UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Potassium-argon determinations in the Ketchikan and Prince Rupert quadrangles, southeastern Alaska

By

James G. Smith and Michael F. Diggles

U. S. Geological Survey
Open-File Report 78-73N
1981

This report is preliminary and has
not been edited or reviewed for conformity
with U.S. Geological Survey editorial
standards and stratigraphic nomenclature.

POTASSIUM-ARGON DETERMINATIONS IN THE KETCHIKAN AND PRINCE RUPERT QUADRANGLES, SOUTHEASTERN ALASKA

By

James G. Smith and Michael F. Diggles

INTRODUCTION

This map and its accompanying table list the known potassium-argon (K-Ar) age determinations on rocks and minerals from the Ketchikan and Prince Rupert 1:250,000 quadrangles, Alaska, as of mid-1980. We have not included data from Canadian references. All together, there are more than 130 determinations; this report contains some 50 previously unpublished determinations. The remaining determinations were published previously, but many lacked complete analytical data. For previously published and incomplete determinations we made every effort to obtain all analytical data, to list accurate sample coordinates, and to recalculate the ages using currently accepted abundance and decay constants. Where different authors referred to the same sample with different numbers, we listed all sample numbers. We especially thank M. A. Lanphere of the U. S. Geological Survey for furnishing previously unpublished analytical data for samples from the vicinity of Annette and Duke Islands.

In 1976, a subcomission of the International Union of Geological Sciences recommended adopting a new set of abundance and decay constants (Steiger and Jager, 1977). Since then, most laboratories have adopted the new constants. For our report, we recalculated all ages using the new constants; therefore, age values published more than a few years ago will differ by a few percent from those listed in the table that accompanies this report.

TIMING OF IGNEOUS AND METAMORPHIC EVENTS IN THE KETCHIKAN AND PRINCE RUPERT QUADRANGLES

The K-Ar determinations in this report, when considered with uranium-lead determinations on zircons by T. W. Stern (Smith and others, 1979) show a long history of metamorphism and igneous activity which extends in time from the Devonian or Silurian nearly to the present day. At least three episodes of metamorphism, seven episodes of significant plutonic emplacement, and a Miocene(?) to Holocene extrusive event took place within the two quadrangles. As a result of repeated metamorphism and igneous intrusion, most K-Ar determinations on mineral pairs are discordant. Apparent ages must be interpreted with caution, because they may not accurately measure the time of metamorphism or igneous emplacement of a particular unit.

The oldest radiometrically dated rocks in the Ketchikan and Prince Rupert quadrangles are from the Annette pluton (Berg, 1972). A hornblende from the quartz diorite phase of this pluton on the north shore of Sylburn Harbor gave a K-Ar age of 424 m.y. (million years). Zircons collected from the trondhjemite phase (map unit Sat of Berg, 1972) about 1 km north of the hornblende sample gave a uranium-lead age of 375 m.y. (J. G. Arth, written commun., 1978). The difference in apparent radiometric ages is near the limit of analytical precision for the two methods, although since two different map units were dated it is also possible that the Annette pluton is composed of intrusions of more than one age.

Ultramafic complexes crop out at Alava Bay and on Duke Island and the islands surrounding it. K-Ar ages of rocks at Alava Bay are discordant and do not reflect the age of intrusion. However, they fit exactly into the pattern of widespread resetting of K-Ar ages throughout Portland Penninsula and eastern Revillagigedo Island discussed further on in this report.

The largest area of ultramafic and mafic rocks in the Ketchikan and Prince Rupert quadrangles occurs on and near Duke Island. This ultramafic complex is the southernmost in a chain of ultramafic complexes that extends north some 500 km through southeastern Alaska. Irvine (1967, 1974) divided all the intrusive rocks of Duke Island into three groups: older gabbroic rocks, ultramafic and related rocks of the Duke Island ultramafic complex and postultramafic granitic rocks. K-Ar ages were determined by M. A. Lanphere on gabbroic and ultramafic rocks (Lanphere and Eberlein, 1966). K-Ar ages on hornblende-rich rocks of the ultramafic complex range from 106 to 134 m.y. The most reliable ages range from 106 to 112 m.y. (M. L. Lanphere, oral commun., 1980). These ages indicate that the ultramafic rocks were intruded in mid-Cretaceous time, which is in agreement with intrusion ages for the other ultramafic complexes in this chain. Wherever Irvine was able to deduce relative age relations, the gabbro was older than the ultramafic rocks. He also stated that the two rock types were not genetically related. The single K-Ar age on a gabbroic rock supports this argument but more determinations would be necessary to find out if all the gabbroic rocks on Duke Island are the same age.

Before our radiometric dating studies, all of the plutonic rocks on Revillagigedo Island and Portland Peninsula, and in adjacent areas to the south in Canada were considered to be part of a single, poorly documented, Late Triassic to Late Cretaceous orogeny (Buddington and Chapin, 1929). Our studies show instead that plutonism occurred in several episodes, some more widespread and important than others.

The oldest dated pluton east of Revillagigedo Channel and Tongass Narrows is the Texas Creek Granodiorite. No other plutons as old as the Texas Creek Granodiorite are known on Revillagigedo Island or Portland Peninsula, but subsequent intense metamorphic and plutonic events could have completely reset the radiometric clocks of older plutons to make them radiometrically indistinguishable from younger intrusions. The Texas Creek Granodiorite intruded volcanic rocks that are most likely Late Triassic or Early Jurassic in age. Both the volcanic rocks and the Texas Creek Granodiorite were later subjected to a pervasive low-grade regional metamorphism and a still younger contact metamorphism caused by the intrusion of Eocene plutons. Two samples from just north of the Ketchikan quadrangle in the Bradfield Canal A-1 quadrangle gave strongly discordant apparent ages on biotite and hornblende mineral pairs (Smith, 1977, p.23) indicating that their argon clocks were affected by postintrusion events. Because hornblende retains argon better than biotite when heated during metamorphism, the apparent K-Ar hornblende ages of 203 and 211 m. y. (ages recalculated using new abundance and decay constants) are probably closer to the emplacement age than the apparent biotite ages. Even so, metamorphic events may have driven an unknown amount of argon from the hornblendes, and their apparent ages should be considered minimum ages for intrusion. The Texas Creek Granodiorite could well be older than 211 m. y.

Jurassic (ca. 140 m.y. old) quartz diorite and granodiorite intrude migmatite and gneiss on Portland Peninsula (near the head of Boca de Quadra), and lower grade metasedimentary and metavolcanic rocks on southern Revillagigedo Island (at Moth Point, sample 76SJ632). Heating by subsequent metamorphic-plutonic events was great enough to completely reset the argon clocks in rocks on the Portland Peninsula and partly reset them west of East Behm Canal. Only the uranium-lead radiometric clocks in zircons still record this 140 m.y. intrusive event, and its complete extent is unknown (Smith and others, 1979).

During Cretaceous time (ca. 90 m.y. ago, based on uranium-lead ages) two different types of plutons intruded northern Revillagigedo Island and neighboring Cleveland Penisnula. A large, foliated and gneissic, coarse-grained, hornblende-biotite granodiorite batholith crops out on extreme northern Revillagigedo Island and adjacent Cleveland Peninsula. Stocks of garnet- and plagioclase-bearing porphyritic biotite granodiorite are scattered throughout Revillagigedo Island and Cleveland Peninsula. Intrusive rocks of this age correlative with either of these two types of plutons have not yet been identified east of East Behm Canal and its topographic continuation through Vixen Bay and Nakat Inlet. Field evidence suggests that the original sedimentrary rocks around both types of plutons were regionally metamorphosed largely before intrusion. However, the relative timing of intrusion and metamorphism is not yet well understood. Many plutons have contact metamorphic aureoles around them but other plutons are locally deformed. Intrusion most likely took place during the waning phases of metamorphism.

The most intense plutonic-metamorphic event in the study area took place in the mid-Eocene, 52 to 42 m.y. ago. Most of the plutons intruded during this 10-m. y. interval form a suite of coalescing quartz monzonite to granodiorite batholiths in the northeastern part of the Ketchikan quadrangle. Other plutons of this age were recognized elsewhere on Portland Peninsula, but radiometric determinations so far have not revealed any on Revillagigedo Island, Cleveland Peninsula, or Portland Peninsula west of Vixen Bay and Nakat Inlet (T. W. Stern, oral commun., 1980). The coalescing batholiths are part of a belt of batholiths which extends along the eastern edge of the Coast Plutonic Complex in southeastern Alaska and adjoining British Columbia. The batholiths share similar petrography, field characteristics, position within the Coast Plutonic Complex, and presumably origin. The coalescing batholiths on eastern Portland Peninsula generally have only narrow contact metamorphic auroles along their eastern borders with the bedded rocks they intrude. K-Ar determinations on biotite and hornblende mineral pairs generally give concordant ages. These facts indicate that the K-Ar ages closely date intrusion of individual batholiths.

K-Ar systems in rocks older than 40 m.y. are strongly disturbed over much of the Ketchikan and Prince Rupert quadrangles. The area of maximum disturbance is centered over Portland Peninsula, covers an area greater than 7,000 km^2, and extends an unknown distance northwest and southeast in the Coast Plutonic Complex. The apparent K-Ar ages are not random; instead a regular pattern of apparent ages was superimposed on top of older plutonic and metamorphic rocks. This pattern consists of 3 parts.

The easternmost part is a 30- to 40-km-wide north-northwest-trending band throughout which apparent K-Ar ages for any particular mineral are nearly all the same. This band is bounded on the northeast by the coalescing Eocene plutons and on the southwest by East Behm Canal and its topographic extensions on land. Within this band on eastern Portland Peninsula nearly all hornblende K-Ar apparent ages are between 55 and 50 m.y.; all biotite apparent ages are between 48 and 43 m.y. In any single mineral pair the differences in apparent ages is close to 7 m.y. When ^{40}K is plotted against ^{40}Ar for hornblende, all samples fall close to a straight line which indicates that throughout the central part of Portland Peninsula, hornblende either formed or was completely reset about 52 m.y.

The second part of the pattern is a narrower parallel belt, about 25 km wide, which extends through eastern Revillagigedo Island and Portland Peninsula west of Vixen Bay and Nakat Inlet. This band is marked by a rapid smooth increase in both hornblende and biotite apparent ages. Hornblende apparent ages increase from 55 to 85 m.y. and biotite from 50 to 75 m.y. over a distance of 15 km. However, the zone of most rapid increase in biotite ages is displaced westward from that of hornblende by approximately 10 km.

The third part of the pattern is on western Revillagigedo Island and Cleveland Peninsula where older ages are only partly reset. K-Ar ages approach uranium-lead ages although complete agreement is not reached even at distances of 40 km from central Portland Peninsula. The apparent K-Ar ages scatter somewhat because the rocks originally formed at different times and because the original ages are only partly reset.

The cause of the widespread disturbance to K-Ar systems is unknown. It has been attributed to widespread heating of enigmatic origin (Smith and others, 1979) or to regional uplift and cooling (Hutchison, 1970; Crawford, and others, 1979).

During Oligocene and Miocene time, 31 to 19 m.y. ago, a volumetrically small suite of postorogenic, economically important, epizonal plutons were emplaced. Plutons range in size from a few hundred meters to 10 km across, and are scattered throughout the study area and beyond. This suite of plutons includes gabbro, syenodiorite, and granite and granite porphyry. The plutons are accompanied by dike swarms of felsic porphyry and lamprophyre. Compositions of known plutons suggests the suite may be bimodal. Molybdenum deposits at Quartz Hill (76SJ563 and 76SJ565A) and Burroughs Bay are genetically associated with granitic plutons belonging to this suite (Hudson and others, 1979).

The youngest igneous activity in the study area was the extrusion of a suite of Late Miocene(?) to Holocene alkali basalts. The basalts all crop out in a northeast-trending zone between Carrol Inlet and western Portland Peninsula. Volcanic products include flows, flow breccias, cinder cones, and minor tephra deposits. Although never voluminous, volcanic activity took place over a fairly long period of time. The Holocene cinder cones and the flows which issued from their bases are nearly unmodified by erosion and locally rest on young glacial deposits or glaciated bedrock. Older flows have glacial grooves carved into their flow-top surfaces, and parts of flows are carved away. The oldest K-Ar age is 6.1 m.y. from New Eddystone Rock, a prominent eroded volcanic neck in Behm Canal. This age may be too old, because it seems unlikely that New Eddystone Rock would have survived the Pleistocene glaciers which came down Behm Canal. Other K-Ar determinations indicate volcanic activity at 5.0 m.y. and between 500,000 years ago and approximately 1 m.y. ago.

REFERENCES

Berg, H. C., 1970, Paleozoic plutonism and contrasting metamorphic terranes, Annette Island, Alaska [abs.]: Geological Society of America Abstracts with Programs, v. 2, no. 2, p. 70.

_____1972, Geologic map of Annette Island, Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-684, scale 1:63,360, 8 p.

Berg, H. C., Elliott, R. L., Smith, J. G., and Koch, R. D., 1978, Geologic map of the Ketchikan and Prince Rupert quadrangles, Alaska: U.S. Geological Survey Open-File Report 78-73A, scale 1:250,000.

Berry, A. L., and others, 1976, Summary of miscellaneous potassium-argon age measurements, U.S. Geological Survey, Menlo Park, California, for the years 1972-74: U.S. Geological Survey Circular 727, 13 p.

Buddington, A. F., and Chapin, T. 1929, Geology and mineral deposits of southeastern Alaska: U.S. Geological Survey Bulletin 800, 398 p.

Crawford, M. L., Kraus, D. K., and Hollister, L. S., 1979, Petrologic and fluid inclusion study of calc-silicate rocks, Prince Rupert, B. C.: American Journal of Science, v. 279, p. 1135-1159.

Hudson, Travis, Smith, J. G., and Elliott, R. L., 1979, Petrology, composition, and age of intrusive rocks associated with the Quartz Hill molybdenite deposit, southeastern Alaska: Canadian Journal of Earth Science, v. 16, p. 1805-1822.

Hutchison, W. W., 1970, Metamorphic framework and plutonic styles in the Prince Rupert region of the central Coast Mountains, British Columbia: Canadian Journal of Earth Sciences, v. 7, no. 2, p. 376-405.

Irvine, T. N., 1967, The Duke Island ultramafic complex, southeastern Alaska, in Wyllie, P. J., ed., Ultramafic and related rocks: New York, John Wiley and Sons, p. 84-97.

_____1974, Petrology of the Duke Island ultramafic complex, southeastern Alaska: Geological Society of America Memoir 138, 240 p.

Lanphere, M. A., and Eberlein, G. D., 1966, Potassaium-argon ages of magnetite-bearing ultramafic complexes in southeastern Alaska [abs.]: Geological Society of America Special Paper 87, p. 94.

Smith, J. G., 1977, Geology of the Ketchikan D-1 and Brodfield Canal A-1 quadrangles, southeastern Alaska: U.S. Geological Survey Bulletin 1425, 49 p.

Smith, J. G., Stern, T. W., and Arth, J. G., 1979, Isotopic ages indicate multiple episodes of plutonism and metamorphism in the Coast Mountains near Ketchikan, Alaska [abs.]: Geological Society of America Abstracts with Programs, v. 11, no. 7, p. 519.

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.

Taylor, H. P., Jr., 1967, The zoned ultramafic complexes of southeastern Alaska, in Wyllie, P. J., ed., Ultramafic and related rocks: New York, John Wiley and Sons, p. 97-121.

Turner, D. L., Grybeck, Donald, and Wilson, F. H., 1975, Radiometric dates from Alaska--a 1975 compilation: Alaska Division of Geological and Geophysical Surveys Special Report 10, 64 p.

Wilson, F. H., Dadisman, S. V., and Herzon, P. L., 1979, Map showing radiometric ages of rocks in southeastern Alaska: U.S. Geological Survey Open-File Report 79-594, scales 1:1,000,000 and 1:250,000, 33 p.

Wilson, F. H., and Turner, D. L., Radiometric age map of Alaska, southeastern Alaska: Alaska Department of Geological and Geophysical Surveys, Alaska Open-File Report 82, scale 1:1,000,000, 11 p.

 (Page 6 follows page 4, no page 5)

Table 1

Sample	Quadrangle	UTM Easting (m)	UTM Northing (m)	Rock type	Mineral	K_2O*	$^{40}Ar_{rad}$ Moles/gm x10^{-10}	Percent $^{40}Ar_{rad}$	Age (m.y.)	References[d]
64ALE49B	Ketchikan A-4	363550E.[a]	6121050N.	Hornblendite	Biotite	7.78 7.83 (7.80)	8.720	75	76.1±2.3	Lanphere and Eberlein, 1966; Taylor, 1967; Taylor, 1974; Berg and others, 1978; Wilson and others, 1979; M. A. Lanphere, written commun., 1980
					Hornblende	0.813 0.817 (0.815)	1.194	66	99.0±3.0	Do.
64ALE59	Prince Rupert D-4	352900E.[a]	6083300N.	Pegmatite	Hornblende	0.650 0.654 (0.652)	1.022	79	106±3.2	Do.
64ALE65	Prince Rupert D-4	354900E.[a]	6083700N.	Pegmatite	Hornblende	0.669 0.681 (0.675)	1.298 1.355	74 68	129±3.9 134±4.0	Do. Do.
64ALE66B	Prince Rupert D-4	345200E.	6082700N.	Hornblendite	Hornblende	0.685 0.686 (0.686)	1.139	84	112±3.4	Do.
64ALE79 AA147 Ketch 1	Prince Rupert D-4	352600E.[a]	6904200N.	Gabbro	Biotite	8.20 8.21 (8.20)	21.94	95	177±5.3	Irvine, 1967; Taylor, 1967; Irvine, 1974; Turner and others, 1975; Wilson and Turner, 1975; Berg and others, 1978; Wilson and others, 1979; M. A. Lanphere, written commun., 1980
64ALE81	Prince Rupert D-4	346200E.[a]	6093500N.	Granodiorite	Biotite	8.68 8.87 (8.78)	43.48	95	315±9.4	Berg and others, 1978; M. A. Lanphere, written commun., 1980
					Muscovite	9.46 9.55 (9.50)	16.57	83	117±3.5	Do.
64ALE82	Prince Rupert D-4	346200E.[a]	6093500N.	Diorite	Hornblende	0.386 0.381 (0.384)	1.536	82	259±7.8	Do.
68BG247	Ketchikan A-4	336300E.	6105300N.	Quartz diorite	Biotite	8.81 8.83 (8.82)	42.28	94	306±9.2	Berry and others, 1976; Berg and others, 1978; Wilson and others, 1979

68BG553 Ketch 3	Ketchikan A-5	335800E.	6118100N.	Trondhjemite	Hornblende	0.787	5.416	86	424±12[b]	Berg, 1970; Berg, 1972; Irvine, 1974; Wilson and Turner, 1975; Berg and others, 1978; Wilson and others, 1979
68BG608	Ketchikan A-5	335800E.	6118100N.	Quartz-biotite schist	Hornblende	9.27 9.28 (9.28)	10.82	40	79.3±1.6	Berg and others, 1978; Wilson and others, 1979; M. A. Lanphere, written commun., 1980
68BG679	Ketchikan B-5	340900E.	6127100N.	Quartz diorite	Muscovite	10.34 10.37 (10.36)	13.62	45	89.1±2.7	Berg, 1972; Berg and others, 1978; Wilson and others, 1979; M. A. Lanphere, written commun., 1980
68BG724	Ketchikan A-5	336600E.	6100150N.	Quartz diorite	Hornblende	0.547 0.613 (0.580)	1.810	82	205±16	Berg and others, 1978; Wilson and others, 1979; M. A. Lanphere, written commun., 1980
68BG727	Ketchikan A-5	335850E.	6100150N.	Quartz diorite	Biotite	8.83 8.80 (8.82)	24.28	94	182±5.5	Berry and others, 1976; Berg and others, 1978; Wilson and others, 1979
68DN047	Ketchikan D-1	422475E.	6191100N.	Medium-grained weakly foliated hornblende-biotite granodiorite	Biotite	8.80 8.82 (8.81)	6.073	68	47.3±1.4	This report
68SA026	Prince Rupert D-1	415550E.	6089650N.		Hornblende	1.255 1.263 (1.259)	.9072	83	49.4±1.5	Do.
68SC022	Ketchikan D-5	342950E.	6199650N.	Medium-grained foliated biotite-hornblende quartz diorite	Biotite	8.87 8.87 (8.87)	9.678	91	74.2±2.2	Berg and others, 1978; Wilson and others, 1979
					Hornblende	1.157 1.160 (1.158)	1.367	84	80.2±2.4	This report
68SJ052	Ketchikan D-1	436580E.	6196625N.	Massive sphene-bearing biotite granodiorite	Biotite	8.79 8.80 (8.80)	6.477	74	50.5±1.5	Do.
68SJ196A	Ketchikan D-1	426190E.	6179700N.	Coarse-grained porphyritic hornblende-biotite granodiorite	Biotite	9.19 9.21 (9.20)	6.003	66	44.8±1.3	Do.
					Hornblende	1.022 1.035 (1.028)	.8082	71	53.9±1.6	Do.
69SJ300A	Ketchikan A-3	375670E.	6106520N.	Medium-grained quartz-albite-biotite-zoisite schist	Biotite	9.28 9.38 (9.33)	7.367	73	54.1±2	Berg and others, 1978; Wilson and others, 1979
					Hornblende	.693 .690 (.692)	.7813	56	76.9±3	Do.

70SJ259	Ketchikan B-4	371800E.	6135680N.	Porphyroblastic muscovite-quartz-actinolite-garnet schist	Muscovite	9.07 9.09 (9.08)	7.816	77	58.9±1.8	Do.
					Hornblende	.391 .401 (.396)	.4315	45	74.1±2.2	Do.
70SJ341A	Ketchikan D-5	341490E.	6186750N.	Fine-grained pyritiferous garnet-muscovite-biotite-quartz-plagioclase schist	Biotite	10.24 10.24 10.36 10.36 10.37 10.48 (10.34)	12.20 12.33	90 88	80.2±4.0 81.1±4.0	Do. Do.
70SJ341B	Ketchikan D-5	341490E.	6186750N.	Medium-grained amphibolite	Hornblende	.540 .541 (.540)	.6606	70	83.0±2.5	Do.
70SJ366A	Ketchikan B-5	337380E.	6190790N.	Fine-grained kyanite-biotite-muscovite-quartz-plagioclase schist	Biotite	9.08 9.16 (9.12)	12.91	88	95.7±2.9	Do.
					Muscovite	9.64 9.72 (9.68)	10.93	92	76.8±2.3	Do.
70SJ366C	Ketchikan B-5	337380E.	6190790N.	Massive medium-grained garnet amphibolite	Hornblende	.317 .300 (.308)	.3809 .3827	48 46	83.8±2.5 84.3±2.5	Do. Do.
70SJ379	Ketchikan C-6	329600E.	6181360N.	Porphyritic homogeneous garnet-bearing granodiorite	Biotite	9.19 9.38 9.26 8.94 9.37 (9.23)	11.17	86	82.3±2.5	Do.
					Hornblende	1.673 1.703 (1.688)	2.230	76	89.6±2.7	Do.
70SJ431	Ketchikan D-5	340010E.	6195700N.	Foliated heterogeneous coarse-grained hornblende-biotite quartz diorite	Biotite	9.52 9.67 (9.60)	9.987	67	70.9±2.1	Do.
					Hornblende	1.374 1.398 (1.386)	1.745	76	85.4±2.6	Do.
72BG008	Ketchikan C-3	386575E.	6176200N.	Coarse-grained leucocratic biotite-hornblende granodiorite	Biotite	9.44 9.43 (9.44)	6.175	84	44.9±1.3	Do.
					Hornblende	1.495 1.497 (1.496)	1.169	76	53.5±1.6	Do.

72BG109	Ketchikan D-3	383600E.	6184350N.	Fine-grained quartz-bearing hornblende schist	Hornblende	.203 .207 (.205)	.1645	37	55.0±1.6	This report
72BG113A	Ketchikan D-3	384250E.	6184675N.	Porphyroblastic garnet-sillimanite-muscovite-biotite-potassium feldspar-quartz-plagioclase schist	Biotite	9.14 9.17 (9.16)	5.835	68	43.8±1.3	Do.
72BG335	Ketchikan C-3	377650E.	6152350N.	Fine-grained alkali basalt	Whole rock basalt	4.32 4.36 (4.34)	.3781	70	6.1±0.18[c]	Berg and others, 1978; Wilson and others, 1979
72ER020A	Ketchikan C-3	380450E.	6175900N.	Biotite-hornblende amphibolite	Biotite	9.18 9.20 (9.19)	5.734	85	42.9±1.3	Do.
					Hornblende	.983 .969 (.976)	.8135	72	57.0±1.7	Do.
72ER103	Ketchikan D-2	404475E.	6197300N.	Medium-grained homogeneous folieted hornblende-biotite quartz diorite	Biotite	8.77 8.82 (8.80)	5.804	82	45.3±1.4	Do.
					Hornblende	1.249 1.255 (1.252)	0.8741	66	47.9±1.4	Do.
72ER199A	Ketchikan C-3	382200E.	6167400N.	Coarse-grained weekly foliated homogeneous biotite-hornblende quartz diorite	Biotite	9.15 9.10 (9.12)	6.050	78	45.6±1.4	This report
					Hornblende	1.182 1.186 (1.184)	.9268	47	53.6±1.6	Do.
72ER324A	Ketchikan D-4	372800E.	6192850N.	Medium-grained foliated hornblende-biotite quartz diorite	Biotite	8.96 9.00 (8.98)	6.212	85	47.5±1.4	Berg and others, 1978; Wilson and others, 1979
					Hornblende	1.210 1.213 1.215 (1.213)	.8805	74	49.8±1.5	Do.
72SJ129	Ketchikan D-1	425850E.	6188000N.	Massive coarse-grained very weakly foliated hypidiomorphic sphene-bearing biotite-hornblende granodiorite	Biotite	8.27 8.15 (8.21)	5.850	81	48.8±1.5	Do.
					Hornblende	.750 .755 (.752)	.5951	65	54.2±1.6	Do.

73ER001A	Ketchikan B-3	380400E.	6129400N.	Fine-grained biotite amphibolite	Biotite	9.34 9.05 9.18 9.22 9.02 9.18 9.30 9.34 9.35 (9.22)	6.327	90	47.1±1.4	Do.
					Hornblende	1.071 1.051 (1.061)	.7711	69	49.9±1.5	Do.
73SJ004	Ketchikan B-3	376550E.	6129025N.	Porphyroblastic epidote-biotite-quartz-plagioclase-hornblende schist	Biotite	9.27 9.37 (9.32)	6.407	83	47.2±1.4	Do.
					Hornblende	.539 .544 (.542)	.4830	48	60.9±1.8	Do.
73SJ005	Ketchikan B-3	384500E.	6128475N.	Medium-grained biotite amphibolite	Hornblende	.371 .389 .389 (.383)	.2947	42	52.7±1.5	Do.
73SJ007	Ketchikan B-3	381075E.	6135900N.	Medium-grained weakly foliated hornblende-biotite granodiorite in coarse-grained leucocratic trondhjemite	Biotite	9.08 9.19 (9.14)	6.080	86	45.7±1.4	This report
73SJ014	Ketchikan D-3	382175E.	6195000N.	Medium-grained weakly foliated biotite-hornblende granodiorite	Biotite	9.27 9.14 9.32 (9.24)	6.018	84	44.7±1.3	Berg and others, 1978; Wilson and others, 1979
					Hornblende	1.488 1.475 (1.482)	1.089	79	50.4±1.5	Do.
73SJ015	Ketchikan D-3	387400E.	6202000N.	Hornblende amphibolite	Biotite	8.33 8.37 (8.35)	5.609	86	46.2±1.4	Do.
					Hornblende	1.120 1.110 (1.115)	.8737	66	53.6±1.6	Do.
73SJ022	Ketchikan D-3	388625E.	6184975N.	Coarse-grained massive hornblende-biotite granodiorite	Biotite	7.63 7.49 (7.56)	4.720	66	42.9±1.3	Do.
					Hornblende	1.442 1.408 1.449 (1.433)	1.028 1.035	74 77	49.2±1.5 49.5±1.5	This report

73SJ023	Ketchikan D-4	372500E.	6202150N.	Leucocratic weakly foliated hornblende-biotite granodiorite	Biotite	9.07 8.85 (8.96)	5.938	81	45.5±1.4	Berg and others, 1978; Wilson and others, 1979
					Hornblende	1.264 1.265 (1.264)	.9678	69	52.4±1.6	Do.
73SJ025	Ketchikan D-3	387150E.	6196750N.	Coarse-grained protoclastic biotite-hornblende quartz diorite	Biotite	8.76 8.81 (8.78)	5.786	76	45.1±1.4	Do.
					Hornblende	.887 .884 (.886)	.6914	58	53.4±1.6	Do.
73SJ026	Ketchikan D-3	395450E.	6203025N.	Heterogeneous, coarse-grained schlieric to irregularly banded sphene-bearing hornblende-biotite leuco-quartz diorite	Biotite	8.35 8.20 (8.28)	6.030	75	50.0±1.5	Do.
					Hornblende	1.343 1.333 (1.338)	.9875	60	50.6±1.5	Do.
73SJ029	Ketchikan D-2	404050E.	6189925N.	Compositionally banded hornblende-biotite granodiorite	Biotite	8.69 8.80 (8.74)	5.793	83	45.5±1.4	Do.
73SJ030	Ketchikan D-5	348000E.	6201275N.	Coarse-grained biotite-hornblende quartz diorite	Biotite	9.54 9.34 (9.44)	7.417	85	53.9±1.6	Do.
					Hornblende	1.356 1.335 (1.346)	1.563	80	79.0±2.4	Do.
73SJ031	Ketchikan D-5	353025E.	6203500N.	Coarse-grained weakly foliated leucocratic biotite-hornblende quartz diorite	Biotite	9.04 9.06 (9.05)	6.778	61	51.3±1.5	Do.
					Hornblende	1.709 1.669 (1.689)	1.810	76	73.0±2.2	Do.
73SJ032	Ketchikan D-4	357075E.	6204750N.	Coarse-grained weakly foliated leucocratic biotite-hornblende-quartz diorite	Biotite	8.86 8.88 (8.87)	3.901 3.876	68 77	30.3±0.9[e] 30.1±0.9[e]	Do. Do.
					Hornblende	1.414 1.401 (1.408)	1.218	71	59.2±1.8	Do.
72SJ033	Ketchikan D-4	361850E.	6200725N.	Coarse-grained very weakly foliated hornblende-biotite quartz diorite	Biotite	8.91 8.85 9.30 9.27 (9.08)	6.458	85	48.7±1.5	Do.
					Hornblende	1.201 1.190 (1.196)	.9696	71	55.5±1.7	Do.

73SJ035	Ketchikan D-3	376725E.	6183700N.	Medium-grained weakly foliated biotite-hornblende quartz diorite	Biotite	9.05 9.00 8.95 8.91 (8.98)	5.958	78	45.6±1.4	Do.
					Hornblende	.891 .878 (.884)	.6827	63	50.4±1.6	Do.
73SJ036	Ketchikan D-2	409075E.	6185750N.	Coarse-grained weakly foliated hornblende-biotite granodiorite	Biotite	9.21 9.33 (9.27)	6.234	91	46.8±2.8	Do.
					Hornblende	1.169 1.152 (1.160)	.8539	63	50.4±1.6	Do.
73SJ037	Ketchikan C-2	398050E.	6172025N.	Medium-grained hornblende-biotite-quartz plagioclase gneiss	Biotite	8.57 8.54 (8.56)	5.844	91	46.8±1.4	Do.
					Hornblende	.527 .530 (.528)	.3621	47	47.0±1.4	Do.
73SJ038	Ketchikan C-1	419300E.	6173125N.	Medium-grained slightly porphyritic biotite-hornblende quartz diorite	Biotite	8.79 8.78 (8.78)	5.563	75	43.5±1.3	Do.
					Hornblende	1.204 1.212 (1.208)	.8628	60	48.9±1.5	Do.
73SJ042	Ketchikan C-3	390825E.	6154675N.	Porphyritic alkali basalt	Whole rock basalt	1.647 1.639 1.631 (1.639)	9.509 $\times 10^{-13}$	11	.402±0.06	Do.
					Plagioclase	.553 .560 (.556)	7.817 $\times 10^{-13}$	26	.976±0.4	Do.
73SJ043	Ketchikan B-3	390800E.	6145425N.	Massive medium-grained hypidiomorphic-granular biotite-bearing olivine gabbro	Biotite	8.56 8.67 (8.62)	2.965	69	23.8±2.0	Hudson and others, 1979
75SJ412	Ketchikan D-6	325675E.	6207075N.	Coarse-grained foliated homogeneous biotite quartz diorite	Biotite	9.39 9.50 (9.44)	10.26	85	74.0±2.2	Berg and others, 1978; Wilson and others, 1979
					Hornblende	1.482 1.481 (1.482)	1.732	86	79.5±2.4	Do.

75SJ413	Ketchikan D-6	329190E.	6202275N.	Coarse-grained foliated homogeneoue biotite-hornblende quartz diorite	Biotite	9.41 9.48 (9.44)	10.29 10.33	87 88	74.2±2.2 74.4±2.2	Do. Do.
					Hornblende	1.394 1.393 (1.394)	1.763	74	85.9±2.6	Do.
75SJ414	Ketchikan D-6	332630E.	6196460N.	Coaree-grained atrongly foliated homogeneous biotite-hornblende quartz diorite	Biotite	9.70 9.72 (9.71)	10.63	91	74.4±2.2	Do.
					Hornblande	1.530 1.536 (1.533)	1.847	36	81.8±2.5	Do.
75SJ417	Ketchikan B-5	333750E.	6144720N.	Homogeneoua medium-grained hypidiomorphic granular biotite-hornblande granodiorite	Biotite	8.73 8.71 (8.72)	2.932	74	23.2±0.70	Do.
					Hornblende	.673 .677 (.675)	.2441	38	24.9±0.75	Do.
75SJ463A	Ketchikan B-4	369875E.	6132760N.	Porphyritic alkali basalt	Plagioclaae	.229 .232 (.230)	.01675	2.8	5.0±2	Do.
75SJ473B	Ketchkian A-4	371850E.	6101440N.	Ruaty-weathering fine-grained biotite-epidote-plagioclaae quartz schiat	Biotite	9.83 9.83 (9.83)	9.947	80	69.0±2.1	Do.
75SJ473C	Ketchikan A-4	371850E.	6101440N.	Sheared and recryatallized mafic dike	Actinolite	.399 .402 (.400)	.5088	41	86.2±2.6	Do.
75SJ509	Ketchikan A-4	372380E.	6117380N.	Weakly foliated medium-grained hypidiomorphic hornblende-biotite granodiorite	Biotite	9.51 9.49 (9.50)	8.252	91	59.4±1.8	Do.
					Hornblende	1.069 1.075 (1.072)	1.251	85	79.5±2.4	Do.
76SJ563	Ketchikan B-2	405865E.	6138375N.	Crowded porphyry with very fine grained aplite groundmass and phenocrysts of quartz, plagioclase, microcline, and biotite	Biotite	9.52 9.39 (9.46)	4.172 4.060	67 72	30.4±0.9 29.6±1.2	Berg and others, 1978; Hudson and others, 1979
76SJ565A	Ketchikan B-2	406700E.	6139850N.	Hypidiomorphic aeriate altered biotite granite	Biotite	9.08 9.02 (9.06)	3.529 3.527	88 71	26.9±0.9 26.9±0.9	Berg and others, 1978; Hudson and others, 1979; Wilson and others, 1979 This report
76SJ606A	Princa Rupert D-3	384900E.	6077200N.	Chlorite-muscovite-actinolite-quartz schist	Muscovite	9.55 9.57 (9.56)	7.948	56	56.8±1.7	Do.

76SJ608	Ketchikan B-4	355850E.	6139900N.	"Featherschist," porphyritic garnet-bearing actinolite-muscovite-plagioclase-quartz schist	Biotite	9.33 9.29 (9.31)	11.85	85	86.3±2.6	Berg and others, 1978
76SJ632	Ketchikan B-4	353200E.	6127800N.	Granodiorite	Biotite	8.91 8.85 (8.88)	12.98	91	98.8±3.0	Berg and others, 1978; Wilson and others, 1979
					Hornblende	1.542 1.575 (1.558)	2.574	78	112±3.4	Do.
76SJ642	Ketchikan B-5	332890E.	6152800N.	Porpyritic epidote-bearing biotite granodiorite	Biotite	9.10 8.99 (9.04)	12.91	44	96.5±2.9	This report
					Hornblende	2.006 2.005 (2.005)	2.800	80	94.5±2.8	Do.
77RK468A	Prince Rupert D-3	387920E.	6075370N.	Medium-grained biotite-hornblende amphibolite	Biotite	9.01 8.88 (8.94)	6.624	85	50.7±1.5	Do.
					Hornblende	.435 .430 (.432)	.3667	55	57.9±1.7	Do.
77SJ661B AK-3	Ketchikan A-2	395025E.	6116700N.	Biotite-hornblende granodiorite	Biotite	8.89 8.80 (8.84)	5.644	83	43.8±1.3	Berg and others, 1978
					Hornblende	1.558 1.565 (1.562)	1.341	56	58.7±1.8	This report
77SJ663 AK-6	Ketchikan	402750E.	6127750N.	Coarse-grained hypidiomorphic biotite-hornblende granodiorite	Biotite	9.18 9.22 (9.20)	6.304	79	47.0±1.4	This report
					Hornblende	1.588 1.586 (1.587)	1.148	57	49.5±1.5	Do.
77SJ664 AK-7	Ketchikan B-2	401750E.	6126450N.	Coarse-grained hypidiomorphic biotite-hornblende granodiorite	Hornblende	1.458 1.455 (1.456)	1.116	57	52.4±1.6	Do.
77SJ665 AK-9	Ketchikan A-3	388525E.	6105590N.	Coarse-grained hypidiomorphic biotite-hornblende quartz diorite	Biotite	8.75 8.79 (8.77)	5.994	77	46.9±1.4	Do.
					Hornblende	.940 .940 (.940)	0.7651	61	55.7±1.7	Do.

77SJ669 AK-14	Prince Rupert D-2	400090E.	6074175N.	Coarse-grained hypidiomorphic quartz diorite	Biotite	9.19 9.21 (9.20)	6.171	86	46.0±1.4	Do.
					Hornblende	1.058 1.035 (1.046)	0.7270	52	47.6±1.4	Do.
77SJ670 AK-15	Ketchikan B-1	433700E.	6139100N.	Leucocretic coarse-grained biotite- and hornblende-bearing porphyritic granite	Biotite	8.66 8.80 (8.73)	2.892	71	22.9±1.0	Hudson and others, 1979
					Hornblende	0.695 0.697 (0.696)	0.2710	25	26.8±1.1	Do.
77SJ671 AK-16	Ketchikan B-1	431300E.	6149025N.	Schlieric porphyritic biotite-hornblende granodiorite	Biotite	8.88 8.93 (8.90)	5.344	77	41.2±1.5	This report
					Hornblende	1.340 1.330 (1.335)	0.9978	71	51.2±1.2	Do.
77SJ672 AK-17	Ketchikan C-1	428400E.	6164030N.	Hypidiomorphic sphene end allenite-bearing biotite-hornblende granodiorite	Biotite	9.11 9.03 (9.07)	5.677	76	43.0±1.3	Do.
					Hornblende	.833 .834 (.833)	.6696	57	55.0±1.6	Do.
77SJ673 AK-18	Ketchikan C-1	429150E.	6171050N.	Coarse-greined porphyritic sphene-bearing biotite-hornblende quartz monzonite	Biotite	8.32 8.31 (8.32)	5.674	83	46.8±1.4	Do.
					Hornblende	0.874 0.881 (0.878)	0.6329	42	49.4±1.5	Do.
77SJ903A	Ketchikan C-5	345055E.	6154975N.	Fine-grained quartz-plagioclase biotite-calcite schist	Biotite	9.07 9.01 (9.04)	9.868	51	74.3±1.2	Do.
77SJ903B	Ketchikan C-5	345055E.	6154975N.	Fine-grained, gernet-bearing quartz-plagioclase-hornblende schist	Hornblende	.377 .376 (.376)	0.4806	38	86.6±2.6	Do.
77SJ929A	Ketchikan C-4	367450E.	6170100N.	Garnet-epidote-hornblende-plagioclase schist	Hornblende	1.304 1.292 (1.298)	1.412	55	74.0±2.2	Do.
77SJ929B	Ketchikan C-4	367450E.	6170100N.	Biotite-quartz-plagioclase schist	Biotite	9.67 9.49 (9.58)	7.126	74	50.9±1.5	Do.
77SJ933A	Ketchikan C-4	361500E.	6153390N.	Garnet-bearing hornblende-biotite-plagioclase-quartz-schist	Biotite	9.16 9.09 (9.12)	11.48	76	85.3±2.6	Do.

77SJ933B	Ketchikan C-4	361500E.	6153390N.	Porphyroblastic garnet-actinolite-muscovite-chlorite-epidote-quartz-plagioclase schist, "feather schist"	Hornblende	0.398 0.396 (0.397)	0.5459	59	93.1±2.8	Do.
78SJ961A AK-34	Ketchikan C-3	377200E.	6161680N.	Biotite-quartz-plagioclase schist	Biotite	9.05 9.06 (9.06)	6.296	79	47.7±1.4	Do.
78SJ961B AK-34	Ketchikan C-3	377200E.	6161680N.	Quartz-bearing amphibolite	Hornblende	.570 .568 (.569)	0.5097	32	61.2±1.8	Do.
78SJ963	Ketchikan A-1	419420E.	6108600N.	Gneissic heterogeneous biotite-hornblende granodiorite	Biotite	7.93 7.91 (7.92)	5.204	66	45.0±1.4	Do.
					Hornblende	1.336 1.323 (1.330)	1.001	67	51.5±1.5	Do.
78SJ964 AK-65	Ketchikan A-1	430100E.	6122000N.	Coarse-grained homogeneous sphene-bearing biotite-hornblende granodiorite	Biotite	9.45 9.43 (9.44)	5.922	57	43.1±1.3	Do.
					Hornblende	1.220 1.238 (1.229)	0.8896	70	49.6±1.5	Do.
83642	Ketchikan D-4	355500E.	6206400N.	Unknown, probably granite or quartz monzonite	Biotite + chlorite	3.739 3.739 (3.739)	1.238	22	22.8±1	Hudson and others, 1979
I-28-2 AA148	Prince Rupert D-4	352600E.	6084900N.	Pegmatitic differentiate of ultramafic complex	Hornblende	0.773 0.783 (0.778)	1.286 1.249	80 84	111±3.3 108±3.2	Lanphere end Eberlein, 1966; Irvine, 1967; Taylor, 1967; Irvine, 1974; Turner and others, 1975; Wilson and Turner, 1975; Berg and others, 1978; Wilson and others, 1979; M. A. Lanphere, written commun., 1980

*Average value in ( ).

[a]Approximate location.

[b]Minimum age.

[c]Determinetion may be too old.

[d]Refers to references about individual determinations.

[e]Apparent age probably too young due to possibla resetting by nearby lamprophyre dikes.