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GEOCHRONOLOGIC DATA FOR THE ARABIAN SHIELD

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and Richard Marvin

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GEOCHRONOLOGIC DATA FOR THE ARABIAN SHIELD

Section 1. Radiometric age determinations of some rocks from the Arabian Shield

by

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The radiometric ages reported below were completed during the period 1957-1963. The rock samples were provided and examined petrographically by Glen F. Brown and his associates at the U.S. Geological Survey. The 25 Rb-Sr ages of biotites and feldspars and the 25 K-Ar ages of biotites, hornblendes, and total rock samples constituted the initial suite of ages for the Arabian Shield. Zircons in the quantity required for analysis were not found in any of the rocks examined. The sample locations are distributed over the whole Arabian Shield; the locations, the sample numbers and the rock types as determined by petrographic examination of thin sections are given in table 1. Of the 50 dates, 31 have been published without supporting chemical data on U.S. Geological Survey geologic maps I200A, I204A, I206A, and I211A. (Bramkamp, Layne and others, 1963; Brown and others, 1963; Bramkamp and others, 1963; Brown, Jackson, Bogue, and MacLean, 1963; Jackson and others, 1963). Table 2 includes the minerals analyzed and the analytical data obtained. The sample numbers correspond to those of table 1. All of the analyses were made using stable isotope dilution procedures described previously (Aldrich and others, 1956; Aldrich, 1956). The precision of the ratios $^{87}*Sr/^{87}Rb$ is better than 5% for all samples with a ratio $^{87}Sr/^{88}Sr > 0.11$. For the cases when $0.085 < \frac{^{87}Sr}{^{88}Sr} < 0.11$, the error in the ratio $^{87}*Sr/^{87}Rb$

Table 1. Rock type and location of samples from Saudi Arabia

Sample No.	Locality Name (J.=Jebel) W.=Wadi)	Rock type	Longitude (East)	Latitude (North)
1.	W. Afal	Granodiorite	35°09'17"	28°51'40"
2.	W. Moss	Biotite granite	35°04'18"	28°35'08"
3.	J. Lauz	Biotite perthite granite	35°24'35"	28°33'28"
4.	Shaib as Siq	Diorite	35°44'47"	28°02'10"
5.	Shaib as Siq	Amphibolite schist	35°47'05"	28°02'26"
6.	J. Harb	Microcline granite	35°36'08"	27°55'24"
7.	J. Harb	Charnockite	35°37'14"	27°55'20"
8.	J. Shar	Peralkaline granite	35°42'31"	27°42'42"
9.	J. Selma	Perthite biotite granite	42°07'22"	27°08'33"
10.	J. Tin	Orthoclase granite	42°19'24"	26°16'09"
11.	J. al Aswad	Albite biotite granite	38°13'35"	25°33'32"
12.	J. Um ad Diban	Biotite granodiorite	43°51'54"	24°57'25"
13.	J. Jabalah	Biotite granite	43°55'12"	24°50' 0"
14.	J. Za'abah	Biotite perthite granite	44°48'24"	23°47'42"
15.	J. Hamām	Granodiorite gneiss	41°38'06"	23°41'12"
16.	J. Qusās	Granite gneiss	45°14'31"	23°18'06"
17.	J, Za'n (E. Batholith)	Biotite granite	44°53'57"	22°36'16"
18.	Jidda	Binary granite	39°16'06"	21°30'49"
19.	Mecca	Trondhjemite	39°57'12"	21°30' 0"
20.	Mecca	Pegmatite	40°01'52"	21°32'11"
21.	Taif	Biotite quartz monzonite	40°24'06"	21°13'54"
22.	SE Jebel Qunah	Microcline biotite granite	41°16'26"	20°51'49"
23.	W. Turaba	Quartz diorite	41°14'33"	20°43'24"
24.	J. Rafā'	Peralkaline granite	41°57'30"	20°27'30"
25.	W. Ranya	Calcalkalic granite	42°01'36"	20°21'0"
26.	W. Wahrugh (D-34)	Biotite granite	43°07'25"	17°42'13"
27.	W. Qa'a (D-24)	Orthoclase granite	43°17'30"	17°42'30"

Sample No.	Mineral	^{87}Rb ppm	$^{87}Sr^*$ ppm	$^{87}Sr/^{88}Sr$	$^{87}Sr^*/^{87}Rb$	K (%)	^{40}K ppm	$^{40}Ar^*$ ppm	$^{40}Ar^*/^{40}Ar$ (total)	$^{40}Ar^*/^{40}K$
1.	Hornblende	-	0.590	-	-	0.956	1.14	0.0363	0.74	0.0318
2.	Feldspar	44.8	0.131	0.0901	0.0131	11.0	-	-	-	-
3.	Biotite	221	0.482	0.219	0.00616	5.35	-	-	-	-
4.	Hornblende	-	-	-	-	0.409	0.487	0.0213	0.72	0.0437
5.	Hornblende	-	-	-	-	0.465	0.555	0.0155	0.38	0.0279
6.	Feldspar	125.3	1.157	0.253	0.00923	13.2	-	-	-	-
7.	Hornblende	-	-	-	-	0.937	1.118	0.0430	0.84	0.0384
8.	Hornblende	-	-	-	-	0.398	0.485	0.0464	0.58	0.0977
9.	Biotite	320	2.63	0.335	0.00822	5.61	6.69	0.272	0.67	0.0406
	Feldspar	84.9	0.623	0.0992	0.0072±.0005	7.99	-	-	-	-
10.	Biotite	40.9	0.356	0.0976	0.0087±.0005	3.16	3.77	0.170	0.70	0.0451
11.	Biotite	57.5	0.275	0.0904	0.0048±.0005	5.84	6.97	0.229	0.90	0.0329
12.	Biotite	95.9	0.718	0.1161	0.00748	6.34	7.56	0.303	0.85	0.0401
	Feldspar	123	1.01	0.1274	0.00822	9.59	-	-	-	-
13.	Biotite	230	1.930	0.2104	0.00839	5.09	6.07	0.2388	0.89	0.0393
14.	Biotite	301	2.36	0.434	0.00784	6.09	7.27	0.2650	0.97	0.0365
	Feldspar	101	0.926	0.1226	0.00932	7.52	-	-	-	-
15.	Hornblende	-	-	-	-	0.544	0.649	0.0448	0.90	0.0690
	Biotite	88.5	0.845	0.1152	0.00952	4.87	5.81	0.304	0.94	0.0523
16.	Biotite	53.5	0.765	0.1181	0.0145	6.30	7.52	0.287	0.95	0.0382
17.	Biotite	235	1.80	0.1304	0.00766	4.88	5.82	0.218	0.95	0.0375
18.	Biotite	116	1.70	0.1403	0.0147	5.44	6.49	0.333	0.85	0.0513
19.	Biotite	50.7	0.699	0.1100	0.0138	7.40	8.83	0.484	0.92	0.0548
20.	Muscovite	99.4	1.177	1.301	0.0118	8.88	10.50	0.617	0.86	0.0588
21.	Biotite	116.4	0.874	0.1004	0.0075±.0005	3.93	4.69	0.1703	0.75	0.0393
22.	Biotite	130	0.950	0.1432	0.00735	4.54	5.42	0.1413	0.72	0.0261
	Feldspar	66.5	0.603	0.1256	0.00908	9.42	-	-	-	-
23	Biotite	30.5	0.342	0.1092	0.0112±.0005	5.06	6.04	0.256	0.77	0.0424
24.	Biotite	763	6.25	3.97	0.00819	7.82	9.33	0.360	0.84	0.0386
	Feldspar	319	2.57	0.401	0.00808	10.53	-	-	-	-
25.	Biotite	85.7	0.881	0.1420	0.0103	7.05	8.41	0.449	0.94	0.0534
26.	Total Rock	-	-	-	-	2.20	2.62	0.0686	0.93	0.0261
27.	Total Rock	-	-	-	-	1.54	1.84	0.0647	0.92	0.0352

is indicated. The precision of the $^{87}Sr/^{88}Sr$ is .3% or less and is independent of the assumption of the ratio 86/88 to first order. The absolute ratio, $^{87}Sr/^{88}Sr$, may be in error as much as 0.5% due to processes in thermal ionization and to errors in tracer calibrations which have not, as yet, been discovered.

The precision of the argon determinations is better than 1%. This upper limit is set by the variations in ratios $^{36}Ar/^{40}Ar$ in atmospheric argon observed over the years during which it has been measured at Carnegie. The ^{40}K determination has an error of 3% or less based on reproducibility of results on the same rock sample and the results of mixing standard potassium solutions of different isotopic composition. The errors in the ratios $^{40}Ar/^{40}K$ are less than 4%.

Table 3 gives the ages derived from the analytical measurements of table 2 based on the assumptions as to isotopic abundances and decay constants stated. Fig. 1 is a histogram of the distribution of ages found by the different methods applied to hornblende, biotite, and feldspar-muscovite. The first result of these measurements is the indication that the last event affecting the ages occurred over most of the Arabian Shield about 500 m.y. ago. Secondly, remnants of minerals as old as 1100 m.y. have been found, scattered throughout the shield. The Rb-Sr ages of potassium feldspars and muscovites have been found to be consistently resistant to alteration by metamorphic events which do affect the biotite ages (Aldrich and others, 1965). The six feldspars and the muscovite considered above

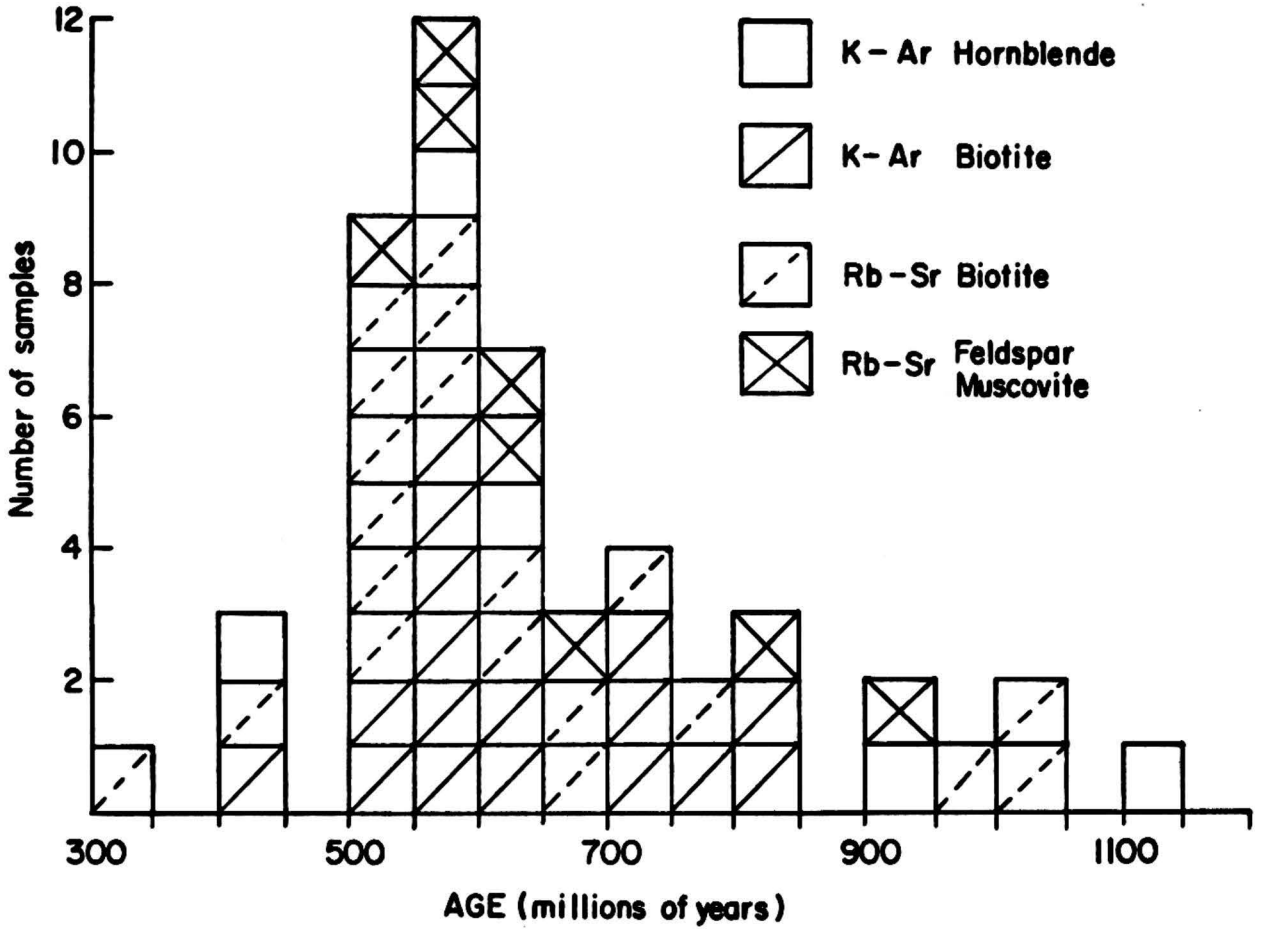

FIG. 1: Histogram showing distribution of K-Ar and Rb-Sr ages for several minerals.

Table 3. Ages of mineral samples from Saudi Arabia

Sample No.	Locality Name (J.=Jebel) (W.=Wadi)	Mineral	Rb-Sr age[1] (m.y.)	K-Ar age[2] (m.y.)
1.	W. Afal	Hornblende	-	480
2.	W. Moss	Feldspar	920±200	-
3.	J. Lauz	Biotite	430	-
4.	Shaib as Siq	Hornblende	-	630
5.	Shaib as Siq	Hornblende	-	425
6.	J. Harb	Feldspar	645	-
7.	J. Harb	Hornblende	-	565
8.	J. Shar	Hornblende	-	1190
9.	J. Selma	Biotite	575	590
	J. Selma	Feldspar	505±50	-
10.	J. Tin	Biotite	610±40	645
11.	J. al Aswad	Biotite	340±70	490
12.	J. Um ad Diban	Biotite	525	585
	J. Um ad Diban	Feldspar	575	-
13.	J. Jabalah	Biotite	590	575
14.	J. Za'abah	Biotite	550	540
	J. Za'abah	Feldspar	655	-
15.	J. Hamam	Hornblende	-	915
	J. Hamam	Biotite	665	730
16.	J. Qusas	Biotite	1010	560
17.	J. Za'n (E. Batholith)	Biotite	540	550
18.	Jidda	Biotite	1025	720
19.	Mecca	Biotite	965	760
20.	Mecca	Muscovite	825	800
21.	Taif	Biotite	525	535
22.	SE Jebel Qunah	Biotite	515	400
		Feldspar	635	-
23.	W. Turaba	Biotite	785	615
24.	J. Rafa'	Biotite	575	565
		Feldspar	565	-
25.	W. Ranya	Biotite	720	740
26.	W. Wahrugh (D-34)	Total Rock	-	400
27.	W. Qa'a (D-24)	Total Rock	-	525

[1] Ages based on Rb^{87} properties: 0.283 g $^{87}Rb/g\ ^{87}Rb$, $\lambda\beta(^{87}Rb) = 1.42 \times 10^{-11}\ yr^{-1}$

[2] Ages based on K^{40} properties: 119.3 μg $^{40}K/g\ K$, $\lambda e(^{40}K) = 0.581 \times 10^{-10}\ yr^{-1}$

$\lambda\beta(^{40}K) = 4.962 \times 10^{-10}\ yr^{-1}$

do not give a pattern basically different from that of the biotites by themselves or from that seen in all of the Rb-Sr ages measured. The pattern of hornblende K-Ar ages is also similar to that obtained from the other minerals. The simplest generalized picture of the Arabian Shield from these data is that of a large area of 1000-1200 m.y. ages on which has been superposed an event culminating 550 m.y.B.P. A particular sequence of samples with geographic proximity is that starting at Jidda with sample No. 18 and continuing southeast about 300 km. Samples 18, 19, 20, 23, 25 have an age pattern similar to that observed for Precambrian rocks in the Appalachians, which is generally discordant and ranging down from 1050 m.y. Samples 21, 22, and 24 are relatively concordant and may represent younger rocks associated with the event which lowered the age of the other rocks.

These data should be compared with the K-Ar ages obtained in Eastern Egypt as published by Higazy and El-Ramly (1960) in the area between latitude 33°-35° East.

The total rock argon ages of samples 26 and 27 are presented, not as a measure of their true age or even an approximation of the time of any "event" in this area, but rather to indicate the minimum age that may be ascribed to these rocks. It must be pointed out that these samples could be older than those in the northern part of the shield and still have this young apparent age, due to argon leakage from the potassium feldspars.

Section II. Tabulation of Rb-Sr and K-Ar ages given by Arabian Shield Rocks

by

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During the course of initial geologic field work by the U.S. Geological Survey in the Arabian Shield, 101 radiometric ages were determined from rocks in the Precambrian Z-Precambrian Y-Cambrian basement. These ages were determined after the pioneer age-work of Tom Aldrich (see Section I). This tabulation of Rb-Sr and K-Ar ages is presented for the benefit of other geologists and geochemists who are presently working in the region. We caution those who use these ages to remember the limitations of Rb-Sr and K-Ar ages.

Carl Hedge analyzed 31 samples (table 4) in the Denver laboratory, U.S. Geological Survey, and obtained 7 Rb-Sr isochron whole-rock ages and 14 Rb-Sr mineral/whole-rock ages. Seven of the 80 K-Ar ages listed in table 5 were determined by Richard Marvin, Harald Mehnert, and Violet Merritt in the Denver laboratory. Thirty-two K-Ar ages were determined by Geochron Laboratories, Krueger Enterprises, Inc., Cambridge, Mass., and 41 K-Ar ages by Teledyne Isotopes, Westwood, New Jersey.

Of the 31 Rb-Sr age determinations by Hedge, 19 were used to plot isochron diagrams. The igneous samples used for the plots range from gneissic quartz monzonite to aegerine granite and porphyritic felsite. Rb-Sr isochron ages range downward from 731 m.y. for gneissic quartz monzonite to 572 m.y. for the porphyritic felsite. Samples from the aegerine granite gave an isochron age of 590 m.y. Where they could be

precisely determined, the initial Sr^{87}/Sr^{86} ratios were relatively low (0.703 - 0.705). An initial ratio of 0.704 was therefore used to calculate the individual ages reported in table 4. Rhyolite sills or flows in the upper beds of the Murdama Group gave an age of 633 m.y., whereas the underlying and older Hulafah (Halaban) gave an age of 651 m.y. from rhyolite near the top of the group. The latter is especially significant as the rhyolite samples came from drill cores in strata-bound ore deposits syngenetically deposited above the middle Hulayfah (Halaban) andesite and in the lower part of the uppermost rhyolite of the Halaban Group.

The K-Ar ages range from 299 to 932 m.y. The ages younger than about 500 m.y. undoubtedly reflect resetting from a later heating event, probably the late Tertiary vulcanism associated with the formation of the Red Sea. Hornblende ages, which are least susceptible to resetting (argon loss), cluster around 550 and 570 m.y. and from 590-660 m.y. These ages represent events in the Pan African orogeny. Older hornblende ages, 710-778 m.y., are from calc-alkaline syngenetic, generally gneissic, quartz monzonite, granodiorite, and granite bodies which are usually exposed in domes. Ages in the span 805-932 m.y. were obtained mostly from diorite, quartz diorite, and granodiorite plutons exposed in the scarps and foothills east of the Red Sea and in the southern part of the Arabian Shield.

Table 4. RUBIDIUM-STRONTIUM AGES analysed by Carl Hedge — SAUDI ARABIAN CRYSTALLINE ROCKS.

Sample Locality No.	Age (m.y.)	ppm Rb	ppm Sr	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}	Material Analyzed	Rock	Collected by	Location Lat. N.	Location Long. E.
59a	492 ± 15	229	16.4	41.60	0.9968	whole rock	granite	Petty	27° 42'	41° 25'
59b	580 ± 18	169	19.6	25.65	0.9173	whole rock	granite	Petty	27° 42'	41° 25'
68		29.9	58.1	1.491	0.7174	whole rock	rhyolite	Delfour	25° 45'	40° 45'
71	651 ± 40*	5.3	157	0.098	0.7052	whole rock	rhyolite	Delfour	25° 36'	41° 26'
98		45.8	61.3	2.167	0.7245	whole rock	rhyolite	Delfour	23° 51'	40° 56'
77	673 ± 60	119	128	2.701	0.7289	whole rock	granite	Brown	24° 30'	39° 30'
94	633 ± 15*	124	82.6	4.364	0.7440	whole rock	dacite	Brown	23° 42'	39° 40'
106		44.7	107	1.211	0.7149	whole rock	latite	Brown	23° 23'	39° 44'
95	520 ± 15	821	53.2	44.61	1.0202	biotite	granite	Goldsmith	23° 36'	40° 32'
96	572 ± 35*	10.0	111	0.263	0.7068	whole rock	porphyritic felsite	Goldsmith	23° 30'	40° 50'
97		85.3	141	1.753	0.7184	whole rock	do	Goldsmith	23° 32'	40° 54'
99	731 ± 15*	13.7	924	0.53	0.7046	whole rock	gneissic qtz. monzonite	Goldsmith	23° 56'	40° 59'
107		54.4	4.3	36.99	1.0841	whole rock	do	Goldsmith	23° 02'	40° 49'
100a		72.1	5.5	38.38	1.077	whole rock	granite	Goldsmith	32° 32'	41° 06'
100b	692 ± 15*	123	5.1	69.25	1.383	K-feldspar	granite	Goldsmith	32° 32'	41° 06'
100c		72.5	13.2	15.90	0.8682	whole rock	granite	Goldsmith	32° 32'	41° 06'
101a		382	21.9	22.05	0.8821	whole rock	granite	Goldsmith	23° 32'	41° 10'
101b	590 ± 10*	659	86.5	50.60	1.1390	whole rock	granite	Goldsmith	23° 32'	41° 10'
101c		320	1.9	494.9	4.857	whole rock	granite	Goldsmith	23° 32'	41° 10'
108	555 ± 15	535	43.5	35.62	0.9699	biotite	granite	Goldsmith	23° 57'	41° 21'

Sample Locality No.	Age (m.y.)	ppm Rb	ppm Sr	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}	Material Analyzed	Rock	Collected by	Location Lat. N.	Lon
135a	617 ± 10*	98.5	48.2	5.94	0.7587	whole rock	granodiorite	Brown	20° 02'	41°
135b		88.9	24.2	10.73	0.7980	whole rock	granodiorite	Brown	20° 02'	41°
137	582 ± 20	64.5	20.5	9.32	0.7827	whole rock	qtz.monzonite	Brown	20° 11'	41°
169	530 ± 20	496	140	10.33	0.7807	K-feldspar	granite gneiss	Brown	20° 58'	43°
170	576 ± 25	188	78.8	6.896	0.7603	whole rock	granite	Whitlow	21° 18'	44°
193	583 ± 15	184	49.5	10.77	0.7930	whole rock	granite	Trent	19° 33'	41°
224	549 ± 30	212	131	4.625	0.7421	whole rock	granite	Brown	17° 57'	42°
233	586 ± 35	148	118	3.629	0.7361	whole rock	rhyolite	Overstreet	18° 20'	44°
234	585 ± 10	387	9.3	121.0	1.755	microcline	pegmatite	Overstreet	18° 07'	44°
235	550 ± 20	122	29.2	12.06	0.8040	whole rock	granite porphyry	Overstreet	18° 08'	44°
240	694 ± 30	129	60.6	6.185	0.7653	whole rock	gneissic granite	Brown	17° 26'	42°

Decay constant for Rb^{87}: $\lambda = 1.42 \times 10^{-11}$/yr.

* isochron ages

Table 5. POTASSIUM-ARGON AGES SAUDI ARABIAN CRYSTALLINE ROCKS

Sample Locality No.	Age (m.y.)	K%	Ar^{40} $\times 10^{-10}$ moles/gm	%Ar^{40}	Ar^{40}/K^{40}	Analyzed by	Material analyzed	Rock	Collected by	Location Lat. N.	Location Long. E.
22	515 ± 17	2.63 2.67	27.33	94	0.0346	USGS-Marvin Mehnert, Merritt	whole rock	andesite	Brown	27° 45'	36° 10'
26	591 ± 18	6.29 6.34	75.81 77.31	96 89	0.0406	Geochron	biotite	granite	Trent	26° 47'	37° 05'
34	605 ± 18	6.68 6.72	82.07 85.07	98 96	0.0418	Geochron	biotite	granite	Trent	26° 13'	37° 26'
40	528 ± 20	6.53 6.43	68.91	99	0.0356	USGS-Marvin Mehnert, Merritt	biotite	andesite	Brown	26° 28'	38° 13'
44	532 ± 15	1.895 1.872	20.19 20.24	63 91	0.0360	Geochron	whole rock	andesite	Brown	26° 20'	38° 37'
54	567 ± 16	6.52 6.36	74.06 74.81	97 98	0.0387	Geochron	biotite	gneiss (?)	Brown	28° 52'	35° 09'
65	827 ± 40	0.385 0.401	7.061 7.231	75 81	0.0609	Geochron	hornblende	diorite	Brown	25° 48'	39° 13'
67	299 ± 11	1.30 1.32	7.393	83	0.0189	USGS-Marvin Mehnert, Merritt	whole rock	andesite (some alteration)	Brown	25° 33'	40° 45'
69	548 ± 18	1.70 1.71	18.95	95	0.0372	USGS-Marvin Mehnert, Merritt	whole rock	andesite	Brown	25° 33'	40° 45'
72	525 ± 16	1.532 1.500	16.11 15.91	81 82	0.0354	Geochron	whole rock	andesite	Brown	24° 52'	39° 11'
89	577 ± 15	7.27 7.29	89.07 82.57	98 97	0.0395	Geochron	biotite	granite	Mytton	25° 01'	43° 48'
92	595 ± 12	6.12 6.10	75.31 74.06	95 97	0.0409	Geochron	biotite	granite	Mytton	24° 30'	43° 19'

Sample Locality No.	Age (m.y.)	K%	Ar^{40} $\times 10^{-10}$ moles/gm	$\%Ar^{40}$	Ar^{40}/K^{40}	Analyzed by	Material analyzed	Rock	Collected by	Location Lat. N.	Long.
102	566 ± 30	1.095 1.126	13.24 12.38	30 80	0.0386	Geochron	whole rock	basalt	Brown	23° 29'	41° 23'
103	506 ± 15	2.180 2.198	22.19 22.17	83 92	0.0339	Geochron	whole rock	diabase dike	Brown	23° 50'	41° 25'
112	585 ± 12	0.50 0.49	5.959 5.915	86 86	0.0402	Isotopes	hornblende	schist	Hanford	22° 24'	39° 24'
117_a	592 ± 23	1.247 1.222	15.11 14.91	88 82	0.0407	Geochron	whole rock	altered basalt	Brown	21° 35'	39° 38'
117_b	576 ± 28	0.550 0.518	6.280 6.280	69 68	0.0394	Geochron	whole rock	dacite	Brown	21° 35'	39° 38'
119	549 ± 20	6.65 6.48	71.56 74.81	74 91	0.0373	Geochron	biotite	granite	Goldsmith	31° 30'	40° 27'
120	577 ± 18	7.10 7.03	82.32 84.32	84 96	0.0395	Geochron	biotite	qtz. monzonite	Goldsmith	21° 41'	40° 40'
121	570 ± 17	7.15 7.22	83.82 83.32	97 98	0.0390	Geochron	biotite	granite	Goldsmith	21° 41'	40° 41'
128	827 ± 16	0.32 0.33	5.829 5.995	82 73	0.0609	Isotopes	hornblende with 5% impurities	diorite	Brown	20° 32'	41° 25'
129_a	932 ± 46	0.489 0.440	9.858 9.808	82 86	0.0709	Geochron	hornblende	grano-diorite	Brown	20° 32'	41° 31'
	821 ± 16	0.49 0.50	8.865 8.994	95 95	0.0604	Isotopes	hornblende with 5% impurities	grano-diorite			
129_b	912 ± 18	0.44 0.45	9.240 9.070	91 90	0.0689	Isotopes	hornblende with 5% impurities	grano-diorite	Brown	20° 32'	41° 31'

Sample Locality No.	Age (m.y.)	K%	Ar^{40} $\times 10^{-10}$ moles/gm	%Ar^{40}	Ar^{40}/K^{40}	Analyzed by	Material analyzed	Rock	Collected by	Location Lat. N.	Location Long. E
130	805 ± 16	0.25 0.24	4.301 4.323	90 92	0.0590	Isotopes	amphibole with 15% impurities	quartz diorite	Brown	20° 26'	40° 26'
131	595 ± 12	3.72 3.52	44.86 43.75	90 97	0.0410	Isotopes	muscovite	paraschist	Brown	20° 26'	40° 49'
132	717 ± 18	0.42 0.42	6.312 6.517	90 94	0.0512	Isotopes	hornblende	gneiss	Brown	20° 28'	40° 56'
136	585 ± 39	0.43 0.43	5.150	87	0.0401	USGS-Marvin, Mehnert, Merritt	whole rock	basalt	Brown	20° 10'	41° 52'
141_a	561 ± 25	3.646 3.635	42.78 40.28	97 98	0.0382	Geochron	whole rock	andesite	Brown	23° 39'	43° 08'
141_b	560 ± 20	2.162 2.277	24.92 25.67	94 94	0.0382	Geochron	whole rock	dacite (?)	Brown	23° 39'	43° 08'
148	580 ± 12	5.32 5.24	62.58 62.62	98 99	0.0393	Isotopes	biotite (+60 mesh)	granite	Brown	22° 53'	44° 56'
	585 ± 12	5.10 4.98	60.08 60.66	99 99	0.0401	Isotopes	biotite (-60 mesh)	granite			
151	644 ± 23	6.44 6.47	86.65	95	0.0450	USGS-Marvin, Mehnert, Merritt	biotite	grabbro	Hanford	22° 19'	42° 24'
153	496 ± 12	0.48 0.49	4.721 4.876	76 26	0.0331	Isotopes	plagioclase and quartz	granite	Brown	22° 25'	43° 48'
165	596 ± 12	0.69 0.71	8.485 8.664	77 87	0.0410	Isotopes	hornblende with 20% impurities	qtz. diorite	Brown	21° 15'	43° 57'
168_a	778 ± 16	0.090 0.092	1.530 1.538	72 72	0.0565	Isotopes	whole rock	troctolite	Brown	20° 32'	42° 32'

Sample Locality No.	Age (m.y.)	K%	Ar^{40} $\times 10^{-10}$ moles/gm	$\%Ar^{40}$	Ar^{40}/K^{40}	Analyzed by	Material analyzed	Rock	Collected by	Location Lat. N.	Location Long. E
168b	710 ± 16	0.092 0.096	1.418 1.421	63 70	0.0506	Isotopes	whole rock	troctolite	Brown	20° 32'	42° 32'
169	539 ± 20	0.38 0.36	4.034 4.022	29 31	0.0365	Isotopes	plagioclase and quartz	gneiss	Brown	20° 58'	43° 49'
173	826 ± 16	4.18 4.21	74.99 77.31	98 97	0.0608	Isotopes	biotite with 10% impurities	granite	Brown	20° 17'	42° 08'
	711 ± 30	0.39 0.36	5.762 5.564	27 24	0.0506	Isotopes	hornblende	granite			
175	484 ± 10	0.12 0.11	1.119 1.097	78 79	0.0323	Isotopes	whole rock	basalt	Brown	20° 33'	43° 28'
180a	598 ± 12	5.11 5.03	63.07 61.51	99 99	0.0412	Isotopes	biotite	granite	Brown	23° 58'	45° 01'
180b	584 ± 12	6.48 6.40	77.00 77.17	99 99	0.0401	Isotopes	biotite	granite	Brown	23° 58'	45° 01'
181	597 ± 12	6.49 6.54	80.17 79.67	99 99	0.0411	Isotopes	biotite	granite	Brown	23° 58'	45° 05'
183	597 ± 12	7.75 7.81	94.63 96.41	99 99	0.0411	Isotopes	biotite	grano-diorite	Brown	23° 41'	45° 08'
184	583 ± 12	6.51 6.51	77.71 77.62	98 98	0.0400	Isotopes	impure biotite	granite	Brown	23° 53'	45° 07'
	546 ± 5	0.50 0.51	5.580 5.580	89 89	0.0370	Isotopes	hornblende	granite			
187	589 ± 12	7.88 7.97	95.88 95.57	99 99	0.0405	Isotopes	biotite	granite	Brown	23° 01'	45° 29'
188	619 ± 12	5.27 5.40	68.69 67.94	99 99	0.0429	Isotopes	biotite	granite	Brown	23° 01'	45° 33'
	629 ± 12	1.38 1.40	18.04 18.23	95 98	0.0437	Isotopes	hornblende	granite			

Sample Locality No.	Age (m.y.)	K%	Ar^{40} × 10^{-10} moles/gm	%Ar^{40}	Ar^{40}/K^{40}	Analyzed by	Material analyzed	Rock	Collected by	Location Lat. N.	Location Long.
189	632 ± 12	4.96 4.92	63.87 65.79	97 99	0.0440	Isotopes	biotite with minor hornblende	granite	Brown	22° 36'	45° 07'
	611 ± 12	0.75 0.74	9.418 9.373	92 92	0.0422	Isotopes	hornblende	granite			
190	759 ± 20	7.41 7.55	123.1 121.6	98 98	0.0548	Geochron	biotite	granite	Trent	19° 55'	41° 33'
191_a	646 ± 12	0.86 0.87	11.62 11.69	89 80	0.0451	Isotopes	hornblende with 10% impurities	granite gneiss	Brown	19° 53'	41° 37'
191_b	759 ± 31	0.931 0.978	15.71 15.54	91 93	0.0548	Geochron	hornblende	granite gneiss	Brown	19° 53'	41° 37'
	694 ± 14	1.03 1.01	15.09 14.88	98 97	0.0492	Isotopes	hornblende with 20% impurities	granite gneiss			
192	607 ± 12	0.88 0.88	10.88 11.15	96 97	0.0419	Isotopes	hornblende	gneiss	Brown	19° 52'	41° 43'
194	676 ± 28	0.408 0.398	5.830 5.630	84 82	0.0476	Geochron	plagioclase	qtz. diorite	Brown	19° 35'	41° 53'
213_a	578 ± 12	0.10 0.10	1.214 1.148	82 60	0.0396	Isotopes	whole rock	gabbro	Brown	19° 09'	43° 48'
213_b	516 ± 10	0.084 0.083	0.8735 0.8548	77 77	0.0347	Isotopes	whole rock	gabbro	Brown	19° 09'	43° 48'
219_a	656 ± 14	0.090 0.102	1.319 1.318	87 79	0.0460	Isotopes	whole rock	norite	Brown	18° 45'	42° 53'
219_b	484 ± 10	0.15 0.15	1.443 1.448	86 83	0.0323	Isotopes	whole rock	norite	Brown	18° 45'	42° 53'
221_a	494 ± 12	0.073 0.070	0.7258 0.6820	88 57	0.0330	Isotopes	whole rock	norite	Brown	18° 56'	43° 02'

Table 4. RUBIDIUM-STRONTIUM AGES analysed by Carl Hedge

SAUDI-ARABIAN CRYSTALLINE ROCKS.

Sample Locality No.	Age (m.y.)	ppm Rb	ppm Sr	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}	Material Analyzed	Rock	Collected by	Location Lat. N.	Location Long. E.
59a	492 ± 15	229	16.4	41.60	0.9968	whole rock	granite	Petty	27° 42'	41° 25'
59b	580 ± 18	169	19.6	25.65	0.9173	whole rock	granite	Petty	27° 42'	41° 25'
68		29.9	58.1	1.491	0.7174	whole rock	rhyolite	Delfour	25° 45'	40° 45'
71	651 ± 40*	5.3	157	0.098	0.7052	whole rock	rhyolite	Delfour	25° 36'	41° 26'
98		45.8	61.3	2.167	0.7245	whole rock	rhyolite	Delfour	23° 51'	40° 56'
77	673 ± 60	119	128	2.701	0.7289	whole rock	granite	Brown	24° 30'	39° 30'
94	633 ± 15*	124	82.6	4.364	0.7440	whole rock	dacite	Brown	23° 42'	39° 40'
106		44.7	107	1.211	0.7149	whole rock	latite	Brown	23° 23'	39° 44'
95	520 ± 15	821	53.2	44.61	1.0202	biotite	granite	Goldsmith	23° 36'	40° 32'
96	572 ± 35*	10.0	111	0.263	0.7068	whole rock	porphyritic felsite	Goldsmith	23° 30'	40° 50'
97		85.3	141	1.753	0.7184	whole rock	do	Goldsmith	23° 32'	40° 54'
99	731 ± 15*	13.7	924	0.53	0.7046	whole rock	gneissic qtz. monzonite	Goldsmith	23° 56'	40° 59'
107		54.4	4.3	36.99	1.0841	whole rock	do	Goldsmith	23° 02'	40° 49'
100a		72.1	5.5	38.38	1.077	whole rock	granite	Goldsmith	32° 32'	41° 06'
100b	692 ± 15*	123	5.1	69.25	1.383	K-feldspar	granite	Goldsmith	32° 32'	41° 06'
100c		72.5	13.2	15.90	0.8682	whole rock	granite	Goldsmith	32° 32'	41° 06'
101a		382	21.9	22.05	0.8821	whole rock	granite	Goldsmith	23° 32'	41° 10'
101b	590 ± 10*	659	86.5	50.60	1.1390	whole rock	granite	Goldsmith	23° 32'	41° 10'
101c		320	1.9	494.9	4.857	whole rock	granite	Goldsmith	23° 32'	41° 10'
108	555 ± 15	535	43.5	35.62	0.9699	biotite	granite	Goldsmith	23° 57'	41° 21'

Sample Locality No.	Age (m.y.)	ppm Rb	ppm Sr	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}	Material Analyzed	Rock	Collected by	Location Lat. N.	Lon
135a	617 ± 10*	98.5	48.2	5.94	0.7587	whole rock	granodiorite	Brown	20° 02'	41°
135b		88.9	24.2	10.73	0.7980	whole rock	granodiorite	Brown	20° 02'	41°
137	582 ± 20	64.5	20.5	9.32	0.7827	whole rock	qtz.monzonite	Brown	20° 11'	41°
169	530 ± 20	496	140	10.33	0.7807	K-feldspar	granite gneiss	Brown	20° 58'	43°
170	576 ± 25	188	78.8	6.896	0.7603	whole rock	granite	Whitlow	21° 18'	44°
193	583 ± 15	184	49.5	10.77	0.7930	whole rock	granite	Trent	19° 33'	41°
224	549 ± 30	212	131	4.625	0.7421	whole rock	granite	Brown	17° 57'	42°
233	586 ± 35	148	118	3.629	0.7361	whole rock	rhyolite	Overstreet	18° 20'	44°
234	585 ± 10	387	9.3	121.0	1.755	microcline	pegmatite	Overstreet	18° 07'	44°
235	550 ± 20	122	29.2	12.06	0.8040	whole rock	granite porphyry	Overstreet	18° 08'	44°
240	694 ± 30	129	60.6	6.185	0.7653	whole rock	gneissic granite	Brown	17° 26'	42°

Decay constant for Rb^{87}: $\lambda = 1.42 \times 10^{-11}$/yr.

* isochron ages

Table 5. POTASSIUM-ARGON AGES SAUDI ARABIAN CRYSTALLINE ROCKS

Sample cality No.	Age (m.y.)	K%	Ar^{40} $\times 10^{-10}$ moles/gm	%Ar^{40}	Ar^{40}/K^{40}	Analyzed by	Material analyzed	Rock	Collected by	Location Lat. N.	Location Long. E.
22	515 ± 17	2.63 2.67	27.33	94	0.0346	USGS-Marvin Mehnert, Merritt	whole rock	andesite	Brown	27° 45'	36° 10'
26	591 ± 18	6.29 6.34	75.81 77.31	96 89	0.0406	Geochron	biotite	granite	Trent	26° 47'	37° 05'
34	605 ± 18	6.68 6.72	82.07 85.07	98 96	0.0418	Geochron	biotite	granite	Trent	26° 13'	37° 26'
40	528 ± 20	6.53 6.43	68.91	99	0.0356	USGS-Marvin Mehnert, Merritt	biotite	andesite	Brown	26° 28'	38° 13'
44	532 ± 15	1.895 1.872	20.19 20.24	63 91	0.0360	Geochron	whole rock	andesite	Brown	26° 20'	38° 37'
54	567 ± 16	6.52 6.36	74.06 74.81	97 98	0.0387	Geochron	biotite	gneiss (?)	Brown	28° 52'	35° 09'
65	827 ± 40	0.385 0.401	7.061 7.231	75 81	0.0609	Geochron	hornblende	diorite	Brown	25° 48'	39° 13'
67	299 ± 11	1.30 1.32	7.393	83	0.0189	USGS-Marvin Mehnert, Merritt	whole rock	andesite (some alteration)	Brown	25° 33'	40° 45'
69	548 ± 18	1.70 1.71	18.95	95	0.0372	USGS-Marvin Mehnert, Merritt	whole rock	andesite	Brown	25° 33'	40° 45'
72	525 ± 16	1.532 1.500	16.11 15.91	81 82	0.0354	Geochron	whole rock	andesite	Brown	24° 52'	39° 11'
89	577 ± 15	7.27 7.29	89.07 82.57	98 97	0.0395	Geochron	biotite	granite	Mytton	25° 01'	43° 48'
92	595 ± 12	6.12 6.10	75.31 74.06	95 97	0.0409	Geochron	biotite	granite	Mytton	24° 30'	43° 19'

Sample Locality No.	Age (m.y.)	K%	Ar^{40} $\times 10^{-10}$ moles/gm	$\%Ar^{40}$	Ar^{40}/K^{40}	Analyzed by	Material analyzed	Rock	Collected by	Location Lat. N.	Long.
102	566 ± 30	1.095 1.126	13.24 12.38	30 80	0.0386	Geochron	whole rock	basalt	Brown	23° 29'	41° 23'
103	506 ± 15	2.180 2.198	22.19 22.17	83 92	0.0339	Geochron	whole rock	diabase dike	Brown	23° 50'	41° 25'
112	585 ± 12	0.50 0.49	5.959 5.915	86 86	0.0402	Isotopes	hornblende	schist	Hanford	22° 24'	39° 24'
117_a	592 ± 23	1.247 1.222	15.11 14.91	88 82	0.0407	Geochron	whole rock	altered basalt	Brown	21° 35'	39° 38'
117_b	576 ± 28	0.550 0.518	6.280 6.280	69 68	0.0394	Geochron	whole rock	dacite	Brown	21° 35'	39° 38'
119	549 ± 20	6.65 6.48	71.56 74.81	74 91	0.0373	Geochron	biotite	granite	Goldsmith	31° 30'	40° 27'
120	577 ± 18	7.10 7.03	82.32 84.32	84 96	0.0395	Geochron	biotite	qts. monzonite	Goldsmith	21° 41'	40° 40'
121	570 ± 17	7.15 7.22	83.82 83.32	97 98	0.0390	Geochron	biotite	granite	Goldsmith	21° 41'	40° 41'
128	827 ± 16	0.32 0.33	5.829 5.995	82 73	0.0609	Isotopes	hornblende with 5% impurities	diorite	Brown	20° 32'	41° 25'
129_a	932 ± 46	0.489 0.440	9.858 9.808	82 86	0.0709	Geochron	hornblende	grano-diorite	Brown	20° 32'	41° 31'
	821 ± 16	0.49 0.50	8.865 8.994	95 95	0.0604	Isotopes	hornblende with 5% impurities	grano-diorite			
129_b	912 ± 18	0.44 0.45	9.240 9.070	91 90	0.0689	Isotopes	hornblende with 5% impurities	grano-diorite	Brown	20° 32'	41° 31'

Sample Locality No.	Age (m.y.)	K%	Ar^{40} $\times 10^{-10}$ moles/gm	$\%Ar^{40}$	Ar^{40}/K^{40}	Analyzed by	Material analyzed	Rock	Collected by	Location Lat. N.	Location Long. E
130	805 ± 16	0.25 0.24	4.301 4.323	90 92	0.0590	Isotopes	amphibole with 15% impurities	quartz diorite	Brown	20° 26'	40° 26'
131	595 ± 12	3.72 3.52	44.86 43.75	90 97	0.0410	Isotopes	muscovite	paraschist	Brown	20° 26'	40° 49'
132	717 ± 18	0.42 0.42	6.312 6.517	90 94	0.0512	Isotopes	hornblende	gneiss	Brown	20° 28'	40° 56'
136	585 ± 39	0.43 0.43	5.150	87	0.0401	USGS-Marvin, Mehnert, Merritt	whole rock	basalt	Brown	20° 10'	41° 52'
141_a	561 ± 25	3.646 3.635	42.78 40.28	97 98	0.0382	Geochron	whole rock	andesite	Brown	23° 39'	43° 08'
141_b	560 ±20	2.162 2.277	24.92 25.67	94 94	0.0382	Geochron	whole rock	dacite (?)	Brown	23° 39'	43° 08'
148	580± 12	5.32 5.24	62.58 62.62	98 99	0.0393	Isotopes	biotite (+60 mesh)	granite	Brown	22° 53'	44° 56'
	585 ± 12	5.10 4.98	60.08 60.66	99 99	0.0401	Isotopes	biotite (-60 mesh)	granite			
151	644 ± 23	6.44 6.47	86.65	95	0.0450	USGS-Marvin, Mehnert, Merritt	biotite	grabbro	Hanford	22° 19'	42° 24'
153	496 ± 12	0.48 0.49	4.721 4.876	76 26	0.0331	Isotopes	plagioclase and quartz	granite	Brown	22° 25'	43° 48'
165	596 ± 12	0.69 0.71	8.485 8.664	77 87	0.0410	Isotopes	hornblende with 20% impurities	qtz. diorite	Brown	21° 15'	43° 57'
168_a	778 ± 16	0.090 0.092	1.530 1.538	72 72	0.0565	Isotopes	whole rock	troctolite	Brown	20° 32'	42° 32'

Sample Locality No.	Age (m.y.)	K%	Ar^{40} $\times 10^{-10}$ moles/gm	$\%Ar^{40}$	Ar^{40}/K^{40}	Analyzed by	Material analyzed	Rock	Collected by	Location Lat. N.	Long. E
168_b	710 ± 16	0.092 0.096	1.418 1.421	63 70	0.0506	Isotopes	whole rock	troctolite	Brown	20° 32'	42° 32'
169	539 ± 20	0.38 0.36	4.034 4.022	29 31	0.0365	Isotopes	plagioclase and quartz	gneiss	Brown	20° 58'	43° 49'
173	826 ± 16	4.18 4.21	74.99 77.31	98 97	0.0608	Isotopes	biotite with 10% impurities	granite	Brown	20° 17'	42° 08'
	711 ± 30	0.39 0.36	5.762 5.564	27 24	0.0506	Isotopes	hornblende	granite			
175	484 ± 10	0.12 0.11	1.119 1.097	78 79	0.0323	Isotopes	whole rock	basalt	Brown	20° 33'	43° 28'
180_a	598 ± 12	5.11 5.03	63.07 61.51	99 99	0.0412	Isotopes	biotite	granite	Brown	23° 58'	45° 01'
180_b	584 ± 12	6.48 6.40	77.00 77.17	99 99	0.0401	Isotopes	biotite	granite	Brown	23° 58'	45° 01'
181	597 ± 12	6.49 6.54	80.17 79.67	99 99	0.0411	Isotopes	biotite	granite	Brown	23° 58'	45° 05'
183	597 ± 12	7.75 7.81	94.63 96.41	99 99	0.0411	Isotopes	biotite	grano-diorite	Brown	23° 41'	45° 08'
184	583 ± 12	6.51 6.51	77.71 77.62	98 98	0.0400	Isotopes	impure biotite	granite	Brown	23° 53'	45° 07'
	546 ± 5	0.50 0.51	5.580 5.580	89 89	0.0370	Isotopes	hornblende	granite			
187	589 ± 12	7.88 7.97	95.88 95.57	99 99	0.0405	Isotopes	biotite	granite	Brown	23° 01'	45° 29'
188	619 ± 12	5.27 5.40	68.69 67.94	99 99	0.0429	Isotopes	biotite	granite	Brown	23° 01'	45° 33'
	629 ± 12	1.38 1.40	18.04 18.23	95 98	0.0437	Isotopes	hornblende	granite			

Sample Locality No.	Age (m.y.)	K%	Ar^{40} $\times 10^{-10}$ moles/gm	%Ar^{40}	Ar^{40}/K^{40}	Analyzed by	Material analyzed	Rock	Collected by	Location Lat. N.	Long.
189	632 ± 12	4.96 4.92	63.87 65.79	97 99	0.0440	Isotopes	biotite with minor hornblende	granite	Brown	22° 36'	45° 07'
	611 ± 12	0.75 0.74	9.418 9.373	92 92	0.0422	Isotopes	hornblende	granite			
190	759 ± 20	7.41 7.55	123.1 121.6	98 98	0.0548	Geochron	biotite	granite	Trent	19° 55'	41° 33'
191_a	646 ± 12	0.86 0.87	11.62 11.69	89 80	0.0451	Isotopes	hornblende with 10% impurities	granite gneiss	Brown	19° 53'	41° 37'
191_b	759 ± 31	0.931 0.978	15.71 15.54	91 93	0.0548	Geochron	hornblende	granite gneiss	Brown	19° 53'	41° 37'
	694 ± 14	1.03 1.01	15.09 14.88	98 97	0.0492	Isotopes	hornblende with 20% impurities	granite gneiss			
192	607 ± 12	0.88 0.88	10.88 11.15	96 97	0.0419	Isotopes	hornblende	gneiss	Brown	19° 52'	41° 43'
194	676 ± 28	0.408 0.398	5.830 5.630	84 82	0.0476	Geochron	plagioclase	qtz. diorite	Brown	19° 35'	41° 53'
213_a	578 ± 12	0.10 0.10	1.214 1.148	82 60	0.0396	Isotopes	whole rock	gabbro	Brown	19° 09'	43° 48'
213_b	516 ± 10	0.084 0.083	0.8735 0.8548	77 77	0.0347	Isotopes	whole rock	gabbro	Brown	19° 09'	43° 48'
219_a	656 ± 14	0.090 0.102	1.319 1.318	87 79	0.460	Isotopes	whole rock	norite	Brown	18° 45'	42° 53'
219_b	484 ± 10	0.15 0.15	1.443 1.448	86 83	0.0323	Isotopes	whole rock	norite	Brown	18° 45'	42° 53'
221_a	494 ± 12	0.073 0.070	0.7258 0.6820	88 57	0.0330	Isotopes	whole rock	norite	Brown	18° 56'	43° 02'

ample ocality No.	Age (m.y.)	K%	Ar^{40} × 10^{-10} moles/gm	%Ar^{40}	Ar^{40}/K^{40}	Analyzed by	Material analyzed	Rock	Collected by	Location Lat. N.	Long.
221_b	422 ± 8	0.12 0.12	0.9806 0.9967	92 92	0.0276	Isotopes	whole rock	norite	Brown	18° 56'	43° 02'
225_a	655 ± 12	7.14 6.98	95.38 97.80	99 98	0.0458	Isotopes	biotite	diorite	Brown	18° 13'	42° 32'
	615 ± 12	0.98 1.02	12.73 12.67	91 92	0.0425	Isotopes	hornblende	diorite			
225_b	686 ± 14	4.86 4.70	68.34 70.03	98 98	0.0485	Isotopes	biotite with 20% impurities	diorite	Brown	18° 13'	43° 32'
228_a	649 ± 23	6.72 6.70	90.83	97	0.0453	USGS-Marvin, Mehnert, Merritt	biotite	gabbro	Brown	18° 24'	42° 42'
228_b	615 ± 12	8.50 8.49	106.9 109.2	93 94	0.0426	Isotopes	muscovite	pegmatite	Brown	18° 24'	42° 42'
229_a	588 ± 17	1.970 2.008	24.17 23.82	95 95	0.0404	Geochron	whole rock	- rock? - (drill core)	Brown	18° 08'	44° 07'
229_b	577 ± 16	2.17 2.13	25.40 25.27	94 90	0.0395	Geochron	whole rock	andesite (drill core)	Brown	18° 08'	44° 07'
229_c	572 ± 15	2.15 2.07	24.37 24.92	94 94	0.0391	Geochron	whole rock	andesite (drill core)	Brown	18° 08'	44° 07'
229_d	571 ± 15	2.61 2.63	30.80 30.25	94 93	0.0390	Geochron	whole rock	andesite (drill core)	Brown	18° 08'	44° 07'
229_e	595 ± 18	2.179 2.194	26.87 26.57	76 83	0.0409	Geochron	whole rock	andesite (drill core)	Brown	18° 08'	44° 07'
230	544 ± 15	3.282 3.192	36.18 35.18	90 85	0.0369	Geochron	whole rock	andesite	Overstreet	18° 24'	44° 11'
231_a	519 ± 15	3.608 3.503	36.65 37.56	93 93	0.0350	Geochron	whole rock	andesite	Overstreet	18° 22'	44° 14'

Sample Locality No.	Age (m.y.)	K%	Ar^{40} $\times 10^{-10}$ moles/gm	%Ar^{40}	Ar^{40}/K^{40}	Analyzed by	Material analyzed	Rock	Collected by	Location Lat. N.	Long. E.
231b	579 ± 22	0.485 0.450	5.454 5.604	68 67	0.0396	Geochron	whole rock	andesite	Overstreet	18° 22'	44° 14'
232	575 ± 15	2.232 2.204	25.57 26.52	83 87	0.0393	Geochron	whole rock	andesite	Overstreet	18° 20'	44° 15'
234	600 ± 24	1.087 1.015	13.09 12.86	83 83	0.0414	Geochron	whole rock	diorite	Overstreet	18° 06'	44° 15'
236	565 ± 16	3.624 3.701	42.48 41.73	96 95	0.0385	Geochron	whole rock	felsite dike	Overstreet	18° 07'	44° 15'

Decay constants for K^{40}: $\lambda_e = 0.581 \times 10^{-10}$/yr. $\lambda\beta = 4.962 \times 10^{-10}$/yr.

Atomic abundance for K^{40} = 0.01167 atomic percent

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