



# Legacy K/Ar and $^{40}\text{Ar}/^{39}\text{Ar}$ Geochronologic Data from the Alaska-Aleutian Range Batholith of South-central Alaska

By Lisa L. Koeneman and Frederic H. Wilson, compilers

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[Available online only at <https://doi.org/10.3133/ofr20181033>]

1. Legacy K/Ar and  $^{40}\text{Ar}/^{39}\text{Ar}$  Geochronologic Data from the Alaska-Aleutian Range Batholith of South-central Alaska.

# Legacy K/Ar and $^{40}\text{Ar}/^{39}\text{Ar}$ Geochronologic Data from the Alaska-Aleutian Range Batholith of South-central Alaska

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## Abstract

Sample descriptions and analytical data for more than 200 K/Ar and  $^{40}\text{Ar}/^{39}\text{Ar}$  analyses from rocks of the Alaska-Aleutian Range batholith of south-central Alaska are reported here. Samples were collected over a period of 20 years by Bruce R. Reed and Marvin A. Lanphere (both U.S. Geological Survey) as part of their studies of the batholith.

## Introduction

Sample descriptions and analytical data for more than 200 K/Ar and  $^{40}\text{Ar}/^{39}\text{Ar}$  analyses from rocks of the Alaska-Aleutian Range batholith on the west side of Cook Inlet in south-central Alaska are reported here (tables 1 and 2). The samples were collected by Bruce R. Reed and Marvin A. Lanphere of the U.S. Geological Survey as part of their studies of the batholith from the 1970s to early 1990s. The data included here were unpublished at the time of Bruce Reed's death in 1993; we have reconstructed sample location and rock description data from his field notes and field sheets. Analytical data are as reported in files provided by Marvin Lanphere to Bruce Reed.

Comparison of these data with existing published data and published geologic maps (Reed and Lanphere, 1969, 1972, and 1973; Wilson and others, 2015) suggests that the re-evaluation of the age assignment of a number of mapped plutons may be warranted on the basis of these newly recovered age determinations. Additionally, a pattern emerges in the overall data set (see also Wilson and others [2015] for additional data); samples in Iliamna, Kenai, and Lake Clark quadrangles tend to have a higher proportion of discordant<sup>1</sup> age determinations (49 percent of 93 samples) relative to samples from the Lime Hills and Tyonek quadrangles (40 percent of 40 samples) (plate 1). For some samples, the discordance is extreme; some biotite samples may yield dates that are as little as half of the hornblende date. This discordance affects older and younger age determinations alike; however, it is most prevalent in samples that yield Eocene biotite ages and Late Cretaceous hornblende ages. Samples yielding Jurassic ages appear to show proportionately less discordance.

The methodology used for processing these samples is that of Faure and Mensing (2005); decay constants used are as reported by Steiger and Jager (1977).

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<sup>1</sup>Discordant in this context means that within analytical error, the dates on different mineral phases do not agree. Concordant dates are generally taken to mean geologically rapid cooling and lack of disturbance to the potassium-argon system. In a few cases, where biotite yields an older date than hornblende, if the dates remain within analytical error they are still considered concordant.

**Table 1.** Potassium-argon analytical data and descriptive information for samples of the Alaska-Aleutian Range batholith in the Tyonek, Lime Hills, Kenai, Lake Clark, and Iliamna 1:250,000-scale quadrangles, south-central Alaska.

[Rock descriptions and notes derived verbatim from the field notes of Bruce L. Reed, additions in italics by report authors. Analyses by Marvin Lanphere. Samples collected by AGe, Bruce Gamble; AL, Marvin Lanphere; ANw, Willis Nelson; AR, Bruce Reed; and ARa, James Ratté. Latitude and longitude use NAD83 datum. AGDB, Alaska Geochemical Database (Granitto and others, 2011); n.a., data not available; CI, color index; Ma, million years ago; %, percent; SD, standard deviation; M/gr, moles per gram]

Map no.	Sample	Latitude (degrees north)	Longitude (degrees west)	Rock type	Mineral	Method	%K <sub>2</sub> O	SD_K <sub>2</sub> O	<sup>40</sup> Ar <sub>rad</sub> M/gr X 10 <sup>-10</sup>	% <sup>40</sup> Ar <sub>rad</sub>	Age (Ma)	Error (Ma) 1σ	Quadrangle	Description
1	88AR 239	61.7356	154.6453	Basalt	Whole rock	K/Ar	0.972	0.001	0.8294	72.9	58.3	1.7	Lime Hills	Dark green and gray, fairly fresh volcanic rock; possibly andesite; possible needles of hornblende; fresh plagioclase. There is a round knob to the north and there may be a small volcanic center with a moat between here and the top.
2	87AR 23	61.4375	153.7042	Granodiorite	Biotite	K/Ar	7.225	0.007	3.52	36.0	33.5	1.0	Lime Hills	Medium to fine-grained biotite granodiorite containing minor chloritized hornblende is description for 85AR 22, this is thought to be same rock; CI 15-20. Biotite fresh, hornblende looks possible; really need hornblende to verify 34.9 Ma age from 1969 sample. <i>Concordant biotite and hornblende.</i>
					Hornblende	K/Ar	0.649	0.008	0.3321	51.7	35.2	1.1		
3	87AR 18	61.4042	153.6161	Monzonite	Biotite	K/Ar	8.910	0.014	6.517	77.9	50.1	1.5	Lime Hills	Biotite monzonite and diorite containing possible greenish feldspar and about 10% fresh biotite. This cuts an unknown black rock to the east and then appears to cut rock to the west. There are a few mineralized float cobbles (Chalcopyrite, pyrite and other minerals). <i>Unpublished <sup>40</sup>Ar/<sup>39</sup>Ar determination yielded 50.1±0.4 Ma.</i>
4	81AR 141	61.165	-152.6567	Granodiorite	Biotite	K/Ar	8.80	0.071	8.860	80.7	68.6	2.1	Tyonek	Non-foliated coarse-grained equigranular hornblende biotite quartz diorite and granodiorite containing abundant titanite and small accessory mafic inclusions. Septum unit. <i>Discordant biotite and hornblende.</i>
					Hornblende	K/Ar	0.943	0.006	1.158	82.8	83.4	2.5		
5	81AR 91	61.1427	152.1573	Tonalite	Biotite	K/Ar	9.680	0.014	9.155	91.2	64.5	1.9	Tyonek	Biotite hornblende quartz diorite containing titanite. Summit Lake sequence. <i>Concordant biotite and hornblende, where biotite is slightly older.</i>
					Hornblende	K/Ar	0.882	0.006	0.8204	72.1	63.5	1.9		
6	87AR 76	61.1356	153.7164	Granodiorite	Biotite	K/Ar	7.660	0.028	4.466	61.0	40.0	1.2	Lime Hills	Biotite hornblende granodiorite. <i>Unpublished <sup>40</sup>Ar/<sup>39</sup>Ar determination yielded 40±0.4 Ma.</i>
7	85AR 21	61.1194	152.9	Quartz monzodiorite	Biotite	K/Ar	8.685	0.050	7.324	72.9	57.6	1.7	Tyonek	Biotite hornblende quartz monzodiorite septum cut by aplitic dikes; CI 25-30; perhaps related to Merrill Pass.
8	85AR 22	61.0972	152.9417	Tonalite	Biotite	K/Ar	7.350	0.014	6.213	79.1	57.8	1.7	Tyonek	Light colored biotite-hornblende quartz diorite and tonalite septum cut by aplitic dikes and containing mafic inclusions. This septum cuts a small septum of 'black rock' that is laced containing white dikes which may be from this rock. This may be early Tertiary. This septum is not typical of septum rocks. <i>Slightly discordant biotite and hornblende.</i>
					Hornblende	K/Ar	0.586	0.001	0.5279	33.4	61.6	1.8		
9	85AR 42	61.0944	153.5244	Granite	Biotite	K/Ar	9.16	0.042	5.045	70.9	37.9	1.1	Lime Hills	Biotite granite containing possibly some minor hornblende and possibly some garnet; CI 10-15.
10	85AR 47	61.0944	153.5244	Granodiorite	Biotite	K/Ar	8.745	0.021	5.689	71.3	44.6	1.3	Lime Hills	Very fresh medium- to dark-gray, medium- to fine-grained biotite granodiorite and quartz diorite or quartz monzodiorite containing possibly some hornblende and some other unknown mineral is quite abundant. This rock is strange and variable but it is chiefly biotite.
11	85AR 23	61.0918	152.9889	Quartz monzodiorite	Hornblende	K/Ar	0.631	0.009	0.6038	53.4	65.3	2.0	Tyonek	Coarse-grained biotite hornblende granodiorite to quartz monzodiorite; most likely a high abundance of K-feldspar and no titanite; CI 20. This rock is more similar to Station 85AR 21 than to Station 85AR 22.
12	81AR 53	61.05	152.1583	Tonalite	Biotite	K/Ar	8.895	0.006	9.29	83.0	71.1	2.1	Tyonek	Hornblende-biotite quartz diorite containing titanite; CI is about 30-35; appears to be Cretaceous. Blockade sequence. <i>Discordant biotite and hornblende where biotite is older.</i>
					Hornblende	K/Ar	1.007	0.004	1.034	51.7	69.9	2.1		
13	85AR 39	61.0383	153.7317	Granodiorite	Hornblende	K/Ar	0.756	0.001	0.883	41.8	79.4	1.4	Lime Hills	Good fresh hornblende-biotite granodiorite containing some epidote; CI 15-20.
14	85AR 25	61.0167	153.0025	Granodiorite	Biotite	K/Ar	8.995	0.050	7.571	73.4	57.5	1.7	Lime Hills	Medium-grained biotite-hornblende quartz diorite to granodiorite surprisingly little K-feldspar; biotite is good and fresh and hornblende is ok. This rock is surprising for the early Tertiary pluton. It would be good to continue up the glacier to the south and see where the K-feldspar-rich pluton comes in.
15	78AR 218	60.996	153.0687	Granodiorite	Biotite	K/Ar	9.255	0.007	7.724	86.3	57.1	1.1	Lake Clark	Coarse-grained biotite hornblende granite or quartz monzonite containing scattered mafic inclusion and minor titanite. The chemistry of these units is probably going to vary but there is no way to separately map this unit other than as one unit. Crystal Creek sequence. <i>Concordant biotite and hornblende though biotite is slightly older.</i>
					Hornblende	K/Ar	0.573	0.004	0.4733	45.4	56.5	1.7		
16	77AR 170	60.9914	153.3251	Granodiorite	Hornblende	K/Ar	0.463	0.013	0.2185	35.2	32.5	1.0	Lake Clark	Biotite and hornblende quartz diorite/granodiorite containing mafic inclusion; same rock as 77AR 169. Neocola unit. <i>Weighted mean of two determinations.</i>
									0.2290	26.1	34.0	1.0		
											<b>33.3</b>	<b>0.7</b>		
17	81AR 101	60.9793	152.1187	Tonalite	Biotite	K/Ar	9.610	0.014	10.91	90.1	77.2	2.3	Kenai	Slightly foliated biotite hornblende granodiorite containing titanite; CI 25. Blockade sequence. <i>Concordant biotite and hornblende.</i>
					Hornblende	K/Ar	0.742	0.002	0.8706	84.4	79.7	2.4		
18	77AR 165	60.9727	153.691	Granodiorite	Biotite	K/Ar	9.125	0.021	4.1100	41.8	31	0.9	Lake Clark	Very fresh hornblende biotite quartz diorite or granodiorite; CI 21.5-22.5; same rock as 77AR 162 and 77AR 163; belt along west flank of mountains. <i>Discordant biotite and hornblende where biotite is older.</i>
					Hornblende	K/Ar	0.732	0.005	0.2886	28.0	27.1	0.8		
									0.3303	47.8	31.0	0.9		
											<b>28.8</b>	<b>0.6</b>		
19	77AR 166	60.9673	153.5793	Granodiorite	Biotite	K/Ar	9.310	0.043	4.279	79.8	31.6	0.9	Lake Clark	Biotite hornblende quartz diorite/granodiorite; good fresh rock forms massive cliffs to the north containing a few mafic inclusions; CI 12-15. Neocola unit. <i>Weighted mean of two determinations.</i>
									4.306	66.2	31.8	1.0		
											<b>31.7</b>	<b>0.7</b>		
20	81AR 126	60.94	152.1288	Granodiorite	Biotite	K/Ar	9.075	0.007	10.89	90.7	81.5	2.4	Kenai	Foliated biotite granodiorite and trondhjemite possibly containing some garnet. The rocks all along the low hills are the same. <i>AGDB reports trondhjemite. Assigned to trondhjemite unit.</i>
21	81AR 96	60.9381	152.3521	Tonalite	Biotite	K/Ar	9.340	0.014	9.717	86.8	70.9	2.1	Kenai	Foliated hornblende biotite quartz diorite containing accessory mafic stringers and titanite; CI 35. These are the same rocks as at Station 81AR 95. Blockade sequence. <i>Concordant biotite and hornblende.</i>
					Hornblende	K/Ar	1.066	0.001	1.109	67.4	70.9	2.1		
22	78AR 227	60.9043	153.7623	Quartz diorite	Biotite	K/Ar	8.32	0.028	7.74	79.7	63.5	1.9	Lake Clark	Very fresh non-foliated hornblende biotite quartz diorite containing abundant titanite; CI is 10-15. Summit Lake sequence. <i>Concordant biotite and hornblende, where biotite is slightly older.</i>
					Hornblende	K/Ar	0.686	0.006	0.6171	73.6	61.5	1.8		
23	78AR 224	60.8989	152.9481	Quartz diorite	Biotite	K/Ar	8.745	0.008	8.586	77.0	66.9	2.0	Kenai	Strongly foliated hornblende and biotite granodiorite or quartz diorite containing elongated mafic stringers and no titanite; CI 30-35. There are pinkish minerals, possibly quartz or K-feldspar. Cut by biotite aplitic dikes and mafic dikes. Septum unit.
24	81AR 135	60.8882	152.3324	Trondhjemite	Biotite	K/Ar	9.00	0.057	9.919	73.7	75.00	2.25	Kenai	Strongly foliated biotite garnet bearing quartz diorite possibly containing some hornblende. Contains abundant late quartz, albite, biotite, and locally good euhedral garnet crystals ptymatically dispersed throughout the rock. Many swirled partially digested septum of amphibolite stringers. The garnets are locally distributed in the rock up to 0.5 inches in size but most are 0.125 inches. Unit is Jurassic tonalite. <i>Discordant biotite and hornblende.</i>
					Hornblende	K/Ar	0.612	0.008	1.223	73.6	134.0	4.0		
25	78AR 304	60.8865	153.5689	Aplite	Biotite	K/Ar	8.945	0.008	2.685	69.7	20.7	0.6	Lake Clark	Biotite aplite or alaskite. Apparently there is a large dike or small stock that may be causing 27 Ma dates to the west. Local irregular inclusions of coarse-grained biotite granite containing aligned biotite around margins. These are the same locations as Stations 77AR 137.
26	81AR 45	60.8829	152.8133	Granodiorite	Biotite	K/Ar	9.275	0.008	9.754	84.3	71.6	2.1	Kenai	Biotite granodiorite containing no titanite. Summit Lake sequence.
27	77AR 134	60.8714	153.637	Granodiorite	Biotite	K/Ar	8.970	0.015	2.808	59.0	21.6	0.6	Lake Clark	Very fresh hornblende granodiorite; CI 18-20; probably the same as 77AR 133 but does not look like Merrill Pass, though assigned to Merrill Pass sequence. <i>Discordant biotite and hornblende.</i>
					Hornblende	K/Ar	0.466	0.019	0.1916	23.2	28.3	0.8		

Map no.	Sample	Latitude (degrees north)	Longitude (degrees west)	Rock type	Mineral	Method	%K <sub>2</sub> O	SD_K <sub>2</sub> O	<sup>40</sup> Ar/ <sup>39</sup> Ar M/gr X 10 <sup>-10</sup>	% <sup>40</sup> Ar <sub>rad</sub>	Age (Ma)	Error (Ma) 1 σ	Quadrangle	Description
28	81AR 137	60.8678	153.0834	Granodiorite	Biotite	K/Ar	8.165	0.035	9.568	84.8	79.6	2.4	Lake Clark	Biotite hornblende granodiorite containing abundant titanite and rounded mafic inclusions. This is good rock and should be good for samples. Septum unit. <i>Discordant biotite and hornblende.</i>
					Hornblende	K/Ar	0.577	0.004	0.7791	78.5	91.4	2.7		
29	81AR 116	60.8677	152.3316	Tonalite	Biotite	K/Ar	9.200	0.014	13.58	93.5	99.7	3.0	Kenai	Strongly foliated hornblende-biotite granitic gneiss containing hornblende crystals up to 3/8 inches long; CI is about 30. Have not seen this rock type before. <i>Discordant biotite and hornblende.</i>
					Hornblende	K/Ar	1.146	0.046	2.684	90.0	155.8	4.7		
30	77AR 140	60.8546	153.601	Quartz monzonite	Biotite	K/Ar	8.210	0.015	2.65	79.6	22.3	0.7	Lake Clark	Biotite hornblende quartz monzonite; Merrill Pass sequence. <i>Weighted mean of two determinations.</i>
									2.60	56.8	21.9	0.7		
											<b>22.1</b>	<b>0.5</b>		
31	81AR 152	60.833	152.2643	Tonalite	Biotite	K/Ar	8.84	0.015	20.08	87.9	151	4.5	Kenai	Good fresh hornblende granodiorite; CI 25; appears to be Jurassic. <i>Concordant biotite and hornblende. Weighted mean of two biotite determinations.</i>
									20.31	95.5	153	4.6		
											<b>152.0</b>	<b>3.2</b>		
					Hornblende	K/Ar	0.818	0.002	1.90	74.8	151	4.65		
32	78ANw 205	60.8253	154.4965	Granite	Biotite	K/Ar	8.960	0.028	8.241	60.7	62.8	1.9	Lake Clark	Biotite granite.
33	78AR 291	60.7632	152.5132	Quartz diorite	Biotite	K/Ar	9.045	0.007	18.54	93.1	137	4.1	Kenai	Slightly foliated leucocratic biotite quartz diorite or possibly granodiorite containing some epidote; CI is about 8-10. The biotite locally is gone to a pale green chlorite. Assigned to trondhjemite unit.
34	77AR 141	60.7516	153.7975	Granodiorite	Hornblende	K/Ar	1.128	0.026	0.8208	70.6	49.8	1.5	Lake Clark	Turquoise stock. Hornblende granite; definitely cuts Tertiary sub-horizontal basalts. CI 8-10. Peralkaline granite unit.
35	81AR 20	60.7317	152.3787	Tonalite	Biotite	K/Ar	8.685	0.008	22.2	86.8	169	5.1	Kenai	Nice fresh hornblende biotite quartz diorite containing no titanite; 50/50 hornblende/biotite; CI is about 15. All the rocks around the small pond appear to be the same. Unit is Jurassic tonalite. <i>Weighted mean of two biotite and hornblende determinations. Discordant biotite and hornblende where biotite is older.</i>
									22.3	87.6	170	5.1		
											<b>169.5</b>	<b>3.6</b>		
					Hornblende	K/Ar	0.602	0.002	1.381	83.5	153	4.6		
									1.316	44.1	146	4.4		
											<b>149.3</b>	<b>3.2</b>		
36	78AR 223	60.7299	153.18	Quartz diorite	Biotite	K/Ar	7.375	0.021	8.132	84.3	75	2.2	Lake Clark	Foliated medium to dark gray hornblende biotite quartz diorite or possibly granodiorite containing lots of titanite. There isn't too much difference between Stations 78AR 221, 78AR 222, and 78AR 223. According to the available notes, the sample was not considered optimum for dating; the pluton is cut by aplitic dikes. Septum unit. <i>Discordant biotite and hornblende.</i>
					Hornblende	K/Ar	0.697	0.002	0.8885	81.75	86.5	2.6		
37	81AR 44	60.718	152.5922	Hornblende	Hornblende	K/Ar	0.357	0.001	0.7785	53.6	146	4.4	Kenai	Hornblende unit; same locality as Station 78AR 294.
38	77AR 117	60.6778	153.4145	Quartz diorite	Biotite	K/Ar	9.205	0.035	11.80	86.0	86.9	2.6	Lake Clark	Medium to coarse grained hornblende biotite granodiorite cuts large epidote joints. Rock appears to cut Jurassic intrusive along the edge of the cliff and also Talkeetna Formation. To the south near the glacier where the sample was collected it is all good intrusive containing minor titanite and very minor magnetite and pink feldspars. Quartz monzodiorite unit. <i>AGDB reports granodiorite. Concordant biotite and hornblende where biotite is older.</i>
					Hornblende	K/Ar	0.876	0.001	1.079	77.2	83.6	2.5		
39	78AR 268	60.6605	153.3307	Granodiorite	Biotite	K/Ar	8.315	0.049	10.53	74.5	85.9	2.6	Lake Clark	Biotite hornblende granodiorite containing abundant titanite. An inclusion present; CI 15-20. Quartz monzodiorite unit. <i>Concordant biotite and hornblende, where biotite is slightly older.</i>
					Hornblende	K/Ar	0.613	0.005	0.7625	79.1	84.5	2.5		
40	78AR 282	60.657	152.7258	Trondhjemite	Muscovite	K/Ar	10.18	0.0	21.69	93.7	142	4.3	Kenai	Coarse-grained muscovite and minor biotite trondhjemite; CI is about 2-3; muscovite is approximately 5-7% of rock. Assigned to trondhjemite unit. <i>AGDB reports quartz diorite. An unpublished <sup>40</sup>Ar/<sup>39</sup>Ar date on biotite was 75.6 ± 2.3 Ma, strongly discordant with the muscovite.</i>
41	77AR 115	60.6415	153.4369	Quartz diorite	Hornblende	K/Ar	0.369	0.002	0.1802	42.3	33.5	1.0	Lake Clark	Hornblende diorite or quartz diorite intruding Talkeetna Formation. CI of 25. Very fresh hornblende; dark greenish-gray feldspars. This is probably a Jurassic intrusive. Very difficult to distinguish from Talkeetna Formation.
42	78AR 283	60.6354	152.6683	Granodiorite	Biotite	K/Ar	9.205	0.007	19.68	94.6	142	4.3	Kenai	Medium-grained medium-gray hornblende biotite quartz diorite containing a medium amount of titanite; CI is about 20. Unit is Jurassic tonalite. These rocks look like the Summit Lake rocks from north of Lake Clark Pass. <i>AGDB reports quartz diorite. Discordant biotite and hornblende where biotite is older.</i>
					Hornblende	K/Ar	0.692	0.014	1.417	88.2	137	4.1		
43	77AR 192	60.6243	152.9395	Granodiorite	Biotite	K/Ar	8.935	0.021	9.041	76.1	69.3	2.1	Kenai	Coarse-grained, strongly foliated hornblende-biotite quartz diorite containing about 2% titanite. Lenticular biotite-rich stringers aligned parallel to foliation, may be partially digested xenoliths; CI 25-30. Identical to 77AR 190. Abundant elongated inclusions suggest Jurassic age. Blockade sequence. <i>AGDB reports quartz diorite. Concordant biotite and hornblende.</i>
					Hornblende	K/Ar	0.771	0.004	0.7967	51.9	70.4	2.1		
44	77AR 129	60.6199	153.5299	Quartz monzonite	Biotite	K/Ar	9.045	0.007	5.272	43.2	40	1.2	Lake Clark	Porphyritic biotite quartz monzonite containing chalk white plagioclase phenocrysts and possible minor hornblende; CI 5; possibly equivalent to 77AR 127. Kijik River granite unit.
45	72AR 146	60.6018	152.8996	Quartz diorite	Biotite	K/Ar	8.86	0.014	10.14	54.2	77.8	2.3	Kenai	Fine grained hornblende biotite quartz diorite. These could be either Summit Lakes or Jurassic intrusions. <i>Concordant biotite and hornblende. Recalculated with constants of Steiger and Jager (1977).</i>
					Hornblende	K/Ar	0.609	0.002	0.7171	47.2	80.1	2.4		
46	78AR 327	60.5919	153.1682	Quartz diorite	Biotite	K/Ar	7.175	0.007	6.263	39.3	59.6	1.8	Lake Clark	Blockade sequence. Biotite K <sub>2</sub> O only 7.33%. <i>Concordant biotite and hornblende.</i>
					Hornblende	K/Ar	0.392	0.002	0.363	56.7	63.1	1.9		
47	78AR 172	60.591	153.6049	Quartz monzonite	Biotite	K/Ar	8.415	0.021	4.914	63.8	40.1	1.2	Lake Clark	Medium- to coarse-grained biotite hornblende quartz monzonite containing some coarse-grained feldspar; hornblende is not very abundant and appears to be altered; biotite is very fresh; CI is about 10. Kijik River granite unit; probably equivalent to Little Lake Clark biotite granite unit.
48	81AR 7	60.5573	152.4562	Quartz monzonite	Biotite	K/Ar	6.865	0.036	18.02	94.6	174	5.2	Kenai	Good coarse-grained biotite quartz monzonite containing decent minor hornblende; looks to be mafic intrusive. It is possibly part of the Talkeetna Formation. Assigned to trondhjemite unit. <i>Biotite K<sub>2</sub>O only 6.865%.</i>
49	78AR 105	60.5476	153.4212	Quartz diorite	Biotite	K/Ar	8.045	0.008	6.425	74.9	54.6	1.6	Lake Clark	Biotite hornblende quartz diorite containing 2-3% titanite; same rocks as Station 78AR 104. Quartz diorite unit. <i>Discordant biotite and hornblende.</i> (Reed's notes to self: separate titanite out for fission track or Pb isotope)
					Hornblende	K/Ar	0.918	0.006	1.089	72.8	80.6	2.4		
50	78AR 111	60.5316	153.3268	Alaskite	Biotite	K/Ar	9.495	0.021	9.096	74.0	65.3	2.0	Lake Clark	Extremely coarse grained biotite granite containing minor hornblende. It looks similar to the Lake Clark granite but has hornblende and K-feldspar crystals up to 1.5 inches long. Island unit. <i>Discordant biotite and hornblende.</i>
					Hornblende	K/Ar	1.211	0.011	1.240	68.6	69.7	2.1		
51	81AR 182	60.5267	152.4567	Quartz monzonite	Biotite	K/Ar	7.905	0.007	20.51	87.8	172	5.2	Kenai	Quartz monzonite body south of the Drift River. Biotite quartz monzonite containing little to no hornblende; biotite is the only dateable mineral; CI is about 10.
52	77AR 203	60.5246	153.4862	Quartz diorite	Biotite	K/Ar	8.910	0.042	4.861	77.1	37.5	1.1	Lake Clark	Very slightly foliated biotite hornblende granodiorite/quartz diorite containing about 1% titanite; CI 20. Biotite is about 0.25 inches across which is larger than most rocks in this area. This should be equivalent to Summit Lakes. Quartz diorite unit. <i>AGDB reports granodiorite. Discordant biotite and hornblende.</i>
					Hornblende	K/Ar	0.812	0.001	0.9308	79.3	77.9	2.3		
53	72AR 293	60.5162	153.33	Quartz monzonite	Biotite	K/Ar	9.140	0.015	8.92	90.5	66.6	2.0	Lake Clark	Biotite quartz monzonite containing minor hornblende. This may be Merrill Pass sequence. It could also be equivalent to 72AR 292. <i>AGDB calls it granodiorite. Recalculated with constants of Steiger and Jager (1977).</i>

Map no.	Sample	Latitude (degrees north)	Longitude (degrees west)	Rock type	Mineral	Method	%K <sub>2</sub> O	SD_K <sub>2</sub> O	<sup>40</sup> Ar/ <sup>39</sup> K M/gr X 10 <sup>-10</sup>	% <sup>40</sup> Ar/ <sup>39</sup> K	Age (Ma)	Error (Ma) 1 σ	Quadrangle	Description	
54	78AR 152	60.5146	152.9544	Granodiorite	Muscovite	K/Ar	10.325	0.049	21.78	96.5	141	4.2	Kenai	Leucocratic biotite granodiorite containing small pegmatite veins have garnet and muscovite; CI is relatively 5-8. Adjacent to Redoubt Volcano. Assigned to trondhjemite unit. <i>Weighted mean of two biotite determinations. Discordant biotite and muscovite.</i>	
					Biotite	K/Ar	9.105	0.008	15.48	79.4	114	3.4			
						weighted mean					114	2.4			
55	81AR 30	60.5127	152.5801	Tonalite	Biotite	K/Ar	8.855	0.009	22.91	89.1	171	5.1	Kenai	Exceptionally fresh hornblende and biotite (probably) quartz diorite containing no titanite and minor K-feldspar; CI is about 15; probably Jurassic. This is a new unit. It may be related to granodiorite and quartz monzonite. Jurassic granite unit. <i>Weighted mean of two hornblende determinations. Discordant biotite and hornblende, where biotite is older.</i>	
					Hornblende	K/Ar	0.669	0.007	1.61	78.9	160	4.8			
						weighted mean					<b>159.5</b>	<b>3.4</b>			
56	77AR 190	60.5104	153.1793	Granodiorite	Amphibole	K/Ar	0.358	0.006	0.4258	51.9	81.7	2.5	Lake Clark	Medium grained hornblende biotite granodiorite; hornblende content is much greater than biotite; CI 25; has definite foliation and is different rock than 77AR 185-189. Locally present are a few float boulders of foliated hornblende quartz diorite; appears to be Jurassic. Also present are hornblende segregations. Blockade sequence.	
57	78AR 278	60.5071	153.5526	Granodiorite	Biotite	K/Ar	9.030	0.014	9.765	75.9	73.6	2.2	Lake Clark	Hornblende biotite granodiorite containing abundant titanite. This is same rocks as 78AR 276. Second quartz monzonite unit. <i>Discordant biotite and hornblende.</i>	
					Hornblende	K/Ar	0.78	0.004	0.9832	70.7	85.5	2.6			
58	81AR 173	60.5065	152.5646	Quartz monzonite	Biotite	K/Ar	7.505	0.049	19.90	88.6	175.4	5.3	Kenai	Hornblende biotite quartz monzonite containing many quartz diorite inclusions; 50/50 hornblende/biotite; more K-feldspar in this sample than at other stations; probably Jurassic(?); CI 10-15. There are well developed stock works of quartz and epidote veinlets. The blocks along the border of pluton merge in size (3'-6' [feet]). <i>Concordant biotite and hornblende where biotite is slightly older.</i>	
					Hornblende	K/Ar	0.678	0.001	1.738	87.7	170	5.1			
59	78AR 273	60.472	153.7076	Granodiorite	Biotite	K/Ar	8.885	0.007	4.928	36.8	38.1	1.1	Lake Clark	Medium grained biotite and hornblende granodiorite to quartz diorite not containing titanite and having accessory inclusions 3-5 inches across; CI is approximately 12. <i>Concordant biotite and hornblende where biotite is slightly older.</i>	
					Hornblende	K/Ar	0.536	0.006	0.2827	53.8	36.3	1.1			
60	81AR 178	60.4702	152.8994	Granodiorite	Biotite	K/Ar	9.015	0.022	21.08	93.0	156	4.7	Kenai	Medium grained biotite granodiorite containing no garnet; CI is about 10. Adjacent to Redoubt Volcano. This is probably a continuation of the body from Station 81AR 177. This rock is not typical of this date so check and see if it is Jurassic. Also check why it is so K-feldspar rich. Look at the slab to make this determination. Jurassic granite unit. <i>AGDB puts location at lat 60.5 and long 152.567; we believe this is in error as it does not match the field sheet.</i>	
61	72AR 44	60.4563	153.1439	Quartz diorite	Biotite	K/Ar	9.165	0.021	9.342	77.8	69.5	2.1	Lake Clark	Excellent sample of medium grained non foliated hornblende-biotite quartz diorite; appears to be Jurassic. Blockade sequence. <i>Recalculated with constants of Steiger and Jager (1977). Discordant biotite and hornblende.</i>	
					Hornblende	K/Ar	0.427	0.001	0.4763	27.2	76	2.3			
62	78AR 123	60.4509	153.513	Granodiorite	Biotite	K/Ar	9.105	0.022	5.495	73.1	41.4	1.2	Lake Clark	Biotite granodiorite or possibly quartz diorite containing some titanite but not an abundant amount and some hornblende; CI is about 15. Check to see if this is equivalent to 78AR 119; 119 may be more mafic because it is close to the margin of the body. <i>Discordant biotite and hornblende.</i>	
63	77AR 189	60.4408	153.183	Quartz diorite	Biotite	K/Ar	9.135	0.008	9.926	84.2	73.9	2.2	Lake Clark	Non-foliated hornblende biotite quartz diorite (possibly granodiorite?) containing rare titanite and epidote. Abundant partially digested xenoliths. There are no obvious difference between this and 77AR 188. Blockade sequence. <i>Concordant biotite and hornblende.</i>	
					Hornblende	K/Ar	0.436	0.003	0.4877	30.5	76.1	2.3			
64	72AR 290	60.4406	153.562	Quartz diorite	Biotite	K/Ar	5.94	0.014	4.819	83.0	55.5	1.7	Lake Clark	Biotite hornblende quartz diorite or granodiorite; CI of about 20. <i>Biotite K<sub>2</sub>O was only 5.93 and 5.95%, such that the biotite age is suspect. Biotite typically has a K<sub>2</sub>O content of about 9%; artificially using 9%, the biotite yields an age of 36.7 Ma, essentially concordant with the hornblende and suggesting potassium loss while retaining argon. Biotite and hornblende are discordant, where biotite is older. Recalculated with constants of Steiger and Jager (1977).</i>	
						weighted mean					<b>55.4</b>	<b>1.2</b>			
					Hornblende	K/Ar	0.671	0.006	0.3388	60.4	34.7	1.0			
						weighted mean					35.5	0.7			
65	72AR 139	60.4267	153.3375	Granodiorite	Biotite	K/Ar	8.960	0.014	9.962	69.2	75.7	2.3	Lake Clark	Medium- to coarse-grained whitish gray hornblende biotite quartz. Same as 72AR 138. <i>Concordant biotite and hornblende. Blockade sequence. Recalculated with constants of Steiger and Jager (1977).</i>	
					Hornblende	K/Ar	0.943	0.004	1.084	76.3	78.2	2.3			
						weighted mean					<b>76.2</b>	<b>1.3</b>			
66	72AR 138	60.3985	153.4448	Quartz diorite	Biotite	K/Ar	8.950	0.028	8.862	84.7	67.5	2	Lake Clark	Fresh whitish-gray hornblende biotite quartz diorite (50/50 hornblende/biotite) and minor lemon-yellow titanite. These rocks are similar to Summit Lake rocks. Cretaceous granodiorite unit. <i>Discordant biotite and hornblende. Recalculated with constants of Steiger and Jager (1977).</i>	
					Hornblende	K/Ar	0.990	0.003	1.189	81.2	81.6	2.4			
67	78AR 137	60.3908	153.6782	Granodiorite	Biotite	K/Ar	8.625	0.007	4.661	68.6	37.1	1.1	Lake Clark	Biotite granite containing pink K-feldspar. These are the same rocks as at Station 78AR 134. Little Lake Clark biotite granite unit.	
68	78AR 156	60.3854	153.0904	Quartz diorite	Biotite	K/Ar	8.655	0.007	18.99	94.9	146	4.4	Lake Clark	Hornblende biotite quartz diorite; typical Jurassic; CI 25; little or no K-feldspar. Unit is Jurassic tonalite. <i>Discordant biotite and hornblende.</i>	
					Hornblende	K/Ar	0.895	0.014	2.119	37.9	157	4.7			
69	77AR 186	60.3452	153.3684	Quartz diorite	Biotite	K/Ar	9.76	0.028	9.637	62.2	67.6	2.0	Lake Clark	Coarse grained biotite hornblende quartz diorite containing 1% titanite and 2-3% epidote; good foliation; CI 15-20; same rock type as 77AR 185. Cretaceous granodiorite unit. <i>Concordant biotite and hornblende.</i>	
					Hornblende	K/Ar	0.918	0.008	0.9261	35.4	68.7	2.1			
70	72AR 278	60.3422	153.7964	Granodiorite	Biotite	K/Ar	8.26	0.015	5.328	74.4	44.3	1.3	Lake Clark	Orange biotite quartz monzonite or quartz diorite containing minor hornblende. Tazamina granite. <i>Recalculated with constants of Steiger and Jager (1977).</i>	
71	72AR 174	60.341	153.599	Quartz diorite	Hornblende	K/Ar	0.532	0.011	0.2692	55.3	35.1	1.1	Lake Clark	Medium-whitish gray non-foliated biotite hornblende quartz diorite with reddish non-foliated dioritic inclusion. These might be Summit Lake rocks. <i>Recalculated with constants of Steiger and Jager (1977).</i>	
72	72AR 172	60.3285	153.5055	Granodiorite	Hornblende	K/Ar	0.957	0.0	1.144	69.2	81.2	2.4	Lake Clark	Medium- to fine-grained biotite quartz diorite to granodiorite and possibly may include some hornblende. Cretaceous granodiorite unit. <i>Discordant biotite and hornblende. Recalculated with constants of Steiger and Jager (1977).</i>	
					Biotite	K/Ar	9.230	0.0	9.262	80.0	68.4	2.1			
73	72AR 136	60.3253	153.6527	Granodiorite	Biotite	K/Ar	8.870	0.028	4.506	80.0	34.9	1.0	Lake Clark	Medium gray hornblende-biotite quartz monzonite or granodiorite. This could be the same rock as 72AR133 and 72AR 134 but it does not have the pinkish feldspar of these. <i>Discordant biotite and hornblende. Recalculated with constants of Steiger and Jager (1977).</i>	
					Hornblende	K/Ar	0.857	0.005	0.5368	52.1	42.9	1.3			
74	77AR 175	60.3233	153.8505	Quartz diorite	Biotite	K/Ar	7.505	0.007	6.153	42.1	56.1	1.7	Lake Clark	Biotite hornblende quartz diorite. This certainly does not appear to be the orange intrusive as previously mapped. It has a quaint look of Jurassic about it. Orange intrusive must be (or must have gone) over the hill. The volcanic rocks on ridge to the south appear to be Talkeetna Formation and trend towards Lake Clark. <i>Concordant biotite and hornblende.</i>	
					Hornblende	K/Ar	0.662	0.003	0.5696	70.8	58.8	1.8			
75	77AR 179	60.3155	153.8117	Quartz monzonite	Biotite	K/Ar	8.125	0.035	4.109	59.6	34.8	1.0	Lake Clark	Hornblende and biotite quartz monzonite hornblende greater than or equal to biotite; CI 12-15. This is what has been called the OI (orange intrusive); must have both hornblende and biotite. Tazamina granite. <i>Discordant biotite and hornblende.</i>	
					Hornblende	K/Ar	0.526	0.017	0.2834	41.3	37.0	1.1			

Map no.	Sample	Latitude (degrees north)	Longitude (degrees west)	Rock type	Mineral	Method	%K <sub>2</sub> O	SD_K <sub>2</sub> O	<sup>40</sup> Ar/ <sup>39</sup> Ar M/gr X 10 <sup>-10</sup>	% <sup>40</sup> Ar <sub>rad</sub>	Age (Ma)	Error (Ma) 1 σ	Quadrangle	Description									
76	72AR 41	60.3117	153.4076	Quartz diorite	Biotite	K/Ar	9.175	0.007	3.918	62.7	29.5	0.9	Lake Clark	Faintly foliated hornblende-biotite quartz diorite (50/50 hornblende/biotite) containing medium amounts of titanite. Cretaceous granodiorite unit. <i>Weighted mean of two biotite determinations. Discordant biotite and hornblende. Recalculated with constants of Steiger and Jager (1977).</i>									
									3.829	17.9	28.8	0.9											
						weighted mean					<b>29.2</b>	<b>0.6</b>											
77	78AR 208	60.3111	153.3178	Granodiorite	Biotite	K/Ar	9.740	0.014	1.288	85.1	76.4	2.3	Lake Clark	Biotite and hornblende granodiorite containing minor titanite; same rocks as to the west. Cretaceous leucocratic granodiorite unit.									
									1.147	0.0	1.288	85.1			76.4	2.3							
78	72AR 122	60.2857	153.1482	Quartz diorite	Biotite	K/Ar	9.250	0.0	20.68	94.3	150	4.5	Lake Clark	Excellent sample of slightly foliated hornblende-biotite quartz diorite. <i>Discordant biotite and hornblende where biotite is older. Recalculated with constants of Steiger and Jager (1977).</i>									
79	77AR 185	60.264	153.3893	Quartz diorite	Biotite	K/Ar	9.54	0.042	9.315	77.7	66.6	2.0	Lake Clark	Slightly foliated medium- to coarse-grained biotite hornblende quartz diorite containing elongated plagioclase. According to the available notes, the biotite is very fresh but hornblende is dull and not considered optimum for dating. Aplitic dikes may have been a part of original pluton or possibly related to younger intrusive. Rock appears to be Jurassic. There are elongated xenoliths aligned parallel to foliation; chlorite and epidote common in rock and in veinlets. Some aplitic veinlets parallel to foliation. This may well be metamorphic rock. Cretaceous granodiorite unit. <i>Concordant biotite and hornblende, where biotite is older.</i>									
									1.077	0.0	2.262	90.3			140	4.2							
80	72AR 188	60.2578	153.2579	Granodiorite	Biotite	K/Ar	8.630	0.0	9.389	86.0	74	2.2	Lake Clark	Biotite-hornblende granodiorite: hornblende is medium-grained; biotite is coarse-grained; no well-defined foliation; CI 10. Cretaceous leucocratic granodiorite unit. <i>Discordant biotite and hornblende. Recalculated with constants of Steiger and Jager (1977).</i>									
									0.566	0.001	0.6557	79.2			78.7	2.4							
81	77AR 196	60.2511	153.7086	Quartz monzonite	Biotite	K/Ar	8.145	0.049	4.243	84.5	35.8	1.1	Lake Clark	Biotite hornblende quartz monzonite, may be equivalent to or earlier than "orange intrusion". CI 5-10. Biotite is very fresh and hornblende is medium-green; K-feldspar greater than plagioclase. Contains abundant (1-4%) ovoid inclusions; some are greenish-gray intrusive rocks that look similar to host except these are darker and contain no K-feldspar. Current Creek granodiorite. <i>Concordant unpublished hornblende (36.0±1.1 Ma <sup>40</sup>Ar/<sup>39</sup>Ar).</i>									
82	72AR 232	60.2457	153.569	Granodiorite	Biotite	K/Ar	8.095	0.007	4.054	56.5	34.5	1.0	Lake Clark	Medium grained biotite and hornblende granodiorite to quartz monzonite. There are probably the same rocks as 72AR 231. Cretaceous granodiorite unit. <i>Weighted mean of two determinations. Discordant biotite and hornblende. Recalculated with constants of Steiger and Jager (1977).</i>									
									4.167	75.9	35.5	1.1											
															weighted mean					<b>35.0</b>	<b>0.7</b>		
															Hornblende	K/Ar	1.002	0.002	1.051	79.6	71.5	2.1	
								weighted mean					<b>71.9</b>	<b>1.5</b>									
83	78AR 195	60.2349	153.5573	Granite	Biotite	K/Ar	7.655	0.050	3.7	70.1	33.3	1.0	Lake Clark	Coarse-grained biotite granite, containing possibly some minor hornblende; same as 78AR 194. Little Lake Clark biotite granite unit.									
84	78ANw 23	60.2264	154.9	Intermediate igneous	Biotite	K/Ar	9.29	0.028	8.95	84.4	65.7	2.0	Lake Clark	n.a.									
85	72AR 224	60.2137	153.3274	Quartz diorite	Biotite	K/Ar	9.025	0.009	9.668	91.1	73	2.2	Lake Clark	Medium grained slightly foliated biotite and hornblende quartz diorite; slightly more biotite than hornblende. CI 15-20. Unit is Jurassic tonalite. <i>Concordant biotite and hornblende. Recalculated with constants of Steiger and Jager (1977).</i>									
									0.509	0.0	0.5641	63.3			75.5	2.3							
86	72AR 119	60.1965	153.1838	Quartz diorite	Biotite	K/Ar	8.115	0.022	18.63	94.8	153.0	4.7	Lake Clark	Quartz diorite. Unit is Jurassic tonalite. <i>According to the available notes, the sample was not considered optimum for dating. Weighted mean of two determinations for each mineral. Discordant biotite and hornblende. Recalculated with constants of Steiger and Jager (1977).</i>									
									19.06	80.1	156.0	4.7											
															weighted mean					<b>154.5</b>	<b>3.3</b>		
															Hornblende	K/Ar	1.091	0.001	2.702	87.8	165.0	5.0	
								weighted mean					<b>167.5</b>	<b>3.6</b>									
87	72AR 71	60.1953	153.4614	Granodiorite	Biotite	K/Ar	7.815	0.021	3.867	75.0	34.1	1.0	Lake Clark	Medium-grained biotite hornblende granodiorite quartz diorite. Cretaceous granodiorite unit. <i>Weighted mean of two biotite determinations. Discordant biotite and hornblende. Recalculated with constants of Steiger and Jager (1977).</i>									
									3.888	20.7	34.2	1.0											
						weighted mean					<b>34.2</b>	<b>0.7</b>											
88	78AR 85	60.1869	153.6474	Quartz monzonite	Biotite	K/Ar	8.830	0.014	0.9011	81.8	71.7	2.2	Lake Clark	Coarse grained biotite quartz monzonite. Specular hematite in altered quartz monzonite. Samples for spectrometry. Little Lake Clark biotite granite unit.									
									0.857	0.0	0.9011	81.8			71.7	2.2							
89	77AR 56	60.1733	153.8697	Granodiorite	Hornblende	K/Ar	0.457	0.008	0.241	33.0	36.3	1.1	Lake Clark	Medium to fine grained relatively fresh hornblende-biotite granodiorite to quartz diorite; biotite and hornblende are green. Current Creek granodiorite. <i>An unpublished biotite <sup>40</sup>Ar/<sup>39</sup>Ar date was 37.8 Ma and concordant with the hornblende.</i>									
90	72AR 67	60.1706	153.3418	Quartz diorite	Biotite	K/Ar	6.685	0.021	7.339	72.9	74.7	2.2	Lake Clark	Good sample of biotite hornblende quartz diorite. Unit is Jurassic tonalite. <i>Biotite K<sub>2</sub>O a bit low at 6.685%, which commonly suggests a problem with the age. Discordant biotite and hornblende. Recalculated with constants of Steiger and Jager (1977).</i>									
									0.797	0.0	1.765	89.0			147	4.4							
91	72AR 51	60.1545	153.4107	Hornblendite	Hornblende	K/Ar	0.395	0.001	0.4628	59.3	79.6	2.4	Lake Clark	There are many large blocks of hornblendite; one was taken for lab standard. Unit is Jurassic tonalite. <i>Approximate location, no dot on field map at label. Recalculated with constants of Steiger and Jager (1977).</i>									
92	78ARa 22a	60.136	154.3632	Rhyolite	Biotite	K/Ar	7.675	0.049	5.564	75.5	49.7	1.5	Lake Clark	Pumiceous ash flow tuff breccia.									
93	72AR 86	60.1242	153.6946	Granodiorite	Biotite	K/Ar	9.075	0.007	4.563	56.7	34.6	1.0	Lake Clark	Biotite hornblende quartz monzonite or granodiorite. This is the same rock as 72AR 72, 72AR 75, and 72AR 76. Crosscut pluton. <i>Concordant biotite and hornblende. Recalculated with constants of Steiger and Jager (1977).</i>									
									0.398	0.001	0.1923	47.1			33.2	1.0							
94	72AR 56	60.1225	153.0677	Quartz diorite	Biotite	K/Ar	7.860	0.014	19.43	94.0	164.0	5.0	Lake Clark	Hornblende-biotite diorite or quartz diorite. Adjacent to Iliamna Volcano. <i>Weighted mean of two determinations for biotite and hornblende. Discordant biotite and hornblende where biotite is older. Recalculated with constants of Steiger and Jager (1977).</i>									
									18.70	83.0	158.0	4.9											
															weighted mean					<b>160.9</b>	<b>3.5</b>		
															Hornblende	K/Ar	0.342	0.001	0.7794	76.5	151.7	4.7	
								weighted mean					<b>152.7</b>	<b>3.3</b>									



Map no.	Sample	Latitude (degrees north)	Longitude (degrees west)	Rock type	Mineral	Method	%K <sub>2</sub> O	SD_K <sub>2</sub> O	<sup>40</sup> Ar <sub>rad</sub> M/gr X 10 <sup>-10</sup>	% <sup>40</sup> Ar <sub>rad</sub>	Age (Ma)	Error (Ma) 1 σ	Quadrangle	Description	
95	77AR 60	60.1141	153.5375	Granodiorite	Biotite	K/Ar	9.045	0.035	4.243	57.2	32.3	1	Lake Clark	Medium grained non-foliated hornblende-biotite granodiorite; 50/50 hornblende biotite; may be 35-40 Ma. This pluton is south of Pile River but does not appear to be the quartz monzonite 77AR 57. Crosscut pluton. <i>Weighted mean of two hornblende determinations. Discordant biotite and hornblende where biotite is older.</i>	
					Hornblende	K/Ar	0.472	0.012	0.1758	14.5	25.7	0.8			
						weighted mean					<b>27.6</b>	<b>0.6</b>			
96	77AR 48	60.0979	153.5565	Quartz monzonite	Biotite	K/Ar	9.505	0.007	4.369	60.3	31.7	1.0	Lake Clark	Medium grained biotite quartz monzonite/granodiorite. This is definitely the same rock as 77AR 46. Cretaceous leucocratic granodiorite unit.	
97	72AR 76	60.0881	153.7206	Granodiorite	Biotite	K/Ar	8.715	0.021	4.343	77.5	34.2	1.0	Lake Clark	Medium-grained fresh biotite hornblende quartz monzonite granodiorite. This is the same as 72AR 72 and 72AR 75. Crosscut pluton. <i>Recalculated with constants of Steiger and Jager (1977). Discordant biotite and hornblende where biotite is slightly older.</i>	
					Hornblende	K/Ar	0.537	0.004	0.2345	33.7	30.1	0.9			
98	77AR 84	60.0704	153.9692	Granodiorite	Biotite	K/Ar	7.055	0.049	4.046	27.1	39.4	1.2	Lake Clark	This may be equivalent to the pink intrusive. Biotite quartz monzonite/granodiorite containing minor hornblende; characterized by many ovoid inclusions of volcanic rock. Tazamina granite. <i>Biotite K<sub>2</sub>O only 7.055%, suggesting a possible problem. Weighted mean of two hornblende determinations. Discordant biotite and hornblende, where biotite is older.</i>	
					Hornblende	K/Ar	0.565	0.004	0.2973	29.2	36.2	1.1			
						weighted mean					<b>35.4</b>	<b>0.7</b>			
99	77AR 59	60.0579	153.7441	Granodiorite	Hornblende	K/Ar	1.132	0.001	1.301	73.6	78.1	2.3	Lake Clark	Aligned hornblende unit. Traverse across hornblende body: 1. Hornblende quartz diorite boulders cut by fine grained hornblende-biotite quartz diorite/granodiorite (33 Ma Body). 2. Hornblende body cuts mafic rock which looks volcanic; Talkeetna Formation? 3. Hornblende body has "boulders" of hornblende 4. Hornblende body is strongly foliated (no compass today!) 5. Hornblende contains elongated xenoliths 6. Hornblende body appears to be Jurassic 7. Hornblende body engulfs porphyritic andesite; Talkeetna Formation. <i>No dot on field map at label, location is approximate.</i>	
100	72AR 94	60.0435	153.4756	Quartz diorite	Biotite	K/Ar	9.160	0.014	4.257	71.2	32.0	1.0	Lake Clark	Medium grained biotite hornblende quartz diorite. <i>Location uncertain, no dot on field map at label. Concordant biotite and hornblende. Recalculated with constants of Steiger and Jager (1977).</i>	
					Hornblende	K/Ar	0.584	0.0	0.2682	55.8	31.6	0.9			
101	78AR 4	60.0389	153.8736	Granodiorite	Biotite	K/Ar	8.98	0.071	6.926	83.6	52.8	1.6	Lake Clark	Aligned hornblende unit. <i>Discordant biotite and hornblende.</i>	
					Hornblende	K/Ar	1.003	0.005	1.156	20.8	78.3	2.3			
102	78AR 147	60.0352	153.7232	Granodiorite	Biotite	K/Ar	8.85	0.042	8.463	62.3	65.2	2.0	Lake Clark	Hornblende and some biotite quartz monzonite; broader phase of biotite quartz monzonite and aligned hornblende; local K-feldspar crystals up to 2 inches long and 1 inch wide. Cretaceous leucocratic granodiorite unit. <i>Weighted mean of two biotite determinations. Discordant biotite and hornblende.</i>	
						weighted mean					<b>65.6</b>	<b>1.4</b>			
103	72AR 112	60.0313	153.379	Quartz diorite	Hornblende	K/Ar	1.210	0.004	1.283	78.0	72.2	2.2	Lake Clark	Also reported as trondhjemite containing accessory titanite. Assigned to trondhjemite unit. <i>Recalculated with constants of Steiger and Jager (1977). Discordant biotite and muscovite.</i>	
					Muscovite	K/Ar	10.405	0.006	21.24	95.9	136	4.1			
104	77ANw 116	60.0306	153.3695	Felsic igneous	Biotite	K/Ar	7.450	0.0	10.83	87.8	98.2	2.9	Lake Clark	<i>Recalculated with constants of Steiger and Jager (1977). Concordant biotite and hornblende.</i>	
					Hornblende	K/Ar	0.570	0.008	0.7078	40.1	84.3	2.5			
105	72AR 82	60.0295	153.6808	Granodiorite	Biotite	K/Ar	8.050	0.014	8.116	40.5	68.7	2.0	Lake Clark	Medium- to medium-coarse-grained biotite quartz monzonite. Cretaceous leucocratic granodiorite unit. <i>Recalculated with constants of Steiger and Jager (1977).</i>	
106	72AR 273	59.9846	153.7595	Granodiorite	Biotite	K/Ar	8.56	0.0	4.777	57.5	38.4	1.2	Iliamna	Biotite hornblende granodiorite. <i>Recalculated with constants of Steiger and Jager (1977).</i>	
107	77AR 91	59.9567	154.0523	Granodiorite	Biotite	K/Ar	8.085	0.007	4.963	78.1	42.1	1.3	Iliamna	Biotite hornblende quartz monzonite; probably equivalent to pink granite. Locally present are ovoid inclusions of volcanic or more mafic intrusive rocks. Tazamina granite. <i>AGDB reports quartz monzonite. Discordant biotite and hornblende; biotite significantly older.</i>	
					Hornblende	K/Ar	0.404	0.013	0.1795	13.4	30.6	0.9			
108	72AR 215	59.9394	153.4735	Trondhjemite	Muscovite	K/Ar	10.15	0.078	21.54	80.4	143.5	4.3	Iliamna	Coarse grained biotite muscovite quartz diorite/trondhjemite. This is very similar to 72AR 96, 72AR 101 and 72AR 112 in the Lake Clark A-2 Quadrangle. Assigned to trondhjemite unit. <i>AGDB calls it quartz diorite. Recalculated with constants of Steiger and Jager (1977).</i>	
109	77AR 94	59.936	154.0406	Granodiorite	Hornblende	K/Ar	1.051	0.001	1.183	78.4	76.5	2.3	Iliamna	Hornblende granodiorite/quartz diorite; as seen at Station 77AR 92. Aligned hornblende unit.	
110	77AR 97	59.9131	154.1451	Quartz diorite	Biotite	K/Ar	8.670	0.015	10.35	85.4	81	2.4	Iliamna	Long smooth ridge of non-foliated hornblende-biotite quartz diorite containing minor titanite. This appears to be Jurassic but it seems to be a little too far west for that. It could still be equivalent to the Knudsen Bay quartz diorite. Aligned hornblende unit. <i>Weighted mean of two hornblende determinations. Discordant biotite and hornblende.</i>	
					Hornblende	K/Ar	0.995	0.001	1.321	78.6	89.9	2.7			
						weighted mean					<b>88.3</b>	<b>1.9</b>			
111	72AR 199	59.8988	153.8578	Granodiorite	Biotite	K/Ar	8.950	0.015	3.344	77.9	25.8	0.8	Iliamna	Non-foliated granodiorite or quartz monzonite, containing hornblende and minor biotite. This could either be equivalent to potassium-rich Jurassic or Knutson Bay intrusive rocks. <i>Discordant biotite and hornblende. Weighted mean of two determinations on biotite. Recalculated with constants of Steiger and Jager (1977). See <sup>40</sup>Ar/<sup>39</sup>Ar hornblende date.</i>	
						weighted mean					<b>26.0</b>	<b>0.6</b>			
112	78AR 12	59.8387	154.1203	Quartz monzonite	Biotite	K/Ar	8.760	0.014	9.898	85.2	76.8	2.3	Iliamna	Very coarse grained biotite granite to quartz monzonite containing pink K-feldspar. Knutson Bay granite unit. It may also be equivalent to 35 Ma quartz monzonite to the east.	
					Hornblende	K/Ar	0.535	0.016	0.273	39.0	35.1	1.0			

**Table 2.** Descriptive information and  $^{40}\text{Ar}/^{39}\text{Ar}$  analytical data for samples of the Alaska-Aleutian Range batholith in the Lime Hills 1:250,000-scale quadrangles, south-central Alaska.

[Rock descriptions and notes derived verbatim from the field notes of Bruce L. Reed, additions in italics by report authors. Analyses by Marvin Lanphere. Samples collected by AR, Bruce Reed; AGe, Bruce Gamble; AL, Marvin Lanphere. Latitude and longitude use NAD83 datum; Ma, million years ago; n.a., data not available; CI, color index; %, percent; cm, centimeter]

Map letter	Sample	Latitude (degrees north)	Longitude (degrees west)	Rock type	Mineral	$^{40}\text{Ar}/^{39}\text{Ar}$	$^{37}\text{Ar}/^{39}\text{Ar}$	$^{36}\text{Ar}/^{39}\text{Ar}$	$^{40}\text{Ar}_{\text{rad}} (\times 10^{-12} \text{ mol})$	% $^{40}\text{Ar}_{\text{rad}}$	K/Ca	J	Age (Ma)	Error (Ma) $1\sigma$	Quadrangle	Description
A	88AR 225	61.9917	153.5431	Granodiorite	Biotite	3.391	0.02071	0.003564	9.249	69.0	23.7	0.0110	45.8	0.7	Lime Hills	Hornblende granodiorite containing some biotite; rock has an altered greenish cast: CI 15.
B	88AR 238	61.9384	154.3584	Granodiorite	Biotite	4.323	0.03556	0.003356	64.47	77.1	13.8	0.01082	63.9	0.5	Lime Hills	Medium- to fine-grained biotite granodiorite possibly containing some hornblende; CI 15. This contains subhedral K(?) feldspar and 15% phenocrysts. This could be considered sub-porphyritic.
C	88AR 241	61.9044	153.235	Granodiorite	Biotite	3.674	0.02482	0.005757	31.97	53.7	19.7	0.01096	38.6	0.4	Lime Hills	Reddish brown medium-grained granite or granodiorite containing generally fresh biotite and weird-appearing soda amphibole or pyroxene; CI 10.
D	88AR 220	61.8394	153.5217	Granodiorite	Biotite	7.087	0.00928	0.001585	31.32	93.3	52.8	0.00556	65.1	0.4	Lime Hills	Medium-grained biotite granodiorite having high quartz content; biotite is excellent; CI 12-15. This rock does not have the greenish gray cast that Station 88AR 219 have. This rock may be more 'calc alkaline' than previous stations. This is a nice rock.
E	88AR 219	61.8039	153.6058	Granodiorite	Hornblende	4.176	0.03417	0.002852	22.88	79.9	14.3	0.01102	65.1	0.6	Lime Hills	Medium-fine grained biotite granodiorite containing altered clots of what might be pyroxene; CI 15.
F	88AR 245	61.7408	153.1908	Granite	Biotite	5.075	0.06988	0.007588	52.96	55.9	7.0	0.01112	56.0	0.5	Lime Hills	Very fresh slightly porphyritic biotite granite containing K-feldspar, quartz, and possibly a little hornblende. This rock is probably the core of the intrusion and probably the main rock type. It appears to be part of the Merrill Pass sequence.
G	88AR 246	61.6692	153.2839	Granite	Biotite	3.723	0.08465	0.005258	6.792	58.4	5.8	0.01072	41.6	0.8	Lime Hills	Very fresh, very fine-grained reddish-white biotite granite containing needles of hornblende; CI is about 10-12. All the rock samples in the cirque are the same. There is some pseudo layering on cliffs that suggests tuff.
H	88AR 234	61.5594	153.7053	Monzonite	Biotite	7.720	0.04859	0.001746	30.98	93.3	10.1	0.005505	70.1	0.4	Lime Hills	Foliated fresh hornblende diorite and monzonite containing some biotite: CI 20.
					Hornblende	9.163	4.017	0.0049975	2.546	98.3	0.12	0.005335	75.6	0.5		<i>Discordant biotite and hornblende.</i>
I	88AR 266	61.5342	153.6767	Monzonite	Hornblende	6.902	5.257	0.01268	1.483	51.7	0.10	0.01162	73.5	5.3	Lime Hills	Hornblende monzodiorite to diorite containing some fresh biotite; both hornblende and biotite are very good; CI 20.
J	88AR 268C	61.4867	153.6894	Tuff	Hornblende	7.44	8.203	0.02134	1.205	23.8	0.10	0.01053	33.6	3.4	Lime Hills	Coarse grained greenish crystal-rich inclusion-rich vent(?) material containing biotite and possibly some hornblende; inclusion clasts of 76 Ma intrusive up to 10 inches?. There are two granitic types in this rock no inclusions of flysch (Kahiltna).
K	88AR 256	61.4469	153.5819	Monzodiorite	Biotite	3.984	0.0201	0.00242	32.2	82.1	24.4	0.01118	64.8	0.5	Lime Hills	Some altered biotite hornblende monzodiorite; the biotite is fine-grained and reddish brown and the rock itself is ok; forget about the hornblende; CI 15.
L	88AR 216	61.4353	153.815	Granodiorite	Biotite	2.601	0.01079	0.002733	27.16	68.9	45.4	0.01121	35.9	0.3	Lime Hills	Biotite hornblende granodiorite to quartz diorite; float from the hillside. <i>Discordant biotite and hornblende where the biotite is slightly older.</i>
M	87AR 38	61.4261	153.395	Granodiorite	Biotite	5.414	0.09572	0.005796	9.808	68.4	5.1	0.00552	36.5	0.3	Lime Hills	Intrusive rock containing biotite and minor amphibole(?). This is not a lithic tuff as thought. It could be a late stage dome-type intrusive. The biotite should provide good clues as to the minimum age of the volcanic rocks.
N	91AL 8	61.4236	153.1095	Granodiorite	Biotite	3.293	0.1614	0.004313	26.94	61.5	3.0	0.01119	40.4	5.2	Lime Hills	n.a.
O	88AR 249	61.3639	153.4767	Rhyolite	Biotite	4.487	0.2813	0.008216	28.84	46.3	1.7	0.01106	41	1.6	Lime Hills	Fresh columnar jointed biotite-bearing rhyolite ash flow. The sanidine is not as good as the biotite. Some sanidine has fresh cleavage faces, tuff includes quartz phenocrysts. The high peak in the north is at least 300 meters of ash.
P	88AR 235	61.3542	153.6711	Granodiorite	Biotite	2.537	0.02028	0.00256	24.58	70.2	24.2	0.01120	35.6	0.3	Lime Hills	Medium-grained granodiorite containing good biotite and minor, possibly chloritized, hornblende; CI is about 15.
Q	88AR 261	61.3506	153.3914	Tuff	Sanidine	4.596	0.2927	0.009325	23.54	40.4	1.7	0.01133	37.6	1.8	Lime Hills	Black albite sanidine lithic crystal tuff. The sanidine seems quite good. This is probably lower in the volcanic pile than the sample collected yesterday in Station 88AR 249. This spot is actually light green lithic tuff containing hard collapsed pumice fragments that seem to be overlain by the black rhyolitic lithic tuff which was sampled from the glacial moraine.
R	87AR 61	61.2689	153.4733	Granite	Biotite	4.246	0.03967	0.000656	2.78	95.4	12.4	0.00578	42.2	0.3	Lime Hills	Biotite granite containing a trace of hornblende. This is what we have been calling the Merrill Pass sequence. The only thing that differs in the Merrill Pass rocks is the amount of hornblende but the difference is not enough to worry about at the moment.
S	87AGe 37	61.2111	153.6158	Granodiorite	Biotite	4.333	0.04146	0.00210	17.4	85.6	11.8	0.00578	38.3	0.3	Lime Hills	Medium-grained equigranular granodiorite(?) containing 15% biotite and 20% quartz and no hornblende; contains a few large K-feldspar phenocrysts (3 cm by 3 cm).
T	87AGe 44	61.0189	153.6481	Granodiorite	Hornblende	10.481	10.65	0.01688	7.478	60.3	0.046	0.00544	61.4	0.7	Lime Hills	Medium-grained equigranular granodiorite containing about 15% hornblende and 15-20% quartz and no biotite like other stations in this intrusive.
E	88AR 219	61.8039	153.6058	Granodiorite	Hornblende	4.176	0.03417	0.002852	22.88	79.9	14.3	0.01102	65.1	0.6	Lime Hills	Medium-fine grained biotite granodiorite containing altered clots of what might be pyroxene; CI 15.
F	88AR 245	61.7408	153.1908	Granite	Biotite	5.075	0.06988	0.007588	52.96	55.9	7.0	0.01112	56.0	0.5	Lime Hills	Very fresh slightly porphyritic biotite granite containing K-feldspar, quartz, and possibly a little hornblende. This rock is probably the core of the intrusion and probably the main rock type. It appears to be part of the Merrill Pass sequence.
G	88AR 246	61.6692	153.2839	Granite	Biotite	3.723	0.08465	0.005258	6.792	58.4	5.8	0.01072	41.6	0.8	Lime Hills	Very fresh, very fine-grained reddish-white biotite granite containing needles of hornblende; CI is about 10-12. All the rock samples in the cirque are the same. There is some pseudo layering on cliffs that suggests tuff.
H	88AR 234	61.5594	153.7053	Monzonite	Biotite	7.720	0.04859	0.001746	30.98	93.3	10.1	0.005505	70.1	0.4	Lime Hills	Foliated fresh hornblende diorite and monzonite containing some biotite: CI 20.
					Hornblende	9.163	4.017	0.0049975	2.546	98.3	0.12	0.005335	75.6	0.5		<i>Discordant biotite and hornblende.</i>
I	88AR 266	61.5342	153.6767	Monzonite	Hornblende	6.902	5.257	0.01268	1.483	51.7	0.10	0.01162	73.5	5.3	Lime Hills	Hornblende monzodiorite to diorite containing some fresh biotite; both hornblende and biotite are very good; CI 20.
J	88AR 268C	61.4867	153.6894	Tuff	Hornblende	7.44	8.203	0.02134	1.205	23.8	0.10	0.01053	33.6	3.4	Lime Hills	Coarse grained greenish crystal-rich inclusion-rich vent(?) material containing biotite and possibly some hornblende; inclusion clasts of 76 Ma intrusive up to 10 inches?. There are two granitic types in this rock no inclusions of flysch (Kahiltna).
K	88AR 256	61.4469	153.5819	Monzodiorite	Biotite	3.984	0.0201	0.00242	32.2	82.1	24.4	0.01118	64.8	0.5	Lime Hills	Some altered biotite hornblende monzodiorite; the biotite is fine-grained and reddish brown and the rock itself is ok; forget about the hornblende; CI 15.
L	88AR 216	61.4353	153.815	Granodiorite	Biotite	2.601	0.01079	0.002733	27.16	68.9	45.4	0.01121	35.9	0.3	Lime Hills	Biotite hornblende granodiorite to quartz diorite; float from the hillside. <i>Discordant biotite and hornblende where the biotite is slightly older.</i>
					Hornblende	8.627	9.007	0.02587	4.913	19.5	0.054	0.01121	34.0	1.2		

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