, 76°58'02"N, 95°26'36.9"W. Sample K1-72-268cL, collected and described by J.W. Kerr.

The specimen is from the chilled margin of a basic dyke which cuts through Ordovician and Pennsylvanian rocks. It is a fine grained, porphyritic diabase or basalt with plagioclase (labradorite-bytownite), clinopyroxene and minor biotite phenocrysts in a microcrystalline groundmass too fine for specific mineral identification but consisting mainly of plagioclase, ore, etc.

A series of north-trending faults cut the Cornwallis Fold belt and some of them are intruded for part of their length by dykes. Since the dykes are not sheared their age should presumably date the last period of faulting.

GSC 81-104 Whole rock, K-Ar age **734 ± 37 Ma**

K = 1.43%, $^{40}Ar/^{40}K$ = 0.05265, radiogenic Ar = 95%.
Concentrate: Crushed whole rock.

From diabase
(68 D) Small unnamed island northeast of Lock Island in the mouth of Browne Bay, Prince of Wales Island, District of Franklin, 73°20'14"N, 97°04'42"W. See GSC Map 37-1963 (Blackadar and Christie). Sample K1-70-53A, collected and described by J.W. Kerr.

The rock was from a diabase sill of fine grainsize and having a dark green fresh surface but weathering slightly rusty brown. It was a fine tholeiitic diabase consisting of feldspar (mainly labradorite) and clinopyroxene, with minor iron, amphibole and quartz. The plagioclase was partly altered to epidote, sericite, etc. and the pyroxene slightly altered to chlorite.

The specimen is from the chilled lower margin of a sill. It is one of many important dykes and sills on the western margin of the Boothia Uplift. These intrusions are of pre-Middle Ordovician age, being overlain by the Cornwallis Group, and are contemporaneous with the major faulting of the Boothia Uplift.

GSC 81-105 Biotite, K-Ar age **644 ± 19 Ma**

K = 4.41%, $^{40}Ar/^{40}K$ = 0.04409, radiogenic Ar = 97.6%.
Concentrate: Relatively clean brown biotite with a trace of hornblende and chlorite contamination.

From diabase
(58 C) South of Aston Bay, northwest Somerset Island, District of Franklin, 73°35'04"N, 94°52'31"W. See "dykes" on GSC Map 37-1963. Sample K1-75-37gL, collected and described by J.W. Kerr.

This sample is from a dyke that intrudes both the Aston and Hunting formations and specifically is from that part of the dyke intruding the Aston Fm. The rock consists of 50% plagioclase (An_{50}), 40% clinopyroxene with abundant brown alteration products, 5% brown biotite (significantly chloritized) intergrown with opaque minerals (5%), and less than 1% each of hornblende and micropegmatite.

See GSC 81-111 for discussion.

GSC 81-106 Biotite, K-Ar age **661 ± 19 Ma**

K = 5.23%, $^{40}Ar/^{40}K$ = 0.04551, radiogenic Ar = 97.7%.
Concentrate: Dark brown biotite with approximately 4% chlorite alteration and a trace of free hornblende contamination.

From diabase
(58 C) South of Aston Bay, northwest Somerset Island, District of Franklin, 73°39'03"N, 95°03'40"W. See "dykes", GSC Map 37-1963. Sample K1-75-033aL, collected and described by J.W. Kerr.

See GSC 81-108 for description and GSC 81-111 for discussion.

GSC 81-107 Hornblende, K-Ar age **694 ± 56 Ma**

K = 0.50%, $^{40}Ar/^{40}K$ = 0.04826, radiogenic Ar = 90.3%.
Concentrate: Pleochroic, brown to green hornblende with approximately 5% biotite and a trace of chlorite contamination.

From diabase
(58 C) Details as for GSC 81-106.

See GSC 81-108 for description and GSC 81-111 for discussion.

GSC 81-108 Whole rock, K-Ar age **575 ± 21 Ma**

K = 2.16%, $^{40}Ar/^{40}K$ = 0.03860, radiogenic Ar = 98.8%.
Concentrate: Crushed whole rock.

From diabase
(58 C) Details as for GSC 81-106.

This dyke (GSC 81-106, 107, 108) intrudes the Hunting formation. It consists of 50% plagioclase An_{40}, 35% completely altered (?)pyroxene, 5% hornblende, 5% brown biotite occurring intergrown with skeletal opaques and hornblende, 5% opaques and 10% micropegmatite.

See GSC 81-111 for discussion.

GSC 81-109 Biotite, K-Ar age **673 ± 16 Ma**

K = 4.38%, $^{40}Ar/^{40}K$ = 0.04649, radiogenic Ar = 98.0%.
Concentrate: Altered brown biotite with approximately 15% chloritization.

From diabase
(58 C) West of Aston Bay, northwest Somerset Island, District of Franklin, 73°43'23"N, 95°29'15"W. See "dykes", GSC Map 37-1963. Sample K1-75-27cL, collected and described by J.W. Kerr.

See GSC 81-110 for description and GSC 81-111 for discussion.

GSC 81-110 Whole rock, K-Ar age **739 ± 34 Ma**

K = 1.13%, $^{40}Ar/^{40}K$ = 0.05211, radiogenic Ar = 95.9%.
Concentrate: Crushed whole rock.

From diabase
(58 C) Details as for GSC 81-109.

The sample was taken from a dyke cutting the Hunting Formation. It consists of 40% plagioclase An_{30-40}, 40% slightly altered clinopyroxene, 5% green amphibole, 4% brown biotite occurring both as intergrowths with opaques and as chloritized anhedral grains, 6% micropegmatite, and 5% opaques.

See GSC 81-111 for discussion.

GSC 81-111 Whole rock, K-Ar age **888 ± 31 Ma**

K = 1.08%, $^{40}Ar/^{40}K$ = 0.06537, radiogenic Ar = 98.1%.
Concentrate: Crushed whole rock.

From diabase (?)
(58 C) Northwest Somerset Island, District of Franklin, 73°32'28"N, 92°31'27"W. See "dykes", GSC Map 37-1963. Sample K1-75-32aL, collected and described by J.W. Kerr.

The sample is from the end of a sill that intrudes the Aston Formation. It consists of 50% plagioclase, 35% altered pyroxene (?), 10% quartz and 5% opaques.

Two periods of intrusion affected the Proterozoic sedimentary rocks of Somerset Island. The first intruded the Aston Formation and is overlain unconformably by the Hunting Formation. The second period of intrusion cuts both formations.

GSC 81-112 Phlogopite, K-Ar age **228 ± 8 Ma**

K = 3.34%, $^{40}Ar/^{40}K$ = 0.01412, radiogenic Ar = 89.7%.
Concentrate: Light brown phlogopite with approximately 6% chlorite alteration.

From kimberlite

(58 C) Small knolls on moderately dissected plateau, upper reaches of Batty River, Somerset Island, District of Franklin, 73°20'N, 92°00'W. Sample C64243, collected and described by J.W. Kerr.

The rock is a kimberlitic breccia consisting of rounded to subangular xenoliths (mostly limestones and dolomites) and xenocrysts of olivine, phlogopite and garnet set in a dark green porphyry matrix. The kimberlite pipe crops out in flat-lying Ordovician (Read Bay) limestones and dolomites. See GSC 81-113 for additional comments.

GSC 81-113 Biotite, K-Ar age **695 ± 16 Ma**

K = 2.81%, $^{40}Ar/^{40}K$ = 0.04924, radiogenic Ar = 96.8%.
Concentrate: Clean, unaltered, brown biotite with no visible chlorite contamination.

From kimberlite

(58 C) Small knolls on moderate dissected plateau, upper reaches of Batty River, Somerset Island, District of Franklin, 73°20'N, 92°00'W. Sample C64244, collected and described by J.W. Kerr.

Description as for GSC 81-112. These discordant ages should be evaluated with considerable suspicion as the extremely low potassium content clearly signals that they are not normal micas.

GSC 81-114 Hornblende, K-Ar age **1592 ± 56 Ma**

K = 1.35%, $^{40}Ar/^{40}K$ = 0.1485, radiogenic Ar = 99.3%.
Concentrate: Clean, fresh and unaltered, pleochroic, brown to dark green hornblende with no visible contamination.

From granite

(58 C) Cape Granite, Somerset Island, District of Franklin, 73°44'N, 95°36½'W. Sample 76-DV-277-a, collected by C. de Vries and R.D. Stevens.

The sample is from a coarse hornblende granite and should provide a minimum age for F-3 deformation.

GSC 81-115 Hornblende, K-Ar age **1876 ± 45 Ma**

K = 1.22%, $^{40}Ar/^{40}K$ = 0.1918, radiogenic Ar = 94.9%.
Concentrate: Clean, unaltered, pleochroic, brown to dark green hornblende with no visible contamination.

From pegmatite

(27 D) East coast of Aulitivik Island, east Baffin, District of Franklin, 69°35'N, 67°54'W. Sample J121-1-HSA79, collected and interpreted by J.R. Henderson.

See GSC 81-116 for discussion.

GSC 81-116 Hornblende, K-Ar age **1927 ± 47 Ma**

K = 1.19%, $^{40}Ar/^{40}K$ = 0.2001, radiogenic Ar = 97.5%.
Concentrate: Clean, unaltered, pleochroic, light brown to dark green hornblende with no visible contamination.

From amphibolite

(27 D) East coast of Aulitivik Island, District of Franklin, 69°35'N, 67°54'W. Sample J121-1-HSA79, collected and interpreted by J.R. Henderson.

The two K-Ar hornblende ages (GSC 81-115 and 116) may indicate either the time the host amphibolite cooled below 500°C* or the ages may be geologically meaningless due to excess argon 40. Excess argon 40 is suspected because we dated a tonalite pegmatite emplaced in an extension fracture of the amphibolite at 1806^{+15}_{-8} Ma by the U-Pb concordia zircon method. If the K-Ar hornblende ages are true cooling ages then the pegmatite crystallized well below the minimum liquidus temperature of a tonalite magma; possibly from a hydrothermal fluid.

*Argon 40 blocking temperatures are those used by Mehta (1980).

References

Henderson, J.R. and Loveridge, W.D.
1981: Age and geological significance of a tonalite pegmatite from east-central Baffin Island; in Rb-Sr and U-Pb Isotopic Age Studies, Report 4; in Current Research, Part C, Geological Survey of Canada, Paper 81-1C, p. 1356-137.

Mehta, P.K.
1980: Tectonic significance of the young mineral dates and the rates of cooling and uplift in the Himalaya; Tectonophysics, v. 62, p. 205-218.

GSC 81-117 Biotite, K-Ar age **1688 ± 24 Ma**

K = 6.03%, $^{40}Ar/^{40}K$ = 0.1624, radiogenic Ar = 99.5%.
Concentrate: Reddish brown biotite with approximately 15% chlorite alteration.

From quartz monzonite

(27 A) Baffin Island, District of Franklin, 68°04'N, 66°53'W. Sample C161-1-HSA79, collected and interpreted by J.R. Henderson.

See GSC 81-119 for discussion.

GSC 81-118 Biotite, K-Ar age **1685 ± 24 Ma**

K = 6.59%, $^{40}Ar/^{40}K$ = 0.1619, radiogenic Ar = 96.4%.
Concentrate: Reddish orange biotite with approximately 8% chlorite alteration.

From megacrystic granitoid

(27 A) East side of fiord, Home Bay area, northeast coast of Baffin Island, District of Franklin, 68°04'N, 66°53'W. Sample C161-2-HSA79, collected by C. Tippett and interpreted by J.R. Henderson.

See GSC 81-119 for discussion.

GSC 81-119 Biotite, K-Ar age **1727 ± 24 Ma**

K = 5.57%, $^{40}Ar/^{40}K$ = 0.1683, radiogenic Ar = 99.1%.
Concentrate: Reddish-brown biotite with approximately 9% chlorite which occurs both as free flakes and as altered biotite.

From megacrystic charnockite

(27 A) East side of Fiord, northeast coast of Baffin Island, District of Franklin, 68°04'N, 66°53'W. Sample C161-3-HSA79, collected by C. Tippett and interpreted by J.R. Henderson.

The biotites were separated from a suite of rocks collected from a large megacrystic charnockite body in Fox Fold Belt, east coast of Baffin Island. The age is interpreted to indicate the time the host rock cooled below the 250°C isotherm.

GSC 81-120 Hornblende, K-Ar age **1758 ± 51 Ma**

K = 0.974%, $^{40}Ar/^{40}K$ = 0.1729, radiogenic Ar = 99.0%.
Concentrate: Clean, fresh, non-pleochroic, dark green hornblende with less than 1% biotite contamination.

From gneiss

(46 N) Northeast of head of Lyon Inlet, Melville Peninsula, District of Franklin, 67°05'N, 84°34'W. Map-unit 10, GSC Map 14-1966. Sample 6RA-3, collected and interpreted by J.R. Henderson.

See GSC 81-124 for discussion.

GSC 81-121 Biotite, K-Ar age **1649 ± 40 Ma**

K = 6.60%, $^{40}Ar/^{40}K$ = 0.1566, radiogenic Ar = 99.7%.
Concentrate: Somewhat impure, light brown biotite with approximately 9-10% chlorite alteration.

From mafic gneiss

(46 N) Mierching Lake, Melville Peninsula, District of Franklin, 67°26'52"N, 84°45'58"W. Sample L494RA-2-74, collected by A.N. LeCheminant and interpreted by J.R. Henderson.

See GSC 81-124 for discussion.

GSC 81-122 Hornblende, K-Ar age **1729 ± 50 Ma**

K = 1.01%, $^{40}Ar/^{40}K$ = 0.1685, radiogenic Ar = 97.8%.
Concentrate: Clean, fresh and unaltered, pleochroic, brown to green hornblende with no visible contamination.

From mafic gneiss

(46 N) Details as for GSC 81-121.

See GSC 81-124 for discussion.

GSC 81-123 Biotite, K-Ar age **1637 ± 50 Ma**

K = 7.78%, $^{40}Ar/^{40}K$ = 0.1550, radiogenic Ar = 99.4%.
Concentrate: Relatively clean, light greenish brown biotite with approximately 1% chlorite alteration.

From mafic augen gneiss

(46 N) Mierching Lake, Melville Peninsula, District of Franklin, 67°23'22"N, 84°41'02"W. Sample L542RA-1-74, collected by A.N. LeCheminant and interpreted by J.R. Henderson.

See GSC 81-124 for discussion.

GSC 81-124 Hornblende, K-Ar age **1687 ± 49 Ma**

K = 1.26%, $^{40}Ar/^{40}K$ = 0.1623, radiogenic Ar = 98.9%.
Concentrate: Somewhat impure, pleochroic, brown to dark green hornblende with approximately 5% intergrown biotite contamination.

From mafic augen gneiss

(46 N) Details as for GSC 81-123.

The hornblende ages are interpreted as argon 40 retention ages related to post-kinematic cooling below the 500°C isotherm* following the Hudsonian Orogeny in the Foxe Fold Belt, Melville Peninsula, while the biotite ages are interpreted as argon 40 retention ages related to post-kinematic cooling below the 250°C isotherm. The K-Ar hornblende and biotite ages were obtained from minerals separated from Archean granitoid gneiss which gave a U-Pb concordia zircon age of 2727 ± 33 Ma (which is interpreted as the time of formation of the igneous host rock), and a 2493 ± 86 Ma Rb-Sr whole rock isochron age (which is interpreted as a recrystallization age of the host rock related to the Kenoran Orogeny). The apparent age of the Hudsonian metamorphic thermal climax in the Foxe Fold Belt is indicated by an 1804 ± 16 Ma Rb-Sr whole rock isochron obtained from Aphebian Penrhyn Group paragneiss. Studies of Fe-Mg partitioning between coexisting garnet-biotite, and garnet-cordierite, as well as the conversion of grunerite to fayalite and quartz indicate that the Hudsonian metamorphism in the region reached a 720°C maximum (Henderson, in press).

In summary, it appears that the Hudsonian Orogeny in the Melville Peninsula had a 720°C post-kinematic thermal climax at 1804 Ma, and the rocks cooled through the 500°C isotherm about 1725 Ma and the 250°C isotherm about 1626 Ma ago.

*Argon 40 blocking temperatures are those used by Mehta, 1980.

References

Henderson, J.R.
Structure and metamorphism of the Aphebian Penrhyn Group and its Archean Basement Complex in the Lyon Inlet area, Melville Peninsula, District of Franklin, Geological Survey of Canada, Bulletin 324. (in press)

Mehta, P.K.
1980: Tectonic significance of the young mineral dates and the rates of cooling and uplift in the Himalaya; Tectonophysics, v. 62, p. 205-218.

GSC 81-125 Biotite, K-Ar age **1764 ± 32 Ma**

K = 4.77%, $^{40}Ar/^{40}K$ = 0.1739, radiogenic Ar = 99.5%.
Concentrate: Light brown biotite with approximately 2-3% chlorite alteration.

From quartz feldspar porphyry

(37 C) 3.2 km north of northwest end of Eqe Bay, Baffin Island, District of Franklin, 69°43'N, 76°40'W. Sample MZ-75-418, collected by W.C. Morgan and described by R.D. Stevens.

The sample is from a grey quartz feldspar porphyry in the Mary River Group and is probably an acid volcanic flow.

In thin section the rock is seen to be strongly foliated, with abundant feldspar and quartz phenocrysts and lines of highly oriented brown biotite. The feldspar phenocrysts tend to be oriented and have granular quartz "shadows" on their

sheltered sides. Biotite streaks are also distorted around the phenocrysts. The quartz phenocrysts are anhedral, fractured, and have carbonate aggregates on their sheltered sides and in fractures. The rock appears to have been vigorously sheared and the biotite is probably related to this event.

GSC 81-126 Muscovite, K-Ar age **1757 ± 41 Ma**

K = 8.50%, $^{40}Ar/^{40}K$ = 0.1728, radiogenic Ar = 99.3%.
Concentrate: Clean, unaltered, clear muscovite with no visible contamination.

From "granite"
(37 C) Island in Grant-Suttie Bay, 8 km east of Cape Jensen, Baffin Island, District of Franklin, 69°45'30"N, 77°22'06"W. Sample MZ-74-586, collected by W.C. Morgan and R.K. Herd.

The sample represents a massive leucocratic "granite" that is intrusive into rocks of the Mary River Group.

GSC 81-127 Biotite, K-Ar age **1663 ± 41 Ma**

K = 7.71%, $^{40}Ar/^{40}K$ = 0.1586, radiogenic Ar = 99.3%.
Concentrate: Clean, unaltered, light brownish orange biotite with no visible contamination.

From gneiss
(37 D) Approximately 16 km west of the north end of Piling Lake, District of Franklin, 69°06'25"N, 75°14'00"W. Sample MZ-74-519A collected by W.C. Morgan and J.W. Pickett.

See GSC 81-129 for description.

GSC 81-128 Biotite, K-Ar age **1621 ± 40 Ma**

K = 6.30%, $^{40}Ar/^{40}K$ = 0.1526, radiogenic Ar = 99.2%.
Concentrate: Light brownish orange biotite with approximately 10% chlorite alteration.

From gneiss
(37 D) Approximately 16 km west of the north end of Piling Lake, District of Franklin, 69°06'25"N, 75°14'00"W. Sample MZ-74-579B, collected by W.C. Morgan and J.W. Pickett.

See GSC 81-129 for description.

GSC 81-129 Biotite, K-Ar age **1641 ± 39 Ma**

K = 6.90%, $^{40}Ar/^{40}K$ = 0.1554, radiogenic Ar = 99.6%.
Concentrate: Light brownish orange biotite with approximately 8% chlorite alteration.

From gneiss
(37 D) Approximately 16 km west of the north end of Piling Lake, District of Franklin, 69°06'25"N, 75°14'00"W. Sample MZ-74-519C, collected by W.C. Morgan and J.W. Pickett.

These three samples are from a granitoid gneiss which was considered to be basement to the Piling Group. At the collection locality the migmatitic gneisses can be separated into three distinct phases sampled individually as A, B and C (GSC 81-127, 128 and 129).

GSC 81-130 Biotite, K-Ar age **1639 ± 41 Ma**

K = 7.52%, $^{40}Ar/^{40}K$ = 0.1553, radiogenic Ar = 99.6%.
Concentrate: Clean, unaltered, light brown biotite with no visible contamination.

From granitoid gneiss
(37 A) 43.4 km southwest of airstrip at Dewar Lakes Dewline site, Baffin Island, District of Franklin, 68°27'N, 72°06'W. Sample MZ-75-376, collected by W.C. Morgan and P.H. Thompson.

The sample was collected from a grey granitoid gneiss constituting basement to the Piling Group.

GSC 81-131 Biotite, K-Ar age **1623 ± 40 Ma**

K = 7.11%, $^{40}Ar/^{40}K$ = 0.1530, radiogenic Ar = 99.4%.
Concentrate: Greenish brown biotite with approximately 3% chlorite alteration.

From granitoid gneiss
(37 D) 21 km southwest of the southwest end of Blanchfield Lake, Baffin Island, District of Franklin, 69°32'N, 73°48'W. Sample MZØ-75-497, collected by A.V. Okulitch and submitted by W.C. Morgan.

See GSC 81-132 for description.

GSC 81-132 Hornblende, K-Ar age **1768 ± 67 Ma**

K = 1.10%, $^{40}Ar/^{40}K$ = 0.1745, radiogenic Ar = 99.3%.
Concentrate: Fresh pleochroic, brown to green hornblende with no visible contamination.

From granitoid gneiss
(37 D) Details as for GSC 81-131.

The sample was collected from a grey to pink granitoid gneiss representing basement to the Piling Group.

GSC 81-133 Biotite, K-Ar age **1686 ± 41 Ma**

K = 7.00%, $^{40}Ar/^{40}K$ = 0.1621, radiogenic Ar = 99.2%.
Concentrate: Light brown biotite with approximately 8% chlorite alteration.

From granulite
(37 C) 27.4 km north-northeast of Cape Jensen, Grant-Suttie Bay, Baffin Island, District of Franklin, 69°58'N, 77°25'W. Sample MZ-75-430, collected by W.C. Morgan.

The sample is from a grey to pink, foliated granulite representing a basement terrane in central Baffin Island.

GSC 81-134 Biotite, K-Ar age **1646 ± 40 Ma**

K = 7.47%, $^{40}Ar/^{40}K$ = 0.1562, radiogenic Ar = 99.6%.
Concentrate: Clean, fresh and unaltered, light brown biotite with no visible contamination.

From granite-granodiorite
(37 A) 27.4 km northeast of Nichols Bluff, Wordie Bay, Baffin Island, District of Franklin, 68°13'N, 72°23'W. Sample MZ-75-360 collected by J.E. Reesor and W.C. Morgan.

The sample was collected from a massive granitoid pluton with charnockitic affinities. The dated specimen was a massive, megacrystic grey granite-granodiorite of possible granulite facies.

GSC 81-135 Muscovite, K-Ar age **1574 ± 31 Ma**

K = 7.94%, $^{40}Ar/^{40}K$ = 0.1460, radiogenic Ar = 99.1%.
Concentrate: Mainly clear muscovite with approximately 4% chlorite contamination.

From "granite"
(37 D) West side of peninsula in Lake Gillian, approximately 19 km north-northeast of Ikpik River, Ikpik Bay, Baffin Island, District of Franklin, 69°31'N, 75°41'W. Sample MZQ-75-496, collected by A.V. Okulitch and submitted by W.C. Morgan.

The sample is from a coarse grained, pink to grey, massive to gently foliated granitoid pluton.

GSC 81-136 Muscovite, K-Ar age **1735 ± 41 Ma**

K = 9.12%, $^{40}Ar/^{40}K$ = 0.1695, radiogenic Ar = 99.3%.
Concentrate: Clean, clear, fresh muscovite with no visible contamination.

From granite
(77 E) "Wellington High", north of Washburn Lake, southern Victoria Island, District of Franklin, 70°08.5'N, 107°34'W. Sample CCA-8-2000-3, collected by F.H.A. Campbell.

The rock is a coarse grained granite with pegmatitic phases. It either intrudes or is basement to the equivalent of the Burnside River Formation of the Goulburn Group (Aphebian). Contact relationships are uncertain as most of the area is underlain by Paleozoic rocks.

GSC 81-137 Whole rock, K-Ar age **1150 ± 92 Ma**

K = 0.44%, $^{40}Ar/^{40}K$ = 0.09346, radiogenic Ar = 96.8%.
Concentrate: Crushed whole rock.

From diabase
(77 D) "Wellington High", south of Ferguson Lake, west of Cambridge Bay, southern Victoria Island, District of Franklin, 69°19'N, 106°07'W. Sample CCA-8-20001, collected by F.H.A. Campbell.

The sample is from a diabase forming a large sill which apparently intrudes the equivalent of the Aphebian Goulburn Group.

GSC 81-138 Biotite, K-Ar age **1591 ± 48 Ma**

K = 7.65%, $^{40}Ar/^{40}K$ = 0.1484, radiogenic Ar = 99.5%.
Concentrate: Brown biotite with approximately 2% chlorite alteration.

From granodioritic gneiss
(46 N) Mierching Lake, District of Franklin, 67°19'04"N, 84°52'14"W. Sample L593RA-3-74, collected by A.N. LeCheminant.

The rock is a biotite quartz feldspar granodioritic gneiss typical of leucocratic layers associated with Prince Albert Group(?) paragneiss and amphibolite in an area characterized by intimate intermixing of granitoid gneisses and Prince Albert(?) Group rocks.

GSC 81-139 Hornblende, K-Ar age **1723 ± 50 Ma**

K = 1.46%, $^{40}Ar/^{40}K$ = 0.1676, radiogenic Ar = 99.8%.
Concentrate: Clean, unaltered, pleochroic, greenish brown to dark green hornblende with no visible contamination.

From charnockite
(26 J) East of Shark Fiord, Cumberland Sound, Baffin Island, District of Franklin, 66°32'N, 66°05'W. Sample JDE-309-70, collected by I.F. Ermanovics and described by G.D. Jackson.

The sample is from a massive, coarse grained charnockite consisting of quartz (30%), plagioclase (30%), perthite (30%), hornblende (7%), hypersthene (2%), magnetite (1%), and traces of apatite and zircon. This charnockite mass occupies 20,000 square miles of central Baffin Island.

GSC 81-140 Hornblende, K-Ar age **1743 ± 50 Ma**

K = 0.360%, $^{40}Ar/^{40}K$ = 0.1673, radiogenic Ar = 97.3%.
Concentrate: Clean, unaltered, pleochroic, brownish green to dark green hornblende with no visible contamination.

From amphibolite
(26 H) Cumberland Peninsula, south of Kingnait Fiord, Baffin Island, District of Franklin, 65°47'N, 64°22'W. Sample JD-358/10-70, collected and described by G.D. Jackson.

The amphibolite is a probable metavolcanic rock of the Hoare Bay Group. It is fine grained, thinly laminated, dark grey to black and consists of quartz (8%), plagioclase (10%), augite (18%), hornblende (43%), sphene (8%), calcite (5%), ilmenite (5%), magnetite (3%), and traces of scapolite and biotite. See Jackson and Taylor (1972) for a general discussion of the Hoare Bay Group.

Reference

Jackson, G.D. and Taylor, F.C.
1972: Correlation of major Aphebian rock units in the northeastern Canadian Shield; Canadian Journal of Earth Sciences, v. 9, no. 12, p. 1665.

District of Mackenzie

(GSC 81-141 to GSC 81-145)

GSC 81-141 Biotite, K-Ar age **2222 ± 49 Ma**

K = 7.00%, $^{40}Ar/^{40}K$ = 0.2543, radiogenic Ar = 99.9%.
Concentrate: Dark brown biotite with approximately 7% chlorite alteration.

From granodiorite
(85 I) 7 km northeast of Turnback Lake, about 100 km east-northeast of Yellowknife, District of Mackenzie, 62°46'07"N, 112°29'00"W. Sample HBA-H-SL-74, collected and interpreted by J.B. Henderson.

Material was collected to determine the zircon age of a metamorphosed, massive, high level granite body near Sunset Lake, 104 km east-northeast of Yellowknife that is intrusive into a dominantly mafic sequence of Archean Yellowknife Supergroup metavolcanic rocks. On the basis of the field relations and the texture of the granite it appeared possible the granite body could be a subvolcanic pluton contemporaneous with felsic volcanic units high in the section. The sample had a discordant zircon $^{207}Pb/^{206}Pb$ age of 2550 Ma, in contrast to an age of volcanism in other parts of the Slave Province of about 2670 Ma (Henderson, 1981; see GSC 81-144). The metamorphic biotite from the sample has a K/Ar age of 2222 ± 49, which presumably represents a much later cooling age unrelated to the emplacement of the body.

GSC 81-142 Biotite, K-Ar age **2107 ± 46 Ma**

K = 7.19%, $^{40}Ar/^{40}K$ = 0.2323, radiogenic Ar = 99.7%.
Concentrate: Light greenish brown biotite with approximately 5% chlorite alteration.

From granitic gneiss
(85 J) Narcisse Lake, 32 km north of Yellowknife, District of Mackenzie, 62°45'N, 114°29'W. Map-unit 1, Yellowknife map area, Open File 353. Sample HBA-NL-2-76, collected and interpreted by J.B. Henderson.

See GSC 81-144 for description and interpretation.

GSC 81-143 Biotite, K-Ar age **2197 ± 48 Ma**

K = 7.41%, $^{40}Ar/^{40}K$ = 0.2494, radiogenic Ar = 99.9%.
Concentrate: Greenish brown biotite with approximately 4% chlorite alteration.

From granitic gneiss
(85 J) Narcisse Lake, about 32 km north of Yellowknife, District of Mackenzie, 62°45'N, 114°29'W. Map-unit 1, Yellowknife map area, GSC Open File 353. Sample HBA-NL-1-76, collected and interpreted by J.B. Henderson.

See GSC 81-144 for description and interpretation.

GSC 81-144 Hornblende, K-Ar age **2506 ± 52 Ma**

K = 1.09%, $^{40}Ar/^{40}K$ = 0.3156, radiogenic Ar = 99.4%.
Concentrate: Clean, unaltered, pleochroic, brown to green hornblende with no visible contamination.

From granitic gneiss
(85 J) Details as for GSC 81-143.

Two samples, represented by GSC 81-142, 143 and 144, of granitoid gneiss less than 2 km apart were collected for zircon geochronology at Narcisse Lake, 33 km north of Yellowknife, from a tonalitic to granitic gneiss terrane with massive intrusive granitic rocks that is thought to be, at least in part, older than Archean Yellowknife Supergroup rocks. The zircon $^{207}Pb/^{206}Pb$ ages at 2648 Ma and 2707 Ma are close to the age of Yellowknife supracrustal rocks at about 2670 Ma elsewhere in the province and are not considered likely to be ages of the basement terrane that in other places has ages of about 3 Ga (i.e. Krogh and Gibbins, 1978). The K/Ar age on hornblende from one sample at 2506 ± 52 Ma probably represents a cooling age after the major thermal event at the end of the Archean, while the two biotite K/Ar ages at 2107 ± 46 and 2197 ± 48 represent much younger, possibly unrelated, cooling ages.

References

Henderson, J.B.
1981: Archean basin evolution in the Slave Province, Canada; in: Precambrian Plate Tectonics, A. Kroner (ed.), Elsevier, Amsterdam, p. 213-235.

Krogh, T.E. and Gibbins, W.
1978: U-Pb isotopic ages of basement and supracrustal rocks in the Point Lake area of the Slave Structural Province, Canada; in: Abstracts with Program, Geological Association of Canada – Mineralogical Association of Canada, v. 3, p. 438.

GSC 81-145 Biotite, K-Ar age **2629 ± 42 Ma**

K = 5.37%, $^{40}Ar/^{40}K$ = 0.3452, radiogenic Ar = 99.7%.
Concentrate: Very fine grained, light brown biotite with approximately 10% chlorite alteration.

From porphyritic rhyolite
(76 B) Back River, District of Mackenzie, 64°44'29"N, 107°58'18"W. Sample 77E695LQ2, collected and interpreted by M.B. Lambert.

The rhyolite sample was from the southern end of the Back River volcanic complex and is interpreted as representing a late stage in the evolution of the complex. It is one of a series of small domes or intrusions that lie within the outer ring complex. The fresh rock is a pale greenish to bluish grey, sparsely porphyritic rhyolite containing phenocrysts of quartz and plagioclase 2 to 5 mm across in an aphanitic matrix. A zircon age of 2667 ± 7 Ma was obtained from this same rock and is discussed in some detail by Lambert and Henderson, 1980.

Reference

Lambert, M.B. and Henderson, J.B.
1980: A uranium-lead age of zircons from volcanics and sediments of the Back River volcanic complex, eastern Slave Province, District of Mackenzie; in Loveridge, W.D., Rubidium-strontium and uranium-lead isotopic age studies, Report 3; in Current Research, Part C, Geological Survey of Canada, Paper 80-1C, p. 239-242, 1980.

District of Keewatin

(GSC 81-146 to GSC 81-196)

GSC 81-146 Hornblende, K-Ar age **1854 ± 39 Ma**

K = 1.48%, $^{40}Ar/^{40}K$ = 0.1881, radiogenic Ar = 98.2%.
Concentrate: Clean, unaltered, pleochroic, brown to dark green hornblende with less than 1% chlorite contamination.

From granodiorite orthogneiss
(65 K) South side of Nowleye Lake, District of Keewatin, 62°18'20"N, 101°16'00"W. Sample EA-86-80, collected and interpreted by K.E. Eade.

The sample is grey biotite hornblende granodiorite orthogneiss with good foliation due to compositional layering, in layers of approximately 5 cm. The rock is medium grained for the most part although some leucocratic layers are pegmatitic, suggesting there is some migmatization.

For interpretation see GSC 81-147.

GSC 81-147 Biotite, K-Ar age **1815 ± 25 Ma**

K = 6.70%, $^{40}Ar/^{40}K$ = 0.1818, radiogenic Ar = 99.6%.
Concentrate: Dark brown biotite with approximately 2% chlorite alteration.

From granodiorite
(65 K) Details as for GSC 81-146.

The K-Ar ages are interpreted to mean that the hornblende passed its argon blocking temperature 1854 ± 39 Ma ago and the biotite passed its argon blocking temperature 1815 ± 25 Ma ago, near the end of the metamorphic event associated with the Hudsonian orogeny and the uplift of the crustal block on the northwest side of the major northeast trending Tulemalu fault. The rocks themselves are considered to have crystallized much earlier during the Archean, and these ages record the youngest regional metamorphic event in this area.

GSC 81-148 Muscovite, K-Ar age **1757 ± 23 Ma**

K = 7.31%, $^{40}Ar/^{40}K$ = 0.1728, radiogenic Ar = 98.7%.
Concentrate: A mixture of clear and brownish coloured muscovite with approximately 2% chlorite contamination.

From granite
(65 K) South side of Dubawnt Lake, District of Keewatin, 62°49'30"N, 101°53'30"W. Sample EA-170-80, collected and interpreted by K.E. Eade.

The sample is from pink biotite muscovite granite, with the biotite almost completely chloritized. The rock is characterized by abundant accessory euhedral sphene and minor fluorite. It is massive, medium to coarse grained, porphyritic in part, and in some parts of the pluton, distinctly miarolitic.

The 1757 ± 23 Ma age is the minimum age of intrusion of the high level pluton. This granite is considered to be a part of the same intrusive suite as the coarse grained, porphyritic, rapakivi-textured granite (GSC 81-149). The miarolitic character of portions of this pluton suggests it may be a slightly higher level pluton and possibly it is slightly younger as the age suggests.

GSC 81-149 Hornblende, K-Ar age **1793 ± 53 Ma**

K = 0.739%, $^{40}Ar/^{40}K$ = 0.1783, radiogenic Ar = 95.8%.
Concentrate: Pleochroic, dark brown to dark green hornblende with approximately 5% chlorite contamination.

From granite
(65 K) Approximately 27.5 km north of Carruthers Lake, District of Keewatin, 62°51'05"N, 100°11'25"W. Sample WN-615-79, collected by R.K. Wanless and interpreted by K.E. Eade.

The sample is massive pink hornblende granite, fluorite bearing, coarse grained, porphyritic and with some rapakivi texture. The granite intrudes rocks of the Dubawnt Group, Christopher Island Formation.

The 1793 ± 53 Ma age is considered to be the minimun age of this large high level pluton intruding the Christopher Island Formation.

GSC 81-150 Hornblende, K-Ar age **1984 ± 78 Ma**

K = 0.377%, $^{40}Ar/^{40}K$ = 0.2101, radiogenic Ar = 92.4%.
Concentrate: Clean, unaltered, pleochroic, light green to dark green hornblende with no detected contamination.

From quartz monzonite
(65 J) Approximately 8 km south-southeast of Tulemalu Lake, District of Keewatin, 62°43'15"N, 99°22'30"W. Sample WN-616-79, collected by R.K. Wanless and interpreted by K.E. Eade.

The sample is pink hornblende quartz monzonite to quartz syenite. The rock is medium grained and massive, with cleavage developed in some places. It is composed of quartz, oligoclase, microcline and hornblende, with accessory apatite, sphene and opaques. Scattered chlorite flakes, possibly derived from biotite, and saussuritization of the plagioclase indicate alteration or minor metamorphism.

The 1984 ± 78 Ma age is a minimum age of crystallization of this pluton, a syntectonic body associated with the Hudsonian orogeny. Late tectonic events of the Hudsonian orogeny probably account for the cleavage evident in the rock and the alteration or slight metamorphism present in the pluton.

GSC 81-151 Whole rock, K-Ar age **1735 ± 52 Ma**

K = 1.66%, $^{40}Ar/^{40}K$ = 0.1695, radiogenic Ar = 99.5%.
Concentrate: Crushed whole rock.

From diabase
(65 O) 3.2 km east of McCrae Lake, District of Keewatin, 63°26'52"N, 98°54'42"W. Sample WN-614-79, collected by R.K. Wanless and A.N. LeCheminant.

The rock is from the chilled margin of a diabase dyke trending NE-SW at right angles to the Mackenzie dykes. The invaded country rock at this locality is a grey gneiss.

GSC 81-152 Biotite, K-Ar age **1747 ± 32 Ma**

K = 6.78%, $^{40}Ar/^{40}K$ = 0.1712, radiogenic Ar = 98.4%.
Concentrate: Dark brown biotite with approximately 10-15% chlorite alteration.

From fluorite granite
(65 J) 24 km east of north end of Tulemalu Lake, District of Keewatin, 62°59'43"N, 98°42'49"W. Sample WN-608-79, collected by R.K. Wanless and A.N. LeCheminant.

The sample was collected from the interior of an extensive fluorite granite body.

GSC 81-153 Biotite, K-Ar age **1827 ± 33 Ma**

K = 3.17%, $^{40}Ar/^{40}K$ = 0.1837, radiogenic Ar = 99.4%.
Concentrate: Very fine-grained, light brown biotite with approximately 5 to 10% hornblende contamination but no detected chlorite.

From hornfels
(65 O) 32 km east of the north end of Tulemalu Lake, District of Keewatin, 63°01'22"N, 98°38'32"W. Sample WN-607-79, collected by R.K. Wanless and A.N. LeCheminant.

See GSC 81-154 for description.

GSC 81-154 Whole rock, K-Ar age **1833 ± 51 Ma**

K = 2.05%, $^{40}Ar/^{40}K$ = 0.1846, radiogenic Ar = 99.6%.
Concentrate: Crushed whole rock.

From hornfels
(65 O) Details as for GSC 81-153.

The sample is a hornfels at the contact with a granite body. The determined ages approximate the minimum date of metamorphism and, by inference, of granite emplacement.

GSC 81-155 Hornblende, K-Ar age **1764 ± 64 Ma**

K = 0.490%, $^{40}Ar/^{40}K$ = 0.1739, radiogenic Ar = 93.7%.
Concentrate: Relatively clean, unaltered, pleochroic, light green to dark green hornblende with a trace of chlorite contamination.

From granite at diabase contact
(65 O) Tebesjuak Lake area, Keewatin, 63°27'42"N, 98°01'44"W. Sample WN-610-79, collected by R.K. Wanless and A.N. LeCheminant.

This granite sample was collected at the contact with diabase dyke of GSC 81-157 to 160 and presumably has been somewhat updated by the intrusion.

GSC 81-156 Hornblende, K-Ar age **1506 ± 70 Ma**

K = 0.86%, $^{40}Ar/^{40}K$ = 0.1367, radiogenic Ar = 97.2%.
Concentrate: Relatively clean, unaltered, pleochroic, light brown to light green hornblende with a trace of chlorite contamination.

From granite
(65 O) District of Keewatin, 63°27'42"N, 98°01'44"W. Sample WN-609-79, collected by R.K. Wanless and A.N. LeCheminant.

The sample was collected from a granite body cut by very fresh diabase dykes striking at 320°.

GSC 81-157 Whole rock, K-Ar age **1010 ± 44 Ma**

K = 1.13%, $^{40}Ar/^{40}K$ = 0.07868, radiogenic Ar = 98.2%.
Concentrate: Crushed whole rock.

From diabase
(65 O) District of Keewatin, 63°27'40"N, 98°01'44"W. Sample WN-611-79(1), collected by R.K. Wanless and A.N. LeCheminant.

See GSC 81-160 for discussion.

GSC 81-158 Whole rock, K-Ar age **1062 ± 47 Ma**

K = 1.09%, $^{40}Ar/^{40}K$ = 0.08400, radiogenic Ar = 97.6%.
Concentrate: Crushed whole rock.

From diabase
(65 O) District of Keewatin, 63°27'42"N, 98°01'40"W. Sample WN-611-79(2), collected by R.K. Wanless and A.N. LeCheminant.

See GSC 81-60 for discussion.

GSC 81-159 Whole rock, K-Ar age **1132 ± 50 Ma**

K = 1.03%, $^{40}Ar/^{40}K$ = 0.09147, radiogenic Ar = 98.8%.
Concentrate: Crushed whole rock.

From diabase
(65 O) District of Keewatin, 63°27'42"N, 98°01'44"W. Sample WN-611-79(3), collected by R.K. Wanless and A.N. LeCheminant.

See GSC 81-160 for discussion.

GSC 81-160 Whole rock, K-Ar age **1112 ± 47 Ma**

K = 1.13%, $^{40}Ar/^{40}K$ = 0.08935, radiogenic Ar = 99.2%.
Concentrate: Crushed whole rock.

From diabase
(65 O) District of Keewatin, 63°27'42"N, 98°01'44"W. Sample WN-611-79(4), collected by R.K. Wanless and A.N. LeCheminant.

The samples were collected from a diabase dyke cutting granite. The dyke varies from 92 to 110 cm wide and strikes at 320°.

This group (GSC 81-157 to 160) of samples represent different slabs cut parallel to the contact at various distances from it and varying from coarser to finer in grain size. No meaningful pattern or trend was observed.

GSC 81-161 Phlogopite, K-Ar age **1821 ± 34 Ma**

K = 7.23%, $^{40}Ar/^{40}K$ = 0.1828, radiogenic Ar = 99.6%.
Concentrate: Very light brown phlogopite with approximately 10% chlorite alteration.

From lamprophyre
(65 O) District of Keewatin, 63°23'07"N, 99°01'24"W. Sample 79LAAT218-1A, collected and described by A.N. LeCheminant.

The sample is from a lamprophyre dyke forming one of a swarm in this part of central Keewatin. This dyke contains coarse phlogopite mantled ocelli up to 2 cm in diameter and

the sample consists of four of these ocelli. The specimen consists of phlogopite (90%), sodic amphibole (trace to 10%), and traces of sphene, fluorite and opaques.

GSC 81-162 Hornblende, K-Ar age **1836 ± 101 Ma**

K = 0.46%, $^{40}Ar/^{40}K$ = 0.1852, radiogenic Ar = 98.2%.
Concentrate: Light green hornblende with a trace of biotite and chlorite contamination.

From lamprophyre
(65 O) District of Keewatin, 63°23'07"N, 99°01'24"W. Sample 79LAAT218-1, collected and described by A.N. LeCheminant.

In this area of central Keewatin two lamprophyre dyke swarms, striking 070° and 110° respectively, cut biotite granodiorite gneiss. The dyke sampled is part of the younger (070°) swarm and the specimen is from near the centre of a 90-100 cm wide dyke. The rock is a porphyritic, medium grained lamprophyre consisting of alkali feldspar (50%), amphibole (20%), biotite/phlogopite (10%), clinopyroxene (15%), and traces of apatite, sphene, allanite-epidote. In thin section the biotite showed up to 10% chlorite alteration.

GSC 81-163 Biotite, K-Ar age **1744 ± 41 Ma**

K = 6.63%, $^{40}Ar/^{40}K$ = 0.1708, radiogenic Ar = 99.9%.
Concentrate: Dark brown biotite with approximately 4% chlorite alteration.

From grey gneiss
(66 H) About 33 km north of Amer Lake, District of Keewatin, 65°54'45"N, 97°12'10"W. Sample 78HF-522, collected and described by W.W. Heywood.

This is a sample of mylonitic grey gneiss collected from outside the Amer mylonite zone. It is a medium to coarse grained biotite amphibole gneiss consisting of quartz (15%), plagioclase (30%), potash feldspar (15%), hornblende (15%), biotite (20%), opaques (2%), apatite (1%), epidote (1%), and zircon (1%).

GSC 81-164 Biotite, K-Ar age **1728 ± 41 Ma**

K = 7.36%, $^{40}Ar/^{40}K$ = 0.1684, radiogenic Ar = 99.8%.
Concentrate: Light brown biotite with approximately 4% chlorite alteration.

From grey gneiss
(66 H) Approximately 35 km north of Amer Lake, District of Keewatin, 65°54'10"N, 97°11'20"W. Sample 78HF-523, collected and interpreted by W.W. Heywood.

This sample of grey gneiss was collected immediately to the north of the northern limit of the Amer mylonite zone. It is a coarse grained amphibole biotite gneiss consisting of quartz (15%), potash feldspar (35%), plagioclase (25%), hornblende (7%), biotite (12%), chlorite (2%), apatite (1%), epidote (2%), opaques (1%), and traces of sphene, zircon and carbonate. The biotite is slightly altered.

GSC 81-165 Hornblende, K-Ar age **1964 ± 92 Ma**

K = 0.74%, $^{40}Ar/^{40}K$ = 0.2064, radiogenic Ar = 96.7%.
Concentrate: Relatively clean, pleochroic, dark green to olive-green hornblende with a trace of chlorite contamination.

From granitoid rock
(66 H) Approximately 30 km northwest of Amer Lake, District of Keewatin, 65°50'48"N, 97°23'20"W. Sample 78HF-519, collected and described by W.W. Heywood.

The sample is from a fine to medium grained, cataclacized, leucocratic granitoid rock collected immediately to the north of the northern limit of the Amer mylonite zone. It consists of quartz (25%), plagioclase (37%), potash feldspar (29%), biotite (6%), hornblende (2%), opaques (1%), and traces of apatite, zircon, epidote and sphene.

GSC 81-166 Biotite, K-Ar age **1839 ± 42 Ma**

K = 7.11%, $^{40}Ar/^{40}K$ = 0.1856, radiogenic Ar = 99.7%.
Concentrate: Dark brown biotite with approximately 4% chlorite alteration.

From amphibolitic gneiss
(66 H) Approximately 35 km north of Amer Lake, District of Keewatin, 65°55'25"N, 97°14'W. Sample 78HF-520, collected and described by S. Tella and W.W. Heywood.

See GSC 81-167 for description.

GSC 81-167 Hornblende, K-Ar age **1902 ± 70 Ma**

K = 1.06%, $^{40}Ar/^{40}K$ = 0.1960, radiogenic Ar = 98.9%.
Concentrate: Clean, unaltered, pleochroic, brown to dark green hornblende with no visible contamination.

From amphibolitic gneiss
(66 H) Details as for GSC 81-166.

This sample of amphibolitic hornblende biotite gneiss was collected from outside of the Amer mylonite zone. It is a coarse grained rock consisting of quartz (10%), potash feldspar (5%), plagioclase (46%), hornblende (20%), biotite (15%), opaques (1%), chlorite (2%), apatite (1%), and traces of garnet and carbonate. The biotite is partly altered to chlorite.

GSC 81-168 Biotite, K-Ar age **1822 ± 33 Ma**

K = 6.86%, $^{40}Ar/^{40}K$ = 0.1830, radiogenic Ar = 99.7%.
Concentrate: Light brown biotite with approximately 15% chlorite alteration.

From gneiss
(66 H) Approximately 30 km northwest of Amer Lake, District of Keewatin, 65°50'40"N, 97°20'45"W. Sample 78HF-517, collected and described by W.W. Heywood.

The rock is a medium to coarse grained, cataclastic biotite gneiss collected from within the Amer mylonite zone. It consists of quartz (25%), plagioclase (39%), potash feldspar (20%), biotite (15%), opaques (1%), and trace quantities of apatite, amphibole, zircon and carbonate.

GSC 81-169 Hornblende, K-Ar age **2002 ± 111 Ma**

K = 0.55%, $^{40}Ar/^{40}K$ = 0.2131, radiogenic Ar = 97.1%.
Concentrate: Clean, unaltered, pleochroic, light green to olive-green hornblende with no visible contamination.

From amphibole-pyroxene rich rock

(66 H) Approximately 30 km northwest of Amer Lake, District of Keewatin, 65°50'49"N, 97°21'45"W. Sample 78HF-518, collected and described by W.W. Heywood.

The sample locality is within the Amer mylonite zone but close to its northern limits. The specimen is of amphibole-pyroxene rich rock consisting of quartz (5%), plagioclase (40%), potash feldspar(?) (5%), hornblende (25%), clinopyroxene (15%), biotite (5%), epidote (1%), opaques (3%), apatite (1%), and a trace of zircon. Biotite is altered to chlorite.

GSC 81-170 Biotite, K-Ar age **1742 ± 41 Ma**

K = 7.51%, $^{40}Ar/^{40}K$ = 0.1705, radiogenic Ar = 99.5%.
Concentrate: Clean concentrate of unaltered, light brown biotite with no chlorite contamination.

From gneiss

(66 H) Approximately 27 km northwest of Amer Lake, District of Keewatin, 65°49'52"N, 97°20'W. Sample 78HF-516, collected and described by S. Tella and W.W. Heywood.

See GSC 81-171 for description.

GSC 81-171 Hornblende, K-Ar age **1877 ± 63 Ma**

K = 1.30%, $^{40}Ar/^{40}K$ = 0.1919, radiogenic Ar = 98.9%.
Concentrate: Clean, unaltered, pleochroic, dark green to olive-green hornblende with no visible contamination.

From gneiss

(66 H) Details as for GSC 81-170.

The sample of cataclastic grey gneiss was collected from within the Amer mylonite zone. It is a medium to coarse grained hornblende biotite gneiss consisting of quartz (30%), plagioclase (45%), amphibole (8%), biotite (15%), opaques (1%), zircon (1%), and a trace of apatite.

GSC 81-172 Biotite, K-Ar age **1830 ± 43 Ma**

K = 6.66%, $^{40}Ar/^{40}K$ = 0.1843, radiogenic Ar = 99.7%.
Concentrate: Light brown biotite with approximately 2% chlorite and 2% hornblende contamination.

From gneiss

(66 H) Approximately 20 km northwest of Amer Lake, District of Keewatin, 65°46'N, 97°20'20"W. Sample 78HF-514, collected and described by S. Tella and W.W. Heywood.

See GSC 81-173 for description.

GSC 81-173 Hornblende, K-Ar age **1737 ± 68 Ma**

K = 1.04%, $^{40}Ar/^{40}K$ = 0.1697, radiogenic Ar = 99.4%.
Concentrate: Pleochroic, green to brown hornblende with approximately 2% biotite contamination.

From gneiss

(66 H) Details as for GSC 81-172.

This sample of mylonitic granitoid gneiss was collected from within the Amer mylonite zone. It is a medium to coarse grained, porphyritic rock consisting of quartz (20%), potash feldspar (38%), plagioclase (24%), biotite (15%), sphene (2%), apatite (1%), and traces of opaques and zircon. The biotite is somewhat replaced by chlorite.

GSC 81-174 Biotite, K-Ar age **1778 ± 41 Ma**

K = 7.38%, $^{40}Ar/^{40}K$ = 0.1760, radiogenic Ar = 99.8%.
Concentrate: Dark brown biotite with approximately 2% chlorite alteration.

From gneiss

(66 H) Approximately 18 km northwest of Amer Lake, District of Keewatin, 65°45'08"N, 97°19'W. Sample 78HF-513, collected and described by S. Tella and W.W. Heywood.

See GSC 81-175 for description.

GSC 81-175 Hornblende, K-Ar age **1918 ± 71 Ma**

K = 1.09%, $^{40}Ar/^{40}K$ = 0.1987, radiogenic Ar = 99.2%.
Concentrate: Clean, unaltered, pleochroic, olive-green to dark green hornblende with no visible contamination.

From gneiss

(66 H) Details as for GSC 81-174.

This medium to coarse grained, porphyritic, biotite amphibole gneiss was collected from within the Amer mylonite zone. It consists of quartz (25%), potash feldspar (30%), plagioclase (26%), biotite (10%), hornblende (5%), epidote (2%), opaques (1%), apatite (1%), and a trace of zircon. The biotite is partly altered to chlorite.

GSC 81-176 Hornblende, K-Ar age **1887 ± 41 Ma**

K = 1.32%, $^{40}Ar/^{40}K$ = 0.1936, radiogenic Ar = 99.5%.
Concentrate: Clean, unaltered, pleochroic, brown to dark green hornblende with no visible contamination.

From grey gneiss

(66 H) Approximately 25 km north-northwest of Amer Lake, District of Keewatin, 65°50'N, 97°13'10"W. Sample 78HF-511, collected and described by S. Tella and W.W. Heywood.

This is a mylonitic grey gneiss collected from within the Amer mylonite zone. It is a rock of granodioritic composition and consists of quartz (30%), plagioclase (36%), potash feldspar (10%), hornblende (10%), biotite (10%), opaques (3%), zircon (1%), and a trace of apatite. The biotite is partly replaced by chlorite.

GSC 81-177 Biotite, K-Ar age **1836 ± 42 Ma**

K = 7.50%, $^{40}Ar/^{40}K$ = 0.1851, radiogenic Ar = 99.7%.
Concentrate: Clean, unaltered, light brown biotite with no chlorite contamination.

From gneiss

(66 H) Approximately 25 km north of Amer Lake, District of Keewatin, 65°49'30"N, 97°12'40"W. Sample 78HF-509, collected and described by S. Tella and W.W. Heywood.

See GSC 81-178 for description.

GSC 81-178 Hornblende, K-Ar age **1732 ± 98 Ma**

K = 0.60%, $^{40}Ar/^{40}K$ = 0.1690, radiogenic Ar = 93.1%.
Concentrate: Clean, unaltered, pleochroic, olive-green to dark green hornblende with no visible contamination.

From gneiss
(66 H) Details as for GSC 81-177.

The sample is from a medium to coarse grained mylonitic hornblende biotite gneiss collected from within the Amer mylonite zone. It consists of quartz (15%), plagioclase (33%), potash feldspar (20%), amphibole (15%), biotite (10%), chlorite (5%), opaques (2%), and a trace of apatite. The biotite is partially altered to chlorite.

GSC 81-179 Biotite, K-Ar age **1852 ± 42 Ma**

K = 7.80%, $^{40}Ar/^{40}K$ = 0.1878, radiogenic Ar = 99.6%.
Concentrate: Clean, unaltered, brown biotite with no chlorite contamination.

From gneiss
(66 H) Approximately 25 km north of Amer Lake, District of Keewatin, 65°47'45"N, 97°08'W. Sample 78HF-505, collected and described by S. Tella and W.W. Heywood.

See GSC 81-180 for description.

GSC 81-180 Hornblende, K-Ar age **1879 ± 44 Ma**

K = 1.06%, $^{40}Ar/^{40}K$ = 0.1923, radiogenic Ar = 98.0%.
Concentrate: Clean, unaltered, pleochroic, olive-green to dark green hornblende with no visible contamination.

From gneiss
(66 H) Details as for GSC 81-179.

The gneiss specimen was collected from within the Amer mylonite zone. It is a coarse grained hornblende biotite gneiss consisting of quartz (25%), plagioclase (37%), potash feldspar (15%), biotite (15%), amphibole (3%), chlorite (2%), opaques (2%), apatite (1%), and traces of sphene and zircon. The biotite is partially altered to chlorite.

GSC 81-181 Biotite, K-Ar age **1726 ± 41 Ma**

K = 7.94%, $^{40}Ar/^{40}K$ = 0.1681, radiogenic Ar = 99.4%.
Concentrate: Relatively clean, dark brown biotite with approximately 1% chlorite alteration.

From augen gneiss
(66 H) Approximately 25 km north of Amer Lake, District of Keewatin, 65°48'08"N, 97°09'W. Sample 78HF-506, collected and described by S. Tella and W.W. Heywood.

The sample of grey augen gneiss was collected from within the Amer mylonite zone. It is a medium to coarse grained mylonitic rock consisting of quartz (25%), plagioclase (40%), potash feldspar (15%), biotite (17%), chlorite (2%), apatite (1%), and traces of opaques, epidote, amphibole and carbonate.

GSC 81-182 Biotite, K-Ar age **1785 ± 42 Ma**

K = 7.27%, $^{40}Ar/^{40}K$ = 0.1772, radiogenic Ar = 99.7%.
Concentrate: Light brown biotite with approximately 6% chlorite alteration.

From gneiss
(66 H) Approximately 25 km north of Amer Lake, District of Keewatin, 65°47'15"N, 97°07'20"W. Sample 78HF-504, collected and described by S. Tella and W.W. Heywood.

This specimen was collected from within the Amer mylonite zone. It is a medium to coarse grained grey gneiss of granodioritic composition, consisting of quartz (25%), plagioclase (50%), biotite (20%), hornblende (3%), opaques (1%), apatite (1%), and traces of epidote and zircon. The biotite and hornblende are both fresh in appearance.

GSC 81-183 Biotite, K-Ar age **1773 ± 41 Ma**

K = 6.71%, $^{40}Ar/^{40}K$ = 0.1752, radiogenic Ar = 99.7%.
Concentrate: Dark brown biotite with approximately 10% chlorite alteration.

From grey gneiss
(66 H) Approximately 25 km north of Amer Lake, District of Keewatin, 65°47'12"N, 97°06'20"W. Sample 78HF-503, collected and described by S. Tella and W.W. Heywood.

This specimen of grey gneiss was collected very close to the southern limit of the Amer mylonite zone. The rock is a medium to coarse grained, foliated granodiorite consisting of quartz (30%), plagioclase (55%), hornblende (5%), biotite (7%), opaques (2%), apatite (1%), and a trace of zircon. The biotite is partially altered to chlorite.

GSC 81-184 Hornblende, K-Ar age **1985 ± 52 Ma**

K = 0.856%, $^{40}Ar/^{40}K$ = 0.2102, radiogenic Ar = 96.4%.
Concentrate: Clean, unaltered, pleochroic, light green to brown hornblende with no visible contamination.

From gneissic granodiorite
(66 H) Approximately 20 km north of Amer Lake, District of Keewatin, 65°46'45"N, 97°05'10"W. Sample 78HF-501, collected and described by W.W. Heywood.

This specimen was collected from outside the southern limit of the Amer mylonite zone and is a medium to coarse grained, leucocratic, foliated granitoid. The material used is gneissic granodiorite consisting of quartz (20%), plagioclase (35%), potash feldspar (30%), biotite (7%), hornblende (5%), opaques (2%), apatite (1%), and a trace of zircon. Biotite is partially altered to chlorite.

GSC 81-185 Biotite, K-Ar age **1786 ± 42 Ma**

K = 6.57%, $^{40}Ar/^{40}K$ = 0.1773, radiogenic Ar = 99.7%.
Concentrate: Dark brown biotite with approximately 15% chlorite alteration.

From granite
(66 H) Approximately 20 km north of Amer Lake, District of Keewatin, 65°46'10"N, 97°05'00"W. Sample 78HF-500, collected and described by W.W. Heywood.

The sample is from a weakly foliated granitoid approximately 3 km southeast from the southern limit of the Amer mylonite zone. It is a medium to coarse grained leucocratic granite composed of quartz (25%), plagioclase (34%), microcline (35%), biotite (4%), hornblende (1%), opaques (1%), and traces of epidote and zircon. The biotite is partially replaced by chlorite.

GSC 81-186 Biotite, K-Ar age **1828 ± 42 Ma**

K = 7.53%, $^{40}Ar/^{40}K$ = 0.1839, radiogenic Ar = 99.6%.
Concentrate: Clean, unaltered, brownish orange biotite with no chlorite contamination.

From mafic syenite
(66 H) Approximately 30 km southwest of Amer Lake, District of Keewatin, 65°23'30"N, 97°43'30"W. Sample 78HF-524, collected and described by W.W. Heywood.

This mafic syenite intrudes the basal quartzites of the Amer Group. It is a coarse grained, massive, undeformed rock consisting of potash feldspar (35%), plagioclase (16%), hornblende (5%), clinopyroxene (25%), biotite (15%), opaques (3%), apatite (1%), and a trace of zircon. Hornblende occurs as rims on the clinopyroxene grains.

GSC 81-187 Muscovite, K-Ar age **1619 ± 40 Ma**

K = 6.05%, $^{40}Ar/^{40}K$ = 0.1523, radiogenic Ar = 99.0%.
Concentrate: Impure muscovite with 5-10% feldspar contamination.

From pegmatitic granite
(66 H) North of Back River, District of Keewatin, 65°59½'N, 97°27'W. Sample HF-170, collected and described by W.W. Heywood.

The sample is from a pegmatitic granite intrusive along the contact of Chantrey Group and basement gneisses. It is a coarse grained, pegmatitic, leucocratic muscovite biotite granite containing scattered pink garnet.

GSC 81-188 Muscovite, K-Ar age **1729 ± 41 Ma**

K = 8.52%, $^{40}Ar/^{40}K$ = 0.1685, radiogenic Ar = 98.8%.
Concentrate: Clean, clear, unaltered muscovite with no visible contamination.

From granite
(66 H) South of Back River, District of Keewatin, 65°32½'N, 97°12½'W. Sample HF-76-T649, collected and described by W.W. Heywood.

This sample is from a granite dyke intruding "Amer Quartzite" and was expected to provide a limiting age for the Amer Group.

GSC 81-189 Hornblende, K-Ar age **1747 ± 50 Ma**

K = 0.391%, $^{40}Ar/^{40}K$ = 0.1712, radiogenic Ar = 93.6%.
Concentrate: Impure, pleochroic, green to bluish green hornblende with traces of biotite and attached quartz and feldspar as contaminants.

From anorthosite
(45 O) Walrus Island, District of Keewatin, 63°16'N, 83°41'W. Sample HF-30-70, collected and described by W.W. Heywood.

Walrus Island consists entirely of anorthosite. It is a fine to coarse grained layered rock in which the layers differ in texture and composition. The main components are plagioclase and minor amounts of biotite and hornblende.

GSC 81-190 Hornblende, K-Ar age **1657 ± 48 Ma**

K = 0.935%, $^{40}Ar/^{40}K$ = 0.1578, radiogenic Ar = 98.6%.
Concentrate: Clean, unaltered, pleochroic, olive-brown to dark green hornblende with no visible contamination.

From anorthosite
(45 J) Coats Island, District of Keewatin, 62°43'N, 82°17½'W. Sample HF-13-70, collected and described by W.W. Heywood.

The sample was taken from an isolated anorthosite knob with no exposed contacts. The rock is composed almost entirely of fine to medium grained labradorite with minor amounts of biotite and hornblende.

GSC 81-191 Biotite, K-Ar age **1784 ± 41 Ma**

K = 6.29%, $^{40}Ar/^{40}K$ = 0.1770, radiogenic Ar = 99.5%.
Concentrate: Light brown biotite with approximately 2% chlorite alteration.

From gneiss
(66 H) Amer Lake area, District of Keewatin, 65°49'32"N, 96°49'36"W. Sample WN-502-78, collected by R.K. Wanless and S. Tella, described by R.D. Stevens.

See GSC 81-192 for description.

GSC 81-192 Hornblende, K-Ar age **1727 ± 56 Ma**

K = 1.51%, $^{40}Ar/^{40}K$ = 0.1682, radiogenic Ar = 98.2%.
Concentrate: Pleochroic, green to light brown hornblende with approximately 3% biotite contamination.

From gneiss
(66 H) Details as for GSC 81-191.

The sample was taken from a banded grey gneiss with coarser granitic and aplitic dykes. The rock consisted of fresh and abundant green hornblende, brown biotite, and anhedral quartz and feldspar. Accessory apatite, opaques, epidote and sphene were noted.

GSC 81-193 Hornblende, K-Ar age **2018 ± 73 Ma**

K = 1.04%, $^{40}Ar/^{40}K$ = 0.2160, radiogenic Ar = 99.3%.
Concentrate: Clean, unaltered, pleochroic, dark green to light brown hornblende with no visible contamination.

From gneiss
(66 H) Amer Lake area, District of Keewatin, 65°45'59"N, 96°45'35"W. Sample WN-501-78, collected by R.K. Wanless and S. Tella, described by R.D. Stevens.

The sample was taken from a grey gneiss interbedded with coarser granitic units and consists of brown biotite, green hornblende, slightly altered feldspar, quartz and accessory opaques, epidote, apatite and zircon.

GSC 81-194 Amphibole, K-Ar age **1679 ± 111 Ma**

K = 0.113%, $^{40}Ar/^{40}K$ = 0.1610, radiogenic Ar = 89.6%.
Concentrate: Nonpleochroic, slightly fibrous light green to colourless amphibole with approximately 2% chlorite alteration.

From diabase
(55 L) Headland in northwestern part of Kaminak Lake, District of Keewatin, 62°17.4'N, 95°18.1'W. Sample WN-12-72, collected by R.K. Wanless and described by R.D. Stevens.

The sample was from a highly altered, medium grained diabase sill in the Hurwitz Group. It consisted of colourless to pale green amphibole tending to a fibrous texture, heavily altered plagioclase, abundant epidote and chlorite, and minor potash feldspar and quartz.

See GSC 81-195 for discussion.

GSC 81-195 Amphibole, K-Ar age **1816 ± 116 Ma**

K = 0.121%, $^{40}Ar/^{40}K$ = 0.1820, radiogenic Ar = 88.7%.
Concentrate: Nonpleochroic, light green to nearly colourless fibrous amphibole with approximately 5% chlorite contamination.

From diabase
(55 L) Between Quartzite Lake and the northeastern end of Kaminak Lake, District of Keewatin, 62°22.7'N, 94°42.4'W. Sample WN-9A-72, collected by R.K. Wanless and described by R.D. Stevens.

The sample was taken from a mafic sill in the Hurwitz Group. The rock was a medium grained sub-ophitic to poikilitic, amphibole rich diabase-gabbro consisting of altered plagioclase, pale green to colourless amphibole, and epidote.

Both samples (GSC 81-194 and 195) were collected in the hope of dating the Hurwitz volcanics. However, in view of the highly altered nature of both rocks the dates obtained probably approximate only to the age of alteration.

GSC 81-196 Biotite, K-Ar age **1951 ± 26 Ma**

K = 7.38%, $^{40}Ar/^{40}K$ = 0.2043, radiogenic Ar = 99.4%.
Concentrate: Fresh, unaltered, light brown biotite with no detected chlorite.

From pegmatite
(56 A) Island in chain immediately west of main anorthosite body, Daly Bay area, District of Keewatin, 64°01'09"N, 89°30'24"W. Sample GVG71-305-3, collected by T.M. Gordon.

The pegmatite unit cross-cuts sheared and isoclinally folded mafic gneiss and garnet granulite and represents the latest recognizable tectonic event in the area (other than emplacement of Mackenzie diabase).

Manitoba

(GSC 81-197 to GSC 81-198)

GSC 81-197 Muscovite, K-Ar age **2174 ± 65 Ma**

K = 8.03%, $^{40}Ar/^{40}K$ = 0.2399, radiogenic Ar = 99%.
Concentrate: Relatively clean, very coarse muscovite in flakes up to ½ cm across. About 50% of the flakes are blistered. The only impurities are traces of quartz and feldspar.

From pegmatite
(63 I) South shore of first island south of Cross Island, Cross Lake, Manitoba, 54°34'N, 97°51'W. Sample MF-557.1, collected and described by R. Mulligan.

The sample is of coarse muscovite from a feldspar-quartz-spodumene-muscovite pegmatite having a steep, ragged contact with metagreywacke/micaceous gneiss which is heavily tourmalinized at the contact. It is one of the lithium pegmatites of northern Manitoba, all of which lie in a linear belt that crosses the boundary from Superior to Churchill Province.

GSC 81-198 Lepidolite, K-Ar age **2427 ± 65 Ma**

K = 7.43%, $^{40}Ar/^{40}K$ = 0.2915, radiogenic Ar = 100%.
Concentrate: Clean, unaltered lepidolite.

From pegmatite
(53 L) North shore of God's Lake, Manitoba, 54°52'N, 94°10'W. Sample MF559, collected and described by R. Mulligan.

This mica was obtained from a feldspar-spodumene-quartz-mica pegmatite of limited outcrop with no exposed contact. Presumably, however, it cuts Oxford Group and is one of the lithium pegmatites in a belt crossing the Superior/Churchill boundary.

Ontario and Michigan

(GSC 81-199 to GSC 81-202)

GSC 81-199 Whole rock, K-Ar age **1189 ± 20 Ma**

K = 3.85%, $^{40}Ar/^{40}K$ = 0.09778, radiogenic Ar = 99.0%.
Concentrate: Crushed whole rock.

From "granite"
(41 J) Near the bottom of a vertical drill hole 79-1-133 on northern Drummond Island, NW 1/4 of SE 1/4 of Sec. 25, T. 43N, R6E, Drummond Tp., Chippawa County, Michigan, 46°06'N, 83°37'30"W. Sample 79-1-133 submitted and interpreted by K.D. Card.

See GSC 81-201 for description and interpretation.

GSC 81-200 Whole rock, K-Ar age **1236 ± 21 Ma**

K = 3.12%, $^{40}Ar/^{40}K$ = 0.1031, radiogenic Ar = 99.5%.
Concentrate: Crushed whole rock.

From "granite"
(41 J) Details as for GSC 81-199. Sample 79-1-134 submitted and interpreted by K.D. Card.

See GSC 81-201 for description and interpretation.

GSC 81-201 Whole rock, K-Ar age **1554 ± 27 Ma**

K = 2.73%, $^{40}Ar/^{40}K$ = 0.1432, radiogenic Ar = 99.4%.
Concentrate: Crushed whole rock.

From "granite"
(41 J) Near the bottom of a vertical drill hole on northern Drummond Island, NE 1/4 of NW 1/4 of Sec. 25, T. 43N, R6E, Drummond Tp., Chippawa County, Michigan, 46°00'30"N, 83°35'35"W. Sample 79-2-70, submitted and interpreted by K.D. Card.

Drill samples of Precambrian granitic basement rocks beneath the Paleozoic cover of Drummond Island in western Lake Huron were provided by David P. Rogers, consulting geologist, Ottawa.

Chip samples GSC 81-199 and 200 came from near the bottom of a vertical drill hole on northern Drummond Island. The hole was logged by Rogers as overburden 0 to 25', Paleozoic sediments – 25' to 716', and Precambrian granite – 716' to 773'. The orange-red weathered, altered granite is massive, medium grained, and consists of perthitic microcline, sericitized plagioclase with some (15%) quartz and minor (5%) chloritized biotite. Iron oxides, both magnetite and hematite stain, are present.

Chip sample GSC 81-201 came from near the bottom of another vertical hole on northern Drummond Island. The hole was logged as overburden 0 to 6', Paleozoic sediments – 6' to 684', and Precambrian granite – 684' to 753'. The granite is pink to orange-red, weathered, medium grained and gneissic toward the bottom of the hole. It consists of sericitized plagioclase and microcline, quartz (20-25%), and chloritized biotite. Magnetite, hematite and a few small zircons are present. Straining and granulation of minerals indicates the presence of a foliation.

The K/Ar whole rock dates of 1189 ± 20 Ma, 1236 ± 21 Ma, and 1554 ± 27 Ma for these samples can be regarded, at best, as only rough approximations of the age of the rocks. The granites are probably of Proterozoic age, and may belong to a suite of 1500 Ma intrusions that are known in this region (Van Schmus, Card, and Harrower, 1975).

Reference

Van Schmus, W.R., Card, K.D., and Harrower, K.L.
1975: Geology and ages of buried Precambrian basement rocks, Manitoulin Island, Ontario; Canadian Journal of Earth Sciences, v. 12, p. 1175-1189.

GSC 81-202 Biotite, K-Ar age **2198 ± 28 Ma**

K = 6.16%, $^{40}Ar/^{40}K$ = 0.2496, radiogenic Ar = 99.6%.
Concentrate: Light brown biotite with approximately 15-20% chlorite alteration.

From granite
(41 O) Borden Lake, Ontario, 47°50'25"N, 83°16'30"W. Sample ZR-3, collected by J.A. Percival.

Sample ZR-3 was collected from a massive to faintly lineated, coarse grained quartz monzonite in the Borden Lake area. U-Pb isotopic data from the zircon of this rock define a chord which cuts the concordia curve at 2633 ± 11 and 362 ± 91 Ma (Percival et al., 1981). The K-Ar age of 2198 ± 28 Ma suggests resetting of the K-Ar system by a post-Archean event. A more detailed discussion of this and other age determinations relating to the Kapuskasing Structural Zone in the vicinity of Chapleau will be found in Percival et al., 1981.

Reference

Percival, J.A., Loveridge, W.D., and Sullivan, R.W.
1981: U-Pb zircon ages of tonalitic metaconglomerate cobbles and quartz monzonite from the Kapuskasing structural zone in the Chapleau area, Ontario; in Loveridge, W.D., Rubidium-strontium and uranium-lead isotopic age studies, Report 4; in Current Research, Part C, Geological Survey of Canada, Paper 81-1C, p. 107-112, 1981.

Quebec

(GSC 81-203 to GSC 81-207)

GSC 81-203 Whole rock, K-Ar age **1718 ± 37 Ma**

K = 1.52%, $^{40}Ar/^{40}K$ = 0.1668, radiogenic Ar = 99.1%.
Concentrate: Crushed whole rock.

From altered gabbro
(32 P) 27 km north of NE end of Mistassini Lake, 11 km NE of Lac Sakash, Quebec, 51°34'40"N, 72°40'30"W. Sample SOQUEM (TAKWA), collected and interpreted by L.P. Tremblay.

This somewhat altered gabbroic rock was composed mainly of feldspar laths greatly altered to dusty black and green material, pyroxene mainly altered to amphibole and chlorite, cubic opaques, and aggregates of sphene and silica in vesicule-like masses.

This age dates the time of intrusion of the gabbro and puts a minimum age on the Papaskwasati Formation of the Mistassini Basin.

(Note: Whole rock age determination on an altered rock of this nature should be evaluated with caution.)

GSC 81-204 Whole rock, K-Ar age **1591 ± 37 Ma**

K = 1.41%, $^{40}Ar/^{40}K$ = 0.1484, radiogenic Ar = 99.1%.
Concentrate: Crushed whole rock.

From gabbro
(23 D) 8 km northeast of Lac Indicator, Quebec, 52°01'00"N, 71°41'45"W. Sample OTISH BASIN, collected and interpreted by L.P. Tremblay.

This dark grey, medium grained massive gabbro was composed mainly of pyroxene, plagioclase and opaques. Much of the pyroxene was altered to amphibole and chlorite, and much of the feldspar also appeared to be "dirty" and charged with small crystals of altered pyroxene. Some interstitial quartz was observed.

The rock was from a north trending, steeply dipping dyke cutting several units of the Otish Group. The age is a minimum for the gabbro and for the rocks of the Otish Group. It does not represent the time of intrusion of the gabbro.

(Note: Whole rock age determination on an altered rock of this nature should be evaluated with caution.)

GSC 81-205 Whole rock, K-Ar age **1362 ± 109 Ma**

K = 0.35%, $^{40}Ar/^{40}K$ = 0.1181, radiogenic Ar = 91.4%.
Concentrate: Crushed whole rock.

From gabbro
(23 M) Drill core, about 1 km south of Berth Lake, Quebec, 55°58'N, 70°31'W. Sample 87-341, collected and interpreted by L.P. Tremblay.

The rock was a massive, medium grained, dark green to almost black gabbro composed mainly of fresh pyroxene in large to small blocky grains, highly altered feldspar laths (now composed of light green chloritic material) and about 10% opaque grains. Occasional rounded masses of altered material may represent original olivine. The section was traversed by numerous parallel quartz veinlets.

This age is a minimum for the gabbro and for the Sakami Formation of this small Proterozoic outlier. This age does not date the time of intrusion of the gabbro nor the true age of formation of the Sakami rocks. It does however date the time when the gabbro was altered, possibly by hydrothermal solutions. This is suggested by the numerous tiny quartz veinlets observed in thin sections of the gabbro and by the strong alterations of its feldspar. This date may correspond to a period when the uranium in the rocks of the outlier was remobilized and reconcentrated.

(Note: Whole rock age determination on an altered rock of this nature should be evaluated with caution.)

GSC 81-206 Biotite, K-Ar age **303 ± 10 Ma**

K = 3.74%, $^{40}Ar/^{40}K$ = 0.01917, radiogenic Ar = 93.5%.
Concentrate: Clean, dark, red-brown biotite with no chlorite contamination.

From mafic tuff
(11 N) Cliff at Cap Noir, Havre Aubert, Magdalen Islands, Quebec, approx. 47°11'N, 61°50'W. Map unit 1b, Quebec Geol. Rept. 106, Sanschagrin 1964. Sample GCA77-57-5, collected and interpreted by H.H.J. Geldsetzer.

This volcanic rock consists of 70% plagioclase, 25% biotite, 3% magnetite and 2% pyroxene, and is fairly fresh.

The flow or dyke occurs within a thick volcanic succession dominated by tuffs and agglomerates. It is much fresher than the other volcanic flows, hence it may be younger in age and a dyke rather than a flow. The age of 303 ± 10 Ma indicates a Westphalian B or C age. However, elsewhere on the islands at Havre aux Maisons, the weathered volcanics are in part interbedded with gray-green siltstones-sandstones that yielded a spore assemblage dated as Windsor or Late Visean in age (GSC Location Number D1481). Therefore, the main volcanic event may be of Late Visean age followed by another volcanic event in the Westphalian.

GSC 81-207 Biotite, K-Ar age **292 ± 10 Ma**

K = 3.78%, $^{40}Ar/^{40}K$ = 0.01839, radiogenic Ar = 92.8%.
Concentrate: Brown biotite with approximately 3% chlorite alteration and a trace of hornblende contamination.

From mafic tuff
(11 N) Cliff between Cap au Diable and Cap Rouge, Ile d'Entrée, Magdalen Islands, Quebec, approx. 46°16'N, 61°41'W. Map unit 1b, Quebec Geol. Rept. 106, Sanschagrin, 1964. Sample GCA77-65-1, collected and interpreted by H.H.J. Geldsetzer.

The sample consists of 70% plagioclase, 25% biotite, 4% pyroxene and 1% magnetite and is fairly fresh.

The flow or dyke is probably in fault contact with interbedded gypsum and green-gray siltstones. Its fresh appearance in contrast with fairly weathered volcanics nearby suggests that it is a later dyke rather than a flow. The age of 292 ± 10 Ma indicates a Westphalian B or C age. The main volcanic event may be of Late Visean age. See comment under sample GCA77-57-5 (GSC 81-206).

(Note: The potassium content of both samples is unusually low and caution in evaluation of these ages is recommended.)

GSC 81-208 Hornblende, K-Ar age **2499 ± 91 Ma**

K = 0.63%, $^{40}Ar/^{40}K$ = 0.3141, radiogenic Ar = 97.3%.
Concentrate: Dark green hornblende with a trace of chlorite contamination.

From tonalite
(13 K) Approximately 7 km west and southwest of Moran Lake, Labrador, Newfoundland, 54°30'N, 61°08'W. Sample EE79-197, collected and interpreted by I.F. Ermanovics.

See GSC 81-211 for description and interpretation.

GSC 81-209 Hornblende, K-Ar age **2752 ± 85 Ma**

K = 0.71%, $^{40}Ar/^{40}K$ = 0.3770, radiogenic Ar = 99.3%.
Concentrate: Pleochroic, dark green to light brown hornblende with a trace of chlorite contamination.

From tonalite
(13 K) Details as for GSC 81-208.

See GSC 81-211 for description and interpretation.

GSC 81-210 Biotite, K-Ar age **2420 ± 50 Ma**

K = 7.74%, $^{40}Ar/^{40}K$ = 0.2960, radiogenic Ar = 99.8%.
Concentrate: Dark brown biotite with approximately 3% chlorite alteration.

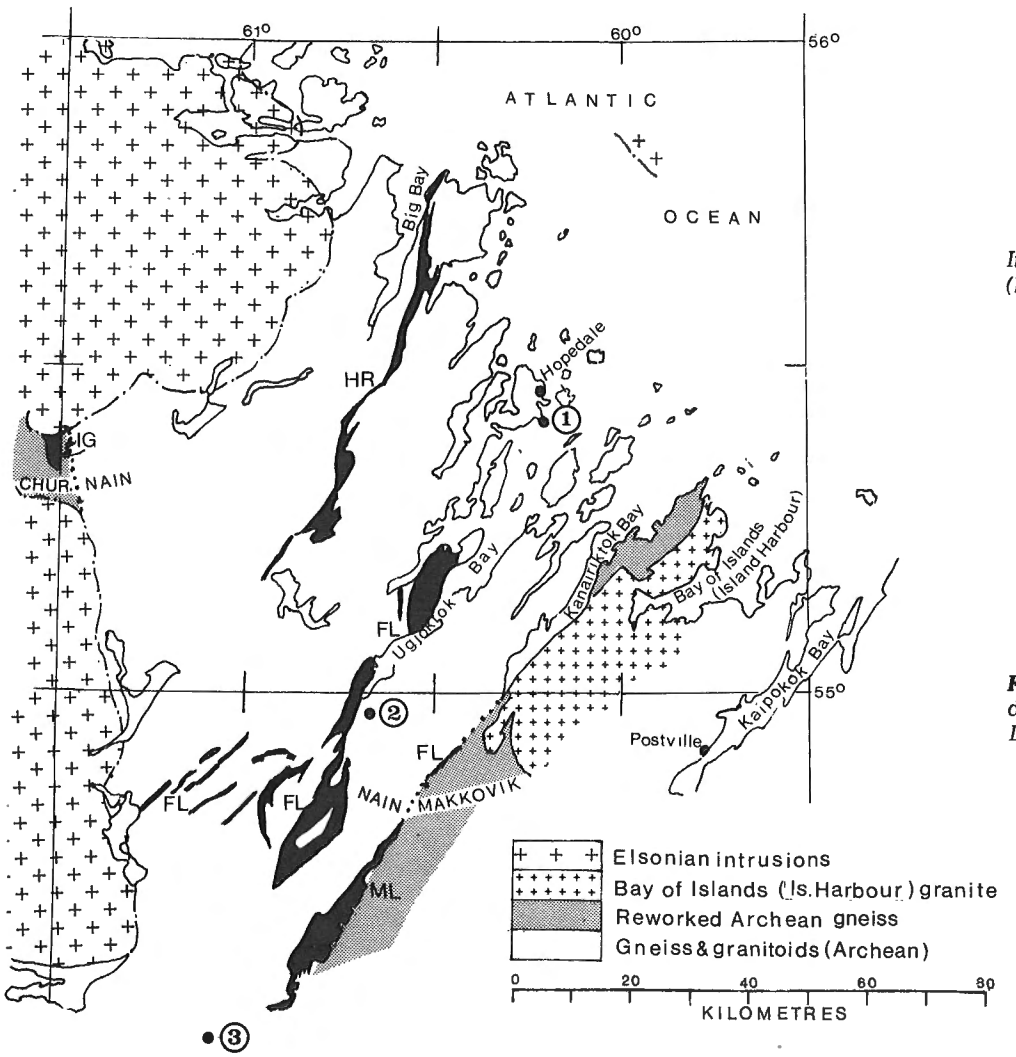
From gneiss
(13 N) Uivak Point, 4.5 km due south of Hopedale, Labrador, Newfoundland, 60°13'00"N, 55°25'30"W. Sample EE78-189, collected and interpreted by I.F. Ermanovics.

See GSC 81-211 for description and interpretation.

GSC 81-211 Hornblende, K-Ar age **1860 ± 60 Ma**

K = 0.84%, $^{40}Ar/^{40}K$ = 0.1891, radiogenic Ar = 91.7%.
Concentrate: Clean, unaltered, pleochroic, light brown to bluish green hornblende with no visible contamination.

From mafic gneiss
(13 K) 9.5 km southeast of end of Ugjoktok Bay, Labrador, Newfoundland, 54°56'15"N, 60°33'30"W. Sample EE79-277B, collected and interpreted by I.F. Ermanovics.



Index to supracrustal rocks (black shading):

IG = Ingrid group (Proterozoic)

HR = Hunt River belt (Archean)

FL = Florence Lake group (Archean)

ML = Moran Lake Group (Proterozoic)

CHUR. = Churchill Province

Figure 7. *Location of age determinations, Hopedale block, Labrador.*

These K-Ar mineral age determinations were intended to gauge the presence of isotopic rejuvenation in Archean rocks of the Hopedale block in Labrador. The terrane has been subjected to several phases of deformation during Archean time and is surrounded by younger igneous and tectonic activity in the range of 1.8-1.3 Ga (Fig. 7, and Ermanovics and Korstgard, 1981).

The data show that isotopic updating has occurred in Archean rocks of the Hopedale block. One determination (GSC 81-211) is interpreted as suggesting that some rejuvenation may have occurred during Proterozoic time.

Samples GSC 81-208 and 209 represent a medium to coarse grained, grey, leucocratic, foliated metagranodiorite-tonalite that outcrops seven kilometres west and southwest of Moran Lake. The rock is host to vein-type uranium mineralization associated with the Proterozoic Moran Lake Group that lies unconformably on the granitoid. At the time of collection of the samples there was some question as to whether the granitoid was Proterozoic or Archean in age. The K-Ar hornblende ages indicate that the granitoid is Archean.

The reason for the disparity in the ages is not known. The granitoid has been metamorphosed twice. The first metamorphism (probably late Archean) produced hornblende and biotite aligned parallel to the gneissosity of the body. The second metamorphism altered biotite to chlorite and plagioclase to epidote and calcite in microshears that sparsely lace the rock. Attempts to date biotite failed because of this alteration. The second metamorphism is lower greenschist grade and is comparable to that found in Moran Lake Group supracrustal rocks. Some parts of the granitoid contain calcite-epidote-sericite fracture fillings that probably reflect Proterozoic paleosurface alteration.

Sample GSC 81-210 represents medium grained, lineated grey, leucocratic tonalite gneiss that outcrops 4.5 kilometres due south of Hopedale at Uivak Point. The gneiss was metamorphosed to upper amphibolite facies and retrograded to epidote-chlorite grade. In addition to plagioclase and quartz, the sample contains 7 per cent biotite, epidote, chlorite, garnet, apatite and zircon.

The rock type is part of the Hopedale gneiss which is a polydeformed unit that includes some of the earliest rocks in the area. U-Pb zircon ages from this locality range from 2950 to 3050 Ma (W.D. Loveridge, personal communication, 1981, U-Pb project 486). Rb-Sr whole rock analysis indicates a similar age of 2937 ± 119 Ma ($^{87}Sr/^{86}Sr$ = 0.7021 ± 0.0006, MSWD = 0.8) (N. Grant, Miami University, Oxford, Ohio, personal communication, 1981).

The K-Ar biotite age may simply represent a time of plutonic cooling during cratonization of the Hopedale block. However, it is possible that the date reflects isotopic rejuvenation brought about during the prolific injection of diabase and gabbroic dykes in the area 2.5-2.0 Ga ago.

Isotopic rejuvenation is also reflected in the large age uncertainties in the above U-Pb zircon and Rb-Sr whole rock ages.

Sample GSC 81-211 is a medium grained, granoblastic layered amphibolite that contains 65-70 per cent small crystals of green-brown hornblende and rods of plagioclase-quartz. The amphibolite is an inclusion (1 x 2 metres) in a sheared, tonalite (Kanairiktok intrusion) that was metamorphosed to amphibolite facies (hornblende + biotite) and retrograded to epidote-chlorite grade. Calcite, epidote, muscovite, and chlorite after biotite occur in dilated shear planes that lace the rock. Although the edges of the amphibolite inclusion are sheared and schistose, the central portions, from which the age determination derives, has remained granoblastic.

A U-Pb zircon age of 2820 (W.D. Loveridge, personal communication, preliminary, project 487) and a Rb-Sr whole rock age of 2780 ± 45 Ma (N. Grant, personal communication, 1981, preliminary) was obtained from this host rock at its type locality 40 km northeast of the present locality. At the type locality the tonalite has been deformed to amphibolite facies and NE-plunging lineations there define the Fiordian structural trend that deflects the earlier NW-trending Hopedale structural trend.

The late Archean Fiordian structural trend appears to have been reactivated by means of narrow but areally significant shears that trend parallel to Fiordian structures. The sample under discussion was obtained 9.5 km south-southeast from the bottom of Ugjoktok Bay from an area deformed by these late shears. Consequently, the K-Ar hornblende age is interpreted as reflecting a Proterozoic age of this late shear deformation. Attempts to date biotite and hornblende from the host tonalite failed because these minerals were completely altered. A Rb-Sr whole rock analysis of the tonalite from this locality produced an errorchron calculation of 2316 ± 530 Ma, MSWD = 4.0 (N. Grant, personal communication, 1981) and appears to support isotopic rejuvenation during Proterozoic time.

Additional K-Ar age determinations in Hopedale block are: GSC 73-78 (hornblende 2511 Ma); GSC 63-172 (hornblende 2665 Ma); GSC 62-178 (biotite 2430 Ma); GSC 61-196 (biotite 2390 Ma); GSC 73-183 (hornblende 1999 Ma). The latter age determination was obtained from a garnetiferous amphibolite west of Big Bay and less than 2 km from anorthosite intrusions of late Paleohelikian age. The age of the amphibolite appears to have been updated from an original Archean age, probably as a result of the heat of intrusion of anorthosite.

Reference

Ermanovics, Ingo and Korstgard, John A.
1981: Geology of Hopedale block and adjacent areas, Labrador: Report 3; in Current Research, Part A, Geological Survey of Canada, Paper 81-1A, p. 69-76.

GSC 81-212 Hornblende, K-Ar age **360 ± 25 Ma**

K = 0.324%, $^{40}Ar/^{40}K$ = 0.02312, radiogenic Ar = 84.8%.
Concentrate: Clean, unaltered, pleochroic, brown to bluish green hornblende with no visible contamination.

From amphibolite
(12 A) Hill 3 km northwest of Lloyds River, Puddle Pond map area, Newfoundland, 48°18'49"N, 57°47'17"W. Sample 78HPA 172/3, collected and interpreted by R.K. Herd.

The rock is a fine-grained to medium-grained equigranular amphibolite with minor felsic stringers, composed of blue-green hornblende (45%), brown biotite (3%), trace cummingtonite, and plagioclase plus quartz (50%), with minor traces of chlorite, iron oxides and leucoxene.

The sample was collected from a small amphibolite horizon within foliated granite; both granite and amphibolite, along with paragneiss, represent the Cormacks Lake complex, a triple-folded region of medium- to high-grade metamorphic rocks inferred to be of Grenville age because of structural relationships and regional correlation with other Grenvillian rocks in western Newfoundland (Herd and Dunning, 1979).

The Acadian age given by the amphibole may have some regional significance. The Lloyds River valley is most likely the site of a major fault zone, an extension of the Cape Ray fault zone of southwestern Newfoundland. Middle Devonian

rocks are deformed in this fault zone north of Port aux Basques (Brown, 1977). In the Puddle Pond map area, the latest phase of folding recognized in the Cormacks Lake complex has NE-SW plunging fold axes and fold axial surfaces trending NE-SW parallel to the Lloyds River zone. In the King George IV Lake area to the south (12 A/4), Silurian-Devonian redbeds and volcanics are locally deformed, and faulted into blocks by NE-SW trending faults (Chandler, 1982).

The date of 360 ± 25 Ma may represent the date of final cooling and uplift of rocks affected by movements along the Lloyds River/Cape Ray fault zones.

See GSC 81-219 for references.

GSC 81-213 Biotite, K-Ar age **436 ± 8 Ma**

K = 6.29%, $^{40}Ar/^{40}K$ = 0.02863, radiogenic Ar = 95.4%.
Concentrate: Brownish biotite with approximately 5% chlorite alteration and a trace of hornblende contamination.

From foliated tonalite agmatizing amphibolite
(12 A) West side of hill, 1.5 km north of small pond on Little Barachois Brook, Puddle Pond map area, Newfoundland, 48°22'38"N, 57°54'13"W. Sample 78HPA 231, collected and interpreted by R.K. Herd.

See GSC 81-214 for description and interpretation.

GSC 81-214 Hornblende, K-Ar age **426 ± 20 Ma**

K = 0.80%, $^{40}Ar/^{40}K$ = 0.02794, radiogenic Ar = 89.8%.
Concentrate: Clean, unaltered, pleochroic, brown to dark green hornblende with no visible contamination.

From amphibolitic inclusion in foliated tonalite
(12 A) Details as for GSC 81-213.

The tonalite is a medium- to coarse-grained granitoid rock containing layered mafic inclusions, mainly medium-grained equigranular amphibolite. The tonalite contains brown biotite (7-10%), plagioclase An_{35-50} (40%), quartz (45%), prehnite (2%), and apatite, clinozoisite and epidote (5%), with traces of iron oxide, chlorite. Prehnite alteration locally affects the biotite.

The sample was collected from an area of amphibolitic inclusions in the foliated tonalite; the hornblende in the sample comes from the hybrid contact zone. Just east of the sample site, the tonalite includes metagabbroic rocks thought to represent ophiolite similar to that in the Annieopsquotch mountains (Herd and Dunning, 1979; Dunning and Herd, 1980). The age of the tonalite should be a minimum age for the inclusions within it.

The Taconian age given by both the biotite and the hornblende is consistent with the field observations. The foliated tonalitic rocks enclose a suite of mafic to ultramafic rocks of variable extent, at least some of which are sufficiently well preserved to show their ophiolitic affinity through their lithology and by comparison with ophiolite sequences in the region. Dunning and Krogh (in prep.) have found a lower Ordovician age for zircons from trondhjemites in the Annieopsquotch, Bay of Islands and Betts Cove ophiolite complexes.

Whether the foliated tonalite terrane, informally called the Southwest Brook complex, represents disrupted oceanic crust or remobilized continental margin material, the K-Ar dates are consistent with it being a granitoid complex produced during the Taconic orogeny, and containing older inclusions. The terrane is faulted against the Cormacks Lake complex to the southwest, along Little Barachois Brook, and the fault zone is probably folded; regional structural trends are conformable in the Cormacks Lake complex and in the Southwest Brook complex. Foliated tonalite contains mafic-ultramafic inclusions in a zone extending northeast at least as far as Buchans (Dunning, Carter and Best, 1982), and in southwestern Newfoundland (Chorlton and Dingwell, 1981). The Hungry Mountain complex in the Buchans map area (Kean, 1979) and the Long Range gneiss in the Port aux Basques map area (Brown, 1977), represent similar terranes, widely thought to be Early Paleozoic or Precambrian in age, but probably a product of extensive Taconic plutonic activity.

The dates of 436 ± 8 Ma and 426 ± 20 Ma may represent final cooling and uplift of a Late Ordovician plutonic complex.

See GSC 81-219 for references.

GSC 81-215 Biotite, K-Ar age **424 ± 8 Ma**

K = 6.51%, $^{40}Ar/^{40}K$ = 0.02778, radiogenic Ar = 96.8%.
Concentrate: Greenish brown biotite with traces of chlorite and hornblende contamination.

From hornblende tonalite
(12 A) Route 480, the Burgeo Road, south of Southwest Brook and the junction of the stream flowing from Abbots Pond, Puddle Pond map area, Newfoundland, 48°27'58"N, 57°52'30"W. Sample 78HPA 236, collected and interpreted by R.K. Herd.

See GSC 81-219 for description and interpretation.

GSC 81-216 Hornblende, K-Ar age **455 ± 14 Ma**

K = 1.36%, $^{40}Ar/^{40}K$ = 0.03004, radiogenic Ar = 91.6%.
Concentrate: Clean, unaltered, pleochroic, brown to dark green hornblende with no visible contamination.

From hornblende tonalite
(12 A) Details as for GSC 81-215.

See GSC 81-219 for description and interpretation.

GSC 81-217 Biotite, K-Ar age **449 ± 8 Ma**

K = 6.18%, $^{40}Ar/^{40}K$ = 0.02962, radiogenic Ar = 95.5%.
Concentrate: Dark brown biotite with approximately 3% chlorite alteration.

From foliated biotite tonalite
(12 A) Route 480, the Burgeo Road, south of Southwest Brook, 2 km past prominent razorback hill on west boundary of map area, Puddle Pond map area, Newfoundland, 48°28'08"N, 57°58'47"W. Sample 78HPA 237 collected and interpreted by R.K. Herd.

See GSC 81-219 for description and interpretation.

GSC 81-218 Biotite, K-Ar age **447 ± 8 Ma**

K = 4.37%, $^{40}Ar/^{40}K$ = 0.02946, radiogenic Ar = 95.8%.
Concentrate: Unaltered, reddish orange biotite with no detected chlorite but containing less than 5% hornblende contamination.

From hornblende-bearing leuconorite

(12 B) Route 480, the Burgeo Road, south of Southwest Brook, at base of razorback hill on east boundary of map area, Main Gut map area, Newfoundland, 48°28'29"N, 58°01'03"W. Sample 78HPA 238 collected and interpreted by R.K. Herd.

See GSC 81-219 for description and interpretation.

GSC 81-219 Hornblende, K-Ar age **455 ± 65 Ma**

K = 0.25%, $^{40}Ar/^{40}K$ = 0.03009, radiogenic Ar = 83.6%.
Concentrate: Clean, unaltered, pleochroic, light green to light brown hornblende with no visible contamination.

From diabasic hornblende diorite/gabbro

(12 B) Area of small lakes, 2 km northeast of White Hill, Main Gut map area, Newfoundland, 48°27'26"N, 58°01'48"W. Sample 78HPA 239 collected and interpreted by R.K. Herd.

The rock is a medium- to coarse-grained hornblende-plagioclase diorite with obvious igneous texture, the plagioclase forming a network of lath-shaped crystals. Local hornblende or plagioclase phenocrysts, or both, occur. Mineralogical composition is green hornblende (25%), brown biotite with prehnite and chlorite (10%), plagioclase, zoned from An_{40-45} (55%), and minor quartz, apatite, saussurite, iron oxides, pyrite and pumpellyite.

The sample was collected from a sequence of hornblende-bearing diorites and gabbroic rocks which form a gently folded, layered igneous complex of uncertain origin, contained as a large inclusion in the foliated tonalite terrane or Southwest Brook complex (see GSC 81-214). The rocks may have appinitic affinities (Carew, 1979) or represent hypabyssal intrusions; inclusions of this kind of diabasic rock, some noritic (orthopyroxene-bearing), also occur extensively east of Battle Pond in the Puddle Pond map area, in the foliated tonalite terrane. The tonalites also may be orthopyroxene-bearing next to noritic inclusions.

Sample GSC 81-218 is from a homogeneous hornblende-bearing leuconorite, medium-grained to coarse-grained, with plagioclase laths and orthopyroxene oikocrysts; mineralogical composition is orthopyroxene, with minor clinopyroxene lamellae (35%), olive-brown hornblende reaction rims on orthopyroxene (10%), plagioclase An_{55} (30%), iron oxides and pyrrhotite (20%), apatite (3-5%), and red-brown biotite, trace. The hornblende and biotite are probably late magmatic.

This leuconorite is a coarse-grained representative of the noritic inclusions within the foliated tonalitic terrane. It is probably unmetamorphosed, the sample being taken from a fresh roadcut remote from the marginal contact where the noritic rocks become agmatized by tonalite. A variety of noritic rocks occur within this mass, which forms a razorback, prominent hill along the north side of the road. These particular noritic rocks may be co-magmatic with the diabasic hornblende diorites and gabbros (above), as structures in the two areas described here are conformable, although the masses (Herd and Dunning, 1979, units 6, 7) are separated by a narrow zone of tonalitic rocks.

Sample GSC 81-217 is from an area of foliated biotite tonalite, containing inclusions of hornblende-biotite tonalite, diabasic and gabbroic rocks, locally all cut by pink aplite. The rock is a tonalitic orthogneiss, layered on a .5 to 1 cm scale, medium- to coarse-grained with local white plagioclase augen or biotite clots. Minerals present are brown biotite (15%), zoned plagioclase An_{35} (50%), quartz (30%), and traces of chlorite, magnetite, pyrite, apatite, and tourmaline.

Samples GSC 81-215 and 216 are from an area of massive hornblende-biotite tonalite, locally cut by granite/aplite veins and dykes and late shear zones and joint sets with growth of prehnite. The rock shows minor feldspar eyes and hornblende-rich clots in a coarse-grained equigranular to foliated matrix. The minerals present are blue-green hornblende (20%), brown biotite (10%), zoned plagioclase An_{30} (35%), quartz (30%), zoned clinozoisite-epidote (2%), and traces of cummingtonite, carbonate, quartz, zircon, sphene, pyrite, apatite, and prehnite.

The hornblende-biotite tonalite and biotite tonalite rocks are part of the foliated tonalite terrane or Southwest Brook complex, which contains inclusions of ophiolitic rocks, paragneiss, diabase-gabbro and norite (see above). The hornblende-bearing tonalite is locally older than the biotite tonalite but they are also gradational into one another. They are variably deformed, the most intense foliation being developed where they contain inclusions. The granite-aplite dykes and veins are representative of late, essentially undeformed granites which may be correlative with the Topsails granites, dated at 419 to 443 Ma ($^{207}Pb/^{206}Pb$, Taylor and Strong, in press). The late joints and shear zones are typically present, as is minor chalcopyrite and molybdenite mineralization in the veins. A few late diabase dykes cut the tonalites and are themselves cut by the joints and shear zones.

The ages of 449 ± 8 Ma and 455 ± 14 Ma from the biotite and hornblende-biotite tonalites probably represent cooling and uplift of the same Late Ordovician plutonic complex as GSC 81-214. The age of 424 ± 8 Ma on biotite from the hornblende-biotite tonalite may indicate the effect of later magmatism associated with the late granites, and expressed by veining and prehnitization. The age of 447 ± 8 Ma on biotite from the leuconorite inclusion, and the age of 455 ± 65 Ma on hornblende from the diabasic inclusion (Main Gut intrusion) are consistent with those masses being older than the surrounding tonalites, although the K-Ar ages may just reflect cooling and uplift of the whole geologically complex terrane.

References

Brown, P.A.
1977: Geology of the Port aux Basques map area (11 O/11) Newfoundland; Mineral Development Division, Newfoundland Department of Mines and Energy, Report 77-2.

Carew, W.P.
1979: A layered appinitic intrusion in southwest Newfoundland: a field, petrographical and geochemical investigation; unpublished B.Sc. thesis, Memorial University of Newfoundland.

Chandler, F.C.
1982: Sedimentology of two Middle Paleozoic terrestrial sequences, King George IV Lake area, Newfoundland, and some comments on regional paleoclimate; in Current Research, Part A, Geological Survey of Canada, Paper 82-1A, p. 213-219.

Chorlton, L.B. and Dingwell, D.B.
1981: Grandys Lake (11 O/15), Newfoundland; in Current Research, Mineral Development Division, Newfoundland Department of Mines and Energy, Report 81-1, p. 57-69.

Dunning, G.R., Carter, P.J., and Best, M.A.
1982: Geology of Star Lake (west half), southwest Newfoundland (NTS 12 A/11W); in Current Research, Part B, Geological Survey of Canada, Paper 82-1B.

Dunning, G.R. and Herd, R.K.
1980: The Annieopsquotch ophiolite complex, southwest Newfoundland, and its regional relationships; in Current Research, Part A, Geological Survey of Canada, Paper 80-1A, p. 227-234.

Herd, R.K. and Dunning, G.R.
1979: Geology of Puddle Pond map area, southwestern Newfoundland; in Current Research, Part A, Geological Survey of Canada, Paper 79-1A, p. 305-310.

Kean, B.F.
1979: Buchans map area (12 A/15), Newfoundland; in Report of Activities for 1978, Mineral Development Division, Newfoundland Department of Mines and Energy, Report 79-1, p. 18-24.

Taylor, R.P. and Strong, D.F.
Rb-Sr and U-Pb geochronology of the Topsails igneous complex; manuscript submitted to Canadian Journal of Earth Sciences.

Offshore

(GSC 81-220 to GSC 81-225)

GSC 81-220 Whole rock, K-Ar age **984 ± 36 Ma**

K = 1.53%, $^{40}Ar/^{40}K$ = 0.07607, radiogenic Ar = 96.7%.
Concentrate: Crushed whole rock.

From basalt
Julianehaab Canyon, southwest Greenland, 60°15'N, 46°50'W. Sample OSG-31, collected by L. Johnson and described by S.P. Srivastava.

See GSC 81-222 for comments.

GSC 81-221 Whole rock, K-Ar age **57.1 ± 11.2 Ma**

K = 0.090%, $^{40}Ar/^{40}K$ = 0.00337, radiogenic Ar = 17.1%.
Concentrate: Crushed whole rock.

From basalt
Julianehaab Canyon, southwest Greenland, 60°15'N, 46°50'W. Sample OSG-58, collected by L. Johnson and described by S.P. Srivastava.

See GSC 81-222 for comments.

GSC 81-222 Whole rock, K-Ar age **55.1 ± 13.4 Ma**

K = 0.18%, $^{40}Ar/^{40}K$ = 0.00325, radiogenic Ar = 40.2%.
Concentrate: Crushed whole rock.

From basalt
Julianehaab Canyon, southwest Greenland, 60°15'N, 46°50'W. Sample OSG-59, collected by L. Johnson and described by S.P. Srivastava.

These three determinations were carried out on basaltic samples dredged from Julianehaab Canyon in order to establish whether or not the basalt has originated from a fracture zone located west of the dredge site.

All three determinations have large error limits related to their very low potassium content and the ages should therefore be treated with caution. However, the great age difference between OSG-31 and OSG-58 and 59 is certainly a clear indication of radically different origins for the Precambrian and Tertiary samples.

GSC 81-223 Whole rock, K-Ar age **1123 ± 27 Ma**

K = 1.58%, $^{40}Ar/^{40}K$ = 0.09047, radiogenic Ar = 97.4%.
Concentrate: Crushed whole rock.

From basalt
Southern Greenland continental slope, 61°40'N, 50°50'W. Sample OSG-558, collected and described by S.P. Srivastava.

See GSC 81-225 for comments.

GSC 81-224 Whole rock, K-Ar age **1117 ± 28 Ma**

K = 1.45%, $^{40}Ar/^{40}K$ = 0.08990, radiogenic Ar = 97.7%.
Concentrate: Crushed whole rock.

From basalt
Southern Greenland continental slope, 62°22.3'N, 51°13'W. Sample OSG-561, collected and described by S.P. Srivastava.

See GSC 81-225 for comments.

GSC 81-225 Whole rock, K-Ar age **2311 ± 80 Ma**

K = 0.71%, $^{40}Ar/^{40}K$ = 0.2726, radiogenic Ar = 98.3%.
Concentrate: Crushed whole rock.

From basalt
Southern Greenland continental slope, 63°40'N, 52°00'W. Sample OSG-594, collected and described by S.P. Srivastava.

The samples were fresh, dark grey and fine grained. All were collected in dredge hauls from the southwest Greenland continental slope. The shelf contains mainly Precambrian rocks which, on the slope and at the foot of the slope, are covered by thin layers of sediments. Basalt outcrops as dykes at certain places.

Ghana

(GSC 81-226)

GSC 81-226 Amphibole, K-Ar age **2223 ± 288 Ma**

K = 0.18%, $^{40}Ar/^{40}K$ = 0.2545, radiogenic Ar = 96.6%.
Concentrate: Very light green, non-pleochroic amphibole with a trace of chlorite contamination.

From mafic tuff
Northeastern Ghana, 10°54'00"N, 0°37'23"W. Sample 164-380/BV, collected by K. Attoh and interpreted by K.D. Card.

Sample 164-380/BV submitted by K. Attoh, post-doctoral fellow, G.S.C., is from near the top of the Birimian volcanic succession in northeast Ghana. The sample is a bedded mafic tuff consisting of subhedral amphibole crystals in a finer grained amphibole-plagioclase matrix with some biotite. The date of 2223 ± 288 Ma may approximate the age of early Proterozoic, Birimian volcanic succession in this part of Africa.

APPENDIX

The numbers listed below refer to the individual sample determination numbers, e.g. (GSC) 62-189, published in the Geological Survey of Canada age reports listed below:

	Determinations
GSC Paper 60-17, Report 1	59-1 to 59-98
GSC Paper 61-17, Report 2	60-1 to 60-152
GSC Paper 62-17, Report 3	61-1 to 61-204
GSC Paper 63-17, Report 4	62-1 to 62-190
GSC Paper 64-17, Report 5	63-1 to 63-184
GSC Paper 65-17, Report 6	64-1 to 64-165
GSC Paper 66-17, Report 7	65-1 to 65-153
GSC Paper 67-2A, Report 8	66-1 to 66-176
GSC Paper 69-2A, Report 9	67-1 to 67-146
GSC Paper 71-2, Report 10	70-1 to 70-156
GSC Paper 73-2, Report 11	72-1 to 72-163
GSC Paper 74-2, Report 12	73-1 to 73-198
GSC Paper 77-2, Report 13	76-1 to 76-248
GSC Paper 79-2, Report 14	78-1 to 78-230
GSC Paper 81-2, Report 15	80-1 to 80-208
GSC Paper 82-2, Report 16	81-1 to 81-226 (this report)

GSC Age Determinations Listed by N.T.S. Co-ordinates

1-M	62-189, 190; 63-136, 137; 66-170, 171; 70-145, 146, 147, 152
1-N	65-150; 70-156
2-C	70-155
2-D	59-94, 95, 96, 97, 98; 60-151, 152; 63-182; 65-142, 143; 66-172; 70-153, 154
2-E	62-187, 188; 63-168, 169, 170, 171, 183, 184; 64-159; 65-144, 145, 146, 147, 148, 149; 67-144; 70-151; 78-229, 230
2-F	70-148; 80-206
2-L	72-158, 159
2-M	66-173; 73-192, 193, 194
3-D	63-161
10-N	72-163
11-D	70-122, 123
11-E	66-156, 157, 158; 70-124, 125; 78-209
11-F	62-168, 169; 78-211; 80-200
11-J	78-212
11-K	66-159, 160, 161; 78-210; 80-199
11-L	65-133, 134, 135; 66-163; 70-128, 129, 130; 72-124, 125, 126; 76-231, 232, 233, 234, 235, 236, 237, 238, 239
11-N	78-206, 207, 208; 81-206, 207
11-O	61-202; 63-162; 65-138, 139, 140, 141; 66-168
11-P	67-143
12-A	67-142; 70-120, 121; 72-160, 161; 73-197, 198; 81-212, 213, 214, 215, 216, 217
12-B	60-147; 61-199; 62-186; 63-166, 167; 81-218, 219
12-E	65-129; 66-153; 70-102, 103, 104, 105; 72-95
12-H	60-148; 61-203, 204; 70-143, 144, 149
12-I	60-149; 61-200, 201; 64-158; 66-169; 70-150; 72-153, 154, 155, 156, 157; 73-195, 196
12-L	60-133, 134, 143
12-M	78-202, 203, 204, 205
12-O	60-135
12-P	73-191
13-C	66-167; 67-138
13-D	60-132
13-E	64-160; 70-133; 80-201
13-F	60-145; 67-136, 137
13-H	60-146; 67-141
13-I	70-138, 142; 72-140, 150
13-J	70-134, 135, 136, 137; 72-139; 78-228
13-K	60-144; 61-196; 62-183, 184, 185; 63-178, 179; 72-141, 142, 143; 73-168, 169; 76-241, 242, 244, 247, 248; 81-208, 209, 211
13-L	61-197; 62-177; 63-148, 163, 177; 64-157; 65-151; 73-163, 164, 167; 76-240, 245
13-M	63-174; 64-162; 70-131, 132; 73-174; 76-243
13-N	62-178; 63-172; 73-176, 177, 178, 179, 183, 184; 76-246; 81-210
13-O	62-179, 180, 181, 182; 67-133, 134, 135; 70-140, 141; 72-144, 145, 146, 147, 148, 149, 151, 152; 73-180, 181, 185, 186, 187, 188, 189, 190
14-C	72-138; 73-182
14-D	60-143; 63-175; 65-122, 152; 73-166
14-E	61-195; 62-172; 63-181; 64-164; 65-153; 66-166; 72-134; 73-165, 172
14-F	62-171; 63-180; 64-163; 72-135, 136, 137
14-L	63-173, 176; 64-165; 67-130, 131, 132, 140; 73-171, 175; 78-213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227
14-M	67-129; 72-133; 73-170, 173
15-M	76-174, 175
20-I	72-162
20-P	61-194; 62-167
21-A	59-93; 62-163, 164, 165, 166; 65-132; 66-155
21-B	61-193; 62-161, 162

Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada