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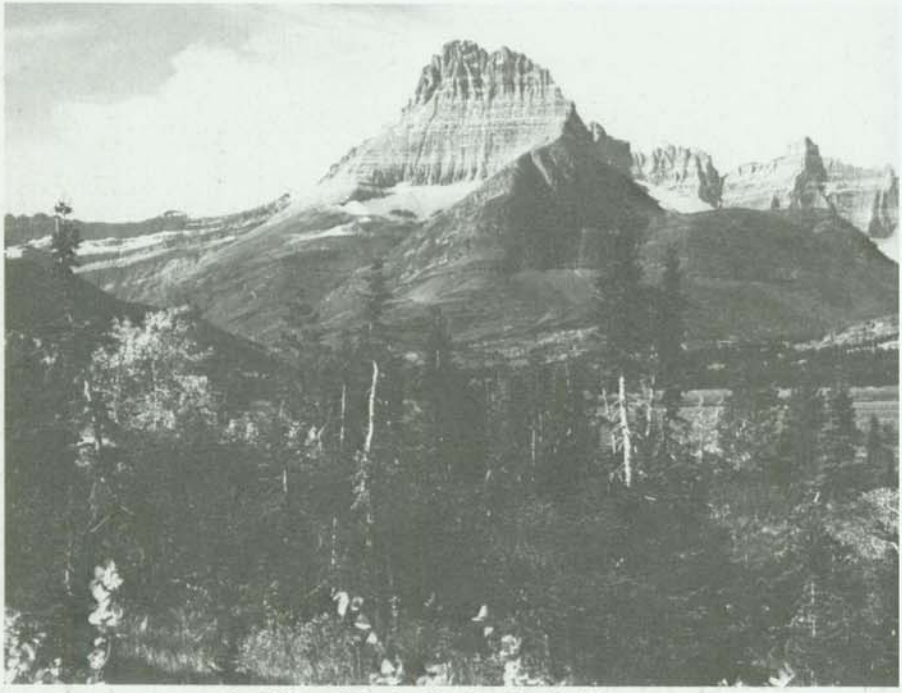
RADIOMETRIC DATES OF ROCKS IN MONTANA

compiled by
Faith Daniel
and
Richard B. Berg



Mt. Wilbur, Glacier National Park, Montana.

Bulletin 114 1981

Montana Bureau of Mines and Geology
A Department of
Montana College of Mineral Science and Technology

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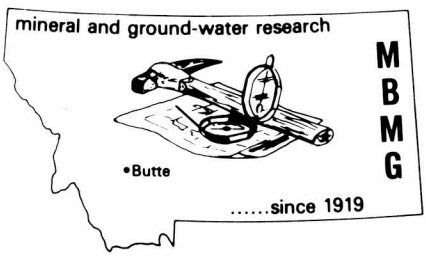

1981

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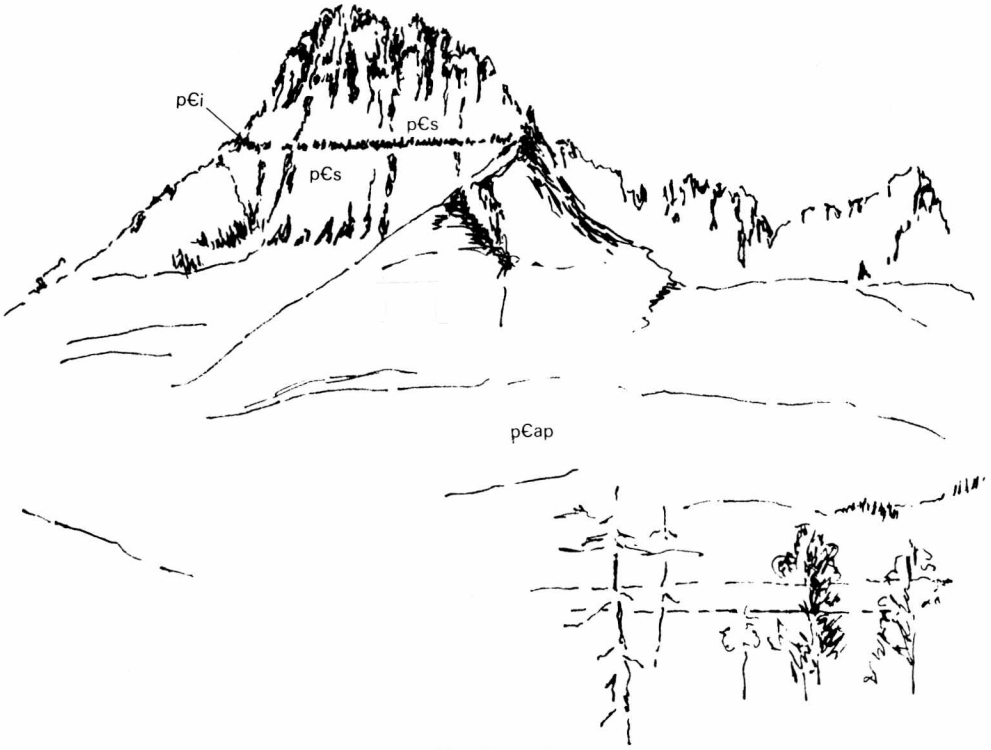

Explanation

PRECAMBRIAN

Belt Supergroup

- p€s — Siyeh Limestone—Dark blue to gray, medium- to thick-bedded argillaceous limestone (4,000 ft. thick).
- p€g — Grinnell Formation—Dark red, shaly, partly arenaceous argillite (1,000-1,800 ft. thick).
- p€ap — Appekunny Formation—Predominantly gray to black, thin-bedded argillite with interbedded white quartzite (2,000+ ft. thick).

Intrusive Rocks

- p€i — Purcell sill—Diabase (100 ft. thick).

Cover photo:
Courtesy: Travel Promotion Unit,
Montana Department of Highways.

Preface

This list of more than 600 radiometric dates was begun in July 1979, and compiled mainly from published dates. Several unpublished dates determined in conjunction with Montana Bureau of Mines and Geology projects are also included, as are dates of rocks in Idaho and Wyoming from geologic units that continue into Montana. No attempt was made to interpret the dates, but rather they are offered in what the compilers hope is an easily usable format.

The compilers wish to thank Burlington Northern, Inc., for releasing unpublished information concerning young volcanic rocks for our use. We appreciate the assistance of Richard Marvin, U.S. Geological Survey, and David Fountain, Department of Geology, University of Montana, in correcting omissions and errors in an early version of the compilation. Robert Chadwick of the Department of Earth Sciences, Montana State University, reviewed the completed manuscript and contributed helpful suggestions for its improvement. J. J. Donovan, Montana Bureau of Mines and Geology, also reviewed selected parts of the manuscript. Acknowledgment is also extended to the Department of Energy (Contract No. DE-AS07, 761D12029), and to the principal investigator, John L. Sonderegger, for financial assistance.

A compilation such as this seems to lend itself to the creation of errors and inconsistencies. Corrections and additions are solicited, and should be sent to the compilers at the Montana Bureau of Mines and Geology.

Faith Daniel
Geological Technician

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Economic Geologist

Butte
July 20, 1981

Introduction

The main body of the compilation is of course the entries, which are arranged in order of decreasing reported age. The format of the entries follows that generally used in *Isochron/West*, and standard nomenclature is used in the presentation of analytical data and radiometric constants. Information on the geological significance attached to the date is included where given in the original article. No attempt was made to recalculate dates by using constants other than those used by the authors of the original articles.

An **Addendum** of dates was added from several sources obtained after the main compilation was arranged. [The addendum entries are not in chronological order.] Information from articles published after January 1980, is not included. Also, radiocarbon determinations are not included; however, a selected bibliography of articles pertaining to radiocarbon dates on Montana materials follows in the reference section.

There are several entries that have been omitted in the numerical sequence [No. 364, 365, 405, 483, 484, 533, 563], because those dates were found to be recalculations from Woakes, 1960, and the information has been included in No. 371, 379, 481, 482, 535, 567.

Two histograms, one for Precambrian dates **(fig. 1)** and one for Phanerozoic dates **(fig. 2)**, illustrate the distribution of published dates. It should be noted that these histograms show the distribution of published dates only, and do not show the temporal distribution of Montana rocks. In spite of this obvious limitation, some comments on the distribution of published dates are worthwhile. The histogram of published Precambrian dates shows three maxima. The oldest maximum of approximately 2600 m.y. represents a regional metamorphic event that affected much if not all of the crystalline basement of southwestern Montana. The broad maximum centered around approximately 1600 m.y. is presumably caused by one or more metamorphic overprints. The dates concentrated in the 1000 to 1200 m.y. range are from sedimentary rocks of the Belt Supergroup, and are thought to indicate the time of deposition of those rocks.

The concentration of dates in the 60 to 80 m.y. range shown on the histogram for published Phanerozoic dates, is attributed in large part to the Boulder batholith. That much-dated composite pluton gives ages in the range of 68 to 78 m.y. The maximum of dates centered about 50 m.y. represents the abundant Cenozoic volcanics of southwestern Montana, and the smaller cluster of dates younger than 6 m.y. is mainly composed of very young dates on volcanic rocks in the Yellowstone National Park area.

The localities of dated rocks are plotted on **Sheets 1 and 2** (back pocket), and are as accurate as possible from the sometimes scanty locality information provided in the published sources.

Entries are indexed by author, geologic feature, geographic area, county, and other areas. Articles that contain no "new" dates, but provide interesting information on the interpretation of dates from Montana, are included in a section entitled *Bibliography of additional reading*. Likewise, abstracts referring to nearly 100 additional dates of Montana rocks (which have not been published), are also in the *Additional reading* section.

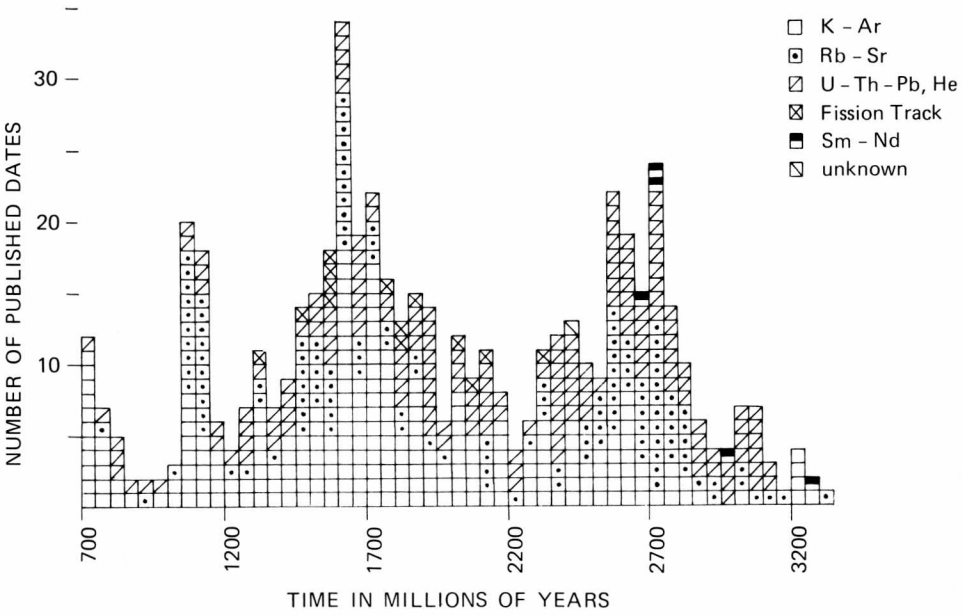

Figure 1– Histogram of radiometric dates of Precambrian rocks.

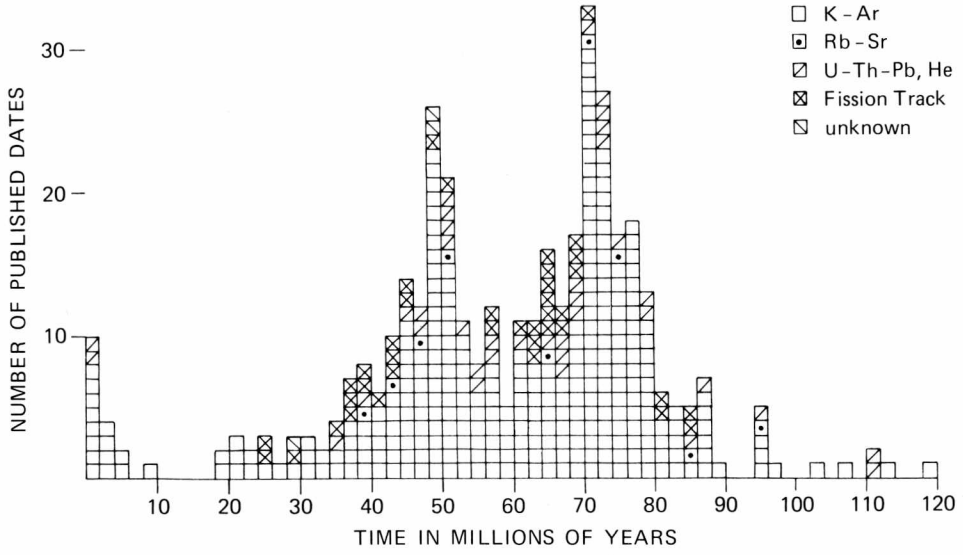

Figure 2– Histogram of radiometric dates of Phanerozoic rocks. 120 m. y. is an arbitrary cut-off date. Fourteen of the 26 dates in the interval between 120 and 700 m. y. are questionable.

Radiometric dates

1. *James and Hedge (1980)* Rb-Sr
15-69
Layered, coarse-grained granitic gneiss with oligoclase, quartz, slightly perthitic microcline, red-brown biotite, minor garnet and muscovite, accessory zircon. (45°04'55"N, 112°30'00"W; NE¼ sec. 6, T. 9 S., R. 7 W.; Ashbough Canyon 7½' quad; Timber Creek road, Ruby Range, Beaverhead Co.) ***Analytical data:*** Rb = 73.9 ppm, Sr = 87.5 ppm, Rb^{87}/Sr^{86} = 2.488, Sr^{87}/Sr^{86} = 0.8883, assumed initial Sr^{87}/Sr^{86} = 0.701. ***Constants:*** Rb^{87} λ = 1.42 x 10^{-11}/yr. ***Method:*** Isotope dilution. ***Collected and dated by:*** H. L. James, C. E. Hedge. ***Comment:*** Sample from an incompletely mapped area; reason for anomalous isotopic results is not known.

(whole rock) 5114 m.y.

2. *James and Hedge (1980)* Rb-Sr
16-69
Layered, coarse-grained granitic gneiss with oligoclase, quartz, slightly perthitic microcline, red-brown biotite, minor garnet and muscovite, accessory zircon. (45°04'55"N, 112°30'00"W; NE¼ sec. 6, T. 9 S., R. 7 W.; Ashbough Canyon 7½' quad; Timber Creek road, Ruby Range, Beaverhead Co.) ***Analytical data:*** Rb = 79.1 ppm, Sr = 95.3 ppm, Rb^{87}/Sr^{86} = 2.335, Sr^{87}/Sr^{86} = 0.8620, assumed initial Sr^{87}/Sr^{86} = 0.701. ***Constants:*** Rb^{87} λ = 1.42 x 10^{-11}/yr. ***Method:*** X-ray fluorescence. ***Collected and dated by:*** H. L. James, C. E. Hedge. ***Comment:*** Sample from an incompletely mapped area; reason for anomalous isotopic results is not known.

(whole rock) 4696 m.y.

3. *DePaolo and Wasserburg (1979)* Sm-Nd Rb-Sr
DSC-110
Cordierite-biotite-anthophyllite hornfels, contact metamorphic aureole, Stillwater Complex. (110°08'35"W, 45°26'55"N; NW¼ NE¼ sec. 8, T. 5 S., R. 13 E.; Mt. Douglas 15' quad; 1 km from igneous contact, Sweet Grass Co.) ***Analytical data:*** Nd = 21.3 ppm, Sr = 20.0 ppm. ***Constants:*** Rb^{87} λ = 1.39 x 10^{-11}/yr, Sm^{147} λ = 6.54 x 10^{-12}/yr. ***Method:*** Isotope dilution. ***Collected by:*** D. J. DePaolo; ***dated by:*** D. J. DePaolo, G. J. Wasserburg. ***Comment:*** Dates indicate presence of crust older than 2700 m.y., which contaminated the Rb-Sr, Sm-Nd systems.

Sm-Nd (whole rock) 3270 ± 60 m.y.
Rb-Sr (whole rock) 3940 ± 50 m.y.

4. *Casella (1969)* K-Ar
Pyroxenes, Stillwater Complex (About 45°20'N,110°W; Mt. Douglas and Mt. Wood 15' quads; Stillwater and Sweet Grass Co.)

(pyroxene) 3800 ± 400 m.y.

5. *Brookins (1965)* Rb-Sr
R1007, R1016
Quartz amphibole schist 30 ft. below surface, Iron Duke shaft; and biotite quartzite 700 ft. below surface, Jardine mine. (45°04'10"N, 110°37'20"W; NW¼ NE¼ sec. 9, T. 9 S., R. 9 E.; Gardiner 15' quad; Park Co.) ***Analytical data:*** (R1007) Sr^{86}/Sr^{88} = 0.1198, $Sr^{87}/*Sr^{86}$ = 0.7168, Rb^{87}/Sr^{86} = 0.25; (R1016) Sr^{86}/Sr^{88} = 0.1183, $Sr^{87}/*Sr^{86}$ = 0.7913, Rb^{87}/Sr^{86} = 1.90; initial Sr^{87}/Sr^{86} = 0.780. ***Constants:*** Rb^{87} λ = 1.39 x 10^{-11}/yr, Sr^{86}/Sr^{88} = 0.1194. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer and x-ray spectrograph. ***Collected by:*** L. E. Brown; ***dated by:*** D. G. Brookins and L. E. Brown. ***Comment:*** More work is needed on these metasediments before this date can be fully accepted.

(whole rock isochron) 3340 ± 300 m.y.

6. *Giletti (1966, 1971)* K-Ar
16, 10 Rb-Sr
Granitic gneiss, medium to fine grained, with quartz, microcline, biotite, rare muscovite, small chlorite veinlets (45°18'40"N, 111°10'15"W; NE¼ SE¼ SE¼ sec. 13, T. 6 S., R. 4 E.; Garnet Mountain 15' quad; Gallatin Co.) ***Analytical data:*** (a) K = 6.76%, $*Ar^{40}$ = 22.91 x 10^4 scc/g, Ar^{40}atm = 0.00 x 10^4 scc/g, $*Ar^{40}/K^{40}$ = 0.497; (b) K = 6.76%, $*Ar^{40}$ = 23.62 x 10^4 scc/g, Ar^{40}atm = 0.113 x 10^4 scc/g, $*Ar^{40}/K^{40}$ = 0.512; (c) Rb = 791 ppm, Sr = 16.3 ppm, Rb^{87}/Sr^{86} = 140.1, Sr^{87}/Sr^{86} = 4.135, assumed initial Sr^{87}/Sr^{86} = 0.710; (d) Rb = 121 ppm, Sr = 258 ppm, Rb^{87}/Sr^{86} = 1.361, Sr^{87}/Sr^{86} = 0.764, whole rock analysis. ***Constants:*** (K) λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio, (Rb^{87}) λ = 1.47 x 10^{-11}/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Rb, Sr, Ar) isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** No date calculated for (d); (a) and (b) "old" dates interpreted as excess Ar^{40} in the sample; (c) affected by a regional metamorphism 1600 m.y. ago.

(a) (biotite) 3220 m.y.
(b) (biotite) 3270 m.y.
(c) (biotite) 1640 m.y.

7. *Donn, Donn and Valentine (1965)* K-Ar

Metamorphic aureole bordering the Stillwater intrusion. (About 45°20'N., 110°W; Mt. Douglas and Mt. Wood 15' quads; Stillwater and Sweet Grass Co.)

(biotite) 3200 m.y.

8. *Kistler, Obradovich and Jackson (1969)* K-Ar

53NB-11

Diabasic gabbro from chilled border of the Stillwater Complex, basal zone. (109°49'45"W, 45°22'20"N; NW¼ NW¼ sec. 25, T. 5 S., R. 15 E.; Mt. Wood 15' quad; Nye Basin area, Stillwater Co.) ***Analytical data:*** (a) K = 0.13, 0.13%, $*Ar^{40}$ = 193.2 x 10^{-11} moles/g, $*Ar^{40}$ = 97%; (b) K = 0.23%, $*Ar^{40}$ = 202.7 x 10^{-11} moles/g, $*Ar^{40}$ = 87%; (c) K = 0.23%, $*Ar^{40}$ = 215.9 x 10^{-11} moles/g, $*Ar^{40}$ = 97%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Flame photometry (K). ***Comment:*** These dates show that the layered mafic intrusion was either emplaced or thermally metamorphosed about 2600 m.y. ago. Mica and plagioclase dates and work by others tend to support the thermal metamorphism interpretation.

(a) (whole rock) 3200 m.y.
(b) (plagioclase) 2400 m.y.
(c) (plagioclase) 2500 m.y.

9. *Casella (1969)* K-Ar

Chilled border phase, Stillwater Complex. (About 45°20'N, 110°W; Mt. Douglas and Mt. Wood 15' quads; Stillwater and Sweet Grass Co.) ***Comment:*** Stillwater Complex was emplaced before a 2750 m.y. old crystallization event in the Beartooth Mountains.

(whole rock) 3200 ± 200 m.y.

10. *James and Hedge (1980)* Rb-Sr

80-72

Foliated gray gneiss with microcline, quartz, biotite, lesser oligoclase; accessories are garnet, apatite and epidote. (45°18'55"N, 111°13'40"W; NW¼ sec. 15, T. 5 S., R. 4 E.; Garnet Mountain 15' quad; outcrop on U.S. Hwy 191, near bridge over Gallatin River, Gallatin Co.) ***Analytical data:*** Rb = 124 ppm, Sr = 210 ppm, Rb^{87}/Sr^{86} = 1.720, Sr^{87}/Sr^{86} = 0.7808, assumed initial Sr^{87}/Sr^{86} = 0.701. ***Constants:*** Rb^{87} λ = 1.42 x 10^{-11}/yr. ***Method:*** Isotope dilution. ***Collected and dated by:*** H. L. James, C. E. Hedge. ***Comment:*** Age supports Giletti's work (1966, 1971).

(whole rock) 3193 m.y.

11. *Nunes (1970)* U-Pb
Nunes and Tilton (1971)

J21-2

Schist, Stillwater Complex aureole, with cordierite, anthophyllite, biotite, zircon in quartz, and apatite. (45°23'57"N, 110°08'53"W; sec. 17, T. 5 S., R. 13 E. [est.]; Mt. Douglas 15' quad; N side of head of Miller Creek, elevation 9050' ± 50', Sweet Grass Co.) ***Analytical data:*** U^{238} = 730.0 ppm, Pb^{206} = 306.5 ppm, Pb^{206}/Pb^{204} = 1407, Pb^{206}/Pb^{207} = 4.145, Pb^{206}/Pb^{208} = 7.008. ***Constants:*** U^{238} λ = 1.54 x 10^{-10}/yr, U^{235} λ = 9.72 x 10^{-10}/yr, U^{238}/U^{235} = 137.8 atomic ratio. ***Method:*** Isotope dilution with a 9-inch solid-source mass spectrometer. ***Collected and dated by:*** P. D. Nunes. ***Comment:*** Discordant data seem best explained by episodic Pb loss, but U gain is possible; dates indicate emplacement of the complex at 2750 m.y. ago.

(zircon) Pb^{206}/U^{238} 2570 m.y.
Pb^{207}/U^{235} 2890 m.y.
Pb^{207}/Pb^{206} 3125 m.y.

12. *Nunes (1970)* U-Pb
Nunes and Tilton (1971)

J21-3

Hornfels, Stillwater Complex, with reddish-brown biotite, hypersthene (partially altered to serpentine), cordierite, quartz, biotite, zircon and opaques. (110°07'29"W, 45°25'46"N; sec. 4, T. 5 S., R. 13 E. [est.]; Mt. Douglas 15' quad; 1000 ft. S 85°W from saddle at head of Bobcat Creek, crest of a N-facing cliff, Sweet Grass Co.) ***Analytical data:*** U^{238} = 457.1 ppm, Pb^{206} = 219.8 ppm, Pb^{206}/Pb^{204} = 4274, Pb^{206}/Pb^{207} = 4.290, Pb^{206}/Pb^{208} = 7.179. ***Constants:*** U^{238} λ = 1.54 x 10^{-10}/yr, U^{235} λ = 9.72 x 10^{-10}/yr, U^{238}/U^{235} = 137.8 atomic ratio. ***Method:*** Isotope dilution with a 9-inch solid-source mass spectrometer. ***Collected and dated by:*** P. D. Nunes. ***Comment:*** Discordant data seem best explained by episodic Pb loss, but U gain is possible; dates indicate

emplacement of the complex about 2750 m.y. ago.

(zircon) Pb^{206}/U^{238} 2870 m.y.
Pb^{207}/U^{235} 3010 m.y.
Pb^{207}/Pb^{206} 3105 m.y.

13. *Green (1972)* Rb-Sr
Hornfels of thermal aureole, Stillwater Complex, Sweet Grass Co. ***Collected by:*** R. J. Beltrame; ***dated by:*** P. A. Mueller. ***Comment:*** From personal communication to L. H. Larsen; isochron also intersects plots of 2 thermal aureole samples of Powell, Skinner and Walker, 1969.

(whole rock isochron) 3100 m.y.

14. *Nunes (1970)* U-Pb
Nunes and Tilton (1971)
J15-3
Schist with garnet porphyroblasts, reddish-brown biotite, elongate quartz and oligoclase grains, moderate alteration of garnet to chlorite and sericite. (110°11'35"W, 45°23'06"N; sec. 24, T. 5 S., R. 12 E. [est.]; Mt. Douglas 15' quad; roadcut, W side of Boulder River road, 0.6 mi S of point where road crosses Speculator Creek, Sweet Grass Co.) ***Analytical data:***

	(a)	(b)
U^{238} (ppm)	566.4	22.38
Pb^{206} (ppm)	204.9	4.788
Pb^{206}/Pb^{204}	2067	81.25
Pb^{206}/Pb^{207}	4.277	3.290
Pb^{206}/Pb^{208}	7.634	2.008

Constants: U^{238} $\lambda = 1.54 \times 10^{-10}$/yr, U^{235} $\lambda = 9.72 \times 10^{-10}$/yr, $U^{238}/U^{235} = 137.8$ atomic ratio. ***Method:*** Isotope dilution with a 9-inch solid-source mass spectrometer. ***Collected and dated by:*** P. D. Nunes. ***Comment:*** Discordant data seem best explained by episodic Pb loss, but U gain is possible; dates indicate emplacement of the complex about 2750 m.y. ago.

(a) (zircon) Pb^{206}/U^{238} 2265 m.y.
Pb^{207}/U^{235} 2725 m.y.
Pb^{207}/Pb^{206} 3090 m.y.
(b) (apatite) Pb^{206}/U^{238} 1435 m.y.
Pb^{207}/U^{235} 1860 m.y.
Pb^{207}/Pb^{206} 2390 ± 35 m.y.

15. *Nunes (1970)* U-Pb
Nunes and Tilton (1971)
J8-5
Hornfels, Stillwater Complex, with 60% quartz (plus cordierite ?), hypersthene, biotite, sulfides, minor alteration to serpentine and limonite. (109°54'13"W, 45°22'00"N; sec. 29, T. 5 S., R. 15 E. [est.]; Mt. Wood 15' quad; ridge crest 1100 ft. N of Verdigris Creek, elevation 7820 ft. ± 25 ft., Stillwater Co.) ***Analytical data:***

	(a)	(b)	(c)
U^{238} (ppm)	499.5	725.9	1068
Pb^{206}(ppm)	218.2	268.4	320.7
Pb^{206}/Pb^{204}	2626	2656	1534
Pb^{206}/Pb^{207}	4.310	4.462	4.550
Pb^{206}/Pb^{208}	7.968	8.237	7.610

Constants: U^{238} $\lambda = 1.54 \times 10^{-10}$/yr, U^{235} $\lambda = 9.72 \times 10^{-10}$/yr, $U^{238}/U^{235} = 137.8$ atomic ratio. ***Method:*** Isotope dilution with a 9-inch solid-source mass spectrometer. ***Collected and dated by:*** P. D. Nunes. ***Comment:*** Discordant data seem best explained by episodic Pb loss, but U gain is possible; dates indicate emplacement of the complex about 2750 m.y. ago.

(a) (zircon) Pb^{206}/U^{238} 2655 m.y.
Pb^{207}/U^{235} 2905 m.y.
Pb^{207}/Pb^{206} 3085 m.y.
(b) (zircon) Pb^{206}/U^{238} 2310 m.y.
Pb^{207}/U^{235} 2710 m.y.
Pb^{207}/Pb^{206} 3030 m.y.
(c) (zircon) Pb^{206}/U^{238} 1935 m.y.
Pb^{207}/U^{235} 2495 m.y.
Pb^{207}/Pb^{206} 2970 m.y.

16. *Giletti (1966)* K-Ar
2 Rb-Sr
Pre-Cherry Creek gneiss, with quartz, microcline, biotite, oligoclase. (44°53'20"N, 112°33'13"W; NE¼ NE¼ SE¼ sec. 15, T. 11 S., R. 8 W.; Beach Creek 7½' quad; Beaverhead Co.) ***Analytical data:*** (a) K = 6.91%, $*Ar^{40}$ = 6.97×10^{4} scc/g, $*Ar^{40}$ = 99.32%, $*Ar^{40}/K^{40}$ = 0.148; (b) Rb ≡ 1034 ppm, Sr = 10.6 ppm, $*Sr/Rb^{87}$ = 0.0231; (c) Rb = 224 ppm, Sr = 166 ppm, $*Sr/Rb^{87}$ = 0.046. ***Constants:*** (K) $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, Rb^{87} $\lambda = 1.47 \times 10^{-11}$/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution with a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** These dates indicate a regional metamorphism of the pre-Cherry Creek, Cherry Creek and Pony gneisses 1600 m.y. ago.

(a) (biotite) 1600 m.y.
(b) (biotite) 1540 m.y.
(c) (whole rock) 3080 m.y.

17. *Catanzaro and Kulp (1964)* U-Pb
59MZ5
Migmatite. (109°25'51"W, 45°01'32"N; sec. 19, T. 9 S., R. 19 E. [est.]; Mount Maurice 15' quad; Carbon Co.) ***Analytical data:*** U = 1600 ppm, Th = 238 ppm, Pb = 507 ppm, common Pb = 2.0%, Pb^{204}/Pb^{206} = 0.045 ± 0.0003, Pb^{207}/Pb^{206} = 23.20, Pb^{208}/Pb^{206} = 5.24. ***Constants:*** U^{238} λ = 1.54 x 10^{-10}/yr, U^{235} λ = 9.72 x 10^{-10}/yr, Th^{232} λ = 4.88 x 10^{-11}/yr. ***Method:*** Using a 6-inch 60° mass spectrometer. ***Collected and dated by:*** E. J. Catanzaro. ***Comment:*** These dates indicate a 2700 m.y. old metamorphism and pegmatite formation.

(zircon) U^{238}/Pb^{206} 1630 ± 50 m.y.
U^{235}/Pb^{207} 2360 ± 70 m.y.
Pb^{206}/Pb^{207} 3080 ± 50 m.y.
Th^{232}/Pb^{208} 1530 m.y.

18. *Catanzaro and Kulp (1964)* U-Pb
59MZ6
Granite gneiss. (109°25'51"W, 45°01'32"N; sec. 19, T. 9 S., R. 19 E. [est.]; Mount Maurice 15' quad; Carbon Co.) ***Analytical data:*** U = 1548 ppm, Th = 834 ppm, Pb = 521 ppm, common Pb = 2.8%, Pb^{204}/Pb^{206} = 0.058 ± 0.001, Pb^{207}/Pb^{206} = 23.39, Pb^{208}/Pb^{206} = 10.18. ***Constants:*** U^{238} λ = 1.54 x 10^{-10}/yr, U^{235} λ = 9.72 x 10^{-10}/yr, Th^{232} λ = 4.88 x 10^{-11}/yr. ***Method:*** Using a 6-inch 60° mass spectrometer. ***Collected and dated by:*** E. J. Catanzaro. ***Comment:*** These dates indicate a 2700 m.y. metamorphism and pegmatite formation.

(zircon) U^{238}/Pb^{206} 1660 ± 50 m.y.
U^{235}/Pb^{207} 2380 ± 70 m.y.
Pb^{206}/Pb^{207} 3080 ± 50 m.y.
Th^{232}/Pb^{208} 870 m.y.

19. *Catanzaro (1962)* Pb^{207}/Pb^{206}
Zircon, Beartooth Mountains. (Carbon, Park, Stillwater and Sweet Grass Co.)

(zircon) 3075 m.y.

20. *Nunes (1970)* U-Pb
Nunes and Tilton (1971)
A24-4
Schist, Stillwater Complex aureole, with 70% quartz, greenish-brown biotite, garnet (rimmed with chlorite alteration), epidote, cordierite, oligoclase, accessories zircon and opaques. (109°59'09"W, 45°22'49"N; sec. 22, T. 5 S., R. 14 E. [est.]; Mt. Wood 15' quad; crest of cliffs facing West Fork of Stillwater River, and midway between Cathedral Creek and Saderbalm Creek, elevation 8500 ft. ± 25 ft., Sweet Grass Co.) ***Analytical data:*** U^{238} = 709.4 ppm, Pb^{206} = 185.7 ppm, Pb^{206}/Pb^{204} = 1543, Pb^{206}/Pb^{207} = 4.314, Pb^{206}/Pb^{208} = 7.220. ***Constants:*** U^{238} λ = 1.54 x 10^{-10}/yr, U^{235} λ = 9.72 x 10^{-10}/yr, U^{238}/U^{235} = 137.8 atomic ratio. ***Method:*** Isotope dilution with a 9-inch solid-source mass spectrometer. ***Collected and dated by:*** P. D. Nunes. ***Comment:*** Discordant data seem best explained by episodic Pb loss, but U gain is possible; dates indicate emplacement of the complex about 2750 m.y. ago.

(zircon) Pb^{206}/U^{238} 1715 m.y.
Pb^{207}/U^{235} 2405 m.y.
Pb^{207}/Pb^{206} 3065 m.y.

21. *Giletti (1971)* K-Ar
9 Rb-Sr
Quartzofeldspathic gneiss. (45°18'25"N, 111°10'05"W; SE¼ SE¼ sec. 13, T. 6 S., R. 4 E.; Garnet Mountain 15' quad; Gallatin Co.) ***Analytical data:*** (a) K = 7.40%, $*Ar^{40}$ = 21.85 x 10^4 scc/g, Ar^{40}atm = 0.115 x 10^4 scc/g, $*Ar^{40}/K^{40}$ = 0.433; (b) Rb = 142 ppm, Sr = 244 ppm, Rb^{87}/Sr^{86} = 1.685, Sr^{87}/Sr^{86} = 0.770, whole rock analysis. ***Constants:*** (K) λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio; (Rb^{87}) λ = 1.47 x 10^{-11}/yr. ***Method:*** Isotope dilution, (K) using a Perkin-Elmer flame photometer with Li internal standard, (Ar) using a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** "Old" date interpreted as excess Ar^{40} in the sample; Rb-Sr data did not give an age.

(a) (biotite) 3010 m.y.

22. *Nunes (1970)* U-Pb
Nunes and Tilton (1971)
J10-3
Schist lens in granitic gneiss, Stillwater Complex aureole, with greenish-brown biotite, oligoclase, quartz, garnet, moderate limonite alteration along joints. (109°57'49"W, 45°20'16"N; sec. 2, T. 6 S., R. 14 E. [est.]; Mt. Wood 15' quad; W of central part, Sioux Charlie Lake, and 50 ft. above footpath at head of talus slope, Stillwater Co.) ***Analytical data:*** U^{238} = 667.2 ppm, Pb^{206} = 170.1 ppm, Pb^{206}/Pb^{204} = 1537, Pb^{206}/Pb^{207} = 4.431, Pb^{206}/Pb^{208} = 6.993. ***Constants:*** U^{238} λ = 1.54 x 10^{-10}/yr, U^{235} λ = 9.72 x 10^{-10}/yr, U^{238}/U^{235} = 137.8 atomic ratio. ***Method:*** Isotope dilution with a 9-inch solid-source mass spectrometer. ***Collected and dated by:*** P. D. Nunes. ***Com-***

ment: Discordant data seem best explained by episodic Pb loss, but U gain is possible; dates indicate emplacement of the complex about 2750 m.y. ago.

(zircon) Pb^{206}/U^{238} 1675 m.y.
Pb^{207}/U^{235} 2350 m.y.
Pb^{207}/Pb^{206} 3010 m.y.

23. *Wooden (1975)* Rb-Sr

Granitic gneiss. (110°29'W, 45°32'N; sec. 33-35, T. 3 S., R. 10 E. [est.]; Livingston Peak 7½' quad; Mt. Delano, Absaroka Range, Park Co.) ***Comment:*** From a personal communication by W. J. McMannis.

(whole rock) 3000 m.y.

24. *Wooden (1975)* Rb-Sr

Orthoamphibolite dikes with hornblende, plagioclase and quartz; Beartooth Mountains.

	Lat (N)	Long (W)	County
WCB-11	45°14'30"	110°08'10"	Sweet Grass
WCB-12	45°14'30"	110°08'10"	Sweet Grass
WCB-22	45°16'57"	110°05'30"	Sweet Grass
WCB-23	45°16'57"	110°05'30"	Sweet Grass
WCB-24	45°16'57"	110°05'30"	Sweet Grass
WCB-45	45°20'33"	109°58'57"	Stillwater
WCB-46	45°20'33"	109°58'57"	Stillwater
XG-48	45°20'33"	110°01'05"	Stillwater
XI-27	45°18'05"	109°56'12"	Stillwater
XS-37	45°14'50"	110°12'15"	Sweet Grass
XS-70	45°15'40"	110°12'20"	Sweet Grass

Analytical data:

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	$Sr^{87}/Sr^{86}{}_n$
WCB-11	22.3	132	0.489	0.7200
WCB-12	29.9	134	0.649	0.7215
WCB-22	54.2	170	0.925	0.7391
WCB-23	29.3	137	0.619	0.7231
WCB-24	37.6	134	0.816	0.7306
WCB-45	18.4	142	0.376	0.7158
WCB-46	26.0	125	0.604	0.7201
XG-48	24.7	149	0.481	0.7164
XI-27	14.1	136	0.300	0.7113
XS-37	17.1	125	0.395	0.7165
XS-70	36.7	241	0.441	0.7166

Initial Sr^{87}/Sr^{86} = 0.7000. ***Constants:*** Rb^{87} λ = 1.39 x 10^{-11}/yr. ***Method:*** Isotope dilution using a 12-inch 90° Nuclide Corp. mass spectrometer. ***Collected and dated by:*** J. L. Wooden. ***Comment:*** Using all samples, an isochron of 2000 m.y. (initial ratio = 0.7024) is possible; using only 4 of the samples gives a more reasonable construction of 3000 m.y.

(whole rock isochron) 3000 m.y.

25. *Nunes (1970)* U-Pb
Nunes and Tilton (1971)
J14-4

Quartz monzonite with K-spar (some alteration to sericite), veinlets of chlorite, opaques, biotite, sericite; accessories are apatite, zircon and opaques. (109°52'56"W, 45°22'54"N; sec. 21, T. 5 S., R. 15 E. [est.]; Mt. Wood 15' quad; roadcut, W side of Stillwater River 1.5 mi NE of Beartooth ranch, and 0.62 mi NE of head of Verdigris Creek alluvial fan, Stillwater Co.)

Analytical data: (See below.)

Constants: U^{238} λ = 1.54 x 10^{-10}/yr, U^{235} λ = 9.72 x 10^{-10}/yr, U^{238}/U^{235} = 137.8 atomic ratio; Th^{232} λ = 4.99 x 10^{-11}/yr. ***Method:*** Isotope dilution with a 9-inch solid-source mass spectrometer. ***Collected and dated by:*** P. D. Nunes. ***Comment:*** Discordant data seem best explained by episodic Pb loss, but U gain is possible; dates indicate emplacement of the complex about 2750 m.y. ago.

(a) (zircon) Pb^{206}/U^{238} 2075 m.y.
Pb^{207}/U^{235} 2430 m.y.
Pb^{207}/Pb^{206} 2750 m.y.
(b) (zircon) Pb^{206}/U^{238} 1720 m.y.
Pb^{207}/U^{235} 2230 m.y.
Pb^{207}/Pb^{206} 2745 m.y.
(c) (zircon) Pb^{206}/U^{238} 1570 m.y.
Pb^{207}/U^{235} 2140 m.y.
Pb^{207}/Pb^{206} 2750 m.y.
(d) (zircon) Pb^{206}/U^{238} 2400 m.y.
Pb^{207}/U^{235} 2510 m.y.
Pb^{207}/Pb^{206} 2600 ± 40 m.y.
(e) (zircon) Pb^{206}/U^{238} 2365 m.y.
Pb^{207}/U^{235} 2475 m.y.
Pb^{207}/Pb^{206} 2565 ± 40 m.y.
(f) (zircon) Pb^{206}/U^{238} 2980 m.y.
Pb^{207}/U^{235} 2775 m.y.
Pb^{207}/Pb^{206} 2625 ± 155 m.y.
Pb^{208}/Th^{232} 2945 ± 45 m.y.

Analytical data for No. 25:

	U^{238}(ppm)	Pb^{206}(ppm)	Pb^{206}/Pb^{204}	Pb^{206}/Pb^{207}	Pb^{206}/Pb^{208}	Th^{232}(ppm)
(a)	765.3	249.1	2714	5.226	6.398	—
(b)	995.2	260.8	1975	5.230	6.464	—
(c)	1143	270.6	1899	5.211	6.109	—
(d)	36.76	14.22	280	4.686	3.223	—
(e)	2.653	2.524	308	4.845	3.516	—
(f)	0.2096	0.179	31.56	1.786	0.1516	7.345

26. *DePaolo and Wasserburg (1979)* Sm-Nd

DSC-131

Biotite-muscovite granite gneiss, Stillwater Complex aureole. (45°20'15"N, 109°55'00" W; NE¼ SE¼ sec. 6, T. 4 S., R. 15 E., Mt. Wood 15' quad; Stillwater River valley, Stillwater Co.) ***Analytical data:*** Nd = 10.9 ppm. ***Constants:*** Sm^{147} λ = 6.54 x 10^{-12}/yr. ***Method:*** Isotope dilution. ***Collected by:*** D. J. DePaolo; ***dated by:*** D. J. DePaolo, G. J. Wasserburg. ***Comment:*** This date gives little indication of the presence of crust that is much older than 2700 m.y.; see No. 3 (DSC-110).

(whole rock) 2970 ± 70 m.y.

27. *Small (1970)* Pb^{207}/Pb^{206}

Ore samples, Beartooth Mountains.

	Mine	Lat (N)	Long (W)	County
594	4-Sevens	45°12'10"	110°12'40"	Park
595	Irma	45°00'30"	109°56'15"	Park
604	Granite Mtn.	46°02'40"	110°17'45"	Park

Analytical data:

	Pb^{206}/Pb^{204}	Pb^{207}/Pb^{204}	Pb^{208}/Pb^{204}
594	17.563	15.728	38.880
595	16.283	15.460	37.173
604	15.768	15.460	36.658

Constants: U^{238} λ = 1.54 x 10^{-10}/yr, U^{235} λ = 9.72 x 10^{-10}/yr, Pb^{206}/Pb^{204} = 18.67, Pb^{207}/Pb^{204} = 15.80, Pb^{208}/Pb^{204} = 39.55. ***Method:*** Isotope dilution using the U.B.C. MS-1 mass spectrometer. ***Collected by:*** F. A. Crowley, F. N. Earll; ***dated by:*** W. D. Small. ***Comment:*** Ore from these mines is described in MBMG Bulletin 30 (1962).

2950 m.y.

28. *James and Hedge (1980)* Rb-Sr

45-72

Layered gneiss, light-colored garnetiferous layer with perthitic K-feldspar, quartz, pink garnet, rare plagioclase grains; accessories are magnetite and sphene. (45°25'05"N, 112°08'55"W; NW¼ sec. 7, T. 5 S., R. 4 W; Sheridan 7½' quad; Horse Creek road, quarried roadside outcrop, Tobacco Root Mountains, Madison Co.) ***Analytical data:*** Rb = 152 ppm, Sr = 73.2 ppm, Rb^{87}/Sr^{86} = 6.165, Sr^{87}/Sr^{86} = 0.9636, assumed initial Sr^{87}/Sr^{86} = 0.701. ***Constants:*** Rb^{87} λ = 1.42 x 10^{-11}/yr. ***Method:*** Isotope dilution. ***Collected and dated by:*** H. L. James, C. E. Hedge. ***Comment:*** Age corresponds to the 2750 m.y. old metamorphic event in the Beartooth Mountains.

(whole rock) 2938 m.y.

29. *James and Hedge (1980)* Rb-Sr

79-72

Fine-grained gray gneiss with microcline, quartz, greenish-brown biotite, minor oligoclase, rare muscovite; accessories are sphene, zircon, magnetite and apatite. (45°18'55"N, 111°11'05"W; NW¼ sec. 13, T. 6 S., R. 4 E.; Garnet Mountain 15' quad; Portal Creek road, Gallatin Canyon, Gallatin Co.) ***Analytical data:*** Rb = 126 ppm, Sr = 150 ppm, Rb^{87}/Sr^{86} = 2.451, Sr^{87}/Sr^{86} = 0.8053, assumed initial Sr^{87}/Sr^{86} = 0.701. ***Constants:*** Rb^{87} λ = 1.42 x 10^{-11}/yr. ***Method:*** Isotope dilution. ***Collected and dated by:*** H. L. James, C. E. Hedge. ***Comment:*** This age supports B. J. Giletti's work (1966, 1971).

(whole rock) 2935 m.y.

30. *James and Hedge (1980)* Rb-Sr

78-72

Layered gneiss with microcline, quartz, rare untwinned plagioclase, and perthite, minor biotite, muscovite and clinozoisite. (45°18'25" N, 111°10'25"W; SW¼ sec. 13, T. 6 S., R. 4 E.; Garnet Mountain 15' quad; Portal Creek road, Gallatin Canyon, Gallatin Co.) ***Analytical data:*** Rb = 118 ppm, Sr = 121 ppm, Rb^{87}/Sr^{86} = 2.856, Sr^{87}/Sr^{86} = 0.8205, assumed initial Sr^{87}/Sr^{86} = 0.701. ***Constants:*** Rb^{87} λ = 1.42 x 10^{-11}/yr. ***Method:*** Isotope dilution. ***Collected and dated by:*** H. L. James, C. E. Hedge. ***Comment:*** Age supports B. J. Giletti's work (1966, 1971).

(whole rock) 2887 m.y.

31. *Keevil (1943)* He

Quad Creek diabase. (109°24'27"W, 45°01'42" N; sec. 20, T. 9 S., R. 19 E. [est.]; Mount Maurice 15' quad; Carbon Co.) ***Analytical data:*** He = 16.6 x 10^{-5} cc/g; Ra = 1.4, 1.6 x 10^{-13} g/g; Th = 1.6, 2.6 x 10^{-6} g/g; 0.28, 0.40 α/mġ/hr; I = 1810, 1275; I/A = 1.0; He index = 1550. ***Dated by:*** N. B. Keevil.

2875 m.y.

32. *Giletti (1971)* K-Ar

7

Layer D, amphibolite layer 2.5 cm thick, from a gneiss with alternating quartzofeldspathic and amphibolitic layers. (45°18'25"N, 111°10'10" W; SW¼ SE¼ sec. 13, T. 6 S., R. 4 E.; Garnet Mountain 15' quad; Gallatin Co.) ***Analytical data:*** (a) K = 4.63%, $*Ar^{40}$ = 12.30 x 10^4 scc/g, Ar^{40}atm = 0.114 x 10^4 scc/g, $*Ar^{40}/K^{40}$ = 0.390, excess Ar^{40} = 7.3 x 10^4 scc/g, mesh

= 80-120; (b) K = 0.680%, $*Ar^{40}$ = 1.210 x 10^{4} scc/g, $Ar^{40}atm$ = 0.0218 x 10^{4} scc/g, $*Ar^{40}/K^{40}$ = 0.261. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Isotope dilution, (K) using a Perkin-Elmer flame photometer with Li internal standard, (Ar) using a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** "Old" dates interpreted as excess Ar^{40} in the sample.

(a) (biotite) 2850 m.y.
(b) (hornblende) 2290 m.y.

33. *Nunes (1970)* U-Pb
Nunes and Tilton (1971)
J23-1
Granodioritic gneiss, pinkish-gray with microcline, 30% quartz, plagioclase, myrmekite, zircon, apatite, muscovite, epidote. (109°56'30" W, 45°20'16"N; sec. 1, T. 6 S., R. 14 E. [est.]; Mt. Wood 15' quad; 1 mi NE of central part, Sioux Charlie Lake, on the footpath, Stillwater Co.) ***Analytical data:*** (See below.)

Constants: U^{238} λ = 1.54 x 10^{-10}/yr, U^{235} λ = 9.72 x 10^{-10}/yr, U^{238}/U^{235} = 137.8 atomic ratio. ***Method:*** Isotope dilution with a 9-inch solid-source mass spectrometer. ***Collected and dated by:*** P. D. Nunes. ***Comment:*** Discordant data seem best explained by episodic Pb loss, but U gain is possible; dates indicate emplacement of the Stillwater Complex at 2750 m.y. ago.

(a) (zircon) Pb^{206}/U^{238} 1640 m.y.
Pb^{207}/U^{235} 2215 m.y.
Pb^{207}/Pb^{206} 2815 m.y.
(b) (zircon) Pb^{206}/U^{238} 1475 m.y.
Pb^{207}/U^{235} 2130 m.y.
Pb^{207}/Pb^{206} 2850 m.y.
(c) (apatite) Pb^{206}/U^{238} 2460 m.y.
Pb^{207}/U^{235} 2600 m.y.
Pb^{207}/Pb^{206} 2705 ± 40 m.y.

34. *Giletti (1971)* K-Ar
8 Rb-Sr
Amphibolite. (45°18'25"N, 111°10'05"W; SE¼ SE¼ sec. 13, T. 6 S., R. 4 E., Garnet Mountain 15' quad; Gallatin Co.) ***Analytical data:*** (a) K = 6.51%, $*Ar^{40}$ = 17.17 x 10^{4} scc/g, $Ar^{40}atm$ = 0.052 x 10^{4} scc/g, $*Ar^{40}/K^{40}$ = 0.387; (b) K = 1.107%, $*Ar^{40}$ = 1.425 x 10^{4} scc/g, $Ar^{40}atm$ = 0.0086 x 10^{4} scc/g, $*Ar^{40}/K^{40}$ = 0.189; (c) Rb = 14.9 ppm, Sr = 154 ppm, Rb^{87}/Sr^{86} = 0.280, Sr^{87}/Sr^{86} = 0.725, whole rock analysis. ***Constants:*** (K) λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio; Rb^{87} λ = 1.47 x 10^{-11}/yr. ***Method:*** Isotope dilution, (K) using a Perkin-Elmer flame photometer with Li internal standard, (Ar) using a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** Rb-Sr data did not give an age; K-Ar dates affected by a regional metamorphism 1900 m.y. ago, sample was not significantly affected by a regional metamorphism 1600 m.y. ago.

(a) (biotite) 2840 m.y.
(b) (hornblende) 1890 m.y.

35. *Page (1977)* Rb-Sr
Hornfels, Stillwater Complex. (110°08'W, 45°24'N; T. 5 S., R. 13 E. [est.]; Mt. Douglas 15' quad; S of Chrome Mountain, Sweet Grass Co.) ***Dated by:*** P. A. Mueller. ***Comment:*** This isochron gives the age of the Stillwater Complex thermal aureole.

(whole rock isochron) 2822 ± 23 m.y.

36. *Mueller and Wooden (1976)* Rb-Sr
Cordierite-pyroxene hornfels, Stillwater Complex. (110°09'08"W, 45°26'57"N; NW¼ sec. 32, T. 4 S., R. 13 E. [est.]; Mt. Douglas 15' quad; Sweet Grass Co.) ***Analytical data:***

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}_n
CM-7	34.3	18.5	5.50	0.9216
CM-8	41.4	20.1	6.08	0.9301
CM-15	58.5	46.3	3.71	0.8485
CM-11	10.1	70.7	0.41	0.7186
CM-12	18.9	104.2	0.53	0.7219

(a) Initial Sr^{87}/Sr^{86} = 0.703 ± 0.015; (b) CM-8 omitted, initial Sr^{87}/Sr^{86} = 0.701 ± 0.004. ***Constants:*** Rb^{87} λ = 1.39 x 10^{-11}/yr. ***Method:*** Isotope dilution using a 30-cm, single-focusing mass spectrometer. ***Collected by:*** L. H. Larsen, R. J. Beltrame; ***dated by:*** P. A. Mueller and J. L. Wooden.

(a) (whole rock isochron) 2720 ± 250 m.y.
(b) (whole rock isochron) 2820 ± 81 m.y.

Analytical data for No. 33:

	U^{238}(ppm)	Pb^{206}(ppm)	Pb^{206}/Pb^{204}	Pb^{206}/Pb^{207}	Pb^{206}/Pb^{208}
(a)	2235	555.5	954	4.864	8.439
(b)	1663	367.7	1368	4.859	11.05
(c)	6.138	2.450	47.90	2.307	1.136

37. *James and Hedge (1980)* Rb-Sr
14-69
Sheetlike body of foliated gneiss interlayered with quartzite and dolomitic marble; with finely perthitic microcline, quartz, sericitized andesine, minor dark brown biotite, accessories garnet, magnetite, zircon and allanite(?). (45° 07'05"N, 112°32'10"W; SW¼ sec. 24, T. 8 S., R. 8 W.; Ashbough Canyon 7½' quad; N side of Axes Canyon, Ruby Range, Beaverhead Co.) ***Analytical data:*** Rb = 169 ppm, Sr = 58.6 ppm, Rb^{87}/Sr^{86} = 8.642, Sr^{87}/Sr^{86} = 1.0539, assumed initial Sr^{87}/Sr^{86} = 0.701. ***Constants:*** $Rb^{87}\ \lambda = 1.42 \times 10^{-11}$/yr. ***Method:*** X-ray fluorescence. ***Collected and dated by:*** H. L. James and C. E. Hedge. ***Comment:*** Age corresponds to the 2750 m.y. old metamorphic event in the Beartooth Mountains.

(whole rock) 2819 m.y.

38. *James and Hedge (1980)* Rb-Sr
13-69
Sheetlike body of foliated gneiss interlayered with quartzite and dolomitic marble; with andesine, quartz, K-feldspar, green hornblende, dark brown biotite, accessories garnet, magnetite, apatite and allanite(?); Dillon granite gneiss. (45°07'05"N, 112°32'10"W; SW¼ sec. 24, T. 8 S., R. 8 W.; Ashbough Canyon 7½' quad; N side of Axes Canyon, Ruby Range, Beaverhead Co.) ***Analytical data:*** Rb = 140 ppm, Sr = 67.1 ppm, Rb^{87}/Sr^{86} = 6.130, Sr^{87}/Sr^{86} = 0.9503, assumed initial Sr^{87}/Sr^{86} = 0.701. ***Constants:*** $Rb^{87}\ \lambda = 1.42 \times 10^{-11}$/yr. ***Method:*** X-ray fluorescence. ***Collected and dated by:*** H. L. James, C. E. Hedge. ***Comment:*** Age corresponds to the 2750 m.y. old metamorphic event in the Beartooth Mountains.

(whole rock) 2807 m.y.

39. *Casella (1969)* Rb-Sr
Gneisses. (109°40'W, 45°N; T. 58 N., R. 106 W. [est.]; Beartooth Butte 15' quad; near Beartooth Butte, Park Co., Wyo.) ***Comment:*** From a personal communication, 1967, by R. W. Kistler.

(whole rock isochron) 2800 m.y.

40. *Gast (1958)* Rb-Sr
Gast, Kulp and Long (1958) K-Ar
GmYB-11
Muscovite from zoned conformable pegmatite, 100 ft. long, 10 ft. wide. (109°22'05"W, 44°57'55"N; NE¼ sec. 33, T. 58 N., R. 104 W; Deep Lake 15' quad; Christmas Lake, Park Co., Wyo.) ***Analytical data:*** (See below.) ***Constants:*** (K) $\lambda_e = 0.58 \times 10^{-10}$/yr, $\lambda_\beta = 4.8 \times 10^{-10}$/yr, $Rb^{87}\ \lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** A. Poldervaart. ***Comment:*** These dates indicate that the major regional metamorphism and granitization occurred about 2750 m.y. ago; D. S. Miller, 1968, calculated a fission track age of 35 m.y. for muscovite from this sample (U = 100 ppb); the extremely young date is explained as resulting from annealing of tracks, either gradually or during specific events.

(a) (muscovite) 2800 ± 50 m.y.
(b) (muscovite) 2470 ± 50 m.y.

41. *Catanzaro and Kulp (1964)* U-Pb
SGG
Granite gneiss. (110°55'W, 45°23'N; T. 5 S., R. 6 E. [est.]; Fridley Peak 15' quad; Sweet Grass Co.) ***Analytical data:*** U = 2088 ppm, Pb = 612 ppm, common Pb = 4.6%, Pb^{204}/Pb^{206} = 0.105 ± 0.0002, Pb^{207}/Pb^{206} = 20.46, Pb^{208}/Pb^{206} = 24.26. ***Constants:*** $U^{238}\ \lambda_D = 1.54 \times 10^{-10}$/yr, $U^{235}\ \lambda_F = 9.72 \times 10^{-10}$/yr. ***Method:*** Using a 6-inch 60° mass spectrometer. ***Collected and dated by:*** E. J. Catanzaro. ***Comment:*** These dates indicate metamorphism and pegmatite formation 2700 m.y. ago.

(zircon) U^{238}/Pb^{206} 1350 ± 40 m.y.
U^{235}/Pb^{207} 2020 ± 60 m.y.
Pb^{206}/Pb^{207} 2800 ± 50 m.y.

42. *Catanzaro and Kulp (1964)* U-Pb
59MZ4
Amphibolite. (45°01'32"N, 109°25'51"W; sec. 19, T. 9 S., R. 19 E. [est.]; Mount Maurice 15' quad; Carbon Co.) ***Analytical data:*** U = 1332 ppm, Th = 872 ppm, Pb = 430 ppm, common Pb = 2.3%, Pb^{204}/Pb^{206} = 0.049 ±

Analytical data for No. 40:

	wt(g)	Rb(ppm)	Sr(ppm)	Sr^{87}(ppm)	Sr^{87}/Rb^{87}
(a)	1.0315	4480 ± 77	1.5	50.1 ± 0.7	0.0395 ± 0.0010
	0.4827	4680 ± 97	1.6	52.4 ± 0.7	0.0396 ± 0.0010
	wt(g)	**K(%)**	***Ar^{40}(ppm)**	***Ar^{40}(%)**	**Ar^{40}/K^{40}**
(b)	21.1812	8.36	3.11 ± 0.06	99.0	0.305 ± 0.013
	4.4735	8.34 ± 0.25	3.05 ± 0.06	98.7	0.299 ± 0.011
		8.44 ± 0.17			

0.001, Pb^{207}/Pb^{206} = 19.79, Pb^{208}/Pb^{206} = 14.36. ***Constants:*** U^{238} λ = 1.54 x 10^{-10}/yr, U^{235} λ = 9.72 x 10^{-10}/yr, Th^{232} λ = 4.88 x 10^{-11}/yr. ***Method:*** Using a 6-inch 60° mass spectrometer. ***Collected and dated by:*** E. J. Catanzaro. ***Comment:*** These dates indicate metamorphism and pegmatite formation 2700 m.y. ago.

(zircon) U^{238}/Pb^{206} 1600 ± 50 m.y.
U^{235}/Pb^{207} 2180 ± 65 m.y.
Pb^{206}/Pb^{207} 2800 ± 50 m.y.
Th^{232}/Pb^{208} 1050 m.y.

43. *Giletti (1971)* K-Ar
7 Rb-Sr

Layer B, amphibolite 1.9 cm thick, from a gneiss with alternating quartzofeldspathic and amphibolitic layers. (45° 18'25"N, 111° 10'10" W; SW¼ SE¼ sec. 13, T. 6 S., R. 4 E.; Garnet Mountain 15' quad; Gallatin Co.) ***Analytical data:*** (a) K = 4.41%, $*Ar^{40}$ = 11.22 x 10^4 scc/g, Ar^{40}atm = 0.054 x 10^4 scc/g, $*Ar^{40}/K^{40}$ = 0.373, excess Ar^{40} = 6.5 x 10^4 scc/g, mesh = 40-80; (b) K = 0.972%, $*Ar^{40}$ = 1.251 x 10^4 scc/g, Ar^{40}atm = 0.019 x 10^4 scc/g, $*Ar^{40}/K^{40}$ = 0.189; (c) Rb = 292 ppm, Sr = 45.4 ppm, Rb^{87}/Sr^{86} = 18.65, Sr^{87}/Sr^{86} = 1.169, assumed initial Sr^{87}/Sr^{86} = 0.710; (d) Rb = 65.6 ppm, Sr = 380 ppm, Rb^{87}/Sr^{86} = 0.501, Sr^{87}/Sr^{86} = 0.7311. ***Constants:*** (K) λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio, Rb^{87} λ = 1.47 x 10^{-11}/yr. ***Method:*** Isotope dilution, (K) using a Perkin-Elmer flame photometer with Li internal standard, (Ar) using a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** (d) Whole rock data did not give a date, (a) interpreted as excess Ar in the sample, (b) and (c) affected by regional metamorphism 1900 m.y. and 1600 m.y. ago, respectively.

(a) (biotite) 2790 m.y.
(b) (hornblende) 1880 m.y.
(c) (biotite) 1650 m.y.

44. *Brookins (1965)* Rb-Sr
1022

Biotite-muscovite granite, light gray, medium grained with microperthite, microcline, some orthoclase, quartz, 5% muscovite, 5% biotite. (45° 02'10"N, 110° 36'15"W; NE¼ SE¼ sec. 22, T. 9 S., R. 9 E.; Gardiner 15' quad; SW slope of Crevasse Mountain, 1500 ft. from granite-schist contact, Park Co.) ***Analytical data:***

		Sr^{86}/Sr^{88}	$Sr^{87}/Sr^{86}*$	Rb^{87}/Sr^{86}
(a)	R1022a	0.1205	0.9613	6.50
(b)	R1022b	0.1186	0.9535	6.46
(c)	B1022b	0.1199	7.12	356.0

(a) and (b) assumed initial Sr^{87}/Sr^{86} = 0.710; (c) initial Sr^{87}/Sr^{86} = 0.780. *Corrected for Sr^{86}/Sr^{88} = 0.1194. ***Constants:*** Rb^{87} λ = 1.39 x 10^{-11}/yr. ***Method:*** Isotope dilution with 6-inch 60° mass spectrometer and x-ray spectrograph. ***Collected by:*** L. E. Brown; ***dated by:*** D. G. Brookins and L. E. Brown. ***Comment:*** (a) and (b) give a 2756 ± 100 m.y. date for Crevasse Mountain granite emplacement; (c) indicates a possible low-grade thermal event at 1900-2100 m.y.

(a) (whole rock) 2731 ± 100 m.y.
(b) (whole rock) 2781 ± 100 m.y.
(c) (biotite) 1281 m.y.

45. *Mueller and Wooden (1973)* Rb-Sr
Green (1972)

Cordierite-orthopyroxene grade hornfels, contact aureole, Stillwater Complex; underlain by Mouat quartz monzonite. (45°23'25"N, 109° 54'15"W; NW¼ NW¼ sec. 20, T. 5 S., R. 15 E.; Mt. Wood 15' quad; Stillwater River area, S end of the complex, Stillwater Co.) ***Method:*** X-ray fluorescence and isotope dilution. ***Dated by:*** P. A. Mueller. ***Comment:*** Date concordant with the U-Pb zircon age of 2750 m.y. for the Mouat quartz monzonite (Nunes and Tilton, 1971); sample affected by the intrusion of the Mouat quartz monzonite.

(whole rock isochron) 2780 ± 17 m.y.

46. *Nunes (1970)* U-Pb
Nunes and Tilton (1971)
J24-5

Quartz monzonite, Stillwater Complex aureole, with zoned plagioclase (altered to sericite and kaolinite), perthite, quartz, green biotite, opaques, zircon and apatite. (45°22'54"N, 109°52' 56"W; sec. 21, T. 5 S., R. 15 E. [est.]; Mt. Wood 15' quad; 700 ft. NE of Verdigris Creek, elevation 6000 ft. ± 50 ft., and 300 ft. above a dirt road, Stillwater Co.) ***Analytical data:*** U^{238} = 691.2 ppm, Pb^{206} = 217.2 ppm, Pb^{206}/Pb^{204} = 1345, Pb^{206}/Pb^{207} = 5.079, Pb^{206}/Pb^{208} = 6.124. ***Constants:*** U^{238} λ = 1.54 x 10^{-10}/yr, U^{235} λ = 9.72 x 10^{-10}/yr, U^{238}/U^{235} = 137.8 atomic ratio. ***Method:*** Isotope dilution with a 9-inch solid-source mass spectrometer. ***Collected and dated by:*** P. D. Nunes. ***Comment:*** Discordant data seem best explained by episodic Pb loss, but U gain is possible; dates indicate emplacement of the complex approximately 2750 m.y. ago.

(zircon) Pb^{206}/U^{238} 2010 m.y.
Pb^{207}/U^{235} 2410 m.y.
Pb^{207}/Pb^{206} 2770 m.y.

47. *James and Hedge (1980)* Rb-Sr
2-69
Sill-like body of sheared gray gneiss in dolomitic marble with long stringers of quartz, granulated oligoclase, lesser microcline, minor muscovite, pink garnet and some alteration to sericite and clinozoisite. (45°09'45"N, 112°25'00"W; SW¼ sec. 1, T. 8 S., R. 7 W.; Christensen Ranch 7½' quad; Ruby Range, Madison Co.) ***Analytical data:*** Rb = 121 ppm, Sr = 143 ppm, Rb^{87}/Sr^{86} = 2.469, Sr^{87}/Sr^{86} = 0.7999, assumed initial Sr^{87}/Sr^{86} = 0.701. ***Constants:*** Rb^{87} $\lambda = 1.42 \times 10^{-11}$/yr. ***Method:*** Isotope dilution. ***Collected and dated by:*** H. L. James and C. E. Hedge. ***Comment:*** Age corresponds to the 2750 m.y. old metamorphic event in the Beartooth Mountains.

(whole rock) 2766 m.y.

48. *James and Hedge (1980)* Rb-Sr
Quartzofeldspathic gneiss.

	Lat (N)	Long (W)	County
1-69	45°09'45"	112°23'40"	Madison
2-69	45°09'45"	112°25'00"	Madison
12-69	45°09'40"	112°22'40"	Madison
13-69	45°07'05"	112°32'10"	Beaverhead
14-69	45°07'05"	112°32'10"	Beaverhead
15-69	45°04'55"	112°30'00"	Beaverhead
16-69	45°04'55"	112°30'00"	Beaverhead
43-72	45°25'05"	112°08'55"	Madison
44-72	45°25'05"	112°08'55"	Madison
45-72	45°25'05"	112°08'55"	Madison
78-72	45°18'25"	111°10'25"	Gallatin
79-72	45°18'55"	111°11'05"	Gallatin
80-72	45°18'55"	111°13'40"	Gallatin

Analytical data:

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}
1-69	159	81.5	5.779	0.9236
2-69	121	143	2.469	0.7999
12-69	1.7	203	0.024	0.7052
13-69	140	67.1	6.130	0.9503
14-69	169	58.6	8.642	1.0539
15-69	73.9	87.5	2.488	0.8883
16-69	79.1	95.3	2.335	0.8620
43-72	176	76.5	6.822	0.9606
44-72	163	143	3.349	0.8331
45-72	152	73.2	6.165	0.9636
78-72	118	121	2.856	0.8205
79-72	126	150	2.451	0.8053
80-72	124	210	1.720	0.7808

Initial Sr^{87}/Sr^{86} = 0.704. ***Constants:*** Rb^{87} $\lambda = 1.42 \times 10^{-11}$/yr. ***Method:*** Isotope dilution and x-ray fluorescence. ***Collected and dated by:*** H. L. James, C. E. Hedge. ***Comment:*** Age reflects the time of metamorphism, corresponding to the 2750 m.y. old event in the Beartooth Mountains; 15-69 and 16-69 do not fall on the isochron.

(whole rock isochron) 2760 ± 115 m.y.

49. *Nunes (1970)* U-Pb
Nunes and Tilton (1971)
A18-1
Blue, coarse-grained, fractured metaquartzite, Stillwater Complex aureole, with quartz and veinlets of chlorite and limonite, moderate limonite and sulfide alteration along fractures. (45°23'31"N, 110°01'23"W; sec. 20, T. 5 S., R. 14 E. [est.]; Mt. Douglas 15' quad; roadcut on broad ridge 1000 ft. NE of the lower right-angle bend in Crescent Creek, Sweet Grass Co.) ***Analytical data:*** U^{238} = 137.5 ppm, Pb^{206} = 53.45 ppm, Pb^{206}/Pb^{204} = 775, Pb^{206}/Pb^{207} = 4.975, Pb^{206}/Pb^{208} = 7.837, isotope ratios corrected for a total Pb blank of 4.5%. ***Constants:*** U^{238} $\lambda = 1.54 \times 10^{-10}$/yr, U^{235} $\lambda = 9.72 \times 10^{-10}$/yr, U^{238}/U^{235} = 137.8 atomic ratio. ***Method:*** Isotope dilution with a 9-inch solid-source mass spectrometer. ***Collected and dated by:*** P. D. Nunes. ***Comment:*** Discordant data seem best explained by episodic Pb loss, but U gain is possible; dates indicate emplacement of the complex approximately 2750 m.y. ago.

(zircon) Pb^{206}/U^{238} 2410 m.y.
Pb^{207}/U^{235} 2595 m.y.
Pb^{207}/Pb^{206} 2750 m.y.

50. *Nunes (1970)* U-Pb
Nunes and Tilton (1971)
A29-3
Noritic diabase with 50% labradorite, 30% hypersthene, 10% augite, plus sulfides, olivine, quartz, biotite and zircon. (45°22'57"N, 109°50'28"W; sec. 23, T. 5 S., R. 15 E. [est.]; Mt. Wood 15' quad; roadcut 400 ft. above junction of two large Nye Creek tributaries, Stillwater Co.) ***Analytical data:*** (See below.)
(a) Isotope ratios corrected for total Pb blank of 3%. ***Constants:*** U^{238} $\lambda = 1.54 \times 10^{-10}$/yr, U^{235} $\lambda = 9.72 \times 10^{-10}$/yr, U^{238}/U^{235} = 137.8 atomic ratio. ***Method:*** Isotope dilution with a

Analytical data for No. 50:

	U^{238}(ppm)	Pb^{206}(ppm)	Pb^{206}/Pb^{204}	Pb^{206}/Pb^{207}	Pb^{206}/Pb^{208}
(a)	183.4	80.12	1755	5.195	5.441
(b)	202.3	84.21	800	4.995	4.902

9-inch solid-source mass spectrometer. ***Collected and dated by:*** P. D. Nunes. ***Comment:*** Discordant data seem best explained by episodic Pb loss, but U gain is possible; dates indicate emplacement of the complex approximately 2750 m.y. ago.

(a) (zircon) Pb^{206}/U^{238} 2655 m.y.
Pb^{207}/U^{235} 2710 m.y.
Pb^{207}/Pb^{206} 2750 m.y.
(b) (zircon) Pb^{206}/U^{238} 2550 m.y.
Pb^{207}/U^{235} 2660 m.y.
Pb^{207}/Pb^{206} 2745 m.y.

51. *Giletti (1971)* K-Ar
7
Layer E, quartzofeldspathic layer 1.8 cm thick, from a gneiss with alternating quartzofeldspathic and amphibolitic layers. (45°18'25"N, 111°10'10"W; SW¼ SE¼ sec. 13, T. 6 S., R. 4 E.; Garnet Mountain 15' quad; Gallatin Co.) ***Analytical data:*** (a) K = 6.62%, $*Ar^{40}$ = 16.35×10^4 scc/g, Ar^{40}atm = 0.058×10^4 scc/g, $*Ar^{40}/K^{40}$ = 0.362, excess Ar^{40} = 9.2×10^4 scc/g, mesh = 60-80; (b) K = 1.09%, $*Ar^{40}$ = 1.604×10^4 scc/g, Ar^{40}atm = 0.061×10^4 scc/g, $*Ar^{40}/K^{40}$ = 0.216. ***Constants:*** λ_e = 0.585×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr, K^{40}/K = 1.19×10^{-4} atomic ratio. ***Method:*** Isotope dilution, (K) using a Perkin-Elmer flame photometer with Li internal standard, (Ar) using a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** (a) "Old" date interpreted as excess Ar^{40} in the sample; (b) affected by a regional metamorphism 1900 m.y. ago.

(a) (biotite) 2750 m.y.
(b) (hornblende) 2050 m.y.

52. *Mueller and Wooden (1976)* Rb-Sr
Cordierite-pyroxene hornfels, Stillwater Complex. ***Locations and Analytical data:*** See No. 36, No. 61 and No. 72. (a) Initial Sr^{87}/Sr^{86} = 0.707 ± 0.004; (b) SR-5 and CM-8 omitted, initial Sr^{87}/Sr^{86} = 0.705 ± 0.003. ***Constants:*** Rb^{87} λ = 1.39×10^{-11}/yr. ***Method:*** Isotope dilution using a 30-cm single-focusing mass spectrometer. ***Comment:*** These dates support the conclusion by Nunes and Tilton (1971) that 2750 ± 50 m.y. is the time of emplacement of the Stillwater Complex.

(a) (whole rock isochron) 2695 ± 43 m.y.
(b) (whole rock isochron) 2750 ± 45 m.y.

53. *Gast (1958)* Rb-Sr
Gast, Kulp and Long (1958) K-Ar
GmYB-17
Biotite gneiss with 33% quartz, 20% microcline, 41% plagioclase, 5% biotite. (44°57'40" N, 109°25'42"W; SE¼ sec. 36, T. 58 N., R. 105 W.; Deep Lake 15' quad; roadcut on Hwy 12 SW of Frozen Lake, Park Co., Wyo.) ***Analytical data:*** (a) Wt = 1.1544 gm, Rb = 622 ± 10 ppm, Sr = 10.2 ppm, Sr^{87} = 7.27 ± 0.10 ppm, Sr^{87}/Rb^{87} = 0.0388 ± 0.0009; (b) wt = 1.4922, K = 7.71 ± 0.15%, $*Ar^{40}$ = 2.59 ± 0.05 ppm, $*Ar^{40}$ = 95.8%, Ar^{40}/K^{40} = 0.276 ± 0.010. ***Constants:*** (K) λ_e = 0.58×10^{-10}/yr, λ_β = 4.8×10^{-10}/yr, Rb^{87} λ = 1.39×10^{-11}/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** A. Poldervaart. ***Comment:*** These dates indicate the major regional metamorphism and granitization occurred about 2750 m.y. ago.

(a) (biotite) 2750 ± 60 m.y.
(b) (biotite) 2340 ± 50 m.y.

54. *Brookins (1968)* Rb-Sr
1022a
Biotite-muscovite granite with microperthite, microcline, orthoclase, quartz, plagioclase (An-15), biotite, muscovite, minor apatite, magnetite, pyrite. (45°02'10"N, 110°36'15"W; NE¼ SE¼ sec. 22, T. 9 S., R. 9 E.; Gardiner 15' quad; SW slope of Crevice (Crevasse) Mountain, 1500 ft. from granite-schist contact, Park Co.) ***Analytical data:*** Sr^{86}/Sr^{88} = 0.1205, $Sr^{87}/Sr^{86}{}_n$ = 0.9613, Rb^{87}/Sr^{86} = 6.50, initial Sr^{87}/Sr^{86} = 0.71 (assumed). ***Constants:*** Rb^{87} λ = 1.39×10^{-11}/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** L. E. Brown. ***Comment:*** Crevasse Mountain granite emplaced 2660 ± 80 m.y. ago.

(whole rock) 2731 m.y.

55. *Catanzaro and Kulp (1964)* U-Pb
59MZ1
Granite gneiss. (45°01'42"N, 109°24'27"W; sec. 20, T. 9 S., R. 19 E. [est.]; Mount Maurice 15' quad; Carbon Co.) ***Analytical data:*** U = 1662, 1658 ppm, Th = 1258 ppm, Pb = 536 ppm, common Pb = 17.8%, Pb^{204}/Pb^{206} = 0.447 ± 0.0005, Pb^{207}/Pb^{206} = 23.99, Pb^{208}/Pb^{206} = 36.40. ***Constants:*** U^{238} λ = 1.54×10^{-10}/yr, U^{235} λ = 9.72×10^{-10}/yr, Th^{232} λ = 4.88×10^{-11}/yr. ***Method:*** Using a 6-inch 60° mass spectrometer. ***Collected and dated by:*** E. J. Catanzaro. ***Comment:*** These dates indicate metamorphism and pegmatite formation 2700 m.y. ago.

(zircon) U^{238}/Pb^{206} 1280 ± 40 m.y.
U^{235}/Pb^{207} 1930 ± 60 m.y.
Pb^{206}/Pb^{207} 2730 ± 50 m.y.
Th^{232}/Pb^{208} 1260 m.y.

56. *Gast (1958)* Rb-Sr
Gast, Kulp and Long (1958)
Gm YB-6
Pink microcline with some perthite lamellae from a pegmatite within the Quad Creek metanorite. (45°01.5'N, 109°24.5'W; SE¼ sec. 29, T. 9 S., R. 19 E.; Mount Maurice 15' quad; 200 ft. SW of the biotite pegmatite No. 107 [Gm YB-5], Carbon Co.) ***Analytical data:*** Wt = 1.0000 gm, Rb = 837 ± 24 ppm, Sr = 7.2 ppm, Sr^{87} = 9.13 ± 0.15 ppm, Sr^{87}/Rb^{87} = 0.0386 ± 0.0013. ***Constants:*** Rb^{87} λ = 1.39 x 10^{-11}/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** A. Poldervaart. ***Comment:*** These dates indicate the major regional metamorphism and granitization occurred about 2750 m.y. ago.
(microcline) 2730 ± 70 m.y.

57. *James and Hedge (1980)* Rb-Sr
Quartzofeldspathic gneiss. ***Locations and Analytical data:*** 13 samples from No. 48 and 5 Tobacco Root samples from No. 73, Mueller and Cordua (1976). ***Constants:*** Rb^{87} λ = 1.42 x 10^{-11}/yr. ***Method:*** Isotope dilution and x-ray fluorescence. ***Comment:*** Age reflects the time of metamorphism corresponding to the 2750 m.y. old event in the Beartooth Mountains; No. 15-69 and No. 16-69 do not fall on isochron.
(whole rock isochron) 2730 ± 85 m.y.

58. *Powell, Skinner and Walker (1969)* Rb-Sr
Metasedimentary rocks below the Stillwater Complex, Sweet Grass Co. ***Specimen information*** and ***Analytical data:*** (See below.)
Figures in parentheses represent isotope dilution analyses. ***Constants:*** Sr^{86}/Sr^{88} = 0.1194; Rb^{85}/Rb^{87} = 2.599; Rb^{87} λ = 1.39 x 10^{-11}/yr; initial Sr^{87}/Sr^{86} = 0.705 ± 0.012. ***Method:*** Mass spectrometry and x-ray fluorescence. ***Collected by:*** W. R. Skinner; ***dated by:*** M. Bottino, G. Faure, Z. E. Peterman. ***Comment:*** Date is consistent with analyses by Fenton and Faure (1969), and Gast and others (1958).
(whole rock isochron) 2730 ± 150 m.y.

59. *James and Hedge (1980)* Rb-Sr
44-72
Layered gneiss, dark colored layer with 70% oligoclase, red-brown biotite, quartz, minor K-feldspar and garnet. (45°25'05"N, 112°08'55" W; NW¼ sec. 7, T. 5 S., R. 4 W.; Sheridan 7½' quad; Horse Creek road, quarried roadside outcrop, Tobacco Root Mountains, Madi-

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Specimen information for No. 58:

	Rock	Lat (N)	Long (W)
SZ-2	Cordierite-biotite-plagioclase-quartz-anthophyllite hornfels	45°28'23"	110°13'58"
SZ-12	Cordierite-biotite-plagioclase-quartz-anthophyllite hornfels	45°27'40"	110°12'40"
SZ-20	Quartz-cordierite-anthophyllite-plagioclase-biotite hornfels	45°26'47"	110°12'29"
SG-50a-1	Weakly foliated quartz-plagioclase-cummingtonite rock	45°24'58"	110°11'39"
DR-41,41c	Moderately foliated quartz-plagioclase-cummingtonite rock with 5% biotite	45°24'21"	110°11'55"
SA-35	Quartz-biotite-plagioclase schist	45°23'30"	110°12'30"
SC-14	Quartz-biotite-plagioclase schist	45°22'13"	110°13'14"

Analytical data for No. 58:

	Rb (ppm)	Sr (ppm)	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}
SZ-2	98.7	30.6	9.671	1.1006
	(101.7)	(29.6)		
SZ-12	87.9	33.7	7.717	1.001
SZ-20	55.0	35.3	4.597	0.896
SG-50a-1	2.81	131.5	0.0624	0.710
DR-41	5.61	109.5	0.1467	0.714
	(5.19)	(113.1)		
DR-41c	62.6	108.5	1.675	0.768
SA-35	86.1	206	1.205	0.755
SC-14	258	116	6.561	0.9226

son Co.) ***Analytical data:*** Rb = 163 ppm, Sr = 143 ppm, Rb^{87}/Sr^{86} = 3.349, Sr^{87}/Sr^{86} = 0.8331, assumed initial Sr^{87}/Sr^{86} = 0.701. ***Constants:*** Rb^{87} λ = 1.42 x 10^{-11}/yr. ***Method:*** Isotope dilution. ***Collected and dated by:*** H. L. James, C. E. Hedge. ***Comment:*** Age corresponds to the 2750 m.y. old metamorphic event in the Beartooth Mountains.

(whole rock) 2724 m.y.

60. *Page (1977)* Rb-Sr

Hornfels, Stillwater Complex. (45°22'N, 109°53'W; T. 5 S., R. 15 E. [est.]; Mt. Wood 15' quad; Stillwater River valley, Stillwater Co.) ***Dated by:*** P. A. Mueller. ***Comment:*** This isochron indicates the age of resetting of the complex by intrusion of quartz monzonite.

(whole rock isochron) 2719 ± 76 m.y.

61. *Mueller and Wooden (1976)* Rb-Sr

Cordierite-pyroxene hornfels, Stillwater Complex. (45°28'35"N, 110°10'52"W; NE¼ sec. 24, T. 4 S., R. 12 E. [est.]; Mt. Douglas 15' quad; Sweet Grass Co.) ***Analytical data:***

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}
A1-82	77.8	78.7	2.89	0.8186
A1-79	74.6	21.9	10.24	1.1030
A1-80	69.5	31.7	6.50	0.9608
A2-15	6.6	20.2	0.95	0.7475
A1-82 bio	213.0	31.1	20.68	1.4589

Initial Sr^{87}/Sr^{86} = 0.710 ± 0.008. ***Constants:*** Rb^{87} λ = 1.39 x 10^{-11}/yr. ***Method:*** Isotope dilution using a 30-cm single-focusing mass spectrometer. ***Collected by:*** J. R. Butler; ***dated by:*** P. A. Mueller, J. L. Wooden. ***Comment:*** No date calculated from the biotite data.

(whole rock isochron) 2713 ± 89 m.y.

62. *DePaolo and Wasserburg (1979)* Sm-Nd

Stillwater Complex. ***Specimen information*** (See below.)

Analytical data:

	Sm(ppm)	Nd(ppm)	Sm^{147}/Nd^{144}	Nd^{143}/Nd^{144}
STL-150	0.339	0.998	0.20593	0.511907
STL-145	0.269	0.786	0.20752	0.511956
STL-6	0.299	0.960	0.18899	0.511610
DSC-3	0.558	2.18	0.15519	0.511040
DSC-25	0.089	0.236	0.22801	0.512301
STL-100	0.137	0.414	0.20034	0.511814

Initial Nd^{143}/Nd^{144} = 0.508248. ***Constants:*** Sm^{147} λ = 6.54 x 10^{-12}/yr, Nd^{150}/Nd^{142} = 0.2096. ***Method:*** Isotope dilution. ***Dated by:*** D. J. DePaolo, G. J. Wasserburg.

(whole rock isochron) 2701 ± 8 m.y.

63. *DePaolo and Wasserburg (1979)* Rb-Sr Sm-Nd

STL-100

Lower gabbro zone, Stillwater Complex, gabbro with 46% plagioclase, 36% orthopyroxene (bronzite), and 18% clinopyroxene (augite). (45°23'30"N, 109°58'55"W; NE¼ NE¼ sec. 22, T. 5 S., R. 14 E.; Mt. Wood 15' quad; West Fork Stillwater River area, 15 km SE of the complex, Sweet Grass Co.) ***Analytical data:*** (See below.)

Specimen information for No. 62:

	Rock	Lat (N)	Long (W)	County
STL-150	Gabbro	45°26'10"	110°05'30"	Sweet Grass
STL-145	Gabbro	45°29'05"	110°05'30"	Sweet Grass
STL-6	Norite	not known	not known	
DSC-3	Anorthosite	45°23'00"	109°54'05"	Stillwater
DSC-25	Pyroxenite	45°23'00"	109°54'05"	Stillwater
STL-100	Gabbro	45°23'30"	109°58'55"	Sweet Grass

Analytical data for No. 63

	Rb (ppm)	Sr (ppm)	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}*
plagioclase	0.71	143	0.01427	0.7029
orthopyroxene	0.092	3.55	0.07511	0.70460
clinopyroxene	0.212	7.64	0.08042	0.7052

*Corrected for Sr^{86}/Sr^{88} = 0.1194; initial Sr^{87}/Sr^{86} = 0.70236.

	Sm (ppm)	Nd (ppm)	Sm^{147}/Nd^{144}	Nd^{143}/Nd^{144}*
plagioclase	0.043	0.269	0.09627	0.509965
orthopyroxene	0.036	0.076	0.28428	0.513317
clinopyroxene	0.60	1.47	0.24589	0.512628

*Corrected for Nd^{150}/Nd^{142} = 0.2096; initial Nd^{143}/Nd^{144} = 0.508248.

Constants: Rb^{87} λ = 1.39 x 10^{-11}/yr, Sm^{147} λ = 6.54 x 10^{-12}/yr. ***Method:*** Isotope dilution. ***Collected by:*** S. McCallum, L. Raedeke; ***dated by:*** D. J. DePaolo, G. J. Wasserburg. ***Comment:*** Rb-Sr data indicate a disturbance of the system at some time since 2700 m.y. ago; possible typographical error in the article—sample located 1.5 km SE of the Stillwater Complex?

Rb-Sr (mineral isochron) 2200 m.y.
Sm-Nd (mineral isochron) 2701 ± 8 m.y.

64. *Nunes (1970)* K-Ar
DS-18 20-66
Mafic pegmatite, ultramafic zone, Stillwater Complex. (45°28'52"N, 110°12'10"W; SE¼ sec. 14, T. 4 S., R. 12 E.; Mt. Douglas 15' quad; Gish mine, Sweet Grass Co.) ***Comment:*** From a personal communication (1968) by D. W. Schwartzman and B. J. Giletti.

(biotite) 2700 m.y.

65. *Brown and Brookins (1966)* Rb-Sr
Crevasse Mountain granite. (45°02'10"N, 110°36'15"W; sec. 22, T. 9 S., R. 9 E. [est.]; Gardiner 15' quad; Park Co.)

(whole rock) 2700 m.y.

66. *Nunes (1970)* U-Pb
Nunes and Tilton (1971)
J7-5
Quartz monzonite, Stillwater Complex, with zoned altered oligoclase, fresh microcline, plagioclase (altered to sericite, kaolinite and zoisite?), zircon, biotite and opaques. (45°22'54" N, 109°52'56"W; sec. 21, T. 5 S., R. 15 E. [est.]; Mt. Wood 15' quad; 1000 ft. NE of Verdigris Creek, elevation 5850 ± 50 ft., and 150 ft. above a dirt road, Stillwater Co.) ***Analytical data:*** U^{238} = 1340 ppm, Pb^{206} = 342.7 ppm, Pb^{206}/Pb^{204} = 533, Pb^{206}/Pb^{207} = 4.926, Pb^{206}/Pb^{208} = 5.507. ***Constants:*** U^{238} λ = 1.54 x 10^{-10}/yr, U^{235} λ = 9.72 x 10^{-10}/yr, U^{238}/U^{235} = 137.8 atomic ratio. ***Method:*** Isotope dilution with a 9-inch solid-source mass spectrometer. ***Collected and dated by:*** P. D. Nunes. ***Comment:*** Discordant data seem best explained by episodic Pb loss, but U gain is possible; dates indicate emplacement of the complex approximately 2750 m.y. ago.

(zircon) Pb^{206}/U^{238} 1680 m.y.
Pb^{207}/U^{235} 2185 m.y.
Pb^{207}/Pb^{206} 2700 m.y.

67. *Gast (1958)* U-Pb
Gast, Kulp and Long (1958)
K-156
Albite, quartz, biotite pegmatite surrounding a remnant of amphibolite and surrounded by granitic gneiss. (44°58'39"N, 109°45'30"W; sec. 29, T. 58 N., R. 107 W.; Pilot Peak 15' quad; 1 mi N of crossing of Clarks Fork and U.S. Hwy 12, Park Co.) ***Collected by:*** A. Poldervaart; ***dated by:*** J. Cobb.

(uraninite) Pb^{206}/U^{238} 2600 ± 20 m.y.
Pb^{207}/U^{235} 2640 ± 60 m.y.
Pb^{207}/Pb^{206} 2700 ± 20 m.y.

68. *Gast (1958)* Rb-Sr
Gast, Kulp and Long (1958) K-Ar
GmYB-16
Pink microcline from a discordant pegmatite. (44°57'50"N, 109°24'30"W; SE¼ sec. 31, T. 58 N., R. 104 W.; Deep Lake 15' quad; ¼ mi S of Blackstone Lake, Park Co., Wyo.) ***Analytical data:*** (a) wt = 0.5028 gm, Rb = 1345 ± 25 ppm, Sr = 0.9 ppm, Sr^{87} = 14.48 ± 0.21 ppm, Sr^{87}/Rb^{87} = 0.0380 ± 0.0010; (b) wt = 4.3871 gm, K = 8.74 ± 0.18%, $*Ar^{40}$ = 3.35 ± 0.07 ppm, $*Ar^{40}$ = 98.9%, Ar^{40}/K^{40} = 0.315 ± *0.010.* ***Constants:*** (K) λ_e = 0.58 x 10^{-10}/yr, λ_β = 4.8 x 10^{-10}/yr, Rb^{87} λ = 1.39 x 10^{-11}/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** A. Poldervaart. ***Comment:*** These dates indicate that the major regional metamorphism and granitization occurred about 2750 m.y. ago.

(a) (muscovite) 2700 ± 67 m.y.
(b) (muscovite) 2520 ± 50 m.y.

69. *Gast (1958)* Rb-Sr
Gast, Kulp and Long (1958)
Gm YB-12
Tan-gray microcline with a few perthite lamellae from a zoned conformable pegmatite, 100 ft. long and 10 ft. wide. (44°57'55"N, 109°22'05"W; NE¼ sec. 33, T. 58 N., R. 104 W; Deep Lake 15' quad; Christmas Lake, Park Co., Wyo.) ***Analytical data:*** Wt = 1.000 gm, Rb = 714 ± 22 ppm, Sr = 96.3 ppm, Sr^{87} = 7.91 ± 0.16 ppm, Sr^{87}/Rb^{87} = 0.0392 ± 0.0014. ***Constants:*** Rb^{87} λ = 1.39 x 10^{-11}/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** A. Poldervaart. ***Comment:*** These dates indicate that the major regional metamorphism and granitization occurred about 2750 m.y. ago.

(microcline) 2700 ± 100 m.y.

70. *Mueller (1979)* Rb-Sr

Pink granite with K-feldspar, albitic plagioclase and quartz; intruding a migmatite. (45°05'N, 110°30'W; T. 9 S., R. 18 E. [est.]; Gardiner 15' quad; Hell Roaring plateau, Carbon Co.) ***Analytical data:***

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	$Sr^{87}/Sr^{86}{}_n$
LG-1	138.7	161.7	2.50	0.8000
LG-Y	115.6	174.4	1.93	0.7808
LP-1	252.1	108.2	6.92	0.9715
LP-2	238.1	141.2	4.98	0.9019
LP-4	283.4	121.5	6.92	0.9534
S_3	40.97	126.6	0.94	0.7665

Initial $Sr^{87}/Sr^{86} = 0.704 \pm 0.006$. ***Constants:*** Rb^{87} $\lambda = 1.42 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 12-inch mass spectrometer. ***Collected by:*** P. A. Mueller, L. C. Rowan, L. H. Larsen; ***dated by:*** P. A. Mueller, Geochronology Laboratory, University of North Carolina. ***Comment:*** Because of geologic relations, this date should be considered a minimum for the second folding event in the eastern Beartooth Mountains.

(whole rock isochron) 2694 ± 190 m.y.

71. *Kistler, Obradovich and Jackson (1969)* K-Ar Rb-Sr

61MV-3

Layered olivine cumulate with post-cumulus mica, ultramafic zone, Stillwater Complex. (45°23'25"N, 109°54'15"W; NW¼ NW¼ sec. 20, T. 5 S., R. 15 E.; Mt. Wood 15' quad; Mouat mine, Mount View area, Stillwater Co.) ***Analytical data:*** (a) K = 6.99%, $*Ar^{40} = 7338.1 \times 10^{-11}$ moles/gm, $*Ar^{40}$ = 99%; (b) Rb = 342 ppm, Sr = 12.1 ppm, $*Sr^{87}$ = 3.188 ppm. ***Constants:*** (K) $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio; (Rb^{87}) $\lambda = 1.38 \times 10^{-11}$/yr, Rb^{87}/Rb = 0.283 g/g. ***Method:*** (K) flame photometry, (Rb-Sr) isotope dilution using a Nier-type 6-inch 60° mass spectrometer. ***Comment:*** These dates show the layered mafic intrusion was either emplaced or thermally metamorphosed about 2600 m.y. ago; mica and plagioclase dates and work by others tend to support the thermal metamorphism interpretation.

(a) (phlogopite) 2680 m.y.

(b) (phlogopite) 2330 m.y.

72. *Mueller and Wooden (1976)* Rb-Sr

Cordierite-pyroxene hornfels, Stillwater Complex. (45°20'55"N, 109°52'13"W; SW¼ sec. 34, T. 5 S., R. 15 E. [est.]; Mt. Wood 15' quad; Stillwater Co.) **Analytical data:**

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	$Sr^{87}/Sr^{86}{}_n$
SR-5	71.0	12.9	16.89	1.3483
SR-8	65.3	101.6	1.87	0.7781
SR-10	49.7	182.1	0.79	0.7404
SR-12	82.4	78.3	3.07	0.8252
SR-17	41.0	466.3	0.26	0.7137

Initial $Sr^{87}/Sr^{86} = 0.707 \pm 0.005$. ***Constants:*** Rb^{87} $\lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 30-cm single-focusing mass spectrometer. ***Collected by:*** L. H. Larsen, R. J. Beltrame; ***dated by:*** P. A. Mueller, J. L. Wooden.

(whole rock isochron) 2680 ± 46 m.y.

73. *Mueller and Cordua (1976)* Rb-Sr

Gneisses with quartz, oligoclase, microcline, biotite and hornblende; Tobacco Root Mountains, Madison Co. ***Specimen information:*** (See below.)

Analytical data:

	Rb(ppm)	Sr(ppm)	Sr^{87}/Sr^{86}
S-72-706A	252	124	0.9302
S-72-706B	86	350	0.7351
S-72-708	188	77	0.9833
S-72-908A	141	77	0.9156
S-72-908B	80	326	0.7333

Initial $Sr^{87}/Sr^{86} = 0.707 \pm 0.002$. ***Constants:*** Rb^{87} $\lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution. ***Comment:*** This date is suggested as a minimum age for the amphibolite facies metamorphism in the Tobacco Root Mountains.

(whole rock isochron) 2667 ± 66 m.y.

74. *Nunes (1970)* U-Pb

Nunes and Tilton (1971)

A29-2

Granodiorite dike, Stillwater Complex, basal zone, with microcline, oligoclase, plagioclase, hypersthene, accessories zircon and biotite, alteration products serpentine, chlorite, sericite and limonite. (45°22'57"N, 109°50'28"W; sec. 23, T. 5 S., R. 15 E. [est.]; Mt. Wood 15' quad; roadcut 400 ft. E of No. A29-3, Stillwater Co.)

Specimen information for No. 73:

	Rock	Lat (N)	Long (W)
S-72-706A	Biotitic quartzofeldspathic gneiss	45°25'08"	112°08'43"
S-72-706B	Leucocratic quartzofeldspathic gneiss	45°25'08"	112°08'43"
S-72-708	Leucocratic quartzofeldspathic gneiss	45°27'50"	111°56'40"
S-72-908A	Biotitic quartzofeldspathic gneiss	45°28'53"	112°00'20"
S-72-908B	Leucocratic quartzofeldspathic gneiss	45°28'50"	111°59'35"

Analytical data: U^{238} = 1098 ppm, Pb^{206} = 369.1 ppm, Pb^{206}/Pb^{204} = 1318, Pb^{206}/Pb^{207} = 5.382, Pb^{206}/Pb^{208} = 5.574. ***Constants:*** U^{238} $\lambda = 1.54 \times 10^{-10}$/yr, U^{235} $\lambda = 9.72 \times 10^{-10}$/yr, U^{238}/U^{235} = 137.8 atomic ratio. ***Method:*** Isotope dilution with a 9-inch solid-source mass spectrometer. ***Collected and dated by:*** P. D. Nunes. ***Comment:*** Discordant data seem best explained by episodic Pb loss, but U gain is possible; dates indicate emplacement of the complex approximately 2750 m.y. ago.

(zircon) Pb^{206}/U^{238} 2130 m.y.
Pb^{207}/U^{235} 2415 m.y.
Pb^{207}/Pb^{206} 2665 m.y.

75. *James and Hedge (1980)* Rb-Sr
1-69

Foliated gneiss with irregular texture, and perthitic K-feldspar, quartz, zoned oligoclase, minor muscovite and accessory minerals, Dillon granite gneiss. (45°09'45"N, 112°23'40"W; SW¼ sec. 6, T. 8 S., R. 6 W.; Christensen Ranch 7½' quad; Ruby Range, Madison Co.) ***Analytical data:*** Rb = 159 ppm, Sr = 81.5 ppm, Rb^{87}/Sr^{86} = 5.779, Sr^{87}/Sr^{86} = 0.9236, assumed initial Sr^{87}/Sr^{86} = 0.701. ***Constants:*** Rb^{87} $\lambda = 1.42 \times 10^{-11}$/yr. ***Method:*** Isotope dilution. ***Collected and dated by:*** H. L. James, C. E. Hedge. ***Comment:*** Age corresponds to the 2750 m.y. old metamorphic event in the Beartooth Mountains.

(whole rock) 2662 m.y.

76. *Brookins (1968)* Rb-Sr
1022b

Biotite-muscovite granite with microperthite, microcline, orthoclase, quartz, plagioclase (An-15), biotite, muscovite, minor apatite, magnetite and pyrite. (45°02'10"N, 110°36'15"W; NE¼ SE¼ sec. 22, T. 9 S., R. 9 E.; Gardiner 15' quad; SW slope of Crevice (Crevasse) Mountain, 1500 ft. from granite-schist contact, Park Co.) ***Analytical data:***

	Sr^{86}/Sr^{88}	$Sr^{87}/Sr^{86}{}_n$	Rb^{87}/Sr^{86}	$Sr^{87}/Sr^{86}{}_i$
whole rock	0.1186	0.9535	6.46	0.71
muscovite	0.1188	3.387	88.7	0.785
K-spar	0.1196	0.8898	4.01	0.785

Constants: Rb^{87} $\lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** L. E. Brown. ***Comment:*** Crevice (Crevasse) Mountain granite emplaced 2660 ± 80 m.y. ago; dates reflect the strong metamorphic event of 1700 m.y. ago.

(whole rock) 2661 m.y.
(muscovite) 2110 m.y.
(K-spar) 1850 m.y.

77. *Kistler, Obradovich and Jackson (1969)* K-Ar Rb-Sr
61MV-4

Micaceous phlogopite-pyrrhotite pod below G chromitite zone, Mouat mine, ultramafic zone, Stillwater Complex. (45°23'25"N, 109°54'15"W; NW¼ NW¼ sec. 20, T. 5 S., R. 15 E.; Mt. Wood 15' quad; Mount View area, Stillwater Co.) ***Analytical data:***

	K%	$*Ar^{40}$ ($\times 10^{-11}$ mole/g	$*Ar^{40}$%
(a)	7.26	7554.8	99
(b)	7.50	7621.9	99
(c)	7.38	7161.6	99

	Rb (ppm)	Sr (ppm)	$*Sr^{87}$ (ppm)
(a)	377	3.6	3.587
(b)	370	4.6	3.791
(c)	350	5.3	3.170

Constants: (K) $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio; Rb^{87} $\lambda = 1.38 \times 10^{-11}$/yr, Rb^{87}/Rb = 0.283 g/g. ***Method:*** (K) flame photometry; (Rb-Sr) isotope dilution using a Nier-type 6-inch 60° mass spectrometer. ***Comment:*** These dates show the layered mafic intrusion was either emplaced or thermally metamorphosed about 1600 m.y. ago; mica and plagioclase dates and work by others tend to support the thermal metamorphism interpretation.

(a) (phlogopite) K-Ar 2660 m.y.
Rb-Sr 2390 m.y.
(b) (phlogopite) K-Ar 2630 m.y.
Rb-Sr 2570 m.y.
(c) (phlogopite) K-Ar 2560 m.y.
Rb-Sr 2260 m.y.

78. *DePaolo and Wasserburg (1979)* Sm-Nd
DSC-3

Lower anorthosite zone, Stillwater Complex, anorthosite with plagioclase, orthopyroxene (bronzite), and clinopyroxene (augite), interstitial pyroxenes altered to uralitic amphibole, chlorite, epidote, calcite and sericite. (45°23'00"N, 109°54'05"W; NW¼ SE¼ sec. 20, T. 5 S., R. 15 E.; Mt. Wood 15' quad; Stillwater Co.) ***Analytical data:*** Sm = 0.558 ppm, Nd = 2.18 ppm, Sm^{147}/Nd^{144} = 0.15519, Nd^{143}/Nd^{144} = 0.511040 (corrected for Nd^{150}/Nd^{142} = 0.2096). ***Constants:*** Sm^{147} $\lambda = 6.54 \times 10^{-12}$/yr. ***Method:*** Isotope dilution. ***Collected by:*** D. J. DePaolo; ***dated by:*** D. J. DePaolo, G. J. Wasserburg.

(whole rock) 2653 ± 72 m.y.

79. *Hanson and Gast (1967)* K-Ar
WY12f

Well-foliated para-amphibolite with plagio-

clase, hornblende, quartz, biotite-chlorite, epidote, sphene and microcline, 4.1 m from a vertical 50-m quartz dolerite dike. (44°58'00"N, 109°25'20"W; SW¼ NE¼ sec. 33, T. 58 N., R. 104 W.; Deep Lake 15' quad; Christmas Lake dike, Park Co., Wyo.) ***Analytical data:*** K = 0.734%, $*Ar^{40}$ = 1.64 x 10^4 cc/g, Ar^{40}atm = 4.1%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.18 x 10^{-4} atomic ratio. ***Method:*** (Ar) mass spectrometry; (K) isotope dilution with mass spectrometry. ***Collected and dated by:*** G. N. Hanson. ***Comment:*** A general increase in age is seen with increase in distance from the dike.

(hornblende) 2650 m.y.

80. *Catanzaro and Kulp (1964)* U-Pb
59MZ7

Granite. (45°23'N, 110°55'W; T. 5 S., R. 6 E. [est.]; Fridley Peak 15' quad; Sweet Grass Co.) ***Analytical data:*** U = 1332 ppm, Th = 465 ppm, Pb = 401 ppm, common Pb = 6.7%, Pb^{204}/Pb^{206} = 0.153 ± 0.001, Pb^{207}/Pb^{206} = 19.39, Pb^{208}/Pb^{206} = 22.89. ***Constants:*** $U^{238}\lambda$ = 1.54 x 10^{-10}/yr, $U^{235}\lambda$ = 9.72 x 10^{-10}/yr, $Th^{232}\lambda$ = 4.88 x 10^{-11}/yr. ***Method:*** Using a 6-inch 60° mass spectrometer. ***Collected and dated by:*** E. J. Catanzaro. ***Comment:*** These dates indicate metamorphism and pegmatite formation 2700 m.y. ago.

(zircon) U^{238}/Pb^{206} 1400 ± 40 m.y.
U^{235}/Pb^{207} 1970 ± 60 m.y.
Pb^{206}/Pb^{207} 2650 ± 50 m.y.
Th^{232}/Pb^{208} 2350 m.y.

81. *Kistler, Obradovich and Jackson (1969)* K-Ar Rb-Sr
54ER-136

Micaceous phlogopite-pyrrhotite pod below G chromitite zone, Mouat mine, ultramafic zone, Stillwater Complex. (45°23'25"N, 109°54'15" W; NW¼ NW¼ sec. 20, T. 5 S., R. 15 E.; Mt. Wood 15' quad; Mount View area, Stillwater Co.) ***Analytical data:*** (a) K = 5.78%, $*Ar^{40}$ = 5619.0 x 10^{-11} moles/gm, $*Ar^{40}$ = 98%; (b) Rb = 289 ppm, Sr = 3.9 ppm, $*Sr^{87}$ = 2.967 ppm. ***Constants:*** (K) λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio; (Rb^{87}) λ = 1.38 x 10^{-11}/yr, Rb^{87}/Rb = 0.283 g/g. ***Method:*** (K) flame photometry; (Rb-Sr) isotope dilution using a Nier-type 6-inch 60° mass spectrometer. ***Comment:*** These dates show the layered mafic intrusion was either emplaced or thermally metamorphosed about 2600 m.y. ago; mica and plagioclase dates and work by others tend to support the thermal metamorphism interpretation.

(a) (phlogopite) 2640 m.y.
(b) (phlogopite) 2580 m.y.

82. *Mueller (1979)* Rb-Sr
Dike with large K-feldspar, sodic plagioclase and quartz crystals and biotite; crosscutting a folded sequence of gneiss and amphibolite. (45°05'N, 110°30'W; T. 9 S., R. 18 E. [est.]; Gardiner 15' quad; Hell Roaring plateau, Carbon Co.) ***Analytical data:***

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	$Sr^{87}/Sr^{86}{}_n$
3A	41.1	5124.8	5.71	0.9270
3C	422.2	96.2	13.30	1.2228
3E	338.2	154.1	6.50	0.9495
3H	117.9	127.7	2.70	0.8157
3J	478.7	74.6	19.99	1.4857

Initial Sr^{87}/Sr^{86} = 0.710 ± 0.005. ***Constants:*** $Rb^{87}\lambda$ = 1.42 x 10^{-11}/yr. ***Method:*** Isotope dilution using a 12-inch mass spectrometer. ***Collected by:*** P. A. Mueller, L. C. Rowan, L. H. Larsen; ***dated by:*** P. A. Mueller, Geochronology Laboratory, University of North Carolina. ***Comment:*** This dike intruded after the second folding event in the eastern Beartooth Mountains (post F_2).

(whole rock isochron) 2638 ± 135 m.y.

83. *Brookins (1968)* Rb-Sr
1049b

Biotite-muscovite granite with microperthite, microcline, orthoclase, quartz, plagioclase (An-15), biotite, muscovite, minor apatite, magnetite and pyrite. (45°01'50"N, 110°36'50" W; SW¼ SW¼ sec. 22, T. 9 S., R. 9 E.; Gardiner 15' quad; SW slope of Crevice (Crevasse) Mountain, 5000 ft. SW of No. 1022, 1000 ft. from granite-schist contact, Park Co.) ***Analytical data:*** Sr^{86}/Sr^{88} = 0.1189, $Sr^{87}/Sr^{86}{}_n$ = 0.9417, Rb^{87}/Sr^{86} = 6.22, initial Sr^{87}/Sr^{86} = 0.71 (assumed). ***Constants:*** $Rb^{87}\lambda$ = 1.39 x 10^{-11}/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** L. E. Brown. ***Comment:*** Crevice (Crevasse) Mountain granite emplaced 2660 ± 80 m.y. ago.

(whole rock) 2633 m.y.

84. *James and Hedge (1980)* Rb-Sr
43-72

Layered gneiss, light-colored layer with perthitic microcline, quartz, minor oligoclase, scarce muscovite. (45°25'05"N, 112°08'55"W; NW¼ sec. 7, T. 5 S., R. 4 W.; Sheridan 7½' quad; Horse Creek Road, quarried roadside outcrop, Tobacco Root Mountains, Madison Co.) ***Analytical data:*** Rb = 176 ppm, Sr =

76.5 ppm, Rb^{87}/Sr^{86} = 6.822, Sr^{87}/Sr^{86} = 0.9606, assumed initial Sr^{87}/Sr^{86} = 0.701. ***Constants:*** Rb^{87} λ = 1.42 x 10^{-11}/yr. ***Method:*** Isotope dilution. ***Collected and dated by:*** H. L. James, C. E. Hedge. ***Comment:*** Age corresponds to the 2750 m.y. old metamorphic event in the Beartooth Mountains.

(whole rock) 2630 m.y.

85. *Giletti (1966)* K-Ar
KW-84-62
Granitic gneiss, medium to fine grained, with quartz, microcline, oligoclase, biotite, rare muscovite. (44°54'30"N, 111°42'00"W; NE¼ NE¼ sec. 3, T. 11 S., R. 1 W.; Cliff Lake 15' quad; about 800 ft. SW of the 9233-ft. peak of Granite Mountain, Madison Co.) ***Analytical data:*** K = 6.87%, $*Ar^{40}$ = 15.52 x 10^4 scc/g, $*Ar^{40}$ = 99.06%, $*Ar^{40}/K^{40}$ = 0.331. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution with a 6-inch 60° mass spectrometer. ***Collected by:*** K. L. Wier; ***dated by:*** Brown University.

(biotite) 2620 m.y.

86. *Brookins (1968)* Rb-Sr
1049a
Biotite-muscovite granite with microperthite, microcline, orthoclase, quartz, plagioclase (An-15), biotite, muscovite, minor apatite and magnetite. (45°01'50"N, 110°36'50"W; SW¼ SW¼ sec. 22, T. 9 S., R. 9 E.; Gardiner 15' quad; SW slope of Crevice (Crevasse) Mountain, 5000 ft. SW of No. 1022, 1000 ft. from granite-schist contact, Park Co.) ***Analytical data:*** Sr^{86}/Sr^{88} = 0.1198, $Sr^{87}/Sr^{86}{}_n$ = 0.9402, Rb^{87}/Sr^{86} = 6.21, initial Sr^{87}/Sr^{86} = 0.71 (assumed). ***Constants:*** Rb^{87} λ = 1.39 x 10^{-11}/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** L. E. Brown. ***Comment:*** Crevice (Crevasse) Mountain granite emplaced 2660 ± 80 m.y. ago.

(whole rock) 2619 m.y.

87. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-42
Diabase dike with plagioclase and pyroxene. (45°02'05"N, 109°24'15"W; SE¼ sec. 17, T. 9 S., R. 19 E.; Mount Maurice 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 1.26 ppm, Ar^{40} = 0.4149 ppm, $*Ar^{40}$ = 99.9%, Ar^{40}/K^{40} = 0.3293. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) flame photometric and gravimetric methods, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 2610 m.y.

88. *Hanson and Gast (1967)* K-Ar
WY12n Rb-Sr
Well-foliated para-amphibolite with plagioclase, hornblende, quartz, biotite-chlorite, epidote, sphene and microcline, 19 m from a vertical 50-m quartz dolerite dike. (44°58'00"N, 109°25'20"W; SW¼ NE¼ sec. 33, T. 58 N., R. 104 W.; Deep Lake 15' quad; Christmas Lake dike, Park Co., Wyo.) ***Analytical data:*** (a) K = 6.05%, $*Ar^{40}$ = 13.5, 13.5 x 10^4 cc/g, Ar^{40}atm = 2.2, 3.7%; (b) Rb = 378 ppm, Sr_n = 41.0 ppm, $*Sr^{87}$ = 3.77 ppm, initial Sr^{87}/Sr^{86} = 0.705. ***Constants:*** Rb^{87} λ = 1.47 x 10^{-11}/yr, Rb^{87}/Rb^{85} = 0.385, (K) λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.18 x 10^{-4} atomic ratio. ***Method:*** (Ar) mass spectrometry, (K, Rb, Sr) isotope dilution with mass spectrometry. ***Collected and dated by:*** G. N. Hanson. ***Comment:*** A general increase in age is seen with increase in distance from the dike.

(a) (biotite) 2610 m.y.
(b) (biotite) 2350 m.y.

89. *Hanson and Gast (1967)* K-Ar
WY12j Rb-Sr
Well-foliated para-amphibolite with plagioclase, hornblende, quartz, biotite-chlorite, epidote, sphene and microcline, 10.2 m from a vertical 50-m quartz dolerite dike. (44°58'00"N, 109°25'20"W; SW¼ NE¼ sec. 33, T. 58 N., R. 104 W.; Deep Lake 15' quad; Christmas Lake dike, Park Co., Wyo.) ***Analytical data:*** (a) K = 4.03%, $*Ar^{40}$ = 7.19 x 10^4 cc/g, Ar^{40} atm = 4.1%; (b) K = 0.714%, $*Ar^{40}$ = 1.59, 1.53, 1.69 x 10^4 cc/g, Ar^{40}atm = 3.6, 3.9, 2.3%; (c) Rb = 281 ppm, Sr_n = 24.8 ppm, $*Sr^{87}$ = 2.74 ppm, initial Sr^{87}/Sr^{86} = 0.705. ***Constants:*** Rb^{87} λ = 1.47 x 10^{-11}/yr, Rb^{87}/Rb^{85} = 0.385, (K) λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.18 x 10^{-4} atomic ratio. ***Method:*** (Ar) mass spectrometry, (K, Rb, Sr) isotope dilution with mass spectrometry. ***Collected and dated by:*** G. N. Hanson. ***Comment:*** A general increase in age is seen with increase in distance from the dike.

(a) (biotite) 2290 m.y.
(b) (hornblende) 2610 m.y.
(c) (biotite) 2300 m.y.

90. *Schwartzman (1966)* K-Ar
DS-6
Harzburgite with olivine, bronzite, biotite, plagioclase, augite and chromite; Stillwater Complex, between chromite zones G and H, upper part of lower subzone, ultramafic zone. (45°23'25"N, 109°54'15"W; NW¼ NW¼ sec. 20, T. 5 S., R. 15 E.; Mt. Wood 15' quad; No. 2 level dump, Mouat chromite mine, Stillwater Co.) ***Analytical data:*** K = 6.51%, $*Ar^{40}$ = 1.45 x 10^{-3} scc/g, Ar^{40}atm = 0.633%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) using a Perkin-Elmer model 146 flame photometer with Li internal standard; (Ar) isotope dilution using a 6-inch 60° mass spectrometer. ***Collected and dated by:*** D. W. Schwartzman. ***Comment:*** Biotite date indicates a possible reheating of the complex at 2500 m.y. ago.

(biotite) 2600 m.y.

91. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-57
Small mafic intrusion with plagioclase and pyroxene. (45°07'41"N, 109°52'30"W; SW¼ sec. 16, T. 8 S., R. 15 E.; Cooke City 15' quad; Park Co.) ***Analytical data:*** K^{40} = 0.45 ppm (a), 0.41 ppm (b), Ar^{40} = 0.1412 ppm, $*Ar^{40}$ = 95.0%, Ar^{40}/K^{40} = 0.3284. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 2600 m.y.

92. *Giletti (1971)* K-Ar
7 Rb-Sr
Layer A; gneiss with alternating quartzofeldspathic and amphibolitic layers; quartzofeldspathic layer 1.8 cm thick. (45°18'25"N, 111°10'10"W; SW¼ SE¼ sec. 13, T. 6 S., R. 4 E., Garnet Mountain 15' quad; Gallatin Co.) ***Analytical data:*** (a) K = 6.20%, $*Ar^{40}$ = 13.65 x 10^4 scc/g, Ar^{40}atm = 0.069, $*Ar^{40}/K^{40}$ = 0.323, excess Ar^{40} = 7.0 x 10^4 scc/g, mesh = 40-200; (b) K = 1.35%, $*Ar^{40}$ = 1.782 x 10^4 scc/g, Ar^{40}atm = 0.022, $*Ar^{40}$ = 0.194; (c) Rb = 446 ppm, Sr = 25.3 ppm, Rb^{87}/Sr^{86} = 51.1, Sr^{87}/Sr^{86} = 1.936, assumed initial Sr^{87}/Sr^{86} = 0.710; (d) Rb = 60.1 ppm, Sr = 609 ppm, Rb^{87}/Sr^{86} = 0.2855, Sr^{87}/Sr^{86} = 0.7144. ***Constants:*** (K) λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio, (Rb^{87}) λ = 1.47 x 10^{-11}/yr. ***Method:*** Isotope dilution, (K) using a Perkin-Elmer flame photometer with Li internal standard, (Ar) using a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** (d) Whole rock data did not give a date, (a) "old" date interpreted as excess Ar in the sample, (b) and (c) affected by regional metamorphism 1900 m.y. and 1600 m.y. ago, respectively.

(a) (biotite) 2580 m.y.
(b) (hornblende) 1910 m.y.
(c) (biotite) 1610 m.y.

93. *Catanzaro and Kulp (1964)* U-Pb
GLGG
Granite gneiss. (44°57'45"N, 109°23'23"W; sec. 32, T. 58 N., R. 104 W. [est.]; Deep Lake 15' quad; Park Co., Wyo.) ***Analytical data:*** U = 1330 ppm, Pb = 280 ppm, common Pb = 24.8%, Pb^{204}/Pb^{206} = 0.683 ± 0.002, Pb^{207}/Pb^{206} = 25.42, Pb^{208}/Pb^{206} = 50.20. ***Constants:*** U^{238} λ = 1.54 x 10^{-10}/yr, U^{235} λ = 9.72 x 10^{-10}/yr. ***Method:*** Using a 6-inch 60° mass spectrometer. ***Collected and dated by:*** E. J. Catanzaro. ***Comment:*** These dates indicate metamorphism and pegmatite formation 2700 m.y. ago.

(zircon) U^{238}/Pb^{206} 770 ± 25 m.y.
U^{235}/Pb^{207} 1400 ± 40 m.y.
Pb^{206}/Pb^{207} 2580 ± 50 m.y.

94. *Page (1977)* Rb-Sr
Hornfels, Stillwater Complex. (45°24'N, 110°11'W; T. 5 S., R. 12 E. [est.]; Mt. Douglas 15' quad; Boulder River valley, Sweet Grass Co.) ***Dated by:*** P. A. Mueller.

(whole rock isochron) 2573 ± 29 m.y.

95. *Wooden (1975)* Pb-Pb
Granitic gneiss. (45°23'24"N, 110°29'00"W; NW¼ sec. 22, T. 5 S., R. 10 E. [est.]; Mt. Cowen 15' quad; Mount Cowen, Absaroka Range, Park Co.)

(zircon) 2565 m.y.

96. *Mueller (1979)* Rb-Sr
Dike with large K-feldspar, sodic plagioclase and quartz crystals, and biotite; crosscutting a folded sequence of gneiss and amphibolite and post F_2 dikes. (45°05'N, 110°30'W; T. 9 S., R. 18 E. [est.]; Gardiner 15' quad; Hell Roaring plateau, Carbon Co.) ***Analytical data:***

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	$Sr^{87}/Sr^{86}{}_n$
4'	54.2	184.7	0.85	0.7463
4''	247.0	72.0	10.34	1.1300
4-2	214.4	99.7	6.37	0.9477
4-3	252.9	112.7	6.66	0.9684
4-5	218.4	53.9	12.27	1.1700
4-7	288.5	80.9	10.73	1.1080

Initial $Sr^{87}/Sr^{86} = 0.7142 \pm 0.004$. ***Constants:*** Rb^{87} $\lambda = 1.42 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 12-inch mass spectrometer. ***Collected by:*** P. A. Mueller, L. C. Rowan and L. H. Larsen; ***dated by:*** P. A. Mueller, Geochronology Laboratory, University of North Carolina. ***Comment:*** This dike intruded after the third folding event in the eastern Beartooth Mountains (post F_3).

(whole rock isochron) 2565 ± 95 m.y.

97. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-48

Small mafic intrusion with plagioclase and pyroxene. (45°01'42"N, 109°24'30"W; NW¼ sec. 20, T. 9 S., R. 19 E.; Mount Maurice 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 0.49 ppm (a), 0.465 ppm (b), Ar^{40} = 0.1533 ppm, $*Ar^{40}$ = 96.8%, Ar^{40}/K^{40} = 0.3214. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence; (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 2560 m.y.

98. *Kistler, Obradovich and Jackson (1969)* K-Ar Rb-Sr
53-424-1

Granitic pegmatite in dike fault, Mouat mine, post-Stillwater Complex. (45°23'25"N, 109°54'15"W; NW¼ NW¼ sec. 20, T. 5 S., R. 15 E.; Mt. Wood 15' quad; Mount View area, Stillwater Co.) ***Analytical data:*** (a) K = 7.74%, $*Ar^{40} = 7512.5 \times 10^{-11}$ moles/gm, $*Ar^{40}$ = 99%; (b) Rb = 1268 ppm, Sr = 3.9 ppm, $*Sr^{87}$ = 11.78 ppm. ***Constants:*** (K) $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio; (Rb^{87}) $\lambda = 1.38 \times 10^{-11}$/yr, Rb^{87}/Rb = 0.283 g/g. ***Method:*** (K) flame photometry, (Rb-Sr) isotope dilution using a Nier-type 6-inch 60° mass spectrometer. ***Comment:*** These dates show the layered mafic intrusion was either emplaced or thermally metamorphosed about 2600 m.y. ago; mica and plagioclase dates and work by others tend to support the thermal metamorphism interpretation.

(a) (biotite) 2560 m.y.
(b) (biotite) 2330 m.y.

99. *Giletti (1971)* K-Ar
7

Layer C, quartzofeldspathic layer 1.3 cm thick, from a gneiss with alternating quartzofeldspathic and amphibolitic layers. (45°18'25"N, 111°10'10"W; SW¼ SE¼ sec. 13, T. 6 S., R. 4 E.; Garnet Mountain 15' quad; Gallatin Co.) ***Analytical data:*** (a) K = 6.35%, $*Ar^{40} = 13.70 \times 10^4$ scc/g, $Ar^{40}atm = 0.0 \times 10^4$ scc/g, $*Ar^{40}/K^{40}$ = 0.316, excess $Ar^{40} = 6.9 \times 10^4$ scc/g, mesh = 60-80; (b) K = 1.28%, $*Ar^{40} = 1.611 \times 10^4$ scc/g, $Ar^{40}atm = 0.032 \times 10^4$ scc/g, $*Ar^{40}/K^{40}$ = 0.184. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** Isotope dilution, (K) using a Perkin-Elmer flame photometer with Li internal standard, (Ar) using a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** (a) "Old" date interpreted as excess Ar^{40} in the sample; (b) affected by a regional metamorphism 1900 m.y. ago.

(a) (biotite) 2560 m.y.
(b) (hornblende) 1860 ± 100 m.y.

100. *Larson, Reynolds and Hoblitt (1973)* Rb-Sr
BT-3

Microporphyritic, fine-grained diabase dike with plagioclase, augite, hornblende; minor magnetite, orthopyroxene, quartz, sericite and chlorite. (44°57'14"N, 109°28'35"W; NE¼ sec. 6, T. 57 N., R. 104 W.; Deep Lake 15' quad; Park Co., Wyo.) ***Dated by:*** P. A. Mueller. ***Comment:*** Condie and others (1969) dated this dike at 2160 m.y. (K-Ar).

(whole rock) 2550 m.y.

101. *Larson, Reynolds and Hoblitt (1973)* Rb-Sr
BT-5

Microporphyritic, fine-grained diabase dike with plagioclase, augite, hornblende; minor magnetite, orthopyroxene, quartz, sericite and chlorite. (44°56'32"N, 109°30'15"W; NE¼ sec. 11, T. 57 N., R. 105 W.; Beartooth Butte 15' quad; Park Co., Wyo.) ***Dated by:*** P. A. Mueller. ***Comment:*** Condie and others (1969) dated this dike at 1960 m.y. (K-Ar).

(whole rock) 2550 m.y.

102. *Larson, Reynolds and Hoblitt (1973)* Rb-Sr
BT-6

Microporphyritic, fine-grained diabase dike with plagioclase, augite, hornblende; minor magnetite, orthopyroxene, quartz, sericite and chlorite. (44°55'52"N, 109°38'08"W; SW¼ sec. 11, T. 57 N., R. 106 W.; Beartooth Butte 15' quad; Park Co., Wyo.) ***Dated by:*** P. A.

Mueller. ***Comment:*** Condie and others (1969) dated this dike at 2000 m.y. (K-Ar).

(whole rock) 2550 m.y.

103. *Larson, Reynolds and Hoblitt (1973)* Rb-Sr

BT-1

Microporphyritic, fine-grained diabase dike with plagioclase, augite, hornblende; minor magnetite, orthopyroxene, quartz, sericite and chlorite. (45°01'15"N, 109°25'33"W; SW¼ SE¼ sec. 19, T. 9 S., R. 19 E.; Mount Maurice 15' quad; Carbon Co.) ***Dated by:*** P. A. Mueller. ***Comment:*** Condie and others (1969) dated this dike at 1010 m.y. (K-Ar); Baadsgaard and Mueller (1973) dated this dike at 880 m.y. (K-Ar), and 1080 m.y. (K-Ar).

(whole rock) 2550 m.y.

104. *Larson, Reynolds and Hoblitt (1973)* Rb-Sr

BT-4

Microporphyritic, fine-grained diabase dike with plagioclase, augite, hornblende; minor magnetite, orthopyroxene, quartz, sericite and chlorite. (4a: 44°56'35"N, 109°29'30"W; 4b: 44°57'45"N, 109°30'15"W; 4c: 44°58'05"N 109°31'05"W; Park Co., Wyo.) ***Dated by:*** P. A. Mueller. ***Comment:*** Condie and others (1969) dated this dike at 1690 m.y. (K-Ar); Baadsgaard and Mueller (1973) dated this dike at 1700 m.y. and 1600 m.y. (K-Ar).

(whole rock) 2550 m.y.

105. *Baadsgaard and Mueller (1973)* Rb-Sr

Group II diabase dikes, with plagioclase and pyroxene.

	Lat (N)	Long (W)	County
MBT-1	44°57'24"	109°30'05"	Park; Wyo.
MBT-2	44°56'35"	109°29'30"	Park; Wyo.
MBT-16A	44°58'20"	109°31'25"	Park; Wyo.
MBT-21	44°59'15"	109°33'15"	Park; Wyo.
MBT-29	45°01'20"	109°38'20"	Carbon; Mt.

Analytical data:

	Rb(ppm)	Sr^N(ppm)	Sr^{87}/Sr^{86}	Rb^{87}/Sr^{86}
MBT-1	35.9	162.1	0.7259	0.640
MBT-2	23.1	58.5	0.7447	1.142
MBT-16A	52.0	133.8	0.7327	0.865
MBT-21	37.5	162.5	0.7280	0.668
MBT-29	31.0	116.0	0.7431	0.766

Initial $Sr^{87}/Sr^{86} = 0.7024 \pm 0.0019$. ***Method:*** Isotope dilution using a 6-inch mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta, and University of North Carolina. ***Comment:*** MBT-29 does not fall on the isochron; probably contaminated.

(whole rock isochron) 2548 ± 162 m.y.

106. *Baadsgaard and Mueller (1973)* Rb-Sr

Groups I and II diabase dikes. ***Locations and analytical data:*** See No. 105 and No. 108; initial $Sr^{87}/Sr^{86} = 0.7024 \pm 0.0006$. ***Method:*** Isotope dilution using a 6-inch mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta, and University of North Carolina. ***Comment:*** MBT-17 and MBT-29 do not fall on the isochron; probably contaminated.

(whole rock isochron) 2538 ± 58 m.y.

107. *Gast (1958)* Rb-Sr
Gast, Kulp and Long (1958) K-Ar

GmYB-5

Small discordant pegmatite with biotite, plagioclase, some chloritization. (45°01'29"N, 109°24'22"W; SE¼ sec. 29, T. 9 S., R. 19 E.; Mount Maurice 15' quad; 500 ft. S of N intersection of Route 12 and Quad Creek metanorite, Carbon Co.) ***Analytical data:*** (See below.) ***Constants:*** (K) $\lambda_e = 0.58 \times 10^{-10}$/yr, $\lambda_\beta = 4.8 \times 10^{-10}$/yr, $Rb^{87}\ \lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** A. Poldervaart. ***Comment:*** These dates indicate that the major regional metamorphism and granitization occurred about 2750 m.y. ago; D. S. Miller (1968) calculated a fission-track

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Analytical data for No. 107:

	wt (g)	Rb (ppm)	Sr (ppm)	Sr^{87} (ppm)	Sr^{87}/Rb^{87}
(a)	0.7006	1333 ± 26	6.8	13.36 ± 0.23	0.0354 ± 0.0009
	1.301	1228 ± 25			
	1.0189	1251 ± 19	12.8	12.79 ± 0.18	0.0360 ± 0.0008
	wt (g)	**K%**	***Ar^{40}%**	***Ar^{40} (ppm)**	**Ar^{40}/K^{40}**
(b)	1.7466	6.42 ± 0.12	92.2	2.05 ± 0.05	0.265 ± 0.012
		6.26 ± 0.10			

date of 75 m.y. for biotite from this sample (U = 66 ppb); the extremely young date is explained as due to annealing of tracks, either gradually or during specific events.

(a) (biotite) 2530 ± 45 m.y.
(b) (biotite) 2290 ± 60 m.y.

108. *Baadsgaard and Mueller (1973)* Rb-Sr

Group I diabase dikes, with plagioclase and pyroxene.

	Lat (N)	Long (W)	County, State
MBT-6	45°26'45"	110°03'12"	Sweet Grass, Mt.
MBT-7	45°26'12"	110°04'00"	Sweet Grass, Mt.
MBT-17	44°57'28"	109°30'58"	Park, Wyo.
MBT-20	45°03'00"	109°26'10"	Carbon, Mt.
MBT-34	45°01'25"	109°37'10"	Carbon, Mt.
MBT-41	45°01'55"	109°24'20"	Carbon, Mt.
MBT-46	44°58'40"	109°23'40"	Park, Wyo.
MBT-47	44°58'43"	109°25'05"	Park, Wyo.
MBT-48	45°01'42"	109°24'30"	Carbon, Mt.
MBT-50A	44°59'35"	109°24'53"	Park, Wyo.
MBT-57	45°07'41"	109°52'30"	Park, Mt.

Analytical data:

	Rb (ppm)	Sr (ppm)	Sr^{87}/Sr^{86}	Rb^{87}/Sr^{86}
MBT-6	72.9	137.6	0.7563	1.531
MBT-7	1.01	107.1	0.7036	0.02072
MBT-17	22.3	512.9	0.7232	1.024
MBT-20	55.3	156.3	0.7373	0.126
MBT-34	15.2	118.7	0.7147	0.371
MBT-41	17.7	172.9	0.7130	0.296
MBT-46	31.3	142.9	0.7263	0.633
MBT-47	62.0	190.6	0.7385	0.941
MBT-48	16.2	154.5	0.7133	0.304
MBT-50A	47.6	172.8	0.7305	0.796
MBT-57	16.1	118.4	0.7150	0.393

Initial $Sr^{87}/Sr^{86} = 0.7024 \pm 0.0007$. ***Method:*** Isotope dilution using a 6-inch mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta; and University of North Carolina. ***Comment:*** MBT-17 does not fall on the isochron; probably contaminated.

(whole rock isochron) 2515 ± 62 m.y.

109. *Hanson and Gast (1967) Hanson (1964)* K-Ar

WY12d

Well-foliated para-amphibolite with plagioclase, hornblende, quartz, biotite-chlorite, epidote, sphene and microcline, 2.1 m from a vertical 50-m quartz dolerite dike. (44°58'00"N, 109°25'20"W; SW¼ NE¼ sec. 33, T. 58 N., R. 104 W.; Deep Lake 15' quad; Christmas Lake dike, Park Co., Wyo.) ***Analytical data:*** (bio) K = 6.05%, $*Ar^{40} = 3.37 \times 10^4$ cc/g, Ar^{40} atm = 1.8%; (hb) K = 0.762%, $*Ar^{40} = 1.58 \times 10^4$ cc/g, Ar^{40}atm = 3.0%. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.18 \times 10^{-4}$ atomic ratio. ***Method:*** (Ar) mass spectrometry, (K) isotope dilution with mass spectrometry. ***Collected and dated by:*** G. N. Hanson. ***Comment:*** A general increase in age is seen with increase in distance from the dike; biotite date was recalculated in 1967 (using $\lambda_e = 0.584 \times 10^{-10}$/yr) as 1050 m.y.

(biotite) 1070 m.y.
(hornblende) 2510 m.y.

110. *Mueller (1971) Baadsgaard and Mueller (1973)* K-Ar

MBT-41

Small mafic intrusion with plagioclase and pyroxene. (45°01'55"N, 109°24'20"W; NE¼ sec. 20, T. 9 S., R. 19 E.; Mount Maurice 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 0.51, 0.50 ppm (a), 0.51 ppm (b), $Ar^{40} = 0.1561$ ppm, $*Ar^{40} = 73.9\%$, $Ar^{40}/K^{40} = 0.3078$. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) isotope dilution; (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 2500 m.y.

111. *Schwartzman (1966)* K-Ar

DS-5

Mafic pegmatite with poikilitic bronzite, olivine inclusions, interstitial plagioclase, and associated biotite, augite and chromite; from between chromite zones G and H, upper part of lower subzone, ultramafic zone, Stillwater Complex. (45°23'25"N, 109°54'15"W; NW¼ NW¼ sec. 20, T. 5 S., R. 15 E.; Mt. Wood 15' quad; No. 2 level dump, Mouat mine, Stillwater Co.) ***Analytical data:*** (a) K = 0.0078 ± 0.0002%, $*Ar^{40} = 15.1, 14.5 \times 10^{-6}$ scc/g, Ar^{40} atm = 4.55, 4.60%, minimum excess Ar = 12.4×10^{-6} scc/g; (b) K = 6.56%, $*Ar^{40} = 1.33 \times 10^{-3}$ scc/g, Ar^{40}atm = 2.76%. ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** Isotope dilution, (K) using a Perkin-Elmer model 146 flame photometer with Li internal standard, (Ar) using a 6-inch 60° mass spectrometer. ***Collected and dated by:*** D.W. Schwartzman. ***Comment:*** Biotite date indicates a possible reheating of the complex at 2500 m.y. ago.

(a) (bronzite) 6200 m.y.
(b) (biotite) 2470 m.y.

112. *Hayden and Wehrenberg (1960)* K-Ar

Medium-grained amphibolite with quartz, and minor plagioclase and biotite. (45°01'29"N, 109°24'22"W; SE¼ sec. 29, T. 9 S., R. 19 E.; Mount Maurice 15' quad; Cooke City Hwy 14.1 mi from U.S. Forest boundary, S from Red Lodge, roadcut at Quad Creek, Carbon Co.) ***Analytical data:*** K = 0.465%, Ar^{40} = 9.35 x 10^{-5}STP cc/g, $*Ar^{40}$ = 94.5%, Ar^{40}/K^{40} = 0.295. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr. ***Method:*** Isotope dilution, (K) using a Perkin-Elmer flame photometer, (Ar) using a 6-inch 60° mass spectrometer. ***Collected and dated by:*** R. J. Hayden and J. P. Wehrenberg. ***Comment:*** This amphibolite corresponds to the para-amphibolite of Eckelmann and Poldervaart (1957); this date corresponds well to the K-Ar dates of Gast and others (1958).

(hornblende) 2450 m.y.

113. *Catanzaro and Kulp (1964)* U-Pb

60MZ26

Migmatite with segregated mafic and felsic layers, with sodic plagioclase, microcline, green-brown biotite, hornblende, quartz; accessories epidote, apatite, sphene, zircon, opaques, monazite; some alteration to chlorite and sericite. (47°02'02"N, 110°46'52"W; NE¼ sec. 25, T. 15 N., R. 7 E.; Monarch 7½' quad; Little Belt Mountains, Cascade Co.) ***Analytical data:*** U = 361 ppm, Th = 101 ppm, Pb = 113 ppm, common Pb = 6.0%, Pb^{204}/Pb^{206} = 0.125 ± 0.001, Pb^{207}/Pb^{206} = 17.18, Pb^{208}/Pb^{206} = 13.63. ***Constants:*** $U^{238}\ \lambda = 1.54 \times 10^{-10}$/yr, $U^{235}\ \lambda = 9.72 \times 10^{-10}$/yr, $Th^{232}\ \lambda = 4.88 \times 10^{-11}$/yr. ***Method:*** Using a 6-inch 60° mass spectrometer. ***Collected and dated by:*** E. J. Catanzaro. ***Comment:*** These dates indicate a metamorphic event at about 1920 m.y. ago.

(zircon) U^{238}/Pb^{206} 1570 ± 45 m.y.
U^{235}/Pb^{207} 1980 ± 60 m.y.
Pb^{206}/Pb^{207} 2450 ± 40 m.y.
Th^{232}/Pb^{208} 1790 m.y.

114. *Fenton and Faure (1969) Steuber and Murthy (1966)* Rb-Sr

Stillwater Complex, Sweet Grass Co.

	rock	Lat (N)	Long (W)
R4961	harzburgite	45°29'00"	110°12'33"
R4967	harzburgite	45°22'15"	109°46'20"
R4964	harzburgite	45°22'40"	109°53'25"
110	norite	45°28'30"	110°05'00"
R4971	noritic harzburgite	45°21'40"	109°46'43"
R4969	anorthosite	45°23'30"	109°52'00"
R4186	anorthosite	45°28'00"	110°05'00"
Mon-1-1†	peridotite	ultramafic zone	

Analytical data:

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}_{corr}
R4961	2.55	2.71	0.272	0.7192
	2.33	2.52		0.7175
	2.34	2.47		0.7189
R4967	0.72	39.4	0.049	0.7075
	0.58	37.5		0.7076
R4964	0.54	14.6	0.104	0.7059
	0.47	13.8		0.7056
110	1.49	18.3	0.243	0.7110
	1.54	18.1		0.7111
R4971	1.21	70.7	0.048	0.7058
	1.07	70.3		0.7026
		65.5		0.7046
				0.7048
R4969	3.9	158.0	0.072	0.7056
				0.7052
				0.7054
R4186	6.59	155.8	0.113	0.7072
	5.55	156.5		0.7077
Mon-1-1†	0.382	13.36	0.028	0.7063

†Sr^{87}/Sr^{86} = 0.7077; Sr^{88}/Sr^{86} = 8.409.

Constants: $Rb^{87}\ \lambda = 1.39 \times 10^{-11}$/yr, initial Sr^{87}/Sr^{86} = 0.7029 ± 0.0006; (Mon-1-1) $Rb^{87}\ \lambda = 1.47 \times 10^{-11}$/yr. ***Method:*** Replicate isotope dilution analyses using a 6-inch 60° mass spectrometer; (Mon-1-1) using a 12-inch 60° solid-source mass spectrometer. ***Collected by:*** H.H. Hess; ***dated by:*** M. D. Fenton and G. Faure, (Mon-1-1) A. M. Steuber and J. R. Murthy. ***Comment:*** Date indicates the Stillwater Complex is younger than many previously believed; date is consistent with analyses by Schwartzman and Giletti (1968).

(whole rock isochron) 2450 ± 210 m.y.

115. *Baadsgaard and Mueller (1973)* K-Ar

MBT-7

Chilled margin of diabase dike, with plagioclase and pyroxene. (45°26'12"N, 110°04'00" W; NW¼ sec. 1, T. 5 S., R. 13 E.; Mt. Douglas 15' quad; Sweet Grass Co.) ***Analytical data:*** K^{40} = 0.12, 0.15 ppm, Ar^{40} = 0.0394 ppm, $*Ar^{40}$ = 95.2%, Ar^{40}/K^{40} = 0.2918. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) flame photometric and gravimetric methods, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta. ***Comment:*** Mueller (1971) calculated this date as 2490 m.y.

(whole rock) 2441 m.y.

116. *Giletti (1966)* K-Ar
20

Phyllite, fine grained, with quartz, muscovite, biotite, chlorite. (45°03'10"N, 110°39'04"W; SW¼ NE¼ NW¼ sec. 17, T. 9 S., R. 9 E.; Gardiner 15' quad; Park Co.) ***Analytical data:*** (a) K = 6.75%, $*Ar^{40}$ = 13.30 x 10^4 scc/g, $*Ar^{40}$ = 98.82%, $*Ar^{40}/K^{40}$ = 0.289; (b) K = 6.75%, $*Ar^{40}$ = 13.03 x 10^4 scc/g, $*Ar^{40}$ = 99.65%, $*Ar^{40}/K^{40}$ = 0.283. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution with a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University.

(a) (biotite) 2430 m.y.
(b) (biotite) 2400 m.y.

117. *Giletti (1971)* K-Ar
5 Rb-Sr

Quartzofeldspathic gneiss. (45°18'50"N, 111°10'53"W; NW¼ NE¼ sec. 13, T. 6 S., R. 4 E.; Garnet Mountain 15' quad; Gallatin Co.) ***Analytical data:*** (a) K = 7.31%, $*Ar^{40}$ = 14.43 x 10^4 scc/g, Ar^{40}atm = 0.038 x 10^4 scc/g, $*Ar^{40}/K^{40}$ = *0.290; (b) Rb* = 772 ppm, Sr = 8.29 ppm, Rb^{87}/Sr^{86} = 269.4, Sr^{87}/Sr^{86} = 7.471, assumed initial Sr^{87}/Sr^{86} = 0.710; (c) Rb = 113 ppm, Sr = 237 ppm, Rb^{87}/Sr^{86} = 1.377, Sr^{87}/Sr^{86} = 0.7560, whole rock analysis. ***Constants:*** (K) λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio; Rb^{87} λ = 1.47 x 10^{-11}/yr. ***Method:*** Isotope dilution, (K) using a Perkin-Elmer flame photometer with Li internal standard, (Ar) using a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** No date calculated for (c); K-Ar age affected by regional metamorphism 1900 m.y. ago; Rb-Sr age reset by regional metamorphism 1600 m.y. ago.

(a) (biotite) 2430 m.y.
(b) (biotite) 1680 m.y.

118. *Giletti (1971)* K-Ar
6 Rb-Sr

(45°18'40"N, 111°10'30"W; SE¼ SE¼ sec. 13, T. 6 S., R. 4 E.; Garnet Mountain 15' quad; Gallatin Co.) ***Analytical data:*** (a) K = 7.25%, $*Ar^{40}$ = 14.32 x 10^4 scc/g, Ar^{40}atm = 0.0905 x 10^4 scc/g, $*Ar^{40}/K^{40}$ = 0.290; (b) K = 1.25%, $*Ar^{40}$ = 1.836 x 10^4 scc/g, Ar^{40}atm = 0.0219 x 10^4 scc/g, $*Ar^{40}/K^{40}$ = 0.215; (c) Rb = 511 ppm, Sr = 16.8 ppm, Rb^{87}/Sr^{86} = 87.9, Sr^{87}/Sr^{86} = 2.86, assumed initial Sr^{87}/Sr^{86} = 0.710. ***Constants:*** (K) λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio; Rb^{87} λ = 1.47 x 10^{-11}/yr. ***Method:*** Isotope dilution, (K) using a Perkin-Elmer flame photometer with Li internal standard, (Ar) using a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** K-Ar ages affected by regional metamorphism 1900 m.y. ago; Rb-Sr age reset by regional metamorphism 1600 m.y. ago.

(a) (biotite) 2430 m.y.
(b) (hornblende) 2040 m.y.
(c) (biotite) 1640 m.y.

119. *McMannis and Chadwick (1964)*
(45°04'N, 110°36'W; sec. 9, T. 9 S., R. 9 E. [est.]; Gardiner 15' quad; Jardine, Park Co.) ***Dated by:*** B. J. Giletti.

2420 m.y.

120. *Catanzaro and Kulp (1964)* U-Pb
60MZ27

Migmatite with segregated mafic and felsic layers, with sodic plagioclase, microcline, green-brown biotite, hornblende, quartz; accessories epidote, apatite, sphene, zircon, opaques, monazite; some alteration to chlorite and sericite. (47°02'15"N, 110°46'55"W; NW¼ sec. 25, T. 15 N., R. 7 E.; Monarch 7½' quad; Little Belt Mountains, Cascade Co.) ***Analytical data:*** U = 590 ppm, Th = 154 ppm, Pb = 138 ppm, common Pb = 9.2%, Pb^{204}/Pb^{206} = 0.190 ± 0.003, Pb^{207}/Pb^{206} = 17.51, Pb^{208}/Pb^{206} = 16.57. ***Constants:*** U^{238} λ = 1.54 x 10^{-10}/yr, U^{235} λ = 9.72 x 10^{-10}/yr, Th^{232} λ = 4.88 x 10^{-11}/yr. ***Method:*** Using a 6-inch 60° mass spectrometer. ***Collected and dated by:*** E. J. Catanzaro. ***Comment:*** These dates indicate a metamorphic event at about 1920 m.y. ago.

(zircon) U^{238}/Pb^{206} 1170 ± 35 m.y.
U^{235}/Pb^{207} 1670 ± 50 m.y.
Pb^{206}/Pb^{207} 2390 ± 45 m.y.
Th^{232}/Pb^{208} 1500 m.y.

121. *Catanzaro and Kulp (1960)* Pb^{207}/Pb^{206}

Zircons from Archean migmatite gneisses, Little Belt Mountains. (Meagher, Cascade and Judith Basin Co.) ***Comment:*** Samples from 4 different exposures along a 5-mi traverse, which cut across the strike of the foliation of the gneisses; authors concluded from discordant results that the area underwent metamorphism 2700 m.y. ago, and that discordancy was caused by Pb loss by diffusion.

(zircon) 1650 m.y.
(zircon) 1920 m.y.
(zircon) 1940 m.y.
(zircon) 2380 m.y.

122. *Catanzaro and Kulp (1964)* U-Pb K-Ar
59MZ15
Migmatite with segregated mafic and felsic layers with sodic plagioclase, microcline, green-brown biotite, hornblende, quartz; accessories epidote, apatite, sphene, zircon, opaques, monazite; some alteration to chlorite and sericite. (47°02'18"N, 110°47'15"W; SW¼ sec. 24, T. 15 N., R. 7 E.; Monarch 7½' quad; Little Belt Mountains, Cascade Co.) ***Analytical data:*** (zircon) U = *375 ppm, Pb* = 110 ppm, common Pb = 11.7%, Pb^{204}/Pb^{206} = 0.253 ± 0.002, Pb^{207}/Pb^{206} = 18.18, Pb^{208}/Pb^{206} = 19.40; (hornblende) K = 1.20%, $*Ar^{40}$ = 11.6×10^{-5} scc/g, $*Ar^{40}$ = 98%. ***Constants:*** U^{238} λ = 1.54×10^{-10}/yr, U^{235} λ = 9.72×10^{-10}/yr; (K) λ_e = 0.584×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** E. J. Catanzaro; ***dated by:*** E. J. Catanzaro and R. Kologrivov. ***Comment:*** These dates indicate a metamorphic event at about 1920 m.y. ago.
(zircon) U^{238}/Pb^{206} 1390 ± 40 m.y.
U^{235}/Pb^{207} 1830 ± 50 m.y.
Pb^{206}/Pb^{207} 2380 ± 45 m.y.
(hornblende) K-Ar 1780 m.y.

123. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-36
Diabase dike with plagioclase and pyroxene. (45°01'40"N, 109°39'00"W; SE¼ sec. 20, T. 9 S., R. 17 E.; Alpine 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 0.336 ppm (a), 0.309 ppm (b), Ar^{40} = 0.0884 ppm, Ar^{40} = 99.9%, Ar^{40}/K^{40} = 0.2741. ***Constants:*** λ_e = 0.585×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr, K^{40}/K = 1.19×10^{-4} atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.
(whole rock) 2360 m.y.

124. *Green (1972)* F.T.
HRL-7
Metasedimentary zircon core from a quartzite unit exposed on the glaciated floor of the Hell Roaring Lakes. (45°02'N, 109°30'W; sec. 14, 15, T. 9 S., R. 18 E. [est.]; Mount Maurice 15' quad; Hell Roaring Lakes, Carbon Co.) ***Analytical data:*** area = 0.085 mm^2, 27.825 density ϱ_s/unit area, 1.333 density ϱ_i/unit area, ϱ_s density/ϱ_i density = 20.874. ***Constants:*** λ_D = 1.54×10^{-10}/yr, λ_F = 6.85×10^{-17}/yr, ς = $582 \times 10^{-24} cm^2$, U^{235}/U^{238} = 7.26×10^{-3} atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** The U concentration in this sample was lower than that of other grains from this unit; some fission tracks were annealed by a metasomatic event 2700 m.y. ago.
(zircon) 2346 m.y.

125. *Hanson and Gast (1967)* K-Ar
WY12b
Well-foliated para-amphibolite with plagioclase, hornblende, quartz, biotite-chlorite, epidote, sphene and microcline, 0.6 m from a vertical 50-m quartz dolerite dike. (44°58'00"N, 109°25'20"W; SW¼ NE¼ sec. 33, T. 58 N., R. 104 W.; Deep Lake 15' quad; Christmas Lake dike, Park Co., Wyo.) ***Analytical data:*** K = 0.819%, $*Ar^{40}$ = 1.50, 1.51×10^4 cc/g, Ar^{40}atm = 4.7, 2.1%. ***Constants:*** λ_e = 0.584×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr, K^{40}/K = 1.18×10^{-4} atomic ratio. ***Method:*** (Ar) mass spectrometry, (K) isotope dilution with mass spectrometry. ***Collected and dated by:*** G. N. Hanson. ***Comment:*** A general increase in age is seen with increase in distance from the dike.
(hornblende) 2340 m.y.

126. *Hanson (1964)* K-Ar
WY10d
Amphibole-biotite-feldspar gneiss 1.5 m from a 26-m basalt dike. (44°56'50"N, 109°29'00"W; SE¼ NE¼ sec. 1, T. 57 N., R. 105 W.; Deep Lake 15' quad; Park Co., Wyo.) ***Analytical data:*** K = 5.90%, $*Ar^{40}$ = 10.52×10^4 cc/g, Ar^{40}atm = 1.9%. ***Constants:*** λ_e = 0.585×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr, K^{40}/K = 1.18×10^{-4} atomic ratio. ***Method:*** (Ar) mass spectrometry, (K) isotope dilution with mass spectrometry. ***Collected and dated by:*** G. N. Hanson. ***Comment:*** An increase in age is seen with an increase in distance from the dike.
(biotite) 2330 m.y.

127. *Schwartzman and Giletti (1968)* K-Ar
Nunes (1970)
A1-82
Hornfels zone below the Stillwater Complex. (About 45°20'N, 110°W; Mt. Douglas and Mt. Wood 15' quads; Stillwater and Sweet Grass Co.) ***Dated by:*** Lamont Geological Observatory. ***Comment:*** (a) −40 + 60 mesh, (b) −80

+ 120 mesh; from a personal communication (1968) by B. J. Giletti; Butler (1966) cited J. L. Kulp (1963, personal communication) regarding this sample—biotite from hornfels, Stillwater aureole yields apparent age of 3065 m.y.

(a) (biotite) 2330 m.y.
(b) (biotite) 1880 m.y.

128. *Kistler, Obradovich and Jackson (1969)* K-Ar

55BE-1

Diabasic gabbro from chilled border of the Stillwater Complex, basal zone. (45°21'30"N, 109°48'35"W; NE¼ NE¼ sec. 36, T. 5 S., R. 15 E.; Mt. Wood 15' quad; Benbow area, Stillwater Co.) ***Analytical data:*** K = 0.066%, $*Ar^{40}$ = 51.39 x 10^{-11} moles/g, $*Ar^{40}$ = 85%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) flame photometry. ***Comment:*** This date shows that the layered mafic intrusion was either emplaced or thermally metamorphosed at 2600 m.y. ago. Mica and plagioclase dates and work by others tend to support the thermal metamorphism interpretation.

(whole rock) 2300 m.y.

129. *Kistler, Obradovich and Jackson (1969)* K-Ar

55MV-29

Layered olivine-orthopyroxene cumulate with post-cumulus plagioclase, ultramafic zone, Stillwater Complex. (45°23'00"N, 109°54'05" W; NW¼ SE¼ sec. 20, T. 5 S., R. 15 E.; Mt. Wood 15' quad; Mount View area, Stillwater Co.) ***Analytical data:*** K = 0.17%, $*Ar^{40}$ = 129.15 x 10^{-11} moles/gm, $*Ar^{40}$ = 54%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) flame photometry. ***Comment:*** This date shows that the layered mafic intrusion was either emplaced or thermally metamorphosed 2600 m.y. ago. Mica and plagioclase dates and work by others tend to support the thermal metamorphism interpretation.

(plagioclase) 2300 m.y.

130. *Jahn (1967)* K-Ar

11, BJ-13-66

Biotite-quartz-fledspar gneiss with plagioclase, K-spar, zircon, epidote, muscovite, garnet. (44°55'55"N, 111°39'55"W; sec. 25, T. 10 S., R. 1 W.; Cliff Lake 15' quad; Madison Co.) ***Analytical data:*** K = 7.67%, $*Ar^{40}$ = 13.43 x 10^4 scc/gm, $Ar^{40}atm$ = 6.59 x 10^4 scc/gm. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) using a Perkin-Elmer model 146 flame photometer with Li internal standard, (Ar) isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Collected and dated by:*** B. Jahn. ***Comment:*** This date helps define the margin of a 1600 m.y. old metamorphism in southwest Montana.

(biotite) 2270 m.y.

131. *Small (1970)* Pb^{207}/Pb^{206}

Ore samples, Little Belt Mountains.

	Mine	Lat (N)	Long (W)	County
603	Tiger	45°05'00"	110°37'20"	Judith Basin
598	Block P	47°05'00"	110°37'20"	Judith Basin
601	Boss	46°56'40"	110°42'55"	Cascade
600	Lexington	46°56'40"	110°42'55"	Cascade

Analytical data:

	Pb^{206}/Pb^{204}	Pb^{207}/Pb^{204}	Pb^{208}/Pb^{204}
603	16.794	15.526	37.766
598	16.686	15.525	37.740
601	17.099	15.562	37.824
600	17.124	15.589	37.926

Constants: U^{238} λ = 1.54 x 10^{-10}/yr, U^{235} λ = 9.72 x 10^{-10}/yr, Pb^{206}/Pb^{204} = 18.67, Pb^{207}/Pb^{204} = 15.80, Pb^{208}/Pb^{204} = 39.55. ***Method:*** Isotope dilution using the U.B.C. MS-1 mass spectrometer. ***Collected by:*** F. A. Crowley and F. N. Earll; ***dated by:*** W. D. Small. ***Comments:*** Ore from these mines is described in Montana Bureau of Mines and Geology Bulletin 30 (1962).

2200 m.y.

132. *Hanson and Gast (1967)* Rb-Sr
Hanson (1964) K-Ar

WY12h

Well-foliated para-amphibolite with plagioclase, hornblende, quartz, biotite-chlorite, epidote, sphene and microcline, 7.0 m from a vertical 50-m quartz dolerite dike. (44°58'00"N, 109°25'20"W; NE¼ sec. 33, T. 58 N., R. 104 W.; Deep Lake 15' quad; Christmas Lake dike, Park Co., Wyo.) ***Analytical data:*** (a) Rb = 439, 446 ppm, Sr_n = 61.8 ppm, $*Sr^{87}$ = 4.11 ppm, initial Sr^{87}/Sr^{86} = 0.705; (b) K = 5.70%, $*Ar^{40}$ = 7.70 x 10^4 cc/g, $Ar^{40}atm$ = 2.8%. ***Constants:*** Rb^{87} λ = 1.47 x 10^{-11}/yr, Rb^{87}/Rb^{85} = 0.385; (K) λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.18 x 10^{-4} atomic ratio. ***Method:*** (Ar) mass spectrometry, (K, Rb, Sr) isotope dilution with mass spectrometry. ***Collected and dated by:*** G. N. Hanson. ***Comment:*** A general increase in age is seen with increase in distance from the dike; K-Ar date recalculated in 1967 (using λ_e = 0.584 x 10^{-10}/yr) as 1950 m.y.

(a) (biotite) 2180 m.y.
(b) (biotite) 1980 m.y.

133. *Condie, Leech and Baadsgaard (1969)* K-Ar
BT-31
Microporphyritic, fine-grained diabase dike with plagioclase, augite, hornblende; minor magnetite, orthopyroxene, quartz, sericite and chlorite. (44°57'14"N, 109°28'35"W; NE¼ sec. 6, T. 57 N., R. 104 W; Deep Lake 15' quad; Park Co., Wyo.) ***Analytical data:*** K_2O = 0.39%, Ar^{40}/K^{40} = 0.2372, $*Ar^{40}$ = 98%. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) x-ray fluorescence and gravimetric analyses, (Ar) isotope dilution using an AEI MS-10 mass spectrometer. ***Comment:*** Larson and others (1973) dated this dike at 2550 m.y. (Rb-Sr).

(whole rock) 2160 m.y.

134. *Jahn (1967)* K-Ar
18; BG-121-62
Pegmatite with quartz, K-spar, muscovite, plagioclase, garnet. (44°54'20"N, 111°45'00"W; sec. 5, T. 11 S., R. 1 W.; Cliff Lake 15' quad; 0.15 mi S60°W of Granite Mountain peak, Madison Co.) ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) using a Perkin-Elmer model 146 flame photometer with Li internal standard, (Ar) isotope dilution using a 6-inch 60° Nier-type mass spectrometer.

(muscovite) 2160 m.y.

135. *Jahn (1967)* K-Ar
14; BG-18-64
Pink, medium-grained granite gneiss with quartz, microcline, biotite and plagioclase. (44°55'10"N, 111°42'15"W; sec. 34, T. 10 S., R. 1 W.; Cliff Lake 15' quad; Madison Co.) ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) using a Perkin-Elmer model 146 flame photometer with Li internal standard, (Ar) isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Comment:*** This date helps define the margin of a 1600 m.y. old metamorphism in southwest Montana.

(biotite) 2150 m.y.

136. *Wooden (1975)* Rb-Sr
Cathredral Peak dike, hypersthene diabase with elongate crystals of orthopyroxene and clinopyroxene. (45°20'35"N, 109°58'55"W; SW¼ NE¼ sec. 3, T.6 S., R. 14 E.; Mt. Wood 15' quad; Beartooth Mountains, Sweet Grass Co.) ***Analytical data:***

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	$Sr^{87}/Sr^{86}{}_n$
WCB-34	17.7	129	0.398	0.7130
WCB-47	45.9	130	1.025	0.7319

Initial Sr^{87}/Sr^{86} = 0.7010. ***Constants:*** Rb^{87} $\lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 12-inch 90° Nuclide Corp. mass spectrometer. ***Collected and dated by:*** J. L. Wooden.

(whole rock isochron) 2140 m.y.

137. *Green (1972)* F.T.
SB-3
Metasedimentary zircon core from green micaceous quartzite, North Snowy block. (45°30' 10"N, 110°31'00"W; NE¼ SW¼ sec. 8, T. 4 S., R. 10 E.; Brisbin 7½' quad; Pine Creek quarry, Park Co.) ***Analytical data:*** (a) (first half) area = 0.160 mm^2, 35.844 density ϱ_s/unit area, 1.917 density ϱ_i/unit area, ϱ_s density/ϱ_i density = 18.698; (b) (second half) area = 0.160 mm^2, 36.281 density ϱ_s/unit area, 2.042 density ϱ_i/unit area, ϱ_s density/ϱ_i density = 17.767; (c) (total) area = 0.320 mm^2, 36.063 density ϱ_s/unit area, 1.979 density ϱ_i/unit area, ϱ_s density/ϱ_i density = 18.223. ***Constants:*** $\lambda_D = 1.54 \times 10^{-10}$/yr, $\lambda_F = 6.85 \times 10^{-17}$/yr, $\varsigma = 582 \times 10^{-24}$ cm^2, $U^{235}/U^{238} = 7.26 \times 10^{-3}$ atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Ages reflect different degrees of annealing of detrital zircon that is at least 3100 m.y. old; annealing occurred during both the 2700 m.y. and the 1600 m.y. old metamorphic events, and also due to burial temperatures since the 1600 m.y. old event.

(a) (zircon) 2138 m.y.
(b) (zircon) 2046 m.y.
(c) (zircon) 2091 m.y.

138. *Giletti (1966)* K-Ar
19
Granitic gneiss, medium grained, with quartz, oligoclase, biotite and microcline. (45°20'10" N, 110°35'10"W; SE¼ SE¼ SW¼ sec. 2, T. 6 S., R. 9 E.; Emigrant 15' quad; Park Co.) ***Analytical data:*** K = 6.24%, $*Ar^{40}$ = 9.73 x 10^4 scc/g, Ar^{40}atm = 0.00%, Ar^{40}/K^{40} = 0.229. ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University.

(biotite) 2120 m.y.

139. *Brookins (1965)* Rb-Sr
1022

Biotite-muscovite granite, light gray, medium grained, with microperthite, microcline, some orthoclase, quartz, 5% muscovite, 5% biotite. (45°02'10"N, 110°36'15"W; NE¼ SE¼ sec. 22, T. 9 S., R. 9 E.; Gardiner 15' quad; SW slope of Crevasse Mountain, 1500 ft. from granite-schist contact, Park Co.) ***Analytical data:***

		Sr^{86}/Sr^{88}	Sr^{87}/Sr^{86}	Rb^{87}/Sr^{86}
R1022a	whole rock	0.1205	0.9613	6.50
R1022b	whole rock	0.1186	0.9535	6.46
F1022b	K-feldspar	0.1196	0.8898	4.01
M1022b	muscovite	0.1188	3.387	88.7

Initial Sr^{87}/Sr^{86} = 0.780. ***Constants:*** Rb^{87} λ = 1.39 x 10^{-11}/yr, Sr^{86}/Sr^{88} = 0.1194 atomic ratio. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer, and x-ray spectrograph. ***Collected by:*** L. E. Brown; ***dated by:*** D. G. Brookins and L. E. Brown. ***Comment:*** Date indicates a possible low-grade thermal event at 1900-2100 m.y. ago.

(whole rock-mineral isochron) 2110 ± 200 m.y.

140. *Wooden (1975)* Rb-Sr

Hypersthene diabase dikes with elongate crystals of orthopyroxene and clinopyroxene; Beartooth Mountains.

	Lat (N)	Long (W)	County, State
WCB-5	45°15'17"	110°08'55"	Sweet Grass, Mt.
WCB-6	45°15'17"	110°08'55"	Sweet Grass, Mt.
WCB-16	45°16'42"	110°07'40"	Sweet Grass, Mt.
WCB-17	45°16'42"	110°07'40"	Sweet Grass, Mt.
WCB-19	45°16'25"	110°07'15"	Sweet Grass, Mt.
MBT-34	45°01'25"	109°37'10"	Carbon, Mt.
MBT-68	44°58'35"	109°25'20"	Park, Wyo.
MBT-80	44°58'05"	109°28'50"	Park, Wyo.

Analytical data:

	Rb (ppm)	Sr (ppm)	Rb^{87}/Sr^{86}	$Sr^{87}/Sr^{86}{}_n$
WCB-5	33.6	116	0.841	0.7244
WCB-6	56.6	147	1.121	0.7385
WCB-16	68.4	118	1.687	0.7535
WCB-17	44.1	115	1.112	0.7315
WCB-19	28.8	116	0.721	0.7243
MBT-34	15.2	119	0.371	0.7147
MBT-68	50.4	141	1.035	0.7381
MBT-80	26.0	133	0.568	0.7199

Initial Sr^{87}/Sr^{86} = 0.7030. ***Constants:*** Rb^{87} λ = 1.39 x 10^{-11}/yr. ***Method:*** Isotope dilution using a 12-inch 90° Nuclide Corp. mass spectrometer, and x-ray fluorescence. ***Collected and dated by:*** J. L. Wooden. ***Comment:*** MBT-34, -68 and -80 are from P. A. Mueller.

(whole rock isochron) 2100 m.y.

141. *Giletti (1971)* K-Ar
4

(45°17'22"N, 111°12'40"W; SE¼ SE¼ sec. 22, T. 6 S., R. 4 E.; Garnet Mountain 15' quad; Gallatin Co.) ***Analytical data:*** K = 7.11%, $*Ar^{40}$ = 10.66 x 10^4 scc/g, Ar^{40}atm = 0.26 x 10^4 scc/g, $*Ar^{40}/K^{40}$ = 0.220. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Isotope dilution, (K) using a Perkin-Elmer flame photometer with Li internal standard, (Ar) using a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** This date reflects a regional metamorphism 1900 m.y. ago; sample was not significantly affected by the 1600 m.y. old regional metamorphism. [See other entries by Giletti.]

(biotite) 2070 m.y.

142. *Reid, McMannis and Palmquist (1975)* K-Ar
PW. 69.103

Metadiabase, Mount Delano block, with actinolite, plagioclase, microcline, quartz, epidote, biotite, chlorite, accessories magnetite, pyrite and apatite. (Near 45°30'N, 110°30'W; Park Co.) ***Analytical data:*** K = 0.453, 0.450%, K^{40} = 0.550 ppm, Ar^{40} = 0.124, 0.118 ppm, $Ar^{40}/Ar^{40}{}_{TOT}$ = 0.940, 0.817. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.22 x 10^{-4} g/g. ***Dated by:*** Geochron Laboratories, Inc. ***Comment:*** This unit intruded during the third metamorphic event of the North Snowy block; K-Ar age may be too high or the D_3 event may be as old as 2500 m.y.

(amphibole) 2066 ± 99 m.y.

143. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-54

Chilled margin of diabase dike, with plagioclase and pyroxene. (45°05'50"N, 109°54'16" W; NE¼ sec. 31, T. 8 S., R. 15 E.; Cooke City 15' quad; Park Co.) ***Analytical data:*** K^{40} = 0.56, 0.54 ppm, Ar^{40} = 0.1204 ppm, $*Ar^{40}$ = 98.0%, Ar^{40}/K^{40} = 0.2189. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) flame photometric and gravimetric methods, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 2060 m.y.

144. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-18
Diabase dike with plagioclase and pyroxene. (45°02'35"N, 109°26'49"W; SE¼ sec. 13, T. 9 S., R. 18 E.; Mount Maurice 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 0.84 ppm (a), 0.84 ppm (b), Ar^{40} = 0.1818 ppm, Ar^{40} = 98.4%, Ar^{40}/K^{40} = 0.2164. ***Constants:*** λ_e = 0.585×10^{-10}/yr, $\lambda\beta$ = 4.72×10^{-10}/yr, K^{40}/K = 1.19×10^{-4} atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 2050 m.y.

145. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-26
Small mafic intrusion with plagioclase and pyroxene. (45°00'38"N, 109°39'00"W; NE¼ sec. 32, T. 9 S., R. 17 E.; Alpine 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 0.82 ppm (a), 0.84 ppm (b), Ar^{40} = 0.178 ppm, $*Ar^{40}$ = 99.9%, Ar^{40}/K^{40} = 0.2145. ***Constants:*** λ_e = 0.585×10^{-10}/yr, $\lambda\beta$ = 4.72×10^{-10}/yr, K^{40}/K = 1.19×10^{-4} atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) isotope dilution, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 2040

146. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-4
Small mafic intrusion with plagioclase and pyroxene. (44°58'20"N, 109°27'45"W; SW¼ sec. 29, T. 58 N., R. 104 W.; Deep Lake 15' quad; Park Co., Wyo.) ***Analytical data:*** K^{40} = 2.24, 2.23 ppm, Ar^{40} = 0.4836 ppm, $*Ar^{40}$ = 97.9%, Ar^{40}/K^{40} = 0.2164. ***Constants:*** λ_e = 0.585×10^{-10}/yr, $\lambda\beta$ = 4.72×10^{-10}/yr, K^{40}/K = 1.19×10^{-4} atomic ratio. ***Method:*** (K) flame photometric and gravimetric methods, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 2040 m.y.

147. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-35
Chilled margin of diabase dike, with plagioclase and pyroxene. (45°01'40"N, 109°36'45" W; SE¼ sec. 22, T. 9 S., R. 17 E.; Alpine 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 0.62 ppm (a), 0.62 ppm (b), Ar^{40} = 0.1335 ppm, $*Ar^{40}$ = 99.8%, Ar^{40}/K^{40} = 0.2153. ***Constants:*** λ_e = 0.585×10^{-10}/yr, $\lambda\beta$ = 4.72×10^{-10}/yr, K^{40}/K = 1.19×10^{-4} atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 2040 m.y.

148. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-53
Chilled margin of diabase dike, with plagioclase and pyroxene. (45°05'50"N, 109°54'16" W; NE¼ sec. 31, T. 8 S., R. 15 E.; Cooke City 15' quad; Park Co.) ***Analytical data:*** K^{40} = 1.11, 1.10 ppm, Ar^{40} = 0.2353 ppm, Ar^{40} = 98.1%, Ar^{40}/K^{40} = 0.2129. ***Constants:*** λ_e = 0.585×10^{-10}/yr, $\lambda\beta$ = 4.72×10^{-10}/yr, K^{40}/K = 1.19×10^{-4} atomic ratio. ***Method:*** (K) flame photometric and gravimetric methods, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 2030 m.y.

149. *Horwood and Keevil (1943)* He
Stillwater norite. (45°25'N, 110°W; T. 5 S., R. 14 E. [est.]; Mt. Douglas 15' quad; Sweet Grass Co.)

2000 m.y.

150. *Condie, Leech and Baadsgaard (1969)* K-Ar
BT-39
Microporphyritic, fine-grained diabase dike with plagioclase, augite, hornblende; minor magnetite, orthopyroxene, quartz, sericite and chlorite. (44°56'08"N, 109°38'08"W; SW¼ sec. 11, T. 57 N., R. 106 W; Beartooth Butte 15' quad; Park Co., Wyo.) ***Analytical data:*** K_2O = 0.58%, Ar^{40}/K^{40} = 0.2080, $*Ar^{40}$ = 98%. ***Constants:*** λ_e = 0.585×10^{-10}/yr, $\lambda\beta$ = 4.72×10^{-10}/yr, K^{40}/K = 1.19×10^{-4} atomic ratio. ***Method:*** (K) x-ray fluorescence and gravimetric analyses, (Ar) isotope dilution using an AEI MS-10 mass spectrometer. ***Comment:*** Larson and others (1973) dated this dike at 2550 m.y. (Rb-Sr).

(whole rock) 2000 m.y.

151. *Kistler, Obradovich and Jackson (1969)* K-Ar
61SC
Gabbro pegmatite pod below G chromitite zone, Mouat mine, ultramafic zone, Stillwater Complex. (45°23'25"N, 109°54'15"W; NW¼ NW¼ sec. 20, T. 5 S., R. 15 E.; Mt. Wood 15' quad; Mount View area, Stillwater Co.) ***Analytical data:***

	K%	$*Ar^{40}$ (x 10^{-11} mole/g)	$*Ar^{40}$%
(a)	0.0020	27.66	87
(b)	0.0045	38.03	80
(c)	0.0496	30.9	71
(d)	0.0496	31.6	81

Constants: $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** Isotope dilution (K). ***Comment:*** These dates show that the layered mafic intrusion was either emplaced or thermally metamorphosed at 2600 m.y. ago. Mica and plagioclase dates and work by others tend to support the thermal metamorphism interpretation.

(a) (bronzite) 8400 m.y.
(b) (augite) 7100 m.y.
(c) (plagioclase) 2000 m.y.
(d) (plagioclase) 2000 m.y.

152. *Condie, Leech and Baadsgaard (1969)* K-Ar
BT-29
Microporphyritic, fine-grained diabasic dike with plagioclase, augite, hornblende; minor magnetite, orthopyroxene, quartz, sericite and chlorite. (44°56'32"N, 109°30'15"W; NE¼ sec. 11, T. 57 N., R. 105 W; Beartooth Butte 15' quad; Park Co., Wyo.) ***Analytical data:*** $K_2O = 1.67\%$, $Ar^{40}/K^{40} = 0.2023$, $*Ar^{40} = 98\%$. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) x-ray fluorescence and gravimetric analyses, (Ar) isotope dilution using an AEI MS-10 mass spectrometer. ***Comment:*** Larson and others (1973) dated this dike at 2550 m.y. (Rb-Sr).

(whole rock) 1960 m.y.

153. *Giletti (1971)* K-Ar
1
(45°21'58"N, 111°22'49"W; SW¼ SE¼ sec. 29, T. 5 S., R. 3 E.; Spanish Peaks 15' quad; Madison Co.) ***Analytical data:*** (a) K = 7.64%, $*Ar^{40} = 9.79 \times 10^4$ scc/g, $Ar^{40}atm = 0.0412 \times 10^4$ scc/g, $*Ar^{40}/K^{40} = 0.188$; (b) K = 0.757%, $*Ar^{40} = 1.038 \times 10^4$ scc/g, $Ar^{40}atm = 0.008 \times 10^4$ scc/g, $*Ar^{40}/K^{40} = 0.201$. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** Isotope dilution, (K) using a Perkin-Elmer flame photometer with Li internal standard, (Ar) using a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** These dates reflect a regional metamorphism 1900 m.y. ago; this sample was not significantly affected by the 1600 m.y. old regional metamorphism.

(a) (biotite) 1880 m.y.
(b) (amphibole) 1960 m.y.

154. *Catanzaro and Kulp (1964)* U-Pb
59MZ14 K-Ar
Migmatite with segregated mafic and felsic layers, with sodic plagioclase, microcline, green-brown biotite, hornblende, quartz; accessories epidote, apatite, sphene, zircon, opaques, monazite; some alteration to chlorite and sericite. (47°01'40"N, 110°46'38"W; SE¼ sec. 25, T. 15 N., R. 7 E.; Monarch 7½' quad; Little Belt Mountains, Cascade Co.) ***Analytical data:*** (zircon) U = 1417 ppm, Th = 276 ppm, Pb = 216 ppm, common Pb = 7.7%, $Pb^{204}/Pb^{206} = 0.152 \pm 0.001$, $Pb^{207}/Pb^{206} = 13.70$, $Pb^{208}/Pb^{206} = 14.47$; (monazite) U = 2134 ppm, Th = 88400 ppm, Pb = 8020 ppm, common Pb = 1.8%, $Pb^{204}/Pb^{206} = 0.320 \pm 0.003$, $Pb^{207}/Pb^{206} = 16.07$, $Pb^{208}/Pb^{206} = 11.32$; (biotite) K = 5.74%, $*Ar^{40} = 52.2 \times 10^{-5}$ scc/g, $*Ar^{40} = 99\%$. ***Constants:*** $U^{238}\lambda = 1.54 \times 10^{-10}$/yr, $U^{235}\lambda = 9.72 \times 10^{-10}$/yr, $Th^{232}\lambda = 4.88 \times 10^{-11}$/yr; (K) $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** E. J. Catanzaro; ***dated by:*** E. J. Catanzaro and R. Kologrivov. ***Comment:*** These dates indicate a metamorphic event at about 1920 m.y. ago.

(zircon) U^{238}/Pb^{206} 830 ± 25 m.y.
U^{235}/Pb^{207} 1190 ± 35 m.y.
Pb^{206}/Pb^{207} 1940 ± 40 m.y.
Th^{232}/Pb^{208} 1260 m.y.
(monazite) U^{238}/Pb^{206} 1860 ± 40 m.y.
U^{235}/Pb^{207} 1890 ± 40 m.y.
Pb^{206}/Pb^{207} 1920 ± 30 m.y.
Th^{232}/Pb^{208} 1790 ± 40 m.y.
(biotite) K-Ar 1500 m.y.

155. *Hanson (1964)* K-Ar
WY10c
Amphibole-biotite-feldspar gneiss 0.6 m from a 26-m basalt dike. (44°56'50"N, 109°29'00"W; SE¼ NE¼ sec. 1, T. 57 N., R. 105 W.; Deep Lake 15' quad; Park Co., Wyo.) ***Analytical data:*** K = 2.51%, $*Ar^{40} = 3.26 \times 10^4$ cc/g, $Ar^{40}atm = 3.1\%$. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.18 \times$

10^{-4} atomic ratio. ***Method:*** (Ar) mass spectrometry, (K) isotope dilution with mass spectrometry. ***Collected and dated by:*** G. N. Hanson. ***Comment:*** An increase in age is seen with increase in distance from the dike.

(biotite) 1930 m.y.

156. *Jahn (1967)* K-Ar
20, BJ-7-66
Muscovite-quartz schist with 50% quartz, 42% muscovite, biotite and epidote. (44°52'10"N, 111°41'55"W; NE¼ NE¼ sec. 22, T. 11 S., R. 1 W.; Cliff Lake 15' quad; 0.94 mi N 61° E of Freezeout Mountain peak, Madison Co.) ***Analytical data:*** K = 8.28%, $*Ar^{40}$ = 11.03 x 10^4 scc/gm, Ar^{40}atm = 10.31 x 10^4 scc/gm. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) using a Perkin-Elmer model 146 flame photometer with Li internal standard, (Ar) isotope dilution using a 6-inch 60° Nier-type mass spectrometer.

(muscovite) 1930 m.y.

157. *Schwartzman (1966)* K-Ar
BG-61-65
Norite with pyroxene, plagioclase, hypersthene, augite and chromite; Stillwater Complex. (45°27'20"N, 110°08'09"W; NE¼ SE¼ sec. 25, T. 4 S., R. 12 E.; Mt. Douglas 15' quad; East Boulder plateau, Sweet Grass Co.) ***Analytical data:*** (a) K = 0.0064 ± 0.0003%, $*Ar^{40}$ = 7.54, 7.65 x 10^{-6} scc/g, Ar^{40}atm = 1.41%, minimum excess Ar = 6.28 x 10^{-6} scc/g; (b) K = 0.0874, 0.0013%, $*Ar^{40}$ = 11.7 x 10^{-6} scc/g, Ar^{40}atm = 7.87%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) using a Perkin-Elmer model 146 flame photometer with Li internal standard, (Ar) isotope dilution using a 6-inch 60° mass spectrometer.

(a) (hypersthene) 5300 m.y.
(b) (plagioclase) 1930 ± 90 m.y.

158. *Hanson (1964)* Rb-Sr
WY12c K-Ar
Well-foliated para-amphibolite with plagioclase, hornblende, quartz, biotite-chlorite, epidote, sphene and microcline, 1.1 m from a vertical 50-m quartz dolerite dike. (44°58'00"N, 109°25'20"W; SW¼ NE¼ sec. 33, T. 58 N., R. 104 W.; Deep Lake 15' quad; Christmas Lake dike, Park Co., Wyo.) ***Analytical data:*** (a) Rb = 344, 351, 362 ppm, Sr_n = 30.3 ppm, $*Sr^{87}$ = 2.85 ppm, initial Sr^{87}/Sr^{86} = 0.705; (b) K = 5.38%, $*Ar^{40}$ = 5.54, 4.97 x 10^4 cc/g, Ar^{40} atm = 2.1, 2.6%. ***Constants:*** Rb^{87} λ = 1.47 x 10^{-11}/yr, Rb^{87}/Rb^{85} = 0.385, (K) λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.18 x 10^{-4} atomic ratio. ***Method:*** (Ar) mass spectrometry, (K, Rb, Sr) isotope dilution with mass spectrometry. ***Collected and dated by:*** G. N. Hanson. ***Comment:*** A general increase in age is seen with increase in distance from the dike.

(a) (biotite) 1920 m.y.
(b) (biotite) 1600 m.y.

159. *Catanzaro and Kulp (1960)* U-Pb
Catanzaro (1962)
Monazites from Archean migmatite gneisses, Little Belt Mountains. (Meagher, Cascade and Judith Basin Co.) ***Comment:*** Two samples yielding concordant results; authors concluded that the area experienced metamorphism 1920 m.y. ago.

(monazite) 1920 ± 30 m.y.

160. *Catanzaro and Kulp (1964)* U-Pb
59MZ13
Migmatite with segregated mafic and felsic layers, with sodic plagioclase, microcline, green-brown biotite, hornblende, quartz; accessories epidote, apatite, sphene, zircon, opaques, monazite; some alteration to chlorite and sericite. (47°00'48"N, 110°46'13"W; SW¼ sec. 31, T. 15 N., R. 8 E.; Monarch 7½' quad; Little Belt Mountains, Cascade Co.) ***Analytical data:*** U = 549 ppm, Th = 217 ppm, Pb = 138 ppm, common Pb = 5.5%, Pb^{204}/Pb^{206} = 0.144 ± 0.001, Pb^{207}/Pb^{206} = 12.98, Pb^{208}/Pb^{206} = 18.27. ***Constants:*** U^{238} λ = 1.54 x 10^{-10}/yr, U^{235} λ = 9.72 x 10^{-10}/yr, Th^{232} λ = 4.88 x 10^{-11}/yr. ***Method:*** Using a 6-inch 60° mass spectrometer. ***Collected and dated by:*** E. J. Catanzaro. ***Comment:*** These dates indicate a metamorphic event at about 1920 m.y. ago.

(zircon) U^{238}/Pb^{206} 1290 ± 40 m.y.
U^{235}/Pb^{207} 1540 ± 45 m.y.
Pb^{206}/Pb^{207} 1910 ± 40 m.y.
Th^{232}/Pb^{208} 1550 m.y.

161. *Evans and others (1939)* He
L15
Ophitic gabbro with 10 x 3 mm phenocrysts, 15 mm mottles. (45°01'29"N, 109°24'22"W; sec. 29, T. 9 S., R. 19 E.; Mount Maurice 15' quad; at the head of Quad Creek, Carbon Co.) ***Analytical data:*** (a) He = 17.1 x 10^{-5} cc/g, Ra = 1.2 x 10^{-13} g/g; (b) He = 18.0 x 10^{-5} cc/g, Ra = 1.35 x 10^{-13} g/g, Th = 1.60 x 10^{-6} g/g. ***Collected by:*** A. Lane and E. Lammers; ***dated by:*** N. B. Keevil and C. Goodman.

Comment: Dates considered too high by the Committee on Measurement of Geologic Time.

(a) 1900 m.y.

(b) 1300 m.y.

162. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-34

Chilled margin of diabase dike, with plagioclase and pyroxene. (45°01'25"N, 109°37'10" W; NE¼ sec. 27, T. 9 S., R. 17 E.; Alpine 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 0.419 ppm (a), 0.353 ppm (b), Ar^{40} = 0.0720 ppm, $*Ar^{40}$ = 98.4%, Ar^{40}/K^{40} = 0.1875. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1890 m.y.

163. *Green (1972)* F.T.
HRL-10

Metasedimentary zircon core from a quartzite unit exposed on the glaciated floor of the Hell Roaring Lakes. (45°02'N, 109°30'W; sec. 14, 15, T. 9 S., R. 18 E. [est.]; Mount Maurice 15' quad; Hell Roaring Lakes, Carbon Co.) ***Analytical data:*** Area = 0.093 mm^2, 20.151 density ϱ_s/unit area, 1.250 density ϱ_i/unit area, ϱ_s density/ϱ_i density = 16.121. ***Constants:*** $\lambda_D = 1.54 \times 10^{-10}$/yr, $\lambda_F = 6.85 \times 10^{-17}$/yr, $\zeta = 582 \times 10^{-24}$ cm^2, $U^{235}/U^{238} = 7.26 \times 10^{-3}$ atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** The U concentration in this sample was lower than that of other grains in this quartzite; some fission tracks were annealed by a metasomatic event 2700 m.y. ago.

(zircon) 1882 m.y.

164. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-39

Chilled margin of diabase dike, with plagioclase and pyroxene. (45°03'05"N, 109°43'45" W; NW¼ sec. 14, T. 9 S., R. 16 E.; Alpine 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 0.93, 0.89 ppm, Ar^{40} = 0.1715 ppm, $*Ar^{40}$ = 75.1%, Ar^{40}/K^{40} = 0.1885. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) flame photometric and gravimetric methods, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1880 m.y.

165. *Giletti (1971)* K-Ar
11

(45°18'25"N, 111°10'05"W; SE¼ SE¼ sec. 13, T. 6 S., R. 4 E.; Garnet Mountain 15' quad; Gallatin Co.) ***Analytical data:*** K = 1.123%, $*Ar^{40} = 1.426 \times 10^4$ scc/g, $Ar^{40}atm = 0.034 \times 10^4$ scc/g, $*Ar^{40}/K^{40}$ = 0.186. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** Isotope dilution, (K) using a Perkin-Elmer flame photometer with Li internal standard, (Ar) using a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti. ***Dated by:*** Brown University. ***Comment:*** Date reflects a regional metamorphism 1900 m.y. ago; sample was not significantly affected by a regional metamorphism 1600 m.y. ago.

(hornblende) 1870 m.y.

166. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-33

Chilled margin of diabase dike, with plagioclase and pyroxene. (45°01'25"N, 109°37'35" W; NW¼ sec. 27, T. 9 S., R. 17 E.; Alpine 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 1.21 ppm (a), 1.17 ppm (b), Ar^{40} = 0.2234 ppm, $*Ar^{40}$ = 99.3%, Ar^{40}/K^{40} = 0.1877. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1870 m.y.

167. *Green (1972)* F.T.
SB-10

Metasedimentary zircon core from green micaceous quartzite, North Snowy block. (45°30' 10"N, 110°31'00"W; NE¼ SW¼ sec. 8, T. 4 S., R. 10 E.; Brisbin 7½' quad; Pine Creek quarry, Park Co.) ***Analytical data:*** Area = 0.080 mm^2, 19.700 density ϱ_s/unit area, 1.250 density ϱ_i/unit area, ϱ_s density/ϱ_i density = 15.760. ***Constants:*** $\lambda_D = 1.54 \times 10^{-10}$/yr, $\lambda_F = 6.85 \times 10^{-17}$/yr, $\zeta = 582 \times 10^{-24}$ cm^2, $U^{235}/U^{238} = 7.26 \times 10^{-3}$ atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Age reflects different degrees of annealing of detrital zircon that is at least 3100 m.y. old; annealing occurred during both the 2700 m.y. and 1600 m.y. old

metamorphic events, and also due to burial temperatures since the 1600 m.y. old event.

(zircon) 1845 m.y.

168. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-45
Small mafic intrusion with plagioclase and pyroxene. (45°02'35"N, 109°24'15"W; NE¼ sec. 17, T. 9 S., R. 19 E.; Mount Maurice 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 1.45 ppm (a), 1.37 ppm (b), Ar^{40} = 0.2579 ppm, $*Ar^{40}$ = 81.0%, Ar^{40}/K^{40} = 0.1829. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1840 m.y.

169. *Jahn (1967)* K-Ar
22 BG-51-64
Quartzite with muscovite, biotite and plagioclase. (44°52'10"N, 111°41'55"W; NE¼ NE¼ sec. 22, T. 11 S., R. 1 W.; Cliff Lake 15' quad; 0.94 mi N 61° E of Freezeout Mountain peak, Madison Co.) ***Analytical data:*** K = 6.94%, $*Ar^{40} = 8.50 \times 10^4$ scc/gm, Ar^{40}atm = 10.14×10^4 scc/gm. ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) using a Perkin-Elmer model 146 flame photometer with Li internal standard, (Ar) isotope dilution using a 6-inch 60° Nier-type mass spectrometer.

(muscovite) 1830 m.y.

170. *Green (1972)* F.T.
SB-5
Metasedimentary zircon core from green micaceous quartzite, North Snowy block. (45°30'10"N, 110°31'00"W; NE¼ SW¼ sec. 8, T. 4 S., R. 10 E.; Brisbin 7½' quad; Pine Creek quarry, Park Co.) ***Analytical data:*** Area = 0.160 mm², 28.375 density ϱ_s/unit area, 1.828 density ϱ_i/unit area, ϱ_s density/ϱ_i density = 15.522. ***Constants:*** $\lambda_D = 1.54 \times 10^{-10}$/yr, $\lambda_F = 6.85 \times 10^{-17}$/yr, $\varsigma = 582 \times 10^{-24}$ cm², $U^{235}/U^{238} = 7.26 \times 10^{-3}$ atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Age reflects different degrees of annealing of detrital zircon that is at least 3100 m.y. old; annealing occurred during both the 2700 m.y. and 1600 m.y. old metamorphic events, and also due to burial temperatures since the 1600 m.y. old event.

(zircon) 1821 m.y.

171. *Jahn (1967)* K-Ar
9, BJ-22-66
Dark-gray, medium-grained biotite gneiss with quartz, K-spar, plagioclase, biotite, apatite, sphene, chlorite and epidote. (44°56'45"N, 111°39'55"W; sec. 24, T. 10 S., R. 1 W.; Cliff Lake 15' quad; Madison Co.) ***Analytical data:*** K = 7.51%, $*Ar^{40} = 9.14 \times 10^4$ scc/gm, Ar^{40} atm = 10.56×10^4 scc/gm. ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) using a Perkin-Elmer model 146 flame photometer with Li internal standard, (Ar) isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Collected and dated by:*** B. Jahn. ***Comment:*** This date helps to define the margin of a 1600 m.y. old metamorphism in southwest Montana.

(biotite) 1820 m.y.

172. *Hanson and Gast (1967)* Rb-Sr
Hanson (1964)
WY12g
Well-foliated para-amphibolite with plagioclase, hornblende, quartz, biotite-chlorite, epidote, sphene and microcline, 5.3 m from a vertical 50-m quartz dolerite dike. (44°58'00"N, 109°25'20"W; SW¼ NE¼ sec. 33, T. 58 N., R. 104 W.; Deep Lake 15' quad; Christmas Lake dike, Park Co., Wyo.) ***Analytical data:*** (a) Rb = 371 ppm, Sr_n = 35.3 ppm, $*Sr^{87}$ = 2.86 ppm; (b) Rb = 354 ppm, Sr_n = 42.2 ppm, $*Sr^{87}$ = 2.65 ppm; initial Sr^{87}/Sr^{86} = 0.705. ***Constants:*** Rb^{87} $\lambda = 1.47 \times 10^{-11}$/yr, Rb^{87}/Rb^{85} = 0.385. ***Method:*** Isotope dilution with mass spectrometry. ***Collected and dated by:*** G. N. Hanson. ***Comment:*** A general increase in age is seen with increase in distance from the dike.

(a) (biotite) 1820 m.y.
(b) (biotite) 1780 m.y.

173. *Catanzaro and Kulp (1964)* K-Ar
KAT-5
Pinto meta-diorite with andesine, biotite, hornblende; minor orthoclase, quartz, apatite, sphene, epidote and opaques. (46°57'37"N, 110°45'15"W; NE¼ sec. 19, T. 14 N., R. 8 E.; Belt Park Butte 7½' quad; 9 ft. from a 45-ft. porphyry dike (KAT-1), Little Belt Mountains, Cascade Co.) ***Analytical data:*** (biotite) K = 4.27%, $*Ar^{40} = 47.7 \times 10^{-5}$ scc/g, $*Ar^{40}$ = 99%; (hornblende) K = 1.43%, $*Ar^{40}$ = 17.4 x

10^{-5} scc/g, $*Ar^{40}$ = 97%. ***Constants:*** λ_e = 0.584×10^{-10}/yr, $\lambda\beta$ = 4.72×10^{-10}/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** E. J. Catanzaro; ***dated by:*** R. Kologrivov. ***Comment:*** Intrusion of the Laramide porphyry dike did not cause drastic Ar loss from biotite in the host rock.

(biotite) 1720 m.y.
(hornblende) 1820 m.y.

174. *Catanzaro and Kulp (1964)* U-Pb
60MZ34 K-Ar

Augen gneiss with orthoclase, microcline, sodic plagioclase, quartz, biotite, chlorite; accessories epidote, sphene, apatite, zircon, opaques; some alteration sericite present. (46° 56'13"N, 110°44'55"W; NW¼ sec. 32, T. 14 N., R. 8 E.; Neihart 7½' quad; Little Belt Mountains, Cascade Co.) ***Analytical data:*** (zircon) U = 553 ppm, Th = 159 ppm, Pb = 115 ppm, common Pb = 5.1%, Pb^{204}/Pb^{206} = 0.096 ± 0.001, Pb^{207}/Pb^{206} = 12.21, Pb^{208}/Pb^{206} = 11.64; (hornblende) K = 2.27%, $*Ar^{40}$ = 23.1×10^{-5} scc/g, $*Ar^{40}$ = 97%. ***Constants:*** $U^{238}\lambda = 1.54 \times 10^{-10}$/yr, $U^{235}\lambda = 9.72 \times 10^{-10}$/yr, $Th^{232}\lambda = 4.88 \times 10^{-11}$/yr, (K) $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** E. J. Catanzaro; ***dated by:*** E. J. Catanzaro and R. Kologrivov. ***Comment:*** See No. 113.

(zircon) U^{238}/Pb^{206} 1140 ± 35 m.y.
U^{235}/Pb^{207} 1400 ± 40 m.y.
Pb^{206}/Pb^{207} 1820 ± 40 m.y.
Th^{232}/Pb^{208} 1080 m.y.
(hornblende) K-Ar 1620 m.y.

175. *Brookins (1965, 1968)* K-Ar
1024

Biotite-muscovite granite with microperthite, microcline, orthoclase, quartz, plagioclase (An-15), biotite, muscovite, minor apatite, magnetite and pyrite. (45°02'10"N, 110°36'15" W; NE¼ SE¼ sec. 22, T. 9 S., R. 9 E.; Gardiner 15' quad; SW slope of Crevice Mountain, 1000 ft. from granite-schist contact, Park Co.) ***Analytical data:***

	K%	$*Ar^{40}$(ppm)	$*Ar^{40}$%
(K-feldspar)	3.42	0.400	98.2
(biotite)	6.74	1.273	99.5
(muscovite)	8.52	1.86	99.0

Constants: $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.22 \times 10^{-4}$ g/g. ***Method:*** (K) flame photometry, (Ar) isotope dilution. ***Collected by:*** L. E. Brown; ***dated by:*** Geochron Laboratories. ***Comment:*** These dates reflect the strong metamorphic event of 1700 m.y. ago.

(K-feldspar) 1180 ± 35 m.y.
(biotite) 1655 ± 40 m.y.
(muscovite) 1820 ± 50 m.y.

176. *Giletti and Gast (1961)* Rb-Sr
16

Garnet muscovite schist. (45°07'N, 112°32'W; T. 8 S., R. 8 W. [est.]; Dillon East 7½' quad; east of Dillon, Beaverhead Co.) ***Constants:*** $Rb^{87}\lambda = 1.4 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a Vickers MS-5 mass spectrometer. ***Comment:*** These dates seem to indicate a metamorphic event about 1600 m.y. ago.

(muscovite) 1810 m.y.
(biotite) 1620 m.y.
(biotite) 1660 m.y.

177. *Catanzaro and Kulp (1964)* U-Pb
60MZ31

Gray gneiss with green-brown biotite, sodic plagioclase, potash feldspar, quartz; accessories apatite, epidote, sphene, zircon, opaques; some alteration to chlorite and sericite. (46°56' 46"N, 110°45'00"W; NE¼ sec. 30, T. 14 N., R. 8 E.; Neihart 7½' quad; Little Belt Mountains, Cascade Co.) ***Analytical data:*** U = 1047 ppm, Th = 338 ppm, Pb = 176 ppm, common Pb = 15.5%, Pb^{204}/Pb^{206} = 0.330 ± 0.002, Pb^{207}/Pb^{206} = 15.31, Pb^{208}/Pb^{206} = 24.47. ***Constants:*** $U^{238}\lambda = 1.54 \times 10^{-10}$/yr, $U^{235}\lambda = 9.72 \times 10^{-10}$/yr, $Th^{232}\lambda = 4.88 \times 10^{-11}$/yr. ***Method:*** Using a 6-inch 60° mass spectrometer. ***Collected and dated by:*** E. J. Catanzaro. ***Comment:*** See No. 113.

(zircon) U^{238}/Pb^{206} 810 ± 25 m.y.
U^{235}/Pb^{207} 1130 ± 35 m.y.
Pb^{206}/Pb^{207} 1810 ± 45 m.y.
Th^{232}/Pb^{208} 950 m.y.

178. *Catanzaro and Kulp (1964)* U-Pb
60MZ41

Gray gneiss with green-brown biotite, sodic plagioclase, potash feldspar, quartz; accessories apatite, epidote, sphene, zircon, opaques; some alteration to chlorite and sericite. (46°54' 20"N, 110°42'12"W; SE¼ sec. 4, T. 13 N., R. 8 E.; Neihart 7½' quad; Little Belt Mountains, Cascade Co.) ***Analytical data:*** U = 710 ppm, Th = 346 ppm, Pb = 123 ppm, common Pb = 8.0%, Pb^{204}/Pb^{206} = 0.159 ± 0.001, Pb^{207}/Pb^{206} = 12.94, Pb^{208}/Pb^{206} = 16.97. ***Constants:*** $U^{238}\lambda = 1.54 \times 10^{-10}$/yr, $U^{235}\lambda = 9.72 \times 10^{-10}$/yr, $Th^{232}\lambda = 4.88 \times 10^{-11}$/yr. ***Method:*** Using a 6-inch 60° mass spectrometer. ***Collected and dated by:*** E. J. Catanzaro. ***Com-***

ment: See No. 113.

(zircon) U^{238}/Pb^{206} 910 ± 30 m.y.
U^{235}/Pb^{207} 1210 ± 35 m.y.
Pb^{206}/Pb^{207} 1800 ± 40 m.y.
Th^{232}/Pb^{208} 700 m.y.

179. *Burwash, Baadsgaard and Peterman (1962)* K-Ar

AK 176, AK 265

Biotite-hornblende gneiss. (47°01'N, 110°46' W; sec. 31, T. 15 N., R. 8 E.; Monarch 15' quad; 7.3 mi N of Neihart on U.S. Hwy 89, Little Belt Mountains, Cascade Co.) ***Analytical data:*** (biotite) K_2O = 8.99%, Ar^{40}/K^{40} = 0.171; (hornblende) K_2O = 0.77%, Ar^{40}/K^{40} = 0.177. ***Constants:*** $\lambda_e = 0.589 \times 10^{-10}$/yr, $\lambda_\beta = 4.76 \times 10^{-10}$/yr, $K^{40}/K = 1.18 \times 10^{-4}$ atomic ratio. ***Method:*** (K) gravimetric methods and flame photometry, (Ar) isotope dilution with mass spectrometry. ***Dated by:*** University of Alberta.

(biotite) 1750 m.y.
(hornblende) 1790 m.y.

180. *Giletti (1966, 1971)* K-Ar

15, 3 Rb-Sr

Psammitic schist, medium grained with quartz, biotite, rare orthoclase and plagioclase. (45°21'08"N, 111°10'25"W; SE¼ SW¼ SE¼ sec. 36, T. 5 S., R. 4 E.; Garnet Mountain 15' quad; Gallatin Co.) ***Analytical data:*** (a) K = 7.10%, $*Ar^{40} = 8.43 \times 10^4$ scc/g, $Ar^{40}atm = 0.000 \times 10^4$ scc/g, $*Ar^{40}/K^{40}$ = 0.174; (b) Rb = 652 ppm, Sr = 24.2 ppm, Rb^{87}/Sr^{86} = 78.0, Sr^{87}/Sr^{86} = 2.596, assumed initial Sr^{87}/Sr^{86} = 0.710. ***Constants:*** (K) $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio, (Rb) $\lambda = 1.47 \times 10^{-11}$/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** These dates reflect a regional metamorphism 1600 m.y. ago.

(a) (biotite) 1790 m.y.
(b) (biotite) 1620 m.y.

181. *Peterman and Hedge (1964)* Rb-Sr

3798

Pegmatite and amphibolite. (47°37'30"N, 105° 34'20"W; sec. 33, T. 22 N., R. 48 E.; Shell NP 32-33B, sample depth at 11,050 ft. below surface, McCone Co.) ***Analytical data:*** Rb^{87} = 75.6 ppm; $*Sr^{87}$ = 2.02 ppm; $*Sr^{87}/Sr^{87}$ = 0.10. ***Constants:*** (Rb^{87}) $\lambda = 1.47 \times 10^{-11}$/yr; Rb^{87}/Rb = 0.283 g/g; Sr^{87}/Sr^{86} = 0.703 (assumed initial ratio); Sr^{86}/Sr^{88} = 0.1194. ***Comment:*** Date correlated with the Penokean orogeny.

(K-feldspar) 1790 ± 220 m.y.

182. *Catanzaro and Kulp (1964)* K-Ar

KAT-10

Pinto meta-diorite with andesine, biotite, hornblende; minor orthoclase, quartz, apatite, sphene, epidote and opaques. (46°57'35"N, 110°45'15"W; NE¼ sec. 19, T. 14 N., R. 8 E.; Belt Park Butte 7½' quad; 300 ft. from a 45-ft. porphyry dike (KAT-1), Little Belt Mountains, Cascade Co.) ***Analytical data:*** (biotite) K = 3.20%, $*Ar^{40} = 35.0 \times 10^{-5}$ scc/g, $*Ar^{40}$ = 98%; (hornblende) K = 1.38%, $*Ar^{40} = 16.2 \times 10^{-5}$ scc/g, $*Ar^{40}$ = 95%. ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** E. J. Catanzaro; ***dated by:*** R. Kologrivov. ***Comment:*** Intrusion of the Laramide porphyry dike did not cause drastic Ar loss from biotite in the host rock.

(biotite) 1700 m.y.
(hornblende) 1780 m.y.

183. *Green (1972)* F.T.

SB-9

Metasedimentary zircon core from green micaceous quartzite, North Snowy Block. (45°30' 10"N, 110°31'00"W; NE¼ SW¼ sec. 8, T. 4 S., R. 10 E.; Brisbin 7½' quad; Pine Creek quarry, Park Co.) ***Analytical data:*** Area = 0.128 mm^2, 38.886 density ϱ_s/unit area, 2.583 density ϱ_i/unit area, ϱ_s density/ϱ_i density = 15.055. ***Constants:*** $\lambda_D = 1.54 \times 10^{-10}$/yr, $\lambda_F = 6.85 \times 10^{-17}$/yr, $\varsigma = 582 \times 10^{-24}$ cm^2, $U^{235}/U^{238} = 7.26 \times 10^{-3}$ atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Age reflects different degrees of annealing of detrital zircon that is at least 3100 m.y. old; annealing occurred during both the 2700 m.y. and 1600 m.y. old metamorphic events, and also due to burial temperatures since the 1600 m.y. old event.

(zircon) 1773 m.y.

184. *Hayden and Wehrenberg (1960)* K-Ar

Medium- to coarse-grained pink granite gneiss with minor biotite. (45°00'45"N, 109°23'51"W; SW¼ NW¼ sec. 28, T. 9 S., R. 19 E.; Mount Maurice 15' quad; Cooke City Hwy 16.4 mi from US Forest boundary, S from Red Lodge, roadcut near 9410 ft. elevation marker, Carbon Co.) ***Analytical data:*** K = 7.93%, Ar^{40} = 9.29

x 10^{-4} STP cc/gm, $*Ar^{40}$ = 98.5%, Ar^{40}/K^{40} = 0.172. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta$ = 4.72×10^{-10}/yr. ***Method:*** (K) using a Perkin-Elmer flame photometer, (Ar) isotope dilution using a 6-inch 60° mass spectrometer. ***Collected and dated by:*** R. J. Hayden and J. P. Wehrenberg. ***Comment:*** This gneiss is a massive variety of the banded biotite migmatite of Eckelmann and Poldervaart (1957).

(K-feldspar) 1770 m.y.

185. *Jahn (1967)* K-Ar
10, BG-19-64
Granite gneiss with biotite, quartz, plagioclase, K-spar, zircon, epidote, muscovite and garnet. (44°55'55"N, 111°39'55"W; sec. 25, T. 10 S., R. 1 W.; Cliff Lake 15' quad; Madison Co.) ***Analytical data:*** K = 7.65%, $*Ar^{40}$ = 8.92×10^4 scc/gm, Ar^{40}atm = 7.03×10^4 scc/gm. ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) using a Perkin-Elmer model 146 flame photometer with Li internal standard, (Ar) isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Collected and dated by:*** B. Jahn. ***Comment:*** This date helps to define the margin of a 1600 m.y. old metamorphism in southwest Montana.

(biotite) 1770 m.y.

186. *Peterman and Hedge (1964)* K-Ar
Burwash, Baadsgaard, Peterman (1962)
AK36
Hornblende biotite gneiss. (47°37'30"N, 105°34'20"W; sec. 33, T. 22 N., R. 48 E.; Shell NP 32-33B, sample depth at 11,050 ft. below surface, McCone Co.) ***Analytical data:*** (biotite) K_2O = 7.90%, Ar^{40}/K^{40} = 0.166. ***Constants:*** $\lambda_e = 0.589 \times 10^{-10}$/yr, $\lambda\beta = 4.76 \times 10^{-10}$/yr, $K^{40}/K = 1.18 \times 10^{-4}$ atomic ratio. ***Method:*** (K) gravimetric methods and flame photometry, (Ar) isotope dilution with mass spectrometry. ***Dated by:*** University of Alberta. ***Comment:*** No analytical data available for the hornblende sample; dates correlated with the Penokean orogeny.

(biotite) 1720 m.y.
(hornblende) 1770 m.y.

187. *Schwartzman and Giletti (1968)* K-Ar
Albite amphibolite overlying the Stillwater Complex. (About 45°20'N, 110°W; Mt. Douglas and Mt. Wood 15' quads; Stillwater and Sweet Grass Co.)

(hornblende) 1760 m.y.

188. *Burwash, Baadsgaard and Peterman (1962)* K-Ar
AK 177
Porphyroblastic biotite schist interlayered with amphibolite. (47°56'N, 108°34'W; sec. 7, T. 25 N., R. 25 E.; Zortman 7½' quad; 1.5 mi N of Zortman along road to Ruby Gulch gold mine, Little Rocky Mountains, Phillips Co.) ***Analytical data:*** K_2O = 8.13%, Ar^{40}/K^{40} = 0.170. ***Constants:*** $\lambda_e = 0.589 \times 10^{-10}$/yr, $\lambda\beta = 4.76 \times 10^{-10}$/yr, $K^{40}/K = 1.18 \times 10^{-4}$ atomic ratio. ***Method:*** (K) gravimetric methods and flame photometry, (Ar) isotope dilution with mass spectrometry. ***Dated by:*** University of Alberta.

(biotite) 1750 m.y.

189. *Catanzaro and Kulp (1964)* K-Ar
59MZ10
Migmatite with segregated mafic and felsic layers, with sodic plagioclase, microcline, green-brown biotite, hornblende, quartz; accessories monazite; some alteration to chlorite and sericite. (46°57'37"N, 110°45'15"W; NE¼ sec. 19, T. 14 N., R. 8 E.; Belt Park Butte 7½' quad; Little Belt Mountains, Cascade Co.) ***Analytical data:*** K = 1.46%, $*Ar^{40}$ = 16.6×10^{-5} scc/g, $*Ar^{40}$ = 88%. ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** E. J. Catanzaro; ***dated by:*** R. Kologrivov.

(hornblende) 1740 m.y.

190. *Marvin and Dobson (1979)* K-Ar
USGS(D)-63R8
Gneiss with biotite, hornblende, microcline and oligoclase. (45°45'39"N, 111°43'22"W; SE¼ SE¼ sec. 9, T. 1 S., R. 1 W.; Three Forks 15' quad; 45 m W of pegmatite [USGS(D)-63R6], Madison Co.) ***Analytical data:*** K_2O = 0.96%, $*Ar^{40}$ = 40.5×10^{-10} mole/g, $*Ar^{40}$ = 99%. ***Constants:*** $\lambda_e = 0.581 \times 10^{-10}$/yr, $\lambda\beta = 4.962 \times 10^{-10}$/yr, $K^{40}/K = 1.167 \times 10^{-4}$ atomic ratio. ***Collected by:*** G. D. Robinson; ***dated by:*** R. F. Marvin, H. H. Mehnert and P. L. D. Elmore. ***Comment:*** This date is a minimum age of metamorphism.

(hornblende) 1740 ± 90 m.y.

191. *Giletti (1966)* K-Ar
13
Amphibolite gneiss, medium to fine grained, with quartz, oligoclase, green hornblende, biotite and garnet. (45°46'49"N, 111°01'17"W; NE¼ SE¼ NE¼ sec. 6, T. 1 S., R. 6 E.; Belgrade 15' quad; Gallatin Co.) ***Analytical data:***

K = 6.55%, $*Ar^{40}$ = 7.38 x 10^4 scc/g, $*Ar^{40}$ = 99.31%, $*Ar^{40}/K^{40}$ = 0.165. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution with a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** See No. 180.

(biotite) 1730 m.y.

192. *Giletti (1971)* K-Ar
12 Rb-Sr
(45°18'28"N, 111°09'30"W; SE¼ SW¼ sec. 18, T. 6 S., R. 5 E.; Garnet Mountain 15' quad; Gallatin Co.) ***Analytical data:*** (a) K = 8.26%, $*Ar^{40}$ = 9.26 x 10^4 scc/g, Ar^{40}atm = 0.040 x 10^4 scc/g, $*Ar^{40}/K^{40}$ = 0.164; (b) Rb = 616 ppm, Sr = 5.42 ppm, Rb^{87}/Sr^{86} = 328.9, Sr^{87}/Sr^{86} = 9.20, assumed initial Sr^{87}/Sr^{86} = 0.710. ***Constants:*** (K) λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio; Rb^{87} λ = 1.47 x 10^{-11}/yr. ***Method:*** isotope dilution, (K) using a Perkin-Elmer flame photometer with Li internal standard, (Ar) using a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** See No. 180.

(a) (biotite) 1720 m.y.
(b) (biotite) 1730 m.y.

193. *Giletti (1971)* K-Ar
2
(45°20'00"N, 111°21'55"W; SE¼ NW¼ sec. 9, T. 6 S., R. 3 E.; Spanish Peaks 15' quad; Gallatin Co.) ***Analytical data:*** (a) K = 7.48%, $*Ar^{40}$ = 7.68 x 10^4 scc/g, Ar^{40}atm = 0.0417 x 10^4 scc/g, $*Ar^{40}/K^{40}$ = 0.151; (b) K = 1.29%, $*Ar^{40}$ = 1.452 x 10^4 scc/g, $*Ar^{40}$atm = 0.0152, $*Ar^{40}/K^{40}$ = 0.165. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Isotope dilution, (K) using a Perkin-Elmer flame photometer with Li internal standard, (Ar) using a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** These dates reflect a regional metamorphism 1600 m.y. ago.

(a) (biotite) 1630 m.y.
(b) (amphibole) 1730 m.y.

194. *Giletti (1966)* K-Ar
9
Pony gneiss(?), gneiss with quartz, oligoclase, biotite, garnet, some plagioclase and orthoclase (slightly altered). (45°19'03"N, 111°50'17"W; SW¼ SE¼ SW¼ sec. 10, T. 6 S., R. 2 W.; Virginia City 15' quad; Madison Co.) ***Analytical data:*** K = 6.85%, $*Ar^{40}$ = 7.66 x 10^4 scc/g, $*Ar^{40}$ = 99.04%, $*Ar^{40}/K^{40}$ = 0.164. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution with a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** See No. 16.

(biotite) 1720 m.y.

195. *Marvin and Dobson (1979)* K-Ar
USGS(D)-63R6
Pegmatite. (45°45'39"N, 111°43'22"W; SE¼ SE¼ sec. 9, T. 1 S., R. 1 W.; Three Forks 15' quad; Madison Co.) ***Analytical data:*** K_2O = 10.32%, $*Ar^{40}$ = 426 x 10^{-10} mole/g, $*Ar^{40}$ = 99%. ***Constants:*** λ_e = 0.581 x 10^{-10}/yr, $\lambda\beta$ = 4.962 x 10^{-10}/yr, K^{40}/K = 1.167 x 10^{-4} atomic ratio. ***Collected by:*** G. D. Robinson; ***dated by:*** R. F. Marvin, H. H. Mehnert and P. L. D. Elmore. ***Comment:*** This date is a minimum age for the pegmatite emplacement.

(muscovite) 1720 ± 50 m.y.

196. *Burwash, Baadsgaard and Peterman (1962)* K-Ar
AK 167
Amphibolite interlayered with biotite schist. (47°56'N, 108°34'W; sec. 7, T. 25 N., R. 25 E.; Zortman 7½' quad; 1.5 mi N of Zortman along road to Ruby Gulch gold mine, Little Rocky Mountains, Phillips Co.) ***Analytical data:*** K_2O = 1.11%, Ar^{40}/K^{40} = 0.165. ***Constants:*** λ_e = 0.589 x 10^{-10}/yr, $\lambda\beta$ = 4.76 x 10^{-10}/yr, K^{40}/K = 1.18 x 10^{-4} atomic ratio. ***Method:*** (K) gravimetric methods and flame photometry, (Ar) isotope dilution with mass spectrometry. ***Dated by:*** University of Alberta.

(hornblende) 1710 m.y.

197. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-47
Chilled margin of diabase dike, with plagioclase and pyroxene. (44°58'43"N, 109°25'05"W; NE¼ sec. 27, T. 58 N., R. 104 W.; Deep Lake 15' quad; Park Co., Wyo.) ***Analytical data:*** K^{40} = 1.46 ppm (a), 1.48 ppm (b), Ar^{40} = 0.237 ppm, $*Ar^{40}$ = 99.6%, Ar^{40}/K^{40} = 0.1612. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spec-

trometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1700 m.y.

198. *Giletti and Gast (1961)* Rb-Sr
18
Pegmatite, Cherry Creek gneiss. (45°20'N, 112°05'W; T. 6 S., R. 4 W. [est.]; Ruby Dam 7½' quad; Alder, Madison Co.) ***Constants:*** Rb^{87} $\lambda = 1.4 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a Vickers MS-5 mass spectrometer. ***Comment:*** These dates seem to indicate a metamorphic event about 1600 m.y. ago.

(muscovite) 1700 m.y.
(microcline) 1640 m.y.

199. *Baadsgaard and Mueller (1973)* K-Ar
Mueller (1971)
MBT-2
Diabase dike with plagioclase and pyroxene. (44°56'35"N, 109°29'30"W; SE¼ sec. 1, T. 57 N., R. 105 W.; Deep Lake 15' quad; Park Co., Wyo.) ***Analytical data:*** (a) K^{40} = 1.52 ppm, Ar^{40} = 0.2464 ppm, $*Ar^{40}$ = 99.5%, Ar^{40}/K^{40} = 0.1621; (b) K^{40} = 1.38 ppm (a), 1.34 ppm (b), Ar^{40} = 0.1996 ppm, $*Ar^{40}$ = 99.0%, Ar^{40}/K^{40} = 0.1468. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta. ***Comment:*** Condie and others (1969) dated this dike at 1690 m.y. (K-Ar); Larson and others (1973) dated this dike at 2500 m.y. (Rb-Sr).

(a) (whole rock) 1700 m.y.
(b) (whole rock) 1600 m.y.

200. *Giletti (1966)* K-Ar
14
Granitic gneiss, medium to fine grained, with quartz, microcline, oligoclase, biotite, rare muscovite. (45°24'25"N, 111°13'00"W; NE¼ NW¼ NW¼ sec. 15, T. 5 S., R. 4 E.; Garnet Mountain 15' quad; Gallatin Co.) ***Analytical data:*** K = 7.33%, $*Ar^{40} = 7.95 \times 10^4$ scc/g, $*Ar^{40}$ = 85.12%, $*Ar^{40}/K^{40}$ = 0.159. ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** See No. 180.

(biotite) 1690 m.y.

201. *Condie, Leech and Baadsgaard (1969)* K-Ar
BT-37
Microporphyritic, fine-grained diabase dike with plagioclase, augite, hornblende; minor magnetite, orthopyroxene, quartz, sericite and chlorite. (44°56'35"N, 109°29'30"W; SE¼ sec. 1, T. 57 N., R. 105 W.; Deep Lake 15' quad; Park Co., Wyo.) ***Analytical data:*** K_2O = 1.38%, Ar^{40}/K^{40} = 0.1597, $*Ar^{40}$ = 98%. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) x-ray fluorescence and gravimetric analysis, (Ar) isotope dilution using an AEI MS-10 mass spectrometer. ***Comment:*** Larson and others (1973) dated this dike at 2550 m.y. (Rb-Sr); Baadsgaard and Mueller (1973) dated this dike at 1600 m.y. and 1700 m.y. (K-Ar).

(whole rock) 1690 m.y.

202. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-31
Small mafic intrusion with plagioclase and pyroxene. (45°02'20"N, 109°39'50"W; NW¼ sec. 20, T. 9 S., R. 17 E.; Alpine 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 2.05 ppm, Ar^{40} = 0.3278 ppm, $*Ar^{40}$ = 99.6%, Ar^{40}/K^{40} = 0.1599. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) flame photometric and gravimetric methods, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1690 m.y.

203. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-21
Chilled margin of diabase dike, with plagioclase and pyroxene. (44°59'15"N, 109°33'15" W; NW¼ sec. 28, T. 58 N., R. 105 W.; Beartooth Butte 15' quad; Park Co., Wyo.) ***Analytical data:*** K^{40} = 1.25 ppm (a), 1.21 ppm (b), Ar^{40} = 0.196 ppm, $*Ar^{40}$ = 99.4%, Ar^{40}/K^{40} = 0.1593. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1690 m.y.

204. *Giletti (1966)* K-Ar
5 Rb-Sr
Cherry Creek gneiss, quartz-muscovite-biotite schist. (45° 10'57"N, 112°26'15"W; NE¼ NE¼ SE¼ sec. 34, T. 7 S., R. 7 W.; Christensen Ranch 7½' quad; Madison Co.) ***Analytical data:*** (See below). ***Constants:*** (K) $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, ($Rb^{87}$) $\lambda = 1.47 \times 10^{-11}$/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Rb, Sr, Ar) isotope dilution with a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** (K-Ar) Brown University, (Rb-Sr) Lamont Geological Observatory, Columbia University, and Department of Geology, Oxford University. ***Comment:*** These dates indicate a regional metamorphism of the pre-Cherry Creek, Cherry Creek and Pony gneisses 1600 m.y. ago.

(a) (biotite) 1600 m.y.
(b) (biotite) 1620 m.y.
(c) (muscovite) 1680 m.y.
Rb-Sr (whole rock-mineral isochron) 1530 m.y.

205. *Giletti (1966)* K-Ar
4
Dillon granite gneiss, medium-fine grained, with quartz, microcline, biotite, rare oligoclase. (45°02'55"N, 112°31'37"W; NE¼ SW¼ SE¼ sec. 13, T. 9 S., R. 8 W.; Ashbough Canyon 7½' quad; Beaverhead Co.) ***Analytical data:*** K = 6.87%, $*Ar^{40} = 7.26 \times 10^4$ scc/g, $*Ar^{40}$ = 99.57%, $*Ar^{40}/K^{40} = 0.155$. ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution with a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** This date and others by B. J. Giletti indicate that the Dillon gneiss was intruded after the regional metamorphism of basement rocks 1600 m.y. ago.

(biotite) 1660 m.y.

206. *Giletti (1966)* K-Ar
8 Rb-Sr
Pegmatite in Cherry Creek gneiss, with quartz, K-feldspar and muscovite. (45° 19'03"N, 112° 02'10"W; SW¼ SW¼ SE¼ sec. 12, T. 6 S., R. 4 W.; Alder 7½' quad; Madison Co.) ***Analytical data:*** (a) K = 7.99%, $*Ar^{40} = 8.48 \times 10^4$ scc/g, $*Ar^{40}$ = 97.17%, $*Ar^{40}/K^{40} = 0.156$; (b) Rb = 783 ppm, Sr = 2.15 ppm, $*Sr/Rb^{87}$ = 0.0238; (c) Rb = 818 ppm, Sr = 12.8 ppm, $*Sr/Rb^{87}$ = 0.0242. ***Constants:*** (K) $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, ($Rb^{87}$) $\lambda = 1.47 \times 10^{-11}$/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Rb, Sr, Ar) isotope dilution with a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** (K-Ar) Brown University, (Rb-Sr) Lamont Geological Observatory, Columbia University, and Department of Geology, Oxford University. ***Comment:*** These dates, together with others, indicate a regional metamorphism of the pre-Cherry Creek, Cherry Creek and Pony gneisses 1600 m.y. ago.

(a) (muscovite) 1660 m.y.
(b) (muscovite) 1590 m.y.
(c) (K-feldspar) 1620 m.y.

207. *Catanzaro and Kulp (1964)* U-Pb
59MZ11 K-Ar
Migmatite with segregated mafic and felsic layers, with sodic plagioclase, microcline, green-brown biotite, hornblende, quartz; accessories epidote, apatite, sphene, zircon, opaques, monazite; some alteration to chlorite and sericite. (46°58'17"N, 110°45'28"W; SE¼ sec. 18, T. 14 N., R. 8 E.; Belt Park Butte 7½' quad; Little Belt Mountains, Cascade Co.) ***Analytical data:*** (zircon) U = 2227 ppm, Th = 1421 ppm, Pb = 261 ppm, common Pb = 20.2%, $Pb^{204}/Pb^{206} = 0.437 \pm 0.004$, Pb^{207}/Pb^{206} = 15.98, Pb^{208}/Pb^{206} = 25.81; (hornblende) K = 2.12%, $*Ar^{40} = 21.4 \times 10^{-5}$ scc/gm, $*Ar^{40}$ = 84%. ***Constants:*** $U^{238}\lambda = 1.54 \times 10^{-10}$/yr, $U^{235}\lambda = 9.72 \times 10^{-10}$/yr, $Th^{232}\lambda = 4.88 \times 10^{-11}$/yr; (K) $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda\beta$

Analytical data for No. 204:

		K%	$*Ar^{40}$ (x 10^4 scc/g)	$*Ar^{40}$ (%)	$*Ar^{40}/K^{40}$
(a)	biotite	7.30	7.32	87.88	0.147
(b)	biotite	7.30	7.44	81.31	0.149
(c)	muscovite	7.41	8.02	97.94	0.159
		Rb (ppm)	**Sr (ppm)**	**$*Sr/Rb^{87}$**	
(a)	biotite	461	8.54	0.0228	
(c)	muscovite	172	33.2	0.0254	
(d)	whole rock	138	26.2	0.0249	

= 4.72 x 10^{-11}/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** E. J. Catanzaro; ***dated by:*** E. J. Catanzaro and R. Kologrivov. ***Comment:*** See No. 113.

(zircon) U^{238}/Pb^{206} 560 ± 20 m.y.
U^{235}/Pb^{207} 830 ± 35 m.y.
Pb^{206}/Pb^{207} 1660 ± 40 m.y.
Th^{232}/Pb^{208} 320 m.y.
(hornblende) K-Ar 1610 m.y.

208. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-6
Chilled margin of diabase dike, with plagioclase and pyroxene. (45°26'45"N, 110°03'12"W; SW¼ sec. 36, T. 4 S., R. 14 E.; Mt. Douglas 15' quad; Sweet Grass Co.) ***Analytical data:*** K^{40} = 1.85 ppm (a), 1.79 ppm (b), Ar^{40} = 0.2773 ppm, $*Ar^{40}$ = 98.5%, Ar^{40}/K^{40} = 0.1524. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1640 m.y.

209. *Jahn (1967)* K-Ar
6, BJ-19-66
Biotite gneiss with biotite, quartz, plagioclase, orthoclase, apatite, muscovite and sericite. (44°56'45"N, 111°41'15"W; sec. 23, T. 10 S., R. 1 W.; Cliff Lake 15' quad; Madison Co.) ***Analytical data:*** K = 8.0%, $*Ar^{40}$ = 8.28 x 10^4 scc/gm, Ar^{40}atm = 2.82 x 10^4 scc/gm. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) using a Perkin-Elmer model 146 flame photometer with Li internal standard, (Ar) isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Collected and dated by:*** B. Jahn. ***Comment:*** This date helps to define the margin of a 1600 m.y. old metamorphism in southwest Montana.

(biotite) 1640 m.y.

210. *Hayden and Wehrenberg (1960)* K-Ar
Medium-coarse-grained, light-colored biotite-plagioclase-quartz gneiss, with sugary texture. (45°35'55"N, 111°35'17"W; SW¼ sec. 10, T. 3 S., R. 1 E.; Norris 15' quad; 5.6 mi E of Norris, roadcut on N side of road where road leaves the Madison River, Madison Co.) ***Analytical data:*** K = 7.53%, Ar^{40} = 7.76 x 10^{-4} STP cc/gm, $*Ar^{40}$ = 97.5%, Ar^{40}/K^{40} = 0.151. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr. ***Method:*** (K) using a Perkin-Elmer flame photometer, (Ar) isotope dilution using a 6-inch 60° mass spectrometer. ***Collected and dated by:*** R. J. Hayden and J. P. Wehrenberg. ***Comment:*** This gneiss correlated with the Pony gneiss.

(biotite) 1630 m.y.

211. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-49
Chilled margin of diabase dike, with plagioclase and pyroxene. (45°01'08"N, 109°26'11"W; NW¼ sec. 30, T. 9 S., R. 19 E.; Mount Maurice 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 1.14 ppm, Ar^{40} = 0.1722 ppm, $*Ar^{40}$ = 84.8%, Ar^{40}/K^{40} = 0.1511. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) flame photometric and gravimetric methods, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1630 m.y.

212. *Giletti and Gast (1961)* Rb-Sr
15
Pony gneiss. (44°45'N, 112°45'W; T. 13 S., R. 9 W. [est.]; Kidd 7½' quad; Dell, Beaverhead Co.) ***Constants:*** Rb^{87} λ = 1.4 x 10^{-11}/yr. ***Method:*** Isotope dilution using a Vickers MS-5 mass spectrometer. ***Comment:*** These dates seem to indicate a metamorphic event about 1600 m.y. ago.

(biotite) 1630 m.y.
(biotite) 1570 m.y.

213. *Giletti and Gast (1961)* Rb-Sr
17
Cherry Creek gneiss. (45°28'N, 112°W; T. 4 S., R. 3 W. [est.]; Copper Mountain 7½' quad; Ramshorn Creek, Virginia City, Madison Co.) ***Constants:*** Rb^{87} λ = 1.4 x 10^{-11}/yr. ***Method:*** Isotope dilution using a Vickers MS-5 mass spectrometer. ***Comment:*** This date seems to indicate a metamorphic event about 1600 m.y. ago.

(biotite) 1620 m.y.

214. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-1
Diabase dike with plagioclase and pyroxene.

(44°57'24"N, 109°30'05"W; NW¼ sec. 1, T. 57 N., R. 105 W.; Deep Lake 15' quad; Park Co., Wyo.) ***Analytical data:*** K^{40} = 1.16 ppm (a), 1.17 ppm (b), Ar^{40} = 0.1749 ppm, $*Ar^{40}$ = 99.4%, Ar^{40}/K^{40} = 0.1504. ***Constants:*** λ_e = 0.585×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr, K^{40}/K = 1.19×10^{-4} atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1620 m.y.

215. *Giletti (1966)* K-Ar
11
Granite gneiss with quartz, microcline, oligoclase and muscovite. (45°03'10"N, 111°40'33" W; NE¼ SW¼ NW¼ sec. 13, T. 9 S., R. 1 W.; Cameron 15' quad; Madison Co.) ***Analytical data:*** K = 7.70%, $*Ar^{40}$ = 7.80×10^4 scc/g, $*Ar^{40}$ = 99.20%, $*Ar^{40}/K^{40}$ = 0.149. ***Constants:*** λ_e = 0.584×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution with a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** This date reflects a regional metamorphism 1600 m.y. ago.

(muscovite) 1610 m.y.

216. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-19
Chilled margin of diabase dike, with plagioclase and pyroxene. (45°02'35"N, 109°26'49"W; SE¼ sec. 13, T. 9 S., R. 18 E.; Mount Maurice 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 1.30 ppm (a), 1.31 ppm (b), Ar^{40} = 0.195 ppm, $*Ar^{40}$ = 99.7%, Ar^{40}/K^{40} = 0.1494. ***Constants:*** λ_e = 0.585×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr, K^{40}/K = 1.19×10^{-4} atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1610 m.y.

217. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-29
Chilled margin of diabase dike, with plagioclase and pyroxene. (45°01'20"N, 109°38'20"W; NE¼ sec. 28, T. 9 S., R. 17 E.; Alpine 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 1.29, 1.31 ppm, Ar^{40} = 0.1941 ppm, $*Ar^{40}$ = 99.3%, Ar^{40}/K^{40} = 0.1493. ***Constants:*** λ_e = 0.585×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr, K^{40}/K = 1.19×10^{-4} atomic ratio. ***Method:*** (K) flame photometric and gravimetric methods, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1610 m.y.

218. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-56
Chilled margin of diabase dike, with plagioclase and pyroxene. (44°58'55"N, 109°35'40"W; NW¼ sec. 30, T. 58 N., R. 105 W.; Beartooth Butte 15' quad; Park Co., Wyo.) ***Analytical data:*** K^{40} = 1.21 ppm, Ar^{40} = 0.1779 ppm, $*Ar^{40}$ = 97.1%, Ar^{40}/K^{40} = 0.1470. ***Constants:*** λ_e = 0.585×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr, K^{40}/K = 1.19×10^{-4} atomic ratio. ***Method:*** (K) flame photometric and gravimetric methods, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta. ***Comment:*** Condie and others (1969) dated this dike at 1500 m.y. (K-Ar).

(whole rock) 1600 m.y.

219. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-38
Chilled margin of diabase dike, with plagioclase and pyroxene. (45°03'05"N, 109°43'45"W; NW¼ sec. 14, T. 9 S., R. 16 E.; Alpine 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 1.19, 1.24 ppm, Ar^{40} = 0.1779 ppm, $*Ar^{40}$ = 96.2%, Ar^{40}/K^{40} = 0.1414. ***Constants:*** λ_e = 0.585×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr, K^{40}/K = 1.19×10^{-4} atomic ratio. ***Method:*** (K) flame photometric and gravimetric methods, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1590 m.y.

220. *Mueller (1971)* K-Ar
Baadsgard and Mueller (1973)
MBT-16A
Diabase dike with plagioclase and pyroxene. (44°58'20"N, 109°31'25"W; SE¼ sec. 27, T. 58 N., R. 105 W.; Beartooth Butte 15' quad; Park Co., Wyo.) ***Analytical data:*** K^{40} = 1.52 ppm (a), 1.46 ppm (b), Ar^{40} = 0.2140 ppm, $*Ar^{40}$ = 97.5%, Ar^{40}/K^{40} = 0.1436. ***Con-***

stants: λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1570 m.y.

221. *Green (1972)* F.T.
HRL-1
Metasedimentary zircon core from a quartzite unit exposed on the glaciated floor of the Hell Roaring Lakes. (45°02'N, 109°30'W; sec. 14, 15, T. 9 S., R. 18 E. [est.]; Mount Maurice 15' quad; Hell Roaring Lakes, Carbon Co.) ***Analytical data:*** Area = 0.218 mm², 24.770 density ϱ_S/unit area, 1.895 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 13.080. ***Constants:*** λ_D = 1.54 x 10^{-10}/yr, λ_F = 6.85 x 10^{-17}/yr, ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3} atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Some fission tracks were annealed by a metasomatic event 2700 m.y. ago.

(zircon) 1569 m.y.

222. *Green (1972)* F.T.
HRL-8
Metasedimentary zircon core from a quartzite unit exposed on the glaciated floor of the Hell Roaring Lakes. (45°02'N, 109°30'W; sec. 14, 15, T. 9 S., R. 18 E. [est.]; Mount Maurice 15' quad; Hell Roaring Lakes, Carbon Co.) ***Analytical data:*** Area = 0.128 mm², 36.094 density ϱ_S/unit area, 2.769 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 13.035. ***Constants:*** λ_D = 1.54 x 10^{-10}/yr, λ_F = 6.85 x 10^{-17}/yr, ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3} atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Some fission tracks were annealed by a metasomatic event 2700 m.y. ago.

(zircon) 1561 m.y.

223. *Giletti and Gast (1961)* Rb-Sr
14
Dillon granite gneiss. (44°30'N, 112°45'W; T. 15 S., R. 9 W. [est.]; Caboose Canyon 7½' quad; Tendoy Range, Beaverhead Co.) ***Constants:*** Rb^{87} λ = 1.4 x 10^{-11}/yr. ***Method:*** Isotope dilution using a Vickers MS-5 mass spectrometer. ***Comment:*** These dates seem to indicate a metamorphic event about 1600 m.y. ago.

(biotite) 1560 m.y.
(whole rock) 1550 m.y.

224. *Giletti (1966)* K-Ar
6 Rb-Sr
Cherry Creek gneiss, with hornblende, biotite, quartz and garnet. (45°10'57"N, 112°26'15"W; NE¼ NE¼ SE¼ sec. 34, T. 7 S., R.7 W.; Christensen Ranch 7½' quad; collected about 100 ft. SW of (5) (see 205), Madison Co.) ***Analytical data:*** (a) K = 6.45%, $*Ar^{40}$ = 5.86 x 10^4 scc/g, $*Ar^{40}$ = 99.27%, $*Ar^{40}/K^{40}$ = 0.133; (b) Rb = 323 ppm, Sr = 4.55 ppm, $*Sr/Rb^{87}$ = 0.0233. ***Constants:*** (K) λ_e = 0.584 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, (Rb^{87}) λ = 1.47 x 10^{-11}/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Rb, Sr, Ar) isotope dilution with a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** (K-Ar) Brown University, (Rb-Sr) Lamont Geological Observatory, Columbia University, and Department of Geology, Oxford University. ***Comment:*** These dates indicate a regional metamorphism of the pre-Cherry Creek, Cherry Creek and Pony gneisses 1600 m.y. ago.

(a) (biotite) 1520 m.y.
(b) (biotite) 1560 m.y.

225. *Green (1972)* F.T.
HRL-4
Metasedimentary zircon core from a quartzite unit exposed on the glaciated floor of the Hell Roaring Lakes. (45°02'N, 109°30'W; sec. 14, 15, T. 9 S., R. 18 E. [est.]; Mount Maurice 15' quad; Hell Roaring Lakes, Carbon Co.) ***Analytical data:*** Area = 0.160 mm², 27.563 density ϱ_S/unit area, 2.125 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 12.971. ***Constants:*** λ_D = 1.54 x 10^{-10}/yr, λ_F = 6.85 x 10^{-17}/yr, ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3} atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Some fission tracks annealed by a metasomatic event 2700 m.y. ago.

(zircon) 1554 m.y.

226. *Green (1972)* F.T.
HRL-9
Metasedimentary zircon core from a quartzite unit exposed on the glaciated floor of the Hell Roaring Lakes. (45°02'N, 109°30'W; sec. 14, 15, T. 9 S., R. 18 E. [est.]; Mount Maurice 15' quad; Hell Roaring Lakes, Carbon Co.) ***Analytical data:*** Area = 0.094 mm², 36.017 density ϱ_S/unit area, 2.778 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 12.965. ***Constants:*** λ_D = 1.54 x 10^{-10}/yr, λ_F = 6.85 x 10^{-17}/yr, ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3} atomic ratio. ***Collected and dated by:*** D. Green. ***Com-***

ment: Some fission tracks were annealed by a metasomatic event 2700 m.y. ago.

(zircon) 1554 m.y.

227. *Giletti (1966)* K-Ar
12
Biotite schist, medium grained with quartz, microcline, fresh biotite. (45°38'50"N, 111°26'41"W; NW¼ NW¼ SE¼ sec. 23, T. 2 S., R. 2 E.; Anceney 15' quad; Gallatin Co.) ***Analytical data:*** K = 6.11%, $*Ar^{40}$ = 5.86 x 10^4 scc/g, $*Ar^{40}$ = 88.24%, $*Ar^{40}/K^{40}$ = 0.141. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution with a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** This date reflects a regional metamorphism 1600 m.y. ago.

(biotite) 1550 m.y.

228. *Giletti (1966)* K-Ar
18
Dillon granite gneiss, medium to fine grained, with quartz, microcline, biotite, rare plagioclase, very rare chlorite. (45°03'28"N, 112°15'36"W; SW¼ SW¼ SE¼ sec. 7, T. 9 S., R. 5 W.; Red Canyon 7½' quad; Madison Co.) ***Analytical data:*** K = 6.75%, $*Ar^{40}$ = 6.49 x 10^4 scc/g, $*Ar^{40}$ = 99.75%, $*Ar^{40}/K^{40}$ = 0.141. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution with a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** This date and others by B. J. Giletti indicate the Dillon gneiss was intruded after the regional metamorphism of basement rocks 1600 m.y. ago.

(biotite) 1550 m.y.

229. *Giletti (1966)* Rb-Sr
7
Cherry Creek gneiss, biotite schist with quartz, feldspar and biotite. (45°24'45"N, 112°07'09"W; NW¼ NW¼ SE¼ sec. 8, T. 5 S., R. 4 W.; Copper Mountain 7½' quad; Madison Co.) ***Analytical data:*** Rb = 56.5 ppm, Sr = 8.92 ppm, $*Sr/Rb^{87}$ = 0.0227. ***Constants:*** λ = 1.47 x 10^{-11}/yr. ***Method:*** Isotope dilution with a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Lamont Geological Observatory, Columbia University, and Department of Geology, Oxford University. ***Comment:*** This date and others by B. J. Giletti indicate a regional metamorphism of the pre-Cherry Creek, Cherry Creek and Pony gneisses 1600 m.y. ago.

(biotite) 1530 m.y.

230. *Giletti (1966)* K-Ar
10
Cherry Creek gneiss, kyanite schist with quartz, biotite, oligoclase, chlorite, garnet, rare minor alteration of plagioclase. (45°10'21"N, 111°46'12"W; NW¼ NW¼ NE¼ sec. 6, T. 8 S., R. 1 W.; Varney 15' quad; Madison Co.) ***Analytical data:*** K = 6.17%, $*Ar^{40}$ = 5.73 x 10^4 scc/g, $*Ar^{40}$ = 97.22%, $*Ar^{40}/K^{40}$ = 0.136. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution with a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** This date indicates a regional metamorphism of the pre-Cherry Creek, Cherry Creek and Pony gneisses 1600 m.y. ago.

(biotite) 1520 m.y.

231. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-46
Diabase dike with plagioclase and pyroxene. (44°58'40"N, 109°23'40"W; SW¼ sec. 24, T. 58 N., R. 104 W.; Deep Lake 15' quad; Park Co., Wyo.) ***Analytical data:*** K^{40} = 0.97 ppm (a), 0.95 ppm (b), Ar^{40} = 0.1308 ppm, $*Ar^{40}$ = 87.8%, Ar^{40}/K^{40} = 0.1363. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1520 m.y.

232. *Condie, Leech and Baadsgaard (1969)* K-Ar
BT-21
Microporphyritic, fine-grained diabasic dike with plagioclase, augite, hornblende; minor magnetite, orthopyroxene, quartz, sericite and chlorite. (44°58'55"N, 109°35'40"W; NW¼ sec. 30, T. 58 N., R. 105 W.; Beartooth Butte 15' quad; Park Co., Wyo.) ***Analytical data:*** K_2O = 1.13%, Ar^{40}/K^{40} = 0.1334, $*Ar^{40}$ = 85%. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) x-ray fluorescence and gra-

vimetric analysis, (Ar) isotope dilution using an AEI MS-10 mass spectrometer. ***Comment:*** Baadsgaard and Mueller (1973) dated this dike at 1600 m.y. (K-Ar).

(whole rock) 1500 m.y.

233. *Larson, Reynolds and Hoblitt (1973)* K-Ar Rb-Sr
BT-8
Microporphyritic, fine-grained diabase dike with plagioclase, augite, hornblende; minor magnetite, orthopyroxene, quartz, sericite and chlorite. (45°00'47"N, 109°37'30"W; SW¼ sec. 27, T. 9 S., R. 17 E.; Alpine 15' quad; 1 km N of Tiel Lake, Carbon Co.) ***Dated by:*** P. A. Mueller.

K-Ar (whole rock) 1500 m.y.
Rb-Sr (whole rock) 1500 m.y.

234. *Larson, Reynolds and Hoblitt (1973)* K-Ar Rb-Sr
BT-7
Microporphyritic, fine-grained diabase dike with plagioclase, augite, hornblende; minor magnetite, orthopyroxene, quartz, sericite and chlorite. (44°59'07"N, 109°35'30"W; NE¼ sec. 30, T. 58 N., R. 105 W.; Beartooth Butte 15' quad; Park Co., Wyo.) ***Dated by:*** P. A. Mueller.

K-Ar (whole rock) 1500 m.y.
Rb-Sr (whole rock) 1500 m.y.

235. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-43A
Chilled margin of diabase dike, with plagioclase and pyroxene. (45°02'25"N, 109°24'27"W; center sec. 17, T. 9 S., R. 19 E.; Mount Maurice 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 0.81 ppm (a), 0.759 ppm (b), Ar^{40} = 0.1044 ppm, $*Ar^{40}$ = 93.9%, Ar^{40}/K^{40} = 0.1322. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1490 m.y.

236. *Giletti (1966)* K-Ar
3 Rb-Sr
Pre-Cherry Creek gneiss, medium-fine grained, with quartz, microcline, biotite, oligoclase. (44°53'20"N, 112°33'13"W; NE¼ NE¼ SE¼ sec. 15, T. 11 S., R. 8 W.; Beach Creek 7½' quad; Beaverhead Co.) ***Analytical data:*** (a) K = 6.95%, $*Ar^{40}$ = 5.44 x 10^4 scc/g, $*Ar^{40}$ = 98.50%, $*Ar^{40}/K^{40}$ = 0.113;

	Rb (ppm)	Sr (ppm)	$*Sr/Rb^{87}$
(b)	1170	15.2	0.0220
(c)	1172	7.37	0.0221
(d)	1177	12.4	0.0219

Constants: (K) λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, (Rb^{87}) λ = 1.47 x 10^{-11}/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Rb, Sr, Ar) isotope dilution with a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** (K-Ar) Brown University, (Rb-Sr) Lamont Geological Observatory, Columbia University, and Department of Geology, Oxford University. ***Comment:*** See No. 16.

(a) (biotite) 1330 ± 150 m.y.
(b) (biotite) 1480 m.y.
(c) (biotite) 1480 m.y.
(d) (biotite) 1470 m.y.

237. *Giletti (1966)* K-Ar
1 Rb-Sr
Dillon granite gneiss, medium-fine grained, with quartz, microperthite, garnet, oligoclase, biotite, minor allanite, rare plagioclase (altered). (44°36'00"N, 112°48'49"W; SW¼ SW¼ NW¼ sec. 22, T. 14 S., R. 10 W.; Caboose Canyon 7½' quad; Beaverhead Co.) ***Analytical data:*** (a) K = 6.29%, $*Ar^{40}$ = 5.26 x 10^4 scc/g, $*Ar^{40}$ = 96.24%, $*Ar^{40}/K^{40}$ = 0.123; (b) Rb = 558 ppm, Sr = 12.6 ppm, $*Sr/Rb^{87}$ = 0.0232; (c) Rb = 203 ppm, Sr = 146 ppm, $*Sr/Rb^{87}$ = 0.0218. ***Constants:*** (K) λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, Rb^{87} λ = 1.47 x 10^{-11}/yr. ***Method:*** (K) in triplicate with Perkin-Elmer flame photometer with Li internal standard, (Rb, Sr, Ar) isotope dilution with a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** (K-Ar) Brown University, (Rb-Sr) Lamont Geological Observatory, Columbia University, and Department of Geology, Oxford University. ***Comment:*** See No. 205.

(a) (biotite) 1410 m.y.
(b) (biotite) 1480 m.y.
(c) (whole rock) 1460 m.y.

238. *Catanzaro and Kulp (1964)* K-Ar
KAT-4
Pinto meta-diorite with andesine, biotite, hornblende; minor orthoclase, quartz, apatite, sphene, epidote and opaques. (46°57'37"N, 110°45'15"W; NE¼ sec. 19, T. 14 N., R. 8 E.; Belt Park Butte 7½' quad; 5 ft. from a 45-ft.

porphyry dike [KAT-1], Little Belt Mountains, Cascade Co.) ***Analytical data:*** (biotite) K = 2.99%, $*Ar^{40}$ = 24.2 x 10^{-5} scc/gm, $*Ar^{40}$ = 87%; (hornblende) K = 1.31%, $*Ar^{40}$ = 11.7 x 10^{-5} scc/gm, $*Ar^{40}$ = 95%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** E. J. Catanzaro; ***dated by:*** R. Kologrivov. ***Comment:*** Intrusion of the Laramide porphyry dike did not cause drastic Ar loss from biotite in the host rock.

(biotite) 1380 m.y.
(hornblende) 1480 m.y.

239. *Hanson and Gast (1967)* K-Ar
WY12a
Well-foliated para-amphibolite with plagioclase, hornblende, quartz, biotite-chlorite, epidote, sphene and microcline, 0.2 m from a vertical 50-m thick quartz dolerite dike. (44°58'00" N, 109°25'20"W; SW¼ NE¼ sec. 33, T. 58 N., R. 104 W.; Deep Lake 15' quad; Christmas Lake dike, Park Co., Wyo.) ***Analytical data:*** (a) K = 5.35%, $*Ar^{40}$ = 2.17 x 10^4 cc/g, Ar^{40} atm = 6.7%; (b) K = 3.71%, $*Ar^{40}$ = 1.39, 1.35 x 10^4 cc/g, Ar^{40}atm = 11.2, 10.2%; (c) K = 0.641, 0.654%, $*Ar^{40}$ = 0.589, 0.575 x 10^4 cc/g, Ar^{40}atm = 17.5, 6.7%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.18 x 10^{-4} atomic ratio. ***Method:*** (Ar) mass spectrometry, (K) isotope dilution with mass spectrometry. ***Collected and dated by:*** G. N. Hanson. ***Comment:*** These dates are a good indication of time of emplacement of the dike.

(a) (biotite) 819 m.y.
(b) (biotite) 758 m.y.
(c) (hornblende) 1480 m.y.

240. *Green (1972)* F.T.
HRL-2
Metasedimentary zircon core from a quartzite unit exposed on the glaciated floor of the Hell Roaring Lakes. (45°02'N, 109°30'W; sec. 14, 15, T. 9 S., R. 18 E. [est.]; Mount Maurice 15' quad; Hell Roaring Lakes, Carbon Co.) ***Analytical data:*** Area = 0.205 mm^2, 32.251 density ϱ_S/unit area, 2.644 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 12.198. ***Constants:*** λ_D = 1.54 x 10^{-10}/yr, λ_F = 6.85 x 10^{-17}/yr, ς = 582 x 10^{-24} cm^2, U^{235}/U^{238} = 7.26 x 10^{-3} atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Some fission tracks annealed by metasomatic event 2700 m.y. ago.

(zircon) 1471 m.y.

241. *Catanzaro and Kulp (1964)* K-Ar
KAT-2A
Pinto meta-diorite with andesine, biotite, hornblende; minor orthoclase, quartz, apatite, sphene, epidote and opaques. (46°57'37"N, 110°45'15"W; NE¼ sec. 19, T. 14 N., R. 8 E.; Belt Park Butte 7½' quad; 4 inches from a 45-ft. thick porphyry dike [KAT-1], Little Belt Mountains, Cascade Co.) ***Analytical data:*** K = 0.98%, $*Ar^{40}$ = 8.61 x 10^{-5} scc/gm, $*Ar^{40}$ = 87%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** E. J. Catanzaro; ***dated by:*** R. Kologrivov.

(hornblende) 1465 m.y.

242. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-32
Chilled margin of diabase dike, with plagioclase and pyroxene. (45°01'47"N, 109°39'22"W; SE¼ sec. 20, T. 9 S., R. 17 E.; Alpine 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 1.19 ppm, Ar^{40} = 0.1534 ppm, $*Ar^{40}$ = 91.2%, Ar^{40}/K^{40} = 0.1289. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) flame photometric and gravimetric methods, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1460 m.y.

243. *Wooden (1975)* Rb-Sr
Wooden and others (1978)
Group A dikes; fine- to medium-grained diabase sills with clinopyroxene, plagioclase, minor opaques and biotite; Tobacco Root Mountains and Ruby Range.

	Lat (N)	Long (W)	County
WTR-1	45°25'10"	112°08'55"	Madison
WTR-2	45°25'10"	112°08'55"	Madison
WTR-4	45°25'10"	112°08'55"	Madison
WTR-8	45°23'10"	112°03'10"	Madison
WTR-9	45°23'10"	112°03'10"	Madison
WTR-11	45°23'10"	112°03'10"	Madison
WTR-12	45°23'50"	112°04'25"	Madison
WTR-42	45°24'50"	112°08'05"	Madison
WTR-43	45°24'50"	112°08'05"	Madison
WTR-18	45°23'50"	112°03'10"	Madison
WTR-19	45°23'50"	112°03'10"	Madison
WTR-20	45°23'50"	112°03'35"	Madison
WTR-40	45°25'20"	112°06'40"	Madison

Analytical data:

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	$Sr^{87}/Sr^{86}n$
WTR-1	12.2	150	0.235	0.7081
WTR-2	4.4	137	0.093	0.7044
WTR-4	7.4	138	0.155	0.7060
WTR-8	7.6	136	0.162	0.7051
WTR-9	16.5	143	0.334	0.7082
WTR-11	19.0	172	0.320	0.7117
WTR-12	8.2	136	0.175	0.7050
WTR-42	5.4	141	0.111	0.7055
WTR-43	17.3	147	0.340	0.7077
WTR-18	9.1	144	0.183	0.7104
WTR-19	11.0	179	0.178	0.7139
WTR-20	12.9	148	0.253	0.7070
WTR-40	24.1	163	0.427	0.7160

Initial $Sr^{87}/Sr^{86} = 0.7019 \pm 0.0008$. ***Constants:*** $Rb^{87}\ \lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 12-inch 90° Nuclide Corp. mass spectrometer. ***Dated by:*** University of North Carolina. ***Comment:*** Tobacco Root samples scatter around the isochron.

(whole rock isochron) 1455 ± 125 m.y.

244. *Wooden (1975)* Rb-Sr

Group A diabase dikes, Ruby Range.

	Lat (N)	Long (W)	County
WRR-11	45°10'25"	112°25'41"	Madison
WRR-14	45°10'37"	112°25'33"	Madison
WRR-16	45°10'37"	112°25'33"	Madison
WRR-18	45°11'22"	112°26'33"	Madison
WRR-21	45°11'32"	112°26'28"	Madison
WRR-24	45°10'47"	112°26'18"	Madison

Analytical data:

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	$Sr^{87}/Sr^{86}n$
WRR-11	49	161	0.870	0.7193
WRR-14	8.0	136	0.170	0.7057
WRR-16	15.5	146	0.306	0.7077
WRR-18	7.7	143	0.156	0.7048
WRR-21	16.3	154	0.307	0.7081
WRR-24	26.0	146	0.516	0.7134

Initial $Sr^{87}/Sr^{86} = 0.7019 \pm 0.0005$. ***Constants:*** $Rb^{87}\ \lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 12-inch 90° Nuclide Corp. mass spectrometer. ***Collected and dated by:*** J. L. Wooden.

(whole rock isochron) 1454 ± 72 m.y.

245. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-37A

Chilled margin of diabase dike, with plagioclase and pyroxene. (45°01'20"N, 109°38'53"W; NW¼ sec. 28, T. 9 S., R. 17 E.; Alpine 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 1.266 ppm (a), 1.23 ppm (b), Ar^{40} = 0.1579 ppm, $*Ar^{40}$ = 96.0%, Ar^{40}/K^{40} = 0.1270. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1440 m.y.

246. *Catanzaro and Kulp (1964)* K-Ar
KAT-2B

Pinto meta-diorite with andesine, biotite, hornblende; minor orthoclase, quartz, apatite, sphene, epidote and opaques. (46°57'37"N, 110°45'15"W; NE¼ sec. 19, T. 14 N., R. 8 E.; Belt Park Butte 7½' quad; 8 inches from a 45-ft. porphyry dike [KAT-1], Little Belt Mountains, Cascade Co.) ***Analytical data:*** K = 1.03%, $*Ar^{40} = 8.70 \times 10^{-5}$ scc/gm, $*Ar^{40}$ = 84%. ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** E. J. Catanzaro; ***dated by:*** R. Kologrivov.

(hornblende) 1420 m.y.

247. *Hunt (1962)* K-Ar
PM-1

Green amphibole, Paradise sill. (47°23'29"N, 114°47'43"W; sec. 21, T. 19 N., R. 25 W. [est.]; Plains 15' quad; Paradise, Sanders Co.) ***Analytical data:*** K_2O = 0.30%; error = ±6%. ***Constants:*** $\lambda_e = 0.589 \times 10^{-10}$/yr; $\lambda\beta = 4.76 \times 10^{-10}$/yr; $K^{40}/K = 1.18 \times 10^{-4}$ atomic ratio. ***Dated by:*** H. Baadsgaard.

(amphibole) 1400 m.y.

248. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-50A

Chilled margin of diabase dike, with plagioclase and pyroxene. (44°59'35"N, 109°24'53"W; NW¼ sec. 22, T. 58 N., R. 104 W.; Deep Lake 15' quad; Park Co., Wyo.) ***Analytical data:*** K^{40} = 1.29 ppm (a), 1.26 ppm (b), Ar^{40} = 0.1521 ppm, $*Ar^{40}$ = 99.6%, Ar^{40}/K^{40} = 0.1193. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1380 m.y.

249. *Walker (1963)* U-Pb
GS/256/53
Boulder batholith, U-mineralized zone in quartz monzonite. (46°26'41"N, 112°00'10"W; NE¼ SE¼ sec. 17, T. 8 N., R. 3 W.; Jefferson City 15' quad; W. Wilson mine, Clancy-Lump Gulch district, Jefferson Co.) ***Comment:*** L. R. Stieff and T. W. Stern (written communication cited in Walker) noted that these ages are strikingly similar to some of the ages determined for U-mineralization in Colorado Plateau; this sample poorly suited for age determinations.

(pitchblende) 95 m.y. Pb^{206}/U^{238}
(pitchblende) 450 m.y. Pb^{207}/U^{238}
(pitchblende) 1380 m.y. Pb^{207}/Pb^{206}

250. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-20
Diabase dike with plagioclase and pyroxene. (45°03'00"N, 109°26'10"W; SW¼ sec. 7, T. 9 S., R. 19 E.; Mount Maurice 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 1.62 ppm (a), 1.70 ppm (b), Ar^{40} = 0.1962 ppm, $*Ar^{40}$ = 98.6%, Ar^{40}/K^{40} = 0.1182. ***Constants:*** λ_e = 0.585×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr, K^{40}/K = 1.19×10^{-4} atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1370 m.y.

251. *Hanson and Gast (1967)* Rb-Sr
Hanson (1964) K-Ar
WY12e
Well-foliated para-amphibolite with plagioclase, hornblende, quartz, biotite-chlorite, epidote, sphene and microcline, 3.4 m from a vertical 50-m quartz dolerite dike. (44°58'00"N, 109°25'20"W; SW¼ NE¼ sec. 33, T. 58 N., R. 104 W.; Deep Lake 15' quad; Christmas Lake dike, Park Co., Wyo.) ***Analytical data:*** (a) Rb = 304, 312, 371 ppm, Sr_n = 27.7 ppm, $*Sr^{87}$ = 1.75 ppm, initial Sr^{87}/Sr^{86} = 0.705; (b) K = 5.40%, $*Ar^{40}$ = 3.72, 3.86×10^4 cc/g, Ar^{40} atm = 3.1, 1.6%. ***Constants:*** $Rb^{87}\lambda = 1.47 \times 10^{-11}$/yr, Rb^{87}/Rb^{85} = 0.385, (K) λ_e = 0.585×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr, K^{40}/K = 1.18×10^{-4} atomic ratio. ***Method:*** (Ar) mass spectrometry, (K, Rb, Sr) isotope dilution with mass spectrometry. ***Collected and dated by:*** G. N. Hanson. ***Comment:*** A general increase in age is seen with increase in distance from the dike; K-Ar date was recalculated in 1967 (using λ_e = 0.584×10^{-10}/yr) as 1250 m.y.

(a) (biotite) 1360 m.y.
(b) (biotite) 1270 m.y.

252. *Hayden and Wehrenberg (1960)* K-Ar
Medium- to coarse-grained pink granite dike, with minor biotite. (46°57'43"N, 110°45'00"W; NE¼ sec. 19, T. 14 N., R. 8 E.; Neihart 7½' quad; 2 mi N of Neihart on U.S. Hwy 89 roadcut on E side of road, Cascade Co.) ***Analytical data:*** K = 7.39%, (a) Ar^{40} = 5.65×10^{-4} STP cc/gm, $*Ar^{40}$ = 88%; Ar^{40}/K^{40} = 0.112; (b) Ar^{40} = 5.73×10^{-4} STP cc/gm, $*Ar^{40}$ = 79%, Ar^{40}/K^{40} = 0.114. ***Constants:*** λ_e = 0.585×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr. ***Method:*** (K) using a Perkin-Elmer flame photometer, (Ar) isotope dilution using a 6-inch 60° mass spectrometer. ***Collected and dated by:*** R. J. Hayden and J. P. Wehrenberg. ***Comment:*** Dike cuts a coarse-grained, blotchy structured biotite-plagioclase-quartz gneiss.

(a) (K-feldspar) 1320 m.y.
(b) (K-feldspar) 1340 m.y.

253. *Green (1972)* F.T.
HRL-5
Metasedimentary zircon core from a quartzite unit exposed on the glaciated floor of the Hell Roaring Lakes. (45°02'N, 109°30'W; sec. 14, 15, T. 9 S., R. 18 E. [est.]; Mount Maurice 15' quad; Hell Roaring Lakes, Carbon Co.) ***Analytical data:*** Area = 0.160 mm^2, 44.634 density ϱ_s/unit area, 4.063 density ϱ_i/unit area, ϱ_s density/ϱ_i density = 10.985. ***Constants:*** λ_D = 1.54×10^{-10}/yr, λ_F = 6.85×10^{-17}/yr, ζ = 582×10^{-24} cm^2, U^{235}/U^{238} = 7.26×10^{-3} atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** The U concentration of this overgrowth was significantly greater than that of other grains from this quartzite; some fission tracks annealed by metasomatic event 2700 m.y. ago.

(zircon) 1339 m.y.

254. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-55
Chilled margin of diabase dike, with plagioclase and pyroxene. (44°59'15"N, 109°36'35"W; SE¼ sec. 24, T. 58 N., R. 106 W.; Beartooth Butte 15' quad; Park Co., Wyo.) ***Analytical data:*** K^{40} = 1.33 ppm (a), 1.39 ppm (b), Ar^{40} = 0.1539 ppm, Ar^{40}/K^{40} = 0.1132. ***Constants:*** λ_e = 0.585×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr, K^{40}/K = 1.19×10^{-4} atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric

methods, (b) isotope dilution, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1330 m.y.

255. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-25

Chilled margin of diabase dike, with plagioclase and pyroxene. (44°59'00"N, 109°36'40"W; NW¼ sec. 25, T. 58 N., R. 106 W.; Beartooth Butte 15' quad; Park Co., Wyo.) ***Analytical data:*** K^{40} = 1.58 ppm, Ar^{40} = 0.178 ppm, $*Ar^{40}$ = 95.0%, Ar^{40}/K^{40} = 0.1127. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) flame photometric and gravimetric methods, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1330 m.y.

256. *Obradovich and Peterman (1968)* K-Ar

Metamorphic biotite from the Prichard Formation. (47°01'N, 114°21'W; T. 15 N., R. 21 W. [est.]; Alberton 15' quad; Alberton area, Mineral Co.) ***Analytical data:*** K_2O = 7.30%, $*Ar^{40} = 2.08 \times 10^{-8}$ moles/g, $*Ar^{40}$ = 100%. ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Dated by:*** C. E. Hedge, R. F. Marvin.

(biotite) 1330 ± 45 m.y.

257. *Wooden (1975)* Rb-Sr

Olivine diabase dikes; Group III of Baadsgaard and Mueller (1973). (45°29'25"N, 110°26'52" W; NE¼ sec. 14, T. 4 S., R. 10 E.; Mt. Cowen 15' quad; Absaroka Range, Park Co.) ***Analytical data:***

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	$Sr^{87}/Sr^{86}{}_n$
WWB-2	104	320	0.943	0.7229
WWB-3	88.8	316	0.814	0.7209

Initial $Sr^{87}/Sr^{86} = 0.7051 \pm 0.0006$. ***Constants:*** $Rb^{87}\ \lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 12-inch 90° Nuclide Corp. mass spectrometer. ***Collected and dated by:*** J. L. Wooden. ***Comment:*** This isochron includes 6 samples from Baadsgaard and Mueller (1973) that alone make an isochron of 1237 ± 77 m.y. (See No. 260 for location and analytical data.)

(whole rock isochron) 1330 ± 75 m.y.

258. *Obradovich and Peterman (1968)* Rb-Sr

Argillaceous rocks from the Greyson (upper part), Newland, Chamberlain and Neihart formations. (46°47'00"N, 111°45'30"W; sec. 20, T. 12 N., R. 1 W.; Nelson 7½' quad; Big Belt and Little Belt mountains, Lewis and Clark Co.) ***Analytical data:***

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	$Sr^{87}/Sr^{86}{}_n$
Greyson	71.5	119	1.74	0.7403
	150	41.2	10.8	0.9138
	112	64.7	5.06	0.8013
Newland	28.2	62.7	0.13	0.7092
	77.5	62.5	3.61	0.7737
Chamberlain	206	64.1	9.45	0.8818
	239	58.5	12.1	0.9288
	131	57.9	6.61	0.8329
	254	66.1	11.4	0.9121
Neihart	182	68.3	7.80	0.8493

Initial $Sr^{87}/Sr^{86} = 0.7070 \pm 0.0006$. ***Constants:*** $Rb^{87}\ \lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Dated by:*** C. E. Hedge, R. F. Marvin.

(whole rock isochron) 1325 ± 15 m.y.

259. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-17

Chilled margin of diabase dike, with plagioclase and pyroxene. (44°57'28"N, 109°30'58"W; SW¼ sec. 35, T. 58 N., R. 105 W.; Beartooth Butte 15' quad; Park Co., Wyo.) ***Analytical data:*** K^{40} = 0.62, 0.61 ppm, Ar^{40} = 0.0685 ppm, $*Ar^{40}$ = 96.2%, Ar^{40}/K^{40} = 0.1114. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) flame photometric and gravimetric methods, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1310 m.y.

260. *Baadsgaard and Mueller (1973)* Rb-Sr

Beartooth Butte dikes (Group III), with plagioclase and pyroxene.

	Lat (N)	Long (W)	County
MBT-25	44°59'00"	109°36'40"	Park, Wyo.
MBT-27	45°00'50"	109°38'25"	Carbon
MBT-28	45°00'50"	109°38'20"	Carbon
MBT-32	45°01'47"	109°39'22"	Carbon
MBT-37A	45°01'20"	109°38'53"	Carbon

Analytical data:

	Rb(ppm)	Sr_n(ppm)	Sr^{87}/Sr^{86}	Rb^{87}/Sr^{86}
BT-21	45.0	276.4	0.7147	0.471
MBT-25	68.3	274.1	0.7172	0.721
MBT-27a	31.0	303.4	0.7109	0.296
MBT-27b	31.0	305.5	0.7104	0.294
MBT-28	43.5	304.1	0.7128	0.414
MBT-32	32.5	307.2	0.7104	0.306
MBT-37A	32.0	323.7	0.7104	0.286

Initial $Sr^{87}/Sr^{86} = 0.7055 \pm 0.0005$. ***Method:*** Isotope dilution using a 6-inch mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta; and University of North Carolina.

(whole rock isochron) 1237 ± 77 m.y.

261. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-27

Chilled margin of diabase dike, with plagioclase and pyroxene. (45°00'50"N, 109°38'25"W; SW¼ sec. 28, T. 9 S., R. 17 E.; Alpine 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 1.06 ppm, Ar^{40} = 0.1076 ppm, $*Ar^{40}$ = 87.0%, Ar^{40}/K^{40} = 0.1015. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) flame photometric and gravimetric methods, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1230 m.y.

262. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-28

Chilled margin of diabase dike, with plagioclase and pyroxene. (45°00'50"N, 109°38'20"W; SE¼ sec. 29, T. 9 S., R. 17 E.; Alpine 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 1.21, 1.17 ppm, Ar^{40} = 0.1202 ppm, $*Ar^{40}$ = 97.9%, Ar^{40}/K^{40} = 0.1010. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) flame photometric and gravimetric methods, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1230 m.y.

263. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-44

Chilled margin of diabase dike, with plagioclase and pyroxene. (45°02'35"N, 109°24'15"W; NE¼ sec. 17, T. 9 S., R. 19 E.; Mount Maurice 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 1.38 ppm (a), 1.38 ppm (b), Ar^{40} = 0.1342 ppm, $*Ar^{40}$ = 99.5%, Ar^{40}/K^{40} = 0.0972. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1190 m.y.

264. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-40

Chilled margin of diabase dike, with plagioclase and pyroxene. (45°01'40"N, 109°41'42"W; SE¼ sec. 24, T. 9 S., R. 16 E.; Alpine 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 1.06 ppm, Ar^{40} = 0.0980 ppm, $*Ar^{40}$ = 97.6%, Ar^{40}/K^{40} = 0.0925. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) flame photometric and gravimetric methods, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 1150 m.y.

265. *Obradovich and Peterman (1968)* K-Ar Rb-Sr

Glauconite, McNamara Formation. (47°30'00" N, 112°58'07"W; sec. 11, T. 20 N., R. 11 W.; Pretty Prairie 7½' quad; upper reaches of the Sun River, Lewis and Clark Co.) ***Analytical data:*** (a) K_2O = 4.90%, $*Ar^{40} = 1.12 \times 10^{-8}$ moles/g, $*Ar^{40}$ = 99%; (b) Rb = 187 ppm, Sr = 14.8 ppm, Rb^{87}/Sr^{86} = 38.6, Sr^{87}/Sr^{86}_n = 1.317, initial Sr^{87}/Sr^{86} = 0.7089. ***Constants:*** (K) $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio; $Rb^{87}\ \lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Dated by:*** C. E. Hedge, R. F. Marvin. ***Comment:*** Mudge (1972a) cited a Rb-Sr age of 1135 ± 55 m.y. for this sample.

(a) (glauconite) 1130 ± 55 m.y.
(b) (glauconite) 1125 m.y.

266. *Evans and others (1939)* He
L14

Center of 25-ft. dike, strike NNW, dip 45°E. (44°57.8'N, 109°28.4'W; sec. 34, T. 58 N., R. 105 W.; Deep Lake 15' quad; Park Co., Wyo.) ***Analytical data:*** He = 18.2×10^{-5} cc/g, Ra = 1.99×10^{-13} g/g, Th = 2.65×10^{-6} g/g. ***Collec-***

ted by: A. Lane, E. Lammers; ***dated by:*** N. B. Keevil.

1130 ± 100 m.y.

267. *Koehler (1973)* Rb-Sr
Wooden and others (1978)

Group C dikes; medium-grained diabase with plagioclase, augite, pigeonite, minor hornblende, biotite, opaques, moderate alteration with antigorite and chlorite; Tobacco Root Mountains.

	Lat (N)	Long (W)	County
K-21	45°25'40"	112°04'25"	Madison
K-23	45°25'25"	112°03'40"	Madison
K-50	45°21'25"	111°46'30"	Madison
K-51	45°21'25"	111°46'15"	Madison
K-52	45°21'10"	111°46'30"	Madison

Analytical data:

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}_n
K-21	23	150	0.449	0.7157
K-23	53	212	0.724	0.7229
K-50	64	170	1.085	0.7256
K-51	55	161	0.994	0.7246
K-52	48	167	0.836	0.7227

Initial $Sr^{87}/Sr^{86} = 0.7090 \pm 0.0020$. ***Constants:*** $Rb^{87}\ \lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 12-inch 90° Nuclide Corp. mass spectrometer. ***Dated by:*** University of North Carolina. ***Comment:*** Sample K-23 shows significant alteration.

(whole rock isochron) 1130 ± 130 m.y.

268. *Obradovich and Peterman (1968)* K-Ar Rb-Sr
2

Glauconite, McNamara Formation. (47°32'40" N, 112°56'15"W; sec. 30, T. 21 N., R. 10 W.; Pretty Prairie 7½' quad; upper reaches of the Sun River, Lewis and Clark Co.) ***Analytical data:*** (a) $K_2O = 7.98\%$, $*Ar^{40} = 1.69 \times 10^{-8}$ moles/g, $*Ar^{40} = 99\%$; (b) Rb = 331 ppm, Sr = 14.1 ppm, $Rb^{87}/Sr^{86} = 76.2$, $Sr^{87}/Sr^{86}_n = 1.909$, initial $Sr^{87}/Sr^{86} = 0.7089$. ***Constants:*** (K) $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio; $Rb^{87}\ \lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Dated by:*** C. E. Hedge, R. F. Marvin. ***Comment:*** Mudge (1972a) cited a Rb-Sr age of 1130 ± 55 m.y. for this sample.

(a) (glauconite) 1070 ± 55 m.y.
(b) (glauconite) 1125 m.y.

269. *Obradovich and Peterman (1968)* K-Ar Rb-Sr
5

Glauconite, Shepard Formation. (47°30'00"N, 112°54'00"W; sec. 8, T. 20 N., R. 10 W.; Pretty Prairie 7½' quad; ½ mi W of South Fork of the Sun River, Lewis and Clark Co.) ***Analytical data:*** (a) $K_2O = 8.25\%$, $*Ar^{40} = 1.86 \times 10^{-8}$ moles/g, $*Ar^{40} = 100\%$; (b) Rb = 317 ppm, Sr = 17.2 ppm, $Rb^{87}/Sr^{86} = 58.4$, $Sr^{87}/Sr^{86}_n = 1.590$, initial $Sr^{87}/Sr^{86} = 0.7089$. ***Constants:*** (K) $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio, $Rb^{87}\ \lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Dated by:*** C. E. Hedge, R. F. Marvin. ***Comment:*** Mudge (1972a) cited a Rb-Sr age of 1085 ± 55 m.y. for this sample.

(a) (glauconite) 1120 ± 55 m.y.
(b) (glauconite) 1075 m.y.

270. *Wooden (1975)* Rb-Sr
Wooden and others (1978)

Group B dikes; medium-grained diabase with clinopyroxene (some alteration to uralite), plagioclase (replaced by clays and mica), minor biotite (some chlorite), micropegmatite and opaques; Tobacco Root Mountains.

	Lat (N)	Long (W)	County
WTR-6	45°25'40"	112°08'20"	Madison
WTR-17	45°23'50"	112°03'10"	Madison
WTR-21	45°23'35"	112°03'45"	Madison
WTR-23	45°23'35"	112°03'45"	Madison
WTR-24	45°21'55"	111°55'05"	Madison
WTR-25	45°21'55"	111°55'05"	Madison
WTR-28	45°21'55"	111°55'05"	Madison
WTR-31	45°25'15"	112°06'40"	Madison
WTR-32	45°25'15"	112°06'40"	Madison
WTR-37	45°25'15"	112°06'55"	Madison
WTR-38	45°25'15"	112°06'55"	Madison
WTR-41	45°25'45"	112°06'05"	Madison
WTR-46	45°23'10"	111°58'05"	Madison
WTR-47	45°23'10"	111°58'05"	Madison

Analytical data:

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}_n
WTR-6	64	212	0.876	0.7162
WTR-17	51	183	0.806	0.7135
WTR-21	33	219	0.440	0.7159
WTR-23	49	192	0.737	0.7098
WTR-24	48	183	0.771	0.7146
WTR-25	66	192	0.988	0.7175
WTR-28	59	192	0.896	0.7170
WTR-31	58	241	0.701	0.7171
WTR-32	54	232	0.669	0.7159
WTR-37	44	181	0.703	0.7136
WTR-38	44	185	0.690	0.7129
WTR-41	43	190	0.652	0.7147
WTR-46	72	202	1.028	0.7203
WTR-47	85	200	1.237	0.7237

Initial $Sr^{87}/Sr^{86} = 0.7025 \pm 0.0022$. ***Constants:*** $Rb^{87}\ \lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 12-inch 90° Nuclide Corp. mass spectrometer. ***Dated by:*** University of North

Carolina. ***Comment:*** Samples WTR-21, -23, -17, -41, -46, -47 indicate contamination after emplacement.

(whole rock isochron) 1120 ± 185 m.y.

271. *Obradovich and Peterman (1968)* Rb-Sr

6

Glauconite, Shepard Formation. (47°45'N, 113° W [est.]; upper reaches of the Sun River, Lewis and Clark Co.) ***Analytical data:*** Rb = 299 ppm, Sr = 41.2 ppm, Rb^{87}/Sr^{86} = 21.9, Sr^{87}/Sr^{86}_n = 1.050, initial Sr^{87}/Sr^{86} = 0.7089. ***Constants:*** $Rb^{87}\lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Dated by:*** C. E. Hedge, R. F. Marvin.

(glauconite) 1110 m.y.

272. *Hunt (1962)* K-Ar

LP-4

Brown amphibole, Logan Pass sill. (48°41'34" N, 113°42'55"W; NW¼ sec. 21, T. 34 N., R. 16 W.; Logan Pass 7½' quad, Logan Pass, Glacier Park, Glacier Co.) ***Analytical data:*** K_2O = 0.48%, error = ± 6%. ***Constants:*** $\lambda_e = 0.589 \times 10^{-10}$/yr; $\lambda_\beta = 4.76 \times 10^{-10}$/yr; $K^{40}/K = 1.18 \times 10^{-4}$ atomic ratio. ***Dated by:*** H. Baadsgaard.

(amphibole) 1110 m.y.

273. *Obradovich and Peterman (1968)* K-Ar Rb-Sr

8

Glauconite, Shepard Formation. (47°30'00"N, 112°54'00"W; sec. 8, T. 20 N., R. 10 W.; Pretty Prairie 7½' quad; ½ mi W of South Fork of the Sun River, Lewis and Clark Co.) ***Analytical data:*** (a) K_2O = 5.60%, $*Ar^{40} = 1.24 \times 10^{-8}$ moles/g, $*Ar^{40}$ = 95%; (b) Rb = 316 ppm, Sr = 10.2 ppm, Rb^{87}/Sr^{86} = 104.7, Sr^{87}/Sr^{86}_n = 2.335, initial Sr^{87}/Sr^{86} = 0.7089. ***Constants:*** (K) $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio; $Rb^{87}\lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Dated by:*** C. E. Hedge, R. F. Marvin.

(a) (glauconite) 1100 ± 55 m.y.
(b) (glauconite) 1100 m.y.

274. *Obradovich and Peterman (1968)* K-Ar Rb-Sr

7

Glauconite, Shepard Formation. (47°30'00"N, 112°54'00"W; sec. 8, T. 20 N., R. 10 W.; Pretty Prairie 7½' quad; ½ mi W of South Fork of the Sun River, Lewis and Clark Co.) ***Analytical data:*** (a) K_2O = 8.35%, $*Ar^{40} = 1.74 \times 10^{-8}$ moles/g, $*Ar^{40}$ = 99%; (b) Rb = 402 ppm, Sr = 14.6 ppm, Rb^{87}/Sr^{86} = 91.3, Sr^{87}/Sr^{86}_n = 2.121, initial Sr^{87}/Sr^{86} = 0.7089. ***Constants:*** (K) $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio; $Rb^{87}\lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Dated by:*** C. E. Hedge, R. F. Marvin.

(a) (glauconite) 1050 ± 50 m.y.
(b) (glauconite) 1100 m.y.

275. *Obradovich and Peterman (1968)* Rb-Sr

Argillaceous rocks from the McNamara, Mt. Shields, Shepard, Helena, Empire (upper part) and Helena (carbonate) formations. (From the area 47°45'N to 47°30'N, 112°37'30"W to 113° W; upper reaches of the Sun River, Lewis and Clark Co.) ***Analytical data:***

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}_n
McNamara	150	25.7	17.3	0.9942
	126	33.0	11.2	0.9046
	103	35.4	8.79	0.8625
	153	49.9	8.98	0.8702
	151	18.0	25.1	1.118
Mt. Shields	151	50.4	8.63	0.8725
Shepard	80.9	46.8	5.04	0.8073
	96.2	121	2.32	0.7627
Helena	82.8	41.8	5.79	0.8304
	162	33.2	14.4	0.9475
Empire	157	31.2	14.9	0.9707
Helena (carbonate)	11	95	0.33	0.7141

Initial $Sr^{87}/Sr^{86} = 0.7325 \pm 0.0087$. ***Constants:*** $Rb^{87}\lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Dated by:*** C. E. Hedge, R. F. Marvin.

(whole rock isochron) 1100 ± 53 m.y.

276. *Obradovich and Peterman (1968)* Rb-Sr

Argillaceous rocks, McNamara Formation. (From the area 47°30'N to 47°45'N, 112°37'30"W to 113°W; upper reaches of the Sun River, Lewis and Clark Co.) ***Analytical data:***

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}_n
(a)	150	25.7	17.3	0.9942
(b)	126	33.0	11.2	0.9046
(c)	103	35.4	8.79	0.8625
(d)	153	49.9	8.98	0.8702
(e)	151	18.0	25.1	1.118

Initial $Sr^{87}/Sr^{86} = 0.7293 \pm 0.0095$. ***Constants:*** $Rb^{87}\lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Dated by:*** C. E. Hedge, R. F. Marvin.

(whole rock isochron) 1100 ± 60 m.y.

277. *Obradovich and Peterman (1968)* Rb-Sr

Argillaceous rocks and glauconites from the McNamara, Shepard, Empire (upper part), Mt. Shields, Helena and Helena (carbonate) formations. (From the area 47°30'N to 47°45'N, 112°37'30"W to 113°W; upper reaches of the Sun River, Lewis and Clark Co.) ***Analytical data:*** See No. 275 and No. 276. ***Constants:*** $Rb^{87}\ \lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Dated by:*** C. E. Hedge, R. F. Marvin.

(whole rock isochron) 1097 ± 20 m.y.

278. *Obradovich and Peterman (1968)* Rb-Sr

Glauconite from the McNamara, Shepard and Empire (upper part) formations. (From the area 47°30'N to 47°45'N, 112°37'30"W to 113°W; upper reaches of the Sun River, Lewis and Clark Co.) ***Analytical data:***

		Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	$Sr^{87}/Sr^{86}{}_n$
McNamara	(1)	187	14.8	38.6	1.317
	(2)	331	14.1	76.2	1.909
Shepard	(4)	324	35.1	27.8	1.129
	(5)	317	17.2	58.4	1.590
	(6)	299	41.2	21.9	1.050
	(7)	402	14.6	91.3	2.121
	(8)	316	10.2	104.7	2.335
	(9)	336	17.2	61.3	1.613
	(10)	341	15.2	72.0	1.807
Empire	(11)	320	21.9	45.3	1.400

Initial $Sr^{87}/Sr^{86} = 0.7089 \pm 0.0135$. ***Constants:*** $Rb^{87}\ \lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Dated by:*** C. E. Hedge, R. F. Marvin.

(whole rock isochron) 1095 ± 22 m.y.

279. *Obradovich and Peterman (1968)* Rb-Sr

10

Glauconite, Shepard Formation. (47°30'00"N, 112°54'00"W; sec. 8, T. 20 N., R. 10 W.; Pretty Prairie 7½' quad; ½ mi W of South Fork of the Sun River, Lewis and Clark Co.) ***Analytical data:*** Rb = 341 ppm, Sr = 15.2 ppm, $Rb^{87}/Sr^{86} = 72.0$, $Sr^{87}/Sr^{86}{}_n = 1.807$, initial $Sr^{87}/Sr^{86} = 0.7089$. ***Constants:*** $Rb^{87}\ \lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Dated by:*** C. E. Hedge, R. F. Marvin.

(glauconite) 1090 m.y.

280. *Gulbrandsen, Goldich and Thomas (1963)* K-Ar Rb-Sr

Dark-green glauconite pellets in a pink and dark-green spotted, medium-grained, feldspathic quartzite, upper Missoula Group, and within a few thousand feet of the Flathead Quartzite. (48°00'04"N, 113°07'36"W; NW¼ sec. 12, T. 26 N., R. 12 W.; Gable Peaks 7½' quad; at 6000 ft. on E flank of ridge between Ringer Mountain and Cruiser Mountain, Flathead Co.) ***Analytical data:*** (a) $K_2O = 8.36\%$, $*Ar^{40} = 0.733$ ppm; (b) Rb = 294 ppm, Sr = 22.2 ppm, $*Sr^{87} = 1.30$ ppm. ***Constants:*** (K-Ar) $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40} = 1.22 \times 10^{-4}$ g/gK; (Rb-Sr) $\lambda = 1.47 \times 10^{-11}$/yr, $Rb^{87} = 0.283$ g/g Rb. ***Dated by:*** (K-Ar) H. H. Thomas, C. O. Ingamells; (Rb-Sr) C. E. Hedge, F. A. Walthall. ***Comment:*** Average of dates considered a minimum age for the Missoula Group.

(a) (glauconite) 1090 m.y.
(b) (glauconite) 1050 m.y.

281. *Obradovich and Peterman (1968)* K-Ar Rb-Sr

11

Glauconite, Empire Formation. (47°40'29"N, 112°49'31"W; sec. 12, T. 22 N., R. 9 W.; Arsenic Peak 7½' quad; upper reaches of the Sun River, Lewis and Clark Co.) ***Analytical data:*** (a) $K_2O = 8.06\%$, $*Ar^{40} = 1.65 \times 10^{-8}$ moles/g, $*Ar^{40} = 93\%$; (b) Rb = 320 ppm, Sr = 21.9 ppm, $Rb^{87}/Sr^{86} = 45.3$, $Sr^{87}/Sr^{86}{}_n = 1.400$, initial $Sr^{87}/Sr^{86} = 0.7089$. ***Constants:*** (K) $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio; $Rb^{87}\ \lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Dated by:*** C. E. Hedge, R. F. Marvin. ***Comment:*** Mudge (1972a) cited a Rb-Sr age of 1100 ± 55 m.y. for this sample.

(a) (glauconite) 1040 ± 50 m.y.
(b) (glauconite) 1090 m.y.

282. *Obradovich and Peterman (1968)* K-Ar Rb-Sr

4

Glauconite, McNamara Formation. (47°34'50"N, 113°00'40"W; sec. 15, T. 21 N., R. 11 W.; Prairie Reef 7½' quad; W side of upper reaches of Reef Creek, about 1 mi S of Prairie Reef lookout, Lewis and Clark Co.) ***Analytical data:*** (a) $K_2O = 7.84\%$, $*Ar^{40} = 1.64 \times 10^{-8}$ moles/g, $*Ar^{40} = 99\%$; (b) Rb = 324 ppm, Sr = 35.1 ppm, $Rb^{87}/Sr^{86} = 27.8$, $Sr^{87}/Sr^{86}{}_n = 1.129$, initial $Sr^{87}/Sr^{86} = 0.7089$. ***Constants:*** (K) $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19$ atomic ratio; $Rb^{87}\ \lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer.

Dated by: C. E. Hedge, R. F. Marvin. ***Comment:*** Mudge (1972a) cited a Rb-Sr age of 1090 ± 55 m.y. for this sample.

(a) (glauconite) 1060 ± 55 m.y.
(b) (glauconite) 1080 m.y.

283. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-52

Chilled margin of diabase dike, with plagioclase and pyroxene. (45°01'15"N, 109°25'33"W; SW¼ SE¼ sec. 19, T. 9 S., R. 19 E.; Mount Maurice 15' quad; Carbon Co.) ***Analytical data:*** (a) K^{40} = 1.18 ppm, Ar^{40} = 0.1001 ppm, $*Ar^{40}$ = 98.4%, Ar^{40}/K^{40} = 0.0848; (b) K^{40} = 0.83 ppm, Ar^{40} = 0.0709 ppm, $*Ar^{40}$ = 96.6%, Ar^{40}/K^{40} = 0.0854; (c) K^{40} = 0.62 ppm, Ar^{40} = 0.0409 ppm, $*Ar^{40}$ = 89.6%, Ar^{40}/K^{40} = 0.066. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) flame photometric and gravimetric methods, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta. ***Comment:*** Condie and others (1969) dated this dike at 1010 m.y. (K-Ar); Larson and others (1973) dated this dike at 2550 m.y. (Rb-Sr).

(a) (whole rock) 1080 m.y.
(b) (whole rock) 1080 m.y.
(c) (whole rock) 880 m.y.

284. *Obradovich and Peterman (1968)* K-Ar
3

Glauconite, McNamara Formation. (47°34'50" N, 113°00'40"W; sec. 15, T. 21 N., R. 11 W.; Prairie Reef 7½' quad; W side of upper reaches of Reef Creek, about 1 mi S of Prairie Reef lookout, Lewis and Clark Co.) ***Analytical data:*** K_2O = 6.71%, $*Ar^{40}$ = 1.44 x 10^{-8} moles/g, $*Ar^{40}$ = 99%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Dated by:*** C. E. Hedge, R. F. Marvin.

(glauconite) 1080 ± 55 m.y.

285. *Obradovich and Peterman (1968)* Rb-Sr
9

Glauconite, Shepard Formation. (47°45'N, 113°W [est.]; upper reaches of the Sun River, Lewis and Clark Co.) ***Analytical data:*** Rb = 336 ppm, Sr = 17.2 ppm, Rb^{87}/Sr^{86} = 61.3, Sr^{87}/Sr^{86}_n = 1.613, initial Sr^{87}/Sr^{86} = 0.7089. ***Constants:*** Rb^{87} λ = 1.39 x 10^{-11}/yr. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Dated by:*** C. E. Hedge, R. F. Marvin.

(glauconite) 1050 m.y.

286. *Condie, Leech and Baadsgaard (1969)* K-Ar
BT-35

Microporphyritic, fine-grained tholeiitic diabase dike, with plagioclase, augite, hornblende, minor magnetite, orthopyroxene, quartz, sericite and chlorite. (45°01'15"N, 109° 25'33"W; SW¼ SE¼ sec. 19, T. 9 S., R. 19 E.; Mount Maurice 15' quad; Carbon Co.) ***Analytical data:*** K_2O = 0.67%; Ar^{40}/K^{40} = 0.0781; $*Ar^{40}$ = 89%. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) x-ray fluorescence and gravimetric analysis, (Ar) isotope dilution using an AEI MS-10 mass spectrometer. ***Comment:*** Sample collected from 1 m inside the unexposed dike contact; Larson and others (1973) dated this dike at 2550 m.y. (Rb-Sr); Baadsgaard and Mueller (1973) dated this dike at 880 m.y. and 1080 m.y. (K-Ar).

(whole rock) 1010 m.y.

287. *Obradovich and Peterman (1968)* Rb-Sr

Argillaceous rocks from the Pilcher and Garnet Range formations. (47°01'N, 114°21'W; T. 15 N., R. 21 W. [est.]; Alberton 15' quad; Alberton area, Mineral Co.)

Analytical data:

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}_n
Pilcher	91.1	15.9	17.0	0.9534
Pilcher	320	48.6	19.7	1.034
Pilcher	294	47.0	18.5	0.9779
Pilcher	263	42.6	18.4	0.9893
Pilcher	312	35.0	26.9	1.134
Pilcher	214	27.6	23.1	1.031
Garnet Range	281	116.0	7.07	0.8196
Garnet Range	353	42.8	24.6	1.049
Garnet Range	321	54.8	17.4	0.9629
Garnet Range	321	53.1	18.0	0.9630
Garnet Range	128	13.5	28.4	1.089
Garnet Range	180	77.2	6.82	0.8179
Garnet Range	241	32.0	22.4	1.036
Garnet Range	249	61.8	11.9	0.9022
Garnet Range	250	36.7	20.3	1.032
Garnet Range	300	74.5	11.9	0.9152

Initial Sr^{87}/Sr^{86} = 0.730. ***Constants:*** Rb^{87} λ = 1.39 x 10^{-11}/yr. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Dated by:*** C. E. Hedge, R. F. Marvin.

(whole rock isochron) 930 m.y.

288. *Marvin and Dobson (1979)* K-Ar
USGS (D)-63R4
Biotitic gabbro sill intruding Newland Limestone, Belt Supergroup. (46°43'16"N, 111°36'13"W; SE¼ sec. 9, T. 11 N., R. 1 E.; Hellgate Gulch 7½' quad; Broadwater Co.) ***Analytical data:*** K_2O = 0.38%, $*Ar^{40}$ = 5.73 x 10^{-10} mole/gm, $*Ar^{40}$ = 89%. ***Constants:*** λ_e = 0.581 x 10^{-10}/yr, $\lambda\beta$ = 4.962 x 10^{-10}/yr, K^{40}/K = 1.167 x 10^{-4} atomic ratio. ***Collected by:*** G. D. Robinson; ***dated by:*** R. F. Marvin, H. H. Mehnert, P. L. D. Elmore. ***Comment:*** This sill belongs to a widespread group of mafic dikes and sills that gave late Proterozoic-Y to early Proterozoic-Z ages.
(pyroxene with minor biotite) 826 ± 41 m.y.

289. *Goldich and others (1959)* Rb-Sr
Thin, hard, light-green shale near top of the Siyeh limestone, Belt Supergroup. (48°41'34" N, 113°42'55"W; NW¼ sec. 21, T. 34 N., R. 16 W.; Logan Pass 7½' quad; Logan Pass, Glacier Park, Glacier Co.) ***Analytical data:*** Rb = 235 ppm, Sr^{87} = 0.72 ppm. ***Constants:*** Rb^{87} $\lambda\beta$ = 1.39 x 10^{-11}/yr. ***Method:*** Isotope dilution. ***Collected by:*** J. L. Wilson, Shell Development Co.; ***dated by:*** Shell Development Co., Houston. ***Comment:*** Exceptionally pure illitic shale sample used; shale not considered to be seriously modified by thermal metamorphism.
(illite) 780 m.y.

290. *Hanson and Gast (1967)* K-Ar
Hanson (1964)
WY13
Quartz dolerite dike with plagioclase, clinopyroxene, opaques, hornblende, quartz, orthopyroxene. (44°58'00"N, 109°25'20"W; SW¼ NE¼ sec. 33, T. 58 N., R. 104 W.; Deep Lake 15' quad; Christmas Lake dike, Park Co., Wyo.) ***Analytical data:*** K = 0.905%, $*Ar^{40}$ = 0.339, 0.348 x 10^4 cc/g, Ar^{40}atm = 4.0, 14.9%. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.18 x 10^{-4} atomic ratio. ***Method:*** (Ar) mass spectrometry, (K) isotope dilution with mass spectrometry. ***Collected and dated by:*** G. N. Hanson. ***Comment:*** This date is a good indication of time of emplacement of the dike; date was recalculated in 1967 (using λ_e = 0.584 x 10^{-10}/yr) as 776 m.y.
(whole rock) 780 m.y.

291. *Goldich and others (1959)* K-Ar
Thin, hard, light-green shale near top of the Siyeh limestone; Belt Supergroup. (48°41'34" N, 113°42'55"W; NW¼ sec. 21, T. 34 N., R. 16 W.; Logan Pass 7½' quad; Logan Pass, Glacier Park, Glacier Co.) ***Analytical data:*** K_2O = 10.38%; Ar^{40} = 3.13 x 10^{-4} cc STP/gm; Ar^{40}/K^{40} = 0.0532. ***Constants:*** (a) λ_e = 0.557 x 10^{-10}/yr; (b) λ_e = 0.583 x 10^{-10}/yr; $\lambda\beta$ = 4.72 x 10^{-10}/yr. ***Methods:*** (K) modified J. Lawrence Smith method, (Ar) fusion techniques. ***Collected by:*** J. L. Wilson, Shell Development Co.; ***dated by:*** University of Minnesota. ***Comment:*** Exceptionally pure illitic shale sample used; shale not considered to be seriously modified by thermal metamorphism.
(a) (illite) 773 m.y.
(b) (illite) 744 m.y.

292. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-3
Chilled margin of diabase dike, with plagioclase and pyroxene. (44°58'08"N, 109°29'00"W; NW¼ sec. 31, T. 58 N., R. 104 W.; Deep Lake 15' quad; Park Co., Wyo.) ***Analytical data:*** K^{40} = 1.25 ppm (a), 1.20 ppm (b), Ar^{40} = 0.0680 ppm, $*Ar^{40}$ = 96.4%, Ar^{40}/K^{40} = 0.0555. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.
(whole rock) 770 m.y.

293. *Obradovich and Peterman (1968)* K-Ar
Sill intruding the Garnet Range Formation. (47°01'N, 114°21'W; T. 15 N., R. 21 W. [est.]; Alberton 15' quad; Alberton area, Mineral Co.) ***Analytical data:*** K_2O = 5.91%, $*Ar^{40}$ = 0.82 x 10^{-8} moles/g, $*Ar^{40}$ = 97%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer. ***Dated by:*** C. E. Hedge, R. F. Marvin.
(biotite) 760 ± 50 m.y.

294. *Marvin and Dobson (1979)* K-Ar
USGS (D)-63R5
Biotitic diabase sill intruding the Empire Formation, Belt Supergroup. (46°39'12"N, 111°32'53"W; SW¼ sec. 1, T. 10 N., R. 1 E.; Hellgate Gulch 7½' quad; Broadwater Co.) ***Analytical data:*** K_2O = 0.42%, $*Ar^{40}$ = 5.57 x 10^{-10} mole/gm, $*Ar^{40}$ = 92%. ***Constants:*** λ_e

= 0.581 x 10^{-10}/yr, $\lambda\beta$ = 4.962 x 10^{-10}/yr, K^{40}/K = 1.167 x 10^{-4} atomic ratio. ***Collected by:*** G. D. Robinson; ***dated by:*** R. F. Marvin, H. H. Mehnert, P. L. D. Elmore. ***Comment:*** This sill belongs to a widespread group of mafic dikes and sills that gave late Proterozoic-Y to early Proterozoic-Z ages.

(pyroxene with minor biotite) 744 ± 37 m.y.

295. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-51

Chilled margin of diabase dike, with plagioclase and pyroxene. (44°58'20"N, 109°26'20"W; SE¼ sec. 28, T. 58 N., R. 104 W.; Deep Lake 15' quad; Park Co., Wyo.) ***Analytical data:*** K^{40} = 0.99 ppm, Ar^{40} = 0.0525 ppm, $*Ar^{40}$ = 91.3%, Ar^{40}/K^{40} = 0.0530. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) flame photometric and gravimetric methods, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 740 m.y.

296. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-24

Chilled margin of diabase dike, with plagioclase and pyroxene. (44°59'55"N, 109°33'15"W; NE¼ sec. 20, T. 58 N., R. 105 W.; Beartooth Butte 15' quad; Park Co., Wyo.) ***Analytical data:*** K^{40} = 1.11 ppm (a), 1.08 ppm (b), 1.09 ppm (iso dil), Ar^{40} = 0.0579 ppm, $*Ar^{40}$ = 92.6%, Ar^{40}/K^{40} = 0.0530. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 740 m.y.

297. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-5

Chilled margin of diabase dike, with plagioclase and pyroxene. (44°58'20"N, 109°26'07"W; NW¼ sec. 33, T. 58 N., R. 104 W.; Deep Lake 15' quad; Park Co., Wyo.) ***Analytical data:*** K^{40} = 1.14 ppm (a), 1.15 ppm (b), Ar^{40} = 0.0602 ppm, Ar^{40} = 95.1%, Ar^{40}/K^{40} = 0.0526. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta. ***Comment:*** Condie and others (1969) dated this dike at 730 m.y. (K-Ar); Larson and others (1973) also dated this dike at 730 m.y. (K-Ar).

(whole rock) 740 m.y.

298. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-22

Chilled margin of diabase dike, with plagioclase and pyroxene. (44°59'55"N, 109°33'15"W; NE¼ sec. 20, T. 58 N., R. 105 W.; Beartooth Butte 15' quad; Park Co., Wyo.) ***Analytical data:*** K^{40} = 1.04 ppm (a), 1.05 ppm (b), Ar^{40} = 0.0549 ppm, $*Ar^{40}$ = 90.1%, Ar^{40}/K^{40} = 0.0525. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 730 m.y.

299. *Mueller (1971)* K-Ar
Baadsgaard and Mueller (1973)
MBT-23

Chilled margin of diabase dike, with plagioclase and pyroxene. (44°59'55"N, 109°33'15"W; NE¼ sec. 20, T. 58 N., R. 105 W.; Beartooth Butte 15' quad; Park Co., Wyo.) ***Analytical data:*** K^{40} = 1.14 ppm (a), 1.13 ppm (b), Ar^{40} = 0.0599 ppm, $*Ar^{40}$ = 92.4%, Ar^{40}/K^{40} = 0.0528. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 730 m.y.

300. *Larson, Reynolds and Hoblitt (1973)* K-Ar
BT-2

Microporphyritic, fine-grained diabase dike with plagioclase, augite, hornblende; minor magnetite, orthopyroxene, quartz, sericite and chlorite. (2a: 44°58'32"N, 109°25'53"W, Park Co., Wyo.; 2b: 45°00'35"N, 109°38'08"W, Carbon Co., Mt.) ***Dated by:*** P. A. Mueller. ***Comment:*** Condie and others (1969) also

dated this dike at 730 m.y. (K-Ar); Baadsgaard and Mueller (1973) dated this dike at 740 m.y. (K-Ar).

(whole rock) 730 m.y.

301. *Condie, Leech and Baadsgaard (1969)* K-Ar

BT-33

Microporphyritic, fine-grained diabase dike with plagioclase, augite, hornblende; minor magnetite, orthopyroxene, quartz, sericite and chlorite. (44°58'20"N, 109°26'07"W; NW¼ sec. 33, T. 58 N., R. 104 W.; Deep Lake 15' quad; Park Co., Wyo.) ***Analytical data:*** K_2O = 1.16%, Ar^{40}/K^{40} = 0.0522, $*Ar^{40}$ = 95%. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) x-ray fluorescence and gravimetric analyses, (Ar) isotope dilution using an AEI MS-10 mass spectrometer. ***Comment:*** Baadsgaard and Mueller (1973) dated this dike at 740 m.y. (K-Ar); Larson and others (1973) dated this dike at 730 m.y. (K-Ar).

(whole rock) 730 m.y.

302. *Earhart (1975)* K-Ar

L-519

Quartz diorite sill, medium grained, equigranular. (47°03'06"N, 112°45'58"W; SW¼ SE¼ sec. 17, T. 15 N., R. 9 W.; Arrastra Mountain 7½' quad; Lewis and Clark Co.) ***Analytical data:*** K_2O = 1.26, 1.27%; $*Ar^{40} = 16.64 \times 10^{-10}$ moles/gm; $*Ar^{40}$ = 86%. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Dated by:*** R. F. Marvin, H. H. Mehnert. ***Comment:*** This date and one by Mudge (1972) (750 ± 25 m.y.) suggest that the diorite sills in this area may all be Precambrian Z in age.

(hornblende) 730 ± 30 m.y.

303. *Mueller (1971) Baadsgaard and Mueller (1973)* K-Ar

MBT-30

Chilled margin of diabase dike, with plagioclase and pyroxene. (45°00'38"N, 109°37'40"W; NE¼ sec. 33, T. 9 S., R. 17 E.; Alpine 15' quad; Carbon Co.) ***Analytical data:*** K^{40} = 0.98 ppm (a), 1.02 ppm (b), Ar^{40} = 0.0509 ppm, $*Ar^{40}$ = 95.6%, Ar^{40}/K^{40} = 0.0509. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) (a) flame photometric and gravimetric methods, (b) x-ray fluorescence, (Ar) isotope dilution with an AEI MS-10 mass spectrometer. ***Dated by:*** Geochronology Laboratory, University of Alberta.

(whole rock) 720 m.y.

304. *Chaudhuri and Brookins (1969)* Rb-Sr

Red and green shales near top of the Flathead Formation; glauconites mixed with clastic material, pellets show close similarity in size and sorting with clastics; mineralogy uniform over large area; quartz, well-crystallized illite, minor chlorite, occasional calcite. (SW Montana). ***Analytical data:*** 100 mesh, >99% purity, initial ratio = 0.7183 ± 0.001. (See below.) ***Constants:*** $\lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution with 60° 6-inch mass spectrometer, age and initial ratio determined by least squares regression. ***Dated by:*** S. Chaudhuri, L. E. Brookins. ***Comment:*** This date is in fair agreement, within stated limits, with previous age of 540 m.y. for base of Middle Cambrian; initial ratio suggests presence of inherited *Sr; age should be considered a maximum.

(whole rock isochron) 555 ± 18 m.y.

305. *Chaudhuri and Brookins (1969)* Rb-Sr

Shale near the top of the Flathead Formation; glauconites mixed with clastics, pellets show close similarity with size and sorting of clastics; mineralogy uniform over large area; quartz, well-crystallized illite, minor chlorite, occasional calcite. (SW Montana.) ***Analytical data:*** 100 mesh, >99% purity, initial ratio = 0.707 (seawater Sr), Rb = 224.0 ppm, Sr = 110.8 ppm, Rb^{87}/Sr^{86} = 5.88, Sr^{87}/Sr^{86} =

Analytical data for No. 304:

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86} (corr.)	Sr^{86}/Sr^{88}
AV-4	308.3	151.3	5.94	0.7645	0.1191
NG-2	248.7	199.6	3.60	0.7474	0.1192
NG-1	226.8	134.0	4.92	0.7563	0.1195
NG-3	203.1	118.6	4.77	0.7534	0.1193
SB-6	310.0	251.3	3.81	0.7492	0.1194
SB-12	305.8	208.7	4.26	0.7496	0.1186
SB-15	276.8	94.5	8.54	0.7839	0.1200

0.7514 (corrected), Sr^{86}/Sr^{88} = 0.1199. ***Constants:*** $\lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution with 60° 6-inch solid-source mass spectrometer, age and initial ratio determined by least squares regression. ***Dated by:*** S. Chaudhuri, L. E. Brookins. ***Comment:*** This date is in good agreement with presently accepted stratigraphic timescale; by assuming same initial ratio as whole rock samples, the age becomes 400 m.y.—too young for Middle Cambrian.

(glauconite) 542 m.y.

306. *Green (1972)* F.T.
BS-14
Metasedimentary zircon core from massive blue quartzite, Stillwater Complex thermal aureole. (45°26'10"N, 110°08'15"W; SE¼ sec. 32, T. 4 S., R. 13 E.; Mt. Douglas 15' quad; top of Chrome Mountain, Sweet Grass Co.) ***Analytical data:*** (a) (first half) area = 0.160 mm², 13.625 density ϱ_S/unit area, 4.000 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 3.406; (b) (second half) area = 0.160 mm², 12.750 density ϱ_S/unit area, 3.675 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 3.469; (c) (total) area = 0.320 mm², 13.125 density ϱ_S/unit area, 3.838 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 3.420. ***Constants:*** U^{238} $\lambda_D = 1.54 \times 10^{-10}$/yr, U^{238} $\lambda_F = 6.85 \times 10^{-17}$/yr, U^{235} $\varsigma = 582 \times 10^{-24}$ cm², $U^{235}/U^{238} = 7.26 \times 10^{-3}$ atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Extremely low dates are due to annealing since 183 m.y. ago, but cause of the annealing is unknown.

(a) (zircon) 446 m.y.
(b) (zircon) 454 m.y.
(c) (zircon) 447 m.y.

307. *Ramspott and Scholten (1964)* K-Ar
Scholten and Ramspott (1968)
Microsyenite dike which cuts syenite. (44° 24.1'N, 113°01.4'W; sec. 5, T. 12 N., R. 29 E. [est.]; Nicholia 15' quad; Willow Creek, Beaverhead Range, Lemhi Co., Id.) ***Dated by:*** Geochron Laboratories, Inc. ***Comment:*** A similar age has been determined (Rb-Sr) by the U.S.G.S. for a sample from Railroad Canyon, 20 mi N of the main body of the Beaverhead Pluton.

(biotite) 441 ± 15 m.y.

308. *Green (1972)* F.T.
BS-3
Metasedimentary zircon core from massive blue quartzite, Stillwater Complex thermal aureole. (45°26'10"N, 110°08'15"W; SE¼ sec. 32, T. 4 S., R. 13 E.; Mt. Douglas 15' quad; top of Chrome Mountain, Sweet Grass Co.) ***Analytical data:*** Area = 0.179 mm², 27.094 density ϱ_S/unit area, 8.167 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 3.317. ***Constants:*** U^{238} $\lambda_D = 1.54 \times 10^{-10}$/yr, U^{238} $\lambda_F = 6.85 \times 10^{-17}$/yr, U^{235} $\varsigma = 582 \times 10^{-24}$ cm², $U^{235}/U^{238} = 7.26 \times 10^{-3}$ atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Extremely low date is due to annealing since 183 m.y. ago, but cause of the annealing is unknown.

(zircon) 434 m.y.

309. *Green (1972)* F.T.
BS-4
Metasedimentary zircon core from massive blue quartzite, Stillwater Complex thermal aureole. (45°26'10"N, 110°08'15"W; SE¼ sec. 32, T. 4 S., R. 13 E.; Mt. Douglas 15' quad; top of Chrome Mountain, Sweet Grass Co.) ***Analytical data:*** Area = 0.435 mm², 6.784 density ϱ_S/unit area, 2.057 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 3.298. ***Constants:*** U^{238} $\lambda_D = 1.54 \times 10^{-10}$/yr, U^{238} $\lambda_F = 6.85 \times 10^{-17}$/yr, U^{235} $\varsigma = 582 \times 10^{-24}$ cm², $U^{235}/U^{238} = 7.26 \times 10^{-3}$ atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Extremely low date is due to annealing since 183 m.y. ago, but cause of the annealing is unknown.

(zircon) 432 m.y.

310. *Green (1972)* F.T.
BS-7
Metasedimentary zircon core from massive blue quartzite, Stillwater Complex thermal aureole. (45°26'10"N, 110°08'15"W; SE¼ sec. 32, T. 4 S., R. 13 E.; Mt. Douglas 15' quad; top of Chrome Mountain, Sweet Grass Co.) ***Analytical data:*** Area = 0.320 mm², 28.357 density ϱ_S/unit area, 10.094 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 2.809. ***Constants:*** U^{238} $\lambda_D = 1.54 \times 10^{-10}$/yr, U^{238} $\lambda_F = 6.85 \times 10^{-17}$/yr, U^{235} $\varsigma = 582 \times 10^{-24}$ cm², $U^{235}/U^{238} = 7.26 \times 10^{-3}$ atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Extremely low date is due to annealing since 183 m.y. ago, but cause of the annealing is unknown.

(zircon) 370 m.y.

311. *Green (1972)* F.T.
BS-11
Metasedimentary zircon core from massive blue quartzite, Stillwater Complex thermal aureole. (45°26'10"N, 110°08'15"W; SE¼ sec. 32, T. 4 S., R. 13 E.; Mt. Douglas 15' quad; top of Chrome Mountain, Sweet Grass Co.) ***Analytical data:*** (a) (first half) area =

0.160 mm², 18.375 density ϱ_S/unit area, 7.156 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 2.568; (b) (second half) area = 0.160 mm², 20.000 density ϱ_S/unit area, 8.547 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 2.340; (c) (total) area = 0.320 mm², 19.188 density ϱ_S/unit area, 7.850 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 2.444. ***Constants:*** U^{238} λ_D = 1.54 x 10^{-10}/yr, U^{238} λ_F = 6.85 x 10^{-17}/yr, U^{235} ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3} atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Extremely low dates are due to annealing since 183 m.y. ago, but cause of the annealing is unknown.

(a) (zircon) 339 m.y.
(b) (zircon) 309 m.y.
(c) (zircon) 323 m.y.

312. *Green (1972)* F.T.
BS-9

Metasedimentary zircon core from massive blue quartzite, Stillwater Complex thermal aureole. (45°26'10"N, 110°08'15"W; SE¼ sec. 32, T. 4 S., R. 13 E.; Mt. Douglas 15' quad; top of Chrome Mountain, Sweet Grass Co.) ***Analytical data:*** Area = 0.346 mm², 7.378 density ϱ_S/unit area, 2.889 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 2.554. ***Constants:*** U^{238} λ_D = 1.54 x 10^{-10}/yr, U^{238} λ_F = 6.85 x 10^{-17}/yr, U^{235} ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3} atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Extremely low date is due to annealing since 183 m.y. ago, but cause of the annealing is unknown.

(zircon) 337 m.y.

313. *Green (1972)* F.T.
BS-1

Metasedimentary zircon core from massive blue quartzite, Stillwater Complex thermal aureole. (45°26'10"N, 110°08'15"W; SE¼ sec. 32, T. 4 S., R. 13 E.; Mt. Douglas 15' quad; top of Chrome Mountain, Sweet Grass Co.) ***Analytical data:*** (a) area = 0.432 mm², 17.338 density ϱ_S/unit area, 7.251 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 2.391; (b) area = 0.320 mm², 15.513 density ϱ_S/unit area, 6.406 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 2.423. ***Constants:*** U^{238} λ_D = 1.54 x 10^{-10}/yr, U^{238} λ_F = 6.85 x 10^{-17}/yr, U^{235} ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3} atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Extremely low dates are due to annealing since 183 m.y. ago, but cause of the annealing is unknown.

(a) (zircon) 316 m.y.
(b) (zircon) 320 m.y.

314. *Green (1972)* F.T.
BS-2

Metasedimentary zircon core from massive blue quartzite, Stillwater Complex thermal aureole. (45°26'10"N, 110°08'15"W; SE¼ sec. 32, T. 4 S., R. 13 E.; Mt. Douglas 15' quad; top of Chrome Mountain, Sweet Grass Co.) ***Analytical data:*** Area = 0.288 mm², 15.513 density ϱ_S/unit area, 6.375 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 2.410. ***Constants:*** U^{238} λ_D = 1.54 x 10^{-10}/yr, U^{238} λ_F = 6.85 x 10^{-17}/yr, U^{235} ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3} atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Extremely low date is due to annealing since 183 m.y. ago, but cause of the annealing is unknown.

(zircon) 318 m.y.

315. *Green (1972)* F.T.
BS-5

Metasedimentary zircon core from massive blue quartzite, Stillwater Complex thermal aureole. (45°26'10"N, 110°08'15"W; SE¼ sec. 32, T. 4 S., R. 13 E.; Mt. Douglas 15' quad; top of Chrome Mountain, Sweet Grass Co.) ***Analytical data:*** Area = 0.102 mm², 19.873 density ϱ_S/unit area, 8.300 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 2.394. ***Constants:*** U^{238} λ_D = 1.54 x 10^{-10}/yr, U^{238} λ_F = 6.85 x 10^{-17}/yr, U^{235} ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3} atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Extremely low date is due to annealing since 183 m.y. ago, but cause of the annealing is unknown.

(zircon) 316 m.y.

316. *Green (1972)* F.T.
BS-13

Metasedimentary zircon core from massive blue quartzite, Stillwater Complex thermal aureole. (45°26'10"N, 110°08'15"W; SE¼ sec. 32, T. 4 S., R. 13 E.; Mt. Douglas 15' quad; top of Chrome Mountain, Sweet Grass Co.) ***Analytical data:*** (a) (first half) area = 0.160 mm², 8.500 density ϱ_S/unit area, 5.125 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 1.659; (b) (second half) area = 0.160 mm², 7.646 density ϱ_S/unit area, 3.250 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 2.353; (c) (total) area = 0.320 mm², 8.063 density ϱ_S/unit area, 4.188 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 1.925. ***Constants:*** U^{238} λ_D = 1.54 x 10^{-10}/yr, U^{238} λ_F = 6.85 x 10^{-17}/yr, U^{235} ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3} atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Extremely low dates are

due to annealing since 183 m.y. ago, but cause of the annealing is unknown.

(a) (zircon) 221 m.y.
(b) (zircon) 311 m.y.
(c) (zircon) 256 m.y.

317. *Earhart (1975)* K-Ar
L-521

Porphyritic meta-andesite with 60 to 75% plagioclase, biotite, hornblende, some augite and calcite, and phenocrysts of plagioclase, biotite, hornblende (biotite and hornblende largely altered to chlorite) and accessories of quartz and magnetite. (47°06'08"N, 112°44'46"W; NE¼ sec. 33, T. 16 N., R. 9 W.; Stonewall Mountain 7½' quad; Lewis and Clark Co.) ***Analytical data:*** K_2O = 4.25, 4.26%, $*Ar^{40}$ = 19.93 x 10^{-10} moles/gm, $*Ar^{40}$ = 94%, error = $\pm 2\varsigma$. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Flame photometer with Li internal standard. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt. ***Comment:*** Date indicates regional metamorphism; sill thought to have been intruded in Precambrian Y.

(sericitized feldspar) 293 ± 10 m.y.

318. *Green (1972)* F.T.
BS-12

Metasedimentary zircon core from massive blue quartzite, Stillwater Complex thermal aureole. (45°26'10"N, 110°08'15"W; SE¼ sec. 32, T. 4 S., R. 13 E.; Mt. Douglas 15' quad; top of Chrome Mountain, Sweet Grass Co.) ***Analytical data:*** (a) (first half) area = 0.224 mm², 7.006 density ϱ_S/unit area, 3.288 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 2.131; (b) (second half) area = 0.224 mm², 6.163 density ϱ_S/unit area, 2.813 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 2.191; (c) (total) area = 0.448 mm², 6.584 density ϱ_S/unit area, 3.050 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 2.159. ***Constants:*** U^{238} λ_D = 1.54 x 10^{-10}/yr, U^{238} λ_F = 6.85 x 10^{-17}/yr, U^{235} ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3} atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Extremely low dates are due to annealing since 183 m.y. ago, but cause of the annealing is unknown.

(a) (zircon) 282 m.y.
(b) (zircon) 290 m.y.
(c) (zircon) 286 m.y.

319. *Earhart (1975)* K-Ar
L-522

Porphyritic meta-andesite sill with 60 to 75% plagioclase, biotite, hornblende, some augite and calcite, and phenocrysts of plagioclase, biotite, hornblende (biotite and hornblende largely altered to chlorite), and accessories of quartz and magnetite. (47°06'02"N, 112°44'58"W; NE¼ sec. 33, T. 16 N., R. 9 W.; Stonewall Mountain 7½' quad; Lewis and Clark Co.) ***Analytical data:*** K_2O = 3.89, 3.92%, $*Ar^{40}$ = 17.58 x 10^{-10} moles/gm, $*Ar^{40}$ = 95%, error = $\pm 2\varsigma$. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Flame photometer with Li internal standard. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt. ***Comment:*** Date indicates regional metamorphism; sill thought to have been intruded in Precambrian Y.

(sericitized feldspar) 283 ± 10 m.y.

320. *Green (1972)* F.T.
BS-6

Metasedimentary zircon core from massive blue quartzite, Stillwater Complex thermal aureole. (45°26'10"N, 110°08'15"W; SE¼ sec. 32, T. 4 S., R. 13 E.; Mt. Douglas 15' quad; top of Chrome Mountain, Sweet Grass Co.) ***Analytical data:*** Area = 0.256 mm², 15.313 density ϱ_S/unit area, 8.230 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 1.861. ***Constants:*** U^{238} λ_D = 1.54 x 10^{-10}/yr, U^{238} λ_F = 6.85 x 10^{-17}/yr, U^{235} ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3} atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Extremely low date is due to annealing since 183 m.y. ago, but cause of the annealing is unknown.

(zircon) 247 m.y.

321. *McDowell (1966, 1971)* K-Ar
L-1119

Libby stock, large syenite boulder, medium porphyritic with plagioclase, augite (altered to hornblende around edges), primary hornblende?, orthoclase and phenocrysts of orthoclase. (48°29'16"N, 115°35'25"W; SW¼ SE¼ sec. 32, T. 32 N., R. 31 W.; Libby 7½' quad; 6 mi N of Libby, Lincoln Co.) ***Analytical data:*** K = 0.107%, $*Ar^{40}$ = 0.490 x 10^{-10} moles/gm, Ar^{40} = 63%, error = 1 ς, 98% with aggregate and epidote. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) isotope dilution with mass spectrometry, (Ar) stable isotope dilution with 4.5-inch Reynolds-type mass spectrometer, samples concentrated by

fractionation in heavy liquids. ***Collected and dated by:*** F. W. McDowell. ***Comment:*** Date could be result of Precambrian material incorporated in the intrusion, or could be valid and intrusion related to igneous activity to the N from which biotite ages of same magnitude have been obtained.

(augite) 242 ± 7 m.y.

322. *Green (1972)* F.T.
BS-10
Metasedimentary zircon core from massive blue quartzite, Stillwater Complex thermal aureole. (45°26'10"N, 110°08'15"W; SE¼ sec. 32, T. 4 S., R. 13 E.; Mt. Douglas 15' quad; top of Chrome Mountain, Sweet Grass Co.) ***Analytical data:*** Area = 0.160 mm², 9.250 density ϱ_S/unit area, 5.438 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 1.701. ***Constants:*** U^{238} λ_D = 1.54 x 10^{-10}/yr, U^{238} λ_F = 6.85 x 10^{-17}/yr, U^{235} ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3} atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Extremely low date is due to annealing since 183 m.y. ago, but cause of the annealing is unknown.

(zircon) 226 m.y.

323. *Earhart (1975)* K-Ar
L-520
Metadacite, fine grained to subvitrophyric, with 80% feldspar, 15% quartz, 5% hornblende and biotite and phenocrysts of plagioclase and orthoclase. (47°07'38"N, 112°43'50" W; NE¼ sec. 27, T. 16 N., R. 9 W.; Heart Lake 7½' quad; Lewis and Clark Co.) ***Analytical data:*** K_2O = 3.33, 3.30%, $*Ar^{40}$ = 10.46 x 10^{-10} moles/gm, $*Ar^{40}$ = 94%, error = ± 2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Flame photometer with Li internal standard. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt. ***Comment:*** Date indicates regional metamorphism; sill thought to have been intruded in Precambrian Y.

(sericitized feldspar) 202 ± 7 m.y.

324. *Fenton and Faure (1970)* Rb-Sr
Rainy Creek alkalic-ultramafic complex. (48° 26'30"N, 115°24'00"W; sec. 23, T. 31 N., R. 30 W.; Vermiculite Mountain 7½' quad; Libby, Lincoln Co.) ***Analytical data:*** Initial Sr^{87}/Sr^{86} = 0.7038 ± 0.0002. (See below.) ***Constants:*** λ = 1.39 x 10^{-11}/yr. ***Method:*** Duplicate isotope dilution with 60° 6-inch mass spectrometer. ***Dated by:*** M. D. Fenton and G. Faure. ***Comment:*** Difference between this date and Boettcher's 1967 date (94 m.y.) is unexplained; authors accept their date as the valid age for the Rainy Creek complex and did not evaluate Boettcher's date because no analytical data were available.

(whole rock-biotite isochron) 184 ± 3 m.y.

325. *Green (1972)* F.T.
BS-8
Metasedimentary zircon core from massive blue quartzite, Stillwater Complex thermal aureole. (45°26'10"N, 110°08'15"W; SE¼ sec. 32, T. 4 S., R. 13 E.; Mt. Douglas 15' quad; top of Chrome Mountain, Sweet Grass Co.) ***Analytical data:*** Area = 0.512 mm², 9.219 density ϱ_S/unit area, 6.727 density ϱ_i/unit area, ϱ_S density/ϱ_i density = 1.370. ***Constants:*** U^{238} λ_D = 1.54 x 10^{-10}/yr, U^{238} λ_F = 6.85 x 10^{-17}/yr, U^{235} ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3} atomic ratio. ***Collected and dated by:*** D. Green. ***Comment:*** Extremely low date is due to annealing since 183 m.y. ago, but cause of the annealing is unknown.

(zircon) 183 m.y.

326. *Giletti (1966)* K-Ar
21
Granitic gneiss, medium grained with quartz,

Analytical data for No. 324:

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}** (corr.)
LV-1,	164.7	860.4	0.5591	0.7060 ± 0.0004
pyroxene syenite	167.6	859.9		0.7050 ± 0.0003
LV-2,	155.3	1394	0.3242	0.7048 ± 0.0001
pyroxene syenite	157.4	1396		0.7037 ± 0.0021
LV-3,	178.0	513.0	1.007	0.7060 ± 0.0006
phlogopite syenite		509.8		0.7061 ± 0.0007
LV-4,	182.0	1209	0.4271	0.7059 ± 0.0005
pyroxene syenite	175.1	1217		0.7044 ± 0.0003
LV-5, biotite	102.0	351.4	10.0	0.7295 ± 0.0008

**Corrected for isotope fractionation assuming Sr^{86}/Sr^{88} = 0.1194.

muscovite, orthoclase and oligoclase. (45°37′24″N, 112°30′12″W; NW¼ SW¼ NW¼ sec. 32, T. 2 S., R. 7 W.; Nez Perce Hollow 7½′ quad; Rochester mining district, Madison Co.) ***Analytical data:*** K = 7.99%, $*Ar^{40}$ = 0.578 x 10^4 scc/g, $*Ar^{40}$ = 92.23%, $*Ar^{40}/K^{40}$ = 0.0106, error = 1 ς. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution with a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** This unit mapped as Precambrian; proximity to Boulder batholith probable reason for very young date.

(muscovite) 175 m.y.

327. *Marvin and Cole (1978)* K-Ar
USGS (D)-PL4

Porphyritic meta-andesite with 60 to 75% plagioclase, biotite, hornblende, some augite and calcite, and phenocrysts of plagioclase, biotite and hornblende (biotite and hornblende largely altered to chlorite), plus accessories quartz and magnetite; Purcell Lava, Belt Supergroup. (48°46′05″N, 113°47′01″W; NE¼ sec. 24, T. 35 N., R. 17 W.; Aherns Pass 7½′ quad; Glacier National Park, Flathead Co.) ***Analytical data:*** K_2O = 3.54, 3.56%, $*Ar^{40}$ = 9.386 x 10^{-10} moles/gm, $*Ar^{40}$ = 92%, error = 2 ς. ***Constants:*** λ_e = 0.581 x 10^{-10}/yr, $\lambda\beta$ = 4.962 x 10^{-10}/yr, K^{40}/K = 1.167 x 10^{-4} atomic ratio. ***Collected by:*** R. L. Earhart; ***dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt. ***Comment:*** Other studies have shown the Purcell Lava to be about 1 b.y. old, and thus the Jurassic age of this sample is in error; in most instances, altered igneous material is not suitable for age determination, except in an indirect manner (Earhart, 1975).

(plagioclase) 175 ± 6 m.y.

328. *Fenton and Faure (1970)* Rb-Sr
Rainy Creek alkalic-ultramafic complex. (48°26′30″N, 115°24′00″W; sec. 23, T. 31 N., R. 30 W.; Vermiculite Mountain 7½′ quad; Libby, Lincoln Co.) ***Analytical data:*** (See below.) Initial Sr^{87}/Sr^{86} = 0.7038 ± 0.0004. ***Constants:*** λ = 1.39 x 10^{-11}/yr. ***Method:*** Duplicate isotope dilution with 60° 6-inch mass spectrometer. ***Dated by:*** M. D. Fenton, G. Faure.

(whole rock isochron) 143 ± 43 m.y.

329. *Walker (1963)* U-Pb
GS/257/53

Boulder batholith, U-mineralized zone in quartz monzonite, sample contained some uranophane. (46°26′41″N, 112°00′10″W; NW¼ NE¼ sec. 17, T. 8 N., R. 3 W.; Jefferson City 15′ quad; Haynes property, Clancy-Lump Gulch district, Jefferson Co.) ***Comment:*** L. R. Stieff, T. W. Stern (in a written communication cited by Walker) noted that these ages are "strikingly similar to some of the ages determined for U mineralization in Colorado plateau deposits."

(pitchblende) Pb^{206}/U^{238} 50 m.y.
Pb^{207}/U^{235} 55 m.y.
Pb^{207}/Pb^{206} 135 m.y.

330. *Catanzaro and Kulp (1964)* K-Ar
KAT-1

Laramide porphyry, felsic dike. (46°57′43″N, 110°45′00″W; sec. 19, T. 14 N., R. 8 E.; Neihart 7½′ quad; on Belt Creek adjacent to U.S. Hwy 89, N of Neihart, Little Belt Mountains, Cascade Co.) ***Analytical data:*** K = 2.86%, $*Ar^{40}$ = 1.43 x 10^{-5} scc/g, $*Ar^{40}$ = 43%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr. ***Method:*** Isotope dilution using a 6-inch 60° mass spectrometer. ***Collected by:*** E. J. Catanzaro; ***dated by:*** R. Kologrivov.

(hornblende) 120 ± 10 m.y.

Analytical data for No. 328:

	Rb(ppm)	Sr(ppm)	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}** (corr.)
LV-1,	164.7	860.4	0.5591	0.7060 ± 0.0004
pyroxene syenite	167.6	859.9		0.7050 ± 0.0003
LV-2,	155.3	1394	0.3242	0.7048 ± 0.0001
pyroxene syenite	157.4	1396		0.7037 ± 0.0021
LV-3,	178.0	513.0	1.007	0.7060 ± 0.0006
phlogopite syenite		509.8		0.7061 ± 0.0007
LV-4,	182.0	1209	0.4271	0.7059 ± 0.0005
pyroxene syenite	175.1	1217		0.7044 ± 0.0003

**Corrected for isotope fractionation assuming Sr^{86}/Sr^{88} = 0.1194.

331. *McDowell (1966, 1971)* K-Ar
L-1118
Tobacco Root batholith, medium slightly porphyritic quartz monzonite with plagioclase, quartz, orthoclase, biotite and hornblende (abundant inclusions and empty space, some biotite alteration). (45°31'54"N, 111°41'57"W; SW¼ NW¼ sec. 35, T. 3 S., R. 1 W.; Norris 15' quad; 2 mi S of Norris along State Route 287A, Madison Co.) ***Analytical data:*** (biotite) 98% with chloritic grains, 19% chlorite, (a) K = 6.33%, $*Ar^{40}$ = 8.22 x 10^{-10} moles/gm, $*Ar^{40}$ = 90%, (b) K = 6.33%, $*Ar^{40}$ = 8.40 x 10^{-10} moles/gm, $*Ar^{40}$ = 74%; (hornblende) 98% with biotite and aggregate, K = 0.704%, $*Ar^{40}$ = 1.53 x 10^{-10} moles/gm, $*Ar^{40}$ = 72%; error = 1 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) isotope dilution with mass spectrometry, (Ar) stable isotope dilution with 4.5-inch Reynolds-type mass spectrometer, samples concentrated by fractionation in heavy liquids. ***Collected and dated by:*** F. W. McDowell. ***Comment:*** Discordance between dates probably due to the incorporation of some Precambrian material during intrusion.

(a) (biotite) 71.9 ± 2.2 m.y.
(b) (biotite) 73.4 ± 2.2 m.y.
(hornblende) 118 ± 4 m.y.

332. *Knopf (1964)* K-Ar
Clancy granodiorite. (46°27'35"N, 112°00'10" W; NE¼ sec 8, T. 8 N., R. 3 W.; Jefferson City 15' quad; Kain quarry, near Clancy, Jefferson Co.) ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr. ***Collected by:*** A. Knopf; ***dated by:*** Geochron Laboratories, Inc. ***Comment:*** (b) is a rerun date on purified hornblende; (a) interpreted as excess $*Ar^{40}$.

(a) (hornblende) 113 m.y.
(b) (hornblende) 76 m.y.
(biotite) 73.2 ± 2.2 m.y.

333. *Jaffe and others (1959)* Pb-α
53C-160b
Boulder batholith, granitic rock inclusion in quartz monzonite. ***Analytical data:*** −80 to +400 mesh, 340 α/mg/hr, Pb = 15 ppm. ***Constants:*** Selected Th/U = 1.0, c = 2485, k = 1.56 x 10^{-4}. ***Method:*** (Pb) Waring and Worthing 1953 spectrographic method, (α) thick source α counting techniques. ***Collected by:*** R. W. Chapman; ***dated by:*** C. L. Waring, H. W. Worthing, N. W. Jaffe, D. Gottfried.

(zircon) 110 m.y.

334. *Larsen and Schmidt (1958) Armstrong (1975)* Pb-α
CPR-123
Quartz monzonite, fine textured, light colored with 29% quartz, 35% perthite, 31% plagioclase (26% An), and 4% biotite. (46°07'16"N, 114°19'38"W; NE¼ sec. 9, T. 4 N., R. 22 W.; Como Peaks 7½' quad; 8.15 mi up creek from U.S. Hwy 93, Lost Horse Canyon, Ravalli Co.) ***Analytical data:*** (Original) (zircon) 262 α/mg/hr, Pb = 5.6 ppm, (monazite) 2925 α/mg/hr, Pb = 80.0 ppm; (redetermined) (zircon) 254 α/mg/hr, Pb = 10.9 ppm, (monazite) 2920 α/mg/hr, Pb = 64 ppm. ***Method:*** (Pb) Waring and Worthing 1953 spectrographic method, (α) thick source α counting techniques. ***Collected by:*** C. P. Ross, B. F. Leonard; ***dated by:*** H. W. Jaffe, USGS; ***redetermined by:*** T. W. Stern, USGS (1973). ***Comment:*** This quartz monzonite is younger than the main Idaho batholith; it may be related to Tertiary granite body along the Middle Fork of the Salmon River, Idaho.

original: (zircon) 53 ± 10 m.y.
(monazite) 57 ± 10 m.y.
redetermined: (zircon) 110 ± 10 m.y.
(monazite) 50 ± 10 m.y.

335. *Daugherty and Vitaliano (1969)* K-Ar
Quartz-bearing syenite, Sand Creek sill complex. (45°43'09"N, 111°52'33"W; sec. 29, T. 1 S., R. 2 W. [est.]; Harrison 15' quad; Madison Co.) ***Comment:*** Widespread alteration, locally intense and in part hydrothermal; low-rank metamorphism of the complex likely; date indicates "Laramide" orogeny started as early as mid-Cretaceous.

(biotite) 106 ± 6 m.y.

336. *McMannis and Chadwick (1964)* K-Ar
Hornblende andesite porphyry sill. (45°27'00" N, 111°12'40"W; NE¼ sec. 34, T. 4 S., R. 4 E.; Garnet Mountain 15' quad; NW part of Garnet Mountain quad, Gallatin Co.) ***Dated by:*** Geochron Laboratories, Inc. ***Comment:*** This date suggests the sill and a nearby small diorite stock may be Middle Cretaceous rather than Tertiary.

103.5 ± 6.8 m.y.

337. *Folinsbee, Baadsgaard and Cumming (1963)* K-Ar
Bentonite, *Neogastroplites americanus* zone, Mowry Shale. (46°21'45"N, 109°41'20"W;

sec. 14, T. 7 N., R. 16 E.; Winnecook Ranch, Wheatland Co.)

(sanidine) 95.3 m.y.
(sanidine) 96.1 m.y.

338. *Obradovich and Cobban (1975)* K-Ar
2684, 2720
Ten m bentonite in the Arrow Creek member of the Colorado Shale, *Neogastroplites cornutus* zone brackets the bed. (47°19'25"N, 110°28'52"W; SE¼ NW¼ sec. 17, T. 18 N., R. 10 E.; Tiggs Flat 7½' quad; Judith Basin Co.) ***Analytical data:*** (a) K = 6.20%, $*Ar^{40}$ = 10.77 x 10^{-10} moles/gm, $*Ar^{40}$ = 95.5%; (b) K = 9.48%, $*Ar^{40}$ = 16.47 x 10^{-10} moles/gm, $*Ar^{40}$ = 96.8%; 150 mesh. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Isotope dilution, samples concentrated by fractionation in heavy liquids. ***Dated by:*** J. D. Obradovich, W. A. Cobban. ***Comment:*** These dates compatible with other radiometric dates of various *Neogastroplites* zones.

(a) (biotite) 95.3 ± 1.0 m.y.
(b) (sanidine) 95.3 ± 1.0 m.y.

339. *Boettcher (1967)* Rb-Sr
RCB-12
Biotitite core of Rainy Creek complex, almost entirely biotite, accessories feldspar, pyrite, trace of calcite and riebeckite(?) (alteration products). (48°26'30"N, 115°24'00"W; sec. 23, T. 31 N., R. 30 W.; Vermiculite Mountain 7½' quad; near the western border of the biotitite body, Lincoln Co.) ***Comment:*** Date considered good and places Rainy Creek event earlier than previously thought.

(biotite) 94 m.y.

340. *Obradovich and Cobban (1975)* K-Ar
2681
Bottom 10 cm of a 1-m bentonite bed within lower part of the *Inoceramus labiatus* zone, Marias River Shale. (47°39'30"N, 111°40'25" W; sec. 13, T. 22 N., R. 1 W.; Vaughn 15' quad; Cascade Co.) ***Analytical data:*** K = 3.78%, $*Ar^{40}$ = 6.12 x 10^{-10} moles/gm, $*Ar^{40}$ = 91.6%, 150 mesh. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Isotope dilution, sample concentrated by fractionation in heavy liquids. ***Dated by:*** J. D. Obradovich, W. A. Cobban. ***Comment:*** On the basis of this date (and others), Cenomanian-Turonian boundary placed at 89-90 m.y., depending on the level in the *Inoceramus labiatus* zone that is sampled.

(biotite) 88.9 ± 0.9 m.y.

341. *Woakes (1960)* K-Ar
Granodiorite, Boulder batholith. (46°25'N, 112°05'W; T. 8 N., R. 4 W. [est.]; Jefferson City 15' quad; 40 mi NE of Butte, on Clancy Creek, Jefferson Co.) ***Collected by:*** A. Knopf. ***Comment:*** From a personal communication by R. E. Folinsbee and J. H. Reynolds; biotite from sample dated at 79.7 m.y. (J. F. Evernden and G. H. Curtis, personal communication) and 85 m.y. (R. E. Folinsbee, personal communication).

(feldspar) 87.2 m.y.

342. *Knopf (1956)* K-Ar
Pegmatitic schlier (K-spar rich) in granodiorite. (46°27'35"N, 112°00'10"W; NE¼ sec. 8, T. 8 N., R. 3 W.; Jefferson City 15' quad; Kain quarry, 1 mi W of Clancy, Jefferson Co.) ***Analytical data:*** K = 8.21%, $*Ar^{40}/K^{40}$ = 0.00399, $*Ar^{40}$ = 79%, 20-100 mesh. ***Method:*** (K) flame photometer in duplicate, (Ar) mass spectrometer. ***Collected by:*** A. Knopf; ***dated by:*** R. E. Folinsbee, J. H. Reynolds. ***Comment:*** (a) uses a K^{40} branching ratio of 0.089; (b) uses the true K^{40} branching ratio of 0.11 ± 0.1, assumes no Ar leakage in the sample.

(a) (orthoclase) 87.2 m.y.
(b) (orthoclase) 70.8 ± 6.5 m.y.

343. *Obradovich and Cobban (1975)* K-Ar
1540, 2689
Micaceous bentonite, 152 m below top of Colorado Shale, near base of *Scaphites preventricosus* zone. (48°25'45"N, 111°53'33"W; SW¼ NE¼ sec. 20, T. 31 N., R. 2 W.; Poverty Coulee 7½' quad; Toole Co.) ***Analytical data:*** (a) K = 5.59%, $*Ar^{40}$ = 8.85 x 10^{-10} moles/gm, $*Ar^{40}$ = 91.5%; (b) K = 5.59%, $*Ar^{40}$ = 8.82 x 10^{-10} moles/gm, $*Ar^{40}$ = 93.0%; 150 mesh. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Isotope dilution, sample concentrated by fractionation in heavy liquids. ***Dated by:*** J. D. Obradovich, W. A. Cobban. ***Comment:*** These dates place the Turonian-Conacian boundary at about 87 m.y.

(a) (biotite) 87.0 ± 1.7 m.y.
(b) (biotite) 86.7 ± 0.9 m.y.

344. *Tripp (1976)* U-Pb
A14
Fresh quartz diorite orthogneiss with 68% plagioclase (An_{43}), 15% quartz, 11% biotite, some hornblende, accessories apatite, chlorite, zircon, opaques, epidote and sphene. (46°33'17" N, 114°20'44"W; SW¼ NW¼ sec. 11, T. 7 N., R. 22 W.; Saint Joseph Peak 7½' quad; approximately 1.3 km N of contact with batholith and 1 km W of Central Kootenai Lake along S side of ridge, Ravalli Co.) ***Analytical data:*** U^{238} = 927.694 μg/g, U^{235} = 6.647 μg/g, Pb^{206}/Pb^{204} = 121.749, Pb^{206}/U^{238} = 0.0228, Pb^{206}/U^{235} = 0.2458. ***Constants:*** U^{238} λ = 1.537 x 10^{-10}/yr, U^{235} λ = 9.72 x 10^{-11}/yr. ***Method:*** Mass spectrometry. ***Dated by:*** Isotope Geochemistry Laboratory, University of Kansas. ***Comment:*** This zircon age for the batholith supports the idea that the 85 ± 35 m.y. isochron represents the approximate time of final resetting of the quartzofeldspathic gneiss Rb-Sr system. The resetting was probably a response to the thermal effects of emplacement of the batholith.

(zircon concordia) 87 ± 10 m.y.

345. [Unpublished date]
McClernan and Berg K-Ar
Personal communication (1980)
SG-1
Granodiorite with K-spar, plagioclase, quartz, hornblende (no alteration), sphene, opaques, apatite. (46°39'50"N, 112°04'30"W; NE¼ SW¼ sec. 35, T. 11 N., R. 4 W.; Helena 15' quad; outcrop in streambed, Scratch Gravel Hills, Lewis and Clark Co.) ***Analytical data:*** −60/+200 mesh, K = 0.938%, $*Ar^{40}$ = 0.005898 ppm, $*Ar^{40}$ = 49%, $*Ar^{40}/K^{40}$ = 0.005154. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40} = 1.22 x 10^{-4} g/gK. ***Collected by:*** H. G. McClernan, R. B. Berg, MBMG; ***dated by:*** Geochron Laboratories, Inc.

(hornblende) 86.1 ± 4.0 m.y.

346. *Woakes (1960)* K-Ar
Granodiorite, Boulder batholith. (46°25'N, 112°05'W; T. 8 N., R. 4 W. [est.]; Jefferson City 15' quad; 40 mi NE of Butte, on Clancy Creek, Jefferson Co.) ***Collected by:*** A. Knopf. ***Comment:*** From a personal communication by R. E. Folinsbee; biotite from sample dated at 79.7 m.y. (J. F. Evernden and G. H. Curtis, personal communication), and feldspar dated at 87.2 m.y. (R. E. Folinsbee and J. H. Reynolds, personal communication).

(biotite) 85 m.y.

347. *Ferguson (1972, 1975)* F.T.
XK-3
Quartz diorite orthogneiss with 11% quartz, 73% plagioclase, some biotite, hornblende and K-spar, trace chlorite, diopside, apatite, sphene. (46°37'10"N, 114°22'20"W; NW¼ sec. 19, T. 38 N., R. 17 E. [est.]; Saint Joseph Peak 7½' quad; Idaho Co., Idaho.) ***Analytical data:*** (apatite) ϱ_s = 7.45 x 10^5 tracks/cm², counts = 134, ϱ_i = 37.10 x 10^5 tracks/cm², counts = 382; (sphene) ϱ_s = 11.70 x 10^5 tracks/cm², counts = 247, ϱ_i = 15.30 x 10^5 tracks/cm², counts = 281; ϕ = 1.833 x 10^{15} neutrons/cm². ***Constants:*** (U^{238}) λ_D = 1.54 x 10^{-10}/yr, (U^{238}) λ_F = 6.85 x 10^{-17}/yr, (U^{235}) ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3}. ***Method:*** Sample concentrated by fractionation in heavy liquids; see Naeser and Dodge (1969). ***Collected and dated by:*** J. A. Ferguson. ***Comment:*** Prior to 38 m.y., this unit was at depths too great for apatite to retain its fission tracks; at 38 m.y., uplift brought apatite to a thermal depth at which it did retain fission tracks; nearby intrusions and volcanism are thought to have only local effect on apatite.

(apatite) 24 ± 3 m.y.
(sphene) 85 ± 9 m.y.

348. *Tripp (1976)* Rb-Sr
Chase, Bickford and Tripp (1978)
A15
Quartzofeldspathic gneiss with 79% quartz, 7% K-spar, 5% each biotite and muscovite, 4% plagioclase (An_{29}), and accessories chlorite, zircon, sphene, sillimanite, rutile and opaques. (46°32'50"N, 114°19'16"W; SW¼ SW¼ sec. 12, T. 9 N., R. 22 W.; Saint Joseph Peak 7½' quad; about 1 km N of contact with Idaho batholith, from freshly blasted zone along train to South Kootenai Lake, about 500 m N of lake along W side of trail, Ravalli Co.) ***Analytical data:*** Initial ratio = 0.7265.

	Rb^{87} μg/g	Sr^{86} μg/g	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}
A15R1	17.6	3.26	5.49 ± 0.110	0.7337 ± 0.0037
A15R2-A	27.5	16.5	1.65 ± 0.033	0.7445 ± 0.0041
A15R2-B	5.43	10.7	0.502 ± 0.010	0.7410 ± 0.0022
A15R3-A	19.6	17.8	1.09 ± 0.022	0.7354 ± 0.0040
A15R6	11.0	3.06	3.54 ± 0.071	0.7303 ± 0.0023
A15R7-A	14.1	2.77	5.01 ± 0.100	0.7288 ± 0.0015
A15R7-B	13.2	3.38	3.87 ± 0.077	0.7299 ± 0.0026
A15R8	20.2	61.4	0.325 ± 0.006	0.7269 ± 0.0004

Constants: Rb^{87} λ = 1.39 x 10^{-11}/yr, Sr^{86}/Sr^{88} = 0.1194 atomic ratio, Sr^{84}/Sr^{88} = 0.0068 atomic ratio, Rb^{85}/Rb^{87} = 2.5927 atomic ratio. ***Method:*** Standard isotope dilution techniques, mass spectrometry, samples concentrated by fractionation in heavy liquids. ***Dated***

by: Isotope Geochemistry Laboratory, University of Kansas. ***Comment:*** Whole rock Rb-Sr data did not yield isochrons because of low Rb^{87}/Sr^{86} ratios, "mineral" isochrons actually a biotite age with initial Sr^{87}/Sr^{86} ratio determined by whole rock, plagioclase and apatite analyses; samples came from a single outcrop of freshly blasted rock which showed strong compositional banding—several samples from adjacent bands were collected; total rock samples were last a closed system to Rb and Sr about 85 m.y. ago, data points (A15R2-A, R2-B, R3-A, R7-A), which do not lie on the 85 m.y. isochron are from samples of equivalent ages having an initial ratio of greater than 0.7265.

(mineral isochron) 85 ± 35 m.y.

349. *Elliott, Naeser and Hedge (1974)* F.T.
Elliott (1974, 1979)
Goose Lake syenite stock. (45°07'30"N, 109°54'30"W; sec. 19, T. 8 S., R. 15 E.; Cooke City 7½' quad; Goose Lake, Park Co.) ***Analytical data:*** $\varrho_s = 2.48 \times 10^6$ tracks/cm², tracks = 517; $\varrho_i = 1.92 \times 10^6$ tracks/cm², tracks = 401; $\phi = 2.15 \times 10^{15}$ neutron/cm². ***Constants:*** U^{238} $\lambda_F = 6.85 \times 10^{-17}$/yr. ***Collected by:*** J. E. Elliott; ***dated by:*** C. W. Naeser.

(sphene) 84.6 ± 11.2 m.y.

350. *Robinson and Marvin (1967)* K-Ar
D1303, D1304
Maudlow welded glass; very dark gray, pearly glass (95%) with altered volcanic rock (2%) and phenocrysts (3%); labradorite, biotite, augite and hypersthene. (46°06'17", 111°04'46"W; NE¼ sec. 15, T. 4 N., R. 5 E. [est.]; Maudlow 15' quad; 2 mi NE of Maudlow, Gallatin Co.) ***Analytical data:*** (biotite) K_2O = 6.47, 6.37%, $*Ar^{40}$ = 0.0320 ppm, $*Ar^{40}$ = 90%, $*Ar^{40}/K^{40}$ = 0.00493; (plagioclase) K_2O = 0.62, 0.61%, $*Ar^{40}$ = 0.00261 ppm, $*Ar^{40}$ = 91%, $*Ar^{40}/K^{40}$ = 0.00421. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, in duplicate. ***Dated by:*** R. F. Marvin, H.H.Mehnert, W. Mountjoy. ***Comment:*** "Ages for biotite and plagioclase are considered identical within the limits of experimental error"; "reason for age difference unknown, possibly due to slight alteration of material analyzed."

(biotite) 83 ± 2 m.y.
(plagioclase) 71 ± 7 m.y.

351. [Unpublished date]
McClernan and Berg K-Ar
Personal communication (1980)
K-1
Andesite with plagioclase, quartz, biotite, calcite, magnetite, trace of chlorite; biotite is pleochroic from olive drab to light tan and looks fresh. (45°39'55"N, 112°37'W; SW¼ SE¼ sec. 17, T. 2 S., R. 8 W.; Wickiup 7½' quad; outcrop of sill on N side of road and creek, Camp Creek, Silver Bow Co.) ***Analytical data:*** −60/+200 mesh, K = 2.178%, $*Ar^{40}$ = 0.01317 ppm, $*Ar^{40}$ = 66%, $*Ar^{40}/K^{40}$ = 0.004956. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40} = 1.22 \times 10^{-4}$ g/gK. ***Collected by:*** H. G. McClernan, R. B. Berg, MBMG; ***dated by:*** Geochron Laboratories, Inc. ***Comment:*** Sill intruded into Cambrian Wolsey Shale.

(whole rock) 82.9 ± 3.4 m.y.

352. *Obradovich and Cobban (1975)* K-Ar
2685
Thin 8-cm bentonite in lower part of Telegraph Creek Formation, in *Desmoscaphites bassleri* zone. (Sec. 6, T. 14 N., R. 2 E., Petroleum Co.; R. 2 E. apparently a typographical error, located in Meagher Co.; Telegraph Creek Formation present in T. 14 N., R. 27, 28, 29 E., Petroleum Co.) ***Analytical data:*** K = 6.45%, $*Ar^{40} = 9.67 \times 10^{-10}$ moles/gm, $*Ar^{40}$ = 97.4%, 150 mesh. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** Isotope dilution, mass spectrometry, sample concentrated by fractionation in heavy liquids. ***Dated by:*** J. D. Obradovich, W. A. Cobban. ***Comment:*** Date suggests Santonian-Campanian boundary might be placed at 82 m.y.

(biotite) 82.5 ± 0.8 m.y.

353. *Marvin and Dobson (1979)* K-Ar
A-2929
Andesite dike. (45°41'20"N, 109°54'25"W; NW¼ SW¼ sec. 5, T. 2 S., R. 15 E.; Ross Canyon 7½' quad; Sweet Grass Co.) ***Analytical data:*** K_2O = 0.834%, $*Ar^{40}$ = 1.012 x 10^{-10} mole/gm, $*Ar^{40}$ = 19%. ***Collected by:*** L. A. McPeek; ***dated by:*** Geochron Laboratories, Inc.

(amphibole) 82.4 ± 4.1 m.y.

354. *Baadsgaard, Folinsbee and Lipson (1961)* K-Ar
AK 48
Boulder batholith, light-gray granodiorite with quartz, orthoclase, zoned plagioclase, hornblende and biotite. (46°27'35"N, 112°00'10"W; NE¼ sec. 8, T. 8 N., R. 3 W.; Jefferson City 15' quad; Kain quarry, Jefferson Co.) ***Analytical data:*** K = 4.86%, $*Ar^{40}/K^{40}$ = 0.00494, assumed deviation = ±5%. ***Constants:*** $\lambda_e = 0.589 \times 10^{-10}$/yr, $\lambda_\beta = 4.76 \times 10^{-10}$/yr, $K^{40}/K = 1.18 \times 10^{-4}$ atomic ratio. ***Method:*** (K) J. Lawrence Smith fusion and tetraphenylboron precipitation, (Ar) isotope dilution with Nier-type 6-inch mass spectrometer. ***Collected by:*** A. Knopf; ***dated by:*** A. Stelmach. ***Comment:*** Date indicates the last major heating of the rock from which the biotite came.

(biotite) 82 m.y.

355. *Marvin and Dobson (1979)* K-Ar
B-2930
Diorite. (45°36'40"N, 109°56'25"W; SW¼ SE¼ sec. 36, T. 2 S., R. 14 E.; Sliderock Mountain 7½' quad; Iron Mountain, Sweet Grass Co.) ***Analytical data:*** K_2O = 6.426%, $*Ar^{40} = 7.739 \times 10^{-10}$ mole/gm, $*Ar^{40}$ = 58%. ***Collected by:*** L. A. McPeek; ***dated by:*** Geochron Laboratories, Inc.

(biotite) 81.8 ± 3.1 m.y.

356. *McDowell (1966) Tilling and others (1968)* K-Ar
L-1117
Boulder batholith, Butte-Clancy unit, coarse equigranular quartz monzonite with plagioclase, orthoclase (minor sericite), biotite (occasional chlorite grains), and hornblende. (46°09'51"N, 112°22'05"W; SW¼ SW¼ sec. 21, T. 5 N., R. 6 W.; Elk Park 15' quad; along U.S. Hwy 91, 13.2 mi NE of Butte, Jefferson Co.) ***Analytical data:*** (a) K = 7.43%, $*Ar^{40} = 10.2 \times 10^{-10}$ moles/gm, $*Ar^{40}$ = 89%; (b) K = 7.43%, $*Ar^{40} = 9.84 \times 10^{-10}$ moles/gm, $*Ar^{40}$ = 93%; (hornblende) K = 0.519%, $*Ar^{40} = 0.769 \times 10^{-10}$ moles/gm, $*Ar^{40}$ = 39%; error = 1 ς. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) isotope dilution with mass spectrometry, (Ar) stable isotope dilution with 4.5-inch Reynolds-type mass spectrometer, samples concentrated by fractionation with heavy liquids. ***Collected and dated by:*** F. W. McDowell. ***Comment:*** Hornblende date too high, analytical cause; dates indicate a short time for the emplacement and cooling of the Boulder batholith; Tilling, Klepper, Obradovich (1968) recalculated McDowell's data using $\lambda_e = 0.584 \times 10^{-10}$/yr, and (incorrectly) assuming weight of sample = 1 g. This weight assumption caused a greater variation in the recalculated dates than should be seen when simply converting from one λ_e to another.

(a) (biotite) 76.0 ± 2.3 m.y.
(b) (biotite) 73.2 ± 2.2 m.y.
(hornblende) 81.7 ± 2.7 m.y.

357. *Evernden and others (1961)* K-Ar
KA 177
Clancy granodiorite. (46°27'35"N, 112°00'10" W; NE¼ sec. 8, T. 8 N., R. 3 W.; Jefferson City 15' quad; Kain quarry on Clancy Creek, 1 mi W of Clancy, Jefferson Co.) ***Analytical data:*** K = 6.96%, $*Ar^{40}/K^{40}$ = 0.00486, $*Ar^{40}$ = 89%. ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr. ***Collected by:*** A. Knopf. ***Comment:*** Stratigraphic age is Upper Colorado (Niobrara), Reeside (1938); age probably post-Montana (Santonian-Maestrichtian), Lyons (1944); this date seems to make this unit older than Maestrichtian.

(biotite) 81 m.y.

358. *Ferguson (1972, 1975)* F.T.
K-7
Skookum Butte stock with 68% plagioclase, 12% quartz, 10% K-spar, some biotite and hornblende, trace chlorite, zircon, apatite, sphene and opaques. (46°39'30"N, 114°22'20" W; NW¼ sec. 6, T. 38 N., R. 17 E. [est.]; Dick Creek 7½' quad; Idaho Co., Idaho.) ***Analytical data:*** (apatite) $\varrho_s = 4.27 \times 10^5$ tracks/cm², counts = 267, $\varrho_i = 8.53 \times 10^5$ tracks/cm², counts = 320; (sphene) $\varrho_s = 34.10 \times 10^5$ tracks/cm², counts = 410, $\varrho_i = 46.80 \times 10^5$ tracks/cm², counts = 374; $\phi = 1.833 \times 10^{15}$ neutrons/cm². ***Constants:*** (U^{238}) $\lambda_D = 1.54 \times 10^{-10}$/yr, ($U^{238}$) $\lambda_F = 6.85 \times 10^{-17}$/yr, ($U^{235}$) $\varsigma = 582 \times 10^{-24}$ cm², $U^{235}/U^{238} = 7.26 \times 10^{-3}$. ***Method:*** Sample concentrated by fractionation in heavy liquids; see Naeser and Dodge (1969). ***Collected and dated by:*** J. A. Ferguson. ***Comment:*** Intrusion of Skookum Butte stock at (at least) 82 m.y. was at depths too great for apatite to retain its fission tracks; at 38 m.y., uplift brought apatite to a thermal depth at which it did retain fission tracks; nearby instrusions and volcanism are thought to have only local effect on apatite.

(apatite) 56 ± 5 m.y.
(sphene) 81 ± 7 m.y.

359. *Ferguson (1972, 1975)* F.T.
K-6
Medium-grained calc-silicate inclusion in quartzite, border zone Idaho batholith; 36% plagioclase, 22% quartz, 42% diopside, trace of chlorite and sphene. (46°37'40"N, 114°22'35"W; NW¼ sec. 18, T. 38 N., R. 17 E. [est.]; Saint Joseph Peak 7½' quad; Idaho Co., Idaho.) ***Analytical data:*** (apatite) ϱ_S = 22.10 x 10^5 tracks/cm², counts = 566, ϱ_i = 62.63 x 10^5 tracks/cm², counts = 476; (sphene) ϱ_S = 47.58 x 10^5 tracks/cm², counts = 571, ϱ_i = 65.60 x 10^5 tracks/cm², counts = 446; ϕ = 1.833 x 10^{15} neutrons/cm². ***Constants:*** (U^{238}) λ_D = 1.54 x 10^{-10}/yr, (U^{238}) λ_F = 6.85 x 10^{-17}/yr, (U^{235}) ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3}. ***Method:*** Sample concentrated by fractionation in heavy liquids; see Naeser and Dodge (1969). ***Collected and dated by:*** J. A. Ferguson. ***Comment:*** Prior to 38 m.y., this unit was at depths too great for apatite to retain its fission tracks; at 38 m.y., uplift brought apatite to a thermal depth at which it did retain fission tracks; nearby intrusions and volcanism are thought to have only local effect on apatite.

(apatite) 39 ± 3 m.y.
(sphene) 81 ± 7 m.y.

360. *McDowell (1966, 1971)* K-Ar
Tilling and others (1968)
L-952
Boulder batholith, Butte-Clancy unit, coarse porphyritic equigranular quartz monzonite with altered plagioclase, partially altered orthoclase, quartz, biotite (chlorite along cleavage), and hornblende with plagioclase and quartz inclusions. (45°56'24"N, 112°28'59"W; NW¼ sec. 9, T. 2 N., R. 7 W. [est.]; Homestake 7½' quad; N of U.S. Hwy 10, 2 mi SE of Butte, Silver Bow Co.) ***Analytical data:*** (See below.) ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) isotope dilution with mass spectrometry, (Ar) stable isotope dilution with 4.5-inch Reynolds-type mass spectrometer; samples concentrated by fractionation in heavy liquids. ***Collected and dated by:*** F. W. McDowell. ***Comment:*** Biotite dates are low, possible Ar loss; hornblende dates are high; Tilling and others (1968) recalculated McDowell's data using 0.584 x 10^{-10}/yr, and (incorrectly) assuming weight of sample = 1 g. This weight assumption caused a greater variation in the recalculated dates than should be seen when simply converting from one λ_e to another.

(a) (biotite) 70.6 ± 2.1 m.y.
(b) (biotite) 70.4 ± 2.1 m.y.
(c) (hornblende) 80.6 ± 2.4 m.y.
(d) (hornblende) 78.4 ± 9.2 m.y.

361. *Woakes (1960)* K-Ar
Granodiorite, Boulder batholith. (46°25'N, 112°05'W; T. 8 N., R. 4 W. [est.]; Jefferson City 15' quad; 40 mi NE of Butte, on Clancy Creek, Jefferson Co.) ***Collected by:*** A. Knopf. ***Comment:*** From a personal communication by J. F. Evernden and G. H. Curtis; feldspar from sample dated at 87.2 m.y. (R. E. Folinsbee and J. H. Reynolds, personal communication), and biotite dated at 85 m.y. (R. E. Folinsbee, personal communication.)

(biotite) 79.7 m.y.

362. *Skipp and McGrew (1977)* K-Ar
Dacite flow, grayish-purple porphyritic hornblende lava flow, Member B, Maudlow Formation. (46°02'46"N, 111°09'57"W; NW¼ NW¼ sec. 1, T. 3 N., R. 4 E.; Maudlow 15' quad; Gallatin Co.) ***Collected by:*** B. Skipp.

(hornblende) 78.9 ± 1 m.y.

Analytical data for No. 360:

	Mesh	Purity	K%	*Ar^{40}x10^{-10} moles/gm	*Ar^{40}%
biotite (a)	20	98% w/aggregate 15% chlorite	6.34	8.09	87
biotite (b)	80-100	95% w/hornblende	4.97	6.33	57
hornblende (c)	80-100	98% w/biotite	0.477	0.697	78
hornblende (d)	80-100	98% w/biotite	0.477	0.678	13

363. *Tilling, Klepper and Obradovich (1968)* K-Ar
Robinson, Klepper and Obradovich (1968)
D1567
Base of Elkhorn Mountains Volcanics; hornblende phenocrysts from autoclastic breccia. (45°49.1'N, 111°45.0'W; sec. 20, T. 1 N., R. 1 W.; Jefferson Island 15' quad; Jefferson Canyon, Jefferson Co.) ***Analytical data:*** (a) K_2O = 0.829%, $*Ar^{40}$ = 0.984 x 10^{-10} moles/gm, $*Ar^{40}$ = 94%; (b) K_2O = 0.834%, $*Ar^{40}$ = 0.975 x 10^{-10} moles/gm, $*Ar^{40}$ = 95%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Replicate K analyses, isotope dilution. ***Dated by:*** J. D. Obradovich. ***Comment:*** Sample from 12 mi N of nearest batholith exposure (Tobacco Root); remoteness reduces the chance that this date has been affected by later thermal events; dates consistent with geologic relations, lower member at least must be early Campanian (81 to 77 m.y.) to have provided the welded-tuff clasts of the Cokedale Formation.

(a) (hornblende) 78.8 ± 2.4 m.y.
(b) (hornblende) 77.6 ± 2.4 m.y.

[No. 364 and 365 were omitted.]

366. *Obradovich and Cobban (1975)* K-Ar
2687
Two-m bentonite (bed R), lies about 60 m below No. 2688, in *Baculites* sp. (weak flank ribs) zone. (45°45'00"N, 107°27'04"W; NE¼ NE¼ sec. 13, T. 1 S., R. 34 E.; Little Dry Creek 7½' quad; about 7 mi E of Hardin, Big Horn Co.) ***Analytical data:*** K = 6.93%, $*Ar^{40}$ = 9.84 x 10^{-10} moles/gm, $*Ar^{40}$ = 95.7%, error = 1 ς, 150 mesh. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Isotope dilution, mass spectrometry, sample concentrated by fractionation in heavy liquids. ***Dated by:*** J. D. Obradovich, W. A. Cobban.

(biotite) 78.2 ± 0.8 m.y.

367. *Prostka (1966)* K-Ar
Tilling, Klepper and Obradovich (1968)
Mafic monzonite border, Ringing Rocks stock, dark gray to black, with 28% zoned plagioclase, 24% K-spar, 2% olivine (largely altered to serpentine, talc, magnetite), 12% hypersthene, 6% clinopyroxene, 10% biotite, 13% green hornblende and 2% quartz. (45°57'15" N, 112°14'15"W; sec. 9, T. 2 N., R. 5 W.; Dry Mountain 7½' quad; Jefferson Co.) ***Analytical data:*** K_2O = 8.75%, $*Ar^{40}$ = 10.31 x 10^{-10} moles/gm, $*Ar^{40}$ = 89%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Replicate K analyses, flame photometer. ***Dated by:*** J. D. Obradovich. ***Comment:*** Age suggests that stock is somewhat older than the Butte quartz monzonite.

(biotite) 78.2 ± 3.1 m.y.

368. *Obradovich and Cobban (1975)* K-Ar
1541, 2690
85 cm bentonite 22 m above base of type Claggett Shale, sample near the top of *Baculites obtusus* zone or at base of *Baculites mclearni* zone. (47°40'45"N, 109°38'12"W; SW¼ SE¼ NW¼ sec. 14, T. 22 N., R. 16 E.; Council Island 7½' quad; Fergus Co.) ***Analytical data:*** (a) K = 6.71%, $*Ar^{40}$ = 9.51 x 10^{-10} moles/gm, $*Ar^{40}$ = 96.8%; (b) K = 6.71%, $*Ar^{40}$ = 9.49 x 10^{-10} moles/gm, $*Ar^{40}$ = 94.2%; 150 mesh, error = 1 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Isotope dilution, sample concentrated by fractionation in heavy liquids. ***Dated by:*** J. D. Obradovich, W. A. Cobban.

(a) (biotite) 78.1 ± 1.6 m.y.
(b) (biotite) 77.9 ± 0.8 m.y.

369. *Obradovich and Cobban (1975)* K-Ar
2683
Thin 5 cm bentonite near the top of Marias River Shale, in *Desmoscaphites erdmanni* zone. (48°29'31"N, 112°01'45"W; NW¼ sec. 32, T. 32 N., R. 3 W.; Valier 15' quad; Toole Co.) ***Analytical data:*** 150 mesh, K = 4.51%, $*Ar^{40}$ = 6.38 x 10^{-10} moles/gm, $*Ar^{40}$ = 92.0%, error = 1 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Isotope dilution, mass spectrometry, sample concentrated by fractionation in heavy liquds. ***Dated by:*** J. D. Obradovich, W. A. Cobban.

(biotite) 78.0 ± 0.8 m.y.

370. *Baadsgaard, Folinsbee and Lipson (1961)* K-Ar
AK 63
Marysville stock, granodiorite with zoned plagioclase, quartz, orthoclase, hornblende, biotite with ideal hypidiomorphic granular fabric. (46°44'45"N, 112°19'00"W; SE¼ sec. 35, T. 12 N., R. 6 W.; Elliston 15' quad; Lewis and

Clark Co.) ***Analytical data:*** K = 5.43%, $*Ar^{40}/K^{40}$ = 0.00470, assumed deviation = ± 5%. ***Constants:*** $\lambda_e = 0.589 \times 10^{-10}$/yr, $\lambda_\beta = 4.76 \times 10^{-10}$/yr, $K^{40}/K = 1.18 \times 10^{-4}$ atomic ratio. ***Method:*** (K) J. Lawrence Smith fusion and tetraphenylboron precipitation, (Ar) isotope dilution with Nier-type 6-inch mass spectrometer. ***Collected by:*** A. Knopf; ***dated by:*** A. Stelmach. ***Comment:*** Date indicates the last major heating of the rock from which the biotite came.

(biotite) 78 m.y.

371. *Miller (1973)* K-Ar
Woakes (1960)
Meyer and others (1968)
443-10
Butte quartz monzonite, altered, close to the E-W vein system, biotite partly altered to chlorite. (46°00'45"N, 112°32'25"W; sec. 13, T. 3 N., R. 8 W. [est.]; Butte North 15' quad; Mountain Con shaft, 50 ft. from State Vein, 4500 ft. below surface, Butte, Silver Bow Co.) ***Analytical data:*** (a) >35 mesh, >10% chlorite, K = 5.23 ± 0.02%, wt = 1.0548 gm, $*Ar^{40} = 7.895 \times 10^{-10}$ moles, $*Ar^{40}$ = 89%; (b) 35-105 mesh, 40% chlorite, K = 3.85 ± 0.1%, wt = 1.1085 gm, $*Ar^{40} = 3.389 \times 10^{-10}$ moles, $*Ar^{40}$ = 37%. ***Constants:*** $\lambda_e = 0.577 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.1477 \times 10^{-4}$ atomic ratio; (a) recalculated by Meyer and others (1968) using $\lambda_e = 0.585 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** Isotope dilution, (K) flame photometer, (Ar) Reynolds-type mass spectrometer. ***Collected by:*** M. E. Woakes; ***dated by:*** L. Kovich, M. E. Woakes. ***Comment:*** (a) done on hand-picked, cleaner biotite, (b) rejected; if dates on coarse biotite of quartz monzonite and rhyolite are correct, hydrothermal alteration of the rhyolite took place 30 m.y. after emplacement of the batholith and more than 10 m.y. after mineralization of the big veins; original date by Woakes for (a) is 82.4 m.y.

(a) (biotite) 78.4 ± 2.0 m.y.
(b) (biotite) 46.3 ± 1.4 m.y.

372. *Hanna (1973)* K-Ar
Elkhorn Mountains Volcanics, which are intruded by "diorite prophyry" of Prostka (1966), which is in turn intruded by the Ringing Rocks stock. (45°57'15"N, 112°14'15"W; sec. 9, T. 2 N., R. 5 W.; Dry Mountain 7½' quad; Jefferson Co.) ***Comment:*** Ringing Rocks stock has been dated at 78.2 ± 3.1 m.y. (biotite, K-Ar).

78 ± 1.7 m.y.

373. *Knopf (1964)* Rb-Sr
Boulder batholith adamellite. (46°29'30"N, 112°01'55"W; sec. 31, T. 9 N., R. 3 W. [est.]; Jefferson City 15' quad; 6 mi S of Helena, Jefferson Co.) ***Constants:*** (a) $\lambda = 1.47 \times 10^{-11}$/yr; (b) $\lambda = 1.37 \times 10^{-11}$/yr. ***Collected by:*** A. Knopf; ***dated by:*** U.S. Geological Survey.

(a) 74 ± 10 m.y.
(b) 78 ± 10 m.y.

374. *Knopf (1964)* K-Ar
Unionville granodiorite, a darkish rock of dioritic appearance. (46°31'56"N, 111°59'13"W; SW¼ sec. 16, T. 9 N., R. 3 W. [est.]; East Helena 15' quad; 10.5 mi in an airline from the summit of Colorado Mountain and 2600 ft. lower, Jefferson Co.) ***Analytical data:*** $*Ar^{40}/K^{40}$ = 0.00464. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr. ***Collected by:*** A. Knopf; ***dated by:*** Geochron Laboratories, Inc. ***Comment:*** This date's close agreement with age of the Clancy sample (73-76 m.y.) is interpreted to indicate that no appreciable amount of $*Ar^{40}$ was driven out of the Unionville unit during intrusion of the Clancy unit.

(biotite) 77.8 ± 1.6 m.y.

375. *Tilling, Klepper and Obradovich (1968)* K-Ar
Robinson, Klepper and Obradovich (1968)
D1564
Elkhorn Mountains Volcanics, lower member, medium-dark gray, very fine grained with abundant plagioclase phenocrysts. (46°21.3'N, 112°30.6'W; sec. 17, T. 7 N., R. 7 W.; Deer Lodge 15' quad; top of Cliff Mountain, 11 mi E of Deer Lodge, Powell Co.) ***Analytical data:*** K_2O = 0.988%, $*Ar^{40} = 1.155 \times 10^{-10}$ moles/gm, $*Ar^{40}$ = 90%. ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** Replicate K analyses, isotope dilution. ***Dated by:*** J. D. Obradovich. ***Comment:*** Sample from 3000 ft. above the base of volcanics and 5 mi from the nearest batholith exposure; date consistent with geologic relations—lower member at least must be early Campanian (81 to 77 m.y.) to have provided the welded-tuff clasts of the Cokedale Formation.

(hornblende) 77.6 ± 2.4 m.y.

376. *Obradovich and Cobban (1975)* K-Ar
2688
58 cm bentonite (bed T) in lower part of the Claggett Shale, in *Baculites obtusus* zone. (45°

45'00"N, 107°27'04"W; NE¼ NE¼ sec. 13, T. 1 S., R. 34 E.; Little Dry Creek 7½' quad; about 7 mi E of Hardin, Big Horn Co.) ***Analytical data:*** K = 7.08%, $*Ar^{40}$ = 9.95 x 10^{-10} moles/gm, $*Ar^{40}$ = 94.7%, 150 mesh, error = 1 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Isotope dilution, sample concentrated by fractionation in heavy liquids. ***Dated by:*** J. D. Obradovich, W. A. Cobban.

(biotite) 77.5 ± 0.8 m.y.

377. *McDowell (1966, 1971) Tilling and others (1968)* K-Ar

L-1023

Boulder batholith, medium, slightly porphyritic diorite with plagioclase (abundant laths), orthoclase, and phenocrysts of hornblende (severely resorbed, loaded with inclusion and poikiliths of feldspar and biotite) and biotite (same characteristics plus some chlorite). (45° 46'08"N, 112°49'12"W; NE¼ sec. 10, T. 1 S., R. 10 W. [est.]; Dewey 7½' quad; along State Hwy 43 W of Divide, Silver Bow Co.) ***Analytical data:*** (biotite) 60-100 mesh, 98% with chloritic grains, 12% chlorite, K = 5.83%, $*Ar^{40}$ = 8.16 x 10^{-10} moles/gm, $*Ar^{40}$ = 57%; (hornblende) 60-100 mesh, 98% with aggregate and biotite, <2% chlorite, K = 0.455%, $*Ar^{40}$ = 0.637 x 10^{-10} moles/gm, $*Ar^{40}$ = 56%; error = 1 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) isotope dilution with mass spectrometry, (Ar) stable isotope dilution with 4.5-inch Reynolds-type mass spectrometer, samples concentrated by fractionation in heavy liquids. ***Collected and dated by:*** F. W. McDowell. ***Comment:*** These dates indicate a short time for the emplacement and cooling of the Boulder batholith; Tilling, Klepper and Obradovich (1968) recalculated McDowell's data using λ_e = 0.584 x 10^{-10}/yr and (incorrectly) assuming weight of sample = 1 g. This weight assumption caused greater variation in the recalculated dates than should be seen when simply converting from one λ_e to another.

(biotite) 77.3 ± 2.3 m.y.
(hornblende) 77.4 ± 2.3 m.y.

378. *Tilling, Klepper and Obradovich (1968)* K-Ar

7

Mafic rocks (intrusive). (46°32.0'N, 111°51.5' W; sec. 16, T. 9 N., R. 2 W.; East Helena 15' quad; Jefferson Co.) ***Analytical data:*** (a) K_2O = 9.54%, $*Ar^{40}$ = 10.88 x 10^{-10} moles/gm, $*Ar^{40}$ = 93%; (b) K_2O = 9.24%, $*Ar^{40}$ = 10.77 x 10^{-10} moles/gm, $*Ar^{40}$ = 91%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (a) single K analysis, flame photometer; (b) replicate K analyses, flame photometer. ***Dated by:*** (a) R. F. Marvin, H. H. Thomas; (b) J. D. Obradovich.

(a) (biotite) 75.8 ± 3.8 m.y.
(b) (biotite) 77.4 ± 3.1 m.y.

379. *Woakes (1960) Meyer and others (1968)* K-Ar

443-4

Timber Butte quartz monzonite, SW of mineralized zone; biotite slightly altered to chlorite. (45°59'N, 112°35'W; sec. 27, T. 3 N., R. 8 W. [est.]; Butte South 15' quad; Butte, Silver Bow Co.) ***Analytical data:*** (a) 28 mesh, K = 6.59%, wt = 0.6259 gm, $*Ar^{40}$ = 5.471 x 10^{-10} moles, $*Ar^{40}$ = 83.9%; (b) 35-150 mesh, <3% hornblende and chlorite, K = 6.25%, wt = 0.7998 gm, $*Ar^{40}$ = 5.769 x 10^{-10} moles, $*Ar^{40}$ = 72.8%; (c) 35-150 mesh, <5% hornblende and chlorite, K = 6.25 ± 0.03%, wt = 0.9754 gm, $*Ar^{40}$ = 6.906 x 10^{-10} moles, $*Ar^{40}$ = 46.0%. ***Constants:*** λ_e = 0.577 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.1477 x 10^{-4} atomic ratio; (c) recalculated by Meyer and others (1968) using λ_e = 0.585 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Isotope dilution, (K) flame photometer, (Ar) Reynolds-type mass spectrometer. ***Collected by:*** M. E. Woakes; ***dated by:*** M. E. Woakes, J. F. Evernden, L. Kovich. ***Comment:*** (a) the more acceptable age; if dates on coarse biotite of quartz monzonite and rhyolite are correct, hydrothermal alteration of the rhyolite took place 30 m.y. after emplacement of the batholith and more than 10 m.y. after mineralization of the big veins; original date by Woakes for (c) is 65.7 ± 2.0 m.y.

(a) (biotite) 77.0 m.y.
(b) (biotite) 68.7 m.y.
(c) (biotite) 62.8 m.y.

380. *Zen, Marvin and Mehnert (1975)* K-Ar

DR

Quartz diorite, Pioneer batholith. (45°35'36"N, 112°57'10"W; SE¼ sec. 8, T. 3 S., R. 9 W.; Vipond Park 15' quad; Beaverhead Co.) ***Analytical data:*** (biotite) K_2O = 8.93, 8.87%, $*Ar^{40}$ = 9.496 x 10^{-10} moles/gm, $*Ar^{40}$ = 95%; (hornblende) (a) K_2O = 0.887%, $*Ar^{40}$ =

1.021 x 10^{-10} moles/gm, $*Ar^{40}$ = 86%; (hornblende) (b) K_2O = 0.887%, $*Ar^{40}$ = 1.028 x 10^{-10} moles/gm, $*Ar^{40}$ = 65%; <99% pure, no visible alteration products, error = ±2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, L. Schlocker. ***Comment:*** Ar content redetermined for hornblende (b) and age recalculated; mapping shows that the quartz diorite (No. DR) occurs as inclusions in porphyritic granodiorite (No. BH 9850), which is cut by apophyses of granite (No. BHS); biotite age agrees with the ages of the 2 younger intrusions, possibly lost some $*Ar^{40}$ during intrusion of granodiorite and/or granite; the hornblende ages indicate the age of intrusion of the quartz diorite.

(biotite) 71.0 ± 2.4 m.y.
(a) (hornblende) 76.5 ± 2.1 m.y.
(b) (hornblende) 77.0 ± 2.2 m.y.

381. *McDowell (1966, 1971)* K-Ar
Tilling and others (1968)
L-951

Boulder batholith, Rader Creek Granodiorite with plagioclase, orthoclase (partially altered), quartz, biotite and hornblende (abundant feldspar and opaque inclusions). (45°49'47"N, 112°19'12"W; SW¼ sec. 14, T. 1 N., R. 6 W. [est.]; Grace 7½' quad; along U.S. Hwy 10, 2.7 mi W of intersection with State Hwy 41, Jefferson Co.) ***Analytical data:*** (biotite) 95% with hornblende and aggregate, K = 5.72%, $*Ar^{40}$ = 7.96 x 10^{-10} moles/gm, $*Ar^{40}$ = 79%; (hornblende) 98% with aggregate and biotite, K = 0.694%, $*Ar^{40}$ = 0.966 x 10^{-10} moles/gm, $*Ar^{40}$ = 46%; error = 1 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) isotope dilution with mass spectrometry; (Ar) stable isotope dilution with 4.5-inch Reynolds-type mass spectrometer; samples concentrated by fractionation in heavy liquids. ***Collected and dated by:*** F. W. McDowell. ***Comment:*** Dates indicate a short time for the emplacement and cooling of the Boulder batholith; Tilling, Klepper and Obradovich (1968) recalculated McDowell's data using λ_e = 0.584 x 10^{-10}/yr and (incorrectly) assuming weight of sample = 1 g. This weight assumption caused a greater variation in the recalculated dates than should be seen when simply converting from one λ_e to another.

(biotite) 76.9 ± 2.3 m.y.
(hornblende) 76.9 ± 2.3 m.y.

382. *Ehinger (1971)* K-Ar
Hyndman, Obradovich and Ehinger (1972)
BB-6

Philipsburg batholith; mafic-rich granodiorite with orthoclase, quartz, hornblende, biotite, magnetite, plagioclase, apatite. (46°16'19"N, 113°14'07"W; center sec. 16, T. 6 N., R. 13 W.; Fred Burr 7½' quad; 1.85 mi W of Red Lion mine, Granite Co.) ***Analytical data:*** (biotite) K = 7.40%, $*Ar^{40}$ = 9.93 x 10^{-10} moles/gm, $*Ar^{40}$ = 92.6%; (hornblende) K = 0.780%, $*Ar^{40}$ = 1.085 x 10^{-10} moles/gm, $*Ar^{40}$ = 93.1%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Collected by:*** R. F. Ehinger; ***dated by:*** J. D. Obradovich. ***Comment:*** These dates correlate the Flint Creek episode with the Boulder batholith episode.

(biotite) 74.0 ± 2.1 m.y.
(hornblende) 76.7 ± 2.5 m.y.

383. *Tilling, Klepper and Obradovich (1968)* K-Ar
18b

Butte quartz monzonite. (45°52.7'N, 112°26.1' W; sec. 35, T. 2 N., R. 7 W.; Homestake 7½' quad; Silver Bow Co.) ***Analytical data:*** (biotite) K_2O = 9.00%, $*Ar^{40}$ = 9.84 x 10^{-10} moles/gm, $*Ar^{40}$ = 74%; (a) K_2O = 0.600%, $*Ar^{40}$ = 0.691 x 10^{-10} moles/gm, $*Ar^{40}$ = 57%; (b) K_2O = 0.602%, $*Ar^{40}$ = 0.680 x 10^{-10} moles/gm, $*Ar^{40}$ = 72%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Replicate K analyses, (biotite) flame photometer, (hornblende) isotope dilution. ***Dated by:*** J. D. Obradovich. ***Comment:*** Hornblende dates consistent with geologic relations, but at variance with McDowell's 1966 hornblende dates.

(biotite) 72.7 ± 3.0 m.y.
(a) (hornblende) 76.5 ± 2.4 m.y.
(b) (hornblende) 75.0 ± 3.4 m.y.

384. *Knopf (1964)* K-Ar

Unionville granodiorite, a darkish rock of dioritic appearance. (46°30'05"N, 112°12'25"W; SE¼ sec. 27, T. 9 N., R. 5 W.; Elliston 15' quad; summit of Colorado Mountain, Lewis and Clark Co.) ***Analytical data:*** $*Ar^{40}/K^{40}$ = 0.00455. ***Constants:*** λ_e = 0.585 x 10^{-10}/hr, $\lambda\beta$ = 4.72 x 10^{-10}/yr. ***Collected by:*** A. Knopf; ***dated by:*** Geochron Laboratories, Inc. ***Comment:*** This date's close agreement with the age of the Clancy date (73-76 m.y.) is interpreted to indicate that no appreciable amount of $*Ar^{40}$ was driven out of the Unionville unit during intrusion of the Clancy unit.

(biotite) 76.4 ± 2.3 m.y.

385. *McDowell (1966, 1971) Tilling and others (1968)* K-Ar
L-1116
Boulder batholith, Butte-Clancy unit, coarse, equigranular quartz monzonite with plagioclase, quartz, orthoclase (somewhat sericitic), biotite (partially chloritic), hornblende with magnetite inclusions. (46°02'00"N, 112°27'58" W; SW¼ SW¼ sec. 3, T. 3 N., R. 7 W.; Elk Park 15' quad; along U.S. Hwy 91, 3 mi NE of Butte, Silver Bow Co.) ***Analytical data:*** (biotite) 98% with hornblende, 18% chlorite, K = 6.89%, $*Ar^{40}$ = 9.38 x 10^{-10} moles/gm, $*Ar^{40}$ = 79%; (hornblende) 60-100 mesh, K = 0.432%, $*Ar^{40}$ = 0.587 x 10^{-10} moles/gm, $*Ar^{40}$ = 53%; error = 1 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) isotope dilution with mass spectrometry, (Ar) stable isotope dilution with 4.5-inch Reynolds-type mass spectrometer; samples concentrated by fractionation in heavy liquids. ***Collected and dated by:*** F. W. McDowell. ***Comment:*** These dates indicate a short time for the emplacement and cooling of the Boulder batholith; Tilling, Klepper and Obradovich (1968) recalculated McDowell's data using λ_e = 0.584 x 10^{-10}/yr and (incorrectly) assuming weight of sample = 1 g. This weight assumption caused a greater variation in the recalculated dates than should be seen when simply converting from one λ_e to another.

(biotite) 75.2 ± 2.3 m.y.
(hornblende) 75.1 ± 2.3 m.y.

386. [Unpublished date]
Berg and McClernan K-Ar
Personal communication (1980)
RR-1
Mafic monzonite rim, Ringing Rocks stock, with plagioclase, K-spar, quartz, biotite (unaltered), pyroxenes, hornblende, apatite and magnetite. (45°56'31"N, 112°14'15"W; SW¼ NW¼ sec. 9, T. 2 N., R. 5 W.; Dry Mountain 7½' quad; Jefferson Co.) ***Analytical data:*** K = 7.730%, $*Ar^{40}/K^{40}$ = 0.004481, $*Ar^{40}$ = 71.5%. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40} = 1.22 x 10^{-4} g/gK. ***Method:*** Replicate K analyses. ***Collected by:*** R. B. Berg, H. G. McClernan, MBMG; ***dated by:*** Geochron Laboratories, Inc. ***Comment:*** This date consistent with geologic relations.

(biotite) 75.1 ± 2.8 m.y.

387. *Tilling, Klepper and Obradovich (1968)* K-Ar
13
Alaskite from the Butte quartz monzonite. (46° 07.5'N, 112°28.6'W; sec. 4, T. 4 N., R. 7 W.; Elk Park 15' quad; Jefferson Co.) ***Analytical data:*** K_2O = 8.61%, $*Ar^{40}$ = 9.73 x 10^{-10} moles/gm, $*Ar^{40}$ = 86%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Single K analysis, flame photometer. ***Dated by:*** R. F. Marvin, H. H. Thomas.

(biotite) 75.1 ± 3.7 m.y.

388. *Giletti (1966)* K-Ar
22
Biotite schist, medium to fine grained, with quartz, biotite, microcline, oligoclase, rare muscovite. (45°35'40"N, 112°29'10"W; NE¼ NE¼ NE¼ sec. 8, T. 3 S., R. 7 W.; Twin Bridges 15' quad; Rochester mining district, Madison Co.) ***Analytical data:*** K = 6.59%, $*Ar^{40}$ = 0.200 x 10^4 scc/g, $*Ar^{40}$ = 87.49%, $*Ar^{40}/K^{40}$ = 0.00444, error = 1 ς. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution with a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** This unit mapped as Precambrian; proximity to the Boulder batholith is the probable reason for very young age.

(biotite) 75 m.y.

389. *Giletti (1966)* K-Ar
24
Tobacco Root batholith, gneiss with quartz, plagioclase, biotite, orthoclase, some chlorite. (45°29'35"N, 111°59'43"W; NW¼ NW¼ NE¼ sec. 17, T. 4 S., R. 3 W.; Virginia City 15' quad; Madison Co.) ***Analytical data:*** K = 6.06%, $*Ar^{40}$ = 0.184 x 10^4 scc/g, $*Ar^{40}$ = 86.55%, $*Ar^{40}/K^{40}$ = 0.00445, error = ± 1 ς. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution with a Nier-type 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University.

(biotite) 75 m.y.

390. *Metz (1971)* U-Pb
Rosenberg and others (1970)
Armstrong (1975)
SB-130, SB-140
Th mineral from Snowbird deposit, ore cuts Beltian rocks (Wallace Formation). (46°46'41" N, 114°47'30"W; S½ SW¼ sec. 19, T. 12 N., R. 25 W.; Straight Peak 15' quad; near Idaho-Montana boundary W of Missoula, Mineral Co.) ***Analytical data:*** (a) U = 57.5 ppm, Th = 17,100 ppm, Pb = 55.2 ppm, Pb^{204}:Pb^{206}:Pb^{207}:Pb^{208} = 0.0062:1.228:0.1455:98.62; (b) U = 53.2 ppm, Th = 14,500 ppm, Pb = 48.4 ppm, Pb^{204}:Pb^{206}:Pb^{207}:Pb^{208} = 0.0146:1.466:0.2790:98.24; common Pb (measured on pyrite with 5 ppm Pb) Pb^{204}:Pb^{206}:Pb^{207}:Pb^{208} = 1.00:19.79:15.67:40.59. ***Collected by:*** P. E. Rosenberg, Washington State University; ***dated by:*** R. E. Zartman, U.S.G.S. ***Comment:*** U-Pb dates cited for these samples by Metz (1971) are: (a) Pb^{206}/U^{238}, 79 ± 2 m.y., Pb^{207}/U^{235}, 71 ± 4 m.y.; (b) Pb^{206}/U^{238}, 80 ± 2 m.y., Pb^{207}/U^{235}, 68 ± 9 m.y.

(a) (parisite) Pb^{208}/Th^{232} 73 ± 2 m.y.
Pb^{206}/U^{238} 78 ± 2 m.y.
Pb^{207}/U^{235} 73 ± 4 m.y.
(b) (parisite) Pb^{208}/Th^{232} 75 ± 2 m.y.
Pb^{206}/U^{238} 79 ± 2 m.y.
Pb^{207}/U^{235} 72 ± 9 m.y.

391. *Knopf (1964)* Rb-Sr
Boulder batholith granite. (46°31'06"N, 111°55'25"W; sec. 24, T. 9 N., R. 3 W. [est.]; East Helena 15' quad; Jefferson Co.) ***Constants:*** (a) $\lambda = 1.47 \times 10^{-11}$/yr; (b) $\lambda = 1.37 \times 10^{-11}$/yr. ***Collected by:*** A. Knopf; ***dated by:*** U.S.G.S.

(a) 71 ± 7 m.y.
(b) 75 ± 7 m.y.

392. *Skipp and McGrew (1977)* K-Ar
Hornblende phenocrysts, dacite flow, Member F of the Maudlow Formation. (46°01'54"N, 111°10'06"W; NE¼ sec. 12, T. 3 N., R. 4 E.; Maudlow 15' quad; Gallatin Co.) ***Comment:*** Date indicates the time of cessation of active rhyodacite volcanism in the Maudlow area.

(hornblende) 74.9 ± 1 m.y.

393. *Tilling, Klepper and Obradovich (1968)* K-Ar
17
Homestake pluton. (45°54.4'N, 112°24.8'W; sec. 24, T. 2 N., R. 7 W.; Homestake 7½' quad; Jefferson Co.) ***Analytical data:*** (a) K_2O = 8.61%, $*Ar^{40}$ = 9.13×10^{-10} moles/gm, $*Ar^{40}$ = 90%; (b) K_2O = 8.61%, $*Ar^{40}$ = 9.28×10^{-10} moles/gm, $*Ar^{40}$ = 91%; (hornblende) K_2O = 0.399%, $*Ar^{40}$ = 0.449×10^{-10} moles/gm, $*Ar^{40}$ = 63%. ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (a) and (b) single K analysis, flame photometer; (b) replicate Ar analyses; (hornblende) replicate K analyses, isotope dilution. ***Dated by:*** (a) R. F. Marvin, H. H. Thomas; (b) and (hornblende) J. D. Obradovich.

(a) (biotite) 70.5 ± 3.5 m.y.
(b) (biotite) 71.7 ± 3.3 m.y.
(hornblende) 74.7 ± 2.6 m.y.

394. *Tilling, Klepper and Obradovich (1968)* K-Ar
24
Rader Creek granodiorite. (45°49.5'N, 112°16.5'W; sec. 9, T. 1 N., R. 5 W.; Grace 7½' quad; Jefferson Co.) ***Analytical data:*** (biotite) K_2O = 6.79%, $*Ar^{40}$ = 7.55×10^{-10} moles/gm, $*Ar^{40}$ = 82%; (hornblende) K_2O = 0.476%, $*Ar^{40}$ = 0.535×10^{-10} moles/gm, $*Ar^{40}$ = 60%. ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (biotite) single K analysis, flame photometer; (hornblende) replicate K analyses, flame photometer. ***Dated by:*** (biotite) R. F. Marvin, H. H. Thomas; (hornblende) J. D. Obradovich.

(biotite) 73.9 ± 3.7 m.y.
(hornblende) 74.7 ± 3.0 m.y.

395. *Tilling, Klepper and Obradovich (1968)* K-Ar
21
Donald pluton. (45°49.3'N, 112°26.1'W; sec. 23, T. 1 N., R. 7 W.; Pipestone Pass 7½' quad; Silver Bow Co.) ***Analytical data:*** (a) K_2O = 7.91%, $*Ar^{40}$ = 8.35×10^{-10} moles/gm, $*Ar^{40}$ = 86%; (b) K_2O = 7.91%, $*Ar^{40}$ = 8.80×10^{-10} moles/gm, $*Ar^{40}$ = 93%; (hornblende) K_2O = 0.417%, $*Ar^{40}$ = 0.459×10^{-10} moles/gm, $*Ar^{40}$ = 79%. ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (biotite) replicate K analyses, flame photometer; (b) replicate Ar analyses; (hornblende) replicate K analyses, isotope dilution. ***Dated by:*** (a) R. F. Marvin, H. H. Thomas; (b) and (hornblende) J. D. Obradovich.

(a) (biotite) 70.2 ± 3.5 m.y.
(b) (biotite) 74.0 ± 3.0 m.y.
(hornblende) 73.2 ± 2.5 m.y.

396. *Robinson and Marvin (1967)* K-Ar
312
Three Forks perlite, dark gray, vitreous, slightly greasy glass (70%), with fine perlitic cracks and heavily charged phenocrysts (15%, half clear zoned plagioclase, half brown biotite, dark-green pyroxene and magnetite) and volcanic rock and mineral fragments (15%, mostly glass of different texture or color than the groundmass). (45°49'52"N, 111°43'17"W; SW¼ SW¼ SW¼ sec. 15, T. 1 N., R. 1 W.; Three Forks 15' quad; 10 mi due W of Three Forks, Jefferson Co.) ***Analytical data:*** (biotite) K_2O = 8.22%, $*Ar^{40}$ = 0.0368 ppm, $*Ar^{40}$ = 83%, $*Ar^{40}/K^{40}$ = 0.00442; (plagioclase) K_2O = 1.11, 1.20%, $*Ar^{40}$ = 0.00516 ppm, $*Ar^{40}$ = 92%, $*Ar^{40}/K^{40}$ = 0.00441; (a) K_2O = 3.32, 3.37%, $*Ar^{40}$ = 0.00454 ppm, $*Ar^{40}$ = 63%, $*Ar^{40}/K^{40}$ = 0.00134; (b) K_2O = 3.32, 3.37%, $*Ar^{40}$ = 0.00427 ppm, $*Ar^{40}$ = 30%, $*Ar^{40}/K^{40}$ = 0.00126; (c) K_2O = 3.26%, $*Ar^{40}$ = 0.00373 ppm, $*Ar^{40}$ = 19%, $*Ar^{40}/K^{40}$ = 0.00113. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard. ***Dated by:*** R. F. Marvin, H. H. Thomas, P. L. D. Elmore, H. H. Mehnert, W. Mountjoy. ***Comment:*** Other work indicates these glasses are probably several m.y. older than the plagioclase and biotite ages suggest; 78 m.y. sounds reasonable; low glass ages due to Ar loss.

(biotite) 74 ± 4 m.y.
(plagioclase) 74 ± 4 m.y.
(a) (glass) 23 ± 7 m.y.
(b) (glass) 21 ± 7 m.y.
(c) (glass) 19 ± 2 m.y.

397. *Tilling, Klepper and Obradovich (1968)* K-Ar
26
Hell Canyon pluton. (45°37.1'N, 112°19.8'W; sec. 34, T. 2 S., R. 6 W.; Twin Bridges 15' quad; Madison Co.) ***Analytical data:*** (biotite) K_2O = 8.21%, $*Ar^{40} = 8.65 \times 10^{-10}$ moles/gm, $*Ar^{40}$ = 90%; (hornblende) K_2O = 0.486%, $*Ar^{40} = 0.540 \times 10^{-10}$ moles/gm, $*Ar^{40}$ = 71%. ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (biotite) single K analysis, flame photometer; (hornblende) replicate K analyses, flame photometer. ***Dated by:*** (biotite) R. F. Marvin, H. H. Thomas; (hornblende) J. D. Obradovich.

(biotite) 70 ± 3.5 m.y.
(hornblende) 73.9 ± 3.0 m.y.

398. *Hughes (1971, 1975)* K-Ar
BP-1
Pale-gray to pinkish-gray quartz latite porphyry dike with quartz, feldspar, sericite, kaolinite and euhedral phenocrysts of quartz, K-spar, plagioclase, muscovite and accessories of magnetite, pyrite, apatite and zircon; noticeable lack of mafic minerals. (46°26'00"N, 113°25'30"W; sec. 24, T. 8 N., R. 15 W. [est.]; Black Pine Ridge 7½' quad; between Miners Gulch and Henderson stocks, Granite Co.) ***Analytical data:*** $*Ar^{40}/K^{40}$ = 0.00440. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40} = 1.22 \times 10^{-4}$ g/gK. ***Collected by:*** G. J. Hughes, Jr.; ***dated by:*** Geochron Laboratories, Inc. ***Comment:*** Muscovite may be result of alteration of biotite; dike believed to be comagmatic with Miners Gulch and Henderson stocks and intruded when they were emplaced.

(muscovite) 73.7 ± 2.4 m.y.

399. *Elliott, Naeser and Hedge (1974)* K-Ar
Elliott (1974, 1979)
K alteration associated with Cu mineralization in the Goose Lake syenite stock. (45°07'30"N, 109°54'30"W; sec. 19, T. 8 S., R. 15 E.; Cooke City 7½' quad; Copper King mine, Goose Lake, Park Co.) ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Collected by:*** J. E. Elliott; ***dated by:*** C. E. Hedge. ***Comment:*** Goose Lake syenite stock dated at 84.6 ± 11.2 m.y.

(adularia) 73.6 ± 0.9 m.y.

400. *Knopf (1964)* K-Ar
Boulder batholith adamellite. (46°29'30"N, 112°01'55"W; sec. 31, T. 9 N., R. 3 W. [est.]; Jefferson City 15' quad; 6 mi S of Helena, Jefferson Co.) ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr. ***Collected by:*** A. Knopf; ***dated by:*** Geochron Laboratories, Inc. ***Comment:*** This date is higher than that of the Clancy unit, which this unit intrudes, but is still within experimental error.

(biotite) 73.5 ± 1.4 m.y.

401. [Unpublished date]
Berg and McClernan K-Ar
Personal communication (1980)
EL-1
Biotite-bearing granodiorite, unaltered, with zoned plagioclase, quartz, hornblende, magnetite, apatite and opaques; Easter Lily stock. (45°55'56"N, 112°14'04"W; SE¼ SW¼ sec.

9, T. 2 N., R. 5 W.; Dry Mountain 7½′ quad; Jefferson Co.) ***Analytical data:*** K = 6.76%, $*Ar^{40}/K^{40}$ = 0.004383, $*Ar^{40}$ = 74.5%. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40} = 1.22 x 10^{-4} g/gK. ***Method:*** Replicate K analyses. ***Collected by:*** R. B. Berg, H. G. McClernan, MBMG; ***dated by:*** Geochron Laboratories, Inc. ***Comment:*** This date is close to the age of the silicic facies of the Butte quartz monzonite, consistent with geologic relations.

(biotite) 73.5 ± 2.7 m.y.

402. *Tilling, Klepper and Obradovich (1968)* K-Ar

9

Mafic rocks. (46°28.6′N, 111°44.0′W; sec. 4, T. 8 N., R. 1 W.; Townsend 15′ quad; Broadwater Co.) ***Analytical data:*** K_2O = 8.82%, $*Ar^{40}$ = 9.76 x 10^{-10} moles/gm, $*Ar^{40}$ = 91%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Replicate K analyses, flame photometer. ***Dated by:*** J. D. Obradovich. ***Comment:*** This age is almost certainly a minimum because the sample is from within ¼ mi of a younger intrusive mass.

(biotite) 73.5 ± 2.9 m.y.

403. *Ehinger (1971) Hyndman, Obradovich and Ehinger (1972)* K-Ar

AA-4

Philipsburg batholith, medium-grained granodiorite with 45% plagioclase, 20% K-spar, 20% quartz, 15% mafic minerals. (46°18′21″N, 113°13′39″W; NE¼ sec. 4, T. 6 N., R. 13 W.; Fred Burr Lake 7½′ quad; 1.1 mi SW of Granite, Granite Co.) ***Analytical data:*** (biotite) K = 7.36%, $*Ar^{40}$ = 9.79 x 10^{-10} moles/gm, $*Ar^{40}$ = 90.5%; (hornblende) K = 0.424%, $*Ar^{40}$ = 0.553 x 10^{-10} moles/gm, $*Ar^{40}$ = 63.1%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Collected by:*** R. F. Ehinger; ***dated by:*** J. D. Obradovich. ***Comment:*** These dates correlate the Flint Creek episode with the Boulder batholith episode.

(biotite) 73.4 ± 2.1 m.y.
(hornblende) 72.0 ± 2.5 m.y.

404. *Tilling, Klepper and Obradovich (1968)* K-Ar

10b

Butte quartz monzonite. (46°27′35″N, 112°27′35″W; NE¼ sec. 8, T. 8 N., R. 3 W.; Jefferson City 15′ quad; Kain quarry, Jefferson Co.) ***Analytical data:*** (a) K_2O = 0.456%, $*Ar^{40}$ = 0.503 x 10^{-10} moles/gm, $*Ar^{40}$ = 84%; (b) K_2O = 0.459%, $*Ar^{40}$ = 0.492 x 10^{-10} moles/gm, $*Ar^{40}$ = 70%; (c) K_2O = 8.74%, $*Ar^{40}$ = 9.42 x 10^{-10} moles/gm, $*Ar^{40}$ = 96%; (d) K_2O = 8.74%, $*Ar^{40}$ = 9.45 x 10^{-10} moles/gm, $*Ar^{40}$ = 96%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (a) and (b) replicate K analyses, isotope dilution; (c) and (d) replicate K analyses, flame photometer; (d) replicate Ar analyses. ***Dated by:*** J. D. Obradovich. ***Comment:*** These dates are in good agreement with the biotite age by Geochron Laboratories, Inc. (Knopf, 1964).

(a) (hornblende) 73.3 ± 2.5 m.y.
(b) (hornblende) 71.4 ± 2.5 m.y.
(c) (biotite) 71.9 ± 2.2 m.y.
(d) (biotite) 71.7 ± 2.3 m.y.

[No. 405 was omitted.]

406. *Robinson and Marvin (1967)* K-Ar

649

Wolf Creek welded glass, similar to the Three Forks perlite, but with more mafic phenocrysts: labradorite, augite, hornblende, hypersthene and locally biotite. (46°59′11″N, 112°02′35″W; NE¼ sec. 12, T. 14 N., R. 4 W.; Sheep Creek 7½′ quad; 1 mi SE of Wolf Creek, Lewis and Clark Co.) ***Analytical data:*** (biotite) K_2O = 3.85, 3.75%, $*Ar^{40}$ = 0.0168 ppm, $*Ar^{40}$ = 86%, $*Ar^{40}/K^{40}$ = 0.00437; (plagioclase) K_2O = 0.81%, $*Ar^{40}$ = 0.00352 ppm, $*Ar^{40}$ = 64%, $*Ar^{40}/K^{40}$ = 0.00429; (glass) K_2O = 1.31%, $*Ar^{40}$ = 0.00250 ppm, $*Ar^{40}$ = 51%, $*Ar^{40}/K^{40}$ = 0.00188. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard. ***Dated by:*** R. F. Marvin, H. H. Mehnert, W. Mountjoy. ***Comment:*** Other work indicates that these glasses are probably several m.y. older than the plagioclase age suggests; 78 m.y. sounds good; low glass age due to Ar loss.

(biotite) 73 ± 2 m.y.
(plagioclase) 72 ± 7 m.y.
(glass) 32 ± 2 m.y.

407. *Tilling, Klepper and Obradovich (1968)* K-Ar

16

Butte quartz monzonite. (45°55.3′N, 112°18.6′W; sec. 14, T. 2 N., R. 6 W.; Delmoe Lake 7½′ quad; Jefferson Co.) ***Analytical data:*** (bio-

tite) K_2O = 7.33%, $*Ar^{40}$ = 8.08×10^{-10} moles/gm, $*Ar^{40}$ = 86%; (hornblende) K_2O = 0.550%, $*Ar^{40}$ = 0.589×10^{-10} moles/gm, $*Ar^{40}$ = 69%. ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (biotite) single K analysis, flame photometer; (hornblende) replicate K analyses, flame photometer. ***Dated by:*** (biotite) R. F. Marvin, H. H. Thomas; (hornblende) J. D. Obradovich. ***Comment:*** These young ages are probably due to the proximity (less than ½ mi) of the younger Homestake pluton.

(biotite) 72.9 ± 3.6 m.y.
(hornblende) 71.2 ± 3.6 m.y.

408. *Tilling, Klepper and Obradovich (1968)* K-Ar

23

Rader Creek granodiorite. (45°48.4'N, 112° 21.2'W; sec. 28, T. 1 N., R. 6 W.; Grace 7½' quad; Silver Bow Co.) ***Analytical data:*** K_2O = 8.84%, $*Ar^{40}$ = 9.68×10^{-10} moles/gm, $*Ar^{40}$ = 92%. ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** Single K analysis, flame photometer. ***Dated by:*** R. F. Marvin, H. H. Thomas. ***Comment:*** Age may have been reduced by reheating.

(biotite) 72.8 ± 3.6 m.y.

409. *McDowell (1966, 1971) Tilling and others (1968)* K-Ar

L-1025

Boulder batholith, porphyritic quartz monzonite with quartz, orthoclase and biotite, and with phenocrysts of plagioclase, orthoclase, hornblende (rare, severely altered to biotite), and biotite (primary). (46°34'32"N, 112°14'13" W; NE¼ SW¼ sec. 33, T. 10 N., R. 5 W.; Helena 15' quad; along U.S. Hwy 12, 5 mi E of McDonald Pass, Lewis and Clark Co.) ***Analytical data:*** (a) K = 7.10%, $*Ar^{40}$ = 9.39×10^{-10} moles/gm, $*Ar^{40}$ = 78%; (b) K = 7.10%, $*Ar^{40}$ = 9.26×10^{-10} moles/gm, $*Ar^{40}$ = 83%; error = 1 ς. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) isotope dilution with mass spectrometry, (Ar) stable isotope dilution with 4.5-inch Reynolds-type mass spectrometer; samples concentrated by fractionation in heavy liquids. ***Collected and dated by:*** F. W. McDowell. ***Comment:*** These ages may be minimum ages due to a nearby younger pluton; Tilling, Klepper and Obradovich (1968) recalculated McDowell's data using $\lambda_e = 0.584 \times 10^{-10}$/yr and (incorrectly) assuming weight of sample = 1 g. This weight assumption caused a greater variation in the recalculated dates than should be seen when simply converting from one λ_e to another.

(a) (biotite) 72.7 ± 2.2 m.y.
(b) (biotite) 71.8 ± 2.2 m.y.

410. *Tilling, Klepper and Obradovich (1968)* K-Ar

Unionville granodiorite. (46°32.0'N, 111°54.0' W; sec. 18, T. 9 N., R. 2 W. [est.]; East Helena 15' quad; Jefferson Co.) ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio.

(biotite) 72.4 m.y.

411. *Hoffman, Hower and Aronson (1976) Hoffman (1976)* K-Ar

MB-11

Potash bentonite with kaolin, Telegraph Creek Formation. (47°01'28"N, 112°03'04"W; sec. 25, T. 15 N., R. 4 W. [est.]; Wolf Creek 7½' quad; Wolf Creek, Lewis and Clark Co.) ***Analytical data:*** K_2O = 2.86%, adjusted K = 25.7%, $*Ar^{40}$ = 2.311×10^{-10} moles/g, $*Ar^{40}$ = 59%, 54% expandable (smectite) layers in the mixed-layered clays. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) I.L. flame photometer with Li internal standard, (Ar) isotope dilution. ***Dated by:*** J. L. Hoffman, J. L. Aronson. ***Comment:*** Age calculated using the "fixed" K content of Thompson and Hower (1973); approximate age of deposition = 82 to 85 m.y. ago; age interpreted as "coincident with time of maximum temperatures generated during or after thrusting in the disturbed belt."

(illite/smectite) 72.2 m.y.

412. *Chapman, Gottfried and Faul (1954) Walker (1963)* Pb-α

53-C-8

Boulder batholith, medium-grained alaskite. (46°18'13"N, 111°56'19"W; NE¼ sec. 2, T. 6 N., R. 3 W. [est.]; Clancy 15' quad; ½ mi SW of summit of Elkhorn Peak, Jefferson Co.) ***Analytical data:*** (zircon) 4990 α/mg/hr, Pb = 127 ppm; (monazite) 6545 α/mg/hr, Pb = 231 ppm. ***Method:*** (Pb) Waring and Worthing (1953) spectrographic method, (α) thick source α counting techniques; samples concentrated by fractionation in heavy liquids. ***Collected by:*** R. W. Chapman; ***dated by:*** C. L. Waring, D. Gottfried. ***Comment:*** Dates agree with structural and stratigraphic evi-

dence, and indicate that the Boulder batholith was emplaced at or near the end of the Cretaceous.

(zircon) 61 m.y.
(monazite) 72 m.y.

413. *Tilling, Klepper and Obradovich (1968)* K-Ar
11
Pulpit Rock pluton. (46°15.3'N, 112°10.3'W; sec. 24, T. 6 N., R. 5 W.; Jefferson City 15' quad; Jefferson Co.) ***Analytical data:*** (a) K_2O = 9.10%, $*Ar^{40}$ = 89%, $*Ar^{40}$ = 9.84 x 10^{-10} moles/gm; (b) K_2O = 9.10%, $*Ar^{40}$ = 87%, $*Ar^{40}$ = 9.59 x 10^{-10} moles/gm. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Single K analyses, flame photometer; (a) replicate Ar analyses. ***Dated by:*** R. F. Marvin, H. H. Thomas.

(a) (biotite) 71.9 ± 3.6 m.y.
(b) (biotite) 70.2 ± 3.5 m.y.

414. *Hoffman, Hower and Aronson (1976) Hoffman (1976)* K-Ar
LTE-27
Potash bentonite, 3 inches thick, with 92% total layer silicates, 3% quartz, 5% plagioclase, Marias River Formation. (48°45'48"N, 113°24'57"W; sec. 34, T. 35 N., R. 14 W. [est.]; Saint Mary 7½' quad; Glacier Park, Saint Mary, Glacier Co.) ***Analytical data:*** K_2O = 4.39%, adjusted K = 18.5%, $*Ar^{40}$ = 3.866 x 10^{-10} moles/g, $*Ar^{40}$ = 73%, 41% expandable (smectite) layers in the mixed-layered clay. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) I.L. flame photometer with Li internal standard, (Ar) isotope dilution. ***Dated by:*** J. L. Hoffman, J. L. Aronson. ***Comment:*** Age calculated using the "fixed" K content of Thompson and Hower (1973); approximate age of deposition = 85 to 88 m.y. ago; age interpreted as "coincident with time of maximum temperatures generated during or after thrusting in the disturbed belt."

(illite/smectite) 71.8 m.y.

415. *Obradovich and Cobban (1975)* K-Ar
2686
60-cm bentonite bed about 6 m below the *Baculites compressus* zone in the middle of the Bearpaw Shale. (47°00'05"N; 107°47'35"W; SW¼ NE¼ sec. 4, T. 14 N., R. 31 E.; Barney Pinnacle 7½' quad; Garfield Co.) ***Analytical data:*** K = 4.41%, $*Ar^{40}$ = 5.71 x 10^{-10} moles/gm, Ar^{40} = 93.6%, 150 mesh, error = 1 ς. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-14} atomic ratio. ***Method:*** Sample concentrated by fractionation in heavy liquids, mass spectrometry, (K) isotope dilution. ***Dated by:*** J. D. Obradovich, W. A. Cobban.

(biotite) 71.5 ± 0.7 m.y.

416. *Hoffman, Hower and Aronson (1976) Hoffman (1976)* K-Ar
LTE-23
Potash bentonite, 5 inches thick, with 63% total layer silicates, 8% quartz, 4% plagioclase, 25% calcite, trace of chlorite, Colorado Group. (47°52'32"N, 112°47'36"W; NE¼ sec. 31, T. 25 N., R. 9 W. [est.]; Mount Wright 7½' quad; Teton Pass, Flathead Co.) ***Analytical data:*** (a) 0.2-0.5 μm, K_2O = 4.98%, adjusted K = 7.9%, $*Ar^{40}$ = 4.937 x 10^{-10} moles/g, $*Ar^{40}$ = 90%; 12% expandable (smectite) layers in the mixed-layered clay; (b) 0.06-0.2 μm K_2O = 5.14%, $*Ar^{40}$ = 4.971 x 10^{-10} moles/g. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) I.L. flame photometer with Li internal standard, (Ar) isotope dilution. ***Dated by:*** J. L. Hoffman, J. L. Aronson. ***Comments:*** Age calculated using the "fixed" K content of Thompson and Hower (1973); approximate age of deposition is less than 94 m.y. ago; age interpreted as "coincident with time of maximum temperatures generated during or after thrusting in the Disturbed Belt."

(a) (illite/smectite) 71.5 m.y.
(b) (illite/smectite) 67.9 m.y.

417. *Zen, Marvin and Mehnert (1975)* K-Ar
IVP
Tonalite of Pioneer batholith. (45°31'15"N, 112°50'20"W; NW¼ sec. 4, T. 4 S., R. 10 W.; Vipond Park 15' quad; Beaverhead Co.) ***Analytical data:*** (biotite) K_2O = 9.12, 9.08%, $*Ar^{40}$ = 9.712 x 10^{-10} moles/gm, $*Ar^{40}$ = 94%; (hornblende) K_2O = 0.627, 0.627%, $*Ar^{40}$ = 0.6405 x 10^{-10} moles/gm, $*Ar^{40}$ = 80%; > 99% pure, no visible alteration products, error = ± 2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, L. Schlocker. ***Comment:*** "Ages closely approximate time of intrusion."

(biotite) 71.0 ± 2.7 m.y.
(hornblende) 68.0 ± 1.9 m.y.

418. *Beveridge and Folinsbee (1956)* K-Ar
KA 34
Boulder batholith, a pegmatitic veinlet in quartz monzonite. (46°30'N, 112°05'W; T. 8 N., R. 4 W. [est.]; Jefferson City 15' quad; Jefferson Co.) ***Constants:*** $\lambda_e = 0.55 \times 10^{-10}$/yr, $\lambda_\beta = 4.55 \times 10^{-10}$/yr. ***Method:*** Mass spectrometer. ***Collected by:*** A. Knopf; ***dated by:*** J. H. Reynolds, J. Lipson.

(orthoclase) 71 m.y.

419. *Chapman, Gottfried and Waring (1955)* Pb-α
Faul (1954)
Walker (1963)
52-C-60-Z
Medium- to fine-grained hornblende-biotite quartz monzonite with more ferromagnesian minerals than No. 52-C-45, from the Boulder batholith. (46°10'58"N, 112°20'26"W; sec. 15, T. 5 N., R. 6 W., [est.]; Elk Park 15' quad; road-cut 3 mi NE of Elk Park, Jefferson Co.) ***Analytical data:*** 203 α/mg/hr, Pb = 6 ppm. ***Method:*** (Pb) Waring and Worthing (1953) spectrographic method, (α) thick source α counting techniques, sample concentrated by fractionation with heavy liquids. ***Collected by:*** R. W. Chapman; ***dated by:*** D. Gottgried, C. L. Waring. ***Comment:*** Date agrees with structural and stratigraphic evidence; indicates that the Boulder batholith was emplaced at or near the end of the Cretaceous.

(zircon) 71 m.y.

420. *Baty (1973, 1976)* F.T.
S28-4
Royal stock. (46°25'15"N, 113°06'10"W; NE¼ sec. 28, T. 8 N., R. 12 W. [est.]; Pikes Peak 7½' quad; Granite Co.) ***Analytical data:*** $\varrho_S = 572$, 40 grains counted, 14.3 density ϱ_S/unit area; $\varrho_i = 667$, 40 grains counted, 16.7 density ϱ_i/unit area; $\phi = 1.35 \times 10^{15}$ neutron/cm², 65-115 mesh, 95% purity, sample concentrated by fractionation in heavy liquids. ***Constants:*** (U^{238}) $\lambda_D = 1.54 \times 10^{-10}$/yr, ($U^{238}$) $\lambda_F = 6.85 \times 10^{-17}$/yr, ($U^{235}$) $\varsigma = 582 \times 10^{-24}$ cm², $U^{235}/U^{238} = 7.26 \times 10^{-3}$. ***Collected and dated by:*** J. B. Baty. ***Comment:*** Although Baty's fission track dates are about 10 m.y. younger than Obradovich's K-Ar dates, all are consistent with geologic relations and past research in the area.

(apatite) 70.8 m.y.

421. *Hughes (1971, 1975)* K-Ar
WC-7
Rim facies quartz diorite, Miners Gulch stock, with 50% plagioclase, 16% biotite, 14% quartz, 11% hornblende and some K-spar and opaques. (46°24'30"N, 113°31'34"W; NW¼ sec. 31, T. 8 N., R. 15 W.; Alder Gulch 7½' quad; Granite Co.) ***Analytical data:*** $*Ar^{40}/K^{40} = 0.00421$. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40} = 1.22 \times 10^{-4}$ g/gK. ***Collected by:*** G. J. Hughes, Jr.; ***dated by:*** Geochron Laboratories, Inc. ***Comment:*** Close agreement of this date with that for Henderson stock supports idea that these stocks were co-magmatic and emplaced contemporaneously.

(biotite) 70.6 ± 2.3 m.y.

422. *Zen, Marvin and Mehnert (1975)* K-Ar
BHS
Coarse granite, Pioneer batholith. (45°35'14"N, 112°56'55"W; NW¼ sec. 15, T. 3 S., R. 11 W; Vipond Park 15' quad; Beaverhead Co.) ***Analytical data:*** $K_2O = 9.30, 9.32\%$, $*Ar^{40} = 9.886 \times 10^{-10}$ moles/gm, $*Ar^{40} = 90\%$, error = ± 2 ς, > 99% pure, no visible alteration products. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, L. Schlocker. ***Comment:*** Mapping shows that the quartz diorite (No. DR) occurs as inclusions in porphyritic granodiorite (No. BH 9850), which is cut by apophyses of granite (No. BHS); the K-Ar ages agree with this order, though the age difference between the two younger intrusions is not established.

(biotite) 70.6 ± 2.4 m.y.

423. *Tilling, Klepper and Obradovich (1968)* K-Ar
20
Climax Gulch pluton. (45°51.0'N, 112°32.3'W; sec. 12, T. 1 N., R. 8 W.; Butte South 15' quad; Silver Bow Co.) ***Analytical data:*** $K_2O = 7.92\%$, $*Ar^{40} = 85\%$, $*Ar^{40} = 8.34 \times 10^{-10}$ moles/gm. ***Constants:*** $\lambda_c = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** Single K analysis, flame photometer. ***Dated by:*** R. F. Marvin, H. H. Thomas.

(biotite) 70.6 ± 3.5 m.y.

424. *Zen, Marvin and Mehnert (1975)* K-Ar

287-1, 287-2

Biotite gneiss, Silver Hill Formation, border of Pioneer batholith. (45°36'29"N, 112°55'20"W; NW¼ sec. 1, T. 3 S., R. 11 W.; Vipond Park 15' quad; Hecla, Beaverhead Co.) ***Analytical data:*** (a) K_2O = 9.45, 9.50%, $*Ar^{40}$ = 9.962 x 10^{-10} moles/gm, $*Ar^{40}$ = 95%; (b) K_2O = 9.43, 9.51%, $*Ar^{40}$ = 10.04 x 10^{-10} moles/gm, $*Ar^{40}$ = 91%; > 99% pure, no visible alteration products, error = ± 2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, L. Schlocker.

(a) (biotite) 70.0 ± 2.4 m.y.
(b) (biotite) 70.5 ± 2.4 m.y.

425. *Knopf (1964)* K-Ar

Boulder batholith granite. (46°31'06"N, 111°55'25"W; sec. 24, T. 9 N., R. 3 W. [est.]; East Helena 15' quad; Jefferson Co.) ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr. ***Collected by:*** A. Knopf; ***dated by:*** Geochron Laboratories, Inc.

(biotite) 70.2 ± 1.5 m.y.

426. *Hughes (1971, 1975)* K-Ar

HM-57

Henderson stock with 41% plagioclase, 36% quartz, 13% K-spar and 10% biotite. (46°28'53"N, 113°18'58"W; NE¼ sec. 2, T. 8 N., R. 14 W.; Saddle 7½' quad; Granite Co.) ***Analytical data:*** $*Ar^{40}/K^{40}$ = 0.00418. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40} = 1.22 x 10^{-4} g/gK. ***Collected by:*** G. J. Hughes, Jr.; ***dated by:*** Geochron Laboratories, Inc. ***Comment:*** Close agreement of this date with that for Miners Gulch stock supports idea that these stocks were comagmatic and emplaced contemporaneously.

(biotite) 70.1 ± 2.5 m.y.

427. *Zen, Marvin and Mehnert (1975)* K-Ar

BH 9850

Porphyritic granodiorite, Pioneer batholith. (45°35'18"N, 112°56'55"W; SW¼ sec. 10, T. 3 S., R. 11 W.; Vipond Park 15' quad; Beaverhead Co.) ***Analytical data:*** (biotite) K_2O = 9.40, 9.42%, $*Ar^{40}$ = 9.888 x 10^{-10} moles/gm, $*Ar^{40}$ = 90%; (hornblende) K_2O = 0.915, 0.915%, $*Ar^{40}$ = 0.9243 x 10^{-10} moles/gm, $*Ar^{40}$ = 81%; > 99% purity, no visible alteration products; error = ± 2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, L. Schlocker. ***Comment:*** Mapping shows that the quartz diorite (No. DR) occurs as inclusions in the porphyritic granodiorite (No. BH 9850), which is cut by apophyses of granite (No. BHS); the K-Ar ages agree with this order, though the age difference between the two younger intrusions is not established.

(biotite) 69.9 ± 2.4 m.y.
(hornblende) 67.2 ± 1.9 m.y.

428. *Baty (1973, 1976)* F.T.

S16-7

Mt. Powell pluton. (46°14'50"N, 113°03'55"W; NE¼ sec. 26, T. 6 N., R. 12 W. [est.]; West Valley 7½' quad; Granite Co.) ***Analytical data:*** ϱ_s = 238, 48 grains counted, 5.0 density $\varrho_s$unit area; ϱ_i = 277, 40 grains counted, 5.9 density ϱ_i/unit area; ϕ = 1.35 x 10^{15} neutron/cm²; 65-115 mesh, 95% purity, sample concentrated by fractionation in heavy liquids. ***Constants:*** (U^{238}) λ_D = 1.54 x 10^{-10}/yr, (U^{238}) λ_F = 6.85 x 10^{-17}/yr, (U^{235}) ς = 582 x 10^{-24}, U^{235}/U^{238} = 7.26 x 10^{-3}. ***Collected and dated by:*** J. B. Baty. ***Comment:*** Although Baty's fission track dates are about 10 m.y. younger than Obradovich's K-Ar dates, all are consistent with geologic relations and past research in the area.

(apatite) 69.7 m.y.

429. *Hoffman, Hower and Aronson (1976) Hoffman (1976)* K-Ar

LT-85

Potash bentonite, 7 ft. thick, with 58% total layer silicates, 30% quartz, 3% plagioclase, 9% calcite, Kevin Shale Member, Marias River Formation. (47°37'21"N, 112°55'18"W; sec. 32, T. 22 N., R. 10 W. [est.]; Pretty Prairie 7½' quad; South Fork of the Sun River, Lewis and Clark Co.) ***Analytical data:*** K_2O = 5.48%, adjusted K = 18.0%, $*Ar^{40}$ = 4.711 x 10^{-10} moles/g, $*Ar^{40}$ = 80%, 40% expandable smectite) layers in the mixed-layered clay. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) I.L. flame photometer with Li internal standard, (Ar) isotope dilution. ***Dated by:*** J. L. Hoffman, J. L. Aronson. ***Comment:*** Age calculated using the "fixed" K content of Thompson and Hower (1973); approximate age of deposition = 89 m.y. ago; age interpreted as "coincident with time of maximum temperatures generated during or after thrusting in the Disturbed Belt."

(illite/smectite) 69.7 m.y.

430. [Unpublished date] K-Ar
McClernan and Berg
Personal communication (1980)
K-2
Medium-grained granodiorite with plagioclase, quartz, K-spar, biotite, hornblende and traces of apatite, opaques, sphene; quartz and K-spar interstitial to plagioclase; biotite and hornblende mostly fresh (local chloritization). (46° 27'20''N, 111°21'30''W; SE¼ NW¼ sec. 16, T. 8 N., R. 3 E.; Duck Creek Pass 15' quad; outcrop on N side of road and creek, Big Belt Mountains, Broadwater Co.) ***Analytical data:*** (biotite) −60/+200 mesh, K = 6.357%, $*Ar^{40}$ = 0.02900 ppm, $*Ar^{40}$ = 61%, $*Ar^{40}/K^{40}$ = 0.003738; (hornblende) −80/+200 mesh, K = 1.213%, $*Ar^{40}$ = 0.006154 ppm, $*Ar^{40}$ = 52%, $*Ar^{40}/K^{40}$ = 0.004157. ***Constants:*** λ_e = 0.585×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr, K^{40} = 1.22×10^{-4} g/gK. ***Collected by:*** H. G. McClernan, R. B. Berg, MBMG; ***dated by:*** Geochron Laboratories, Inc. ***Comment:*** Geology of area in Mertie, Fischer and Hobbs (1951).

(biotite) 62.8 ± 2.4 m.y.
(hornblende) 69.7 ± 3.2 m.y.

431. *Baty (1973, 1976)* F.T.
H31-1
Royal stock. (46°26'55''N, 113°01'10''W; NE¼ sec. 18, T. 8 N., R. 11 W. [est.]; Pikes Peak 7½' quad; Powell Co.) ***Analytical data:*** ϱ_S = 452, 48 grains counted, 9.4 density ϱ_S/unit area; ϱ_i = 423, 40 grains counted, 10.6 density ϱ_i/unit area; $\phi = 1.29 \times 10^{15}$ neutron/cm²; 65-115 mesh, 95% purity, sample concentrated by fractionation in heavy liquids. ***Constants:*** (U^{238}) $\lambda_D = 1.54 \times 10^{-10}$/yr, ($U^{238}$) $\lambda_F = 6.85 \times 10^{-17}$/yr, ($U^{235}$) $\varsigma = 582 \times 10^{-24}$ cm², $U^{235}/U^{238} = 7.26 \times 10^{-3}$. ***Collected and dated by:*** J. B. Baty. ***Comment:*** Although Baty's fission track dates are about 10 m.y. younger than Obradovich's K-Ar dates, all are consistent with geologic relations and past research in the area.

(apatite) 69.3 m.y.

432. *McDowell (1966, 1971)* K-Ar
Tilling and others (1968)
L-1024
Boulder batholith, Butte-Clancy unit, coarse porphyritic quartz monzonite with plagioclase, quartz, orthoclase, biotite (some chloritization) and hornblende, and with phenocrysts of quartz, microcline (plagioclase and biotite inclusions) and biotite. (45°49'00''N, 112°36'44''W; SW¼ sec. 21, T. 1 N., R. 8 W. [est.]; Butte South 15' quad; along Forest Service road 3.2 mi E of U.S. Hwy 91 and 11 miS of U.S. Hwy 10, Silver Bow Co.) ***Analytical data:*** (biotite) 3% chlorite, K = 6.91%, $*Ar^{40}$ = 8.50×10^{-10} moles/gm, $*Ar^{40}$ = 82%; (hornblende) 2% biotite, K = 1.07%, $*Ar^{40}$ = 1.337 x 10^{-10} moles/gm, $*Ar^{40}$ = 69%; error = 1 ς. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) isotope dilution with mass spectrometry, (Ar) stable isotope dilution with 4.5-inch Reynolds-type mass spectrometer, samples concentrated by fractionation in heavy liquids. ***Collected and dated by:*** F. W. McDowell. ***Comment:*** "Dates low, possible Ar loss"; Tilling, Klepper and Obradovich (1968) recalculated McDowell's data using λ_e = 0.584×10^{-10}/yr and (incorrectly) assuming weight of sample = 1 g. This weight assumption caused a greater variation in the recalculated dates than should be seen when simply converting from one λ_e to another.

(biotite) 68.1 ± 2.0 m.y.
(hornblende) 69.2 ± 2.1 m.y.

433. *Chapman, Gottfried and Waring (1955)* Pb-α
Faul (1954)
Walker (1963)
52-C-45-Z
Medium-grained porphyritic hornblende-biotite quartz monzonite with large phenocrysts of pink potash feldspar, Boulder batholith. (46° 15'10''N, 112°08'57''W; SE¼ sec. 19, T. 6 N., R. 4 W. [est.]; Jefferson City 15' quad; quarry 1½ mi W of Boulder, Jefferson Co.) ***Analytical data:*** 227 α/mg/hr, Pb = 8 ppm. ***Method:*** (Pb) Waring and Worthing (1953) spectrographic method, (α) thick source α counting technique, sample concentrated by fractionation in heavy liquids. ***Collected by:*** R. W. Chapman; ***dated by:*** D. Gottfried, C. L. Waring. ***Comment:*** Date agrees with structural and stratigraphic evidence and indicates that the Boulder batholith was emplaced at or near the end of the Cretaceous.

(zircon) 69 m.y.

434. *Chapman, Gottfried and Waring (1955)* Pb-α
Faul (1954)
Walker (1963)
52-C-10a-Z
Medium-grained quartz monzonite with about 30% biotite and hornblende, from the border of the Boulder batholith. (46°30'N, 112°W; T. 9 N., R. 3 W. [est.]; Jefferson City 15' quad; 7 mi SE of Helena, Jefferson Co.) ***Analytical***

data: 160 α/mg/hr, Pb = 4.6 ppm. ***Method:*** (Pb) Waring and Worthing (1953) spectrographic method, (α) thick source α counting techniques, samples concentrated by fractionation with heavy liquids. ***Collected by:*** R. W. Chapman; ***dated by:*** D. Gottfried, C. L. Waring. ***Comment:*** Date agrees with structural and stratigraphic evidence; indicates that Boulder batholith was emplaced at or near the end of Cretaceous.

(zircon) 69 m.y.

435. *Knopf (1964)* Rb-Sr

Clancy granodiorite. (46°27'35"N, 112°00'10" W; NE¼ sec. 8, T. 8 N., R. 3 W.; Jefferson City 15' quad; Kain quarry near Clancy, Jefferson Co.) ***Constants:*** (a) $\lambda = 1.47 \times 10^{-11}$/yr; (b) $\lambda = 1.37 \times 10^{-11}$/yr. ***Collected by:*** A. Knopf; ***dated by:*** U.S. Geological Survey.

(a) (biotite) 65 ± 7 m.y.
(b) (biotite) 69 ± 7 m.y.

436. *Zen, Marvin and Mehnert (1975)* K-Ar

BC

Porphyritic granodiorite, Pioneer batholith. (45°25'00"N, 112°51'12"W; SW¼ sec. 9, T. 5 S., R. 10 W.; Twin Adams Mountain 7½' quad; Beaverhead Co.) ***Analytical data:*** K_2O = 8.77, 8.73%, $*Ar^{40} = 9.049 \times 10^{-10}$ moles/gm, $*Ar^{40}$ = 93%, error = ± 2 ς, > 99% pure, no visible alteration products. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, L. Schlocker.

(biotite) 68.8 ± 2.3 m.y.

437. *Baty (1973, 1976)* F.T.

S30-5

Philipsburg batholith. (46°21'15"N, 113°12'40" W; SE¼ sec. 15, T. 7 N., R. 13 W. [est.]; Fred Burr Lake 7½' quad; Granite Co.) ***Analytical data:*** ϱ_S = 629, 26 grains counted, 24.2 density ϱ_S/unit area; ϱ_i = 754, 28 grains counted, 27.0 density ϱ_i/unit area; $\phi = 1.35 \times 10^{15}$ neutron/cm²; 65-115 mesh, 95% purity, sample concentrated by fractionation in heavy liquids. ***Constants:*** (U^{238}) $\lambda_D = 1.54 \times 10^{-10}$/yr, ($U^{238}$) $\lambda_F = 6.85 \times 10^{-17}$/yr, ($U^{235}$) $\varsigma = 582 \times 10^{-24}$ cm², $U^{235}/U^{238} = 7.26 \times 10^{-3}$. ***Collected and dated by:*** J. B. Baty. ***Comment:*** Although Baty's fission track dates are about 10 m.y. younger than Obradovich's K-Ar dates, all are consistent with geologic relations and past research in the area.

(apatite) 68.2 m.y.

438. *Schmidt, Worthington and Thomssen (1979)* K-Ar

Primary rock biotite from dril core, quartz monzonite stock. (45°39'16"N, 112°56'25"W; NE¼ sec. 22, T. 2 S., R. 11 W.; Vipond Park 15' quad; Cannivan Gulch, Beaverhead Co.)

(biotite) 68.0 ± 2.5 m.y.

439. *Jaffe and others (1959)* Pb-α

55-RR-1

Tobacco Root batholith granite. (45°36'24"N, 112°00'25"W; NW¼ sec. 5, T. 3 S., R. 3 W. [est.]; Waterloo 15' quad; near Hollow Top Lake, SE flank of Mount Jefferson, 5 mi SW of Pony, Madison Co.) ***Analytical data:*** −80 to +400 mesh, 493 α/mg/hr, Pb = 13.5 ppm. ***Constants:*** Selected Th/U = 1.0, c = 2485, $K = 1.56 \times 10^{-4}$. ***Method:*** (Pb) Waring and Worthing (1953) spectrographic method, (α) thick source α counting technique. ***Collected by:*** R. R. Reid; ***dated by:*** C. L. Waring, H. W. Worthing, H. W. Jaffe, D. Gottfried.

(zircon) 68 m.y.

440. *Marvin and others (1973)* K-Ar

7

Yogo stock, shonkinite. (46°55'23"N, 110°33' 20"W; NE¼ sec. 3, T. 13 N., R. 9 E.; Yogo Peak 7½' quad; Judith Basin Co.) ***Analytical data:*** (biotite) K_2O = 9.16%, $*Ar^{40} = 6.930 \times 10^{-10}$ moles/gm, $*Ar^{40}$ = 87%; (orthoclase) K_2O = 9.02%, $*Ar^{40} = 9.118 \times 10^{-10}$ moles/gm, $*Ar^{40}$ = 97%; error = ± 2 ς. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Dates can have two interpretations: (a) ages indicate age of emplacement; (b) ages have been reset by magmatic activity 44 m.y. ago.

(biotite) 50.6 ± 1.5 m.y.
(orthoclase) 67.3 ± 2.0 m.y.

441. *Faul (1954)* Pb-α
Chapman, Gottfried and Waring (1955)
Larsen and Schmidt (1958)
Walker (1963)

53-C-210; 47-L166

Medium-grained white gneissoid quartz monzonite with 29% quartz, 35% perthite, 31% plagioclase (26% An), and 4% biotite, from the border zone of the Idaho batholith. (46°13'27"

N, 114°24'20"W; NE¼ sec. 1, T. 5 N., R. 23 W.; Tenmile Lake 7½' quad; Lost Horse Canyon, 6 mi below crest of the Bitterroot Range, Ravalli Co.) ***Analytical data:*** (zircon) 275 α/mg/hr, Pb = 6.2 ppm; (a) 3213 α/mg/hr, Pb = 79.0 ppm; (b) 2974 α/mg/hr, Pb = 96.0 ppm. ***Method:*** (Pb) Waring and Worthing (1953) spectrographic method, (α) thick source α counting technique; samples concentrated by fractionation with heavy liquids. ***Collected by:*** R. W. Chapman, E. S. Larsen, Jr.; ***dated by:*** D. Gottfried, C. L. Waring. ***Comment:*** This quartz monzonite is younger than the main Idaho batholith, and may be related to a Tertiary granite body along the Middle Fork of the Salmon River, Idaho; Larsen and Schmidt (1958) recalculated the zircon date as 56 m.y.

(zircon) 54 m.y.
(a) (monazite) 51 m.y.
(b) (monazite) 67 m.y.

442. *Tripp (1976)* U-Pb
A18, A20
Idaho batholith.

	Lat (N)	Long (W)	County
A18 granodiorite	46°31'44"	114°20'10"	Ravalli
A20 quartz monzonite	46°22'42"	114°18'52"	Ravalli

Analytical data (See below.) ***Constants:*** U^{238} λ = 1.537 x 10^{-10}/yr, U^{235} λ = 9.72 x 10^{-11}/yr. ***Method:*** Mass spectrometry. ***Dated by:*** Isotope Geochemistry Laboratory, University of Kansas. ***Comment:*** This zircon age for the batholith supports the idea that the 85 ± 35 m.y. isochron represents approximate time of final resetting of the quartzofeldspathic gneiss Rb-Sr system. The resetting was probably a response to the thermal effects of emplacement of the batholith.

(zircon concordia) 67 ± 10 m.y.

443. *Baty (1973, 1976)* F.T.
H28-1
Royal stock. (46°26'30"N, 113°05'50"W; SW¼ sec. 15, T. 8 N., R. 12 W. [est.]; Pikes Peak 7½' quad; Granite Co.) ***Analytical data:*** ϱ_S = 273, 40 grains counted, 5.9 density ϱ_S/unit area; ϱ_i = 286, 40 grains counted, 7.1 density ϱ_i/unit area; ϕ = 1.32 x 10^{15} neutron/cm²; 65-115 mesh, 95% purity, sample concentrated by fractionation in heavy liquids. ***Constants:*** (U^{238}) λ_D = 1.54 x 10^{-10}/yr, (U^{238}) λ_F = 6.85 x 10^{-17}/yr, (U^{235}) ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3}. ***Collected and dated by:*** J. B. Baty. ***Comment:*** Although Baty's fission track dates are about 10 m.y. younger than Obradovich's K-Ar dates, all are consistent with geologic relations and past research in the area.

(apatite) 66.9 m.y.

444. *Schmidt, Worthington and Thomssen (1979)* K-Ar
Primary rock biotite from drill core, quartz monzonite stock. (45°39'16"N, 112°56'25"W; NE¼ sec. 22, T. 2 S., R. 11 W.; Vipond Park 15' quad; Cannivan Gulch, Beaverhead Co.)

(biotite) 66.8 ± 2.5 m.y.

445. *Baty (1973, 1976)* F.T.
S1-1
Royal stock. (46°25'15"N, 112°57'25"W; NE¼ sec. 27, T. 8 N., R. 11 W. [est.]; Rock Creek Lake 7½' quad; Powell Co.) ***Analytical data:*** ϱ_S = 387, 40 grains counted, 9.7 density ϱ_S/unit area; ϱ_i = 468, 40 grains counted, 11.7 density ϱ_i/unit area; ϕ = 1.32 x 10^{15} neutron/cm²; 65-115 mesh, 95% purity, sample concentrated by fractionation in heavy liquids. ***Constants:*** (U^{238}) λ_D = 1.54 x 10^{-10}/yr, (U^{238}) λ_F = 6.85 x 10^{-17}/yr, (U^{235}) ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3}. ***Collected and dated by:*** J. B. Baty. ***Comment:*** Although Baty's fission track dates are about 10 m.y. younger than Obradovich's K-Ar dates, all are consistent with geologic relations and past research in the area.

(apatite) 66.7 m.y.

446. *Hoffman, Hower and Aronson (1976)* K-Ar
Hoffman (1976)
LT-178
Potash bentonite, 2 inches thick, with minor kaolin, Colorado Group. (48°26'51"N, 113°23'22"W; sec. 14, T. 31 N., R. 14 W. [est.]; Mount Rockwell 7½' quad; Glacier Park, Two Medicine Creek, Glacier Co.) ***Analytical data:*** K_2O

Analytical data for No. 442:

	U^{238} (μg/g)	U^{235} (μg/g)	Pb^{206}/Pb^{204}	Pb^{206}/U^{238}	Pb^{206}/U^{235}
A18R-A	815.720	5.845	49.020	0.0310	0.3905
A18R-D	810.000	5.804	81.073	0.0296	0.3781
A20R3	1740.860	12.474	164.688	0.0229	0.2710

= 4.96%, adjusted K = 15.6%, $*Ar^{40}$ = 4.186 x 10^{-10} moles/g, $*Ar^{40}$ = 70%, 35% expandable (smectite) layers in the mixed-layered clay. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) I.L. flame photometer with Li internal standard, (Ar) isotope dilution. ***Dated by:*** J. L. Hoffman, J. L. Aronson. ***Comment:*** Age calculated using the "fixed" K content of Thompson and Hower (1973); approximate age of deposition = 85 to 88 m.y. ago; age interpreted as "coincident with time of maximum temperatures generated during or after thrusting in the Disturbed Belt."

(illite/smectite) 66.5 m.y.

447. *Hoffman, Hower and Aronson (1976)* K-Ar
Hoffman (1976)
LT-162

Potash bentonite, 2 inches thick, with 65% total layer silicates, 7% quartz, 15% plagioclase, 9% calcite, 3% dolomite, Kevin Shale Member of the Marias River Formation. (47° 01'28"N, 112°03'04"W; sec. 25, T. 15 N., R. 4 W. [est.]; Wolf Creek 7½' quad; intersection of Interstate 15 and Route 287 near Wolf Creek, Lewis and Clark Co.) ***Analytical data:*** K_2O = 5.09%, adjusted K = 13.3%, $*Ar^{40}$ = 4.407 x 10^{-10} moles/g, $*Ar^{40}$ = 87%, 30% expandable (smectite) layers in the mixed-layered clay. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) I.L. flame photometer with Li internal standard, (Ar) isotope dilution. ***Dated by:*** J. L. Hoffman, J. L. Aronson. ***Comment:*** Age calculated using the "fixed" K content of Thompson and Hower (1973); approximate age of deposition = 85 to 88 m.y. ago; age interpreted as "coincident with time of maximum temperatures generated during or after thrusting in the Disturbed Belt."

(illite/smectite) 66.4 m.y.

448. *Hoffman, Hower and Aronson (1976)* K-Ar
Hoffman (1976)
LT-93A

Potash bentonite, 1 ft. thick, with kaolin and chlorite, Kevin Shale Member of the Marias River Formation. (47°37'21"N, 112°55'18"W; NW¼ sec. 32, T. 22 N., R. 10 W. [est.]; Pretty Prairie 7½' quad; Bear Creek, South Fork of the Sun River, Lewis and Clark Co.) ***Analytical data:*** K_2O = 5.35%, adjusted K = 16.5%, $*Ar^{40}$ = 4.453 x 10^{-10} moles/g, $*Ar^{40}$ = 85%, 37% expandable (smectite) layers in the mixed-layered clay. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) I.L. flame photometer with Li internal standard, (Ar) isotope dilution. ***Dated by:*** J. L. Hoffman, J. L. Aronson. ***Comment:*** Age calculated using the "fixed" K content of Thompson and Hower (1973); approximate age of deposition = 85 to 88 m.y. ago; age interpreted as "coincident with time of maximum temperatures generated during or after thrusting in the Disturbed Belt."

(illite/smectite) 66.3 m.y.

449. *Chase, Bickford and Tripp (1978)* U-Pb
Idaho batholith.

	Lat (N)	Long (W)	County
A14, quartz diorite orthogneiss	46°33'17"	114°20'44"	Ravalli
A18, granodiorite, batholith margin	46°31'44"	114°20'10"	Ravalli
A20, quartz monzonite, batholith interior	46°22'42"	114°18'52"	Ravalli

Analytical data (See next page.) ***Constants:*** U^{238} = 1.55 x 10^{-10}/yr, U^{235} = 9.85 x 10^{-10}/yr. ***Method:*** Mass spectrometry; samples concentrated by fractionation in heavy liquids. ***Dated by:*** Isotope Geochemistry Laboratory, University of Kansas. ***Comment:*** Corrections made using the two-stage common Pb growth model of Stacey and Kramers (1975); rocks of this part of the Idaho batholith formed about 66 m.y. ago with about 6% of the zircons derived from rocks between 1900 and 2250 m.y. old. This is consistent with the geologic setting of the batholith.

(zircon concordia) 66 ± 10 m.y.

450. *Baty (1973, 1976)* F.T.
S31-10

Royal stock. (46°26'05"N, 113°00'00"W; NE¼ sec. 20, T. 8 N., R. 11 W. [est.]; Rock Creek Lake 7½' quad; Powell Co.) ***Analytical data:*** ϱ_s = 546, 40 grains counted, 13.7 density ϱ_s/unit area; ϱ_i = 684, 40 grains counted, 17.1 density ϱ_i/unit area; ϕ = 1.35 x 10^{15} neutron/cm²; 65-115 mesh, 95% purity, sample concentrated by fractionation in heavy liquids. ***Constants:*** (U^{238}) λ_D = 1.54 x 10^{-10}/yr, (U^{238}) λ_F = 6.85 x 10^{-17}/yr, (U^{235}) ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3}. ***Collected and dated by:*** J. B. Baty. ***Comment:*** Although Baty's fission track dates are about 10 m.y. younger than Obradovich's K-Ar dates, all are consistent with geologic relations and past research in the area.

(apatite) 65.9 m.y.

451. *Baty (1973, 1976)* F.T.
H29-9
Philipsburg batholith. (46°21'15''N, 113°11'20''W; SE¼ sec. 14, T. 7 N., R. 13 W. [est.]; Fred Burr Lake 7½' quad; Granite Co.) ***Analytical data:*** ϱ_S = 1256, 40 grains counted, 31.4 density ϱ_S/unit area; ϱ_i = 1404, 40 grains counted, 35.1 density ϱ_i/unit area; ϕ = 1.32×10^{15} neutron/cm²; 65-115 mesh, 95% purity, sample concentrated by fractionation in heavy liquids. ***Constants:*** (U^{238}) λ_D = 1.54×10^{-10}/yr, (U^{238}) λ_F = 6.85×10^{-17}/yr, (U^{235}) ς = 582×10^{-24} cm², U^{235}/U^{238} = 7.26×10^{-3}. ***Collected and dated by:*** J. B. Baty. ***Comment:*** Although Baty's fission track dates are about 10 m.y. younger than Obradovich's K-Ar dates, all are consistent with geologic relations and past research in the area.

(apatite) 65.9 m.y.

452. *Hoffman, Hower and Aronson (1976)* K-Ar
Hoffman (1976)
LT-96A
Potash bentonite, 1 ft. thick, with 70% total layer silicates, 4% quartz, 26% plagioclase, trace of chlorite, Kevin Shale Member of the Marias River Formation. (47°37'21''N, 112°55'18''W; NW¼ sec. 32, T. 22 N., R. 10 W. [est.]; Pretty Prairie 7½' quad; Bear Creek, South Fork of the Sun River, Lewis and Clark Co.) ***Analytical data:*** (a) 0.2-0.5 μm, K_2O = 4.90%, adjusted K = 20.4%, $*Ar^{40}$ = 3.871×10^{-10} moles/g, $*Ar^{40}$ = 82%, 35% expandable (smectite) layers in the mixed-layered clay; (b) < 0.2 μm, K_2O = 4.83%, $*Ar^{40}$ = 3.823×10^{-10} moles/g. ***Constants:*** λ_e = 0.585×10^{-10}/yr, $\lambda\beta$ = 4.72×10^{-10}/yr, K^{40}/K = 1.19×10^{-4} atomic ratio. ***Method:*** (K) I.L. flame photometer with Li internal standard, (Ar) isotope dilution. ***Dated by:*** J. L. Hoffman, J. L. Aronson. ***Comment:*** Age calculated using the "fixed" K content of Thompson and Hower (1973); approximate age of deposition = 85 to 88 m.y. ago; age interpreted as "coincident with time of maximum temperatures generated during or after thrusting in the Disturbed Belt."

(a) (illite/smectite) 65.9 m.y.
(b) (illite/smectite) 62.2 m.y.

453. *Marvin and others (1973) Witkind (1973)* K-Ar
WL-31
Shonkinite plug, dark gray, medium to coarse grained with olivine, clinopyroxene, biotite, some plagioclase, poikilitic orthoclase, some magnetite, analcime, apatite, sphene, ilmenite, thomsonite. (47°13'54''N, 110°44'44''W; NW¼ SE¼ sec. 18, T. 17 N., R. 8 E.; Limestone Butte 7½' quad; Judith Basin Co.) ***Analytical data:***

	K_2O%	$*Ar^{40} \times 10^{-10}$ moles/gm	$*Ar^{40}$%
(a) biotite	8.06	6.719	82
(b) biotite	8.10	5.876	83
(c) orthoclase	8.74	8.257	93
(d) orthoclase	8.42	8.336	92
(e) Ba orthoclase?	7.68	5.215	94

Constants: λ_e = 0.585×10^{-10}/yr, $\lambda\beta$ = 4.72×10^{-10}/yr, K^{40}/K = 1.19×10^{-4} atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Dates can have two interpretations: (a) ages indicate age of emplacement; (b) ages have been reset by magmatic activity 44 m.y. ago.

Analytical data for No. 449:

			Measured atomic ratios			Calculated ratios		
	U(ppm)	$*Pb^{206}$(ppm)	Pb^{208}/Pb^{206}	Pb^{207}/Pb^{206}	Pb^{204}/Pb^{206}	Pb^{207}/Pb^{206}	Pb^{206}/U^{238}	Pb^{207}/U^{235}
†A18A	882.0	23.07	0.8787 ± 0.0024	0.3774 ± 0.0005	0.0202 ± 0.0003	0.1007	0.033	0.454
‡A18A		19.97				0.0989	0.028	0.385
§A18A		20.15				0.0990	0.029	0.389
†A18D	816.3	20.90	0.5799 ± 0.0027	0.2665 ± 0.0001	0.0123 ± 0.0001	0.0977	0.030	0.401
‡A18D		20.40				0.0966	0.029	0.387
§A18D		20.43				0.0967	0.029	0.388
†A14E	934.9	18.52	0.4115 ± 0.0003	0.1960 ± 0.0003	0.0082 ± 0.0003	0.0811	0.023	0.253
‡A14E		17.88				0.0799	0.022	0.245
§A14E		17.92				0.0800	0.022	0.246
†A20	1744.8	34.80	0.3198 ± 0.0026	0.1721 ± 0.0007	0.0060 ± 0.0001	0.0881	0.023	0.281
‡A20		33.71				0.0875	0.022	0.270
§A20		33.78				0.0875	0.022	0.270

†(A) date corrected with 1900 m.y. old common Pb.
‡(A) date corrected with 70 m.y. old common Pb.
§(A) date corrected with mixed common Pb.

(a) (biotite) 51.3 ± 1.5 m.y.
(b) (biotite) 48.5 ± 1.5 m.y.
(c) (orthoclase) 61.0 ± 1.8 m.y.
(d) (orthoclase) 65.9 ± 2.0 m.y.
(e) (Ba orthoclase?) 45.4 ± 1.4 m.y.

454. *Baty (1973, 1976)* F.T.
H14-12
Mt. Powell pluton. (46°14'25"N, 113°03'15" W; SW¼ sec. 25, T. 6 N., R. 12 W. [est.]; West Valley 7½' quad; Granite Co.) ***Analytical data:*** ϱ_S = 283, 48 grains counted, 5.9 density ϱ_S/unit area; ϱ_i = 226, 32 grains counted, 7.1 density ϱ_i/unit area; ϕ = 1.29 x 10^{15} neutron/cm²; 65-115 mesh, 95% purity, sample concentrated by fractionation in heavy liquids. ***Constants:*** (U^{238}) λ_D = 1.54 x 10^{-10}/yr, (U^{238}) λ_F = 6.85 x 10^{-17}/yr, (U^{235}) ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3}. ***Collected and dated by:*** J. B. Baty. ***Comment:*** Although Baty's fission track dates are about 10 m.y. younger than Obradovich's K-Ar dates, all are consistent with geologic relations and past research in the area.

(apatite) 65.7 m.y.

455. *Hoffman, Hower and Aronson (1976)* K-Ar
Hoffman (1976)
LT-109
Potash bentonite, 1 ft. thick, with trace of chlorite, Upper Cretaceous. (48°10'30"N, 112° 52'43"W; NE¼ sec. 22, T. 28 N., R. 10 W. [est.]; Swift Reservoir 7½' quad; Swift Reservoir, Pondera Co.) ***Analytical data:*** K_2O = 5.50%, adjusted K = 8.3%, $*Ar^{40}$ = 4.979 x 10^{-10} moles/g, $*Ar^{40}$ = 88%, 35% expandable (smectite) layers in the mixed-layered clay. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) I.L. flame photometer with Li internal standard, (Ar) isotope dilution. ***Dated by:*** J. L. Hoffman, J. L. Aronson. ***Comment:*** Age calculated using the "fixed" K content of Thompson and Hower (1973); approximate age of deposition at least 94 m.y. ago; age interpreted as "coincident with time of maximum temperatures generated during or after thrusting in the Disturbed Belt."

(illite/smectite) 65.6 m.y.

456. *Armstrong and others (1976)* K-Ar
YU-YAG 788
Hornblende biotite granodiorite, Philipsburg batholith. (46°20'00"N, 113°15'25"W; NW¼ sec. 29, T. 7 N., R. 13 W.; Fred Burr Lake 7½' quad; E side of Granite, Granite Co.) ***Analytical data:*** K = 6.79, 6.8%, $*Ar^{40}$ = 18.11 x 10^{-6} cc/gm, Ar^{40} = 78%. ***Constants:*** λ_e = 0.584 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) atomic absorption spectrophotometry, (Ar) isotope dilution. ***Collected and dated by:*** R. L. Armstrong. ***Comment:*** This date determined to establish the pre-Cenozoic age of structures cut by the batholith and help pin down the age of orogenic deformation in Montana.

(biotite) 65.6 ± 2.0 m.y.

457. *Baty (1973, 1976)* F.T.
H23-8
Royal stock. (46°25'15"N, 113°03'15"W; NW¼ sec. 25, T. 8 N., R. 12 W. [est.]; Pikes Peak 7½' quad; Granite Co.) ***Analytical data:*** ϱ_S = 323, 40 grains counted, 8.1 density ϱ_S/unit area; ϱ_i = 389, 40 grains counted, 9.7 density ϱ_i/unit area; ϕ = 1.29 x 10^{15} neutron/cm²; 65-115 mesh, 95% purity, sample concentrated by fractionation in heavy liquids. ***Constants:*** (U^{238}) λ_D = 1.54 x 10^{-10}/yr, (U^{238}) λ_F = 6.85 x 10^{-17}/yr, (U^{235}) ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3}. ***Collected and dated by:*** J. B. Baty. ***Comment:*** Although Baty's fission track dates are about 10 m.y. younger than Obradovich's K-Ar dates, all are consistent with geologic relations and past research in the area.

(apatite) 65.4 m.y.

458. *Baty (1973, 1976)* F.T.
H10-2
Mt. Powell stock. (46°16'50"N, 113°03'55"W; SE¼ sec. 11, T. 6 N., R. 12 W. [est.]; Pozega Lakes 7½' quad; Granite Co.) ***Analytical data:*** ϱ_S = 289, 40 grains counted, 7.2 density ϱ_S/unit area; ϱ_i = 351, 40 grains counted, 8.8 density ϱ_i/unit area; ϕ = 1.29 x 10^{15} neutron/cm²; 65-115 mesh, 95% purity, sample concentrated by fractionation in heavy liquids. ***Constants:*** (U^{238}) λ_D = 1.54 x 10^{-10}/yr, (U^{238}) λ_F = 6.85 x 10^{-17}/yr, (U^{235}) ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3}. ***Collected and dated by:*** J. B. Baty. ***Comment:*** Although Baty's fission track dates are about 10 m.y. younger than Obradovich's K-Ar dates, all are consistent with geologic relations and past research in the area.

(apatite) 65.4 m.y.

459. *Baty (1973, 1976)* F.T.
H29-14
Philipsburg batholith. (46°20'50"N,

113°11'20"W; NE¼ sec. 23, T. 7 N., R. 13 W. [est.]; Fred Burr Lake 7½' quad; Granite Co.) ***Analytical data:*** ϱ_s = 1189, 40 grains counted, 29.7 density ϱ_s/unit area; ϱ_i = 1347, 40 grains counted, 33.7 density ϱ_i/unit area; ϕ = 1.29×10^{15} neutron/cm²; 65-115 mesh, 95% purity, sample concentrated by fractionation in heavy liquids. ***Constants:*** (U^{238}) λ_D = 1.54×10^{-10}/yr, (U^{238}) λ_F = 6.85×10^{-17}/yr, (U^{235}) ς = 582×10^{-24} cm², U^{235}/U^{238} = 7.26×10^{-3}. ***Collected and dated by:*** J. B. Baty. ***Comment:*** Although Baty's fission track dates are about 10 m.y. younger than Obradovich's K-Ar dates, all are consistent with geologic relations and past research in the area.

(apatite) 64.8 m.y.

460. *Folinsbee and others (1965)* K-Ar
Shafiqullah and others (1964)
4983
20 cm bentonite 70 cm above base of Z coal bed, Fort Union Formation. (47°31'10"N, 106°57'15"W; sec. 1, T. 20 N., R. 37 E.; Maloney Hill 15' quad; Hell Creek, Garfield Co.) ***Analytical data:*** (a) K^{40} = 5.17 ppm, $*Ar^{40}$ = 39%, Ar^{40}/K^{40} = 0.00363; (b) K^{40} = 10.40 ppm, $*Ar^{40}$ = 78%, Ar^{40}/K^{40} = 0.00386; (d) K^{40} = 5.13 ppm, $*Ar^{40}$ = 63%, Ar^{40}/K^{40} = 0.00391; (e) K^{40} = 10.59 ppm, $*Ar^{40}$ = 94%, Ar^{40}/K^{40} = 0.00386. ***Constants:*** λ_e = 0.589×10^{-10}/yr, λ_β = 4.76×10^{-10}/yr, K^{40}/K = 1.18×10^{-4} atomic ratio. ***Method:*** (K) gravimetric methods, (Ar) flux-fusion techniques. ***Comment:*** The Z coal bed is actually the top of the Hell Creek Formation (Collier and Knechtel, 1939); no analytical data given for (c).

(a) (biotite) 60.7 m.y.
(b) (sanidine) 64.4 m.y.
(c) (sanidine) 61.1 m.y.
(d) (biotite) 65 m.y.
(e) (sanidine) 64 m.y.

461. *Hoffman, Hower and Aronson (1976)* K-Ar
Hoffman (1976)
LT-24
Potash bentonite, 3 in. thick, with chlorite and trace of kaolin, Vaughn Member of the Blackleaf Formation. (47°36'30"N, 112°45'00"W; NW¼ sec. 3, T. 21 N., R. 9 W. [est.]; Sawtooth Ridge 7½' quad; eastern end of the Sun River Canyon, Lewis and Clark Co.) ***Analytical data:*** K_2O = 5.95%, adjusted K = 14.4%, $*Ar^{40}$ = 4.908×10^{-10} moles/g, $*Ar^{40}$ = 84%, 26% expandable (smectite) layers in the mixed-layered clay. ***Constants:*** λ_e = 0.585×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr, K^{40}/K = 1.19×10^{-4} atomic ratio. ***Method:*** (K) I.L. flame photometer with Li internal standard, (Ar) isotope dilution. ***Dated by:*** J. L. Hoffman, J. L. Aronson. ***Comment:*** Age calculated using the "fixed" K content of Thompson and Hower (1973); approximate age of deposition = 94 to 95 m.y. ago; age interpreted as "coincident with time of maximum temperatures generated during or after thrusting in the Disturbed Belt."

(illite/smectite) 64.1 m.y.

462. *Jaffe and others (1959)* Pb-α
WTP-3
Nepheline syenite pegmatite, Rocky Boy stock. (48°09'51"N, 109°40'45"W; SW¼ sec. 21, T. 28 N., R. 16 E. [est.]; Warrick 15' quad; Pegmatite Peak, Bearpaw Mountains, Hill Co.) ***Analytical data:*** (a) +20 mesh, 218 α/mg/hr, Pb = 5.6 ppm; (b) 227 α/mg/hr, Pb = 4.0 ppm. ***Constants:*** Selected Th/U = 1.0, c = 2485, k = 1.56×10^{-4}. ***Method:*** (Pb) Waring and Worthing (1953) method, (α) thick source α counting technique. ***Collected by:*** W. T. Pecora; ***dated by:*** C. L. Waring, H. W. Worthing, H. W. Jaffe, D. Gottfried.

(a) (zircon) 64 m.y.
(b) (zircon) 44 m.y.

463. *Baty (1973, 1976)* F.T.
H10-8
Mt. Powell pluton. (46°16'55"N, 113°00'00" W; SE¼ sec. 8, T. 6 N., R. 11 W. [est.]; Pozega Lakes 7½' quad; Powell Co.) ***Analytical data:*** ϱ_s = 1039, 48 grains counted, 21.6 density ϱ_s/unit area; ϱ_i = 1072, 40 grains counted, 26.8 density ϱ_i/unit area; ϕ = 1.29×10^{15} neutron/cm²; 65-115 mesh, 95% purity, sample concentrated by fractionation in heavy liquids. ***Constants:*** (U^{238}) λ_D = 1.54×10^{-10}/yr, (U^{238}) λ_F = 6.85×10^{-17}/yr, (U^{235}) ς = 582×10^{-24} cm², U^{235}/U^{238} = 7.26×10^{-3}. ***Collected and dated by:*** J. B. Baty. ***Comment:*** Although Baty's fission track dates are about 10 m.y. younger than Obradovich's K-Ar dates, all are consistent with geologic relations and past research in the area.

(apatite) 63.6 m.y.

464. *Baty (1973, 1976)* F.T.
H10-6
Mt. Powell pluton. (46°16'55"N, 113°01'15" W; SE¼ sec. 7, T. 6 N., R. 11 W. [est.]; Pozega Lakes 7½' quad; Powell Co.) ***Analytical data:*** ϱ_s = 725, 32 grains counted, 22.7 den-

sity ϱ_s/unit area; ϱ_i = 1164, 40 grains counted, 29.1 density ϱ_i/unit area; ϕ = 1.32 x 10^{15} neutron/cm^2; 65-115 mesh, 95% purity, sample concentrated by fractionation in heavy liquids. ***Constants:*** (U^{238}) λ_D = 1.54 x 10^{-10}/yr, (U^{238}) λ_F = 6.85 x 10^{-17}/yr, (U^{235}) ς = 582 x 10^{-24} cm^2, U^{235}/U^{238} = 7.26 x 10^{-3}. ***Collected and dated by:*** J. B. Baty. ***Comment:*** Although Baty's fission track dates are about 10 m.y. younger than Obradovich's K-Ar dates, all are consistent with geologic relations and past research in the area.

(apatite) 62.9 m.y.

465. *Miller (1973)* K-Ar

K-silicate veins, early dark micaceous veins. (46°00'45"N, 112°32'25"W; sec. 13, T. 3 N., R. 8 W.; Butte North 15' quad; Butte, Silver Bow Co.) ***Comment:*** Biotite altered.

(biotite) 62.8 ± 2.0 m.y.

466. *Schmidt, Worthington and Thomssen (1979)* K-Ar

Coarse hydrothermal muscovite from a quartz-pyrite-MoS_2-orthoclase vein. (45°39'16"N, 112°56'25"W; NE¼ sec. 22, T. 2 S., R. 11 W.; Vipond Park 15' quad; Cannivan Gulch, Beaverhead Co.)

(muscovite) 62.5 ± 2.3 m.y.

467. *Woakes (1960)* K-Ar

443-19

Quartz porphyry dike with "pale" biotite, otherwise unaltered. (46°01'30"N, 112°31'05"W; sec. 7, T. 3 N., R. 7 W. [est.]; Butte North 15' quad; roadcut, Helena Road, 1 mi N of Butte, Silver Bow Co.) ***Analytical data:*** (a) 35-60 mesh, < 3% chlorite, K = 6.66 ± 0.03%, wt = 0.5055 gm, $*Ar^{40}$ = 3.344 x 10^{-10} moles, $*Ar^{40}$ = 75.5%; (b) 35-150 mesh, < 5% chlorite, K = 7.12%, wt = 0.4275 gm, $*Ar^{40}$ = 3.263 x 10^{-10} moles, $*Ar^{40}$ = 72.2%. ***Constants:*** λ_e = 0.577 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.1477 x 10^{-4} atomic ratio. ***Method:*** Isotope dilution, (K) flame photometer, (Ar) Reynolds-type mass spectrometer. ***Collected by:*** M. E. Woakes; ***dated by:*** M. E. Woakes, L. Kovich. ***Comment:*** (b) heated to a higher temperature in the laboratory, thus a more complete Ar release; young dates probably due to Ar loss when the dike was heated by mineralization.

(a) (biotite) 57.7 ± 1.7 m.y.
(b) (biotite) 62.3 m.y.

468. *McDowell and Kulp (1969) McDowell (1966, 1971)* K-Ar

L-1026

Idaho batholith border zone, medium banded granite gneiss with plagioclase and orthoclase, quartz in the light bands, oriented biotite in the dark bands. Recrystallized Belt rock with veins of injection gneiss. (46°10'19"N, 114°03'18" W; SE¼, sec. 23, T. 5 N., R. 20 W. [est.]; Mountain House 7½' quad; 4¾ mi SE of Grantsdale, Skalkaho Creek, Ravalli Co.) ***Analytical data:*** 80-100 mesh, 95% with quartz and feldspar, (a) K = 7.92%, $*Ar^{40}$ = 8.87 x 10^{-10} moles/gm, $*Ar^{40}$ = 88%; (b) K = 7.92%, $*Ar^{40}$ = 8.43 x 10^{-10} moles/gm, $*Ar^{40}$ = 86%; error = 1 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) isotope dilution with mass spectrometry, (Ar) stable isotope dilution with 4.5-inch Reynolds-type mass spectrometer, samples concentrated by fractionation with heavy liquids. ***Collected and dated by:*** F. W. McDowell. ***Comment:*** Dates represent mixed ages.

(a) (biotite) 62.1 ± 1.9 m.y.
(b) (biotite) 59.1 ± 1.8 m.y.

469. *Baty (1973, 1976)* F.T.

H6-8

Mt. Powell pluton. (46°18'20"N, 113°01'15" W; NE¼ sec. 6, T. 6 N., R. 11 W. [est.]; Pozega Lakes 7½' quad; Powell Co.) ***Analytical data:*** ϱ_s = 199, 40 grains counted, 5.0 density ϱ_s/unit area; ϱ_i = 251, 40 grains counted, 6.3 density ϱ_i/unit area; ϕ = 1.29 x 10^{15} neutron/cm^2; 65-115 mesh, 95% purity, sample concentrated by fractionation in heavy liquids. ***Constants:*** (U^{238}) λ_D = 1.54 x 10^{-10}/yr, (U^{238}) λ_F = 6.85 x 10^{-17}/yr, (U^{235}) ς = 582 x 10^{-24} cm^2, U^{235}/U^{238} = 7.26 x 10^{-3}. ***Collected and dated by:*** J. B. Baty. ***Comment:*** Although Baty's fission track dates are about 10 m.y. younger than Obradovich's K-Ar dates, all are consistent with geologic relations and past research in the area.

(apatite) 62.0 m.y.

470. *Hoffman, Hower and Aronson (1976) Hoffman (1976)* K-Ar

LTE-21

Potash bentonite, 2 in. thick, with 91% total layer silicates, 6% quartz, 4% plagioclase, trace of chlorite, Colorado Group. (47°52'32" N, 112°47'36"W; NE¼ sec. 31, T. 25 N., R. 9 W. [est.]; Mount Wright 7½' quad; Teton

Pass, Flathead Co.) ***Analytical data:*** K_2O = 6.01%, adjusted K = 10.3%, $*Ar^{40}$ = 4.923 x 10^{-10} moles/g, $*Ar^{40}$ = 88%, 24% expandable (smectite) layers in the mixed-layered clay. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) I.L. flame photometer with Li internal standard, (Ar) isotope dilution. ***Dated by:*** J. L. Hoffman, J. L. Aronson. ***Comment:*** Age calculated using the "fixed" K content of Thompson and Hower (1973); approximate age of deposition is less than 94 m.y. ago; age interpreted as "coincident with time of maximum temperatures generated during or after thrusting in the Disturbed Belt."

(illite/smectite) 60.8 m.y.

471. *Hoffman, Hower and Aronson (1976)* *Hoffman (1976)* K-Ar

LT-51

Potash bentonite, 9 in. thick, with 86% total layer silicates, kaolin and trace of chlorite, 3% quartz, 9% plagioclase, 2% calcite, Kevin Shale Member of the Marias River Formation. (47°37'00"N, 112°42'07"W; sec. 36, T. 22 N., R. 9 W. [est.]; Sawtooth Ridge 7½' quad; eastern end of the Sun River Canyon, Lewis and Clark Co.) ***Analytical data: (a) 0.2-0.5*** μm, K_2O = 5.30%, adjusted K = 10.8%, $*Ar^{40}$ = 4.031 x 10^{-10} moles/g, $*Ar^{40}$ = 79%; (b) 0.06-0.02 μm, K_2O = 5.26%, $*Ar^{40}$ = 4.108 x 10^{-10} moles/g; (c) < 0.06 μm, K_2O = 5.08%, $*Ar^{40}$ = 4.132 x 10^{-10} moles/g; 30% expandable (smectite) layers in the mixed-layered clay. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) I.L. flame photometer with Li internal standard, (Ar) isotope dilution. ***Dated by:*** J. L. Hoffman, J. L. Aronson. ***Comment:*** Age calculated using the "fixed" K content of Thompson and Hower (1973); approximate age of deposition = 85 to 88 m.y. ago; age interpreted as "coincident with time of maximum temperatures generated during or after thrusting in the Disturbed Belt."

(a) (illite/smectite) 56.8 m.y.
(b) (illite/smectite) 58.7 m.y.
(c) (illite/smectite) 60.8 m.y.

472. *Hoffman, Hower and Aronson (1976)* *Hoffman (1976)* K-Ar

LT-128

Potash bentonite, 1 ft. thick, with 56% total layer silicates, 15% quartz, 22% plagioclase, 6% calcite, trace of kaolin and chlorite, Kevin Shale Member of the Marias River Formation. (48°26'51"N, 113°11'47"W; sec. 17, T. 31 N., R. 12 W. [est.]; East Glacier Park 7½' quad; East Glacier, Two Medicine River, Glacier Co.) ***Analytical data:*** K_2O = 4.56%, adjusted K = 18.0%, $*Ar^{40}$ = 3.392 x 10^{-10} moles/g, $*Ar^{40}$ = 66%, 40% expandable (smectite) layers in the mixed-layered clay. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) I.L. flame photometer with Li internal standard, (Ar) isotope dilution. ***Dated by:*** J. L. Hoffman, J. L. Aronson. ***Comment:*** Age calculated using the "fixed" K content of Thompson and Hower (1973); approximate age of deposition = 85 to 88 m.y. ago; age interpreted as "coincident with time of maximum temperatures generated during or after thrusting in the Disturbed Belt."

(illite/smectite) 60.3 m.y.

473. *Baty (1973, 1976)* F.T.

H23-13

Royal stock. (46°26'05"N, 113°02'00"W; NW¼ sec. 19, T. 8 N., R. 11 W. [est.]; Pikes Peak 7½' quad; Powell Co.) ***Analytical data:*** ϱ_S = 293, 24 grains counted, 12.2 density ϱ_S/unit area; ϱ_i = 398, 24 grains counted, 16.6 density ϱ_i/unit area; ϕ = 1.32 x 10^{15} neutron/cm²; 65-115 mesh, 95% purity, sample concentrated by fractionation in heavy liquids. ***Constants:*** (U^{238}) λ_D = 1.54 x 10^{-10}/yr, (U^{238}) λ_F = 6.85 x 10^{-17}/yr, (U^{235}) ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3}. ***Collected and dated by:*** J. B. Baty. ***Comment:*** Although Baty's fission track dates are about 10 m.y. younger than Obradovich's K-Ar dates, all are consistent with geologic relations and past research in the area.

(apatite) 60.1 m.y.

474. *Marvin and Hearn (1972)* K-Ar

Three K-feldspars from the quartz monzonite and syenite porphyries of the Little Rocky Mountains. (47°50'N, 108°30'W; T. 25 N., R. 25 E. [est.]; Zortman 7½' quad; Phillips Co.)

(K-feldspar) 60 m.y.

475. *Meyer and others (1968)* K-Ar

Sericite from State Vein envelope. (46°00'45" N, 112°32'45"W; sec. 13, T. 3 N., R. 8 W. [est.]; Butte North 15' quad; Mount Con mine, Butte, Silver Bow Co.) ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Comment:*** This date

attributed to Woakes' 1960 thesis, but authors were unable to find a corresponding date in that paper.

(sericite) 60 m.y.

476. *Rostad (1978)* K-Ar
Armstrong, Hollister and Harakal (1978)
Quartz monzonite porphyry that intruded lower Paleozoic sediments; porphyry Mo deposit occurs in both rocks; sample from potassic alteration zone, Mo with coarse quartz, muscovite and orthoclase. (45°39' N, 112°57'W; NE¼, sec. 22, T. 2 S., R. 11 W.; Vipond Park 15' quad; Cannivan Gulch, Beaverhead Co.) ***Analytical data:*** K = 9.395%, $*Ar^{40}$ = 22.48 x 10^{-6} cc STP/gm, $*Ar^{40}$ = 80%, error = 1 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Dated by:*** R. L. Armstrong, V. F. Hollister, J. E. Harakal, K. Scott. ***Comment:*** Date indicates the age of mineralization of the White Cloud-Cannivan porphyry Mo belt (ID-MT), similar to the age of mineralization at Butte, Montana.

(muscovite) 59.1 ± 2.1 m.y.

477. *Hoffman, Hower and Aronson (1976)* K-Ar
Hoffman (1976)
LT-4
Potash bentonite, 6 ft. thick, with 60% total layer silicates, 37% quartz, 2% plagioclase, 1% calcite, Kevin Shale Member of the Marias River Formation. (48°26'54"N, 113°17'00"W; sec. 15, T. 31 N., R. 13 W. [est.]; Squaw Mountain 7½' quad; 2.5 mi W of East Glacier, Glacier Co.) ***Analytical data:*** K_2O = 4.85%, adjusted K = 11.6%, $*Ar^{40}$ = 3.797 x 10^{-10} moles/g, $*Ar^{40}$ = 56%, 35% expandable (smectite) layers in the mixed-layered clay. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) I.L. flame photometer with Li internal standard, (Ar) isotope dilution. ***Dated by:*** J. L. Hoffman, J. L. Aronson. ***Comment:*** Age calculated using the "fixed" K content of Thompson and Hower (1973); approximate age of deposition = 85 to 88 m.y. ago; age interpreted as "coincident with time of maximum temperatures generated during or after thrusting in the Disturbed Belt."

(illite/smectite) 59.0 m.y.

478. *Mehnert and Schmidt (1971)* K-Ar
Quartz monzonite porphyry sill intruded into the Eldorado thrust zone. (47°00'N, 112°05'W; sec. 3, T. 14 N., R. 4 W. [est.]; Wolf Creek 7½' quad; eastern front of the Lewis and Clark Range, near Wolf Creek, Lewis and Clark Co.) ***Comment:*** This date is a minimum age for the time of thrusting in the Disturbed Belt; this entry was omitted from the location maps.

(biotite) 58.3 m.y.

479. *Marvin and Dobson (1979)* K-Ar
USGS(W)-CPR 369
Granite. (45°50'19"N, 113°58'52"W; NW¼, sec. 16, T. 1 N., R. 19 W.; Sula 7½' quad; near Sula, Ravalli Co.) ***Analytical data:*** K_2O = 10.46%, $*Ar^{40}$ = 8.83 x 10^{-10} moles/gm, $*Ar^{40}$ = 86%. ***Constants:*** λ_e = 0.581 x 10^{-10}/yr, $\lambda\beta$ = 4.962 x 10^{-10}/yr, K^{40}/K = 1.167 x 10^{-4} atomic ratio. ***Collected by:*** C. P. Ross; ***dated by:*** H. H. Thomas, R. F. Marvin, F. C. Walthall. ***Comment:*** Date indicates minimum age of intrusion.

(muscovite) 58 ± 3 m.y.

480. *Marvin and others (1973)* K-Ar
Witkind (1973)
WL-583
Vogesite sill, dark gray, fine grained, porphyritic with biotite, augite, salite, orthoclase and plagioclase microlites, some apatite, sphene, magnetite and with phenocrysts of biotite, augite and salite; also contains xenocrysts of quartz, sanidine and plagioclase (apparently relicts of country rock). (47°03'10"N, 110°41' 12"W; SW¼ NE¼ sec. 16, T. 15 N., R. 8 E.; Barker 7½' quad; Cascade Co.) ***Analytical data:*** K_2O = 0.674%, $*Ar^{40}$ = 0.5841 x 10^{-10} moles/gm, $*Ar^{40}$ = 72%, error = ± 2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) isotope dilution, (Ar) isotope dilution with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(hornblende) 57.8 ± 2.2 m.y.

481. *Miller (1973)* K-Ar
Meyer and others (1968)
Woakes (1960)
443-12
White glassy sericite, 4500 ft. below surface, High Ore vein, Blue (N-W) fracture. (46°00'45" N, 112°32'25"W; sec. 13, T. 3 N., R. 8 W. [est.]; Butte North 15' quad; High Ore vein, Mount Con shaft, Butte, Silver Bow Co.) ***Ana-***

lytical data: 150-200 mesh; (a) K = 4.87 ± 0.01%, wt = 1.6153 gm, $*Ar^{40}$ = 8.149 x 10^{-10} moles, $*Ar^{40}$ = 62.0%; (b) K = 4.87 ± 0.01%, wt = 0.8120 gm, $*Ar^{40}$ = 4.108 x 10^{-10} moles, $*Ar^{40}$ = 52.0%. ***Constants:*** λ_e = 0.577 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.1477 x 10^{-4} atomic ratio; data averaged and recalculated by Meyer and others (1968), using λ_e = 0.585 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Isotope dilution, (K) flame photometer, (Ar) Reynolds-type mass spectrometer. ***Collected by:*** M. E. Woakes; ***dated by:*** L. Kovich, M. E. Woakes. ***Comment:*** Original dates by Woakes are: (a) 60.2 ± 1.8 m.y. (sericite); (b) 60.9 ± 1.8 m.y. (sericite).

(a) (sericite) 57.3 ± 1.6 m.y.
(b) (sericite) 57.5 ± 1.8 m.y.

482. *Woakes (1960)* K-Ar
Meyer and others (1968)
443-11

Hard white sericite, no fractures, vein material, footwall of State Vein, 4500 ft. below surface. (46°00'45"N, 112°32'25"W; sec. 13, T. 3 N., R. 8 W. [est.]; Butte North 15' quad; State Vein, Mount Con shaft, Butte, Silver Bow Co.) ***Analytical data:*** < 150 mesh, K = 5.37 ± 0.01%, wt = 1.4197 gm, $*Ar^{40}$ = 7.929 x 10^{-10} moles, $*Ar^{40}$ = 88.4%. ***Constants:*** λ_e = 0.577 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.1477 x 10^{-4} atomic ratio; recalculated by Meyer and others (1968) using λ_e = 0.585 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4}/yr atomic ratio. ***Method:*** Isotope dilution, (K) flame photometer, (Ar) Reynolds-type mass spectrometer. ***Collected by:*** M. E. Woakes; ***dated by:*** L. Kovich, M. E. Woakes. ***Comment:*** Original date calculated by Woakes is 60.4 m.y.; Miller (1973) cited a K-Ar age of 58.0 ± 1.6 m.y. for this sample.

(sericite) 57.5 m.y.

[No. 483 and 484 were omitted.]

485. *Hoffman, Hower and Aronson (1976)* K-Ar
Hoffman (1976)
LT-73

Potash bentonite, 1 in. thick, with minor kaolin and chlorite, Two Medicine Formation. (47°17'08"N, 112°05'57"W; sec. 27, T. 18 N., R. 4 W. [est.]; Henry Creek 7½' quad; Bowman's Corner, Lewis and Clark Co.) ***Analytical data:*** K_2O = 5.61%, adjusted K = 11.2%, $*Ar^{40}$ = 4.252 x 10^{-10} moles/g, $*Ar^{40}$ = 80%, 26% expandable (smectite) layers in the mixed-layered clay. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) I.L. flame photometer with Li internal standard, (Ar) isotope dilution. ***Dated by:*** J. L. Hoffman, J. L. Aronson. ***Comment:*** Age calculated using the "fixed" K content of Thompson and Hower (1973); approximate age of deposition = 70 to 82 m.y. ago; age interpreted as "coincident with time of maximum temperatures generated during or after thrusting in the Disturbed Belt."

(illite/smectite) 56.9 m.y.

486. *Baty (1973, 1976)* F.T.
S9-2

Mt. Powell pluton. (46°15'40"N, 113°04'30" W; NW¼ sec. 23, T. 6 N., R. 12 W. [est.]; Pozega Lakes 7½' quad; Powell Co.) ***Analytical data:*** ϱ_s = 339, 40 grains counted, 8.5 density ϱ_s/unit area; ϱ_i = 497, 40 grains counted, 12.4 density ϱ_i/unit area; ϕ = 1.35 x 10^{15} neutron/cm^2; 65-115 mesh, 95% purity, sample concentrated by fractionation in heavy liquids. ***Constants:*** (U^{238}) λ_D = 1.54 x 10^{-10}/yr, (U^{238}) λ_F = 6.85 x 10^{-17}/yr, (U^{235}) ς = 582 x 10^{-24} cm^2, U^{235}/U^{238} = 7.26 x 10^{-3}. ***Collected and dated by:*** J. B. Baty. ***Comment:*** Although Baty's fission track dates are about 10 m.y. younger than Obradovich's K-Ar dates, all are consistent with geologic relations and past research in the area.

(apatite) 56.4 m.y.

487. *Hoffman, Hower and Aronson (1976)* K-Ar
Hoffman (1976)
LT-14

Potash bentonite, 10 in. thick, with 68% total layer silicates, 19% quartz, 6% plagioclase, 8% calcite, tract of chlorite, Kevin Shale Member of the Marias River Formation. (47°37'14"N, 112°46'16"W; NE¼ sec. 33, T. 22 N., R. 9 W. [est.]; Patricks Basin 7½' quad; eastern end of the Sun River Canyon, Lewis and Clark Co.) ***Analytical data:*** K_2O = 5.31%, adjusted K = 11.1%, $*Ar^{40}$ = 3.982 x 10^{-10} moles/g, $*Ar^{40}$ = 70%, 44% expandable (smectite) layers in the mixed-layered clay. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) I.L. flame photometer with Li internal standard, (Ar) isotope dilution. ***Dated***

by: J. L. Hoffman, J. L. Aronson. ***Comment:*** Age calculated using the "fixed" K content of Thompson and Hower (1973); approximate age of deposition = 85 to 88 m.y. ago; age interpreted as "coincident with time of maximum temperatures generated during or after thrusting in the Disturbed Belt."

(illite/smectite) 56.2 m.y.

488. *Jaffe and others (1959)* Pb-α
55-K-304
Porphyritic granite, inclusions in basalt flow. (46°29'27"N, 112°47'46"W; sec. 36, T. 9 N., R. 10 W. [est.]; Conleys Lake 7½' quad; SE of Garrison, Powell Co.) ***Analytical data:*** −80 to +400 mesh, 575 α/mg/hr, Pb = 13 ppm. ***Constants:*** Selected Th/U = 1.0, c = 2485, k = 1.56 x 10^{-4}. ***Method:*** (Pb) Waring and Worthing (1953) spectrographic method, (α) thick source α counting techniques. ***Collected by:*** M. R. Klepper; ***dated by:*** C. L. Waring, H. W. Worthing, H. W. Jaffe, D. Gottfried. ***Comment:*** Stratigraphic age of basalt flow given as post-Judith River, pre-early Oligocene.

(zircon) 56 m.y.

489. *Jaffe and others (1959)* Pb-α
55-K-307a
Zircon-rich "micro-placers" in dacite tuff; Tertiary volcanic rocks resting on eroded surface of Boulder batholith. (46°16.0'N, 112°13.5'W; sec. 15 and 16, T. 6 N., R. 5 W. [est.]; Jefferson City 15' quad; Obelisk mine, Jefferson Co.) ***Analytical data:*** −200 to +400 mesh, 192 α/mg/hr, Pb = 4.2, 4.5 ppm. ***Constants:*** Selected Th/U = 1.0, c = 2485, k = 1.56 x 10^{-4}. ***Method:*** (Pb) Waring and Worthing (1953) spectrographic method, (α) thick source α counting techniques. ***Collected by:*** M. R. Klepper; ***dated by:*** C. L. Waring, H. W. Worthing, H. W. Jaffe, D. Gottfried.

(zircon) 56 m.y.

490. *Witkind (1973)* K-Ar
WL-210
Clendennin-Peterson laccolith; light gray porphyry with microgranitic mixture of anhedral quartz and alkalic feldspar, some plagioclase microlites and opaques, with phenocrysts of sanidine, oligoclase, hornblende, biotite. (47°07'08"N, 110°36'12"W; NE¼ SE¼ sec. 29, T. 16 N., R. 9 E.; Mixes Baldy 7½' quad; Judith Basin Co.) ***Analytical data:*** (a) K_2O = 8.66%, $*Ar^{40}$ = 7.218 x 10^{-10} moles/gm, $*Ar^{40}$ = 92%; (b) K_2O = 8.66%, $*Ar^{40}$ = 7.116 x 10^{-10} moles/gm, $*Ar^{40}$ = 92%; (sanidine) K_2O = 4.80%, $*Ar^{40}$ = 3.705 x 10^{-10} moles/gm, $*Ar^{40}$ = 92%; error = ± 2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, J. M. Merritt, W. Mountjoy. ***Comment:*** Dates can have two interpretations: (a) ages indicate age of emplacement; (b) ages have been reset by magmatic activity 44 m.y. ago.

(a) (biotite) 55.6 ± 2.3 m.y.
(b) (biotite) 54.9 ± 2.3 m.y.
(sanidine) 51.6 ± 1.8 m.y.

491. *Elliott, Naeser and Hedge (1974)* K-Ar
Elliott (1974, 1979)
Equigranular diorite stock. (45°04'30"N, 109°57'00"W; sec. 2, T. 9 S., R. 14 E.; Cooke City 7½' quad; Scotch Bonnet Mountain, Park Co.) ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Collected by:*** J. E. Elliott; ***dated by:*** C. E. Hedge.

(biotite) 55.3 ± 0.7 m.y.

492. *Schmidt, Worthington and Thomssen (1979)* K-Ar
K-feldspar metasomatized core portion of pluton. (45°39'16"N, 112°56'25"W; NE¼, sec. 22, T. 2 S., R. 11 W.; Vipond Park 15' quad; Cannivan Gulch, Beaverhead Co.) ***Comment:*** Date may be questionable due to some Ar loss.

(adularia) 55.3 ± 2 m.y.

493. *McDowell (1966, 1971) McDowell and Kulp (1969)* K-Ar
L-1120
Idaho batholith, medium porphyritic quartz monzonite with quartz, plagioclase, muscovite, chlorite (from biotite), and phenocrysts of orthoclase (partly sericite). (45°49'56"N, 113°58'24"W; NE¼, sec. 17, T. 1 N., R. 19 W. [est.]; Sula 7½' quad; ½ mi N of Sula along U.S. Hwy 93, Ravalli Co.) ***Analytical data:*** K = 8.61%, $*Ar^{40}$ = 8.50 x 10^{-10} moles/gm, $*Ar^{40}$ = 88%, error = 1 ς, 98% with feldspar. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) isotope dilution with mass spectrometry; (Ar) stable isotope dilution with 4.5-inch Reynolds-type mass spectrometer; sample

concentrated by fractionation in heavy liquids. ***Collected and dated by:*** F. W. McDowell. ***Comment:*** Date represents mixed ages.

(muscovite) 54.8 ± 1.6 m.y.

494. *Marvin and others (1973)* K-Ar
18

Barker porphyry sill; gray quartz latite with poikilitic alkali feldspar in quartz, some apatite, sphene, magnetite and opaque Fe ore with phenocrysts of sanidine, oligoclase, hornblende, biotite and pyroxene. (46°52'07"N, 110°39'56"W; NE¼, sec. 26, T. 13 N., R. 8 E.; Kings Hill 7½' quad; Cascade Co.) ***Analytical data:*** K_2O = 8.21%, $*Ar^{40}$ = 6.636 x 10^{-10} moles/gm, $*Ar^{40}$ = 91%, error = ± 2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60°6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(biotite) 54.0 ± 2.1 m.y.

495. *Chadwick (1969)* K-Ar

Emigrant Peak complex, propylitized hornblende-pyroxene andesite. (45°15'12"N, 110°34'05"W; sec. 1, T. 7 S., R. 9 E. [est.]; Emigrant 15' quad; 6 mi E of Emigrant Peak, West Fork of Mill Creek, Park Co.) ***Dated by:*** Geochron Laboratories, Inc. ***Comment:*** Date consistent with geologic relations.

(biotite) 53.5 ± 2.3 m.y.

496. *Marvin and others (1973)* K-Ar
Witkind (1973)
WL-580

Barker porphyry sill; gray quartz latite with poikilitic alkali feldspar in quartz, some apatite, sphene, magnetite and opaque Fe ore with phenocrysts of sanidine, oligoclase, hornblende, biotite and pyroxene. (47°03'39"N, 110°35'18"W; SW¼ NE¼ sec. 21, T. 15 N., R. 9 E.; Mixes Baldy 7½' quad; Judith Basin Co.) ***Analytical data:*** K_2O = 7.20%, $*Ar^{40}$ = 5.706 x 10^{-10} moles/gm, $*Ar^{40}$ = 94%, error = ± 2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60°6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(biotite) 53.0 ± 2.0 m.y.

497. *Jaffe and others (1959)* Pb-α
5-W-1

Fine-grained igneous rock inclusion near border of Boulder batholith. (46°12'04"N, 112°06'00"W; SW¼ NW¼ sec. 10, T. 5 N., R. 4 W. [est.]; Boulder 15' quad; Boulder Hot Springs, Jefferson Co.) ***Analytical data:*** −80 to +400 mesh, 750 α/mg/hr, Pb = 15, 16, 16, 16 ppm, mean = 16 ppm. ***Constants:*** Selected Th/U = 1.0, c = 2485, k = 1.56 x 10^{-4}. ***Method:*** (Pb) Waring and Worthing (1953) spectrographic method, (α) thick source α counting techniques. ***Collected by:*** R. A. Weeks; ***dated by:*** C. L. Waring, H. W. Worthing, H. W. Jaffe, D. Gottfried.

(zircon) 53 m.y.

498. *Marvin and others (1973)* K-Ar
Witkind (1973)
WL-581

Snow Creek (?) porphyry dike, light gray with microgranular mixture of anhedral quartz and alkalic feldspar, some biotite and with phenocrysts of quartz, orthoclase, albite, biotite. (47°01'42"N, 110°37'53"W; SW¼ NW¼ SE¼ sec. 30, T. 15 N., R. 9 E.; Barker 7½' quad; Judith Basin Co.) ***Analytical data:*** K_2O = 4.36%, $*Ar^{40}$ = 3.453 x 10^{-10} moles/gm, $*Ar^{40}$ = 92%, error = ± 2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60°6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(whole rock) 52.9 ± 2.0 m.y.

499. *Marvin and others (1973)* K-Ar
23

Minette sill with biotite, orthoclase, plagioclase, minor hornblende and pyroxene. (46°47'38"N, 110°40'28"W; SW¼, sec. 14, T. 12 N., R. 8 E.; Kings Hill 7½' quad; Meagher Co.) ***Analytical data:*** K_2O = 8.07%, $*Ar^{40}$ = 6.377 x 10^{-10} moles/gm, $*Ar^{40}$ = 88%, error = ± 2 ς. ***Constants:*** λ_e =

0.585×10^{-10}/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60°6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(biotite) 52.8 ± 2.0 m.y.

500. *Marvin and others (1973)* K-Ar
19

Barker porphyry sill; gray quartz latite with poikilitic alkali feldspar in quartz, some apatite, sphene, magnetite and opaque Fe ore, and with phenocrysts of sanidine, oligoclase, hornblende, biotite and pyroxene. (46°50'14"N, 110°42'54"W; NW¼, sec. 3, T. 12 N., R. 8 E.; Kings Hill 7½' quad; Judith Basin Co.) ***Analytical data:*** $K_2O = 8.58\%$, $*Ar^{40} = 6.765 \times 10^{-10}$ moles/gm, $*Ar^{40} = 93\%$, error = ±2 ς. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60°6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(biotite) 52.7 ± 2.0 m.y.

501. *Marvin and others (1973)* K-Ar
25

Minette sill with biotite, orthoclase, plagioclase, minor hornblende and pyroxene. (46°51'00"N, 110°41'12"W; NW¼, sec. 34, T. 13 N., R. 8 E.; Kings Hill 7½' quad; Cascade Co.) ***Analytical data:*** $K_2O = 7.74\%$, $*Ar^{40} = 6.084 \times 10^{-10}$ moles/gm, $*Ar^{40} = 93\%$, error = ±2 ς. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60°6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(biotite) 52.4 ± 2.0 m.y.

502. *Giletti (1966)* K-Ar
25

Tobacco Root batholith, gneiss with quartz, oligoclase, biotite, chlorite, hornblende, orthoclase. (45°30'00"N, 111°42'00"W; NW¼ NE¼ SW¼ sec. 11, T. 4 S., R. 1 W.; Ennis 15' quad; Madison Co.) ***Analytical data:*** K = 6.75%, $*Ar^{40} = 0.143 \times 10^{4}$ scc/g, $*Ar^{40} = 29.42\%$, $*Ar^{40}/K^{40} = 0.00310$, error = 1 ς. ***Constants:*** $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr. ***Method:*** (K) in triplicate with a Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution with a 6-inch 60° mass spectrometer. ***Collected by:*** B. J. Giletti; ***dated by:*** Brown University. ***Comment:*** It is not clear if this date represents a later phase of the Tobacco Root intrusion.

(biotite) 52 m.y.

503. *Faul (1960)* K-Ar
Kulp (1961)

Rocky Boy stock, carbonatite with large (10 cm) biotite crystals. (48°10'17"N, 109°42'22" W; NE¼, sec. 19, T. 28 N., R. 16 E.; Warrick 15' quad; Bearpaw Mountains, Hill Co.) ***Analytical data:*** K = 7.76%, $*Ar^{40} = 0.0292$, 0.0290 ppm, $*Ar^{40} = 57, 35\%$. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40} = 1.22 \times 10^{-4}$ g/gK. ***Method:*** (K) Perkin-Elmer flame photometer, (Ar) isotope dilution. ***Dated by:*** W. W. Brannock, P. L. D. Elmore, H. Faul, H. H. Thomas. ***Comment:*** This stock correlated with intrusives that cut early Eocene sediments; associated volcanic rocks are interbedded with sediment layers bearing middle and late Eocene fossil plants.

(biotite) 52 ± 2 m.y.

504. [Unpublished date]
Berg K-Ar
Personal communication (1980)
1321

Granite with 23% quartz, 48% K-spar, 25% plagioclase, some reddish-brown biotite and green hornblende (both unaltered). (45°42'00" N, 114°24'36"W; sec. 35, T. 1 S., R. 22 W.; Painted Rocks Lake 15' quad; Ravalli Co.) ***Analytical data:*** (biotite) K = 2.402%, $*Ar^{40} = 0.008808$ ppm, $*Ar^{40}/K^{40} = 0.003006$, $*Ar^{40} = 30.7\%$; (hornblende) K = 0.945%, $*Ar^{40} = 0.003568$ ppm, $*Ar^{40}/K^{40} = 0.003093$, $*Ar^{40} = 48.5\%$. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda\beta = 4.72 \times 10^{-10}$/yr, $K^{40} = 1.22 \times 10^{-4}$ g/gK. ***Collected by:*** R. B. Berg, MBMG; ***dated by:*** Geochron Laboratories, Inc. ***Comment:*** Pos-

sibility of several plutons in the area; dates may be cooling dates for another intrusion.

(biotite) 50.7 ± 2.1 m.y.
(hornblende) 52 ± 2.6 m.y.

505. *Marvin and others (1973)* K-Ar
Witkind (1973)
WL-209
Hughesville stock, brownish-gray quartz monzonite, fine to coarse grained with orthoclase, oligoclase, hornblende, biotite, salite, some sphene, apatite and opaque Fe oxides, and locally phenocrysts of tabular feldspar. (47°04'28"N, 110°38'12"W; SW¼ NE¼ NW¼ sec. 7, T. 15 N., R. 9 E.; Barker 7½' quad; Judith Basin Co.) ***Analytical data:***

	K_2O%	$*Ar^{40}$ ($\times 10^{-10}$ moles/gm)	$*Ar^{40}$%
(a)	9.05	6.075	81
(b)	8.81	5.931	86
(c)	8.06	6.719	82
(d)	8.10	5.876	83

Constants: $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) Nier-type 60° 6-inch mass spectrometer; isotope dilution techniques. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Dates can have two interpretations: (a) ages indicate age of emplacement; (b) ages have been reset by magmatic activity 44 m.y. ago.

(a) (biotite) 44.9 ± 1.5 m.y.
(b) (orthoclase) 45.1 ± 1.5 m.y.
(c) (biotite) 51.3 ± 1.5 m.y.
(d) (biotite) 48.5 ± 1.5 m.y.

506. *Marvin and Dobson (1979)* K-Ar
USGS (D)-KW-39-74
Andesite with microcrystalline feldspar, corroded hornblende phenocrysts, magnetite, rare quartz and feldspar phenocrysts. (45°16'08"N, 111°58'16"W; sec. 34, T. 6 S., R. 3 W.; Virginia City 15' quad; El Fleeda mine, Madison Co.) ***Analytical data:*** K_2O = 2.64, 2.65%, $*Ar^{40} = 1.973 \times 10^{-10}$ moles/gm, $*Ar^{40}$ = 90%. ***Constants:*** $\lambda_e = 0.581 \times 10^{-10}$/yr, $\lambda_\beta = 4.962 \times 10^{-10}$/yr, $K^{40}/K = 1.167 \times 10^{-4}$ atomic ratio. ***Collected by:*** K. L. Wier; ***dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt. ***Comment:*** This basaltic Eocene intrusive forms a plug which cuts mineralized veins within the mine.

(whole rock) 51.1 ± 1.2 m.y.

507. *Marvin and others (1973)* K-Ar
20
Barker porphyry sill; gray quartz latite, poikilitic with alkali feldspar in quartz, some apatite, sphene, magnetite and opaque Fe ore, and with phenocrysts of sanidine, oligoclase, hornblende, biotite and pyroxene. (46°46'49"N, 110°36'57"W; NE¼, sec. 27, T. 12 N., R. 10 E.; Sand Point 7½' quad; Judith Basin Co.) ***Analytical data:*** K_2O = 4.84%, $*Ar^{40} = 3.697 \times 10^{-10}$ moles/gm, $*Ar^{40}$ = 88%, error = ±2 ς. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(biotite) 51.1 ± 1.9 m.y.

508. *Marvin and others (1974)* K-Ar
KW-19-66
Andesite-dacite porphyry with euhedral to subhedral phenocrysts of andesine (30%), commonly 1 to 3 mm in diameter, biotite and magnetite (several %), generally in crystal sizes less than 2 mm, in a cloudy microcrystalline felsic groundmass. (45°17'55"N, 111°56'05"W; NE¼, sec. 23, T. 6 S., R. 3 W.; Virginia City 15' quad; rock quarry N of Virginia City, Madison Co.) ***Analytical data:*** (biotite) K_2O = 8.20%, $*Ar^{40} = 6.275 \times 10^{-10}$ moles/gm, $*Ar^{40}$ = 86%; (plagioclase) K_2O = 0.53, 0.52%, $*Ar^{40} = 0.3953 \times 10^{-10}$ moles/gm, $*Ar^{40}$ = 87%; error = ±2 ς. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40} = 1.22 \times 10^{-4}$ g/gK. ***Method:*** (K) flame photometer with Li internal standard, (Ar) standard isotope dilution procedures. ***Collected by:*** K. L. Wier; ***dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt. ***Comment:*** The porphyry overlies Precambrian gneisses in thin isolated patches and is believed to represent erosional remnants of a volcanic flow.

(biotite) 51.1 ± 1.9 m.y.
(plagioclase) 51.0 ± 3.8 m.y.

509. *Marvin and others (1973)* K-Ar
Witkind (1973)
WL-450
Snow Creek porphyry plug, light gray with microgranular mixture of anhedral quartz and al-

kalic feldspar, some biotite, and phenocrysts of quartz, sanidine, albite and biotite. (47°00'38"N, 110°40'26"W; SE¼ SW¼ SE¼ sec. 35, T. 15 N., R. 8 E.; Barker 7½' quad; Cascade Co.) ***Analytical data:*** (biotite) K_2O = 7.16%, $*Ar^{40}$ = 5.451 x 10^{-10} moles/gm, $*Ar^{40}$ = 82%; (orthoclase) K_2O = 6.16%, $*Ar^{40}$ = 4.566 x 10^{-10} moles/gm, $*Ar^{40}$ = 87%; error = $\pm 2\varsigma$. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Dates can have two interpretations: (a) ages indicate age of emplacement; (b) ages has been reset by magmatic activity 44 m.y. ago.

(biotite) 50.9 ± 1.7 m.y.
(orthoclase) 49.6 ± 1.7 m.y.

510. *Marvin and others (1973)* K-Ar 8

Yogo stock, monzonite(?). (46°56'07"N, 110°31'46"W; SW¼, sec. 36, T. 14 N., R. 9 E.; Yogo Peak 7½' quad; Judith Basin Co.) ***Analytical data:*** K_2O = 8.84%, $*Ar^{40}$ = 6.735 x 10^{-10} moles/gm, $*Ar^{40}$ = 92%, error = $\pm 2\varsigma$. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(biotite) 50.9 ± 2.0 m.y.

511. *Marvin and others (1973)* K-Ar 28

Carpenter Creek porphyry, composite dike. (46°58'00"N, 110°42'35"W; NE¼, sec. 21, T. 14 N., R. 8 E.; Neihart 7½' quad; Cascade Co.) ***Analytical data:*** K_2O = 8.10%, $*Ar^{40}$ = 6.155 x 10^{-10} moles/gm, $*Ar^{40}$ = 92%, error = $\pm 2\varsigma$. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(biotite) 50.8 ± 1.7 m.y.

512. *Baty (1973, 1976)* F.T. H7-9

Mt. Powell pluton. (46°17'25"N, 113°05'40"W; NW¼ sec. 10, T. 6 N., R. 12 W. [est.]; Pozega Lakes 7½' quad; Granite Co.) ***Analytical data:*** ϱ_s = 597, 48 grains counted, 12.4 density ϱ_s/unit area; ϱ_i = 793, 40 grains counted, 19.8 density ϱ_i/unit area; ϕ = 1.32 x 10^{15} neutron/cm²; 65-115 mesh, 95% purity, sample concentrated by fractionation in heavy liquids. ***Constants:*** (U^{238}) λ_D = 1.54 x 10^{-10}/yr, λ_F = 6.85 x 10^{-17}/yr, (U^{235}) ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3} atomic ratio. ***Collected and dated by:*** J. B. Baty. ***Comment:*** Although Baty's fission track dates are about 10 m.y. younger than Obradovich's K-Ar dates, all are consistent with geologic relations and past research in the area; age indicates uplift of plateau occurred before final cooling of this portion of the batholith.

(apatite) 50.7 m.y.

513. *Marvin and others (1973)* K-Ar 24

Minette sill with biotite, orthoclase, plagioclase, minor hornblende and pyroxene. (46°49'34"N, 110°41'37"W; SE¼, sec. 3, T. 12 N., R. 8 E.; Kings Hill 7½' quad; Meagher Co.) ***Analytical data:*** K_2O = 6.42%, $*Ar^{40}$ = 4.857 x 10^{-10} moles/gm, $*Ar^{40}$ = 90%, error = $\pm 2\varsigma$. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(biotite) 50.6 ± 1.9 m.y.

514. *Marvin and others (1973)* K-Ar
Witkind (1973)
WL-575

Clendennin-Peterson laccolith; light gray porphyry with plagioclase microlites, some opaques and phenocrysts of sanidine, oligoclase, hornblende and biotite. (47°07'08"N, 110°36'12"W; NE¼ SE¼ sec. 29, T. 16 N., R. 9 E.; Mixes Baldy 7½' quad; Judith Basin Co.)

Analytical data: K_2O = 8.54%, $*Ar^{40}$ = 6.438 x 10^{-10} moles/gm, $*Ar^{40}$ = 85%, error = ±2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(biotite) 50.4 ± 1.9 m.y.

515. *Marvin and others (1973)* Rb-Sr
Witkind (1973)
WL-589
Granite Mountain bysmalith; light-gray, fine-grained rhyolite with anhedral quartz and alkalic feldspar and phenocrysts of albite and topaz. (47°05'10"N, 110°29'49"W; SW¼ SE¼ SW¼ sec. 6, T. 15 N., R. 10 E.; Wolf Butte 7½' quad; Judith Basin Co.) ***Analytical data:*** (a) Rb = 529 ppm, Sr = 8.51 ppm, Rb^{87}/Sr^{86} = 179.9, Sr^{87}/Sr^{86} = 0.8341; (b) Rb = 523 ppm, Sr = 8.91 ppm, Rb^{87}/Sr^{86} = 169.8, Sr^{87}/Sr^{86} = 0.8269; error = ±2 ς. ***Constants:*** $\lambda\beta$ = 1.39 x 10^{-11}/yr, Rb^{87}/Rb = 0.243 g/g. ***Method:*** Peterman and others (1967). ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(whole rock) 50.0 ± 5.0 m.y.

516. *Chapman, Gottfried and Waring (1955)* Pb-α
Faul (1954)
Walker (1963)
53-C-198-Z
Philipsburg batholith, medium-grained biotite hornblende quartz monzonite. (46°18'56"N, 113°17'54"W; sec. 36, T. 7 N., R. 14 W. [est.]; Philipsburg 7½' quad; 1 mi E of Philipsburg, Granite Co.) ***Analytical data:*** Pb = 18 ppm, 858 α/mg/hr. ***Method:*** (Pb) Waring and Worthing (1953) spectrographic method, (α) thick-source α counting technique, sample concentrated by fractionation in heavy liquids. ***Collected by:*** R. W. Chapman; ***dated by:*** D. Gottfried, C. L. Waring.

(zircon) 50 m.y.

517. *Smedes and Thomas (1965)* K-Ar
300-61B
Lowland Creek volcanics, thin vitrophyre lava unit. (46°02'40"N, 112°37'25"W; center N½, sec. 5, T. 3 N., R. 8 W.; Butte North 15' quad; 4 mi NW of Butte, Silver Bow Co.) ***Analytical data:*** K_2O = 8.50%, $*Ar^{40}$ = 0.0257 ppm, $*Ar^{40}$ = 80%, $*Ar^{40}/K^{40}$ = 0.00298. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40} = 1.22 x 10^{-4} g/gK. ***Dated by:*** H. H. Thomas, R. F. Marvin, P. L. D. Elmore, H. Smith. ***Comment:*** Age establishes pre-Eocene age for Boulder batholith.

(biotite) 50 ± 2 m.y.

518. *Marvin and others (1973)* K-Ar
6
Snow Creek quartz porphyry, Carpenter Creek pluton. (46°57'31"N, 110°42'57"W; SE¼, sec. 21, T. 14 N., R. 8 E.; Neihart 7½' quad; Cascade Co.) ***Analytical data:*** K_2O = 3.20%, $*Ar^{40}$ = 2.376 x 10^{-10} moles/gm, $*Ar^{40}$ = 79%, error = ±2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(whole rock) 49.7 ± 2.0 m.y.

519. *Marvin and others (1973)* K-Ar
Witkind (1973)
WL-582
Barker porphyry laccolith; gray quartz latite, poikilitic alkali feldspar in quartz, some apatite, sphene, magnetite, and opaque Fe ore with phenocrysts of sanidine, oligoclase, hornblende, biotite and pyroxene. (47°05'48"N, 110°43'11"W; SE¼ SW¼ sec. 34, T. 16 N., R. 8 E.; Barker 7½' quad; Judith Basin Co.) ***Analytical data:*** K_2O = 7.90%, $*Ar^{40}$ = 5.875 x 10^{-10} moles/gm, $*Ar^{40}$ = 80%, error = ±2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpreta-

tions: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(biotite) 49.7 ± 2.3 m.y.

520. *Marvin and others (1973) Rostad (1978)* K-Ar
5
Big Ben quartz porphyry, Carpenter Creek pluton. (46°57'55"N, 110°43'00"W; NE¼, sec. 21, T. 14 N., R. 8 E.; Neihart 7½' quad; Cascade Co.) ***Analytical data:*** K_2O = 4.90%, $*Ar^{40}$ = 3.625 x 10^{-10} moles/gm, $*Ar^{40}$ = 91%, error = ±2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(whole rock) 49.5 ± 1.9 m.y.

521. *Chadwick (1969)* K-Ar
Big Creek stock, dacite, intensely fractured, kaolinized, hematized, locally pyritized by solution. (45°18'40"N, 110°53'34"W; center sec. 17, T. 6 S., R. 7 E.; Fridley Peak 15' quad; Big Creek, Gallatin Range, Park Co.) ***Dated by:*** J. D. Obradovich, U.S.G.S. ***Comment:*** The Big Creek stock cuts the Hyalite Peak Volcanics, which are equivalent to the lower half of the Sepulcher Formation. Smedes and Prostka (1972) obtained a K-Ar sanidine date of 49.2 ± 1.5 m.y. for the Lost Creek Tuff, lower part of the Sepulcher Formation, in Yellowstone National Park.

(biotite) 49.5 ± 1.5 m.y.

522. *McDowell (1966, 1971)* K-Ar
L-1020
Fine porphyritic diorite with orthoclase, hornblende, plagioclase, quartz(?), much sericite alteration, and phenocrysts of orthoclase (badly sericitized), hornblende (altered at edges), from large boulder below outcrop, Judith Mountains intrusive. (47°10'25"N, 109°14'42"W; SW¼ NW¼ sec. 6, T. 16 N., R. 20 E.; Judith Peak 15' quad; Warm Spring Creek, ¾ mi W of Maiden Peak, Fergus Co.) ***Analytical data:*** K = 0.490%, $*Ar^{40}$ = 0.434 x 10^{-10} moles/gm, $*Ar^{40}$ = 28%, error = 1 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) isotope dilution with mass spectrometry, (Ar) stable isotope dilution with 4.5-inch Reynolds-type mass spectrometer; samples concentrated by fractionation in heavy liquids. ***Collected and dated by:*** F. W. McDowell. ***Comment:*** Pure hornblende used for analysis; date consistent with geologic relationships of intrusion.

(hornblende) 49.3 ± 2.2 m.y.

523. *Marvin and others (1974)* K-Ar
KW-66-66
Light gray andesite porphyry with euhedral to subhedral phenocrysts of andesine (30%), commonly 1 to 3 mm in diameter, and biotite and magnetite (several %), generally in crystal sizes less than 2 mm, in a cloudy microcrystalline felsic groundmass. (45°17'55"N, 111°56'05"W; NE¼, sec. 23, T. 6 S., R. 3 W.; Virginia City 15' quad; rock quarry N of Virginia City, Madison Co.) ***Analytical data:*** K_2O = 8.19, 8.31%, $*Ar^{40}$ = 6.091 x 10^{-10} moles/gm, $*Ar^{40}$ = 88%, error = 2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40} = 1.22 x 10^{-4} g/gK. ***Collected by:*** K. L. Wier; ***dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt. ***Comment:*** Porphyry overlies Precambrian gneisses in thin isolated patches and is believed to represent erosional remnants of a volcanic flow.

(biotite) 49.3 ± 2.5 m.y.

524. *Tysdal (1966) Chadwick (1967, 1969)* K-Ar
Dacite stock. (45°29'50"N, 110°36'04"W; NE¼ sec. 10, T. 6 S., R. 9 E. [est.]; Emigrant 15' quad; lower Mill Creek canyon, Absaroka Range, Park Co.) ***Dated by:*** Geochron Laboratories, Inc. ***Comment:*** Date consistent with geologic relations.

(biotite) 49.0 ± 1.7 m.y.

525. *Baadsgaard, Folinsbee and Lipson (1961)* K-Ar
KA 156
Big Butte dike rhyolite; pumiceous, glassy, and massive rhyolite fragments occur in finely indurated matrix of fine particles of rhyolite; with andesine and sanidine phenocrysts, biotite, quartz, hornblende. (46°01'N, 112°35'W; sec. 15, T. 3 N., R. 8 W.; Butte North 15' quad; Butte, Silver Bow Co.) ***Analytical data:*** K = 7.21%, $*Ar^{40}/K^{40}$ = 0.00294, assumed deviation = ± 5%. ***Constants:*** λ_e = 0.589 x 10^{-10}/yr, λ_β = 4.76 x 10^{-10}/yr, K^{40}/K

$= 1.18 \times 10^{-4}$ atomic ratio. ***Method:*** (K) J. Lawrence Smith fusion and tetraphenylboron precipitation, (Ar) isotope dilution with Nier-type 6-inch mass spectrometer. ***Dated by:*** A. Stelmach. ***Comment:*** Date indicates last major heating of the rock in which the biotite occurs.

(biotite) 49 m.y.

526. *Blackwell and others (1975)* K-Ar
Bald Butte quartz porphyry. (46°42'31"N, 112° 19'52"W; NE¼ sec. 15, T. 11 N., R. 6 W. [est.]; Elliston 15' quad; Bald Butte, Helena volcanic field, Lewis and Clark Co.)

49 m.y.

527. *Chadwick (1967)*
Dacite intrusion. (East of Gallatin Range, Park Co.)

49 m.y.

528. *Marvin and others (1973)* K-Ar
Witkind (1973)
WL-404
Barker porphyry laccolith, gray quartz latite, poikilitic alkali feldspar in quartz, some apatite, sphene, magnetite, and opaque Fe oxides with phenocrysts of sanidine, oligoclase, hornblende, biotite and pyroxene. (47°06'18"N, 110°41'15"W; NE¼ NE¼ SE¼ sec. 34, T. 16 N., R. 8 E.; Barker 7½' quad; Judith Basin Co.) ***Analytical data:*** (biotite) $K_2O = 8.18\%$, $*Ar^{40} = 5.907 \times 10^{-10}$ moles/gm, $*Ar^{40} = 80\%$; (sanidine) $K_2O = 9.94\%$, $*Ar^{40} = 7.247 \times 10^{-10}$ moles/gm, $*Ar^{40} = 89\%$; error = $\pm 2\ \varsigma$. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(biotite) 48.3 ± 1.6 m.y.
(sanidine) 48.8 ± 1.7 m.y.

529. *Marvin and others (1973)* K-Ar
Witkind (1973)
WL-103
Granite Mountain bysmalith; light gray, fine-grained rhyolite, with microgranular mixture of anhedral quartz, alkalic feldspar, some plagioclase, biotite, opaque Fe oxides and phenocrysts of albite and topaz. (47°05'50"N, 110°30'11"W; center sec. 31, T. 16 N., R. 10 E.; Mixes Baldy 7½' quad; Judith Basin Co.) ***Analytical data:*** $K_2O = 4.10\%$, $*Ar^{40} = 2.991 \times 10^{-10}$ moles/gm, $*Ar^{40} = 84\%$, error = $\pm 2\ \varsigma$. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(whole rock) 48.8 ± 2.0 m.y.

530. *Hughes (1971)* K-Ar
TV-1
Strongly porphyritic biotite andesite with andesine microlites, magnetite (commonly altered to hematite), and phenocrysts of zoned plagioclase and euhedral biotite. (46°26'00"N, 113°25'30"W; sec. 24, T. 8 N., R. 15 W. [est.]; Black Pine Ridge 7½' quad; between Miners Gulch and Henderson stocks, Granite Co.) ***Analytical data:*** $*Ar^{40}/K^{40} = 0.00289$. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40} = 1.22 \times 10^{-4}$ g/gK. ***Collected by:*** G. J. Hughes, Jr.; ***dated by:*** Geochron Laboratories, Inc. ***Comment:*** Date consistent with geologic evidence.

(biotite) 48.7 ± 1.7 m.y.

531. *Marvin and others (1973)* K-Ar
29
Carpenter Creek porphyry dike. (46°57'30"N, 110°44'25"W; NW¼, sec. 29, T. 14 N., R. 8 E.; Neihart 7½' quad; Cascade Co.) ***Analytical data:*** $K_2O = 8.26\%$, $*Ar^{40} = 6.005 \times 10^{-10}$ moles/gm, $*Ar^{40} = 89\%$, error = $\pm 2\ \varsigma$. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(muscovite) 48.7 ± 1.8 m.y.

532. *Marvin and others (1973)* K-Ar
4
Silver Dyke granite porphyry, Carpenter Creek pluton. (46°58'14"N, 110°42'49"W; SW¼ sec. 15, T. 14 N., R. 8 E.; Neihart 7½' quad; Cascade Co.) ***Analytical data:*** K_2O = 9.50%, $*Ar^{40}$ = 6.891 x 10^{-10} moles/gm, $*Ar^{40}$ = 89%, error = ±2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(biotite) 48.5 ± 1.8 m.y.

[No. 533 was omitted.]

534. [Unpublished date]
McClernan and Berg K-Ar
Personal communication (1980)
SB-1
Unnamed stock, granodiorite with plagioclase, biotite, hornblende, fine-grained groundmass composed mainly of plagioclase. (46°54'N, 112°30'W; NW¼ SW¼ sec. 9, T. 13 N., R. 7 W.; Swede Gulch 7½' quad; roadcut on N side of road, Stemple Pass, Lewis and Clark Co.) ***Analytical data:*** −60/+200 mesh, K = 6.211%, $*Ar^{40}$ = 0.02166 ppm, $*Ar^{40}$ = 69%, $*Ar^{40}/K^{40}$ = 0.002858. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40} = 1.22 x 10^{-4} g/gK. ***Collected by:*** H. G. McClernan, R. B. Berg, MBMG; ***dated by:*** Geochron Laboratories, Inc.

(biotite) 48.2 ± 1.8 m.y.

535. *Miller (1973)* K-Ar
Woakes (1960)
Meyer and others (1968)
443-3
Big Butte rhyolite, from the freshest available exposure of the surface rhyolite flows, strongly brecciated in outcrop, biotite appeared unaltered. (46°00'30"N, 112°34'55"W; sec. 15, T. 3 N., R. 8 W. [est.]; Butte North 15' quad; 600 ft. S of crest of Big Butte, in quarry, Butte, Silver Bow Co.) ***Analytical data:*** 35-150 mesh, < 3% impurities, K = 6.96%, wt = 0.9396 gm, $*Ar^{40}$ = 5.690 x 10^{-10} moles, $*Ar^{40}$ = 73.3%. ***Constants:*** λ_e = 0.577 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.1477 x 10^{-4} atomic ratio; recalculated by Meyer and others (1968) using λ_e = 0.585 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Isotope dilution, (K) flame photometer, (Ar) Reynolds-type mass spectrometer. ***Collected by:*** M. E. Woakes; ***dated by:*** L. Kovich, M. E. Woakes. ***Comment:*** If dates on coarse biotite of quartz monzonite and rhyolite are correct, hydrothermal alteration of the rhyolite took place 30 m.y. after emplacement of the batholith and more than 10 m.y. after mineralization of the big veins; original date by Woakes is 50.7 m.y.

(biotite) 48.2 ± 1.5 m.y.

536. *Chadwick (1967)* K-Ar
Pyroxene-hornblende-andesite sequence of flows. (45°20'30"N, 110°49'30"W; sec. 2, T. 6 S., R. 7 E. [est.]; Fridley Peak 15' quad; along Golmeyer Creek in the east-central Gallatin Mountains, Park Co.) ***Comment:*** These flows represent the earlier phase of Eocene volcanism in the Gallatins.

48 m.y.

537. *Rostad (1978)*
Bald Butte. (46°43'N, 112°21'W; sec. 10, T. 13 N., R. 6 W.; Elliston 15' quad; Lewis and Clark Co.)

48 m.y.

538. *Smedes and Thomas (1965)* K-Ar
7S-111; 281B
Lowland Creek volcanics, welded-tuff unit. (45°57'46"N, 112°42'57"W; SE¼ sec. 33, T. 3 N., R. 9 W.; Butte South 7½' quad; 8 mi W of Butte, Silver Bow Co.) ***Analytical data:*** K_2O = 8.53%, $*Ar^{40}$ = 0.0248 ppm, $*Ar^{40}$ = 80%, $*Ar^{40}/K^{40}$ = 0.00287. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40} = 1.22 x 10^{-4} g/gK. ***Dated by:*** H. H. Thomas, R. F. Marvin, P. L. D. Elmore, H. Smith. ***Comment:*** Date establishes pre-Eocene age for Boulder batholith.

(biotite) 48 ± 2 m.y.

539. *Ferguson (1972, 1975)* K-Ar
K10 F.T.
Pelitic schist, quartzofeldspathic gneiss with 44% quartz, 30% plagioclase, 11% biotite, some K-spar and muscovite, trace chlorite, sillimanite, apatite. (46°32'05"N, 114°18'45" W; center of line between sec. 11 and 14, T. 11 N., R. 22 W.; Dick Creek 7½' quad; Missoula Co.) ***Analytical data:*** (biotite) K = 7.18%, $*Ar^{40}$ = 12.7 x 10^{-6} STP cc, air correction =

24%; (apatite) ϱ_s = 8.00 x 10^5 tracks/cm², 400 counts, ϱ_i = 18.60 x 10^5 tracks/cm², 465 counts, ϕ = 1.833 x 10^{15} neutron/cm². ***Method:*** Sample concentrated by fractionation in heavy liquids; see Naeser and Dodge (1969) (FT). ***Collected by:*** J. A. Ferguson; ***dated by:*** J. A. Ferguson, R. L. Armstrong.

(biotite) 43.2 ± 0.9 m.y.
(apatite) 48 ± 4 m.y.

540. *Marvin and others (1973)* K-Ar
3
Aplite, Carpenter Creek pluton. (46°58'06"N, 110°42'58"W; SW¼ sec. 15, T. 14 N., R. 8 E.; Neihart 7½' quad; Cascade Co.) ***Analytical data:*** K_2O = 6.64%, $*Ar^{40}$ = 4.743 x 10^{-10} moles/gm, $*Ar^{40}$ = 94%, error = ±2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(whole rock) 47.8 ± 1.8 m.y.

541. *Marvin and others (1973) Witkind (1973)* K-Ar
WL-579
Wolf porphyry, Mixes Baldy-Anderson Peak laccolith; light gray granite porphyry with large phenocrysts of smoky quartz, feldspar, some hornblende and biotite. (47°03'42"N, 110°35'33"W; NW¼ SE¼ sec. 16, T. 15 N., R. 9 E.; Mixes Baldy 7½' quad; Judith Basin Co.) ***Analytical data:*** (biotite) K_2O = 7.58%, $*Ar^{40}$ = 5.353 x 10^{-10} moles/gm, $*Ar^{40}$ = 91%; (hornblende) K_2O = 0.904%, $*Ar^{40}$ = 0.6248 x 10^{-10} moles/gm, $*Ar^{40}$ = 86%; error = ±2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (hornblende) K determined by isotope dilution; (biotite) K determined with Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Dates can have two interpretations: (a) ages indicates age of emplacement; (b) ages have been reset by magmatic activity 44 m.y. ago.

(biotite) 47.3 ± 1.8 m.y.
(hornblende) 46.3 ± 1.7 m.y.

542. *Williams, Harakal and Armstrong (1976)* K-Ar
Rattler Gulch basalt, fine-grained black crystalline basalt. (46°41'51"N, 113°13'25"W; NW¼ sec. 22, T. 11 N., R. 13 W.; Drummond 15' quad; outcrops on hill just W of junction of Rattler Gulch road and limestone quarry road, Granite Co.) ***Analytical data:*** K = 2.08%, $*Ar^{40}$ = 3.92 x 10^{-6} cc STP/gm, $*Ar^{40}$ = 76%, error = 1 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) duplicate atomic absorption, Techtron AA4 spectrophotometer, (Ar) isotope dilution, AEI MS-10 mass spectrometer. ***Dated by:*** T. R. Williams, J. E. Harakal, R. L. Armstrong, K. Scott. ***Comment:*** Rocks apparently related to Challis-Absaroka-Lowland Creek episode; no longer contributing to the present heat flow; thermal springs in area apparently caused by deep circulation along permeable zones associated with the Bearmouth thrust.

(whole rock) 46.7 ± 2.5 m.y.

543. *Marvin and others (1973) Witkind (1973)* K-Ar
WL-208
Wolf porphyry, Mixes Baldy-Anderson Peak laccolith; light gray granite porphyry with large phenocrysts of smoky quartz, feldspar, some hornblende and biotite. (47°03'57"N, 110°36'12"W; NW¼ NE¼ sec. 17, T. 15 N., R. 9 E.; Mixes Baldy 7½' quad; Judith Basin Co.) ***Analytical data:*** (biotite) K_2O = 8.75%, $*Ar^{40}$ = 6.054 x 10^{-10} moles/gm, $*Ar^{40}$ = 86%; (sanidine) K_2O = 6.59%, $*Ar^{40}$ = 4.420 x 10^{-10} moles/gm, $*Ar^{40}$ = 87%; error = ±2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(biotite) 46.4 ± 1.6 m.y.
(sanidine) 44.9 ± 1.5 m.y.

544. *Jaffe and others (1959)* Pb-α
P-50-49
Light gray to green, porphyritic potassic syenite with zoned sanidine phenocrysts and stony or fine-grained matrix. (48°10'00"N, 109°46'30"W; center sec. 22, T. 28 N., R. 15 E. [est.];

Centennial Mountain 15′ quad; Big Sandy Creek, Bearpaw Mountains, Chouteau Co.) ***Analytical data:*** (a) −80 to +100 mesh, 290 α/mg/hr, Pb = 5.2, 5.6 ppm; (b) −100 to +200 mesh, 275 α/mg/hr, Pb = 5.0, 5.1 ppm. ***Constants:*** Selected Th/U = 1.0, c = 2485, k = 1.56 x 10^{-4}. ***Method:*** (Pb) Waring and Worthing (1953) spectrographic method, (α) thick source α counting techniques. ***Collected by:*** W. T. Pecora; ***dated by:*** C. L. Waring, H. W. Worthing, H. W. Jaffe, D. Gottfried.

(a) (zircon) 46 m.y.
(b) (zircon) 46 m.y.

545. *Tripp (1976)* Rb-Sr
Chase and others (1978)
A18

Idaho batholith, fresh granodiorite with 57% plagioclase (An_{38}), 24% quartz, 13% biotite, some K-spar, muscovite; accessories are apatite, chlorite, zircon, opaques, sphene, epidote. (46°31′44″N, 114°20′10″W; NW¼ NW¼ sec. 23, T. 9 N., R. 22 W.; Saint Joseph Peak 7½′ quad; about 1.6 km S of contact with quartz diorite orthogneiss and quartzofeldspathic gneiss and 1.3 km SW of South Kootenai Lake, Ravalli Co.) ***Analytical data:*** (See below.) ***Constants:*** Rb^{87} λ = 1.39 x 10^{-11}/yr, Sr^{86}/Sr^{88} = 0.1194 atomic ratio, Sr^{84}/Sr^{88} = 0.0068 atomic ratio, Rb^{85}/Rb^{87} = 2.5927 atomic ratio. ***Method:*** Standard isotope dilution techniques with mass spectrometry, sample concentrated by fractionation with heavy liquids. ***Dated by:*** Isotope Geochemistry Laboratory, University of Kansas. ***Comment:*** Whole rock Rb-Sr data did not yield isochrons because of low Rb^{87}/Sr^{86} ratios, "mineral" isochron is actually a biotite age with initial Sr^{87}/Sr^{86} ratio determined by whole rock, apatite and plagioclase analyses.

(mineral isochron) 46 ± 5 m.y.

Analytical data for No. 545:

	Rb^{87} μg/g	Sr^{86} μg/g	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}
whole rock	31.8	72.1	0.435 ± 0.009	0.7111 ± 0.0009
biotite	211	4.97	42.0 ± 0.84	0.7371 ± 0.0021
quartz-plagioclase	3.58	80.6	0.044 ± 0.0009	0.7091 ± 0.0012
K-feldspar	96.7	89.9	1.06 ± 0.021	0.7140 ± 0.0014
apatite	0.620	31.9	0.019 ± 0.0004	0.7104 ± 0.0021

Initial ratio = 0.7103 ± 0.002.

546. *Marvin and others (1973)* K-Ar
McDowell (1966, 1971)
L-1021

Medium porphyritic syenite float, Hughesville stock, with biotite, hornblende (feldspar inclusions, some altered to biotite), quartz and phenocrysts of orthoclase (moderate sericite), and plagioclase. (47°04′52″N, 110°38′11″W; SW¼ sec. 5, T. 15 N., R. 1 E.; Hound Creek Reservoir 7½′ quad; ½ mi NE of Barker, Cascade Co.) ***Analytical data:*** (biotite) 60-100 mesh, K = 6.93%, $*Ar^{40}$ = 5.12 x 10^{-10} moles/gm, $*Ar^{40}$ = 74%; (hornblende) 60-100 mesh, 95% with biotite and aggregate, K = 0.617%, $*Ar^{40}$ = 0.480 x 10^{-10} moles/gm, $*Ar^{40}$ = 45%; error = 1 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) isotope dilution with mass spectrometry, (Ar) stable isotope dilution with 4.5-inch Reynolds-type mass spectrometer, samples concentrated by fractionation with heavy liquids. ***Collected and dated by:*** F. W. McDowell. ***Comment:*** Dates consistent with geologic evidence.

(biotite) 41.2 ± 1.2 m.y.
(hornblende) 44.9 ± 1.3 m.y.

547. *Williams, Harakal and Armstrong (1976)* K-Ar

Bearmouth basalt, gray, fine-grained crystalline basalt. (46°42′47″N, 113°18′49″W; NW¼ sec. 14, T. 11 N., R. 14 W.; Bearmouth 15′ quad; railroad cut S of Clark Fork River and across from site of old Bearmouth warm spring, Granite Co.) ***Analytical data:*** K = 2.18%, $*Ar^{40}$ = 3.95 x 10^{-6} cc STP/gm, $*Ar^{40}$ = 93%, error = 1 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) duplicate atomic absorption, Techtron AA4 spectrophotometer, (Ar) isotope dilution, AEI MS-10 mass spectrometer. ***Dated by:*** T. R. Williams, J. E. Harakal, R. L. Armstrong, K. Scott. ***Comment:*** Rocks apparently related to Challis-Absaroka-Lowland Creek episode; no longer contrib-

uting to present heat flow; thermal springs in area apparently caused by deep circulation along permeable zones associated with the Bearmouth thrust.

(whole rock) 44.9 ± 2.0 m.y.

548. *Marvin and others (1974)* K-Ar
KW-914-67
Light-gray porphyritic rhyolite with 25% oligoclase and several percent each of biotite and quartz phenocrysts, commonly ranging from ¼ to 1 mm in diameter, in a cloudy groundmass of felsic crystallites. (45°14'48"N, 112°05'54"W; NW¼ sec. 9, T. 7 S., R. 4 W.; Ruby Dam 7½' quad; from quarry, Madison Co.) ***Analytical data:*** K_2O = 8.60, 8.57%, $*Ar^{40}$ = 5.720 x 10^{-10} moles/gm, $*Ar^{40}$ = 85%, error = 2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40} = 1.22 x 10^{-4} g/gK. ***Method:*** (K) flame photometry with Li internal standard, (Ar) standard isotope dilution procedures. ***Collected by:*** K. L. Wier; ***dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt. ***Comment:*** This rhyolite intrudes Precambrian rocks and forms an irregular-shaped body 2,000 or 3,000 ft. in maximum diameter.

(biotite) 44.7 ± 1.7 m.y.

549. *Williams, Harakal and Armstrong (1976)* K-Ar
Sanidine from a light gray porphyritic rhyolite with gray quartz and iridescent feldspar crystals, Bearmouth rhyolite. (46°41'50"N, 113°21'30"W; NE¼ sec. 21, T. 11 N., R. 14 W.; Bearmouth 15' quad; roadcut and quarry just N of old U.S. Hwy 10, about 1 mi W of Bearmouth, Granite Co.) ***Analytical data:*** K = 6.51%, $*Ar^{40}$ = 11.69 x 10^{-6} cc STP/gm, $*Ar^{40}$ = 96%, error = 1 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) duplicate atomic absorption, Techtron AA4 spectrophotometer, (Ar) isotope dilution, AEI MS-10 mass spectrometer. ***Dated by:*** T. R. Williams, J. E. Harakal, R. L. Armstrong, K. Scott. ***Comment:*** Rocks apparently related to Challis-Absaroka-Lowland Creek episode; no longer contributing to present heat flow; thermal springs in area apparently caused by deep circulation along permeable zones associated with the Bearmouth thrust.

(sanidine) 44.5 ± 2.0 m.y.

550. *Marvin and others (1973)* K-Ar
31
Vogesite dike; dark gray, fine grained, porphyritic, with biotite, augite, salite, orthoclase and plagioclase microlites, some apatite, sphene and magnetite, and phenocrysts of biotite, augite, salite, also xenocrysts of quartz, sanidine and plagioclase (apparently relicts of country rock). (47°04'44"N, 110°31'58"W; SW¼ sec. 11, T. 15 N., R. 9 E.; Mixes Baldy 7½' quad; Judith Basin Co.) ***Analytical data:*** K_2O = 4.79%, $*Ar^{40}$ = 3.159 x 10^{-10} moles/gm, $*Ar^{40}$ = 96%, error = 2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) isotope dilution techniques with Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(whole rock) 44.2 ± 1.6 m.y.

551. *Marvin and others (1973) Witkind (1973)* K-Ar
WL-576
Kersantite composite dike with biotite, orthoclase, plagioclase, minor hornblende, pyroxene. (47°05'05"N, 110°38'28"W; SW¼ NW¼ SW¼ sec. 6, T. 15 N., R. 9 E.; Barker 7½' quad; Judith Basin Co.) ***Analytical data:*** K_2O = 8.84%, $*Ar^{40}$ = 5.802 x 10^{-10} moles/gm, $*Ar^{40}$ = 87%, error = 2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Isotope dilution techniques, (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(biotite) 44.0 ± 1.7 m.y.

552. *Elliott, Naeser and Hedge (1974) Elliott (1974, 1979)* F.T.
Dacite porphyry laccolith. (45°02'30"N, 109°56'00"W; sec. 13, T. 9 S., R. 14 E.; Cooke City 7½' quad; Henderson Mountain, Park Co.) ***Analytical data:*** ϱ_s = 5.64 x 10^6 tracks/cm², tracks = 1070; ϱ_i = 8.84 x 10^6 tracks/cm², tracks = 839; ϕ = 1.13 x 10^{15} neutron/cm². ***Constants:*** U^{238} λ_F = 6.85 x 10^{-17}/yr. ***Collected by:*** J. E. Elliott; ***dated by:*** C. W. Naeser.

(zircon) 44.0 ± 4.1 m.y.

553. *Ferguson (1972, 1975)* F.T.
K112
Amphibolite layer with weak lineation of hornblende in quartzite, with 64% hornblende, 14% quartz, some plagioclase, biotite, muscovite, sphene and opaques, trace of chlorite. (46°33'15"N, 114°18'55"W; NW¼ SE¼ sec. 11, T. 9 N., R. 22 W.; Saint Joseph Peak 7½' quad; Ravalli Co.) ***Analytical data:*** ϱ_S = 4.10 x 10^5 tracks/cm², 256 counts; ϱ_i = 10.46 x 10^5 tracks/cm², 340 counts, ϕ = 1.833 x 10^{15} neutron/cm². ***Constants:*** (U^{238}) λ_D = 1.54 x 10^{-10}/yr, (U^{238}) λ_F = 6.85 x 10^{-17}/yr, (U^{235}) ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3}. ***Collected and dated by:*** J. A. Ferguson. ***Comment:*** Prior to 38 m.y., this unit was at depths too great for apatite to retain its fission tracks; at 38 m.y., uplift brought apatite to a thermal depth at which it did retain fission tracks; nearby intrusions and volcanism are thought to have only local effect on apatite.

(apatite) 44 ± 4 m.y.

554. *Ferguson (1972, 1975)* K-Ar
K-1 F.T.
Reddish-brown pelitic schist with 44% quartz, 30% plagioclase, 11% biotite, some muscovite and K-spar, trace chlorite, apatite, sphene. (46°35'00"N, 114°22'00"W; NE¼ sec. 6, T. 37 N., R. 17 E. [est.]; Saint Joseph Peak 7½' quad; Idaho Co., ID.) ***Analytical data:*** (biotite) K = 6.99%, Ar^{40} = 12.3 x 10^6 STPcc, air correction = 26%; (apatite) ϱ_S = 4.78 x 10^5 tracks/cm², 418 counts; ϱ_i = 15.00 x 10^5 tracks/cm², 375 counts, ϕ = 1.833 x 10^{15} neutron/cm². ***Method:*** Sample concentrated by fractionation in heavy liquids; see Naeser and Dodge (1969) (F.T.). ***Collected by:*** J. A. Ferguson; ***dated by:*** J. A. Ferguson, R. L. Armstrong.

(biotite) 43.6 ± 0.9 m.y.
(apatite) 36 ± 3 m.y.

555. *Chadwick (1967)* K-Ar
Pyroxene andesite flow with labradorite, augite and hypersthene phenocrysts, resting unconformably on the Golmeyer Creek sequence. (45°20'30"N, 110°49'30"W; sec. 2, T. 6 S., R. 7 E. [est.]; Fridley Peak 15' quad; Golmeyer Creek, Park Co.) ***Comment:*** This flow represents the later phase of Eocene volcanism in the Gallatins.

43 m.y.

556. *Ferguson (1972, 1975)* F.T.
K42
Idaho batholith, quartz monzonite with 33% plagioclase (An_{32}), 33% K-spar, 22% quartz, some biotite, trace of muscovite, chlorite, apatite, sphene, rutile and opaques. (46°32'00"N, 114°20'35"W; SW¼ SE¼ sec. 15, T. 9 N., R. 22 W.; Saint Joseph Peak 7½' quad; Ravalli Co.) ***Analytical data:*** ϱ_S = 6.38 x 10^5 tracks/cm², 676 counts; ϱ_i = 16.72 x 10^5 tracks/cm², 418 counts, ϕ = 1.833 x 10^{15} neutron/cm². ***Constants:*** (U^{238}) λ_D = 1.54 x 10^{-10}/yr, (U^{238}) λ_F = 6.85 x 10^{-17}/yr, (U^{235}) ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3}. ***Method:*** Sample concentrated by fractionation in heavy liquids; see Naeser and Dodge (1969). ***Collected and dated by:*** J. A. Ferguson. ***Comment:*** Prior to 38 m.y., this unit was at depths too great for apatite to retain its fission tracks; at 38 m.y., uplift brought apatite to a thermal depth at which it did retain fission tracks; nearby intrusions and volcanism are thought to have only local effect on apatite.

(apatite) 43 ± 3 m.y.

557. *Ferguson (1972, 1975)* F.T.
K3
Medium-grained calc-silicate inclusion in quartzite, border zone, Idaho batholith; 36% plagioclase, 22% quartz, 42% diopside, trace of chlorite and sphene. (46°32'05"N, 114°18'45"W; SE¼ SE¼ sec. 14, T. 9 N., R. 22 W.; Saint Joseph Peak 7½' quad; Ravalli Co.) ***Analytical data:*** ϱ_S = 5.94 x 10^5 tracks/cm², 297 counts; ϱ_i = 15.40 x 10^5 tracks/cm², 385 counts, ϕ = 1.833 x 10^{15} neutron/cm². ***Constants:*** (U^{238}) λ_D = 1.54 x 10^{-10}/yr, (U^{238}) λ_F = 6.85 x 10^{-17}/yr, (U^{235}) ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3}. ***Method:*** Sample concentrated by fractionation in heavy liquids; see Naeser and Dodge (1969). ***Collected and dated by:*** J. A. Ferguson. ***Comment:*** Prior to 38 m.y., this unit was at depths too great for apatite to retain its fission tracks; at 38 m.y., uplift brought apatite to a thermal depth at which it did retain fission tracks; nearby intrusions and volcanism are thought to have only local effect on apatite.

(apatite) 43 ± 4 m.y.

558. *Tysdal (1966)* K-Ar
700 to 800 ft. above base of volcanic sequence, Gallatin Range. (45°28'N, 110°56'W; T. 4 S., R. 6 E. [est.]; Fridley Peak 15' quad; East Fork of Middle Creek, Gallatin Co.) ***Comment:*** From W. J. McMannis, personal commun., 1966.

42.7 ± 2.4 m.y.

559. *Marvin and others (1973) Witkind (1973)* K-Ar
WL-417
Dark gray fine-grained porphyritic weathered vogesite dike with biotite, augite, salite, orthoclase and plagioclase microlites, some apatite, sphene, magnetite and phenocrysts of biotite, augite and salite, and xenocrysts of sanidine, quartz and plagioclase (apparently relicts of country rock). (47°03'48"N, 110°37'54"W; center sec. 18, T. 15 N., R. 9 E.; Barker 7½' quad; Judith Basin Co.) ***Analytical data:*** (biotite) K_2O = 8.56%, $*Ar^{40}$ = 5.430 x 10^{-10} moles/gm, $*Ar^{40}$ = 93%; (sanidine) K_2O = 11.02%, $*Ar^{40}$ = 6.807 x 10^{-10} moles/gm, $*Ar^{40}$ = 94%; error = ±2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) Isotope dilution, (K) Perkin-Elmer flame photometer with Li internal standard, (Ar) Nier-type 60° 6-inch mass spectrometer. ***Dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt, W. Mountjoy. ***Comment:*** Date can have two interpretations: (a) age indicates age of emplacement; (b) age has been reset by magmatic activity 44 m.y. ago.

(biotite) 42.5 ± 1.3 m.y.
(sanidine) 41.4 ± 1.2 m.y.

560. *McDowell (1966, 1971) McDowell and Kulp (1969)* K-Ar
L-954
Medium porphyritic quartz monzonite, Idaho batholith, with orthoclase (some sericite), plagioclase, quartz, biotite (moderate chlorite), muscovite (minor). (46°08'14"N, 114°26'17" W; NE¼ sec. 3, T. 4 N., R. 23 E.; Tenmile Lake 7½' quad; 14 mi W of canyon mouth, Lost Horse Gulch, Ravalli Co.) ***Analytical data:*** 60-100 mesh, 98% with aggregate, 7% chlorite; K = 7.38%, $*Ar^{40}$ = 5.55 x 10^{-10} moles/gm, $*Ar^{40}$ = 72%, error = 1 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** (K) isotope dilution with mass spectrometry, (Ar) stable isotope dilution with 4.5-inch Reynolds-type mass spectrometer, samples concentrated by fractionation in heavy liquids. ***Collected and dated by:*** F. W. McDowell. ***Comment:*** Date possibly indicates a reheating of the Early Cretaceous(?) Idaho batholith.

(biotite) 42.0 ± 1.3 m.y.

561. *Ferguson (1972, 1975)* F.T.
K8
Skookum Butte stock with 68% plagioclase (An_{30}), 12% quartz, 10% K-spar, some biotite and hornblende, trace chlorite, zircon, apatite, sphene and opaques. (46°40'10"N, 114°21' 55"W; NE¼ SW¼ sec. 33, T. 11 N., R. 22 W.; Dick Creek 7½' quad; Missoula Co.) ***Analytical data:*** ϱ_S = 3.65 x 10^5 tracks/cm², 274 counts; ϱ_i = 9.66 x 10^5 tracks/cm², 290 counts; ϕ = 1.833 x 10^{15} neutron/cm². ***Constants:*** (U^{238}) λ_D = 1.54 x 10^{-10}/yr, (U^{238}) λ_F = 6.85 x 10^{-17}/yr, (U^{235}) ς = 582 x 10^{-24} cm², U^{235}/U^{238} = 7.26 x 10^{-3}. ***Method:*** Sample concentrated by fractionation in heavy liquids; see Naeser and Dodge (1969). ***Collected and dated by:*** J. A. Ferguson. ***Comment:*** Intrusion of Skookum Butte stock at (at least) 82 m.y. was at depths too great for apatite to retain its fission tracks; at 38 m.y., uplift brought apatite to a thermal depth at which it did retain fission tracks; nearby intrusions and volcanism are thought to have only local effect on apatite.

(apatite) 42 ± 4 m.y.

562. *Tripp (1976) Chase, Bickford and Tripp (1978)* Rb-Sr
A14
Fresh quartz-diorite orthogneiss, with 68% plagioclase (An_{43}), 15% quartz, 11% biotite, some hornblende; accessories are apatite, chlorite, zircon, opaques, epidote and sphene. (46°33'17"N, 114°20'44"W; SW¼ NW¼ sec. 11, T. 7 N., R. 22 W.; Saint Joseph Peak 7½' quad; about 1.3 km N of contact with batholith and about 1 km W of Central Kootenai Lake along S side of ridge, Ravalli Co.) ***Analytical data:*** Initial ratio = 0.7075 ± 0.002. (See next page.) ***Constants:*** Rb^{87} λ = 1.39 x 10^{-11}/yr, Sr^{86}/Sr^{88} = 0.1194 atomic ratio, Sr^{84}/Sr^{88} = 0.0068 atomic ratio, Rb^{85}/Rb^{87} = 2.5927 atomic ratio. ***Method:*** Standard isotope dilution techniques, with mass spectrometry, sample concentrated by fractionation in heavy liquids. ***Dated by:*** Isotope Geochemistry Laboratory, University of Kansas. ***Comment:*** Whole rock Rb-Sr data did not yield isochron because of low Rb^{87}/Sr^{86} ratios; "mineral" isochron actually a biotite age with initial Sr^{87}/Sr^{86} ratio determined by whole rock, apatite and plagioclase analyses.

(mineral isochron) 42 ± 8 m.y.

[No. 563 was omitted.]

564. *Elliott, Naeser and Hedge (1974)* F.T.
Elliott (1974, 1979)
Quartz-rich dacite porphyry body. (45°03'30" N, 109°57'00"W; sec. 11, T. 9 S., R. 14 E.; Cooke City 7½' quad; Homestake mine, Beartooth Mountains, Park Co.) ***Analytical data:*** ϱ_s = 5.62 x 10^6 tracks/cm², tracks = 1170; ϱ_i = 9.64 x 10^6 tracks/cm², tracks = 1004; ϕ = 1.13 x 10^{15} neutron/cm². ***Constants:*** (U^{238}) λ_F = 6.85 x 10^{-17}/yr. ***Collected by:*** J. E. Elliott; ***dated by:*** C. W. Naeser.

(zircon) 40.6 ± 3.5 m.y.

565. *Hayden and Wehrenberg (1960)* K-Ar
Idaho batholith, very coarse grained biotite-oligoclase-quartz pegmatite, with minor muscovite; appears to be a metamorphic pegmatite. (46°35'04"N, 114°14'32"W; NE¼ sec. 33, T. 10 N., R. 21 W.; Saint Mary Peak 7½' quad; 3 mi W from mouth of Bass Creek Canyon, on N wall, Bitterroot Mountains, Ravalli Co.) ***Analytical data:*** (a) K = 7.50%, $*Ar^{40}$ = 1.23 x 10^{-5} cc STP/gm, $*Ar^{40}/K^{40}$ = 0.00240, $*Ar^{40}$ = 18%; (b) K = 7.50%, $*Ar^{40}$ = 1.21 x 10^{-5} cc STP/gm, $*Ar^{40}/K^{40}$ = 0.00236, $*Ar^{40}$ = 72%. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr. ***Method:*** (K) Perkin-Elmer flame photometer, isotope dilution, (Ar) isotope dilution with a 60° 6-inch mass spectrometer. ***Dated by:*** J. H. Reynolds, R. J. Hayden, J. P. Wehrenberg. ***Comment:*** First run (a) highly contaminated.

(a) (biotite) 40.5 m.y.
(b) (biotite) 39.9 m.y.

566. *Blackwell and others (1975)* K-Ar
Chadwick (1978)
Quartz porphyry. (46°44'12"N, 112°18'49"W; NE¼ sec. 2, T. 11 N., R. 6 W. [est.]; Elliston 15' quad; Empire vein, Mount Belmont, Lewis and Clark Co.)

40 m.y.

567. *Miller (1973)* K-Ar
Woakes (1960)
Meyer and others (1968)
443-14
Fresh N-S rhyolite dike, unaltered biotite. (46°00'45"N, 112°32'25"W; sec. 13, T. 3 N., R. 8 W. [est.]; Butte North 15' quad; Anselmo shaft, Butte, Silver Bow Co.) ***Analytical data:*** (a) 35-150 mesh, < 3% impurities, K = 6.88 ± 0.01%, wt = 1.1199 gm, $*Ar^{40}$ = 5.510 x 10^{-10} moles, $*Ar^{40}$ = 40%; (b) 35-150 mesh, < 3% impurities, K = 6.88 ± 0.01%, wt = 1.8803 gm, $*Ar^{40}$ = 9.493 x 10^{-10} moles, $*Ar^{40}$ = 82%. ***Constants:*** λ_e = 0.577 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.1477 x 10^{-4} atomic ratio; data averaged and recalculated by Meyer and others (1968) using λ_e = 0.585 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Method:*** Isotope dilution, (K) flame photometer, (Ar) Reynolds-type mass spectrometer. ***Collected by:*** M. E. Woakes; ***dated by:*** L. Kovich, M. E. Woakes. ***Comment:*** Age younger than previously thought; may be due to endothermic alteration of rhyolite; if dates on coarse biotite of quartz monzonite and rhyolite are correct, hydrothermal alteration of the rhyolite took place 30 m.y. after emplacement of the batholith and more than 10 m.y. after mineralization of the big veins; original dates by Woakes are: (a) (biotite) 41.7 ± 1.3 m.y., (b) (biotite) 42.8 m.y.

(a) (biotite) 40.7 ± 1.3 m.y.
(b) (biotite) 39.7 ± 1.3 m.y.

568. *Evans and others (1939)* He
L10
Hornblende inclusion in orthogneiss, strike parallel to gneiss structure. (44°55.9'N, 109°28.3"W; sec. 10, T. 57 N., R. 105 W.; Deep Lake 15' quad; Park Co., WYO) ***Analytical data:*** (a) He = 1.2 x 10^{-5} cc/g, α = 1.0, 0.91/mg/hr; (b) He = 1.4 x 10^{-5} cc/g, α = 0.77/mg/hr. ***Collected by:*** A. Lane, E. Lammers; ***dated by:*** N. B. Keevil, C. Goodman.

(a) 39.3 m.y.
(b) 34 m.y.

Analytical data for No. 562:

	Rb^{87} μg/g	Sr^{86} μg/g	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}
whole rock	21.5	84.9	0.251 ± 0.005	0.7082 ± 0.0010
biotite	105	4.42	23.5 ± 0.47	0.7207 ± 0.0022
hornblende	18.2	6.56	2.75 ± 0.055	0.7095 ± 0.0018
quartz-plagioclase	2.00	106.2	0.019 ± 0.0004	0.7068 ± 0.0011
apatite	0.36	45.2	0.008 ± 0.0002	0.7068 ± 0.0068

569. *Tripp (1976)* Rb-Sr
Chase, Bickford and Tripp (1978)
A20
Fresh quartz monzonite, Idaho batholith interior, with 42% plagioclase (An_{21}), 28% K-spar, 25% quartz, some biotite, muscovite; accessories are apatite, chlorite, zircon, opaques, sphene; slight alteration. (46°22'42"N, 114°18'52"W; NW¼ SW¼ sec. 2, T. 7 N., R. 22 W.; Gash Point 7½' quad; part of semichannel sample located to the S of trail along South Fork drainage of Bear Creek, about 4.4 km W of mouth of Bear Creek, Ravalli Co.) ***Analytical data:*** Initial ratio = 0.7128 ± 0.002. (See below.) ***Constants:*** Rb^{87} $\lambda = 1.39 \times 10^{-11}$/yr, Sr^{86}/Sr^{88} = 0.1194 atomic ratio, Sr^{84}/Sr^{88} = 0.0068 atomic ratio, Rb^{85}/Rb^{87} = 2.5927 atomic ratio. ***Method:*** Standard isotope dilution techniques, with mass spectrometry, sample concentrated by fractionation in heavy liquids. ***Dated by:*** Isotope Geochemistry Laboratory, University of Kansas. ***Comment:*** Whole rock Rb-Sr data did not yield isochrons because of low Rb^{87}/Sr^{86} ratios; "mineral" isochron actually a biotite age with initial Sr^{87}/Sr^{86} ratio determined by whole rock, apatite and plagioclase analyses; muscovite from this sample does not lie on biotite isochron, and apparently has been an open system to Rb and Sr after biotite became closed.

(mineral isochron) 39 ± 2 m.y.

570. *Ferguson (1972, 1975)* F.T.
BC50
Quartz monzonite, Idaho batholith, with 50% plagioclase (An_{36}). 30% quartz, some K-spar and biotite, trace of muscovite, chlorite, zircon, apatite and opaques. (46°30'05"N, 114°19'10"W; SW¼ NE¼ sec. 35, T. 9 N., R. 22 W.; Gash Point 7½' quad; Ravalli Co.) ***Analytical data:*** $\varrho_s = 5.56 \times 10^5$ tracks/cm², 292 counts; $\varrho_i = 16.16 \times 10^5$ tracks/cm², 403 counts, $\phi = 1.833 \times 10^{15}$ neutron/cm². ***Constants:*** (U^{238}) $\lambda_D = 1.54 \times 10^{-10}$/yr, ($U^{238}$) $\lambda_F = 6.85 \times 10^{-17}$/yr, ($U^{235}$) $\varsigma = 582 \times 10^{-24}$ cm², $U^{235}/U^{238} = 7.26 \times 10^{-3}$. ***Method:*** Sample concentrated by fractionation in heavy liquids; see Naeser and Dodge (1969). ***Collected and dated by:*** J. A. Ferguson. ***Comment:*** Prior to 38 m.y., this unit was at depths too great for apatite to retain its fission tracks; at 38 m.y., uplift brought apatite to a thermal depth at which it did retain fission tracks; nearby intrusions and volcanism are thought to have only local effect on apatite.

(apatite) 39 ± 4 m.y.

571. *Chadwick (1978)* K-Ar
CC-3 (Geochron No. F-3871)
Black glassy rhyolite porphyry, in brecciated zone above tuff; fresh clear to milky plagioclase crystals; some quartz; glass isotropic. (45°06'58"N, 112°45'08"W; SW¼ SE¼ sec. 19, T. 8 S., R. 9 W.; Dalys 7½' quad; roadcut on old Hwy 91, W bank of Beaverhead River, Beaverhead Co.) ***Analytical data:*** K = 2.274%, $*Ar^{40}$ = 0.006373 ppm, $*Ar^{40}$ = 38%. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Collected by:*** R. A. Chadwick; ***dated by:*** Geochron Laboratories, Inc.

(plagioclase) 38.9 ± 1.7 m.y.

572. *McDowell (1966, 1971)* K-Ar
McDowell and Kulp (1969)
L-953
Medium porphyritic quartz monzonite, slightly banded; orthoclase, plagioclase, quartz, biotite (some chloritization); from boulder pile near weathered outcrop, Idaho batholith. (46°06'11"N, 114°15'19"W; SW¼ sec. 7, T. 4 N., R. 21 W.; Como Peaks 7½' quad; Lost Horse Gulch, 4 mi W of canyon mouth, Ravalli Co.) ***Analytical data:*** 60-100 mesh, 98% with feldspar, 15% chlorite; K = 6.86%, $*Ar^{40}$ = 4.71 $\times 10^{-10}$ moles/gm, $*Ar^{40}$ = 84%, error = 1 ς. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Method:*** (K) isotope dilution with mass spec-

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Analytical data for No. 569:

	Rb^{87} μg/g	Sr^{86} μg/g	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{88}
whole rock	26.2	56.2	0.416 ± 0.009	0.7128 ± 0.0029
biotite	205	2.32	87.3 ± 1.75	0.7599 ± 0.0015
muscovite	103	9.89	10.3 ± 0.206	0.7155 ± 0.0019
quartz-plagioclase	1.99	49.2	0.040 ± 0.0008	0.7133 ± 0.0013
K-feldspar	81.8	80.4	1.01 ± 0.020	0.7133 ± 0.0021

trometry, (Ar) stable isotope dilution with 4.5-inch Reynolds-type mass spectrometer. ***Collected and dated by:*** F. W. McDowell. ***Comment:*** Date possibly indicates a reheating of the Early Cretaceous(?) Idaho batholith.

(biotite) 38.3 ± 1.1 m.y.

573. [Unpublished date]
McClernan and Berg K-Ar
Personal communication (1980)
JOS
Flow-banded rhyolite. (46°19'55"N, 112°21'30"W; SE¼ NE¼ sec. 26, T. 8 N., R. 6 W.; Basin 15' quad; talus slope SE of Josephine mine, Jefferson Co.) ***Analytical data:*** −60/+200 mesh, K = 3.440%, $*Ar^{40}$ = 0.009303 ppm, $*Ar^{40}$ = 74%, $*Ar^{40}/K^{40}$ = 0.002217. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40} = 1.22 \times 10^{-4}$ g/gK. ***Collected by:*** H. G. McClernan, R. B. Berg, MBMG; ***dated by:*** Geochron Laboratories, Inc. ***Comment:*** Geology of area in Ruppel (1963).

(whole rock) 37.5 ± 1.5 m.y.

574. *Blackwell and others (1975)* K-Ar
Chadwick (1978)
Rhyolite. (46°25'54"N, 112°22'58"W; NW¼ sec. 29, T. 11 N., R. 6 W. [est.]; Basin 15' quad; Hope Creek, N of Mullan Pass, Powell Co.)

37.3 m.y.

575. *Blackwell and others (1975)* K-Ar
Chadwick (1978)
Feldspar porphyry dikes and sills. (46°42'01"N, 112°18'39"W; SE¼ sec. 14, T. 11 N., R. 6 W. [est.]; Elliston 15' quad; SW of Marysville stock, Lewis and Clark Co.)

37 m.y.

576. *Ferguson (1972, 1975)* F.T.
K-4
Skookum Butte stock with 68% plagioclase, 12% quartz, 10% K-spar, some biotite and hornblende, trace chlorite, zircon, apatite, sphene and opaques. (46°37'05"N, 114°24'15"W; NE¼ sec. 23, T. 38 N., R. 16 E. [est.]; Ranger Peak 7½' quad; Idaho Co., ID.) ***Analytical data:*** $\varrho_s = 3.57 \times 10^5$ tracks/cm², 223 counts; $\varrho_i = 10.84 \times 10^5$ tracks/cm², 271 counts, $\phi = 1.833 \times 10^{15}$ neutron/cm². ***Constants:*** U^{238} $\lambda_D = 1.54 \times 10^{-10}$/yr, U^{238} $\lambda_F = 6.85 \times 10^{-17}$/yr, U^{235} $\zeta = 582 \times 10^{-24}$ cm², $U^{235}/U^{238} = 7.26 \times 10^{-3}$. ***Method:*** Sample concentrated by fractionation in heavy liquids; see Naeser and Dodge (1969). ***Collected and dated by:*** J. A. Ferguson. ***Comment:*** Intrusion of Skookum Butte stock at (at least) 82 m.y. ago was at depths too great for apatite to retain its fission tracks; at 38 m.y. ago, uplift brought apatite to a thermal depth at which it did retain fission tracks; nearby intrusion and volcanism are thought to have only local effect on apatite.

(apatite) 37 ± 4 m.y.

577. *Chadwick (1978)* K-Ar
MP-1 (Geochron No. F-4133)
Light-gray porphyritic rhyolite; dark-gray quartz, iridescent sanidine and plagioclase phenocrysts. (46°39'28"N, 112°19'10"W; SE¼ SW¼ sec. 35, T. 11 N., R. 6 W.; Elliston 15' quad; top of hill 1.8 km N of Mullan Pass, Lewis and Clark Co.) ***Analytical data:*** K = 4.905%, $*Ar^{40}$ = 0.01305 ppm, $*Ar^{40}$ = 28%. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio. ***Collected by:*** R. A. Chadwick; ***dated by:*** Geochron Laboratories, Inc.

(sanidine) 36.9 ± 1.5 m.y.

578. *Ferguson (1972, 1975)* F.T.
K22
Pelitic schist, quartzofeldspathic gneiss from border zone, Idaho batholith, with 44% quartz, 30% plagioclase, 11% biotite, some K-spar and muscovite, trace chlorite, sillimanite and apatite. (46°42'25"N, 114°20'20"W; SE¼ SE¼ sec. 15, T. 11 N., R. 22 W.; Dick Creek 7½' quad; Missoula Co.) ***Constants:*** $\phi = 1.833 \times 10^{15}$ neutron/cm², (U^{238}) $\lambda_D = 1.54 \times 10^{-10}$/yr, (U^{238}) $\lambda_F = 6.85 \times 10^{-17}$/yr, (U^{235}) $\zeta = 582 \times 10^{-24}$ cm², $U^{235}/U^{238} = 7.26 \times 10^{-3}$. ***Method:*** Sample concentrated by fractionation in heavy liquids; see Naeser and Dodge (1969). ***Collected and dated by:*** J. A. Ferguson. ***Comment:*** Prior to 38 m.y., this unit was at depths too great for apatite to retain its fission tracks; at 38 m.y., uplift brought apatite to a thermal depth at which it did retain fission tracks; nearby intrusions and volcanism are thought to have only local effect on apatite.

(apatite) 36 m.y.

579. *Chadwick (1978)* K-Ar
LM-1 (Geochron No. F-3643)
Light-gray rhyolite porphyry, clear iridescent sanidine and dark-gray quartz phenocrysts. (46°25'13"N, 111°53'20"W; SW¼ sec. 29, T. 8 N., R. 2 W.; Clancy 15' quad; SE slope Lava Mountain, 9 km SE of Clancy, Jefferson Co.)

Analytical data: K = 7.785%, $*Ar^{40}$ = 0.02007 ppm, $*Ar^{40}$ = 42%. ***Constants:*** λ_e = 0.585×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr, K^{40}/K = 1.19×10^{-4} atomic ratio. ***Collected by:*** R. A. Chadwick; ***dated by:*** Geochron Laboratories, Inc.

(sanidine) 35.8 ± 1.4 m.y.

580. *Marvin and others (1974)* K-Ar
KW-911-67

Dark greenish gray basalt with about 10% scattered phenocrysts of pyroxene, olivine and plagioclase, commonly from ½ to 1 mm in diameter, and a finer-grained matrix of plagioclase, pyroxene and iron oxide crystals. (45°16'52"N, 111°54'18"W; SW¼ sec. 25, T. 6 S., R. 3 W.; Virginia City 15' quad; roadcut on Hwy 287, Madison Co.) ***Analytical data:*** K_2O = 1.48, 1.46, 1.41, 1.39%, $*Ar^{40}$ = 0.7414×10^{-10} moles/gm, $*Ar^{40}$ = 30%, error = 2 ς; the sample was not subjected to the usual degassing at 100°C for 14 hours preceding the fusion of the sample, thus the low percentage of *Ar. ***Constants:*** λ_e = 0.585×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr, K^{40} = 1.22×10^{-4} g/gK. ***Method:*** (K) flame photometry with Li internal standard, (Ar) standard isotope dilution procedures. ***Collected by:*** K. L. Wier; ***dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt. ***Comment:*** The flow is not well enough exposed to allow determination of its thickness, but it belongs to a sequence of flows which individually are about 10 feet to several tens of feet thick, and in aggregate make up a thickness of volcanic rocks at least several hundred feet to perhaps 1,000 feet that overlies Precambrian rocks east of Virginia City.

(whole rock) 34.4 ± 3.0 m.y.

581. *Ferguson (1972, 1975)* F.T.
K21

Pelitic schist, quartzofeldspathic gneiss with 44% quartz, 30% plagioclase, 11% biotite, some K-spar and muscovite, trace chlorite, sillimanite and apatite. (46°41'40"N, 114°21'20"W; SW¼ SW¼ sec. 22, T. 11 N., R. 22 W.; Dick Creek 7½' quad; Missoula Co.) ***Analytical data:*** ϱ_s = 3.84×10^5 tracks/cm², 336 counts; ϱ_i = 12.77×10^5 tracks/cm², 382 counts, ϕ = 1.833×10^{15} neutron/cm². ***Constants:*** (U^{238}) λ_D = 1.54×10^{-10}/yr, (U^{238}) λ_F = 6.85×10^{-17}/yr, (U^{235}) ς = 582×10^{-24} cm², U^{235}/U^{238} = 7.26×10^{-3}. ***Method:*** Sample concentrated by fractionation in heavy liquids; see Naeser and Dodge (1969). ***Collected and dated by:*** J. A. Ferguson. ***Comment:*** Prior to 38 m.y., this unit was at depths too great for apatite to retain its fission tracks; at 38 m.y., uplift brought apatite to a thermal depth at which it did retain fission tracks; nearby intrusions and volcanism are thought to have only local effect on apatite.

(apatite) 34 ± 3 m.y.

582. *Marvin and others (1974)* K-Ar
KW-912-67

Dark-gray to black basalt with about 5% pyroxene phenocrysts, generally less than 1 mm in diameter, scattered in a groundmass of plagioclase laths, pyroxene crystals and iron oxide granules. (45°17'18"N, 111°56'27"W; SE¼ sec. 26, T. 6 S., R. 3 W.; Virginia City 15' quad; Alder Gulch at the placer gold discovery site monument, ½ mi S of Virginia City, Madison Co.) ***Analytical data:*** K_2O = 1.54, 1.55%, $*Ar^{40}$ = 0.7487×10^{-10} moles/gm, $*Ar^{40}$ = 86%, error = 2 ς. ***Constants:*** λ_e = 0.585×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr, K^{40} = 1.22×10^{-4} g/gK. ***Method:*** (K) flame photometry with Li internal standard, (Ar) standard isotope dilution procedures. ***Collected by:*** K. L. Wier; ***dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt. ***Comment:*** The flow seems to be about 20 or 30 feet thick and directly overlies Precambrian gneiss. Its stratigraphic position, however, may not be at or near the base of the thick volcanic sequence lying east of Virginia City; it may be a valley flow which accumulated in a late Tertiary gulch that had been incised through older flows and into Precambrian rocks.

(whole rock) 32.7 ± 1.4 m.y.

583. [Unpublished date]
Sonderegger K-Ar
Personal communication (1980)
LRRL-1

Basalt underlying fluvial sequence and freshwater limestones. (44°43.4'N, 111°51.6'W; SE¼ SE¼ sec. 5, T. 13 S., R. 2 W.; Lower Red Rock Lake 15' quad; Beaverhead Co.) ***Analytical data:*** K = 1.53%, $*Ar^{40}$ = 8.222×10^{-10} moles/gm, $*Ar^{40}atm$ = 54%, wt = 1.98774 gm. ***Constants:*** λ_e = 0.581×10^{-10}/yr, λ_β = 4.962×10^{-10}/yr, K^{40}/K = 1.167×10^{-4} atomic ratio. ***Collected by:*** J. L. Sonderegger, MBMG; ***dated by:*** S. H. Evans, University of Utah. ***Comment:*** This unit was dated to find the maximum age of the sediments; vertebrate remains suggest Lower Miocene age.

(whole rock) 30.8 ± 1.2 m.y.

584. *Marvin and others (1974)* K-Ar
KW-913-67
Dark-gray to black mottled vesicular basalt with 5% small olivine and plagioclase crystals, commonly less than 1 mm in diameter, in a matrix of smaller plagioclase laths and pyroxene crystals. (45°16'55"N, 112°03'26"W; NW¼ sec. 34, T. 6 S., R. 4 W.; Alder 7½' quad; Williams Gulch road, Madison Co.) ***Analytical data:*** K_2O = 1.68, 1.67, 1.64, 1.65, 1.62, 1.63, 1.63, 1.60, 1.59, 1.60%, $*Ar^{40}$ = 0.7343 x 10^{-10} moles/gm, $*Ar^{40}$ = 58%, error = 2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40} = 1.22 x 10^{-4} g/gK. ***Method:*** (K) flame photometry with Li internal standard, (Ar) standard isotope dilution procedures. ***Collected by:*** K. L. Wier; ***dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt. ***Comment:*** Basalt is from a flow interbedded with Tertiary sediments; Petkewich (1972) correlated this flow on Williams Creek with part of the Renova Formation of Kuenzi and Fields (1971), a formation in the Bozeman Group of Tertiary age in southwestern Montana.

(whole rock) 30.3 ± 1.6 m.y.

585. *Chadwick (1978)* K-Ar
VB-1
Black basalt, a few altered olivine phenocrysts, most clinopyroxene fresh but some chloritized, matrix crystalline, fresh-appearing clinopyroxene, lathlike plagioclase, opaques, some calcite vesicle fillings. (46°37'12"N, 110°44'48" W; NE¼ sec. 20, T. 10 N., R. 8 E.; Fourmile Spring 7½' quad; roadcut, U.S. Hwy 12 at W edge of Lake Sutherlin, flow from Volcano Butte vent, Meagher Co.) ***Analytical data:*** K = 1.015%, $*Ar^{40}$ = 1.19 x 10^{-6} cc/gm, $*Ar^{40}$ = 83%. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Collected by:*** R. A. Chadwick; ***dated by:*** R. L. Armstrong, University of British Columbia. ***Comment:*** Matrix appears fresh but owing to mild alteration of larger crystals and presence of some calcite vesicle fillings, age may be slightly older than indicated.

(whole rock) 29.1 ± 1.0 m.y.

586. *Chadwick (1978)* F.T.
Rhyolitic welded tuff overlain by early Miocene sediments. (46°41'01"N, 113°10'06"W; NW¼ sec. 25, T. 11 N., R. 13 W. [est.]; Drummond 15' quad; near Drummond, Granite Co.) ***Dated by:*** R. W. Fields.

29 m.y.

587. *Chadwick (1978)* K-Ar
AVCM-1 (Geochron No. F-3870)
Pink rhyolitic ash-flow tuff, fresh sanidine, quartz and plagioclase crystals, lithic fragments, brown glass shards in matrix. (46°55' 32"N, 112°30'17"W; E½ sec. 32, T. 14 N., R. 7 W.; Swede Gulch 7½' quad; summit of Crater Mountain, 0.7 km SE of rhyolitic vent, Lewis and Clark Co.) ***Analytical data:*** K = 5.539%, $*Ar^{40}$ = 0.01069 ppm, $*Ar^{40}$ = 45%. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Collected by:*** R. A. Chadwick; ***dated by:*** Geochron Laboratories, Inc.

(sanidine) 27.8 ± 1.1 m.y.

588. *Marvin and others (1974)* K-Ar
KW-916-11-67
Dark-gray to black, medium-grained basalt, with 60 to 70% plagioclase laths (An_{55-60}) that range from 1 to 3 mm in length, 25 to 30% pyroxene crystals generally less than 2 mm in diameter, and minor amounts of olivine and iron oxide. (Approx. 44°54'15"N, 111°51'15"W; SW¼ sec. 4, T. 11 S., R. 2 W.; Monument Ridge 15' quad; upper part of Black Butte volcanic plug, Madison Co.) ***Analytical data:*** K_2O = 1.93, 1.93, 1.90, 1.94%, (a) $*Ar^{40}$ = 0.6517 x 10^{-10} moles/gm, $*Ar^{40}$ = 86%; (b) $*Ar^{40}$ = 0.7055 x 10^{-10} moles/gm, $*Ar^{40}$ = 50%; error = 2 ς; for the second age (b), the sample was not subjected to the usual degassing at 100°C for 14 hours preceding the fusion of the sample, thereby yielding the lower percentage of $*Ar^{40}$. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40} = 1.22 x 10^{-4} g/gK. ***Method:*** (K) flame photometry with Li internal standard, (Ar) standard isotope dilution procedures. ***Collected by:*** K. L. Wier; ***dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt. ***Comment:*** The Black Butte plug probably represents a source vent for some of the basalt flows in the adjacent areas.

(a) (whole rock) 22.9 ± 1.2 m.y.
(b) (whole rock) 24.8 ± 1.5 m.y.

589. *Ferguson (1972, 1975)* F.T.
K-2
Medium-grained calc-silicate inclusion in quartzite, border zone, Idaho batholith; 36% plagioclase, 22% quartz, 42% diopside, trace of chlorite and sphene. (46°36'20"N, 114°23' 20"W; NE¼ sec. 25, T. 38 N., R. 16 E. [est.]; Ranger Peak 7½' quad; Idaho Co., ID) ***Analytical data:*** ϱ_s = 2.08 x 10^5 tracks/cm², 286 counts; ϱ_i = 9.60 x 10^5 tracks/cm², 264

counts, ϕ = 1.833 x 10^{15} neutron/cm^2. ***Constants:*** (U^{238}) λ_D = 1.54 x 10^{-10}/yr, (U^{238}) λ_F = 6.85 x 10^{-17}/yr, (U^{235}) ς = 582 x 10^{-24} cm^2, U^{235}/U^{238} = 7.26 x 10^{-3}. ***Method:*** Sample concentrated by fractionation in heavy liquids; see Naeser and Dodge (1969). ***Collected and dated by:*** J. A. Ferguson. ***Comment:*** Prior to 38 m.y., this unit was at depths too great for apatite to retain its fission tracks; at 38 m.y., uplift brought apatite to a thermal depth at which it did retain fission tracks; nearby intrusions and volcanism are thought to have only local effect on apatite.

(apatite) 24 ± 2 m.y.

590. *Chadwick (1978)* K-Ar
Trachyandesite. (45°45'00"N, 112°47'32"W; NW¼ sec. 13, T. 1 S., R. 10 W. [est.]; Dewey 7½' quad; 3 km W of Divide, 35 km SW of Butte, in Beaverhead Co.) ***Comment:*** This rock contains 66% SiO_2, may indicate less silicic volcanism than in other post-Eocene volcanic districts in southwestern Montana.

(whole rock) 20.5 m.y.

591. *Mudge (1972b)* K-Ar
Igneous plug intruding faulted and folded strata of the Two Medicine Formation. (47°23'40"N, 112°33'07"W; SE¼ sec. 13, T. 19 N., R. 8 W.; Nilan Reservoir 7½' quad; Haystack Butte, 10 mi SE of Sun River Canyon area, Lewis and Clark Co.) ***Dated by:*** J. D. Obradovich.

(hornblende) 20 m.y.

592. *Chadwick (1978)* K-Ar
AV-7 (Geochron No. F-3869)
Gray and red rhyolite porphyry with fresh sanidine and dark-gray quartz phenocrysts and minor hematitized biotite. (46°35'39"N, 112°34'45"W; NE¼ NE¼ sec. 27, T. 10 N., R. 8 W.; Avon 15' quad; roadcut, U.S. Hwy 12, 1.5 km E of Avon, Powell Co.) ***Analytical data:*** K = 7.357%, $*Ar^{40}$ = 0.01033 ppm, $*Ar^{40}$ = 18%. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Collected by:*** R. A. Chadwick; ***dated by:*** Geochron Laboratories, Inc. ***Comment:*** More recent age dating suggests that 36 m.y. is a more appropriate age for this rock (Chadwick, 1980, personal commun.)

(sanidine) 19.6 ± 0.8 m.y.

593. *Bush (1967)* K-Ar
Chadwick (1978)
Flow B basalt, dark, fine grained with scattered phenocrysts of plagioclase (47.5%), augite (11.5%), olivine (4.5%), and rich in magnetite and magnetite-bearing glass (35.5%); columnar, vesicular. (45°14'40"N, 110°51'15"W; NW¼ sec. 10, T. 7 S., R. 7 E. [est.]; Miner 15' quad; S of Hepburn's Mesa, Park Co.) ***Analytical data:*** −20/200 mesh, $*Ar^{40}$ = 0.000307 ppm, K^{40} = 0.628 ppm, $*Ar^{40}/K^{40}$ = 0.00049. ***Collected by:*** J. H. Bush; ***dated by:*** Geochron Laboratories, Inc. ***Comment:*** Date indicates Hepburn's Mesa basalts are early Pliocene.

(whole rock) 8.54 ± 0.8 m.y.

594. *Chadwick (1969)* K-Ar
Basalt flow with light-gray ophitic zones above and below a central dark-gray nonophitic zone. (45°20'54"N, 110°46'45"W; NW¼ sec. 5, T. 6 S., R. 8 E. [est.]; Fridley Peak 15' quad; Emigrant, Park Co.) ***Comment:*** Age consistent with geologic relations.

(whole rock) 5.44 m.y.

595. *Peterson (1974)* K-Ar
Marvin and others (1974)
KW-2-72
Grayish-black vesicular basalt with small pyroxene and olivine phenocrysts in a finer-grained groundmass mainly of plagioclase laths and pyroxene and iron oxide granules; capping the Sixmile Creek Formation, Sweetwater Canyon. (45°04'14"N, 112°15'06"W; SE¼ NE¼ sec. 7, T. 9 S., R. 5 W.; Red Canyon 7½' quad; NE of Timber Hill, Madison Co.) ***Analytical data:*** K_2O = 1.71, 1.71%, $*Ar^{40}$ = 0.1071 x 10^{-10} moles/gm, $*Ar^{40}$ = 51%, error = 2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40} = 1.22 x 10^{-4} g/gK. ***Method:*** (K) flame photometry with Li internal standard, (Ar) standard isotope dilution procedures. ***Collected by:*** R. A. Riepe, Indiana University; ***dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt. ***Comment:*** This sample is from the interior part of what seems to be a 30 to 50 ft. thick flow, which is part of the Tertiary rocks in the upper Ruby River basin being studied by R. A. Riepe. Sample KW-3-72 is from the same flow.

(whole rock) 4.2 ± 0.2 m.y.

596. *Marvin and others (1974)* K-Ar
Peterson (1974)
KW-3-72
Dark-gray mottled basalt from a float block on the erosional surface of the Timber Hill flow. (45°03'13"N, 112°16'24"W; SE¼ NE¼ sec.

13, T. 9 S., R. 6 W.; Red Canyon 7½' quad; Madison Co.) ***Analytical data:*** K_2O = 1.55, 1.55%, $*Ar^{40}$ = 0.0866 x 10^{-10} moles/gm, $*Ar^{40}$ = 9%, error = 2 ς. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40} = 1.22 x 10^{-4} g/gK. ***Method:*** (K) flame photometry with Li internal standard, (Ar) standard isotope dilution procedures. ***Collected by:*** R. A. Riepe, Indiana University; ***dated by:*** R. F. Marvin, H. H. Mehnert, V. M. Merritt. ***Comment:*** Basalt is similar in composition to sample KW-2-72 except that it is slightly coarser grained. Both samples are from the same flow and were collected about 1 mi apart (NE of Timber Hill). The flow is flat lying and caps Tertiary sediments.

(whole rock) 3.8 ± 0.4 m.y.

597. [Unpublished date]
Sonderegger K-Ar
Personal communication (1980)
URRL-3
Upper cooling unit of the Huckleberry Ridge Tuff; rhyolitic ash flow tuff. (44°43.83'N, 111°36.84'W; NW¼ NW¼ NE¼ sec. 4, T. 13 S., R. 1 E.; Upper Red Rock Lake 15' quad; Madison Co.) ***Analytical data:*** K = 7.45%, $*Ar^{40}$ = 2.711 x 10^{-10} moles/gm, Ar^{40}atm = 35%, wt = 2.50269 gm. ***Constants:*** λ_e = 0.581 x 10^{-10}/yr, $\lambda\beta$ = 4.962 x 10^{-10}/yr, K^{40}/K = 1.167 x 10^{-4} atomic ratio. ***Collected by:*** J. L. Sonderegger, MBMG; ***dated by:*** S. H. Evans, University of Utah. ***Comment:*** This unit dated for correlation with the Madison Valley and Yellowstone Park units.

(sanidine) 2.09 ± 0.07 m.y.

598. [Unpublished date]
Sonderegger K-Ar
Personal communication (1980)
URRL-1
Huckleberry Ridge Tuff, lower cooling unit; rhyolitic ash flow tuff which underlies basalt (URRL-2). (44°39.24'N, 111°38.84'W; NW¼ SE¼ sec. 31, T. 13 S., R. 1 E.; Upper Red Rock Lake 15' quad; Beaverhead Co.) ***Analytical data:*** K = 7.49%, $*Ar^{40}$ = 2.663 x 10^{-10} moles/gm, Ar^{40}atm = 27%, wt = 3.87410 gm. ***Constants:*** λ_e = 0.581 x 10^{-10}/yr, $\lambda\beta$ = 4.962 x 10^{-10}/yr, K^{40}/K = 1.167 x 10^{-4} atomic ratio. ***Collected by:*** J. L. Sonderegger, MBMG; ***dated by:*** S. H. Evans, University of Utah. ***Comment:*** Age of this tuff may have been reset by basalt (URRL-2).

(sanidine) 2.05 ± 0.07 m.y.

599. *Chadwick (1978)* K-Ar
FM-1 (Geochron No. F-4052)
Gray rhyolitic ash-flow tuff, lath-shaped sanidine and plagioclase crystals, some quartz.(44°50'27"N, 111°38'45"W; SW¼ SE¼ sec. 30, T. 11 S., R. 1 E.; Cliff Lake 15' quad; NE slope of Flatiron Mountain, Madison Co.) ***Analytical data:*** K = 5.850%, $*Ar^{40}$ = 0.000837 ppm, $*Ar^{40}$ = 16%. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Collected by:*** G. J. Weinheimer; ***dated by:*** Geochron Laboratories, Inc.

(sanidine) 2.0 ± 0.1 m.y.

600. [Unpublished date]
Sonderegger K-Ar
Personal communication (1980)
URRL-2
Basalt. (44°39.24'N, 111°38.84'W; NW¼ SE¼ sec. 31, T. 13 S., R. 1 E.; Upper Red Rock Lake 15' quad; Beaverhead Co.) ***Analytical data:*** K = 0.36%, $*Ar^{40}$ = 0.122 x 10^{-10} moles/gm, Ar^{40}atm = 93%, wt = 7.91633 gm. ***Constants:*** λ_e = 0.581 x 10^{-10}/yr, $\lambda\beta$ = 4.962 x 10^{-10}/yr, K^{40}/K = 1.167 x 10^{-4} atomic ratio. ***Collected by:*** J. L. Sonderegger, MBMG; ***dated by:*** S. H. Evans, University of Utah. ***Comment:*** All previous basalt dates in this area have been Tertiary, yet this basalt overlies tuff (URRL-1), which implies a Pleistocene age.

(whole rock) 1.95 ± 0.35 m.y.

601. *Chadwick (1978)* K-Ar
WC-2 (Geochron No. F-3644)
Purple streaked rhyolitic ash-flow tuff, clear sanidine and quartz, some plagioclase, flattened lithic fragments. (44°59'33"N, 111°39'45"W; SE¼ NE¼ sec. 1, T. 10 S., R. 1 W.; Cliff Lake 15' quad; cliff face on W bank Madison River, 2 km N of mouth of Wall Canyon, Madison Co.) ***Analytical data:*** K = 6.888%, $*Ar^{40}$ = 0.000945 ppm, $*Ar^{40}$ = 17%. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Collected by:*** R. A. Chadwick; ***dated by:*** Geochron Laboratories, Inc.

(sanidine) 1.9 ± 0.1 m.y.

602. *Chadwick (1978)* K-Ar
G-1
Black nonporphyritic basalt, columnar jointed, olivine, plagioclase and pyroxene, locally vesicular but vesicles not filled. (45°02'27"N, 110°41'51"W; NE¼ NE¼ sec. 23, T. 9 S., R. 8 E.;

Gardiner 15′ quad; on roadcut on Phelps Creek, 1.0 km NE of Gardiner, Park Co.) ***Analytical data:*** K = 0.326%, $*Ar^{40}$ = 1.52 cc/gm; $*Ar^{40}$ = 1.2%. ***Constants:*** λ_e = 0.585×10^{-10}/yr, λ_β = 4.72×10^{-10}/yr, K^{40}/K = 1.19×10^{-4} atomic ratio. ***Collected by:*** R. L. Armstrong, University of British Columbia. ***Comment:*** This basalt is paleomagnetically normal, and may be about 0.6 to 0.7 m.y. old.

(whole rock) 1.2 ± 0.6 m.y.

603. *Pierce, Obradovich and Friedman (1976)* K-Ar

OCB-66-09

West Yellowstone rhyolite flow. (44°34′50″N, 111°07′14″W; SE¼ sec. 28, T. 14 S., R. 5 E.; West Yellowstone 15′ quad; Gallatin Co.) ***Dated by:*** J. D. Obradovich. ***Comment:*** Authors' best estimate of age of West Yellowstone flow is 114,500 ± 7,300 years; these dates used with obsidian hydration dating to correlate Pinedale Glaciation with Wisconsin Glaciation, and Bull Lake Glaciation with late Illinoisian Glaciation.

(sanidine) 117,000 ± 2,400 years
(sanidine) 129,000 ± 5,900 years
(glass) 106,000 ± 2,600 years

604. *Pierce, Obradovich and Friedman (1976)* K-Ar

YG-72-5

West Yellowstone rhyolite flow. (44°25′45″N, 111°13′00″W; SE¼ sec. 23, T. 13 N., R. 44 E.; Buffalo Lake 15′ quad; Fremont Co., ID.) ***Dated by:*** J. D. Obradovich. ***Comment:*** Authors' best estimate of age of West Yellowstone flow is 114,500 ± 7,300 years; these dates used with obsidian hydration dating to correlate Pinedale Glaciation with Wisconsin Glaciation, and Bull Lake Glaciation with late Illinoisian Glaciation.

(sanidine) 120,000 ± 5,900 years
(glass) 123,000 ± 3,600 years

605. *Rosholt (1976)* Th^{230}/U^{234}

Travertine. (44°57′10″N, 110°43′55″W; sec. 36, T. 58 N., R. 115 W. [est.]; Mammoth 15′ quad; Terrace Mountain, Yellowstone Park, Park Co., WYO.) ***Comment:*** This travertine predates the last glaciation.

(whole rock isochron) 63,000 ± 9,000 years

606. *Rosholt (1976)* Th^{230}/U^{234}

Travertine. (45°03′00″N, 110°42′20″W; sec. 14, T. 9 S., R. 8 E. [est.]; Gardiner 15′ quad; near Gardiner quarries, Park Co.)

(whole rock isochron) 29,000 ± 8,000 years

Addendum

Additional dates:

607. *Reid, McMannis, and Palmquist (1975)* K-Ar Rb-Sr
PJ. 69.15
Diabase with plagioclase, tremolite, magnetite, rutile, chlorite, titanaugite. (Near 45°30'N, 110°30'W; Park Co.) ***Analytical data:*** (a) K = 0.89, 0.90%, *Ar = 8.9491, 7.5069 x 10^{-4} scc/g, *Ar/Ar_{TOT} = 99%, 99%; (b) Rb = 72.2 ppm, Sr = 374 ppm, Rb^{87}/Sr^{86} = 1.31, $Sr^{87}/Sr^{86}N$ = 0.7162. ***Constants:*** (K) λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.22 x 10^{-4} g/g, (Rb) λ = 1.47 x 10^{-11}/yr, Sr^{86}/Sr^{88} = 0.1194, initial Sr^{87}/Sr^{86} = 0.703 ± 0.002. ***Dated by:*** Teledyne Isotopes. ***Comment:*** The high K-Ar date due to excess *Ar; Rb-Sr age also too high due to excess *Sr.

(a) (whole rock) 4862 ± 153.1 m.y.
(b) (whole rock) 1630 ± 310 m.y.

608. *Reid, McMannis, and Palmquist (1975)* U-Pb K-Ar Rb-Sr
PW. 68.124
Mount Delano Gneiss, medium to coarse grained, banded, gray tonolitic gneiss with plagioclase, quartz, biotite, epidote, accessories apatite, ilmenite, magnetite, zircon, sphene, pyrite, goethite. (Near 45°30'N, 110°30'W; Park Co.) ***Analytical data:*** U = 885.8 ppm, Pb = 410.0 ppm, Pb^{204} = 0.0355%, Pb^{206} = 69.3932%, Pb^{207} = 15.4331%, Pb^{208} = 15.1383%, Pb^{206}/U^{238} = 0.3677, Pb^{207}/U^{235} = 10.86, Pb^{207}/Pb^{206} = 0.2164; K = 4.88, 4.90%, *Ar = 5.4964, 5.3805 x 10^{-4} scc/g, *Ar/Ar_{TOT} = 99%, 99%; (b) Rb = 231 ppm, Sr = 314 ppm, Rb^{87}/Sr^{86} = 2.12, $Sr^{87}/Sr^{86}N$ = 0.7639. ***Constants:*** (K) λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.22 x 10^{-4} g/g, (Rb) λ = 1.47 x 10^{-11}/yr, initial Sr^{87}/Sr^{86} = 0.703 ± 0.002, Sr^{86}/Sr^{88} = 0.1194. ***Dated by:*** Teledyne Isotopes. ***Comment:*** Mount Delano Gneiss intruded 3000 m.y. ago, and affected by metamorphic events 2600 m.y. and 1700 m.y. ago.

Pb^{206}/U^{238} (zircon) 2050 ± 4.5 m.y.
Pb^{207}/U^{235} (zircon) 2560 ± 57.4 m.y.
Pb^{207}/Pb^{206} (zircon) 3000 ± 113 m.y.
K-Ar (biotite) 1715 ± 23.8 m.y.
Rb-Sr (biotite) 1970 ± 150 m.y.

609. *Reid, McMannis, and Palmquist (1975)* U-Pb K-Ar Rb-Sr
PR. 69.157
Davis Creek Schist, fine- to medium-grained mica schist with scattered plagioclase porphyroblasts, several intercalated quartzite layers, and a few thin discontinuous marble lenses. (Near 45°30'N, 110°30'W; Park Co.) ***Analytical data:*** U = 990.4 ppm, Pb = 316.6 ppm, Pb^{204} = 0.0723%, Pb^{206} = 77.0647%, Pb^{207} = 14.2042%, Pb^{208} = 8.6589%, Pb^{206}/U^{238} = 0.2735, Pb^{207}/U^{235} = 6.611, Pb^{207}/Pb^{206} = 0.1773; (d) K = 5.32, 5.33%, *Ar = 6.3192, 5.9783 x 10^{-4} scc/g, *Ar/Ar_{TOT} = 99%, 99%; (e) Rb = 288 ppm, Sr = 54.4 ppm, Rb^{87}/Sr^{86} = 15.3, $Sr^{87}/Sr^{86}N$ = 1.0902. ***Constants:*** (K) λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.22 x 10^{-4} g/g, (Rb) λ = 1.47 x 10^{-11}/yr, initial Sr^{87}/Sr^{86} = 0.703 ± 0.002, Sr^{86}/Sr^{88} = 0.1194. ***Dated by:*** Teledyne Isotopes. ***Comment:*** These dates were affected by three deformational events 3100 m.y., 2700 m.y. and 1700 m.y. ago.

Pb^{206}/U^{238} (zircon) 1620 ± 3.6 m.y.
Pb^{207}/U^{235} (zircon) 2102 ± 47.2 m.y.
Pb^{207}/Pb^{206} (zircon) 2625 ± 105.0 m.y.
K-Ar (biotite) 1757.5 ± 31.5 m.y.
Rb-Sr (biotite) 1740 ± 80 m.y.

610. *Reid, McMannis, and Palmquist (1975)* U-Pb
PW. 68.181
Sheared granitized gneiss with biotite (some chlorite), plagioclase, quartz, trace of garnet, accessories rounded zircon, apatite, rutile, allanite, epidote and sphene. (45°29'00''N, 110°27'30''W; sec. 14, T. 4 S., R. 10 E. [est.]; Mt. Cowen 15' quad; Pine Creek Lake, Park Co.) ***Analytical data:*** U = 904.3 ppm, Pb = 284.3 ppm, Pb^{204} = 0.0833%, Pb^{206} = 77.3083%, Pb^{207} = 14.3573, Pb^{208} = 8.2511, Pb^{206}/U^{238} = 0.2761, Pb^{207}/U^{235} = 6.451, Pb^{207}/Pb^{206} = 0.1726. ***Dated by:*** Teledyne Isotopes. ***Comment:*** Pb loss in these zircons was virtually complete during the second deformational event in this area and intrusion of the Mount Cowen Gneiss about 2600 m.y. ago.

Pb^{206}/U^{238} (zircon) 1595 ± 3.5 m.y.
Pb^{207}/U^{235} (zircon) 2085 ± 46.8 m.y.
Pb^{207}/Pb^{206} (zircon) 2620 ± 104.9 m.y.

611. *Reid, McMannis, and Palmquist (1975)* U-Pb K-Ar Rb-Sr
PR. 69.158
Mount Cowen Gneiss, coarse-grained gray granodioritic augen gneiss with plagioclase, microcline, quartz, biotite, epidote, allanite, chlorite, accessories zircon, rutile, sphene, black opaque minerals, rare garnet. (Near 45° 30'N, 110°30'W; Park Co.) ***Analytical data:*** U = 700.3 ppm, Pb = 263.4 ppm, Pb^{204} = 0.568%, Pb^{206} = 67.8647%, Pb^{207} = 12.0170%, Pb^{208} = 20.0614%, Pb^{206}/U^{238} = 0.2907, Pb^{207}/U^{235} = 6.616, Pb^{207}/Pb^{206} = 0.1668; K = 2.15, 2.16%, *Ar = 2.3281, 2.2688 x 10^{-4} scc/g, $*Ar/Ar_{TOT}$ = 99%, 99%; Rb = 112 ppm, Sr = 1930 ppm, Rb^{87}/Sr^{86} = 0.167, $Sr^{87}/Sr^{86}N$ = 0.7130. ***Constants:*** (K) λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.22 x 10^{-4} g/g, (Rb) $\lambda\beta$ = 1.47 x 10^{-11}/yr, Sr^{86}/Sr^{88} = 0.1194. ***Dated by:*** Teledyne Isotopes. ***Comment:*** Pb/Pb age considered a minimum age due to possible Pb loss; Rb-Sr data did not give an age.

Pb^{206}/U^{238} (zircon) 1670 ± 3.7 m.y.
Pb^{207}/U^{235} (zircon) 2102 ± 47.2 m.y.
Pb^{207}/Pb^{206} (zircon) 2565 ± 103.7 m.y.
K-Ar (biotite) 1665.5 ± 14.3 m.y.

612. *Reid, McMannis, and Palmquist (1975)* K-Ar Rb-Sr
PR. 69.61
Metadiabase with actinolite, plagioclase, microcline, quartz, epidote, biotite, chlorite, accessories magnetite, pyrite, apatite. (Near 45° 30'N, 110°30'W; Park Co.) ***Analytical data:*** (a) K = 0.50, 0.49%, *Ar = 8.1596, 8.0197 x 10^{-4} scc/g, $*Ar/Ar_{TOT}$ = 98%, 98%; (b) Rb = 32 ppm, Sr = 180 ppm, Rb^{87}/Sr^{86} = 0.512, $Sr^{87}/Sr^{86}N$ = 0.7213. ***Constants:*** (K) λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.22 x 10^{-4} g/g; (Rb) λ = 1.47 x 10^{-11}/yr, Sr^{86}/Sr^{88} = 0.1194, initial Sr^{87}/Sr^{86} = 0.703 ± 0.002. ***Dated by:*** Teledyne Isotopes. ***Comment:*** This unit intruded during third metamorphic event of the North Snowy Block; Rb-Sr age may be too high or the D_3 event may be as old as 2500 m.y.

(a) (whole rock) 2170 ± 11.1 m.y.
(b) (whole rock) 2470 ± 360 m.y.

613. *Reid, McMannis, and Palmquist (1975)* K-Ar
PW. 70.70
Metadiabase, very little recrystallized, with actinolite, plagioclase, microcline, quartz, epidote, biotite, chlorite, accessories magnetite, pyrite, apatite. (45°21'30"N, 110°25'30"W; sec. 31, T. 5 S., R. 11 E. [est.]; Mt. Cowen 15' quad; Mill Creek Pass, Park Co.) ***Analytical data:*** K = 0.400, 0.393%, K^{40} = 0.483 ppm, Ar^{40} = 0.143, 0.144 ppm, Ar^{40}/Ar_{TOT} = 0.944, 0.940. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.22 x 10^{-4} g/g. ***Dated by:*** Geochron Laboratories, Inc. ***Comment:*** This unit intruded during the third metamorphic event in the North Snowy Block; K-Ar age may be too high or the D_3 event may be as old as 2500 m.y.

(whole rock) 2461 ± 124 m.y.

614. *Reid, McMannis, and Palmquist (1975)* U-Pb K-Ar Rb-Sr
PW. 68.59
Falls Creek Gneiss, with plagioclase, biotite, epidote, sericite (after microcline), sphene, chlorite, muscovite, accessories zircon, leucoxene, apatite, thorite. (Near 45°30'N, 110° 30'W; Park Co.) ***Analytical data:*** U = 923.9 ppm, Pb = 2069.0 ppm, Pb^{204} = 0.3195%, Pb^{206} = 15.9172%, Pb^{207} = 3.467%, Pb^{208} = 80.2867%, Pb^{206}/U^{238} = 0.2751; K = 3.90, 3.90%, *Ar = 6.7386, 6.1400 x 10^{-4} scc/g, $*Ar/Ar_{TOT}$ = 99%, 99%; Rb = 385 ppm, Sr = 69.0 ppm, Rb^{87}/Sr^{86} = 16.1, $Sr^{87}/Sr^{86}N$ = 1.0813. ***Constants:*** (K) λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.22 x 10^{-4} g/g, (Rb) $\lambda\beta$ = 1.47 x 10^{-11}/yr, Sr^{86}/Sr^{88} = 0.1194, initial Sr^{87}/Sr^{86} = 0.703 ± 0.002. ***Dated by:*** Teledyne Isotopes. ***Comment:*** This gneiss intruded during the third metamorphic event of the North Snowy Block about 1700 m.y. ago.

Pb^{206}/U^{238} (zircon) 1604 ± 3.6 m.y.
K-Ar (biotite) 2193 ± 60.3 m.y.
Rb-Sr (biotite) 1620 ± 80 m.y.

615. *Reid, McMannis, and Palmquist (1975)* K-Ar
PW. 69.107
Leucocratic pegmatite cutting metadiabase, Mount Delano Block, with oligoclase, and minor quartz, biotite, chlorite and epidote. (Near 45°30'N, 110°30'W; Park Co.) ***Analytical data:*** K = 7.960, 7.989%, K^{40} = 9.728 ppm, Ar^{40} = 1.821, 1.786 ppm, $Ar^{40}/Ar^{40}{}_{TOT}$ = 0.952, 0.957. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, $\lambda\beta$ = 4.72 x 10^{-10}/yr, K^{40}/K = 1.22 x 10^{-4} g/g. ***Dated by:*** Geochron Laboratories, Inc. ***Comment:*** This age may be a minimum for the pegmatite, requiring the metadiabases to be older than 1900 m.y.

(biotite) 1859 ± 61 m.y.

616. *Reid, McMannis, and Palmquist (1975)* K-Ar

PR. 69.140

Biotite fels xenolith in augen gneiss, Mount Cowen Gneiss. (Near 45°30'N, 110°30'W; Park Co.) ***Analytical data:*** K = 6.549, 6.575%, K^{40} = 8.005 ppm, Ar^{40} = 1.299, 1.299 ppm, Ar^{40}/Ar^{40}_{TOT} = 0.990, 0.985. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.22 x 10^{-4} g/g. ***Dated by:*** Geochron Laboratories, Inc. ***Comment:*** Biotite age has been reset by the third metamorphic event in the North Snowy Block 1700 m.y. ago.

(biotite) 1706 ± 57 m.y.

617. *Reid, McMannis, and Palmquist (1975)* K-Ar

PR. 69.22

Barney Creek Amphibolite with amphibole, biotite, quartz, plagioclase, chlorite, epidote. (45°29'00"N, 110°27'30"W; sec. 14, T. 4 S., R. 10 E. [est.]; Mt. Cowen 15' quad; Pine Creek Lake, Park Co.) ***Analytical data:*** K = 1.786%, K^{40} = 2.132 ppm, Ar^{40} = 0.352, 0.339 ppm, Ar^{40}/Ar^{40}_{TOT} = 0.944, 0.925. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.22 x 10^{-4} g/g. ***Dated by:*** Geochron Laboratories, Inc. ***Comment:*** Biotite age has been reset by the third metamorphic event in the North Snowy Block 1700 m.y. ago.

(biotite) 1704 ± 62 m.y.

618. *Reid, McMannis, and Palmquist (1975)* K-Ar

PR. 69.84

Gray speckled younger metadiabase with actinolite, plagioclase, microcline, quartz, epidote, biotite, chlorite, accessories magnetite, pyrite, apatite. (45°29'00"N, 110°27'30"W; sec. 14, T. 4 S., R. 10 E. [est.]; Mt. Cowen 15' quad; Pine Creek Lake, Park Co.) ***Analytical data:*** K = 0.688, 0.682%, K^{40} = 0.835 ppm, Ar^{40} = 0.131, 0.139 ppm, Ar^{40}/Ar^{40}_{TOT} = 0.900, 0.940. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.22 x 10^{-4} g/g. ***Dated by:*** Geochron Laboratories, Inc. ***Comment:*** This unit intruded during the third metamorphic event of the North Snowy Block about 1700 m.y. ago.

(amphibole) 1701 ± 72 m.y.

619. *Reid, McMannis, and Palmquist (1975)* K-Ar

PW. 70.74

Felsic gneiss, Falls Creek Gneiss, with plagioclase, biotite, epidote, sericite (often microcline), sphene, chlorite, muscovite, accessories zircon, leucoxene, apatite, thorite. (45°28' N, 110°15'W; T. 4 S., R. 12 E. [est.]; Mt. Cowen 15' quad; Falls Creek, Park Co.) ***Analytical data:*** K = 7.276, 7.288%, K^{40} = 8.884 ppm, Ar^{40} = 1.337, 1.360 ppm, Ar^{40}/Ar^{40}_{TOT} = 0.979, 0.945. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.22 x 10^{-4} g/g. ***Dated by:*** Geochron Laboratories, Inc. ***Comment:*** This gneiss intruded during the third metamorphic event of the North Snowy Block about 1700 m.y. ago.

(biotite) 1632 ± 54 m.y.

620. *Reid, McMannis, and Palmquist (1975)* K-Ar

PW. 60.109

Mylonitic gneiss, Mount Delano Block, with quartz, biotite, minor green hornblende and cummingtonite, albite, oligoclase, muscovite, chlorite, some garnet, epidote, pyrite. (Near 45°30'N, 110°30'W; Park Co.) ***Analytical data:*** K = 0.640, 0.637%, K^{40} = 0.778 ppm, Ar^{40} = 0.107, 0.113 ppm, Ar^{40}/Ar^{40}_{TOT} = 0.892, 0.909. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.22 x 10^{-4} g/g. ***Dated by:*** Geochron Laboratories, Inc. ***Comment:*** This age is a minimum for mylonization in the Davis Creek zone.

(whole rock) 1554 ± 67 m.y.

621. *Reid, McMannis, and Palmquist (1975)* K-Ar

PR. 69.134

Mylonitic gneiss with quartz, biotite, minor green hornblende and cummingtonite, albite, oligoclase, muscovite, chlorite, some garnet, cordierite, epidote, pyrite. (45°31.5'N, 110°25.0'W; T. 3 S., R. 11 E. [est.]; Livingston 7½' quad; upper Davis Creek, Park Co.) ***Analytical data:*** K = 0.378, 0.372%, K^{40} = 0.457 ppm, Ar^{40} = 0.0574, 0.0582 ppm, Ar^{40}/Ar^{40}_{TOT} = 0.795, 0.837. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.22 x 10^{-4} g/g. ***Dated by:*** Geochron Laboratories, Inc. ***Comment:*** This age is a minimum age for mylonization in the Davis Creek zone.

(whole rock) 1439 ± 75 m.y.

622. *Reid, McMannis, and Palmquist (1975)* K-Ar

PR. 69.115.1

Mylonitic schist with quartz, biotite, minor green hornblende and cummingtonite, albite, oligoclase, muscovite, chlorite, some garnet, cordierite, epidote, pyrite. (45°31.5'N, 110°

25.0'W; T. 3 S., R. 11 E. [est.]; Livingston 7½' quad; upper Davis Creek, Park Co.) ***Analytical data:*** K = 1.563, 1.559%, K^{40} = 1.904 ppm, Ar^{40} = 0.201, 0.189, 0.208 ppm, Ar^{40}/Ar^{40}_{TOT} = 0.981, 0.937, 0.854. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.22 \times 10^{-4}$ g/g. ***Dated by:*** Geochron Laboratories, Inc. ***Comment:*** This age is a minimum age for mylonization in the Davis Creek zone.

(whole rock) 1258 ± 47 m.y.

623. *Reid, McMannis, and Palmquist (1975)* K-Ar
PR. 69.217
Metadiabase with actinolite, plagioclase, microcline, quartz, epidote, biotite, chlorite, accessories magnetite, pyrite, apatite. (45° 31.5'N, 110°25.0'W; T. 3 S., R. 11 E. [est.]; Livingston 7½' quad; upper Davis Creek, Park Co.) ***Analytical data:*** K = 0.860, 0.860%, K^{40} = 1.049 ppm, Ar^{40} = 0.0974, 0.103 ppm, Ar^{40}/Ar^{40}_{TOT} = 0.841, 0.803. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.22 \times 10^{-4}$ g/g. ***Dated by:*** Geochron Laboratories, Inc. ***Comment:*** This unit intruded during the third metamorphic event in the North Snowy Block about 1,700 m.y. ago.

(whole rock) 1176 ± 48 m.y.

624. *Mudge (1972a)* Rb-Sr
380G, HS411bl
Glauconite, Shepard Formation. (47°30'00"N, 112°54'00"W; sec. 8, T. 20 N., R. 10 W.; Pretty Prairie 7½' quad; ½ mi W of South Fork of the Sun River, Lewis and Clark Co.) ***Constants:*** $\lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer.

(glauconite) 1130 ± 55 m.y.

625. *Mudge (1972a)* K-Ar
379G, HS411d Rb-Sr
Glauconite, Mount Shields Formation. (47°30' 00"N, 112°54'00"W; sec. 8, T. 20 N., R. 10 W.; Pretty Prairie 7½' quad; ½ mi W of South Fork of the Sun River, Lewis and Clark Co.) ***Constants:*** (K) $\lambda_e = 0.584 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.19 \times 10^{-4}$ atomic ratio, Rb^{87} $\lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer.

K-Ar (glauconite) 1110 m.y.
Rb-Sr (glauconite) 1020 ± 50 m.y.

626. *Mudge (1972a)* Rb-Sr
380G, HS411
Glauconite, Shepard Formation. (47°30'00"N, 112°54'00"W; sec. 8, T. 20 N., R. 10 W.; Pretty Prairie 7½' quad; ½ mi W of South Fork of the Sun River, Lewis and Clark Co.) ***Constants:*** $\lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer.

(glauconite) 1070 ± 55 m.y.

627. *Mudge (1972a)* Rb-Sr
515, HS411a
Glauconite, Shepard Formation. (47°30'00"N, 112°54'00"W; sec. 8, T. 20 N., R. 10 W.; Pretty Prairie 7½' quad; ½ mi W of South Fork of the Sun River, Lewis and Clark Co.) ***Constants:*** $\lambda = 1.39 \times 10^{-11}$/yr. ***Method:*** Isotope dilution using a 6-inch 60° Nier-type mass spectrometer.

(glauconite) 1055 ± 50 m.y.

628. *Reid, McMannis, and Palmquist (1975)* K-Ar
PJ. 69.33.1
Granodiorite pluton with plagioclase, microcline, biotite; quartz and minor actinolite, epidote, chlorite, accessories zircon, sphene. (45°31.5'N, 110°25.0'W; T. 3 S., R. 11 E. [est.]; Livingston 7½' quad; upper Davis Creek, Park Co.) ***Analytical data:*** K = 4.718, 4.701%, K^{40} = 5.745 ppm, Ar^{40} = 0.424, 0.423 ppm, Ar^{40}/Ar^{40}_{TOT} = 0.968, 0.957. ***Constants:*** $\lambda_e = 0.585 \times 10^{-10}$/yr, $\lambda_\beta = 4.72 \times 10^{-10}$/yr, $K^{40}/K = 1.22 \times 10^{-4}$ g/g. ***Dated by:*** Geochron Laboratories, Inc. ***Comment:*** This date is a "practically useless minimum" age for the pluton, whose age relation to the diabase is uncertain.

(whole rock) 965 ± 33 m.y.

629. *Evans and others (1939)* He
L8
2 ft. from the margin of 100 ft. wide Long Lake dike. (44°56.5'N, 109°29.5'W; sec. 10, T. 57 N., R. 105 W.; Deep Lake 15' quad; roadcut, Cooke City Hwy., Park Co., WYO.) ***Analytical data:*** (a) He = 7.7, 7.24×10^{-5} cc/g, Ra = 4.62×10^{-13} g/g, Th = 5.93×10^{-6} g/g; (b) He = 7.86, 6.55×10^{-5} cc/g, Ra = 4.65, 4.75 (or 4.95, typographic error in the tables) $\times 10^{-13}$ g/g, Th = 4.08×10^{-6} g/g. ***Collected by:*** A. Lane, E. Lammers; ***dated by:*** N. B. Keevil, C. Goodman. ***Comment:*** Dike considered latest Precambrian, does not cut overlying Cambrian of Beartooth Butte.

(a) 210 ± 15 m.y.
(b) 220 ± 15 m.y.

630. *Evans and others (1939)* He
L7
Center of 100 ft. wide Long Lake dike. (44°56.5'N, 109°29.5'W; sec. 10, T. 57 N., R. 105 W.; Deep Lake 15' quad; roadcut, Cooke City Hwy., Park Co., WYO.) ***Analytical data:*** He = 6.84 x 10^{-5} cc/g, Ra = 4.56, 3.7 x 10^{-13} g/g, Th = 5.15 x 10^{-6} g/g. ***Collected by:*** A. Lane, E. Lammers; ***dated by:*** N. B. Keevil, C. Goodman. ***Comment:*** Dike considered latest Precambrian, does not cut overlying Cambrian of Beartooth Butte.

216 ± 15 m.y.

631. *Evans and others (1939)* He
L9
Closewelded epidotized and pyritic margin of 100 ft. wide Long Lake dike. (44°56.5'N, 109°29.5'W; sec. 10, T. 57 N., R. 105 W.; Deep Lake 15' quad; roadcut, Cooke City Hwy., Park Co., WYO.) ***Analytical data:*** He = 2.4, 2.9 x 10^{-5} cc/g, Ra = 0.78, 0.98 x 10^{-13} g/g, Th = 1.1, 1.0 x 10^{-6} g/g. ***Collected by:*** A. Lane, E. Lammers; ***dated by:*** N. B. Keevil, C. Goodman. ***Comment:*** Dike considered latest Precambrian, does not cut overlying Cambrian of Beartooth Butte.

85 ± 5 m.y.

632. *Folinsbee, Baadsgard and Cumming (1963)* K-Ar
Bentonite in the "Big Dirty" coal seam of the basal Fort Union Formation. (47°33'N, 107°00' W; T. 21 N., R. 36 and 37 E. [est.]; Maloney Hill 15' quad; Hell Creek area, Garfield Co.) ***Comment:*** This bentonite was dated to determine the age of the Cretaceous-Tertiary boundary, but the "Big Dirty" coal is now considered the base of the Lebo Member, middle member of the Fort Union Formation.

(sanidine) 62.7 m.y.
(biotite) 61 m.y.

633. *Chadwick (1980)* K-Ar
NR-1 (Geochron No. B-3908)
Dense white and pink flow-banded rhyolite with sparse biotite phenocrysts. (45°37.1'N, 111°35.0'W; NW¼ SE¼ sec. 34, T. 2 S., R. 1 E; Norris 15' quad; ridge on S side of Red Mountain, 10 km NE of Norris, Madison Co.) ***Analytical data:*** K = 5.490%, $*Ar^{40}$ = 0.02093 ppm, $*Ar^{40}$ = 51%. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Collected by:*** R. A. Chadwick; ***dated by:*** Geochron Laboratories, Inc. ***Comment:*** This rhyolite may mark the start of volcanism along the Absaroka-Gallatin zone of eruptive centers.

(biotite) 52.7 ± 2.0 m.y.

634. *Reid, McMannis and Palmquist (1975)* K-Ar
Dacite. (45°19'30"N, 110°33'00"W; NW¼ sec. 7, T. 6 S., R. 10 E.; Emigrant 15' quad; Arrow Peak area, Park Co.)

(whole rock) 49 m.y.

635. *Chadwick (1980)* K-Ar
CM-2 (Geochron No. B-3909)
Gray rhyolite or rhyodacite porphyry with orthoclase, biotite, plagioclase and quartz phenocrysts. (46°28.7'N, 110°38.5'W; NW¼ NE¼ sec. 7, T. 8 N., R. 9 E.; Castle Town 7½' quad; 10 km NW of Lennep, Castle Mountains, Meagher Co.) ***Analytical data:*** (biotite) K = 6.361%, $*Ar^{40}$ = 0.02190 ppm, $*Ar^{40}$ = 43%; (feldspar) K = 1.628%, $*Ar^{40}$ = 0.005605 ppm, $*Ar^{40}$ = 19%. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Collected by:*** R. A. Chadwick; ***dated by:*** Geochron Laboratories, Inc. ***Comment:*** This rhyolite postdates emplacement of the major granite and diorite stocks in the Castle Mountains igneous complex; the date indicates the late stage of igneous activity in the Castle Mountains as part of the central Montana igneous province.

(biotite) 47.6 ± 1.8 m.y.
(feldspar) 47.6 ± 2.1 m.y.

636. *Chadwick (1980)* K-Ar
CC-1 (Geochron No. R-3872)
Dense black pilotaxitic basalt. (45°06.2'N, 112°46.2'W; SE¼ SW¼ sec. 25, T. 8 S., R. 10 W; Dalys 7½' quad; W bank of Beaverhead River, Beaverhead Co.) ***Analytical data:*** K = 2.308%, $*Ar^{40}$ = 0.007670 ppm, $*Ar^{40}$ = 65%. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Collected by:*** R. A. Chadwick; ***dated by:*** Geochron Laboratories, Inc. ***Comment:*** This date indicates that basaltic volcanism was widespread in Eocene of extreme southwestern Montana.

(whole rock) 46.0 ± 2.0 m.y.

637. *Chadwick (1980)* K-Ar
BM-1
Black olivine basalt of Block Mountain, some vesicles, mostly unfilled. (45°26.7'N, 112° 31.7'W; SE¼ NE¼ sec. 36, T. 4 S., R. 8 W.; Block Mountain 7½' quad; roadcut on N bank of Big Hole River, Beavernead Co.) ***Analytical***

data: K = 1.735%, $*Ar^{40}$ = 3.13895 x 10^{-6} cc/g, $*Ar^{40}$ = 85%. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Collected by:*** R. A. Chadwick; ***dated by:*** R. L. Armstrong, University of British Columbia. ***Comment:*** This date indicates that basaltic volcanism was widespread in Eocene of extreme southwestern Montana.

(whole rock) 44.8 ± 1.6 m.y.

638. [Unpublished date] K-Ar
KA 76-416 (Teledyne Isotopes)
10/16/75-1 (Burlington Northern)
Hog Heaven volcanics, Battle Butte latite. (47° 54'39"N, 114°42'56"W; center sec. 20, T. 25 N., R. 24 W.; Kofford Ridge 7½' quad; roadcut near top of Battle Mountain, Flathead Co.) ***Analytical data:*** K = 6.53, 6.54%, $*Ar^{40}$ = 45, 67%, $*Ar^{40}$ = 0.846, 0.780 x 10^{-5} scc/gm. ***Constants:*** λ_e = 0.585 x 10^{-10}/yr, λ_β = 4.72 x 10^{-10}/yr, K^{40}/K = 1.19 x 10^{-4} atomic ratio. ***Collected by:*** Dan Vice, Burlington Northern; ***dated by:*** Teledyne Isotopes. ***Comment:*** From a personal communication from Burlington Northern; sample dated for a more accurate age of the Hog Heaven volcanics.

(biotite) 30.8 ± 2.4 m.y.

639. *Rasmussen (1977)*
Porphyritic rhyolitic welded tuff interbedded with pre-Cabbage Patch strata at the base of the type section of Cabbage Patch Formation. (46°38'14"N, 113°05'03"W; center E½ sec. 10, T. 10 N., R. 12 W.; Drummond 15' quad; Granite Co.) ***Collected by:*** D. L. Rasmussen; ***dated by:*** C. W. Naeser. ***Comment:*** The lower Cabbage Patch Formation has been equated with the Gering/Sharps formations in Nebraska, which have yielded radiometric dates ranging from 26 m.y. to 29 m.y.; 27 m.y. to 28 m.y. is considered a likely age for the oldest Cabbage Patch strata.

(zircon) 29.5 ± 2.8 m.y.

References cited

Armstrong, R. L., 1975, The geochronometry of Idaho: Isochron/West, No. 14, p. 1-50.

Armstrong, R. L., Hollister, V. F., and Harakal, J. E., 1978, K-Ar dates for mineralization in the White Cloud-Cannivan porphyry molybdenum belt of Idaho and Montana: Economic Geology, v. 73, p. 94-96.

Armstrong, R. L., Speed, R. C., Graustein, W. C., and Young, A. Y., 1976, K-Ar dates from Arizona, Montana, Nevada, Utah, and Wyoming: Isochron/West, No. 16, p. 1-6.

Baadsgaard, H., Folinsbee, R. E., and Lipson, J., 1961, Potassium-argon dates of biotites from Cordilleran granites: Geological Society of America Bulletin, v. 72, p. 689-702.

Baadsgaard, H., and Mueller, P. A., 1973, K-Ar and Rb-Sr ages of intrusive Precambrian mafic rocks, southern Beartooth Mountains, Montana and Wyoming: Geological Society of America Bulletin, v. 84, p. 3635-3643.

Baty, J. B., 1973, Fission track age dates from three granitic plutons in the Flint Creek Range, western Montana [M.S. thesis]: Missoula, University of Montana, 37 p.

_____1976, Fission-track age dates from three granitic plutons in the Flint Creek Range, western Montana: Northwest Geology, v. 5, p. 34-41.

Beveridge, A. J., and Folinsbee, R. E., 1956, Dating Cordilleran orogenies: Royal Society of Canada Transactions, v. 50, p. 19-43.

Blackwell, D. D., Brott, C. A., Goforth, T. T., Holdaway, M. J., Morgan, Paul, Petefish, David, Rape, Thomas, Steele, J. L., Spafford, R. E., and Waibel, A. F., 1975, A brief description of the Marysville geothermal area, *in* Energy Resources of Montana: Montana Geological Society Guidebook, 22nd Annual Field Conference, June 1975, p. 217-222.

Boettcher, A. L., 1967, The Rainy Creek alkaline-ultramafic igneous complex near Libby, Montana I: Journal of Geology, v. 75, p. 526-553.

Brookins, D. G., 1965, Rb-Sr determinations in the Jardine-Crevasse Mountain area, southwestern Montana, *in* Variations in Isotopic Abundances of Strontium, Calcium, and Argon, and Related Topics: U.S. Atomic Energy Commission Contract At(30-1)-1381, 13th Annual Progress Report 1964, Cambridge, Massachusetts Institute of Technology, Department of Geology and Geophysics, p. 177-181.

_____1968, Rb-Sr and K-Ar age determinations from the Precambrian rocks of the Jardine-Crevice Mountain area, southwestern Montana: Earth Science Bulletin, v. 1, No. 2, p. 5-9.

Brown, L. E., and Brookins, D. G., 1966, Geochemical investigation of the Jardine-Crevasse Mountain mining district, Park County, Montana [abs.], *in* Abstracts for 1965: Geological Society of America Special Paper 87, p. 20-21.

Burwash, R. A., Baadsgaard, H., and Peterman, Z. E., 1962, Precambrian K-Ar dates from the western Canada sedimentary basin: Journal of Geophysical Research, v. 67, p. 1617-1625.

Bush, J. H., 1967, The basalts of Yellowstone valley, southwestern Montana [M.S. thesis]: Bozeman, Montana State University, 66 p.

Butler, J. R., 1966, Cathedral Peak area, Montana, Part 6, Geologic evolution of the Beartooth Mountains, Montana and Wyoming: Geological Society of America Bulletin, v. 77, p. 45-63.

Casella, C. J., 1969, A review of the Precambrian geology of the eastern Beartooth Mountains, Montana and Wyoming, *in* Larsen, L. H. [*ed.*], Prinz, Martin, and Manson, Vincent [*co-ed.*], Igneous and Metamorphic Geology: Geological Society of America Memoir 115, p. 53-71.

Catanzaro, E. J., 1962, Uranium-lead age determinations in Montana [abs.], *in* Abstracts for 1961: Geological Society of America Special Paper 68, p. 146-147.

_____1962, A study of discordant zircons from the Little Belt (Montana), Beartooth (Montana), and Santa Catalina (Arizona) Mountains [Ph.D. dissertation]: New York, Columbia University, 149 p.

Catanzaro, E. J., and Kulp, J. L., 1960, U-Pb ages in the Little Belt Mountains [abs.]: Geological Society of America Bulletin, v. 71, p. 1841.

_____1964, Discordant zircons from the Little Belt (Montana), Beartooth (Montana), and Santa Catalina (Arizona) Mountains: Geochimica et Cosmochimica Acta, v. 28, p. 87-124.

Chadwick, R. A., 1968, Two Eocene volcanic episodes, Gallatin Range, Montana, *in* Abstracts for 1967: Geological Society of America Special Paper 115, p. 411-412.

_____1969, The northern Gallatin Range, Montana: Northwestern part of the Absaroka-Gallatin volcanic field: Contributions to Geology [University of Wyoming, Laramie], v. 8, p. 150-166.

_____1978, Geochronology of post-Eocene rhyolitic and basaltic volcanism in southwestern Montana: Isochron/West, No. 22, p. 25-28.

_____1980, Radiometric ages of some Eocene volcanic rocks, southwestern Montana: Isochron/West, No. 27, p. 11.

Chapman, R. W., Gottfried, David, and Waring, C. L., 1955, Age determinations on some rocks from the Boulder batholith and other batholiths of western Montana: Geological Society of America Bulletin, v. 66, p. 607-609.

Chase, R. B., Bickford, M. E., and Tripp, S. E., 1978, Rb-Sr and U-Pb isotopic studies of the northeastern Idaho batholith and border zone: Geological Society of America Bulletin, v. 89, p. 1325-1334.

Chaudhuri, Sambhudas, and Brookins, D. G., 1969, The isotopic age of the Flathead Sandstone (Middle Cambrian), Montana: Journal of Sedimentary Petrology, v. 39, p. 364-368.

Collier, A. J., and Knechtel, M. M., 1939, The coal resources of McCone County, Montana: U.S. Geological Survey Bulletin 905, 80 p.

Condie, K. C., Leech, A. P., and Baadsgaard, H., 1969, Potassium-argon ages of Precambrian mafic dikes in Wyoming: Geological Society of America Bulletin, v. 80, p. 899-905.

Daugherty, F. W., and Vitaliano, C. J., 1969, Sand Creek sill complex, Madison and Gallatin counties, Montana: Geological Society of America Abstracts with Programs, v. 1, pt. 5, p. 19-20.

DePaolo, D. J., and Wasserburg, G. J., 1979, Sm-Nd age of the Stillwater Complex and mantle evolution curve for neodymium: Geochimica et Cosmochimica Acta, v. 43, p. 999-1008.

Donn, W. L., Donn, B. D., and Valentine, W. G., 1965, On the early history of the Earth: Geological Society of America Bulletin, v. 76, p. 287-306.

Earhart, R. L., 1975, Andesite sills in the Red Mountain area, Scapegoat Wilderness, Lewis and Clark County, Montana: Journal of Research of the U.S. Geological Survey, v. 3, p. 415-424.

Eckelmann, F. D., and Poldervaart, Arie, 1957, Archean history of the Quad Creek area, Part 1, Geologic evolution of the Beartooth Mountains, Montana and Wyoming: Geological Society of America Bulletin, v. 68, p. 1225-1261.

Ehinger, R. F., 1971, Petrochemistry of the western half of the Philipsburg batholith, Montana [Ph.D. dissertation]: Missoula, University of Montana, 167 p.

Elliott, J. E., 1974, The geology of the Cooke City area, Montana and Wyoming, *in* Voight, Barry [*ed.*], Rock Mechanics, the American Northwest: University Park, Pennsylvania State University, p. 102-107.

_____1979, Geologic map of the southwest part of the Cooke City quadrangle, Montana and Wyoming: U.S. Geological Survey Miscellaneous Investigations Map I-1084, scale 1:24,000.

Elliott, J. E., Naeser, C. W., and Hedge, C. E., 1974, Ages of intrusives and ore deposits, Cooke City, Montana, *in* Geological Survey Research 1974: U.S. Geological Survey Professional Paper 900, p. 32.

Evans, R. D., Goodman, Clark, Keevil, N. B., and Urry, W. D., 1939, Work at Massachusetts Institute of Technology, Exhibit 3, *in* Report of the Committee on the Measurement of Geologic Time 1937-1938, Appendix J, *in* Annual Report of the Division of Geology and Geography: National Research Council, p. 57-70.

Evernden, J. F., Curtis, G. H., Obradovich, J. D., and Kistler, R., 1961, On the evaluation of glauconite and illite for dating sedimentary rocks by the potassium-argon method: Geochimica et Cosmochimica Acta, v. 23, p. 78-99.

Faul, Henry, 1954, Nuclear Geology: New York, John Wiley and Sons, Inc., 414 p.

_____1960, Geologic time scale: Geological Society of America Bulletin, v. 71, p. 637-644

Fenton, M. D., and Faure, Gunter, 1969, The age of the igneous rocks of the Stillwater Complex of Montana: Geological Society of America Bulletin, v. 80, p. 1599-1604.

_____1970, A Rb-Sr whole rock age determination for the Rainy Creek alkalic-ultramafic complex, Montana: The Mountain Geologist, v. 7, p. 277-280.

Ferguson, J. A., 1972, Fission track and K-Ar dates on the northeastern border zone of the Idaho batholith, Montana-Idaho [M.S. thesis]: Missoula, University of Montana, 32 p.

_____1975, Tectonic implications of some geochronometric data from the northeastern border zone of the Idaho batholith: Northwest Geology, v. 4, p. 53-58.

Folinsbee, R. E., Baadsgaard, H., and Cumming, G. L., 1963, Dating of volcanic ash beds (bentonites) by the K-Ar method, *in* Nuclear Geophysics: National Academy of Science—National Research Council Publication 1075, p. 70-82.

Gast, P. W., 1958, Absolute age determinations from early Precambrian rocks [Ph.D. thesis]: New York, Columbia University, 14 p.

Gast, P. W., Kulp, J. L., and Long, L. E., 1958, Absolute age of early Precambrian rocks in the Bighorn basin of Wyoming and Montana and southeastern Manitoba: American Geophysical Union Transactions, v. 39, p. 322-334.

Giletti, B. J., 1966, Isotopic ages from southwestern Montana: Journal of Geophysical Research, v. 71, p. 4029-4036.

_____1971, Discordant isotopic ages and excess argon in biotites: Earth and Planetary Science Letters, v. 10, p. 157-164.

Giletti, B. J., and Gast, P. W., 1961, Absolute age of Precambrian rocks in Montana and Wyoming: Annals of New York Academy of Science, v. 91, p. 454-458.

Goldich, S. S., Baadsgaard, H., Edwards, G., and Weaver, C. E., 1959, Investigations in radioactivity-dating of sediments: American Association of Petroleum Geologists Bulletin, v. 43, p. 654-662.

Green, David, 1972, Morphologies and fission track ages of zircons from quartzites of the Hellroaring Lakes area, Pine Creek quarry, and Chrome Mountain area, Beartooth Mountains, Montana [M.S. thesis]: Cincinnati, Ohio, University of Cincinnati, 89 p.

Gulbrandsen, R. A., Goldich, S. S., and Thomas, H. H., 1963, Glauconite from the Precambrian Belt Series, Montana: Science, v. 140, p. 390-391.

Hanna, W. F., 1973, Paleomagnetism of the late Cretaceous Boulder batholith, Montana: American Journal of Science, v. 273, p. 778-802.

Hanson, G. N., 1964, The effect of contact metamorphism on mineral ages in the Snowbank Lake area, Minnesota, and in the Beartooth Mountains, Wyoming [Ph.D. dissertation]: Minneapolis, University of Minnesota, 130 p.

Hanson, G. N., and Gast, P. W., 1967, Kinetic studies in contact metamorphic zones: Geochimica et Cosmochimica Acta, v. 31, p. 1119-1153.

Hayden, R. J., and Wehrenberg, J. P., 1960, Ar^{40}-K^{40} dating of igneous and metamorphic rocks in western Montana: Journal of Geology, v. 68, p. 94-97.

Hoffman, J. L., 1976, Regional metamorphism and K-Ar dating of clay minerals in Cretaceous sediments of the Disturbed Belt of Montana [Ph.D. dissertation]: Cleveland, Ohio, Case Western Reserve University, 283 p.

Hoffman, J. L., Hower, John, and Aronson, J. L., 1976, Radiometric dating of time of thrusting in the Disturbed Belt of Montana: Geology, v. 4, p. 16-20.

Horwood, H. C., and Keevil, N. B., 1943, Age relationships of intrusive rocks and ore deposits in the Red Lake area, Ontario: Journal of Geology, v. 51, p. 17-32.

Howland, A. L., Peoples, J. W., and Sampson, Edward, 1936, Stillwater igneous complex and associated occurrences of nickel and platinum group metals: Montana Bureau of Mines and Geology Miscellaneous Contribution 7, 15 p.

Hughes, G. J., Jr., 1971, Petrology and tectonic setting of igneous rocks in the Henderson-Willow Creek igneous belt, Granite County, Montana [Ph.D. dissertation]: Houghton, Michigan Technological University, 236 p.

_____1975, Relationship of igneous rocks to structure in the Henderson-Willow Creek igneous belt, Montana: Northwest Geology, v. 4, p. 15-25.

Hunt, Graham, 1962, Time of Purcell eruption in southeastern British Columbia and southwestern Alberta: Journal of Alberta Society of Petroleum Geologists, v. 10, p. 438-442.

Hyndman, D. W., Obradovich, J. D., and Ehinger, R. F., 1972, Potassium-argon age determinations of the Philipsburg batholith: Geological Society of America Bulletin, v. 83, p. 473-474.

Jaffe, H. W., Gottfried, David, Waring, C. L., and Worthing, H. W., 1959, Lead-alpha age determinations of accessory minerals of igneous rocks, (1953-1957), *in* Studies in Geochronology: U.S. Geological Survey Bulletin 1097-B, p. 65-148.

Jahn, Bor-ming, 1967, K-Ar mica ages and the margin of a regional metamorphism, Gravelly

Range, Montana [M.S. thesis]: Providence, Rhode Island, Brown University, 37 p.

James, H. L. and Hedge, C. E., 1980, Age of the basement rocks of southwest Montana: Geological Society of America Bulletin, v. 91, p. 11-15.

Keevil, N. B., 1943, Helium indexes for several minerals and rocks: American Journal of Science, v. 241, p. 680-693.

Kistler, R. W., Obradovich, J. D., and Jackson, E. D., 1969, Isotopic ages of rocks and minerals from the Stillwater Complex, Montana: Journal of Geophysical Research, v. 74, p. 3226-3237.

Knopf, Adolph, 1956, Argon-potassium determination of the age of the Boulder bathylith, Montana: American Journal of Science, v. 254, p. 744-745.

_____1964, Time required to emplace the Boulder bathylith, Montana—a first approximation: American Journal of Science, v. 262, p. 1207-1211.

Koehler, S. W., 1973, Petrology and petrogeny of the diabase dikes of the Tobacco Root Mountains, southwestern Montana [M.S. thesis]: Bloomington, Indiana University, 61 p.

Kuenzi, W. D., and Fields, R. W., 1971, Tertiary stratigraphy, structure, and geologic history, Jefferson basin, Montana: Geological Society of America Bulletin, v. 82, p. 3373-3393.

Kulp, J. L., 1961, Geologic time scale: Science, v. 133, p. 1105-1114.

Larsen, E. S., Jr., and Schmidt, R. G., 1958, A reconnaissance of the Idaho batholith and comparison with the southern California batholith, *in* Investigations of Western Batholiths: U.S. Geological Survey Bulletin 1070-A, p. 1-33.

Larson, E. E., Reynolds, R., and Hoblitt, R., 1973, New virtual and paleomagnetic pole positions from isotopically dated Precambrian rocks in Wyoming, Montana, and Arizona: Their significance in establishing a North American apparent polar wandering path: Geological Society of America Bulletin, v. 84, p. 3231-3248.

Lyons, J. B., 1944, Igneous rocks of the northern Big Belt Range, Montana: Geological Society of America Bulletin, v. 55, p. 445-472.

Marvin, R. F., and Cole, J. C., 1978, Radiometric ages: Compilation A, U.S. Geological Survey: Isochron/West, No. 22, p. 3-14.

Marvin, R. F., and Dobson, S. W., 1979, Radiometric ages: Compilation B, U.S. Geological Survey: Isochron/West, No. 26, p. 3-32.

Marvin, R. F., and Hearn, B. C., Jr., 1972, Paleocene age of the Little Rocky Mountains uplift, Montana, *in* Geological Survey Research 1972: U.S. Geological Survey Professional Paper 800-A, p. A9.

Marvin, R. F., Wier, K. L., Mehnert, H. H., and Merritt, V. M., 1974, K-Ar ages of selected Tertiary igneous rocks in southwestern Montana: Isochron/West, No. 10, p. 17-20.

Marvin, R. F., Witkind, I. J., Keefer, W. R., and Mehnert, H. H., 1973, Radiometric ages of intrusive rocks in the Little Belt Mountains, Montana: Geological Society of America Bulletin, v. 84, p. 1977-1986.

Matson, R. E., 1970, Strippable coal deposits, McCone County, Montana: Montana Bureau of Mines and Geology Bulletin 78, 13 p.

McDowell, F. W., 1966, Potassium argon dating of Cordilleran intrusives [Ph.D. dissertation]: New York, Columbia University, 246 p.

_____1971, K-Ar ages of igneous rocks from the western United States: Isochron/West, No. 2, p. 1-16.

McDowell, F. W., and Kulp, J. L., 1969, Potassium-argon dating of the Idaho batholith: Geological Society of America Bulletin, v. 80, p. 2379-2382.

McLean, J. R., 1971, Stratigraphy of the upper Cretaceous Judith River Formation in the Canadian Great Plains: Saskatchewan Research Council, Geology Division, Report No. 11, 96 p.

McMannis, W. J., and Chadwick, R. A., 1964, Geology of the Garnet Mountain quadrangle, Gallatin County, Montana: Montana Bureau of Mines and Geology Bulletin 43, 47 p.

Mehnert, H. H., and Schmidt, R. G., 1971, Dating the Eldorado thrust, *in* Geological Survey Research 1971: U.S. Geological Survey Professional Paper 750-A, p. 37.

Mertie, J. B., Jr., Fischer, R. P., and Hobbs, S. W., 1951, Geology of the Canyon Ferry quadrangle, Montana: U.S. Geological Survey Bulletin 972, 97 p.

Metz, M. C., 1971, Geology of the Snowbird deposit, Mineral County, Montana [M.S. thesis]: Pullman, Washington State University, 91 p.

Meyer, C., Shea, E., Goddard, C., and staff (Zeihen, L. G., Guilbert, J. M., Miller, R. N., McAleer, J. F., Brox, G. B., Ingersoll, R. G., Jr., Burns, G. J., Wigal, Thomas), 1968, Ore deposits at Butte, Montana, *in* Ore Deposits in the United States, 1933-1967 [Graton-Sales Volume]: American Institute of Mining and Metallurgical Engineers, v. 2, p. 1373-1416.

Miller, D. S., 1968, Fission track ages on 250 and 2500 m. y. micas: Earth and Planetary Science Letters, v. 4, p. 379-383.

Miller R. N., 1973, Production history of the Butte district and geologic function, past and present: Society of Economic Geologists Guidebook, Butte Field Meeting, Aug. 18-21, p. F1-F10.

Mudge, M. R., 1972a, Pre-Quaternary rocks in the Sun River Canyon area, northwestern Montana, *in* Geology of the Sun River Canyon Area, Northwestern Montana: U.S. Geological Survey Professional Paper 663-A, p. A1-A142.

_____1972b, Structural geology of the Sun River Canyon and adjacent areas, northwestern Montana, *in* Geology of the Sun River Canyon Area, Northwestern Montana: U.S. Geological Survey Professional Paper 663-B, p. B1-B52.

Mueller, P. A., 1971, Geochemistry and geochronology of the mafic rocks of the southern Beartooth Mountains, Montana and Wyoming [Ph.D. dissertation]: Houston, Texas, Rice University, 58 p.

_____1979, Age of deformation in the Hellroaring Plateau area, eastern Beartooth Mountains, Montana: Canadian Journal of Earth Sciences, v. 16, p. 1124-1129.

Mueller, P. A., and Cordua, W. S., 1976, Rb-Sr whole rock age of gneisses from the Horse Creek area, Tobacco Root Mountains, Montana: Isochron/West, No. 16, p. 33-36.

Mueller, P. A., and Wooden, J. L., 1973, Age of the contact aureole of the Stillwater Complex [abs.]: Geological Society of America Abstracts with Programs, v. 5, p. 497.

_____1976, Rb-Sr whole-rock age of the contact aureole of the Stillwater igneous complex, Montana: Earth and Planetary Science Letters, v. 29, p. 384-388.

Naeser, C. W., and Dodge, F. C. W., 1969, Fission-track ages of accessory minerals from granitic rocks of the central Sierra Nevada batholith, California: Geological Society of America Bulletin, v. 80, p. 2201-2211.

Nunes, P. D., 1970, U-Pb mineral ages of the Stillwater igneous complex and associated rocks, Montana [Ph.D. dissertation]: Santa Barbara, University of California at Santa Barbara, 83 p.

Nunes, P. D., and Tilton, G. R., 1971, Uranium-lead ages of minerals from the Stillwater igneous complex and associated rocks, Montana: Geological Society of America Bulletin, v. 82, p. 2231-2249.

Obradovich, J. D., and Cobban, W. A., 1975, A time-scale for the late Cretaceous of the Western Interior of North America, *in* Cretaceous System in the Western Interior of North America: Geological Association of Canada Special Paper 13, p. 31-54.

Obradovich, J. D., and Peterman, Z. E., 1968, Geochronology of the Belt Series, Montana: Canadian Journal of Earth Sciences, v. 5, p. 737-747.

Page, N. J., 1977, Stillwater Complex, Montana: Rock succession, metamorphism and structure of the complex and adjacent rocks: U.S. Geological Survey Professional Paper 999, 79 p.

Peterman, Z. E., Doe, B. R., and Bartel, Ardith, 1967, Data on the rock GSP-1 (granodiorite) and the isotope-dilution method of analysis for Rb and Sr, *in* Geological Survey Research 1967: U.S. Geological Survey Professional Paper 575-B, p. B181-B186.

Peterman, Z. E., and Hedge, C. E., 1964, Age of rocks from the Williston basin of North Dakota and adjacent areas, *in* Short Papers in Geology and Hydrology: U.S. Geological Survey Professional Paper 475-D, p. D100-D104.

Peterson, J. C., 1974, Geology of the Sweetwater Canyon area, and origin of interbasinal canyons, southwestern Montana [M.A. thesis]: Kalamazoo, Western Michigan University, 89 p.

Petkewich, R. M., 1972, Tertiary geology and paleontology of the Beaverhead East area, southwestern Montana [Ph.D. dissertation]: Missoula, University of Montana, 365 p.

Pierce, K. L., Obradovich, J. D., and Friedman, Irving, 1976, Obsidian hydration dating and correlation of Bull Lake and Pinedale glaciations near West Yellowstone, Montana: Geological Society of America Bulletin, v. 87, p. 703-710.

Powell, J. L., Skinner, W. R., and Walker, David, 1969, Whole rock Rb-Sr age of metasedimentary rocks below the Stillwater Complex, Montana: Geological Society of America Bulletin, v. 80, p. 1605-1612.

Prinz, Martin, 1964, Mafic dike swarms of the southern Beartooth Mountains, Part 5, Geological evolution of the Beartooth Mountains, Montana and Wyoming: Geological Society of America Bulletin, v. 75, p. 1217-1245.

Prostka, H. J., 1966, Igneous geology of the Dry Mountain quadrangle, Jefferson County, Montana, *in* Contributions to General Geology: U.S. Geological Survey Bulletin 1221-F, p. F1-F21.

Ramspott, L. D., and Scholten, Robert, 1964, Early Paleozoic batholith in the Beaverhead Range, Idaho-Montana [abs.], *in* Abstracts for 1964: Geological Society of America Special Paper 82, p. 159-160.

Rasmussen, D. L., 1977, Geology and mammalian paleontology of the Oligocene-Miocene Cabbage Patch Formation, central-western Montana [Ph.D. dissertation]: Lawrence, University of Kansas, 794 p.

Reeside, J. B., Jr., 1938, The western interior region of North America in later Cretaceous time [abs.]: Science, n.s., v. 87, p. 466.

Reid, R. R., McMannis, W. J., and Palmquist, J. C., 1975, Precambrian geology of North Snowy Block, Beartooth Mountains, Montana: Geological Society of America Special Paper 157, 135 p.

Robinson, G. D., Klepper, M. R., and Obradovich, J. D., 1968, Overlapping plutonism, volcanism, and tectonism in the Boulder batholith region, western Montana, *in* Coats, R. R., Hay, R. L., and Anderson, C. A. [*eds.*], Studies in Volcanology: Geological Society of America Memoir 116, p. 557-576.

Robinson, G. D., and Marvin, R. F., 1967, Upper Cretaceous volcanic glass from western Montana: Geological Society of America Bulletin, v. 78, p. 601-608.

Rosenberg, P. E., Metz, M. C., Brookins, D. G., and Zartman, R. E., 1970, Genesis of a pegmatitic quartz-carbonate deposit, western Montana [abs.]: Geological Society of America Abstracts with Programs, v. 2, p. 669.

Rosholt, J. N., 1976, $^{230}Th/^{234}U$ dating of travertine and caliche rinds [abs.]: Geological Society of America Abstracts with Programs, v. 8, p. 1076.

Rostad, O. H., Armstrong, R. L., and Hollister, V. F., 1978, K-Ar dates for mineralization in the White Cloud-Cannivan porphyry molybdenum belt of Idaho and Montana: discussion and reply: Economic Geology, v. 73, p. 1366-1368.

Ruppel, E. T., 1963, Geology of the Basin quadrangle, Jefferson, Lewis and Clark, and Powell Counties, Montana: U.S. Geological Survey Bulletin 1151, 121 p.

Schmidt, E. A., Worthington, J. E., and Thomssen, R. W., 1979, K-Ar dates for mineralization in the White Cloud-Cannivan porphyry molybdenum belt of Idaho and Montana; discussion: Economic Geology, v. 74, p. 698-699.

Scholten, Robert, and Ramspott, L. D., 1968, Tectonic mechanisms indicated by structural framework of central Beaverhead Range, Idaho-Montana: Geological Society of America Special Paper 104, 71 p.

Schwartzman, D. W., 1966, Excess argon in minerals from the Stillwater Complex [M.S. thesis]: Providence, Rhode Island, Brown University,38 p.

Schwartzman, D. W., and Giletti, B. J., 1968, Excess argon in minerals from the Stillwater Complex, Montana [abs.]: EOS Transactions, v. 49, p. 359.

Shafiqullah, M., Folinsbee, R. E., Baadsgaard, H., Cumming, G. L., and Lerbekmo, J. F., 1964, Geochronology of Cretaceous-Tertiary Boundary, Alberta, Canada, *in* Cretaceous-Tertiary Boundary Report: International Geological Congress, 22nd Session, New Delhi, India, Part III, p. 1-20.

Skipp, Betty, and McGrew, L. W., 1977, The Maudlow and Sedan Formations of the upper Cretaceous Livingston Group on the west edge of the Crazy Mountains basin, Montana, *in* Contributions to Stratigraphy: U.S. Geological Survey Bulletin 1422-B, p. B1-B68.

Small, W. D., 1970, Cordilleran geochronology deduced from hydrothermal leads [Ph.D. dissertation]: Vancouver, University of British Columbia, 97 p.

Smedes, H. W., and Thomas, H. H., 1965, Reassignment of the Lowland Creek Volcanics to Eocene age: Journal of Geology, v. 73, p. 508-510.

Stacey, J. C., and Kramers, J. D., 1975, Approximation of terrestrial lead isotope evolution by a two-stage model: Earth and Planetary Science Letters, v. 26, p. 207-221.

Steuber, A. M., and Murthy, V. R., 1966, Strontium isotope and alkali element abundances in ultramafic rocks: Geochimica et Cosmochimica Acta, v. 30, p. 1243-1259.

Thompson, G. R., and Hower, John, 1973, An explanation for low radiometric ages from glauconite: Geochimica et Cosmochimica Acta, v. 37, p. 1473-1491.

Tilling, R. I., Klepper, M. R., and Obradovich, J. D., 1968, K-Ar ages and time span of emplacement of the Boulder batholith, Montana: American Journal of Science, v. 266, p. 671-689.

Tripp, S. E., 1976, Rubidium-strontium and uranium-lead geochronology of the northeastern border zone of the Idaho batholith, Bitterroot Range, Montana [M.S. thesis]: Kalamazoo, Western Michigan University, 73 p.

Tysdal, R. G., 1966, Geology of a part of the north end of the Gallatin Range, Gallatin County, Montana [M.S. thesis]: Bozeman, Montana State University, 92 p.

Walker, G. W., 1963, Age of uranium-bearing veins in the conterminous United States, *in* Geology of Uranium-Bearing Veins in the Conterminous United States: U.S. Geological Survey Professional Paper 455-B, p. 29-35.

Waring, C. L., and Worthing, H. W., 1953, A spectrographic method for determining trace amounts of lead in zircon and other minerals: American Mineralogist, v. 38, p. 827-833; Correction: American Mineralogist, 1954, v. 39, p. 151.

Williams, T. R., Harakal, J. E., and Armstrong, R. L., 1976, K-Ar dating of Eocene volcanic rocks near Drummond, Montana: Northwest Geology, v. 5, p. 21-24.

Witkind, I. J., 1973, Igneous rocks and related mineral deposits of the Barker quadrangle, Little Belt Mountains, Montana: U.S. Geological Survey Professional Paper 752, 58 p.

Woakes, M. E., 1960, Potassium-argon dating of mineralization at Butte, Montana [M.S. thesis]: Berkeley, University of California at Berkeley, 42 p.

Wooden, J. L., 1975, Geochemistry and Rb-Sr geochronology of Precambrian mafic dikes from the Beartooth, Ruby Range, and Tobacco Root Mountains, Montana [Ph.D. dissertation]: Chapel Hill, University of North Carolina at Chapel Hill, 229 p.

Wooden, J. L., Vitaliano, C. J., Koehler, S. W., and Ragland, P. C., 1978, The late Precambrian mafic dikes of the southern Tobacco Root Mountains, Montana: Canadian Journal of Earth Sciences, v. 15, p. 467-479.

Young, F. M., Crowley, F. A., and Sahinen, U. M., 1962, Marketing problems of small business enterprises engaged in lead and zinc mining: Montana Bureau of Mines and Geology Bulletin 30, 58 p.

Zen, E-an, Marvin, R. F., and Mehnert, H. H., 1975, Preliminary petrographic, chemical, and age data on some intrusive and associated contact metamorphic rocks, Pioneer Mountains, southwestern Montana: Geological Society of America Bulletin, v. 86, p. 367-370.

Bibliography of radiocarbon articles

Chatters, R. M., 1968, Washington State University natural radiocarbon measurements I: Radiocarbon, v. 10, p. 479-498.

Ives, P. C., Levin, Betsy, Oman, C. L., and Rubin, Meyer, 1967, U.S. Geological Survey radiocarbon dates IX: Radiocarbon, v. 9, p. 505-529.

Lemke, R. W., Mudge, M. R., Wilcox, R. E., and Powers, H. A., 1975, Geologic setting of the Glacier Peak and Mazama ash-bed markers in west-central Montana, *in* Contributions to Stratigraphy: U.S. Geological Survey Bulletin 1395-H, p. H1-H31.

Mehringer, P. J., Jr., Blinman, Eric, and Petersen, K. L., 1977, Pollen influx and volcanic ash: Science, v. 198, p. 257-261.

Mudge, M. R., 1967, Surficial geologic map of the Sawtooth Ridge quadrangle, Teton, and Lewis and Clark Counties, Montana: U.S. Geological Survey Geologic Quadrangle Map GQ-610, scale 1:24,000.

Pierce, K. L., Obradovich, J. D., and Friedman, Irving, 1976, Obsidian hydration dating and correlation of Bull Lake and Pinedale Glaciations near West Yellowstone, Montana: Geological Society of America Bulletin, v. 87, p. 703-710.

Richmond, G. M., 1972, Appraisal of the future climate of the Holocene in the Rocky Mountains: Quaternary Research, v. 2, p. 315-322.

Stoffel, K. L., and Curry, R. R., 1979, Radiometric data on southern Flathead lobe, Montana [abs.]: American Quaternary Association, National Conference Abstracts, No. 5, p. 233.

Bibliography of additional reading

Armstrong, R. L., 1978, Cenozoic igneous history of the U.S. Cordillera from lat 42° to 49°N, *in* Smith, R. B. [*ed.*], Cenozoic Tectonics and Regional Geophysics of the Western Cordillera: Geological Society of America Memoir 152, p. 265-282.

Arth, J. F., 1978, Strontium-isotope data from Pioneer batholith in southwestern Montana, *in* Geological Survey Research 1978: U.S. Geological Survey Professional Paper 1100, p. 61.

Baadsgaard, H., and Lerbekmo, J. F., 1980, A Rb/Sr age for the Cretaceous-Tertiary boundary (Z coal), Hell Creek, Montana: Canadian Journal of Earth Sciences, v. 17, p. 671-673.

Brumbaugh, D. S., 1972, Structural analysis of the complexly deformed Big Hole River area, Beaverhead, Madison, and Silver Bow counties, Montana [Ph.D. dissertation]: Bloomington, Indiana University, 96 p.

Catanzaro, E. J., 1967, Correlation of some Precambrian rocks and metamorphic events in parts of Wyoming and Montana: The Mountain Geologist, v. 4, p. 9-21.

_____1968, The interpretation of zircon ages, *in* Hamilton, E. I., and Farquhar, R. M. [*eds.*], Radiometric Dating for Geologists: London, John Wiley and Sons, Ltd., p. 225-258.

Chadwick, R. A., 1972, Volcanism in Montana: Northwest Geology, v. 1, p. 1-20.

Chase, R. B., and Bickford, M. E., 1979, Origin, structural evolution, and age of the northeastern Idaho batholith igneous-metamorphic complex [abs.]: Geological Society of America Abstracts with Programs, v. 11, p. 400.

Dexter, J. J., Chase, R. B., and Bickford, M. E., 1979, U/Pb zircon ages and crustal contamination of the northeastern Idaho batholith [abs.]: Geological Society of America Abstracts with Programs, v. 11, p. 270.

Doe, B. R., Tilling, R. I., Hedge, C. E., and Klepper, M. R., 1968, Lead and strontium isotope studies of the Boulder batholith, southwestern Montana: Economic Geology, v. 63, p. 884-906.

Fountain, D. M., and Desmarais, N. R., 1980, The Wabowden terrane of Manitoba and the pre-Belt basement of southwestern Montana: a comparison, *in* Guidebook of the Drummond-Elkhorn areas, west-central Montana—The Tobacco Root Geological Society 1978 Field Conference: Montana Bureau of Mines and Geology Special Publication 82, p. 35-46.

Gast, P. W., Kulp, J. L., and Long, L. E., 1959, Reply to Osterwald's discussion of "Absolute age of early Precambrian rocks in the Bighorn basin of Wyoming and Montana, and southeastern Manitoba": Journal of Geophysical Research, v. 64, p. 1344-1345.

Giletti, B. J., 1968, Isotopic geochronology of Montana and Wyoming, *in* Hamilton, E. I., and Farquhar, R. M. [*eds.*], Radiometric Dating for Geologists: London, John Wiley and Sons, Ltd., p. 111-146.

Gill, J. R., and Cobban, W. A., 1973, Stratigraphy and geologic history of the Montana Group and equivalent rocks, Montana, Wyoming, and North and South Dakota: U.S. Geological Survey Professional Paper 776, 37 p.

Gucwa, P. R., and Kehle, R. O., 1978, Bearpaw Mountains rockslide, U.S.A., *in* Voight, Barry [*ed.*], Rockslides and Avalanches, 1: New York, Elsevier, p. 393-421.

Harrison, J. E., Kleinkopf, M. D., and Obradovich, J. D., 1972, Tectonic events at the intersection between the Hope Fault and the Purcell Trench, northern Idaho: U.S. Geological Survey Professional Paper 719, 24 p.

Hearn, B. C., Jr., Marvin, R. F., Zartman, R. E., and Naeser, C. W., 1977, Geochronology of igneous activity in the north-central Montana alkalic province [abs.]: Geological Society of America Abstracts with Programs, v. 9, p. 732.

_____1978, Ages of alkalic igneous activity in north-central Montana, *in* Geological Survey Research 1978: U.S. Geological Survey Professional Paper 1100, p. 60.

Hedge, C. E., and Cady, W. M., 1978, Archean age of major sedimentary sequences in southwestern Montana, *in* Geological Survey Research 1978: U.S. Geological Survey Professional Paper 1100, p. 62-63.

Holloway, C. D., 1980, Petrology of Eocene volcanic sequence, Nez Perce and Blue Joint Creeks, southern Bitterroot Mountains, Montana [M.S. thesis]: Missoula, University of Montana, 129 p.

Larsen, E. S., Jr., Gottfried, David, Jaffe, H. W., and Waring, C. L., 1958, Lead-alpha ages of the Mesozoic batholiths of western North America, *in* Investigations of Western Batholiths: U.S. Geological Survey Bulletin 1070-B, p. 35-62.

Marvin, R. F., Hearn, B. C., Jr., Mehnert, H. H., Naeser, C. W., Zartman, R. E., and Lindsey, D. A., 1980, Late Cretaceous-Paleocene-Eocene igneous activity in north-central Montana: Isochron/West, No. 29, p. 5-25.

Mueller, P. A., 1970, TiO_2 and K-Ar age: a covariation in the mafic rocks of the southern Beartooth Mountains of Montana and Wyoming: Earth and Planetary Science Letters, v. 9, p. 427-430.

Mueller, P. A., and Rogers, J. J. W., 1973, Secular chemical variations in a series of Precambrian mafic rocks, Beartooth Mountains, Montana and Wyoming: Geological Society of America Bulletin, v. 84, p. 3645-3652.

Mueller, P. A., and Wooden, J. L., 1979, Guide to the Precambrian rocks of the Beartooth Mountains: Guidebook, 1979 Field Conference, U.S. National Committee on Archean Geochemistry, Gainsville, University of Florida, 87 p.

Osterwald, F. W., 1959, Discussion of paper by Gast, Kulp, and Long on "Absolute age of early Precambrian rocks in the Bighorn basin of Wyoming and Montana, and southeastern Manitoba": Journal of Geophysical Research, v. 64, p. 269-270.

Schwartzman, D. W., 1971, Excess argon in the Stillwater Complex and the problem of mantle-crustal degassing [Ph.D. dissertation]: Providence, Rhode Island, Brown University, 129 p.

Schwartzman, D. W., and Giletti, B. J., 1977, Argon diffusion and absorption studies of pyroxenes from the Stillwater Complex, Montana: Contributions to Mineralogy and Petrology, v. 60, p. 143-159.

Shaver, K. C., 1974, Dacites of the northern Gallatin and western Beartooth Ranges, Montana [M.S. thesis]: Bozeman, Montana State University, 109 p.

_____1978, Chronology of dacite intrusion in the northwest end of Absaroka-Gallatin volcanic province, Montana: Northwest Geology, v. 7, p. 20-26.

Smedes, H. W., and Prostka, H. J., 1972, Stratigraphic framework of the Absaroka Volcanic Supergroup in the Yellowstone National Park region, *in* Geology of Yellowstone National Park: U.S. Geological Survey Professional Paper 729-C, p. C1-C33.

Snee, L. W., 1978, Petrography, K-Ar ages, and field relations of the igneous rocks of part of the Pioneer batholith, southwestern Montana [M.S. thesis]: Columbus, Ohio State University, 110 p.

Snee, L. W., and Sutter, J. F., 1978, Areal distribution, petrography, and K-Ar dating of the southern portion of the Pioneer batholith, southwestern Montana [abs.]: Geological Society of America Abstracts with Programs, v. 10, p. 238.

_____1979, K-Ar geochronology and major element geochemistry of plutonic and associated volcanic rocks, from the southeastern Pioneer Mountains, Montana [abs.]: Geological Society of America Abstracts with Programs, v. 11, p. 302.

Spang, J. H., 1967, A structural study across a transition of radiometric age dates in the Gallatin canyon area, Gallatin County, Montana [M.S. thesis]: Providence, Rhode Island, Brown University, 82 p.

Stewart, J. H., and Carlson, J. E., 1978, Generalized maps showing distribution, lithology, and age of Cenozoic igneous rocks in the western United States, *in* Smith, R. B. [*ed.*], Cenozoic Tectonics and Regional Geophysics of the Western Cordillera: Geological Society of America Memoir 152, p. 263-264.

Wetherill, G. W., Bickford, M. E., Silver, L. T., and Tilton, G. R., 1965, Geochronology of North America: National Academy of Science—National Research Council Nuclear Science Series Report 41 (NAS-NRC Publ.1276), 315 p.

Woodward, L. A., 1970, Time of emplacement of Pinto Diorite, Little Belt Mountains, Montana: Earth Science Bulletin, v. 3, No. 3, p. 15-26.

Zen, E-an, and Hammarstrom, J. M., 1978, Tectonic implications of granite ages, southwestern Montana, *in* Geological Survey Research 1978: U.S. Geological Survey Professional Paper 1100, p. 61.

Zen, E-an, Hammarstrom, J. M., Marvin, R. F., and Arth, J. G., 1979, Tertiary volcanic rocks, Pioneer Mountains, southwestern Montana [abs.]: Geological Society of America Abstracts with Programs, v. 11, p. 307.

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Sheet 2—(A), Location map of dated rocks from the Little Belt Mountains; (B), Stillwater Complex; (C), Beartooth Mountains.