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A compilation of ^{40}Ar-^{39}Ar and K-Ar ages: Report 25

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Abstract: Twenty-three ^{40}Ar-^{39}Ar age determinations (including two potassium-argon analyses) 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 outline. 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 les résultats de vingt-trois datations ^{40}Ar-^{39}Ar (incluant deux analyses par la méthode K-Ar) réalisées par des scientifiques de la Commission géologique du Canada. Chaque datation est accompagnée d'une description de la roche et du concentré minéral utilisés; lorsque cela est possible, on présente aussi de brefs commentaires sur l'importance géologique de chaque âge déterminé. Le protocole expérimental est décrit dans les grandes lignes. Un index de toutes les datations K-Ar que la Commission géologique du Canada a publiées dans la série *Radiogenic age and isotope studies* a été préparé avec, comme référence principale, les numéros du SNRC.

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INTRODUCTION

This compilation of ^{40}Ar-^{39}Ar ages determined in the Geochronological Laboratories of the Geological Survey of Canada is the latest in a series of reports, the last of which was published in 1994 (Hunt and Roddick, 1994). In this new contribution twenty-three determinations are reported. As in the last report, a number of analyses (2) using the K-Ar technique are reported. An explanation of ^{40}Ar-^{39}Ar procedures used and general interpretation of the data are given below. The format of this compilation is similar to the previous reports, with data ordered by province or territory and subdivided by map sheet number. In addition to the GSC numbers, laboratory numbers (AAxxx and K-Ar xxxx) are included for internal reference.

EXPERIMENTAL PROCEDURES

Conventional K-Ar

The data compiled here represent analyses carried out between 1993 and 1994. Potassium, for conventional analyses, was analyzed by atomic absorption spectrometry on duplicate dissolutions of the samples. Conventional argon extractions were carried out using a radio frequency vacuum furnace with a multi-sample loading system capable of holding six samples. The extraction system is on-line to a modified A.E.I. MS-10 with a 0.18 tesla permanent magnet. An atmospheric Ar aliquot system is also incorporated to provide routine monitoring of mass spectrometer mass discrimination. Details of computer acquisition and processing of data are given in Roddick and Souther (1987). Decay constants recommended by Steiger and Jäger (1977) are used in the age calculations and errors are quoted at the 2 sigma level.

^{40}Ar-^{39}Ar analyses

The Geochronology Laboratory is replacing the conventional K-Ar dating with the ^{40}Ar-^{39}Ar step heating technique for most samples. In this technique a sample is irradiated in a nuclear reactor to convert some K atoms to ^{39}Ar. The ^{39}Ar is used as a measure of the K in the sample and a sample's age is determined by the measurement of the ^{40}Ar-^{39}Ar isotopic ratio (corrected for interfering isotopes and atmospheric Ar). By step-wise heating of a sample in a vacuum furnace ages can be calculated for Ar fractions released at incrementally higher temperatures. In general, ages determined from the higher temperature steps represent Ar released from more retentive sites in a mineral. For further analytical details see Roddick (1990) and for an explanation of the principles of the technique see McDougall and Harrison (1988) or Hanes (1991).

The analyses reported here consist of three heating steps, with the temperature of the first step selected to liberate most of the atmospheric argon but a minimum of the radiogenic argon from the sample. This step contains very little radiogenic Ar and usually is not reported. The next temperature step is selected to release about 50% of the radiogenic argon from the sample. A final fusion step releases any remaining Ar. The analyses are therefore essentially two age measurements and permit a comparative test of the consistency of the ages of argon released from a sample. If the ages of the two fractions are in agreement, it is assumed that a reliable age can be assigned to the sample. Should the ages differ then it is likely that there has been a disturbance to the K-Ar system in the sample.

The results are presented in a format similar to the K-Ar reports but with an additional section detailing the ages of the steps and the preferred age of the sample. The first age given represents the weighted mean age of all three gas fractions, weighted and summed according to the amounts of ^{39}Ar in each fraction, and is indicated as an integrated age with 2σ uncertainty limits. The error limit on the age includes uncertainty in irradiation calibration of the amount of K converted to ^{39}Ar (J factor, typically $\pm$ 0.5 - 1.0% 2σ) which must be considered when comparing the ages of different samples. The integrated age is equivalent to a conventional K-Ar age and, in samples that are not subject to recoil Ar loss (see McDougall and Harrison, 1988), is the age which would be determined by that technique. The per cent atmospheric argon in the sample is given for this integrated age. The ages of the last two steps are given separately, along with their 2σ uncertainties and proportions of sample argon, as percentages of ^{39}Ar, in the fractions. The uncertainties of these ages do not include irradiation calibration error since it does not contribute to uncertainties between heating steps on a single sample. If these two ages agree within their error limits the preferred age is a weighted mean of these fractions weighted by the amounts of ^{39}Ar in the fractions. The error estimate for this age also includes uncertainty in the irradiation calibration. This is termed the plateau age. If these two ages do not agree then one of the steps may be designated as the preferred age. In many cases of known complex geological history the age of highest temperature gas fraction may be the best estimate of the age as the lower temperature release may record a partial ^{40}Ar loss induced by the most recent geological reheating of the sample. In some cases excess argon is present in the initial Ar released and in this case the highest temperature step is also the best estimate of the age of a sample. Some explanation of the reason for the preferred age is given in the geological discussion of a sample.

The potassium concentration of the sample is also given. This is determined from calibration of the mass spectrometer as a precise manometer, the conversion factor for ^{39}Ar production, and the weight of the sample. The precision of this K concentration is one to four per cent and is limited mainly by errors associated with weighing of the small (4 to 30 mg) samples used for analyses.

The complete series of reports including the present one is given in the Appendix.

ACKNOWLEDGMENTS

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BRITISH COLUMBIA (GSC 95-1 TO GSC 95-14)

GSC 95-1 Whole rock
45.1 ± 0.5 Ma, integrated ^{40}Ar-^{39}Ar

Wt % K = 3.43
K-Ar 4524 % Atmos. Ar = 10.5

(AA529) Ages of three heating steps (% gas):
45.3 ± 0.1 Ma (55%), 44.5 ± 0.5 Ma (19%), 44.8 ± 0.2 Ma (15%)
Preferred age: integrated ^{40}Ar-^{39}Ar age of 45.1 ± 0.5 Ma

(93B/12) From a dacite.
From a road outcrop, 0.8 km east of Clisbako Canyon, B.C.; 52°43′20.9"N, 123°33′13.1"W; UTM zone 10, 462607E, 5841329N; sample HHB933710. Collected and interpretated by P. Metcalfe.

For interpretation see GSC 95-4.

GSC 95-2 Whole rock
47.7 ± 0.5 Ma, integrated ^{40}Ar-^{39}Ar

Wt % K = 3.25
K-Ar 4525 % Atmos. Ar = 9.9

(AA530) Ages of two heating steps (% gas):
48.5 ± 0.1 Ma (23%), 47.6 ± 0.2 Ma (10%)
Preferred age: 33% gas plateau age of 48.2 ± 0.5 Ma

(93B/13) From a dacite.
From a roadside outcrop, 3.5 km south of the main Michelle Creek logging road, B.C.; 52°48′2.7"N, 123°43′2.6"W; UTM zone 10, 451645E, 5851368N; sample HHB933306; Collected and interpretated by P. Metcalfe.

For interpretation see GSC 95-4.

GSC 95-3 Whole rock
44.0 ± 0.4 Ma, integrated ^{40}Ar-^{39}Ar

Wt % K = 3.41
K-Ar 4526 % Atmos. Ar = 8.74

(AA531) Ages of three heating steps (% gas):
44.2 ± 0.1 Ma (64%), 41.2 ± 0.4 Ma (7%), 43.4 ± 0.2 Ma (8%)
Preferred age: integrated ^{40}Ar-^{39}Ar age of 44.0 ± 0.4 Ma

(93B/13) From a dacite.
On the west side of Little Mountain, roadside quarry, B.C.; 52°50′6.9"N, 123°54′48.1"W; UTM zone 10, 438469E, 5854119 N; sample HHB933501. Collected and interpretated by P. Metcalfe.

For interpretation see GSC 95-4.

GSC 95-4 Whole rock
48.3 ± 0.5 Ma, integrated ^{40}Ar-^{39}Ar

Wt % K = 2.68
K-Ar 4527 % Atmos. Ar = 8.33

(AA532) Ages of two heating steps (% gas):
48.0 ± 0.3 Ma (13%), 47.6 ± 0.5 Ma (4%)
Preferred age: 17% gas plateau age of 47.9 ± 0.6 Ma

(93C/16) From a dacite.
From the summit of Toil Mountain, B.C., 52°48′26.2"N, 124° 8′14.3"W; UTM zone 10, 423334E 5851224N; sample HHB933005. Collected and interpretated by P. Metcalfe.

The four samples analyzed from the Clisbako River area (GSC 95- 1, 2, 3, 4) are Eocene in age and have previously been assigned to the Ootsa Lake Group. All four samples are dacites and contain augite and plagioclase phenocrysts, with minor hornblende. Geophysical studies, satellite imagery, and chemical coherence of the Clisbako volcanic area indicates that it is the root of an Eocene volcano with a late phase of intense pyroclastic activity. The four samples are interpreted as representing volcanic events prior to this eruption and indicate a period of activity extending from at least 48.2 Ma to 44.0 Ma.

GSC 95-5 Hornblende
119.8 ± 1.2 Ma, integrated ^{40}Ar-^{39}Ar

Wt % K = 0.750
K-Ar 4502 % Atmos. Ar = 17.9

(AA456) Ages of two heating steps (% gas):
120.4 ± 0.2 Ma (78%), 120.5 ± 0.7 Ma (20%)
Preferred age: 98% gas plateau age of 120.4 ± 1.2 Ma

(102P/9E) From a diorite.
From the sea cliffs on the exposed western side of Calvert Island, B.C., about 6 km south of the west end of Owikeno Traverse; 51°35.49′N, 128°8.34′W; UTM zone 9, 559650E, 5715750N; sample RD67.30235. Collected by W.W. Hutchison and interpreted by J.A. Roddick.

This sample is a dark, homogeneous, coarse grained, hornblende-rich diorite. A faint foliation can be seen trending northeast and dipping steeply to the southeast (050/75), oblique to the regional trend. The outcrop is cut by a swarm of basalt dykes trending west-northwest and dipping steeply to the north. The diorite is thought to represent a cleaner phase of the dioritic complex that underlies much of the eastern part of the island south of the apparently younger Calvert Island Pluton.

This is the westernmost dated rock between latitudes 51° and 52°N, and at 120.4 Ma, also the oldest. The Early Cretaceous (Aptian) age on hornblende is about equivalent to the 117 Ma biotite date obtained from a granite on Price Island, about 110 km to the northwest (see GSC 80-26 in Stevens et al., 1982).

For further interpretation see *Summary of ages from the Owikeno Traverse* after GSC 95-14.

GSC 95-6 Biotite
104.2 ± 1.0 Ma, integrated ^{40}Ar-^{39}Ar

Wt % K = 6.82
K-Ar 4505 % Atmos. Ar = 27.3

(AA459) Ages of two heating steps (% gas):
110.2 ± 0.2 Ma (74%), 112.1 ± 1.1 Ma (11%)
Preferred age: 85% gas plateau age of 110.5 ± 1.1 Ma

(102P/9E) From a leucocratic granite.
From the west side of the northern part of Calvert Island, opposite Surf Islands, on the west coast of B.C.; 51°39.90′ N, 128°8.41′W; UTM zone 9, 559470E, 5723920N; sample RD67.30245. Collected by W.W. Hutchison and interpreted by J.A. Roddick.

This sample is from the Pruth Bay Granite, a highly evolved pluton on the west coast. It consists of a leucocratic biotite granite with a highly variable texture that ranges from aplitic to coarse grained. It has well defined jointing, some close (5-30 cm) and some wide (2-70 m). The granite is inclusion-free and in most places massive. It is free of basalt dykes which cut the diorite to the south.

For interpretation see GSC 95-8.

GSC 95-7 Hornblende
110.1 ± 1.2 Ma, integrated ^{40}Ar-^{39}Ar

Wt % K = 0.589
K-Ar 4504 % Atmos. Ar = 43.0

(AA458) Ages of two heating steps (% gas):
110.0 ± 0.4 Ma (84%), 111.9 ± 1.0 Ma (15%)
Preferred age: 99% gas plateau age of 110.3 ± 1.1 Ma

(102P/9E) From a massive quartz monzodiorite.
From the north shore of Calvert Island, B.C., south side of Kwakshua Channel, about 8 km from west coast of the island; 51°39.07′N, 128°1.64′W; UTM zone 9, 567290E, 5722475N; sample RD67.50455. Collected by M. Lasserre and interpreted by J.A. Roddick.

This sample comes from near the western margin of Calvert Island Pluton. The rock is a clean, high-contrast, quartz monzodiorite, with abundant mafic minerals (40% in places), which probably accounts for the high density (2.86). The outcrop is marked by irregularly distributed amphibolitic inclusions, some elongate, some made nebulitic by feldspathic metasomatism.

For interpretation see GSC 95-8.

GSC 95-8 Hornblende
109.3 ± 1.3 Ma, integrated ^{40}Ar-^{39}Ar

Wt % K = 0.513
K-Ar 4503 % Atmos. Ar = 25.7

(AA457) Ages of two heating steps (% gas):
110.5 ± 0.3 Ma (77%), 109.7 ± 1.9 Ma (21%)
Preferred age: 98% gas plateau age of 110.3 ± 1.2 Ma

(92M/12) From a moderately foliated, mafic tonalite.
From the north shore of Calvert Island, B.C., 1.5 km west of Wedgborough Point, about 12 km from west coast of the island; 51°38.88′N, 127°58.10′W; UTM zone 9,

571382E, 5722170N; sample RD67.50575. Collected by M. Lasserre and interpreted by J.A. Roddick.

This sample comes from within 200 m of the eastern margin of Calvert Island Pluton. The rock is a homogeneous, rather dark tonalite containing about 2% amphibolitic inclusions with hornblende and biotite in about equal abundance which form, together, about 25% of the rock. The sample is moderately foliated (325/55), roughly parallel with the pluton margin and the regional trend.

The essentially identical dates of 110 Ma from GSC 95-6, 7, and 8 for hornblende and biotite suggests that the Pruth Granite is possibly a phase of the Calvert Island Pluton. With rapid cooling, the hornblende of the Calvert Island Pluton closed at about the same time as the biotite of the Pruth Granite. On this data alone it is not possible to distinguish between progressive west to east uplift and sequential intrusion.

For further interpretation see *Summary of ages from the Owikeno Traverse* after GSC 95-14.

GSC 95-9 Hornblende
107.8 ± 1.1 Ma, integrated ^{40}Ar-^{39}Ar

Wt % K = 0.6085
K-Ar 4501 % Atmos. Ar = 15.7

(AA455) Ages of two heating steps (% gas):
108.6 ± 0.3 Ma (81%), 109.5 ± 0.7 Ma (18%)
Preferred age: 99% gas plateau age of 108.7 ± 1.1 Ma

(92M/12) From a moderately foliated tonalite.
From the west shore of the B.C. mainland (east side of Fitz Hugh Sound), about 18 km from the west coast; 51°41.34′N, 127°52.81′W; UTM zone 9, 577414E, 5726821N; sample RD67.50371. Collected by M. Lasserre and interpreted by J.A. Roddick.

This sample was collected from near the western margin of Fish Egg Pluton. The actual contact, however, lies somewhere in adjacent Fitz Hugh Sound. The outcrop is formed by clean, coarse grained tonalite with north-trending, near-vertical moderate foliation.

This date was expected to confirm an eastward younging, even within the pluton, that was suggested by previous dates on biotite (103.7 Ma (see GSC 93-11 in Hunt and Roddick, 1993) from the central part of the pluton, and 96.6 Ma (GSC 93-13, Hunt and Roddick, 1993) from the eastern margin. This hornblende date of about 108 Ma, however, is within the error limits of the hornblende date (about 107 Ma, see GSC 93-12, Hunt and Roddick, 1993) obtained from the east side of the pluton. Taken at face value, the results suggest that progressive west to east unroofing of the pluton is reflected in the biotite dates but not in the hornblende dates. A biotite date from the west side and a hornblende date from the central part of the pluton are needed to resolve the matter.

GSC 95-10 Hornblende
78.2 ± 1.1 Ma, integrated ^{40}Ar-^{39}Ar

Wt % K = 0.478
K-Ar 4521 % Atmos. Ar = 20.9

(AA524) Ages of two heating steps (% gas):
77.8 ± 0.1 Ma (83%), 78.8 ± 1.0 Ma (16%)
Preferred age: 99% gas plateau age of 78.0 ± 0.8 Ma

(92M/10) From a mafic-rich, low-contrast diorite.
From a ridge 4 km north of the Machmell River, 9 km east of Owikeno Lake, about 96 km east of the B.C. mainland coast; 51°38.70′N, 126°30.52′W; UTM zone 9, 672377E, 5724283N; sample RD67.50758. Collected by M. Lasserre and interpreted by J.A. Roddick.

This sample is from a dark, low contrast diorite which is cut by synplutonic dykes and a feldspathic stockwork. Although included within the granitoid gneiss map unit, the rock is not foliated. On the basis of its density (2.92) the rock could be classified as a hornblende gabbro. The thin section shows 25-30% mafic minerals, dominated by decussate, irregular-shaped clusters of hornblende.

For interpretation see *Summary of ages from the Owikeno Traverse* after GSC 95-14.

GSC 95-11 Hornblende
85.4 ± 2.0 Ma, integrated ^{40}Ar-^{39}Ar

Wt % K = 0.715
K-Ar 4520 % Atmos. Ar = 19.6

(AA523) Ages of two heating steps (% gas):
84.1 ± 0.4 Ma (85%), 70.2 ± 1.3 Ma (14%)
Preferred age: step 3 age of 70.2 ± 1.5 Ma with 14% gas

(92M/9) From a mafic, strongly foliated quartz diorite.
From a ridge 3 km west of Ankitree Creek, 16 km east of Owikeno Lake, about 103 km east of the B.C. mainland coast; 51°40.45′N, 126°25.33′W; UTM zone 9, 678243E, 5727732N; sample RD67.50728. Collected by M. Lasserre and interpreted by J.A. Roddick.

The sample is from an unnamed quartz diorite pluton lying west of Machmell Pluton and in most places separated from it by the granitoid gneiss map unit. The rock has a prominent vertical foliation, striking northeasterly (065), across the regional trend. Aplitic veining and epidote are common. Mafic minerals are abundant, forming about 30% of the rock and in thin section are about evenly divided between hornblende and biotite. In this sample the ages of the two heating steps do not agree, excess argon was present in the initial Ar released and so in this case the highest temperature step (step 3) is assumed to be the best estimate of the age of sample.

For interpretation see *Summary of ages from the Owikeno Traverse* after GSC 95-14.

GSC 95-12 Hornblende
75.8 ± 1.4 Ma, integrated ^{40}Ar-^{39}Ar

Wt % K = 0.979
K-Ar 4523 % Atmos. Ar = 27.6

(AA526) Ages of two heating steps (% gas):
74.6 ± 0.4 Ma (85%), 74.8 ± 0.7 (14%)
Preferred age: 99% gas plateau age of 74.6 ± 0.8 Ma

(92M/9) From a massive, high-contrast tonalite.
From a ridge south of icefield, 6 km east of Ankitree Creek, about 112 km east of the mainland coast, B.C.; 51°40.46'N, 126°17.53'W; UTM zone 9, 687230E, 5728070N; sample RD82.12183. Collected and interpreted by J.A. Roddick.

This sample is a massive, homogeneous, high-contrast tonalite from the central part of Machmell Pluton. It is cut by epidote veins which are flanked by hydrothermally altered margins. Mafic minerals make up about 15% of the rock, with hornblende and biotite in about equal abundance.

For interpretation see *Summary of ages from the Owikeno Traverse* after GSC 95-14.

GSC 94-13 Hornblende
61.0 ± 0.7 Ma, integrated ^{40}Ar-^{39}Ar

Wt % K = 1.04
K-Ar 4522 % Atmos. Ar = 21.6

(AA525) Ages of three heating steps (% gas):
60.7 ± 5.4 Ma (3%), 61.1 ± 0.2 Ma (83%), 60.6 ± 0.9 Ma (13%)
Preferred age: integrated ^{40}Ar-^{39}Ar age of 61.0 ± 0.7 Ma

(92M/9) From a gneissic quartz diorite.
From 2 km northeast of Mount Brager (within a kilometre of the eastern border of Rivers Inlet map area) B.C.; 51°44.22'N, 126°0.45'W; UTM zone 9, 706620E, 5735810N; sample RD82.12150. Collected and interpreted by J.A. Roddick.

This sample is from the granitoid gneiss map unit that forms a reentrant between Sheemahant and Page plutons. It contains about 15% screens of irregularly layered gneiss which consists of a dark, fine grained, salt and pepper amphibolite cut by a network of feldspathic (partly pegmatitic) veinlets. The gneissic foliation trends nearly due north and dips 70° west. The sample has the composition of quartz diorite, with about 12% mafic minerals. Hornblende and biotite are about equal in abundance.

This date is somewhat older than the 54 Ma and 58 Ma biotite ages from the Sheemahant Pluton (see GSC 80-45 in Stevens, et al., 1982, and GSC 93-10 in Hunt and Roddick, 1993), but the higher closure temperature of hornblende may account for the 61 Ma age. Interpretation is limited by the lack of a biotite date from this sample.

GSC 94-14 Biotite
76.6 ± 0.8 Ma, integrated ^{40}Ar-^{39}Ar

Wt % K = 7.25
K-Ar 4519 % Atmos. Ar = 15.7

(AA522) Ages of two heating steps (% gas):
76.8 ± 0.1 Ma (70%), 77.4 ± 0.2 Ma (28%)
Preferred age: 98% gas plateau age of 77.0 ± 0.8 Ma

(92N/13) From a homogeneous, massive tonalite.
From Mount Waddington map area, about 1 km northeast of Wilderness Mountain, about 180 km east of the B.C. mainland coast; 51°56.76'N, 125°31.03'; UTM zone 10, 327000E, 5757800N; sample RD67.30956. Collected by W.W. Hutchison and interpreted by J.A. Roddick.

This sample is a tonalite from the Wilderness Mountain Pluton which borders the northwest end of Klinaklini Pluton. The outcrop is homogeneous, massive, with no inclusions visible. Thin section shows about 18% biotite. This body has yielded the most highly discordant biotite-hornblende dates in the Coast Mountains (see GSC 78-61,62 in Wanless et al., 1979, and GSC 80-23, 22 in Stevens et al., 1982). The former pair yielded 66 Ma biotite and 121 Ma hornblende, and the latter, 86 Ma biotite and 140 Ma hornblende. On the basis of further work by van der Heyden (1991), who named the body Wilderness Mountain Pluton, U-Pb dates were interpreted as Late Jurassic. This biotite date falls midway between the previous biotite dates, although the specimen was collected about 6 km to the northeast of the previously dated rocks. The specimen which yielded the 140 Ma hornblende came from a foliated quartz diorite-diorite that appears to be thrust north-easterly over the main mass of the pluton. Whether it is part of the pluton, or part of the more gneissic Atnarko Complex to the west is not definitely known. Interpretation remains difficult.

Summary of Ages from the Owikeno Traverse

The *Owikeno Traverse* is a closely sampled (roughly at 500 m intervals) traverse that extends across the Coast Plutonic Complex, from the west coast of Calvert Island (in Queens Sound map area, 102P/9E), across Rivers Inlet (92M) and Mount Waddington map areas (92N), and a short distance into

Anahim Lake map area (92C). In straight line segments the Owikeno Traverse consists of 11 km in 102P, 140 km in 92M, and 70 km in 92N, for a total of 221 km and about 400 stations.

At least one sample was collected at each station and for all homogeneous plutonic samples, specific gravity was measured. Except for gabbros and hornblendites, each plutonic sample was stained before estimates of the mineral abundances were made and the rock classified. The results of 232 chemical analyses from the traverse collection appear in Roddick (1983).

The Coast Mountains granitoid matrix in which the plutons are imbedded is very heterogeneous and difficult to map on any scale. It includes granitoid gneiss, layers of practically normal plutonic rock, dioritic complexes, elongate agmatites with narrow screens of amphibolite, and metavolcanic and metasedimentary rock (including crystalline limestone). In part it resembles the Central Gneiss Complex in the Douglas Channel map area to the north, but in this region it is not a well defined unit. Yet, the granitoid matrix underlies most of the area and, in spite of its complexity, dates from it may be more significant than those from the plutons.

The 10 ^{40}Ar-^{39}Ar age determinations in the current batch extend the dated part of the traverse with five new ages from the west end and five from the east end. The five new dates from the west end of the traverse extends the trend of east to west progressive cooling that was established previously (Hunt and Roddick, 1993, p. 132-136), and adds about 12 Ma to the oldest previous date. From west to east the major units dated are shown in Table 1.

Previous radiogenic dates for the major plutons include 57.5 Ma and 53.0 Ma biotites from the Sheemahant Pluton (see GSC 80-45 in Stevens et al., 1982, and GSC 93-10 in Hunt and Roddick, 1993); a hornblende-biotite pair from the Doos Creek Pluton (82, 85 Ma, respectively; see GSC 89-15, 16 in Hunt and Roddick, 1990); and a 77-67 Ma pair from Kwatna Pluton (see GSC 89-13, 14 in Hunt and Roddick, 1990).

By projecting the locations of those dates to the *Owikeno Traverse*, and treating the hornblende and biotite dates as separate data sets, Figure 1. charts the west to east sequences. The distances were calculated as perpendicular offsets from a line that trends 340 (the regional trend in that part of the world) and passes through the westernmost date (120.4 Ma) on Calvert Island (Table 2). Note that four date locations are off the line of the Owikeno Traverse, but they fit well when projected perpendicular to the axial trend of the Coast Plutonic Complex.

The hornblende sequence shows consistent younging eastward as far as the east side of Owikeno Pluton (biotite 74 Ma, hornblende 81 Ma; see GSC 93-24, 23 in Hunt and Roddick, 1993). The granitoid gneiss which confines the pluton on the east yielded a hornblende age of 100 Ma (see GSC 93-26, Hunt and Roddick, 1993). To the east the four hornblende ages from this study, 78-70-75-61 Ma (GSC 95-10, 11, 12, and 13) show a less consistent trend. The biotite sequence, while less consistent than the hornblende, also reflects a general west to east younging. The sequences may be interpreted as a gradual unroofing of the plutonic terrane from west to east. From other dates in other map areas in the Coast Plutonic Complex, the unroofing spanned a longer period of time, extending from the Late Jurassic to Late Eocene. Some of it seems episodic and some continuous. More data will probably indicate many exceptions to the overall trend and provide focal points for more detailed geological examinations.

Table 1. Major rock units dated from west to east along the Owikeno Traverse.

^{40}Ar-^{39}Ar ages from the Owikeno Traverse			
	Rock Units	Hornblende (Ma)	Biotite (Ma)
	Calvert Island diorite	120.4	
	Pruth Bay Granite		110.5
	Calvert Island Pluton	110.3 (W side) 110.3 (E side)	
	Fish Egg Pluton	108.7 (W side) 106.5	103.7 (central) 96.6 (E side)
West	Dioritic complex		99.4
to	Granitoid gneiss	103.6 97.7 94.2	91.7 89.2 91.2
East	Amback Pluton	87.4	85.4
	Owikeno Pluton	80.5	73.9
	Granitoid gneiss	100.0	80.6
	Unnamed pluton	70.2	
	Machmell Pluton	74.6	
	Granitoid gneiss	61.0	
	Sheemahant Pluton		57.5
	Wilderness Mountain Pluton		77.0

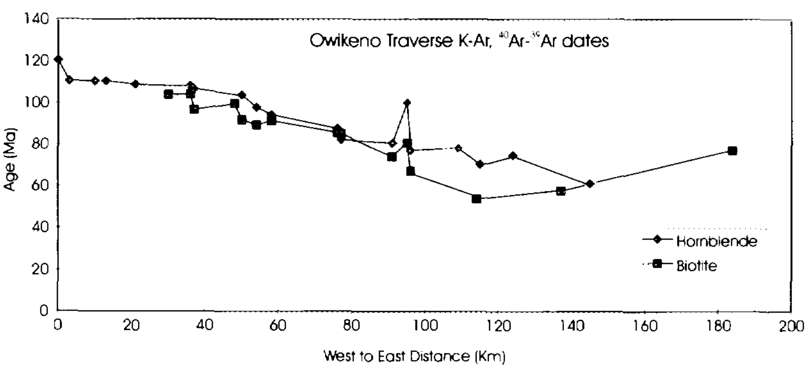

Figure 1.

Plot of age vs. west to east distance in km for hornblende and biotite ^{40}Ar-^{39}Ar and K-Ar ages for the Owikeno Traverse.

Table 2. Summary table of ^{40}Ar-^{39}Ar and K-Ar ages from rock units of the Coast Mt. Plutonic Complex.

Easting	Northing	Distance (km)	Hornblende (Ma)	Biotite (Ma)	Lab No.	Rock Unit	Distance from Traverse
559650	5715750	0.0002	120.4		GSC 95-5	Calvert Island diorite	
559470	5723920	2.70	110.5		GSC 95-6	Pruth Bay granite	
567290	5722475	9.52	110.3		GSC 95-7	Calvert Island Pluton	
571382	5722170	13.24	110.3		GSC 95-8	Calvert Island Pluton	
577414	5726821	20.52	108.7		GSC 95-9	Fish Egg Pluton	
586479	5730021	30.13		103.7	GSC 93-11	Fish Egg Pluton	
610680	5683022	36.29	108	104	GSC 76-17,18	Smith Inlet Pluton	45km S of OT
594563	5729358	37.47	106.5	96.6	GSC 93-12,13	Fish Egg Pluton	
605880	5728300	47.69		99.4	GSC 93-14	dioritic complex	
609171	5725375	49.75	103.6	91.7	GSC 93-16,15	granitoid gneiss	
612800	5726671	53.60	97.7	89.2	GSC 93-18,17	granitoid gneiss	
616972	5727588	57.83	94.2	91.2	GSC 93-20,19	granitoid gneiss	
636171	5728257	76.04	87.4	85.4	GSC 93-22,21	Amback Pluton	
643550	5712250	77.33	82	85	GSC 89-13,14	Doos Creek Pluton	13 km S of OT
652144	5727141	90.60	80.5	73.9	GSC 93-23,24	Owikeno Pluton	
656854	5726912	94.93	100	80.6	GSC 93-26,25	granitoid gneiss	
644600	5762250	95.87	77	67	GSC 89-15,16	Kwatna Pluton	35 km N of OT
672377	5724283	108.54	78		GSC 95-10	granitoid gneiss	
678243	5727732	115.25	70.2		GSC 95-11	unnamed Pluton	
667600	5753200	114.22		53.5	GSC 93-10	Sheemahant Pluton	30 km N of OT
687230	5728070	123.78	74.6		GSC 95-12	Machmell Pluton	
697010	5738540	136.61		57.5	GSC 80-45	Sheemahant Pluton	
706620	5735810	144.65	61		GSC 95-13	granitoid gneiss	
739000	5760800	183.74		77	GSC 95-14	Wilderness Mtn Pluton	

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QUEBEC
GSC 95-15 TO GSC 95-18

GSC 95-15 Biotite
1028 ± 0.7 Ma, integrated ^{40}Ar-^{39}Ar

Wt.% K= 8.10
K-Ar 4492 % Atmos. Ar=0.85

(AA446) Ages of two heating steps (% gas):
1023 ± 1 Ma (37%), 1032 ± 1 Ma (62%)
Preferred age: step 3 age of 1032 ± 8 Ma with 62% gas

(31J/3) From a migmatitic metapelite.
From 1 km east of Lac du Camso, Quebec; 46°02.5′N, 75°25.5′W; UTM zone 18, 467400E, 5097950N; sample CQA3832. Collected and interpreted by K.J.E. Boggs.

This sample is from the melanosome of a strongly foliated, fine- to medium-grained, migmatitic metapelite (Corriveau et al., 1994; Corriveau and Jourdain, 1992). Leucosomes from this sample also have given a U-Pb zircon age of 1188 ± 1.2 Ma. The two step heating ages of this sample do not agree within error and because of the known complex geological history the age of highest temperature gas fraction (step 3) is considered the best estimate of the age. This biotite age is also anomously old, nearly 50 Ma older than nearby biotite samples (see samples GSC 95-16 and GSC 95-17). This is most likely due to excess argon contained within the biotite of this sample. Extraneous argon is typical of Grenville biotite from Ontario (Cosca et al., 1991) to Labrador (Dallmeyer and Rivers, 1983).

See GSC 95-18 for references.

GSC 95-16 Biotite
932 ± 7 Ma, integrated ^{40}Ar-^{39}Ar

Wt% K = 7.36
K-Ar 4493 % Atmos. Ar = 1.2

(AA447) Ages of two heating steps (% gas):
963 ± 2 Ma (39%), 916 ± 1 Ma (60%)
Preferred age: step 3 age of 916 ± 1 Ma with 60% gas

(31 J/3) From migmatitic metapelite.
From 2 km east of Lac Fourchu, Quebec; 46°04.8'N, 75°18.1'W; UTM zone 18, 477200E, 5102800N, sample CQA3302. Collected and interpreted by K.J.E. Boggs.

This sample is from the melanosome of a strongly foliated, fine- to medium-grained, migmatitic metapelite (Corriveau et al., 1994; Corriveau and Jourdain, 1992). A U-Pb monazite from the melanosome of this sample has given a date of 1185 ± 3 Ma. This ^{40}Ar-^{39}Ar biotite age is interpreted as a cooling age through 300°C (Dodson and McClelland-Brown, 1985) following regional metamorphism. In this case where the step heating ages do not agree, the age of the highest temperature gas fraction (step 3) is considered the best estimate of the age.

Metamorphic cooling ages from this portion of the Central Metasedimentary Belt (CMB), Grenville Province, Quebec follow the same general pattern as those observed within the Central Metasedimentary Belt of Ontario (Cosca et al., 1992; Cosca et al., 1991). The belt yields a range of Precambrian cooling ages.

See GSC 95-18 for references.

GSC 95-17 Biotite
956 ± 8 Ma, integrated ^{40}Ar-^{39}Ar

Wt % K = 5.12
K-Ar 4494 % Atmos. Ar = 15.1

(AA448) Ages of two heating steps (% gas):
954 ± 1 Ma (64%), 967 ± 1 Ma (34%)
Preferred age: step 3 age of 967 ± 8 Ma with 34% gas

(31J/6) From a migmatitic metapelite.
From Highway 117, 1 km north of Lac Ganmon and Lacs Allard, Quebec; 46°26.7'N, 75°04.3'W; UTM zone 18, 494300E, 5148850N; sample CQA2039. Collected and interpreted by K.J.E. Boggs.

This sample is from the melanosome of a strongly foliated, fine- to medium-grained migmatitic metapelite (Corriveau et al., 1994; Corriveau and Jourdain, 1992). There are no U-Pb ages from nearby samples. In this case where the step heating ages do not agree, the age of the highest temperature gas fraction (step 3) is considered the best estimate of the age. This date possibly corresponds to cooling through 300°C (Dodson and McClelland-Brown, 1985) after extensive plutonism and shearing along the nearby Nominingue-Cheneville Shear Zone at c. 1165 Ma (Boggs et al., 1994). The Central Metasedimentary yields a range of Precambrian cooling ages.

See GSC 95-18 for references.

GSC 95-18 Biotite
1190 ± 9 Ma, integrated ^{40}Ar-^{39}Ar

Wt% K = 6.77
K-Ar 4495 % Atmos. Ar = 1.14

(AA449) Ages of two heating steps (% gas):
1199 ± 1 Ma (64%), 1191 ± 1 Ma (34%)
Preferred age: 98% gas plateau age of 1197 ± 9 Ma

(31J/6) From a migmatitic metapelite.
From east side of Lac Mountjoie, 1 km south of its northern end, Quebec; 46°18.5'N, 75°05.0'W; UTM zone 18, 491200E, 5128400N; sample CQA1280. Collected and interpreted by K.J.E. Boggs.

This sample is from the melanosome of a strongly foliated, fine- to medium-grained, migmatitic metapelite (Corriveau et al., 1994; Corriveau and Jourdain, 1992). A nearby U-Pb monazite has given an age of 1183 ± 3 Ma. This ^{40}Ar-^{39}Ar biotite age is anomously old, possibly due to extraneous argon incorporated into the biotite during peak metamorphism or shearing along the Nominingue-Cheneville Shear Zone at ca. 1165 Ma (Boggs et al., 1994). These abnormally old ^{40}Ar-^{39}Ar biotite ages are not uncommon throughout the Grenville from Ontario (Cosca et al., 1991) to Labrador (Dallmeyer and Rivers, 1983).

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NOVA SCOTIA
GSC 95-19

GSC 95-19 Biotite
367.7 ± 3.3 Ma, integrated ^{40}Ar-^{39}Ar

Wt % K = 6.16
K-Ar 4506 % Atmos. Ar = 3.72

(AA460) Ages of two heating steps (% gas):
372.5 ± 0.4 Ma (75%), 368.9 ± 0.5 Ma (21%)
Preferred age: step 3 age of 368.9 ± 3.4 Ma with 21% gas

(11K/10) From a pelitic schist.
On the Pembroke Lake road, 2.8 km northeast of Margaree River, Nova Scotia; 46°34′57″N, 60°52′12″W; UTM zone 20, 663497E, 5160448N; sample CP93194. Collected and interpreted by K.L. Currie.

The sample was collected from a pelitic schist, with the assemblage biotite-muscovite-garnet, which forms a screen 4 m wide between migmatitic granite bodies with many pegmatite layers up to several centimetres thick. These migmatitic granites form part of the Belle Cote Road gneiss, for which a Silurian U-Pb zircon emplacement age of 429 Ma was obtained near this locality (Jamieson et al., 1986). The Belle Cote Road gneiss, 500 m to the west (but probably <100 m vertically) is thrust west over the Latest Devonian or Early Carboniferous Fisset Brook Volcanics along the Margaree Shear Zone (Lynch and Tremblay, 1994). This resulted in the formation of new biotite and muscovite in the shear zone. The two heating step ages do not agree within error so therefore the highest temperature gas fraction may be the best estimate of the age. This Ar-Ar age therefore suggests that (i) any screens or enclaves in the Belle Cote Road gneiss were metamorphosed sufficiently at ~370 Ma that no trace of pre-Acadian metamorphism persists (if any existed), and (ii) that traces of post-Acadian (Late Devonian-Carboniferous) metamorphism, if any, cannot be found outside major shear zones. The coincidence of the Ar-Ar date with U-Pb zircon dates for granitic plutons in this region (compare Jamieson et al., 1986) confirms that Acadian granite emplacement was accompanied by rapid uplift and unroofing, a conclusion previously reached on stratigraphic grounds.

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NEWFOUNDLAND
GSC 95-20 to GSC 95-23

GSC 95-20 Muscovite
383 ± 5 Ma
Wt % K = 8.19
Rad. Ar = 1.356×10^{-4} cm^3/g
K-Ar 4387 % Atmos. Ar= 0.7

(11O/10) From a muscovite-rich schistose granite.
Derived from Windowglass Hill Granite, 18 km northeast off Port Aux Basques, Trench along H Brook of the Isle Aux Morts River, Newfoundland; 47°47′00″N, 58°55′00″; UTM zone 21, 356500E 5291500N; sample BD137-91. Collected by B. Dubé and interpreted by B. Dubé and K. Lauzière.

See GSC 95-23 for interpretation.

GSC 95-21 Muscovite
381 ± 6 Ma

Wt % K = 8.14
Rad. Ar = 1.343x10^{-4} cm^3/g
K-Ar 4386 % Atmos. Ar = 0.9

(11O/10) From a muscovite-rich schistose granite. From the Windowglass Hill Granite, 18 km northeast of Port Aux Basques, Trench along H Brook of the Isle Aux Morts River, Newfoundland; 47°47′00"N, 58°55′00"; UTM zone 21, 356500E, 5291500N; sample BD135-91. Collected by B. Dubé and interpreted by B. Dubé and K. Lauzière.

See GSC 95-23 for interpretation.

GSC 95-22 Sericite
383 ± 4 Ma integrated ^{40}Ar-^{39}Ar

Wt% K= 8.17
K-AR 4410 % Atmos. Ar = 2.5

(AA341) Ages of two heating steps + % gas:
383 ± 1 Ma (62%), 382 ± 1 Ma (33%)
Preferred age: 95% gas plateau age of 383 ± 4 Ma

(11O/10) From a sericite-rich schist. Derived from the Windowglass Hill Granite southwest coast of Newfoundland. Trench located on top of Windowglass Hill, on the west bank of the Isle Aux Morts River, Newfoundland; 47°44¢00"N, 58°52'00"W; UTM zone 21 352500E, 5288500N; sample BD115-91; Collected by B. Dubé and interpreted by B. Dubé and K. Lauzière.

See GSC 95-23 for interpretation.

GSC 95-23 Sericite
381 ± 3 Ma integrated ^{40}Ar-^{39}Ar

Wt % K = 7.74
K-AR 4409 % Atmos. Ar = 1.4

(AA340) Ages of two heating steps + % gas:
380 ± 1 Ma (53%), 381 ± 1 Ma (42%)
Preferred age: 95% gas plateau age of 381 ± 3 Ma

(11O/10) From a sericite-rich schist. Derived from the Windowglass Hill Granite, southwest coast of Newfoundland. Trench located on top of Windowglass Hill, on the west bank of the Isle Aux Morts River, Newfoundland; 47°44′00"N, 58°52′00"W; UTM zone 21 352500E, 5288500N; sample BD113-91. Collected by B. Dubé and interpreted by B. Dubé and K. Lauzière.

The K-Ar samples GSC 95-20 and GSC 95-21 are from a muscovite-rich schist located within a trench along the H Brook showing of the Isle aux Morts River. The ^{40}Ar-^{39}Ar samples GSC 95-22 and GSC 95-23 are from a sericite-rich schist located within a trench on top of the Windowglass Hill Granite. The schist is derived from a mylonitized Windowglass Hill Granite (zircon dated at 424 Ma by Dubé et al., in press). Mineralization occurs in stockworks of galena-rich quartz veinlets. Several veinlets are perpendicular to both the strong planar S3b fabric as well as to the down dip L3 stretching lineation suggesting emplacement as extension veinlets during the reverse movement along the Cape Ray Fault Zone (Dubé et al., in press). The integrated ^{40}Ar-^{39}Ar and K-Ar results suggest either that the mineralization is the same age and possibly related to the late tectonic Strawberry granite (zircon, 384 ± 2 Ma) (Dubé et al., in press) or that the age of the sericite and muscovite was reset by this younger intrusion located near the dated samples. Results for the integrated ^{40}Ar-^{39}Ar indicate that the initial step of several per cent gas gave the same age as the next two heating steps suggesting no excess argon present. As the integrated age is the same for the two heating steps, this strongly suggest that these ages have not been reset (J.C. Roddick, pers. comm., 1994). However, structural field relationships indicate that the ductile structures host of the mineralization, are crosscut by the Isle aux Morts granite dated zircons at 386 Ma (Dubé et al., in press). Thus, the gold-bearing hosting structures are pre-emplacement of the Strawberry and/or Isle aux Morts intrusions. However, the mineralization could still have been emplaced in already developed older structures. Because of these conflicting relationships there is no unique interpretation of the age of the mineralizing event but to say that the mineralization is post-424 Ma and pre- to syn-384 Ma (Dubé and Lauzière, unpub. data).

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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 67A, Report 8	66-1 to 66-176
GSC Paper 69a, Report 9	67-1 to 67-146
GSC Paper 71-2, Report 10	70-1 to 70-156
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GSC Paper 74-2, Report 12	73-1 to 73-198
GSC Paper 77-2, Report 13	76-1 to 76-248
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GSC Paper 81-2, Report 15	80-1 to 80-208
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GSC Paper 88-2, Report 18	88-1 to 88-105
GSC Paper 89-2, Report 19	89-1 to 89-135
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GSC Paper 91-2, Report 21	91-1 to 91-187
GSC Paper 92-2, Report 22	92-1 to 92-100
GSC Paper 93-2, Report 23	93-1 to 93-73
GSC Current Research 1994-F, Report 24	94-1 to 94-62
GSC Current Research 1995-F, Report 25	95-1 to 95-23

GSC Age Determinations Listed by N.T.S. Co-ordinates

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