The geochronometry of Idaho (Part 2)

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THE GEOCHRONOMETRY OF IDAHO

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METAMORPHIC ROCKS

Relatively few metamorphic rocks from central and northern Idaho have been dated, and the results are widely scattered in time. One concentration of dates around 45 m.y. reflects the Challis episode, dates of 60 to 100 m.y. probably reflect Mesozoic metamorphism, a few scattered older dates, up to ~200 m.y., may likewise be rocks crystallized during the Mesozoic or they may be artifacts caused by trapping of excess Ar in minerals crystallized during the Mesozoic or Cenozoic. Metamorphic rocks yielding dates over 200 m.y. old are plotted on Figure 5. These dates arise from a variety of causes. None of the results over 200 m.y. old listed below are thought to date a significant geologic event. Most are discordant results arising from partial resetting of older Precambrian dates. In Belt metasediments and basement complexes of pre-Belt age crystallization ages of ~900, ~1600 and ~2500 m.y., respectively, are possible. All of these rocks would have contained significant amounts of radiogenic Ar prior to Mesozoic–Cenozoic heating and recrystallization. Mesozoic–Cenozoic heating that resulted in partial Ar loss would yield intermediate dates, as is observed. Dates of >200 m.y. obtained on samples of Paleozoic and Mesozoic(?) rock are probably due to entrapment of ambient radiogenic Ar during recrystallization. This radiogenic Ar may have been locally generated by decay of K since deposition or Ar acquired from other old rocks that were undergoing degassing at the same time. In a few cases impossibly old dates have resulted from the erratic incorporation of excess Ar. Only dating of individual minerals by independent techniques (e.g., Rb-Sr and K-Ar) will provide an answer in cases where excess Ar is suspected (e.g., the Salmon River arch specimens described in a later section).

A ~550 m.y. Rb-Sr whole rock date for a schist lens near the west edge of the Idaho batholith indicates that Precambrian rocks were present in the area and engulfed and digested by the batholith but it is only a minimum value for the original age of the rock.

SAMPLE DESCRIPTIONS

1. Hayden and Wehrenburg, 1960 — K-Ar — (biotite) 40.2±2 m.y.
Pegmatite in foliated metamorphic rocks (46°35′00″N, 114°11′25″W; NW¼sec. 36, T. 10 N., R. 21 W.; Ravalli Co., MT) Bass Creek Canyon, Bitterroot Mountains. Analytical data: K = 7.50%; $^*Ar^{40}$ = 12.3, 12.1 x 10^{-6} cc/gm (18, 72% Σ Ar^{40}); collected by: J. P. Wehrenburg, U. of Montana; dated by: R. J. Hayden and J. P. Wehrenburg, U. of Chicago.

2. YU-873 — K-Ar — (biotite) 58.0±1.7 m.y.; (muscovite) 63.6±1.9 m.y.
LR3 Muscovite – Biotite Schist (44°20′10″N, 115°13′50″W; NW¼sec. 35, T. 12 N., R. 10 E.; Custer Co., ID) 17 mi NW of Stanley. Analytical data: K = 7.56, 7.42, 7.38%; $^*Ar^{40}$ = 17.53 x 10^{-6} cc/gm (83% Σ Ar^{40}) K = 8.02, 8.10%; $^*Ar^{40}$ = 20.83 x 10^{-6} cc/gm (70% Σ Ar^{40}); collected and dated by: L. Rychener, Yale U.

3. YU-874 — K-Ar — (biotite – 15% Chlorite) 70.6±2.1 m.y.
LR4 Biotite Schist (44°21′30″N, 115°14′00″W; E edge sec. 22, T. 12 N., R. 10 E.; Custer Co., ID) N of Cape Horn Creek, along road, 18 mi NW of Stanley. Analytical data: K = 2.96, 2.95%; $^*Ar^{40}$ = 8.48 x 10^{-6} cc/gm (46% Σ Ar^{40}); collected and dated by: L. Rychener, Yale U.

4. YU-860 — K-Ar — (biotite – 9% Chlorite) 42.2±1.3 m.y.
J D 66-342 Coarse Migmatitic Gneiss (43°47′49″N, 114°10′24″W; NE¼sec. 3, T. 5 N., R. 19 E.; Custer Co., ID) Pioneer Mountains (Dover, 1969). Analytical data: K = 6.26, 6.26%; $^*Ar^{40}$ = 10.67 x 10^{-6} cc/gm (37% Σ Ar^{40}); collected by: J. Dover, Colo. Sch. Mines; dated by: R. L. Armstrong, Yale U.

5. YU-861 K-Ar (biotite) 38.3±1.1 m.y.
JD 64-472 Diorite Gneiss (43°47'24"N, 114°09'35"W; center sec. 2, T. 5 N., R. 19 E.; Custer Co., ID) Pioneer Mountains. Analytical data: K = 7.67, 7.53%; $*Ar^{40}$ = 11.76 x 10^{-6} cc/gm (63% Σ Ar^{40}); collected by: J. Dover, Colo. Sch. Mines; dated by: R. L. Armstrong, Yale U.

6. YU-865 K-Ar (biotite) 38.0±1.1 m.y.
JD 8-14-11a Schist (43°45'40"N, 114°09'24"W; SE¼sec. 14, T. 5 N., R. 19 E.; Blaine Co., ID) Pioneer Mountains. Analytical data: K = 7.10, 7.05%; $*Ar^{40}$ = 10.81 x 10^{-6} cc/gm (72% Σ Ar^{40}); collected by: J. Dover, Colo. Sch. Mines; dated by: R. L. Armstrong, Yale U.

7. YU-868 K-Ar (biotite) 43.7±1.3 m.y.
JD 8-14-10a Schist (43°45'56"N, 114°09'20"W; NE¼sec. 14, T. 5 N., R. 19 E.; Blaine Co., ID) Pioneer Mountains. Analytical data: K = 6.97, 7.06%; $*Ar^{40}$ = 10.59 x 10^{-6} cc/gm (53% Σ Ar^{40}); collected by: J. Dover, Colo. Sch. Mines; dated by: R. L. Armstrong, Yale U.

8. YU-870 K-Ar (whole rock) 36.2±1.1 m.y.
JD 7.8.65.8a Recrystallized fault zone: Muscovite – quartz – plagioclase schist (43°42'44"N, 114°05'36"W; SE corner sec. 32, T. 5 N., R. 20 E.; Blaine Co., ID) Pioneer Mountains. Analytical data: K = 3.94, 4.00%; $*Ar^{40}$ = 5.79 x 10^{-6} cc/gm (49% Σ Ar^{40}); collected by: J. Dover, Colo. Sch. Mines; dated by: R. L. Armstrong, Yale U.

9. Fleck, Faure and others K-Ar (whole rock) 46.2±0.5 m.y.
Written communications (1971, 1974)
68-9-10C Sillimanite – grade schist, Belt Series (46°35.5'N, 115°47.5'W; sec. 35, T. 38 N., R. 5 E.; Clearwater Co., ID). Analytical data: K = 3.85%; $*Ar^{40}$ = 3.204 x 10^{-10} moles/gm (54% Σ Ar^{40}); collected and dated by: R. Fleck, G. Faure, E. Stump and others, Ohio State U.

10. Fleck, Faure and others K-Ar (whole rock) 46.7±0.6 m.y.
Written communications (1971, 1974)
68-9-11C Sillimanite – grade schist, Belt Series (46°47'N, 115°49.5'W; sec. 28, T. 40 N., R. 5 E.; Clearwater Co., ID). Analytical data: K = 2.38%; $*Ar^{40}$ = 2.005 x 10^{-10} moles/gm (35% Σ Ar^{40}); collected and dated by: R. Fleck, G. Faure, E. Stump and others, Ohio State U.

11. Fleck, Faure and others K-Ar (whole rock) 59.9±1.4 m.y.
Written communications (1971, 1974)
68-9-12D Sillimanite – grade schist, Belt Series (46°53.3'N, 116°01'W; sec. 24, T. 41 N., R. 3 E.; Clearwater Co., ID). Analytical data: K = 3.68%; $*Ar^{40}$ = 3.983 x 10^{-10} moles/gm (53% Σ Ar^{40}); collected and dated by: R. Fleck, G. Faure, E. Stump and others, Ohio State U.

12. Fleck, Faure and others K-Ar (whole rock) 189±2 m.y.
Written communications (1971, 1974)
69-7-4A Kyanite – staurolite – grade schist, Belt Series (47°5.7'N, 115°31'W; S edge, sec. 1, T. 43 N., R. 7 E.; Shoshone Co., ID). Analytical data: K = 3.27%; $*Ar^{40}$ = 11.61 x 10^{-10} moles/gm (63% Σ Ar^{40}); collected and dated by: R. Fleck, G. Faure, E. Stump and others, Ohio State U.

13. Hietanen, 1969 K-Ar (biotite) 46.5±1.6 m.y.
971 Kyanite – garnet – biotite – andesine rock (46°59'35"N, 115°50'50"W; NW¼sec. 16, T. 42 N., R. 5 E.; Shoshone Co., ID) near Boehls Butte anorthosite. Analytical data: K_2O = 8.71%; $*Ar^{40}$ = 6.045 x 10^{-10} moles/gm (89% Σ Ar^{40}); collected by: Anna Hietanen, U. S. G. S.; dated by: Joan Engels, U. S. G. S.

14. Hietanen, 1969 K-Ar (biotite) 61.0±2.1 m.y.
912 Cordierte – biotite gneiss (46°52'10"N, 115°51'45"W; NW¼sec. 29, T. 41 N., R. 5 E.; Clearwater Co., ID) near Boehls Butte anorthosite. Analytical data: K_2O = 8.56%; $*Ar^{40}$ = 7.825 x 10^{-10} moles/gm (77% Σ Ar^{40}); collected by: Anna Hietanen, U. S. G. S.; dated by: Joan Engels, U. S. G. S.

15. Hietanen, 1969 K-Ar (biotite) 76.3±2.6 m.y.
(muscovite) 57.0±1.7 m.y.
2127 Kyanite – garnet schist, St. Regis Formation (46°53′20″N, 115°29′30″W; SE¼sec. 18, T. 41 N., R. 8 E.; Clearwater Co., ID). Analytical data: K_2O = 8.73%; $*Ar^{40}$ = 10.05 x 10^{-10} moles/gm (66% Σ Ar^{40}) K_2O = 9.35%; $*Ar^{40}$ = 7.997 x 10^{-10} moles/gm (8% Σ Ar^{40}); collected by: Anna Hietanen, U. S. G. S.; dated by: Joan Engels, U. S. G. S.

16. Harrison and others, 1972 K-Ar (biotite) 68.4±2.7 m.y.
8 Biotitic argillite, Prichard Formation (48°14′15″N, 116°27′50″W; NNE edge sec. 5, T. 56 N., R. 1 W.; Bonner Co., ID). Analytical data: K_2O = 8.30%; $*Ar^{40}$ = 8.53 x 10^{-10} moles/gm (77.9% Σ Ar^{40}); collected by: J. E. Harrison, U. S. G. S.; dated by: J. D. Obradovich, U. S. G. S.

17. Harrison and others, 1972 K-Ar (biotite) 92.3±3.5 m.y.
9 Biotitic argillite, Prichard Formation (48°12′50″N, 116°29′00″W; E side sec. 7, T. 56 N., R. 1 W.; Bonner Co., ID). Analytical data: K_2O = 5.14%; $*Ar^{40}$ = 7.19 x 10^{-10} moles/gm (88.9% Σ Ar^{40}); collected by: J. E. Harrison, U. S. G. S.; dated by: J. D. Obradovich, U. S. G. S.

18. Leonard and Stern, 1966 K-Ar (hornblende) 93±5 m.y.
B. F. Leonard and R. F. Marvin, written communications, 1973 and 1974
L-62-327a Pegmatite from syenite of the Ramey Ridge Complex (45°15.0′N, 115°16.6′W; Idaho Co., ID) 0.5 mi E of Hand Creek, N edge of NE 9th of Big Creek 15′ quad. Analytical data: K_2O = 1.51%; $*Ar^{40}$ = 0.00857 ppm (72% Σ Ar^{40}); collected by: B. F. Leonard, U. S. G. S.; dated by: H. H. Thomas and R. F. Marvin, U. S. G. S.

19. Reid and Greenwood, 1968 K-Ar (hornblende) 172±8 m.y.
Amphibolite (approximately 47°12′N, 116°00′W; Shoshone Co., ID) St. Joe Region, exact locality not reported. Not shown on locality map. Analytical data: none reported; collected by: R. R. Ried, U. of Idaho; probably dated by: Isotopes Inc.

20. Ferguson, 1972 F.T. (λ = 6.85 x 10^{-17}) (apatite) 43±4 m.y.
K3 Calc-silicate in Idaho batholith contact zone, sillimanite grade. (46°32′05″N, 114°18′45″W; SW¼sec. 13, T. 9 N., R. 22 W.; Ravalli Co., MT); collected and dated by: J. A. Ferguson, U. of Montana.

21. Ferguson, 1972 K-Ar (biotite) 43.2±1.3 m.y.
F.T. (λ = 6.85 x 10^{-17}) (apatite) 48±4 m.y.
K10 Pelitic schist, plagioclase zone (46°43′30″N, 114°19′45″W; SE¼sec. 11, T. 11 N., R. 22 W.; Missoula Co., MT). Analytical data: K = 7.31, 7.18%; $*Ar^{40}$ = 12.65 x 10^{-6} cc/gm (76% Σ Ar^{40}); collected by: J. A. Ferguson, U. of Montana; dated by: R. L. Armstrong, Yale U. and J. A. Ferguson, U. of Montana.

22. Ferguson, 1972 K-Ar (biotite) 43.6±1.3 m.y.
F.T. (λ = 6.85 x 10^{-17}) (apatite) 36±3 m.y.
K1 Sillimanite gneiss (46°34′25″N, 114°22′25″W; SW¼sec. 6, T. 37 N., R. 17 E.; Idaho Co., ID). Analytical data: K = 7.00, 6.99%; $*Ar^{40}$ = 12.32 x 10^{-6} cc/gm (74% Σ Ar^{40}); collected by: J. A. Ferguson, U. of Montana; dated by: R. L. Armstrong, Yale U. and J. A. Ferguson, U. of Montana.

23. Jaffe and others, 1959 Pb-α (monazite) 99±10 m.y.
(monazite) 95±10 m.y.
(monazite) 90±10 m.y.
ID-9-30, ID-9-35, ID-51-A Rare metal deposits in limestone layers in Precambrian metasediments (approximately 45°26′N, 114°10′W; Lemhi Co., ID) Indian Creek area, Mineral Hill district. Analytical data: 27.5, 46.5, 26.5 ppm Pb, 578, 1024, 617 α/mg/hr; collected by: E. P. Kaiser, U. S. G. S.; dated by: Jaffe and others, U. S. G. S.

24. Ferguson, 1972 F.T. (λ = 6.85 x 10^{-17}) (apatite) 39±3 m.y.
(sphene) 81±7 m.y.
K6 Quartzite, sillimanite zone. (46°37′25″N, 114°22′40″W; NW¼sec. 19, T. 38 N., R. 17 E.; Idaho Co., ID); collected and dated by: J. A. Ferguson, U. of Montana.

25. Ferguson, 1972 F.T. ($\lambda = 685 \times 10^{-17}$) (apatite) 36±4 m.y.
K 22 Pelitic schist, plagioclase zone. (46°42′25″N, 114°20′20″W; SW¼sec. 14, T. 11 N., R. 22 W.; Missoula Co., MT); collected and dated by: J. A. Ferguson, U. of Montana.

26. Ferguson, 1972 F.T. ($\lambda = 6.85 \times 10^{-17}$) (apatite) 24±3 m.y.
(sphene) 85±9 m.y.
XK 3 Quartz diorite orthogneiss (46°36′50″N, 114°22′30″W; NW¼sec 30, T. 38 N., R. 17 W.; Idaho Co., ID); collected and dated by: J. A. Ferguson, U. of Montana.

27. Ferguson, 1972 F.T. ($\lambda = 6.85 \times 10^{-17}$) (apatite) 24±2 m.y.
K 2 Quartzite, sillimanite zone (46°35′55″N, 114°23′25″W; NE¼sec. 36, T. 38 N., R. 16 E.; Idaho Co., ID); collected and dated by: J. A. Ferguson, U. of Montana.

28. Ferguson, 1972 F.T. ($\lambda = 6.85 \times 10^{-17}$) (apatite) 34±3 m.y.
K 21 Pelitic schist, sillimanite zone (46°41′40″N, 114°21′20″W; SW¼sec. 22, T. 11 N., R. 22 W.; Missoula Co., MT); collected and dated by: J. A. Ferguson, U. of Montana.

29. Ferguson, 1972 F.T. ($\lambda = 6.85 \times 10^{-17}$) (apatite) 44±4 m.y.
K 112 Amphibolite layer in quartzite, sillimanite zone (46°33′15″N, 114°18′55″W; NW¼sec. 12, T. 9 N., R. 22 W.; Ravalli Co., MT); collected and dated by: J. A. Ferguson, U. of Montana.

30. YU-787 K-Ar (whole rock) 262±8 m.y.
Porphyritic amygdaloidal andesite altered to greenschist (42°52′45″N, 112°22′20″W; SW¼sec. 21, T. 6 S., R. 35 E.; Bannock Co., ID) near Pocatello. Eocambrian. Analytical data: K = 1.63, 1.59%; $^*Ar^{40} = 18.06 \times 10^{-6}$ cc/gm (12% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

31. YU-880 K-Ar (whole rock) 341±10 m.y.
Cambrian red phyllite (44°18′30″N, 114°29′00″W; SE¼sec. 5, T. 11 N., R. 17 E.; Custer Co., ID) Squaw Creek, Clayton quad. Specimen occurs in excess Ar halo of Idaho batholith. Muscovite well recrystallized: 10Å peak half width 0.185°, 2θ (S. Schamel, pers. comm.). Analytical data: K = 1.62, 1.60%; $^*Ar^{40} = 23.98 \times 10^{-6}$ cc/gm (19% ΣAr^{40}); collected and dated by: L. Rychener, Yale U.

32. YU-879 K-Ar (whole rock) 331±10 m.y.
Ramshorn Slate (Sericite – quartz – chlorite) (44°15′30″N, 114°22′00″W; NW¼sec. 29, T. 11 N., R. 18 E.; Custer Co., ID) near Clayton. Specimen occurs in excess Ar halo of Idaho batholith. Muscovite well recrystallized: 10Å peak half width 0.232°, 2θ (S. Schamel, pers. comm.) Analytical data: K = 3.47, 3.40; $^*Ar^{40} = 49.55 \times 10^{-6}$ cc/gm (90% ΣAr^{40}); collected and dated by: L. Rychener, Yale U.

33. YU-878 K-Ar (whole rock) 393±12 m.y.
Ramshorn Slate (Quartz – sericite – chlorite) (44°17′00″N, 114°23′30″W; W½sec. 13, T. 11 N., R. 17 E.; Custer Co., ID) Upper Kinnikinic Creek, near Clayton. Specimen occurs in excess Ar halo of Idaho batholith. Muscovite well recrystallized: 10Å peak half width 0.193°, 2θ (S. Schamel, pers. comm.) Analytical data: K = 2.83, 2.85, 2.83%; $^*Ar^{40} = 49.37 \times 10^{-6}$ cc/gm (88% ΣAr^{40}); collected and dated by: L. Rychener, Yale U.

34. Reid and Greenwood, 1968 K-Ar (K feldspar–orthoclase) 300 m.y.
Metasomatically altered "bleached" fault zone (locality uncertain, but approximately 47°12′N, 116°W; Shoshone Co., ID) St. Joe Region. Not shown on locality map. Analytical data: none reported; collected by: R. R. Reid, U. of Idaho; probably dated by: Isotopes Inc.

35. Reid and Greenwood, 1968 K-Ar (hornblende) 669±25 m.y.
Metadiabase (locality uncertain, but approximately 47° 12′N, 116°W; Shoshone Co., ID) St. Joe Region. Not shown on locality map. Analytical data: none reported; collected by: R. R. Reid, U. of Idaho; probably dated by: Isotopes Inc.

36. Fleck, Faure and others K-Ar (whole rock) 328±4 m.y.
Written communications (1971, 1974)
69-7-2B Biotite-grade schist, Belt Series (47°12.3'N, 115°44.5'W; sec. 31, T. 45 N., R. 6 E.; Shoshone Co., ID). Analytical data: K = 2.93%; $^*Ar^{40}$ = 18.68 x 10^{-10} moles/gm (89% Σ Ar^{40}); collected and dated by: R. Fleck, G. Faure, E. Stump and others, Ohio State U.

37. YU-1024 K-Ar (whole rock) 940±28 m.y.
(chlorite) 790±24 m.y.
Extremely chloritized gabbro (calcite-chlorite-sphene-epidote-muscovite-albite) (44°18'N, 114°24'20"W; NE¼sec. 12, T. 11 N., R. 17 E.; Custer Co., ID) road cut, upper Kinnikinic Creek. Mesozoic age expected. Rock altered, appears to lie in excess Ar halo around Idaho batholith. Whole rock largely consists of feldspar and chlorite. Analytical data: K = 0.176, 0.173%; $^*Ar^{40}$ = 8.48, 8.50 x 10^{-6} cc/gm (90, 81% Σ Ar^{40}) K = 0.009, 0.009%; $^*Ar^{40}$ = 0.341 x 10^{-6} cc/gm (5% Σ Ar^{40}); collected by: W. Hayes, U. S. G. S. and R. L. Armstrong, Yale U.; dated by: R. L. Armstrong, Yale U.

38. YU-1025 K-Ar (whole rock) 661±20 m.y.
(chlorite + actinolite) 467±14 m.y.
Extremely chloritized gabbro (actinolite – epidote – sphene – chlorite – calcite – albite) (44°17'50"N, 114° 24'25"W; NE¼sec. 12, T. 11 N., R. 17 E.; Custer Co., ID) road cut, upper Kinnikinic Creek. Mesozoic age expected. Rock altered, appears to lie in excess Ar halo around Idaho batholith. Whole rock largely consists of feldspar, chlorite, and actinolite. Analytical data: K = 0.037, 0.037%; $^*Ar^{40}$ = 1.17 x 10^{-6} cc/gm (40% Σ Ar^{40}) K = 0.021, 0.021%; $^*Ar^{40}$ = 0.425, 0.460 x 10^{-6} cc/gm (13, 11% Σ Ar^{40}); collected by: W. Hayes, U. S. G. S. and R. L. Armstrong, Yale U.; dated by: R. L. Armstrong, Yale U.

39. Sorensen, 1972, K-Ar (whole rock) 279±4 m.y.
written communication, 1974
SS 3600-1 Intensely sheared and bleached St. Regis Formation (47°29'50"N, 116°02'W; sec. 23, T. 48 N., R. 3 E.; Shoshone Co., ID) Silver Summit mine, immediately adjacent to the Silver Summit vein, N side on 3600 level at 80,500 E. Close to vein sericite in appearance. Original metamorphism East Kootenay with subsequent alteration during the Nevadan orogeny. Analytical data: K = 5.52, 5.51%; $^*Ar^{40}$ = 65.53, 66.34 x 10^{-6} cc/gm (98, 98% Σ Ar^{40}); collected by: A. H. Sorensen, Hecla Mining Co.; dated by: Isotopes Inc. for Hecla Mining Co.

40. Sorensen, 1972, K-Ar (whole rock) 500±15 m.y.
written communication, 1974
SS 4000-1 Bleached greenish gray quartzose phyllite – subgraywacke of the St. Regis Formation (47°29'50"N, 116°02'W; sec. 23, T. 48 N., R. 3 E.; Shoshone Co., ID) Silver Summit mine, 4000 level mine station M 4019, S wall. Sericite, formed during East Kootenay orogeny as bedding schistosity and metamorphic foliation with disseminated pyrite and siderite. Analytical data: K = 3.13%; $^*Ar^{40}$ = 72.9 x 10^{-6} cc/gm (90% Σ Ar^{40}); collected by: A. H. Sorensen, Hecla Mining Co.; dated by: Isotopes Inc. for Callahan Mining Co. and Bunker Hill Co.

41. Sorensen, 1972 K-Ar (whole rock) 530±16 m.y.
written communication, 1974
SS 3000-28 Unaltered dark purplish calcareous siltite – argillaceous subgraywacke of the St. Regis Formation (47°29'50"N, 116°02'W; sec. 23, T. 48 N., R. 3 E.; Shoshone Co., ID) 3000 level of Silver Summit mine, station M 3006 + 33.5 ft., N 40 W, NE wall. Sericite, formed during East Kootenay orogeny as bedding schistosity. Analytical data: K = 3.71%; $^*Ar^{40}$ = 92.5 x 10^{-6} cc/gm (97% Σ Ar^{40}); collected by: A. H. Sorensen, Hecla Mining Co.; dated by: Isotopes Inc. for Callahan Mining Co. and Bunker Hill Co.

42. Fleck, Faure and others K-Ar (whole rock) 511±6 m.y.
Written communications (1971, 1974)
69-7-5A Kyanite-grade schist, Belt Series (47°04'N, 115°36'W; sec. 17, T. 43 N., R. 7 E.; Shoshone Co., ID). Analytical data: K = 3.35%; $^*Ar^{40}$ = 34.99 x 10^{-10} moles/gm (88% Σ Ar^{40}); collected and dated by: R. Fleck, G. Faure, E. Stump and others, Ohio State U.

43. Fleck, Faure and others K-Ar (whole rock) 1033±12 m.y.
Written communications (1971, 1974)
69-7-4C Staurolite-grade schist, Belt Series (47°07'N, 115°29'W; sec. 31, T. 44 N., R. 8 E.; Shoshone Co., ID). Analytical data: K = 3.72%; $*Ar^{40} = 91.24 \times 10^{-10}$ moles/gm (96% Σ Ar^{40}); collected and dated by: R. Fleck, G. Faure, E. Stump and others, Ohio State U.

44. Hietanen, 1969 K-Ar (biotite) 1780±53 m.y.
2096 Staurolite-garnet schist of Wallace Formation in contact aureole of Idaho batholith (47°04'35"N, 115° 33'55"W; NW¼sec. 15, T. 43 N., R. 7 E.; Shoshone Co., ID). Analytical data: K_2O = 7.90%; $*Ar^{40} = 345.5 \times 10^{-10}$ moles/gm (97% Σ Ar^{40}); collected by: Anna Hietanen, U. S. G. S.; dated by: Joan Engels, U. S. G. S.

45. YU-McC 48a Rb-Sr (λ = 1.42) (whole rock) ~550±54 m.y.
Assumed initial Sr^{87}/Sr^{86} = 0.706
Schist (Muscovite-Sillimanite – Garnet – Biotite – Adamellite) (44°55'05"N, 115°57'50"W; Valley Co., ID) 5 mi E of McCall. Analytical data: 245 ppm Rb, 196 ppm Sr, Rb/Sr = 1.25, Sr^{87}/Sr^{86} = 0.73421; collected by: A. J. Stewart, Yale U.; dated by: R. L. Armstrong, Yale U.

BELT SUPERGROUP

Obradovich and Peterman (1968) reported Rb-Sr isochron dates for little-metamorphosed Belt sediments in Montana ranging from 1325 m.y., for older units, to 930 m.y., near the top of the section, and felt that these dates spanned the time of deposition of Belt sediments. None of their samples came from Idaho but the Belt rocks in Idaho are correlative with the units dated by Obradovich and Peterman. Several K-Ar dates for Purcell intrusive igneous rocks in Idaho range from 480 to 1260 m.y. and a Rb-Sr date of 1320 m.y. has been reported in an abstract. Most dates on these rocks are probably low because of the effects of Mesozoic-Cenozoic regional metamorphism. Only the values near 1300 are likely to be close to the true age of the rocks. Dates for uranium minerals near Coeur D'Alene have been reported to be about 1200 m.y. (the Pb^{207}/Pb^{206} dates) but Harrison (1972) and Harrison and others (1974) believe that the mineralization date is nearer to 850 m.y. (the U/Pb dates).

Other dates listed below are for a metamorphism ~950 m.y. ago (possibly an effect of the East Kootenay orogeny), a detrital zircon (indicating a provenance of 1500 m.y. rocks), and a whole rock isochron for metamorphosed sediments, showing that there has been some redistribution of Rb and Sr, thus slightly flattening the fresh-rock isochron.

1. McDowell, 1971 K-Ar (hornblende-pyroxene mixture) 1260±40 m.y.
Sorensen, written communication, 1974
L-1049 Page Mine "diabase" (variously described as fine grained basic syenite and quartz bearing diorite) (47°31'45"N, 116°12'10"W; SE corner sec. 4, T. 48 N., R. 2 E.; Shoshone Co., ID) Page Mine, 4 mi SE of Enaville 3070 level, 200 ft N of 85-vein drift. Sill or dike in Revett Formation. Analytical data: K = 0.251%; $*Ar^{40} = 8.37 \times 10^{-10}$ moles/gm (86% Σ Ar^{40}); collected by: A. H. Sorensen, Hecla Mining Co.; dated by: F. W. McDowell, Columbia U.

2. Harrison and others, 1972 K-Ar (hornblende) 870±25 m.y.
6 Gabbro (Purcell sill) (48°19'00"N, 116°10'45"W; E edge sec. 3, T. 57 N., R. 2 E.; Bonner Co., ID). Analytical data: K_2O = .802%; $*Ar^{40} = 13.10 \times 10^{-10}$ moles/gm (98.5% Σ Ar^{40}); collected by: J. E. Harrison, U. S. G. S.; dated by: J. D. Obradovich, U. S. G. S.

3. Harrison and others, 1972 K-Ar (hornblende) 480±15 m.y.
7 Quartz diorite (Purcell sill) (48°18'10"N, 116°22'W; SW¼sec. 8, T. 57 N., R 1 E.; Bonner Co., ID). Analytical data: K_2O = 1.24%; $*Ar^{40} = 10.01 \times 10^{-10}$ moles/gm (97.8% Σ Ar^{40}); collected by: J. E. Harrison, U. S. G. S.; dated by: J. D. Obradovich, U. S. G. S.

4. Bishop, 1973 Rb-Sr (λ = 1.39) (whole rock isochron) 1320 m.y.
Purcell sill, Boundary Co., ID; no additional data given, work still in progress. Not shown on locality map; collected by: D. Bishop, Idaho Bureau of Mines and Geology; dated by: U. S. G. S., Denver.

5. Sorensen, 1972 K-Ar (hornblende-pyroxene mixture) 1105±40 m.y.
written communication, 1974
Cd′ A-7 North Fork diorite dike (47°35′10″N, 116°15′55″W; SE corner sec. 13, T. 49 N., R. 1 E.; Shoshone Co., ID) N of Osburn fault on NW side of N Fork of Coeur d′Alene River 7 mi NW of Kellogg, 1.2 mi NW of Kellogg, 1.2 mi NE of Enaville. Approximately 50 ft thick dike in Burke or Prichard Formation. Analytical data: K = 0.83%; $*Ar^{40}$ = 50.8 x 10^{-6} cc/gm (94% Σ Ar^{40}); collected by: A. H. Sorensen, Hecla Mining Co.; dated by: Isotopes Inc. for Hecla Mining Co.

6. Sorensen, 1972 K-Ar (whole rock) 568±14 m.y.
written communication, 1974
SJ-10 Wishards Sill, pyroxene diorite (47°22′N, 115°34′50″W; sec. 5, T. 46 N., R. 7 E.; Shoshone Co., ID) at crest of Bitterroot Range on Idaho–Montana border, 3.3 mi E of Roland Summit junction. Sample from about 150 ft above base of sill. Analytical data: K = 0.38%; $*Ar^{40}$ = 10.01 x 10^{-6} cc/gm (64% Σ Ar^{40}); collected by: A. H. Sorensen, Hecla Mining Co.; dated by: Isotopes Inc. for Hecla Mining Co.

7. Kerr and Kulp, 1952 U-Pb (pitchblende) >1190 m.y.
Eckelmann and Kulp, 1957 recalculated by Eckelmann and Kulp, 1957
Pb^{207}/Pb^{206} 1190 m.y.
Pb^{206}/U^{238} 700 m.y.
Pb^{207}/U^{235} 830 m.y.
Pitchblende (47°30′N, 116°03′50″W; NW¼sec. 22, T. 48 N., R. 3 E.; Shoshone Co., ID) Sunshine Mine, Coeur D′Alene District, No. 16 stope in footwall of Sunshine vein, W of Jewell crosscut and above 3100′ level. Analytical data: 26.9% U, 4.0% Pb; Pb^{204}, Pb^{206}, Pb^{207}, Pb^{208} = 0.540, 69.20, 12.42, 17.84; common Pb = 1.428, 24.05, 21.99, 52.53; collected by: R. H. Robinson, Sunshine Mine chief geologist; dated by: Clara G. Goldbeck, U.S.A.E.C. and Roger Hibbs, Union Carbide, Oak Ridge.

8. Eckelmann and Kulp, 1957 U-Pb (pitchblende) 1100-1200 m.y.
Pb^{207}/Pb^{206} 1035 m.y.
Pb^{206}/U^{238} 805 m.y.
Pb^{207}/U^{235} 860 m.y.
K-101 Pitchblende (47°30′N, 116°03′50″W; sec. 22, T. 48 N., R. 3 E.; Shoshone Co., ID) Sunshine Mine, Coeur D′Alene District. Analytical data: 3.32% U, 0.015% Th, 0.535% Pb; Pb^{204}, Pb^{206}, Pb^{207}, Pb^{208} = 0.361, 76.70, 10.73, 12.21; common Pb = 1.428, 24.05, 21.99, 52.53; dated by: Eckelmann and Kulp, Columbia U.

9. Hietanen, 1961 U-Pb (uraninite) 1200 or 1250 m.y.
Hobbs and others, 1965
(Approximately 47°30′N, 116°W; Shoshone Co., ID) Fracture related to Osborne fault, Coeur d′Alene district. J. E. Harrison (oral communication, 1974) suggests that this date is quite inaccurate due to large uncertainties in the common Pb correction. Analytical data: not available; dated by: L. R. Steiff and T. W. Stern, U.S.G.S.

10. Reid and others, 1973 U-Pb (zircon) ~940 m.y.
Pb^{207}/Pb^{206} = 846 m.y.
Pb^{206}/U^{238} = 964 m.y.
Pb^{207}/U^{235} = 929 m.y.
120 Pelitic gneiss, Prichard Formation (48°43′N, 116°25′W; Boundary Co., ID) W of Purcell Trench, Jct West Side Road and Myrtle Creek Road, north of Moravia. D. T. Bishop study area. Very nearly concordant. Authors believe date is evidence of East Kootenay orogeny. Analytical data: 388.2 ppm U, 70.9 ppm Pb; Pb^{204}, Pb^{206}, Pb^{207}, Pb^{208} = 0.23, 78.88, 8.58, 12.31%; assumed 1500 m.y. common Pb = 1.46, 23.73, 22.65, 52.17%; collected by: R. R. Reid, U. of Idaho; dated by: Isotopes Inc.

11. Reid and others, 1973 U-Pb (zircon) ~1500 m.y.
Pb^{207}/Pb^{206} = 1490 m.y.
Pb^{206}/U^{238} = 1472 m.y.
Pb^{207}/U^{235} = 1478 m.y.
119 Argillite, Prichard Formation (48°45′N, 116°10′W; Boundary Co., ID) Selkirk Mountains, E of Purcell Trench. D. T. Bishop study area. Concordant, may indicate provenance of Belt sediments. Analytical data:

11. (continued)
607.5 ppm U, 174.1 ppm Pb; Pb^{204}, Pb^{206}, Pb^{207}, Pb^{208} = 0.15, 78.37, 9.31, 12.32%; assumed 1500 m.y. common Pb = 1.46, 23.73, 22.65, 52.17%; collected by: R. R. Reid, U. of Idaho; dated by: Isotopes Inc.

12. Fleck, Faure and others — Rb-Sr ($\lambda = 1.39$) — (whole rock isochron for all except 68-9-13A) 880±150 m.y.
Written communications (1971, 1974) — Initial Sr^{87}/Sr^{86} = 0.720±.010
Wallace Formation near Wallace, and Prichard Formation, near Coeur d'Alene Lake.

Specimen	N Latitude	W Longitude	County	State
1 68-9-13A	47°29′	115°52′	Shoshone	ID
2 68-9-13B	47°29′	115°52′	Shoshone	ID
3 68-9-13C	47°29′	115°52′	Shoshone	ID
4 68-9-13D	47°29′	115°52′	Shoshone	ID
5 69-7-5D	47°20′	115°55′	Shoshone	ID
6 68-9-12D	47°29′	116°39′	Kootenai	ID

Analytical data:	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}
1	62.76	1.1487±.0015
2	16.98	0.9122±.0024
3	26.09	1.0688±.0008
4	28.27	1.0213±.0083
5	4.91	0.7864±.0015
6	8.93	0.8138±.0003

Isochron date less than for fresh Belt sediments due to open system behavior during regional metamorphism. Sample localities not plotted on figure; collected and dated by: R. Fleck, G. Faure, E. Stump and others, Ohio State U.

DETRITAL ZIRCONS IN PALEOZOIC SEDIMENTS

These dates are crude indicators of the age of source regions for the several quartzites studied.

1. R. E. Zartman — Pb-α — (zircon) 2120±240 m.y.
written communication, 1974
1676 Detrital zircon from quartzite (approximately 44°04′N, 113°05′W; Butte Co., ID) Kinnikinic Quartzite, South Lemhi Range. Reflects provenance of clastic sediment. Analytical data: 71 ppm Pb, 67 α/mg/hr; collected by: Keith Ketner; dated by: T. W. Stern and H. Westley.

2. R. E. Zartman — Pb-α — (zircon) 1950±220 m.y.
written communication, 1974
1677 Detrital zircon from quartzite (42°37′N, 112°01′W; T. 9 S., R. 38 E.; Bannock Co., ID) Swan Peak Quartzite, Lava Hot Springs. Reflects provenance of clastic sediment. Analytical data: 63.5 ppm Pb, 67 α/mg/hr; collected by: Keith Ketner; dated by: T. W. Stern and H. Westley.

3. R. E. Zartman — Pb-α — (zircon) 1580±180 m.y.
written communication, 1974
1W1 Detrital zircon from quartzite (47°23′N, 116°03′W; sec. 26, T. 47 N., R. 3 E.; Shoshone Co., ID) Big Creek, SE of Kellogg. From middle quartzite member of Revett Formation, Belt Supergroup. Probably reflects provenance of clastic sediment, not its age or metamorphism. Analytical data: 163 ppm Pb, 219 α/mg/hr; collected by: Paul Weis; dated by: T. W. Stern and H. Westley.

PRECAMBRIAN – PRE-BELT BASEMENT IN CENTRAL AND NORTHERN IDAHO

The Salmon River arch, underlain by rocks at least 1,500 m.y. old, is described and discussed by Armstrong (1975), and the areas where these older rocks are definitely or possibly exposed are shown in figure 5. There is a need for much more field and isotopic work on these rocks, whose extent was unappreciated until quite recently.

1. Salmon River Precambrian Granitic Rocks — Rb-Sr ($\lambda = 1.43$) — (whole rock isochron) ~1500 m.y.
Armstrong, 1975 — Assumed Initial $Sr^{87}/Sr^{86} = 0.703$

Specimen	N Latitude	W Longitude	County	State
1 YU-1039 Adamellite	45°23′45″	114°10′55″	Lemhi	ID
2 YU-1038 Adamellite	45°13′35″	114°19′00″	Lemhi	ID
3 YU-1037 Granodiorite	45°08′30″	114°12′25″	Lemhi	ID
4 YU-1036 Adamellite	45°08′35″	114°12′00″	Lemhi	ID

Analytical data:	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
1	246	131	1.88	0.82108
2	296	99	2.98	0.88519
3	246	124	1.98	0.81628
4	239	115	2.09	0.81890

Collected and dated by: R. L. Armstrong, Yale U.

2. YU-1039 — K-Ar — (biotite) 241±7 m.y.
Armstrong, 1975 — Rb-Sr ($\lambda = 1.43$) — (whole rock–biotitic isochron) 107±11 m.y.
Medium-to coarse-grained, seriate massive biotite adamellite with larger (1 to 2 cm) subhedral K feldspar grains (45°23′45″N, 114°10′55″W; Lemhi Co., ID) near Indianola Ranger Station on Salmon River. Analytical data: Biotite: K = 7.31, 7.35%; $*Ar^{40} = 75.1 \times 10^{-6}$ cc/gm (92% ΣAr^{40}) Whole rock: 246 ppm Rb, 131 ppm Sr, Rb/Sr = 1.88, $Sr^{87}/Sr^{86} = 0.82108$, Biotite: 1057 ppm Rb, 7 ppm Sr, Rb/Sr = 151, $Sr^{87}/Sr^{86} = 1.480$; collected and dated by: R. L. Armstrong, Yale U.

3. YU-1038 — K-Ar — (biotite) 108±3 m.y.
Armstrong, 1975 — Rb-Sr ($\lambda = 1.43$) — (whole rock–biotite isochron) 103±10 m.y.
Gneissic medium-to coarse-grained biotite adamellite with very large (3 x 5 cm) K feldspar augen (45°13′35″ N, 114°19′00″W; Lemhi Co., ID) Panther Creek. Analytical data: Biotite: K = 7.33, 7.32%; $*Ar^{40} = 32.7 \times 10^{-6}$ cc/gm (83% ΣAr^{40}) Whole rock: 296 ppm Rb, 99 ppm Sr, Rb/Sr = 2.98, $Sr^{87}/Sr^{86} = 0.88519$, Biotite: 1280 ppm Rb, 6 ppm Sr, Rb/Sr = 215, $Sr^{87}/Sr^{86} = 1.793$; collected and dated by: R. L. Armstrong, Yale U.

4. YU-1036 — K-Ar — (biotite) 542±16 m.y.
Armstrong, 1975 — Rb-Sr ($\lambda = 1.43$) — (whole rock–biotite isochron) 103±10 m.y.
Massive medium-grained adamellite porphyry with K feldspar porphyroblasts 1 to 2 cm in diameter in a biotite granodiorite matrix (45°08′35″N, 114°12′00″W; SE¼sec. 15, T. 21 N., R. 19 E.; Lemhi Co., ID) Napias Creek Road. Analytical data: Biotite: K = 7.06, 6.94%; $*Ar^{40} = 175.6 \times 10^{-6}$ cc/gm (98% ΣAr^{40}) Whole rock: 239 ppm Rb, 115 ppm Sr, Rb/Sr = 2.09, $Sr^{87}/Sr^{86} = 0.81890$, Biotite: 918 ppm Rb, 12 ppm Sr, Rb/Sr = 76.5, $Sr^{87}/Sr^{86} = 1.135$; collected and dated by: R. L. Armstrong, Yale U.

5. YU-1037 — K-Ar — (biotite) 562±17 m.y.
Armstrong, 1975 — Rb-Sr ($\lambda = 1.43$) — (whole rock–biotite isochron) 115±12 m.y.
Faintly gneissic fine- to medium-grained biotite granodiorite with K feldspar porphyroblasts 1 to 2 cm in diameter (45°08′30″N, 114°12′25″W; SE¼sec. 15, T. 21 N., R. 19 E.; Lemhi Co., ID) Napias Creek Road. Analytical data: Biotite: K = 7.57, 7.53%; $*Ar^{40} = 197.5 \times 10^{-6}$ cc/gm (98% ΣAr^{40}) Whole rock: 246 ppm Rb, 124 ppm Sr, Rb/Sr = 1.98, $Sr^{87}/Sr^{86} = 0.81628$, Biotite: 988 ppm Rb, 6 ppm Sr, Rb/Sr = 159, $Sr^{87}/Sr^{86} = 1.565$; collected and dated by: R. L. Armstrong, Yale U.

6. Jaffe and others, 1959 — Pb-α — (zircon) 737±75 m.y.
(zircon) 674±70 m.y.
(zircon) 908±90 m.y.
55-ID-60, 55-ID-52 Granitic gneiss and 55-ID-55 Granulite (45°25′N, 114°10′W; Lemhi Co., ID) Mineral Hill district. Analytical data: 69.5, 71, 28.5 ppm Pb; 220, 247, 72 α/mg/hr; collected by: E. P. Kaiser, U.S.G.S.; dated by: Jaffe and others, U.S.G.S.

7. Reid, Greenwood, and Morrison, 1970 — U-Pb — (zircon) ~1500 m.y.
Reid and others, 1973 — (data calculated with two different common Pb corrections)
Pb^{207}/Pb^{206} 1525±83 m.y.
Pb^{206}/U^{238} 1378±3 m.y.
Pb^{207}/U^{235} 1436±32 m.y.
Pb^{207}/Pb^{206} = 1442 m.y.
Pb^{206}/U^{238} = 1378 m.y.
Pb^{207}/U^{235} = 1404 m.y.

140 Augen gneiss (45°49′10″N, 115°27′30″W; SW¼sec. 27, T. 29 N., R. 8 E.; Idaho Co., ID) near Elk City. Nearly concordant. The two published versions of this date differ, apparently due to the use of different assumed common Pb compositions. Analytical data: 785.7 ppm U, 271.5 ppm Pb; Pb^{204}, Pb^{206}, Pb^{207}, Pb^{208} = 0.466, 66.219, 12.487, 20.828; assumed 1500 m.y. common Pb = 1.485, 23.764, 22.278, 52.473 and 1.46, 23.73, 22.65, 52.17; collected by: R. R. Reid, U. of Idaho; dated by: Isotopes Inc.

8. Clark, 1973 — U-Pb — (zircon) ~1500 m.y.
Pb^{207}/Pb^{206} 1448 m.y.
Pb^{206}/U^{238} 1150 m.y.
Pb^{207}/U^{238} 1257 m.y.

130 Orthogneiss (48°05′N, 116°55′W; Bonner Co., ID) Priest River area. Moderately discordant, probably dates metamorphism of pre-Belt basement rocks. Analytical data: 508.9 ppm U, 113.8 ppm Pb; Pb^{204}, Pb^{206}, Pb^{207}, Pb^{208} = 0.0958, 75.8884, 8.1915, 15.8243; assumed 1500 m.y. common Pb = 1.46, 23.73, 22.65, 52.17; collected by: S. H. B. Clark, U. of Idaho; dated by: Isotopes Inc.

9. Reid and others, 1973 — U-Pb — (zircon) >100, <1500 m.y.
Pb^{207}/Pb^{206} 1350 m.y.
Pb^{206}/U^{238} 800 m.y.
Pb^{207}/U^{235} 960 m.y.

118 Gneiss (45°49′30″N, 115°34′W; E edge sec. 27, T. 29 N., R. 7 E.; Idaho Co., ID) Idaho Highway 14 to Elk City. Very discordant – probably mixed Mesozoic and Precambrian zircon components, but still indicates minimum age of 1350 for orthogneiss near Elk City. Analytical data: 695.5 ppm U, 97.4 ppm Pb; Pb^{204}, Pb^{206}, Pb^{207}, Pb^{208} = 0.14, 82.63, 9.04, 8.20; assumed 1500 m.y. common Pb = 1.46, 23.73, 22.65, 52.17; collected by: R. R. Reid, U. of Idaho; dated by: Isotopes Inc.

10. Reid and others, 1973 — U-Pb — (zircon) >100, <1850 m.y.
Pb^{206}/Pb^{207} 1803 m.y.
Pb^{206}/U^{238} 1096 m.y.
Pb^{207}/U^{235} 1360 m.y.

111 Canyon Creek orthogneiss (46°12′37″N, 115°32′20″W; NE¼sec. 12, T. 42 N., R. 6 E.; Shoshone Co., ID) confluence of Little N Fork of Clearwater River and Canyon Creek at W end of Sureyors Ridge. Very discordant, may be slice of pre-Belt basement gneiss. Analytical data: 1469 ppm U, 263 ppm Pb; Pb^{204}, Pb^{206}, Pb^{207}, Pb^{208} = 0.16, 88.22, 9.56, 2.06; assumed 1500 m.y. common Pb = 1.46, 23.73, 22.65, 52.17; collected by: R. R. Reid, U. of Idaho; dated by: Isotopes Inc.

11. Reid and others, 1973 — U-Pb — (zircon) ~1700 m.y.
Pb^{206}/Pb^{207} 1625 m.y.
Pb^{206}/U^{238} 1366 m.y.
Pb^{207}/U^{235} 1605 m.y.

110 Boehl's Butte Anorthosite (46°59′15″N, 115°50′35″W; NW¼sec. 16, T. 42 N., R. 5 E.; Shoshone Co., ID) E of Elk River on Goat Mtn., 0.5 mi S of Goat Mtn., lookout where road crosses talus. Slightly discordant. Probably age of pre-Belt basement: Analytical data: 179.9 ppm U, 64.17 ppm Pb; Pb^{204}, Pb^{206}, Pb^{207}, Pb^{208} = 0.45, 63.64, 12.54, 23.38; assumed 1500 m.y. common Pb = 1.46, 23.73, 22.65, 52.17; collected by: R. R. Reid, U. of Idaho; dated by: Isotopes Inc.

12. Reid and others, 1973 U-Pb (zircon) ~1700 m.y.
Pb^{206}/Pb^{207} 1665 m.y.
Pb^{206}/U^{238} 1404 m.y.
Pb^{207}/U^{235} 1530 m.y.

117 Boehl's Butte Formation pelitic schist (47°N, 115°50'W; Clearwater Co., ID) E of Elk River on Goat Mt. where N Fork O'Donnell Creek is crossed by Tinker Creek road. Slightly discordant. Probably date of pre-Belt basement. Analytical data: 273.5 ppm U, 79.4 ppm Pb; Pb^{204}, Pb^{206}, Pb^{207}, Pb^{208} = 0.20, 74.16, 10.24, 15.40; assumed 1500 m.y. common Pb = 1.46, 23.73, 22.65, 52.17; collected by: R. R. Reid, U. of Idaho; dated by: Isotopes Inc.

RAMEY RIDGE COMPLEX AND BEAVERHEAD PLUTON

In central Idaho Leonard (1963) recognized a pre-Idaho batholith syenite complex that produced a surprisingly old Pb-α date (L53/377) which was later confirmed by an isotopic U-Pb zircon date (L-64-1343 B) indicating a very late Precambrian age.

Ramspott and Scholten (1965) and Scholten and Ramspott (1968) described granitic rocks in the Beaverhead Range along the Montana-Idaho border that yielded an Ordovician K-Ar date. Similar granitic rocks exposed in another area to the northwest in the same range gave very similar Rb-Sr dates, thus reinforcing the opinion that these rocks were Paleozoic. A large granite pluton at that time and place would be most exceptional. In Armstrong (1975) reasons are given for suspecting that the rocks in both areas are older Precambrian basement which has been mildly metamorphosed, retrograded, and altered during the Mesozoic, yielding, by coincidence, near concordant but meaningless K-Ar and Rb-Sr dates. The problem cannot be considered settled until further isotopic work is done on the rocks.

1. Leonard and Stern, 1966 U, Th-Pb (zircon) ~725 m.y.
B. F. Leonard and T. W. Stern, written communications, 1973
Pb^{207}/Pb^{206} 680 m.y.
Pb^{206}/U^{238} 574 m.y.
Pb^{207}/U^{235} 596 m.y.
Pb^{208}/Th^{232} 538 m.y.

L-64-1343 B Syenite of the Ramey Ridge Complex (45°14.4'N, 115°17.1'W; Idaho Co., ID) talus 2000' NE along Hand Creek trail from Joe Creek, NE 9th, Big Creek 15' quad. Analytical data: 348.3 ppm Th, 342.6 ppm U, 35.6 ppm Pb; Pb^{204}, Pb^{206}, Pb^{207}, Pb^{208} = .082, 62.36, 5.05, 32.51; common Pb = 1.397, 25.13, 21.34, 52.18; collected by: B. F. Leonard, U. S. G. S.; dated by: T. W. Stern, U. S. G. S.

2. Larsen and others, 1958 Pb-α (zircon—original) 460 m.y. (Larsen) 479 m.y. (Jaffe)
Jaffe and others, 1959 (zircon—redetermined) 520±60 m.y.
B. F. Leonard, written communication, 1973

L53/377 Biotite microantiperthite syenite of the Ramey Ridge Complex (45°12.4'N, 115°16.3'W; Idaho Co., ID) Elevation 7450 on prominent SE-trending nose, 0.45 mi SW of Mahan cabin, NE 9th Big Creek 15' quad. Analytical data: 31 ppm Pb, 158 α/mg/hr; 36 ppm Pb, 167 α/mg/hr; collected by: B. F. Leonard, U. S. G. S.; dated by: H. W. Jaffe, U. S. G. S. Redetermination 12/13/61 by T. W. Stern, U. S. G. S.

3. Ramspott and Scholten, 1965 K-Ar (biotite) 441±15 m.y.
L. D. Ramspott, written communication, 1974

Porphyritic biotite microsyenite dike of Beaverhead pluton (44°24'30"N, 113°01'30"W; NW¼sec. 5, T. 12 N., R. 29 E.; Lemhi Co., ID) near Willow Creek, Nicholia Quad. Geologically postdates a quartzite called Kinnikinic, an orthoquartzite that unconformably overlies a thick section of older quartzites and which is itself disconformably overlain by the Jefferson Formation. Analytical data: K = 6.32, 6.50%; $^{*}Ar^{40}$ = 0.230, 0.226 ppm (91, 92% Σ Ar^{40}); collected by: L. D. Ramspott, Penn. State U.; dated by: Geochron Labs. Inc.

4. Ruppel, 1968 Rb-Sr (λ = 1.42) (K feldspar) 432±60 m.y.
(whole rock) 423±40 m.y.

347 Porphyritic granite (44°43'N, 113°16'05"W; NW¼sec. 17, T. 16 N., R. 27 E.; Lemhi Co., ID) Railroad

4. (continued)
Canyon, Beaverhead Range, east of Leadore.

Analytical data:	ppm Rb	ppm Sr	Sr^{87}/Sr^{86}
1	245.4	29.26	.855
2	150.9	22.41	.823

(recalculated assuming common Sr^{87}/Sr^{86} = .705); collected by: E. Ruppel, U. S. G. S.; dated by: C. E. Hedge and F. G. Walthall, U. S. G. S.

ALBION RANGE

The gneiss domes of the Albion Range (Armstrong, 1968, 1970b, work in progress) are cored by Precambrian basement – granitic and metamorphic rocks of the Green Creek Complex – and mantled by metamorphosed Paleozoic sediments that are disrupted by numerous low angle faults, folded on a variety of scales and injected by granitic rocks. The later granitic rocks range from concordant pre- to synkinematic strongly-deformed mylonitic flaser gneisses to completely undeformed cross-cutting stocks and pegmatite dikes. K-Ar and Rb-Sr dating were extensively applied to try to unravel details of the complex and unique history of this area. The samples analyzed come from the localities plotted on figure 8. The results listed here differ in various minor ways from the data in Armstrong and Hills (1967) due to additional analyses, revision of calibrations, changes in calculation procedure and availability of better base maps for sample location coordinates. Thus, the data in this compilation supercede the previously published results.

The Green Creek Complex was first dated by Armstrong and Hills (1967) as 2.46 b.y. old. Lead isotope data reported by Small (1968) and Small and Slawson (1969) suggested an age closer to 2.7 b.y. This is the only locality in Idaho where rocks this old have been definitely confirmed. Additional samples of flaser gneiss lie close to the isochron previously reported but the scatter is real (figure 9) and probably due to open system behavior during Mesozoic–Cenozoic time. This is demonstrated by the large deviation of hornblende-biotite- and biotite-schist samples from the gneiss isochron (figure 9). These thin mafic layers have exchanged Sr with, or lost radiogenic Sr to, enclosing gneisses during Mesozoic–Cenozoic metamorphism. The explanation cannot be so simple for 3 samples from a large amphibolite (YU-833). The samples represent rim, core, and an intermediate position in a 4m thick pod of amphibolite in the area least affected by Mesozoic–Cenozoic metamorphism. Overlying Paleozoic sediments are in the lower greenschist facies. Sr in the pod is remarkably uniform (~0.733), from core to rim, and although it is less radiogenic than Sr in enclosing rocks (samples 798 and 799 with Sr^{87}/Sr^{86} ~0.87), it lies well above the Green Creek isochron. A notable gradient in Ar content exists, the interior of the pod being 3 times richer in radiogenic Ar than the rim. An explanation for these observations requires another metamorphic episode intermediate between the original crystallization of the gneisses and the Phanerozoic. Assuming that total Sr homogenization occurred between amphibolite pod and country rock during this cryptic episode and that the analyses are representative of the rocks in the area a date of slightly over 2 b.y. is obtained for this previously unknown event. Thus we are able to resolve 3 distinct episodes in the history of the Green Creek Complex – original emplacement of granites into sedimentary rocks (now schist and gneiss) at 2.45 to 2.7 b.y., intrusion of mafic dikes, then high-grade metamorphism, dismemberment of the dikes and conversion to amphibolite pods enclosed in schist and flaser gneiss about 2 b.y. ago, and finally low-grade metamorphism within the last 100 m.y.

On the mineral scale everything except minerals within the large amphibolite pods was reset during the last metamorphism and there is widespread evidence of excess Ar within the Precambrian rocks. K-Ar dates for micas range from 22.9 to 130 m.y. in contrast with Rb-Sr dates ranging from 6 to 22 m.y. Two excellent and exceptionally young mineral isochrons are shown in figure 10. The young Rb-Sr dates were a surprise but have been confirmed on several samples. In Armstrong and Hills (1967) the Ar dates, which were older than Ar dates for minerals in immediately overlying metamorphosed Paleozoic rocks, were attributed to difference in water pressure between Paleozoic sediments and Precambrian crystalline rocks. Excess Ar was thought to be of minor importance. The Sr isochrons force a reversal of this opinion. The minerals remained open systems in these rocks until quite recently – some of the dates are close to the age of volcanic rocks that lap up onto the Albion Range and prove that little erosive downcutting has occurred since 8.5 m.y. ago. The mineral-scale Sr isotope exchange dates are so young as to be somewhat of a mystery. Several are younger by half than the Rb-Sr and K-Ar mineral dates for

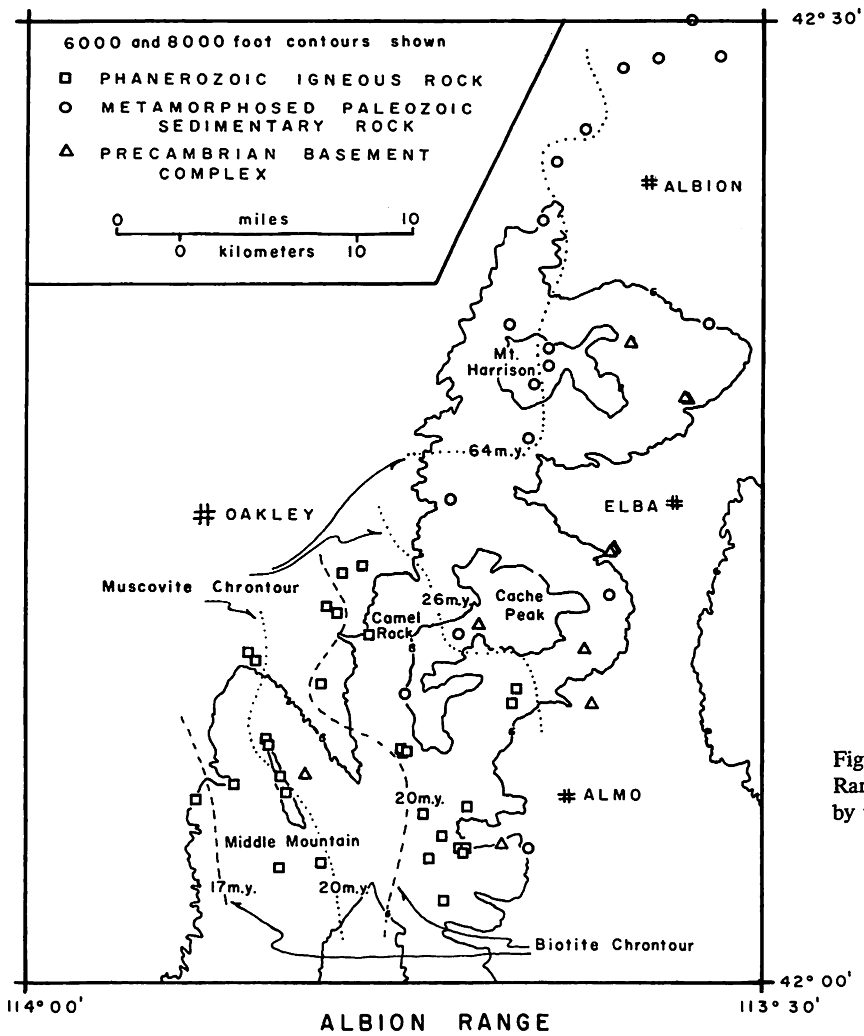

Figure 8. Sample locality map for the Albion Range. Distribution of mica K-Ar dates is indicated by the chrontours.

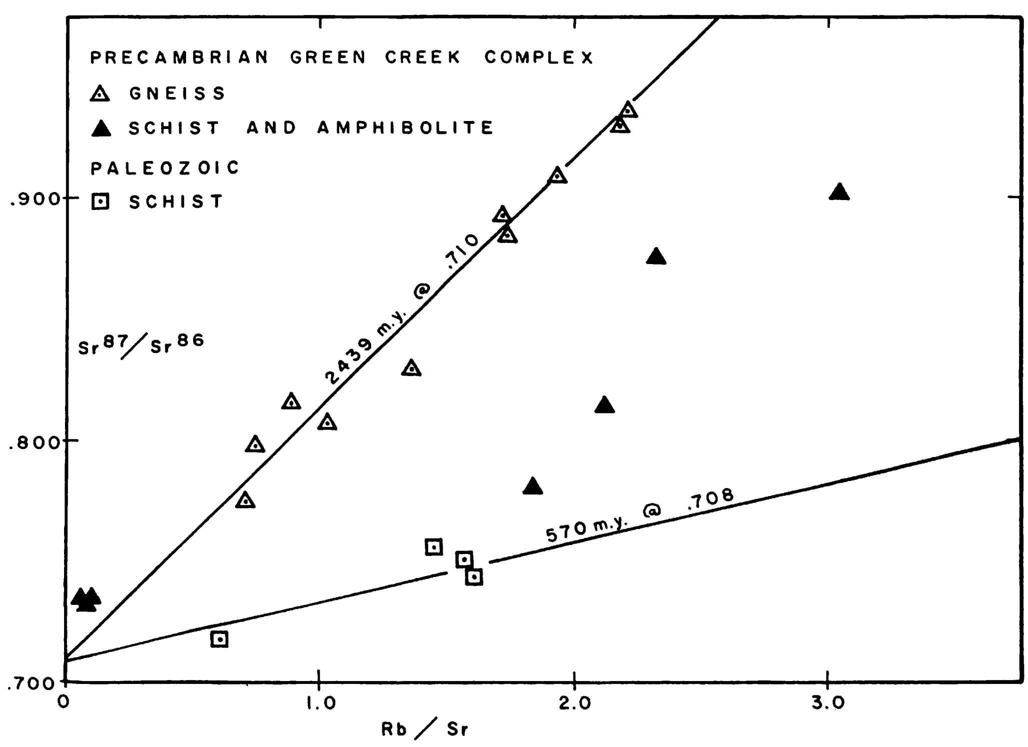

Figure 9. Isochrons for Green Creek Complex and Paleozoic Schists of the Albion Range.

late intrusive granites which occur at comparable structural levels today at ground distances of only a few kilometers from the dated sample localities. If the Sr dates are accepted as indicating open mineral systems the Ar dates for the Precambrian rocks must all be artifacts due to variable amounts of ambient Ar trapped in the recrystallizing minerals.

The Paleozoic Schists yield a Rb-Sr whole rock isochron date consistent with a lower Paleozoic age (Armstrong and Hills, 1967, with one new data point added; figure 9). K-Ar dates, many new, range from several in the 70 to 81 m.y. range for coarse schist and fine-grained phyllite that occur in interlayered tectonic units that are structurally high and far from younger igneous rocks to 25 to 30 m.y. in the first thick schist above the Precambrian–Paleozoic unconformity. Excess Ar is less likely in the setting from which these samples come. Consequently the older dates are taken to be evidence of considerable, if not most, metamorphism occurring before 70 m.y. ago. The youngest fold generation is well developed in rocks yielding the older dates. A hornblende date of 162 m.y. may hint at a metamorphic culmination in Middle Jurassic time or be another artifact for which excess Ar must be blamed. There is no evidence available to choose between these possibilities.

The Middle Mountain injection complex is the westernmost, highest grade, and most deformed group of granitic rocks in the Albion Range. The fine- to medium-grained granitic rocks range from gneiss to mylonite. These form large masses and smaller sheets and pods intrusive into sillimanite-grade Paleozoic sediments. Both gneiss and metasediment are cut by pegmatitic dikes and irregular bodies that show various degrees of deformation. A whole-rock isochron (figure 11) gives an anomalous date of 404 m.y. with a fairly large scatter of individual points and a reasonably low initial ratio. In the surrounding region there is no stratigraphic evidence of any tectonic event at this time (near the beginning of the Devonian). Stratigraphic evidence that is available nearby suggests more or less continuous sedimentation from latest Precambrian through Triassic time. This would restrict plutonic events to Mesozoic–Cenozoic time and this is in apparent conflict with the isochron date. The most reasonable solution to this problem is to suggest that the granitic rocks are the result of digestion and replacement of Paleozoic sediments by Mesozoic magma that was fairly low in Sr and had a low Sr^{87}/Sr^{86} ratio (~.704). The resulting granitic rocks thus acquired much of the isotopic character of their host rocks and violated the assumption on which the isochron date was calculated – namely a constant initial Sr^{87}/Sr^{86} ratio for all phases and subsystems in the rock unit at the time of formation. The intimate mixture of granite and metasediment observed in mapping Middle Mountain makes such a suggestion plausible.

A similar explanation may exist for the anomalously old isochron reported by Kistler and Willden (1968, 1969) for the Ruby Mountains. R. E. Zartman (oral communication, 1974) has likewise observed similar isotopic relationships in the Raft River–Grouse Creek area which is a continuation of the Albion Range rocks southward into Utah. Such anomalous isochrons may occur elsewhere but they have seldom been recognized and often would not be, where stratigraphic control was lacking. Jager and Zwart (1968) describe deformed granitic rocks which gave an isochron older than expected in the Pyrenees. They accepted the date and reinterpreted the geology. It is tempting to speculate that they are dealing with another example of an anomalous isochron – a mixing line or what might be called an "assimilochron."

Whole rock model Rb-Sr dates calculated for pegmatites on Middle Mountain range from 335 down to 60 m.y. The large enrichment in Rb makes the youngest date a maximum age independent of any necessary assumptions. The sweating out or large-scale isotopic equilibration involved in the genesis of that pegmatite cannot be older than 60 m.y. ago.

Mineral dates in the Middle Mountain injection complex vary in a simple and systematic manner (figure 8). There is a consistent decrease in K-Ar date towards the WSW-biotite going from 20.6 to 16 m.y. The muscovite and biotite K-Ar dates are only slightly different, implying rapid cooling and consequent system closure in rapid succession. The coarse pegmatitic muscovite is at most 1 to 2 m.y. older than nearby biotite. Mineral isochrons including biotites (figure 12) for the gneisses are concordant with the K-Ar dates for the same rocks. There is a suggestion for sample 949 that the biotite has been reset some time after closure of plagioclase and K-feldspar, an expectable observation. Coarse minerals from pegmatites give somewhat older and more scattered Rb-Sr dates (23 to 34 m.y.). Again this is an observation consistent with experience (Wetherill and others, 1966). These coarse muscovite Rb-Sr dates were surprisingly young as the chronometer is usually quite robust. Evidently high-grade metamorphic conditions existed in these rocks until mid-Cenozoic time – much later than anywhere else in Idaho. All areas north of the Snake River Plain were cool and stable by about 38 m.y. ago.

The Gneiss of Camel Rock is similar to the Middle Mountain complex in many respects but it is geographically separate, and it lies on the fringes of the high-grade metamorphic area where pegmatite bodies are much scarcer.

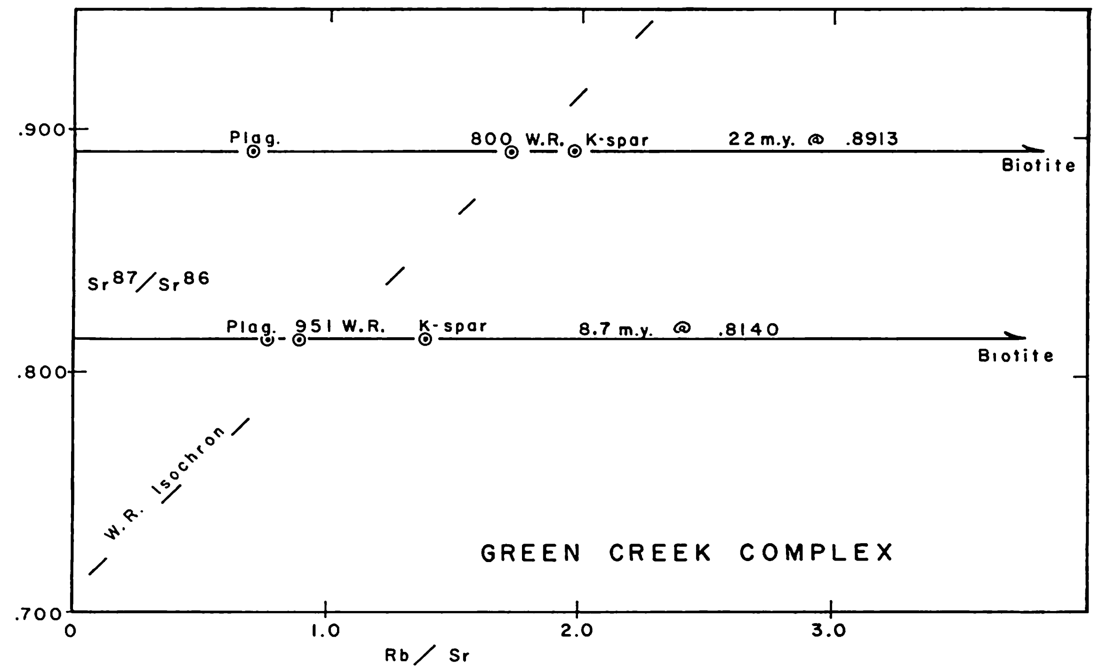

Figure 10. Mineral isochrons for the Green Creek Complex.

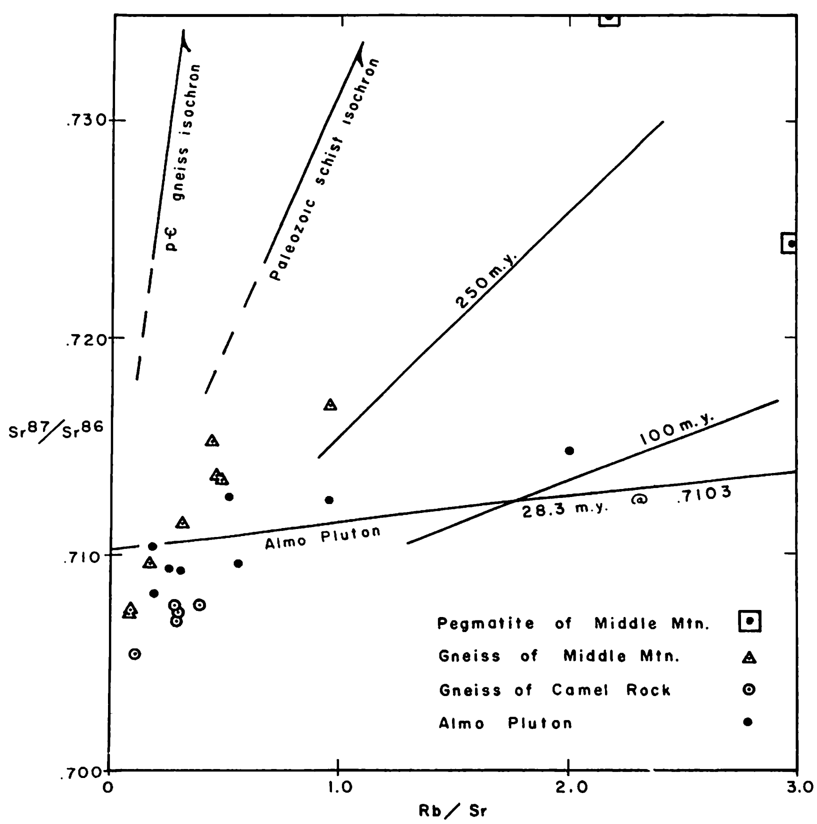

Figure 11. Sr isotope data for Middle Mountain injection complex, Camel Rock Gneiss and Almo Pluton. Several reference isochrons are shown, only the Almo Pluton isochron is fit to some of data shown on the figure.

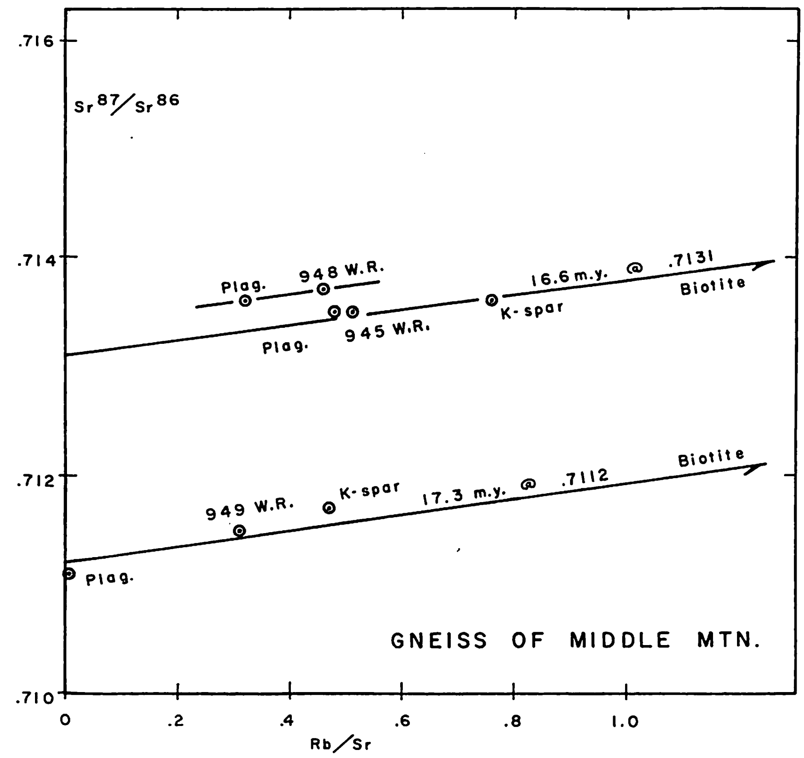

Figure 12. Mineral isochrons for gneisses of Middle Mountain.

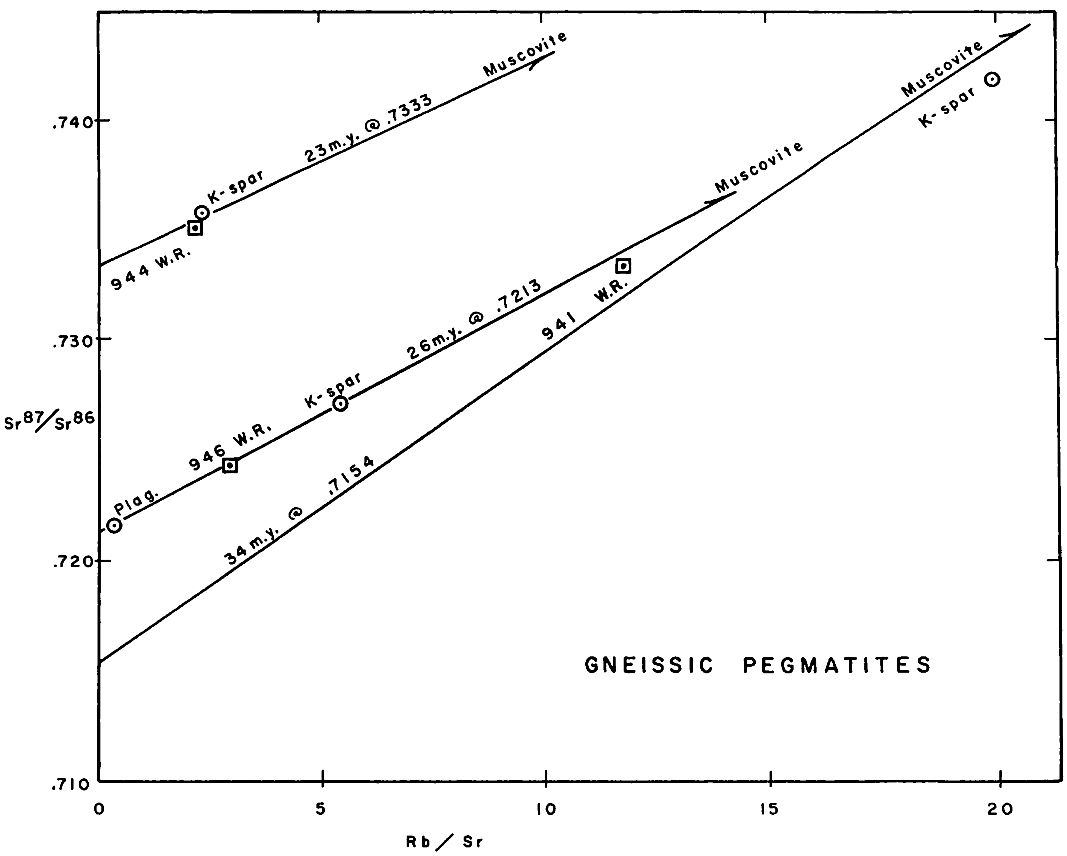

Figure 13. Mineral isochrons for deformed pegmatites of Middle Mountain.

The whole-rock isochron-data cluster (figure 14) is shorter, more scattered, younger, and has a lower initial ratio. It is probable that the isochron date of 230 m.y. is, like that for Middle Mountain, meaningless because of country rock assimilation. Mineral K-Ar dates are slightly older than on Middle Mountain – 18.7 to 20.9 m.y. for biotite and 21.5 to 28.6 m.y. for muscovite, continuing a trend already observed. Mineral isochrons contain a surprise. The Rb-Sr biotite dates are about 3 m.y. older than the K-Ar biotite dates but the Muscovite Rb-Sr dates are much older – 67 and 80 m.y. Once again we find vestiges of a Mesozoic, pre-Campanian, high-grade metamorphic-plutonic process. Here, on the fringes of the high-grade metamorphic area the later heating has been sufficient to completely reset the biotite, and to remove most of the Ar from the muscovite, but not to re-equilibrate Sr in the muscovite with its surroundings.

The Almo Pluton was dated 30 m.y. by Armstrong and Hills, 1967. It is a discordant granitic stock, unfoliated except along the western edge of a western satellite exposure. The inclusion of much new and more precise data has refined this date to 28.3 m.y., but there is significant scatter in the points (figures 11 and 15). Assimilation of country rock (mostly Green Creek gneisses) has somewhat scattered the points near the origin but the extreme Rb enrichment of some adamellite samples fixes the age of the pluton. This age is unique in Idaho, falling between the Challis and Columbia-Snake River episodes but it is similar to epizonal pluton K-Ar dates farther south in Utah and Nevada (Armstrong, 1970a). Biotite K-Ar dates for the Almo Pluton range from 20.1 to 22.7 m.y., fine grained muscovite from 23.3 to 24.5 m.y., and coarse, pegmatitic, muscovite from 24.0 to 25.2 m.y. K-feldspar from pegmatites gave K-Ar dates from 24.6 to 31.9 m.y. and this was unexpected. I cannot explain why the feldspar should have even more Ar than the muscovite unless it has trapped excess Ar, and this has not previously been reported. Medium-grained biotite and muscovite yielded Rb-Sr dates concordant with K-Ar dates on the same samples. Pegmatitic muscovite gave a Rb-Sr date of 28 m.y. All these data are consistent with the gradual cooling over a period of several m.y. of a pluton emplaced slightly before 28 m.y. The order of system closure observed was whole-rock, pegmatitic muscovite Rb-Sr = K-feldspar K-Ar, coarse muscovite K-Ar, finer muscovite K-Ar, biotite K-Ar = biotite Rb-Sr. Except for the K-feldspar K-Ar dates, this is a neat confirmation of the systematics observed in other intensely studied areas (Aldrich and others, 1965; Hanson and Gast, 1967; Hart and others, 1968).

GREEN CREEK COMPLEX

1. Green Creek Complex — Rb-Sr ($\lambda = 1.42$) (W.R. isochron–4 Augen Gneisses) 2550±72 m.y.
Initial Sr^{87}/Sr^{86} 0.7057±0.0029 m.y.

Specimen	N Latitude	W Longitude	County	State
1 C63C Flaser-Augen Gneiss	42°08′35″	113°37′00″	Cassia	ID
2 C63D Biotite-hornblende Schist, 5′ thick	42°08′35″	113 37 00	Cassia	ID
3 C63E Flaser-Augen Gneiss	42°08′35″	113°37′00″	Cassia	ID
4 C64A Flaser Schist-Gneiss	42°10′20″	113°37′15″	Cassia	ID
5 C64B Biotite-hornblende Schist, 42′ thick	42°10′20″	113°37′15″	Cassia	ID
6 C64C Flaser-Augen Gneiss	42°10′20″	113°37′15″	Cassia	ID
7 C66A Flaser-Augen Gneiss	42°04′20″	113°40′30″	Cassia	ID

Analytical data:	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
1	211	109	1.93	0.908
2	275	130	2.12	0.814
3	218	125	1.74	0.884
4	211	91	2.32	0.875
5	274	149	1.84	0.780
6	186	248	0.75	0.796
7	120	170	0.71	0.774

Collected by: M. K. Corbett, Idaho State U.; dated by: R. L. Armstrong, Yale U.

2. Green Creek Complex — Rb-Sr ($\lambda = 1.42$) — (W.R. isochron–RLA samples plus RRI, except 802 schist) 2400±40 m.y.
Armstrong and Hills, 1967

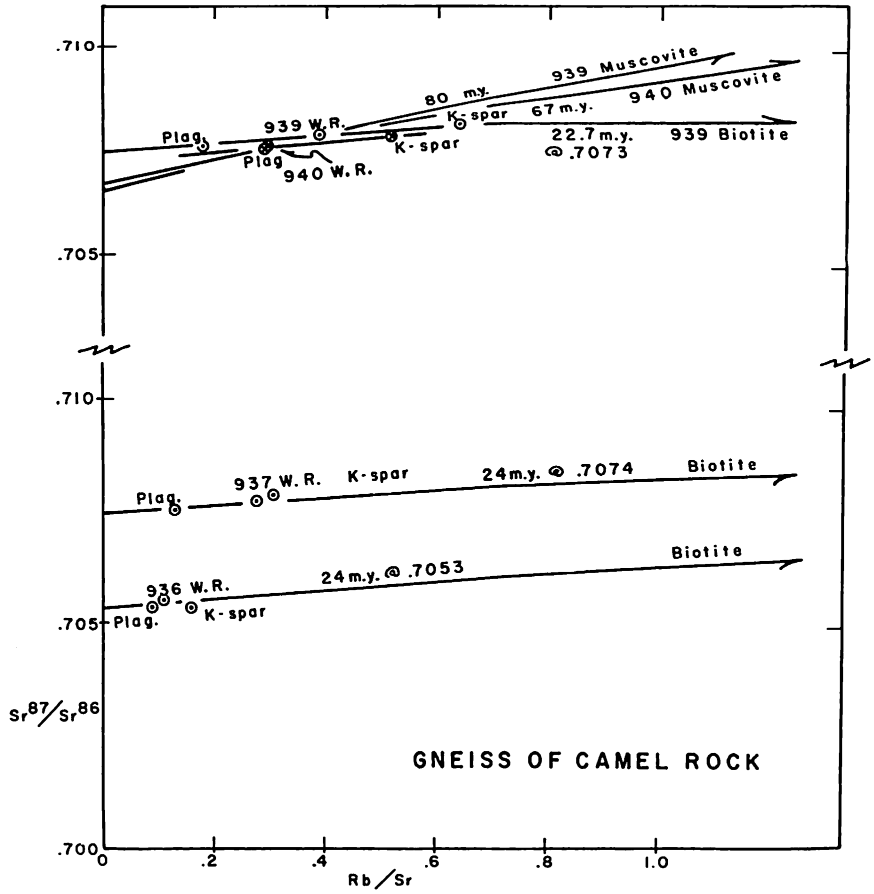

Figure 14. Mineral isochrons for the gneiss of Camel Rock.

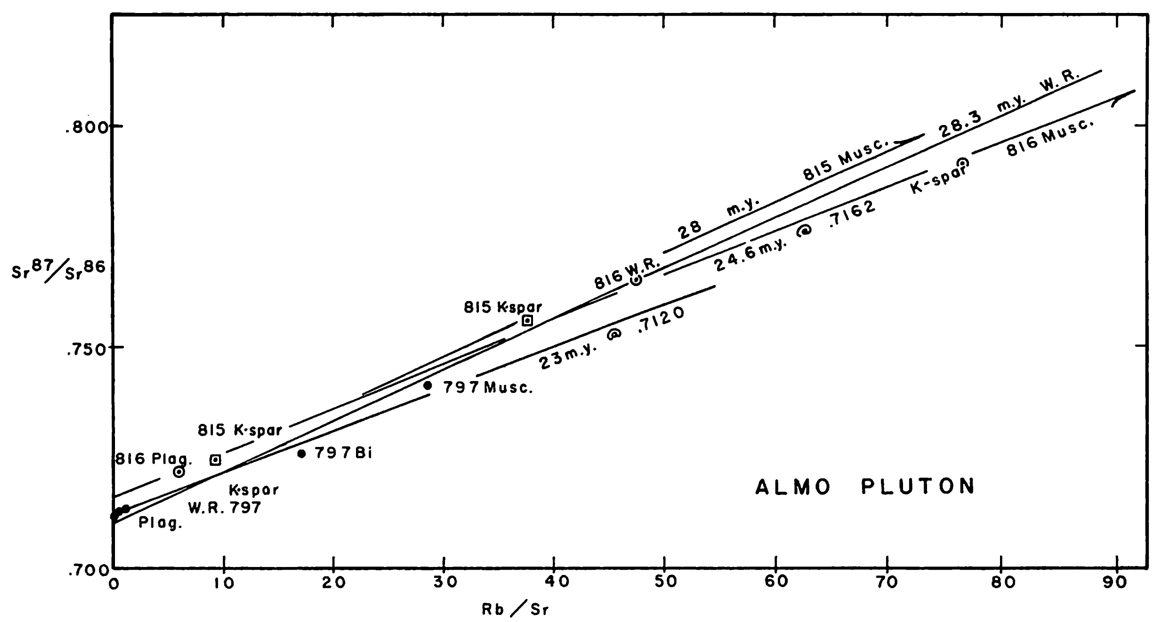

Figure 15. Mineral and whole rock isochrons for the Almo Pluton.

2. (continued)

Initial Sr^{87}/Sr^{86} 0.7118±0.0024
(W.R. isochron—all samples except 802 schist and Corbett schists) 2439±32 m.y.
Initial Sr^{87}/Sr^{86} 0.7097±0.0016
(W.R. isochron—RLA samples except 802 schist and Utah rocks) 2445±73 m.y.
Initial Sr^{87}/Sr^{86} 0.7095±0.0040

	Specimen	N Latitude	W Longitude	County	State
1	798 Bi. Adamellite Gneiss	42°13′20″	113°36′03″	Cassia	ID
2	799 Bi.-Q.-Olig. Schist	42°13′20″	113°36′00″	Cassia	ID
*3	800 Bi. Granite Gneiss	42°18′10″	113°33′15″	Cassia	ID
*4	802 Bi.-Olig.-Q. Schist	42°18′10″	113°33′15″	Cassia	ID
*5	803 Musc. Bi. Leucoadamellite Gneiss	42°19′55″	113°35′15″	Cassia	ID
6	822 Bi. Adamellite Gneiss	42°11′10″	113°41′30″	Cassia	ID
*7	951 (Alb 1742) Bi. Adamellite Gneiss	42°06′30″	113°48′40″	Cassia	ID
8	143 Bi. Adamellite Gneiss	41°55′50″	113°22′45″	Box Elder	UT
9	RR1 Granite (Sayyah and others, 1970)	exact locality not given		Box Elder	UT

Analytical data:	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
1	266	122	2.18	0.930
2	117	113	1.03	0.806
3	314	183	1.72	0.8926
4	410	135	3.04	0.9014
5	199	90	2.21	0.9352
6	177	130	1.36	0.828
7	132	148	0.89	0.8143
8	397	51.3	7.7	1.465
9	246	77	3.19	1.0344

3. YU-799

(W.R.—biotite isochron) 11±1 m.y.
Initial Sr^{87}/Sr^{86} = 0.8055

Analytical data:	Specimen	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
	Rock YU-799	117	113	1.03	0.806
*	Biotite (20% chlorite)	338	14	24.4	0.8165

4. YU-800

(W.R. mineral isochron) 22±0.5 m.y.
Initial Sr^{87}/Sr^{86} = 0.8913±0.00007

Analytical data:	Specimen	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
*	Rock YU-800	314	183	1.72	0.8926
*	Plagioclase (Minor Kspar + Quartz)	150	214	0.70	0.8913
*	K Feldspar (Orthoclase)	592	300	1.97	0.8939
*	Biotite (12% Chlorite)	1347	34	39.6	0.9256

5. YU-822

(W.R.—biotite isochron) 6±1 m.y.
Initial Sr^{87}/Sr^{86} = 0.8277

Analytical data:	Specimen	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
	Rock YU-822	177	130	1.36	0.828
*	Biotite	834	36	23.1	0.8332

6. YU-951

(W.R.—mineral isochron) 8.7±0.2 m.y.
Initial Sr^{87}/Sr^{86} = 0.8140±0.00006

6. (continued)

Analytical data:

	Specimen	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
*	Rock YU-951	132	148	0.89	0.8143
*	Plagioclase (and K Feldspar and Quartz)	150	209	0.72	0.8143
*	K Feldspar	298	215	1.39	0.8144
*	Biotite	714	13	53	0.8329

*New sample, not in reference cited.

Collected and dated by: R. L. Armstrong, Yale U.

7. YU-798 K-Ar (biotite–12% chlorite) 54.3±1.6 m.y.
Armstrong and Hills, 1967
Biotite adamellite gneiss, Green Creek Complex (42°13′20″N, 113°36′03″W; NW¼sec. 12, T. 14 S., R. 24 E.; Cassia Co., ID). Analytical data: K = 5.95, 5.85%; $*Ar^{40} = 12.99 \times 10^{-6}$ cc/gm (80% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

8. YU-799H K-Ar (hornblende) 535±16 m.y.
Armstrong and Hills, 1967
Quartz-andesine-hornblende amphibolite, Green Creek Complex (42°13′20″N, 113°36′00″W; NW¼sec. 12, T. 14 S., R. 24 E.; Cassia Co., ID). 10% Plagioclase and 5% Quartz impurities in separate. Analytical data: K = 0.295, 0.304, 0.300%; $*Ar^{40} = 7.41 \times 10^{-6}$ cc/gm (77% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

9. YU-799 K-Ar (biotite–30% chlorite) 130±4 m.y.
Armstrong and Hills, 1967
Biotite-quartz-oligoclase schist, Green Creek Complex (42°13′20″N, 113°36′00″W; NW¼sec. 12, T. 14 S., R. 24 E.; Cassia Co., ID). Analytical data: K = 5.18, 5.17%; $*Ar^{40} = 27.83 \times 10^{-6}$ cc/gm (81% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

10. YU-800 K-Ar (biotite–12% chlorite) 76.0±2.3 m.y.
Armstrong and Hills, 1967
Biotite-granite gneiss, Green Creek Complex (42°18′10″N, 113°33′15″W; SE¼sec. 8, T. 13 S., R. 25 E.; Cassia Co., ID). Analytical data: K = 6.73, 6.58, 6.88%; $*Ar^{40} = 20.86 \times 10^{-6}$ cc/gm (88% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

11. YU-802 K-Ar (biotite) 52.3±1.6 m.y.
Armstrong and Hills, 1967
Biotite-oligoclase-quartz schist, Green Creek Complex (42°18′10″N, 113°33′15″W; SE¼sec. 8, T. 13 S., R. 25 E.; Cassia Co., ID). Analytical data: K = 7.44, 7.49%; $*Ar^{40} = 15.82 \times 10^{-6}$ cc/gm (85% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

12. YU-803 K-Ar (biotite–17% chlorite + kaolinite) 43.3±1.3 m.y.
Armstrong and Hills, 1967
Porphyritic muscovite-biotite leucoadamellite gneiss, Green Creek Complex (42°19′55″N, 113°35′15″W; SW¼sec. 31, T. 12 S., R. 25 E.; Cassia Co., ID). Analytical data: K = 5.86, 5.88, 5.90%; $*Ar^{40} = 10.30 \times 10^{-6}$ cc/gm (72% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

13. YU-822 K-Ar (biotite) 66.9±2 m.y.
Armstrong and Hills, 1967
Porphyritic biotite adamellite gneiss, Green Creek Complex (42°11′10″N, 113°41′30″W; SE¼sec. 19, T. 14 S., R. 24 E.; Cassia Co., ID). Analytical data: K = 7.06, 7.03%; $*Ar^{40} = 19.17 \times 10^{-6}$ cc/gm (83% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

14. YU-951 K-Ar (biotite) 22.9±0.6 m.y.

Alb 1742 Flaser biotite adamellite augen gneiss, Green Creek Complex (42°06′30″N, 113°48′40″W; E edge sec. 24, T. 15 S., R. 22 E.; Cassia Co., ID) Middle Mountain. Analytical data: K = 7.29, 7.23%; $*Ar^{40} = 6.67 \times 10^{-6}$ cc/gm (73% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

15. Green Creek Complex Rb-Sr Age Indeterminant

Amphibolite YU-833 am

Specimen	N Latitude	W Longitude	County	State
1 833 A Hornblende	42°13′22″	113°36′02″	Cassia	ID
2 833 B Hornblende (Minor Plag. & Chl.)	42°13′22″	113°36′02″	Cassia	ID
3 833 C Hornblende (Minor Plag. & Chl.)	42°13′22″	113°36′02″	Cassia	ID

Analytical data:	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
1	4.0	35	0.11	0.734
2	7.0	117	0.06	0.734
3	7.5	87	0.09	0.731

Collected and dated by: R. L. Armstrong, Yale U.

16. YU-833 am K-Ar
0 m (A hornblende) 412±12 m.y.
1 m (B hornblende) 804±24 m.y.
2 m (C hornblende) 995±30 m.y.

4 m thick amphibolite pod sampled from rim (A) to core (C), Green Creek Complex (42°13′22″N, 113°36′02″W; NW¼sec. 12, T. 14 S., R. 24 E.; Cassia Co., ID). The separates contain small amounts of quartz, plagioclase, and chlorite. Analytical data: A: K = 0.265, 0.262%; $*Ar^{40} = 4.85 \times 10^{-6}$ cc/gm (79% ΣAr^{40}) B: K = 0.276, 0.258%; $*Ar^{40} = 10.69 \times 10^{-6}$ cc/gm (60% ΣAr^{40}) C: K = 0.285, 0.302%; $*Ar^{40} = 15.35 \times 10^{-6}$ cc/gm (82% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

PALEOZOIC SCHISTS

1. Paleozoic Schists Rb-Sr ($\lambda = 1.42$) (W.R. isochron) 570±80 m.y.

Armstrong and Hills, 1967 Assumed Initial $Sr^{87}/Sr^{86} = 0.7080$

Specimen	N Latitude	W Longitude	County	State
1 804 Musc. Microcl. Q. Schist	42°20′25″	113°32′15″	Cassia	ID
2 806 Graph. Staur. Garnet Musc. Q. Schist	42°15′05″	113°42′45″	Cassia	ID
3 819 Musc. K Fsp. Q. Schist	42°04′10″	113°39′30″	Cassia	ID
4 823 Chl. Musc. Q. Schist	42°10′50″	113°42′20″	Cassia	ID
*5 Alb 1757 Epidote Musc. Q. Schist with Bi. Porphyroblasts	42°23′35″	113°39′00″	Cassia	ID

Analytical data:	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
1	222	139	1.60	0.743
2	94	153	0.61	0.717
3	210	135	1.56	0.750
4	189	130	1.45	0.755
5	184	38	4.8	0.8115

* New sample, not in reference cited.

Collected and dated by: R. L. Armstrong, Yale U.

2. YU-Alb 298 K-Ar (biotite + muscovite–5% chlorite) 73.4±2 m.y.

Armstrong and Hills, 1967

2. (continued)
Garnet-staurolite-biotite-quartz-muscovite schist, Dayley Creek Formation (42°20′25″N, 113°40′15″W; NE¼sec. 32, T. 12 S., R. 24 E.; Cassia Co., ID). Analytical data: K = 6.88, 6.89, 7.05%; $^*Ar^{40}$ = 20.72 x 10^{-6} cc/gm (72% Σ Ar^{40}); collected and dated by: R. L. Armstrong, Yale U.

3. YU-804 K-Ar (muscovite) 30.6±0.9 m.y.
Armstrong and Hills, 1967
Muscovite-microcline-quartz schist, Narrows Schist (42°20′25″N, 113°32′15″W; NE¼sec. 33, T. 12 S., R. 25 E.; Cassia Co., ID). Analytical data: K = 9.20, 9.18%; $^*Ar^{40}$ = 11.30 x 10^{-6} cc/gm (72% Σ Ar^{40}); collected and dated by: R. L. Armstrong, Yale U.

4. YU-806 K-Ar (muscovite–10% quartz, 2% chlorite) 42.0±1.3 m.y.
Armstrong and Hills, 1967
Graphitic staurolite-garnet-muscovite-quartz schist, Mahogany Peaks Schist (42°15′05″N, 113°42′45″W; NE¼sec. 36, T. 13 S., R. 23 E.; Cassia Co., ID). Analytical data: K = 5.64, 6.72%; $^*Ar^{40}$ = 9.64 x 10^{-6} cc/gm (81% Σ Ar^{40}); collected and dated by: R. L. Armstrong, Yale U.

5. YU-819 K-Ar (muscovite) 25.0±0.8 m.y.
Armstrong and Hills, 1967
Muscovite-K feldspar-quartz schist, Narrows Schist (42°04′10″N, 113°39′30″W; SW¼sec. 33, T. 15 S., R. 24 E.; Cassia Co., ID). Analytical data: K = 9.10, 9.01%; $^*Ar^{40}$ = 9.07 x 10^{-6} cc/gm (84% Σ Ar^{40}); collected and dated by: R. L. Armstrong, Yale U.

6. YU-823 K-Ar (muscovite) 27.7±0.8 m.y.
Armstrong and Hills, 1967
Chlorite-muscovite-quartz schist, Narrows Schist (42°10′50″N, 113°42′20″W; NE¼sec. 25, T. 14 S., R. 23 E.; Cassia Co., ID). Analytical data: K = 7.65, 7.86, 7.87%; $^*Ar^{40}$ = 8.70 x 10^{-6} cc/gm (72% Σ Ar^{40}); collected and dated by: R. L. Armstrong, Yale U.

7. YU-Alb 461 K-Ar (whole rock) 74.9±2 m.y.
Armstrong and Hills, 1967
Carbonaceous muscovite-quartz phyllite, Mississippian, Manning Canyon-Milligan Phyllite (42°26′30″N, 113° 37′20″W; NW¼sec. 26, T. 11 S., R. 24 E.; Cassia Co., ID). Analytical data: K = 2.98, 2.95%; $^*Ar^{40}$ = 9.04 x 10^{-6} cc/gm (76% Σ Ar^{40}); collected and dated by: R. L. Armstrong, Yale U.

8. YU-Alb 285 K-Ar (phlogopite) 28.8±0.9 m.y.
Muscovite-quartz-biotite-calcite-plagioclase schist, Pogonip(?) Formation (42°24′40″N, 113°38′45″W; SW corner sec. 34, T. 12 S., R. 24 E.; Cassia Co., ID). Analytical data: K = 6.60, 6.65%; $^*Ar^{40}$ = 7.67 x 10^{-6} cc/gm (69% Σ Ar^{40}); collected and dated by: R. L. Armstrong, Yale U.

9. YU-Alb 1005 K-Ar (muscovite) 27.3±0.8 m.y.
Muscovite-quartz schist, Narrows Schist (42°12′00″N, 113°36′15″W; SW¼sec. 13, T. 14 S., R. 24 E.; Cassia Co., ID). Analytical data: K = 7.85, 7.88%; $^*Ar^{40}$ = 8.63 x 10^{-6} cc/gm (79% Σ Ar^{40}); collected and dated by: R. L. Armstrong, Yale U.

10. YU-Alb 1290 K-Ar (whole rock) 66.0±2 m.y.
Graphitic garnet-chloritoid-muscovite-quartz phyllite, Mississippian, Manning Canyon-Milligan Phyllite (42° 16′55″N, 113°39′30″W; N½sec. 21, T. 13 S., R. 24 E.; Cassia Co., ID). Analytical data: K = 1.63, 1.61%; $^*Ar^{40}$ = 4.38, 4.30 x 10^{-6} cc/gm (76, 74% Σ Ar^{40}); collected and dated by: R. L. Armstrong, Yale U.

11. YU-Alb 1361 K-Ar (whole rock) 25.3±0.8 m.y.
Partially retrograded graphitic garnet-staurolite-muscovite-quartz schist, Mahogany Peaks Schist (42°28′50″N, 113°34′15″W; SE¼sec. 7, T. 11 S., R. 25 E.; Cassia Co., ID). Analytical data: K = 4.05, 4.07%; $^*Ar^{40}$ = 4.12 x 10^{-6} cc/gm (65% Σ Ar^{40}); collected and dated by: R. L. Armstrong, Yale U.

12. YU-Alb 1408 K-Ar (hornblende) 71.8±2 m.y.
Platy quartz-plagioclase-hornblende amphibolite, (?) Stevens Spring Schist (42°30′02″N, 113°32′55″W; NW corner sec. 4, T. 11 S., R. 25 E.; Cassia Co., ID). Analytical data: K = 0.310, 0.315%; $*Ar^{40} = 0.913 \times 10^{-6}$ cc/gm (37% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

13. YU-Alb 1446 K-Ar (muscovite) 24.4±0.7 m.y.
Greenish gray muscovite-quartz schist, (?) Narrows Schist (42°28′55″N, 113°31′40″W; W edge sec. 10, T. 11 S., R. 25 E.; Cassia Co., ID). Analytical data: K = 8.50, 8.47%; $*Ar^{40} = 8.33 \times 10^{-6}$ cc/gm (45% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

14. YU-Alb 1757 K-Ar (fine biotite) 73.4±2 m.y.
(coarse biotite) 81.4±2.5 m.y.
Epidote-muscovite-quartz schist with biotite porphyroblasts (42°23′35″N, 113°39′00″W; E½sec. 9, T. 12 S., R. 24 E.; Cassia Co., ID). Analytical data: Fine Biotite: K = 7.49, 7.48%; $*Ar^{40} = 22.36 \times 10^{-6}$ cc/gm (77% ΣAr^{40}) Coarse Biotite: K = 7.23, 7.22%; $*Ar^{40} = 23.99 \times 10^{-6}$ cc/gm (15% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

15. YU-Alb 1871 c K-Ar (whole rock) 36.0±1.0 m.y.
Partially retrograded staurolite-garnet-quartz-muscovite schist, Albion Schist (42°28′25″N, 113°35′40″W; SE¼sec. 12, T. 11 S., R. 24 E.; Cassia Co., ID). Analytical data: K = 2.67, 2.67%· $*Ar^{40} = 3.88 \times 10^{-6}$ cc/gm (73% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

16. YU-Alb 1879 K-Ar (biotite) 32.7±1.0 m.y.
Calcite-biotite-muscovite-quartz schist with biotite and clinozoisite megacrysts, Albion Limestone (42°25′30″ N, 113°38′30″W; NW¼sec. 34, T. 11 S., R. 24 E.; Cassia Co., ID). Analytical data: K = 7.15, 7.19%; $*Ar^{40}$ = 9.53, 9.33 x 10^{-6} cc/gm (64, 58% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

17. YU-Alb 2115 K-Ar (biotite-chlorite mixture) 70.2±2 m.y.
Epidote-muscovite-chlorite-biotite-calcite-quartz schist, Harrison Summit Quartzite (42°18′35″N, 113°39′20″ W; NE¼sec. 9, T. 13 S., R. 24 E.; Cassia Co., ID). Analytical data: K = 5.23, 5.17%; $*Ar^{40} = 14.87 \times 10^{-6}$ cc/gm (61% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

18. YU-Alb 2121 K-Ar (whole rock) 31.3±0.9 m.y.
Graphitic-chloritoid-muscovite-quartz phyllite, Mississippian, Manning Canyon-Milligan Phyllite (42°24′10″N, 113°38′45″W; W½sec. 3, T. 13 S., R. 24 E.; Cassia Co., ID). Analytical data: K = 2.45, 2.46%; $*Ar^{40} = 3.10 \times 10^{-6}$ cc/gm (63% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

19. YU-Alb 2262 K-Ar (hornblende) 162±5 m.y.
Sphene-magnetite-plagioclase-hornblende amphibolite, Stevens Springs Schist (42°09′N, 113°44′35″W; NE¼ sec. 3, T. 15 S., R. 23 E.; Cassia Co., ID). Analytical data: K = 0.259, 0.260%; $*Ar^{40}$ = 1.67, 1.82 x 10^{-6} cc/gm (55, 55% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

MIDDLE MOUNTAIN INJECTION COMPLEX

1. Middle Mountain injection complex gneiss Rb-Sr (λ = 1.42) (W.R. isochron) 404±46 m.y.
Initial Sr^{87}/Sr^{86} 0.7061±0.0003

	Specimen	N Latitude	W Longitude	County	State
1 795	Bi. Adamellite Gneiss	42°09′15″	113°48′00″	Cassia	ID
2 942 (Alb1581)	Mylonitic Sphene-Epidote-Biotite Gneiss	42°15′15″	113°51′00″	Cassia	ID
3 943 (Alb1614)	Mylonitic Bi. Adamellite Gneiss	42°05′55″	113°49′25″	Cassia	ID
4 945 (Alb1616)	Mylonitic Bi. Adamellite Gneiss	42°07′25″	113°50′10″	Cassia	ID

1. (continued)

Specimen	N Latitude	W Longitude	County	State
5 947 (Alb1708) Mylonitic Musc. Bi. Adamellite Gneiss	42°05′40″	113°53′10″	Cassia	ID
6 948 (Alb1735) Mylonite derived from Bi. Adamellite	42°06′10″	113°51′35″	Cassia	ID
7 949 (Alb1740) Bi. Adamellite Gneiss	42°03′35″	113°49′40″	Cassia	ID
8 950 (Alb1741) Bi. Adamellite Gneiss	42°03′45″	113°48′00″	Cassia	ID

Analytical data:	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
1	52	600	0.09	0.7075
2	51	633	0.08	0.7073
3	109	246	0.44	0.7153
4	137	288	0.48	0.7135
5	141	147	0.96	0.7169
6	114	250	0.46	0.7137
7	99	316	0.31	0.7115
8	112	655	0.17	0.7096

Discussion: McIntyre and others, 1966, model II isochron.

2. YU-945

(W.R.-mineral-biotite isochron) 16.6±0.4 m.y.
Initial Sr^{87}/Sr^{86} 0.7131±0.00006

Specimen	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
Rock 945	137	288	0.48	0.7135
Plagioclase (and K Feldspar and Quartz)	201	396	0.51	0.7135
K Feldspar	316	418	0.76	0.7136
Biotite	670	57	11.8	0.7212

3. YU-948

No date calculated

Specimen	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
Rock 948	114	250	0.46	0.7137
Plagioclase (and Quartz)	87	270	0.32	0.7136

4. YU-949

(W.R.-mineral-biotite isochron) 17.3±0.4 m.y.
Initial Sr^{87}/Sr^{86} 0.7112±0.00006

Specimen	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
Rock 949	99	316	0.31	0.7115
Plagioclase (and Quartz)	10	258	0.04	0.7111
K Feldspar	220	465	0.47	0.7117
Biotite	557	40	13.9	0.7211

Collected and dated by: R. L. Armstrong, Yale U.

5. YU-795 K-Ar (biotite) 20.6±0.6 m.y.

Lineated biotite adamellite gneiss, Middle Mountain injection complex (42°09′15″N, 113°48′W; NE corner sec. 6, T. 15 S., R. 23 E.; Cassia Co., ID) on Oakley-Lynn Road. Analytical data: K = 7.15, 7.27%; $*Ar^{40}$ = 5.97 x 10^{-6} cc/gm (56% Σ Ar^{40}); collected and dated by: R. L. Armstrong, Yale U.

6. YU-942 K-Ar (biotite) 19.0±0.6 m.y.

Alb 1581 Mylonitic sphene-epidote-biotite adamellite gneiss, Middle Mountain injection complex (42°15′15″ N, 113°51′W; SW corner sec. 26, T. 14 S., R. 22 E.; Cassia Co., ID). Analytical data: K = 7.43, 7.30%; $*Ar^{40}$ = 5.61 x 10^{-6} cc/gm (45% Σ Ar^{40}); collected and dated by: R. L. Armstrong, Yale U.

7. YU-943 K-Ar (muscovite) 19.4±0.6 m.y.
(biotite) 18.8±0.6 m.y.

Alb 1614 Mylonitic biotite adamellite gneiss, Middle Mountain injection complex (42°05'55"N, 113°49'25" W; N edge sec. 25, T. 15 S., R. 22 E.; Cassia Co., ID). Analytical data: K = 7.17, 7.05%; $*Ar^{40} = 5.53 \times 10^{-6}$ cc/gm (58% ΣAr^{40}) K = 7.05, 7.10%; $*Ar^{40} = 5.35 \times 10^{-6}$ cc/gm (67% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

8. YU-945 K-Ar (biotite) 17.5±0.5 m.y.

Alb 1616 Mylonitic biotite adamellite gneiss, Middle Mountain injection complex (42°07'25"N, 113°50'10" W; NE¼sec. 14, T. 15 S., R. 22 E.; Cassia Co., ID). Analytical data: K = 6.69, 6.79%; $*Ar^{40} = 4.72 \times 10^{-6}$ cc/gm (68% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

9. YU-947 K-Ar (muscovite) 16.1±0.5 m.y.

Alb 1708 Mylonitic muscovite-biotite adamellite gneiss, Middle Mountain injection complex (42°05'40"N, 113°53'10"W; NW¼sec. 28, T. 15 S., R. 22 E.; Cassia Co., ID). Analytical data: K = 8.12, 8.16%; $*Ar^{40} = 5.26 \times 10^{-6}$ cc/gm (48% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

10. YU-948 K-Ar (muscovite) 17.7±0.5 m.y.

Alb 1735 Mylonite derived from biotite adamellite, Middle Mountain injection complex (42°06'10"N, 113° 51'35" W; S½sec. 22, T. 15 S., R. 22 E.; Cassia Co., ID). Analytical data: K = 8.75, 8.58%; $*Ar^{40} = 6.14 \times 10^{-6}$ cc/gm (56% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

11. YU-949 K-Ar (biotite) 18.6±0.6 m.y.

Alb 1740 Biotite adamellite gneiss, Middle Mountain injection complex (42°03'35"N, 113°49'40"W; SW¼sec. 1, T. 16 S., R. 22 E.; Cassia Co., ID). Analytical data: K = 7.35, 7.30%; $*Ar^{40} = 5.47 \times 10^{-6}$ cc/gm (69% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

12. YU-950 K-Ar (biotite) 19.3±0.6 m.y.

Alb 1741 Biotite adamellite gneiss, Middle Mountain injection complex (42°03'45"N, 113°48'00"W; center sec. 6, T. 16 S., R. 23 E.; Cassia Co., ID). Analytical data: K = 7.55, 7.50%; $*Ar^{40} = 5.82 \times 10^{-6}$ cc/gm (66% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

13. Deformed pegmatites Middle Mountain injection complex — Rb-Sr ($\lambda = 1.42$)

(maximum whole rock) 941 Date 60±4 m.y.
Assumed Minimum Initial $Sr^{87}/Sr^{86} = 0.7050$
(maximum whole rock) 944 Date 335±17 m.y.
Assumed Minimum Initial $Sr^{87}/Sr^{86} = 0.7050$
(maximum whole rock) 946 Date 158±8 m.y.
Assumed Minimum Initial $Sr^{87}/Sr^{86} = 0.7050$

Specimen	N Latitude	W Longitude	County	State
1 941 (Alb 1579) Mylonitic Musc. Adamellite Gneiss	42°10'02"	113°50'40"	Cassia	ID
2 944 (Alb 1615) Musc. Bi. Adamellite Gneiss	42°06'25"	113°49'40"	Cassia	ID
3 946 (Alb 1617) Garnet Musc. Adamellite Gneiss	42°07'35"	113°50'15"	Cassia	ID

Analytical data:	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
1	272	23	11.8	0.7333
2	76	35	2.17	0.7350
3	134	45	2.98	0.7244

14. YU-941 (W.R.-mineral-muscovite isochron) 34±0.8 m.y.
Initial $Sr^{87}/Sr^{86} = 0.7154 \pm 0.0016$

14. (continued)

(W.R.-muscovite isochron) 34±2 m.y.
Initial Sr^{87}/Sr^{86} = 0.7168

Specimen	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
Rock 941	272	23	11.8	0.7333
K Feldspar	737	37	19.9	0.7419
Muscovite	1025	5	205	1.0034

15. YU-944

(W.R.-mineral-muscovite isochron) 23±0.5 m.y.
Initial Sr^{87}/Sr^{86} = 0.7333±0.0003
(W.R.-muscovite isochron) 23±2 m.y.
Initial Sr^{87}/Sr^{86} = 0.7330

Specimen	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
Rock 944	76	35	2.17	0.7350
K Feldspar	93	41	2.26	0.7357
Muscovite	500	4.2	119	0.8451

16. YU-946

(W.R.-mineral-muscovite isochron) 26±0.5 m.y.
Initial Sr^{87}/Sr^{86} = 0.7213±0.00008
(W.R.-muscovite isochron) 26±2 m.y.
Initial Sr^{87}/Sr^{86} = 0.7212

Specimen	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
Rock 946	134	45	2.98	0.7244
Plagioclase	25	82	0.30	0.7216
K Feldspar (and Plagioclase)	381	70	5.44	0.7271
Muscovite	616	11	56	0.7815

Collected and dated by: R. L. Armstrong, Yale U.

17. YU-941 K-Ar (muscovite) 19.1±0.6 m.y.
Alb 1579 Coarse-grained mylonitic muscovite-adamellite gneiss, Middle Mountain injection complex (42°10′ 02″N, 113°50′40″W; NW¼sec. 35, T. 14 S., R. 22 E.; Cassia Co., ID). Analytical data: K = 8.23, 8.25%; $*Ar^{40}$ = 6.33 x 10^{-6} cc/gm (57% Σ Ar^{40}); collected and dated by: R. L. Armstrong, Yale U.

18. YU-944 K-Ar (muscovite) 19.9±0.6 m.y.
Alb 1615 Coarse-grained muscovite-adamellite gneiss, Middle Mountain injection complex (42°06′25″N, 113° 49′40″W; NW¼sec. 24, T. 15 S., R. 22 E.; Cassia Co., ID). Analytical data: K = 8.60, 8.43%; $*Ar^{40}$ = 6.81 x 10^{-6} cc/gm (63% Σ Ar^{40}); collected and dated by: R. L. Armstrong, Yale U.

19. YU-946 K-Ar (muscovite) 20.6±0.6 m.y.
Alb 1617 Coarse-grained garnet-muscovite adamellite gneiss, Middle Mountain injection complex (42°07′35″ N, 113°50′15″W; N edge sec. 14, T. 15 S., R. 22 E.; Cassia Co., ID). Analytical data: K = 7.83, 7.87%; $*Ar^{40}$ = 6.51 x 10^{-6} cc/gm (61% Σ Ar^{40}); collected and dated by: R. L. Armstrong, Yale U.

GNEISS OF CAMEL ROCK

1. Gneiss of Camel Rock Rb-Sr (λ = 1.42) (W.R. isochron) 230±35 m.y.
Initial Sr^{87}/Sr^{86} = 0.7045±0.0003

Specimen	N Latitude	W Longitude	County	State
1 936 (Alb 894) Bi. Adamellite Gneiss	42°10′50″	113°46′00″	Cassia	ID
2 937 (Alb 1498) Sphene Bi. Adamellite Gneiss	42°11′30″	113°47′20″	Cassia	ID
3 938 (Alb 1488) Musc. Bi. Adamellite Gneiss	42°12′45″	113°47′10″	Cassia	ID
4 939 (Alb 1536) Bi. Musc. Adamellite Gneiss	42°13′00″	113°46′15″	Cassia	ID
5 940 (Alb 1538) Bi. Musc. Adamellite Gneiss	42°11′40″	113°47′50″	Cassia	ID

1. (continued)

Analytical data:	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
1	100	893	0.11	0.7055
2	132	465	0.28	0.7077
3	158	554	0.29	0.7070
4	151	385	0.39	0.7077
5	147	491	0.30	0.7074

Discussion: McIntyre and others, 1966 model II isochron.

2. YU-936

(W.R.-mineral-biotite isochron) 24±0.5 m.y.
Initial Sr^{87}/Sr^{86} = 0.7053±0.00006

Specimen	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
Rock 936	100	893	0.11	0.7055
Plagioclase (Moderate Quartz)	101	1169	0.09	0.7053
K Feldspar	212	1306	0.16	0.7053
Biotite (Flakes)	564	71	7.98	0.7131
Biotite (Ground)				0.7131

3. YU-937

(W.R.-mineral-biotite isochron) 24±0.6 m.y.
Initial Sr^{87}/Sr^{86} = 0.7074±0.00006

Specimen	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
Rock 937	132	465	0.28	0.7077
Plagioclase (and Quartz)	43	340	0.13	0.7075
K Feldspar (Minor Plag. & Quartz)	194	634	0.31	0.7078
Biotite	702	90	7.80	0.7152

4. YU-938

No date calculated

Specimen	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
Rock 938	158	554	0.29	0.7070
Plagioclase (and Quartz)	22	695	0.03	0.7064

5. YU-939

(W.R.-feldspar-biotite isochron) 22.7±0.5 m.y.
Initial Sr^{87}/Sr^{86} = 0.7073±0.00006
(W.R.-muscovite isochron) 80±4 m.y.
Initial Sr^{87}/Sr^{86} = 0.7064

Specimen	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
Rock 939	151	385	0.39	0.7077
Plagioclase (and Quartz)	95	532	0.18	0.7074
K Feldspar (Minor Plagioclase)	419	655	0.64	0.7079
Muscovite (Ground)	604	95	6.39	0.7272
Muscovite (Flake)				0.7280
Biotite	931	47	19.8	0.7257

6. YU-940

(W.R.-muscovite isochron) 67±4 m.y.
Initial Sr^{87}/Sr^{86} = 0.7066
(W.R.-mineral-muscovite isochron) 67±1.5 m.y.
Initial Sr^{87}/Sr^{86} = 0.7065±0.0001

Specimen	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
Rock 940	147	491	0.30	0.7074
Plagioclase (and Quartz)	179	615	0.29	0.7073

6. (continued)

Specimen	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
K Feldspar	386	747	0.52	0.7077
Muscovite	589	75	7.85	0.7280

Collected and dated by: R. L. Armstrong, Yale U.

7. YU-936 K-Ar (biotite) 20.7±0.6 m.y.
Alb 894 Mylonitic biotite adamellite gneiss, Gneiss of Camel Rock (42°10′50″N, 113°46′00″W; NE¼sec. 28, T. 14 S., R. 23 E.; Cassia Co., ID). Analytical data: K = 7.37, 7.51%; $*Ar^{40} = 6.20 \times 10^{-6}$ cc/gm (48% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

8. YU-937 K-Ar (biotite) 18.6±0.6 m.y.
Alb 1498 Mylonitic sphene biotite adamellite gneiss, Gneiss of Camel Rock (42°11′30″N, 113°47′20″W; NE¼sec. 20, T. 14 S., R. 23 E.; Cassia Co., ID). Analytical data: K = 6.50, 6.37%; $*Ar^{40} = 4.80 \times 10^{-6}$ cc/gm (45% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

9. YU-938 K-Ar (biotite) 20.9±0.6 m.y.
(muscovite) 28.6±0.9 m.y.
Alb 1488 Muscovite biotite adamellite gneiss, Gneiss of Camel Rock (42°12′45″N, 113°47′10″W; NE corner sec. 17, T. 14 S., R. 23 E.; Cassia Co., ID). Analytical data: K = 7.05, 6.97%; $*Ar^{40} = 5.87 \times 10^{-6}$ cc/gm (68% ΣAr^{40}) K = 7.69, 7.60%; $*Ar^{40} = 8.80 \times 10^{-6}$ cc/gm (51% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

10. YU-939 K-Ar (biotite) 20.2±0.6 m.y.
(muscovite) 24.6±0.7 m.y.
Alb 1536 Slightly mylonitic biotite muscovite adamellite gneiss, Gneiss of Camel Rock (42°13′N, 113°46′15″ W; S½sec. 9, T. 14 S., R. 23 E.; Cassia Co., ID). Analytical data: K = 7.15, 7.13%; $*Ar^{40} = 5.78 \times 10^{-6}$ cc/gm (49% ΣAr^{40}) K = 7.85, 7.86%; $*Ar^{40} = 7.77 \times 10^{-6}$ cc/gm (67% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

11. YU-940 K-Ar (muscovite) 21.5±0.6 m.y.
Alb 1538 Mylonitic biotite muscovite adamellite gneiss, Gneiss of Camel Rock (42°11′40″N, 113°47′50″W; NW¼sec. 20, T. 14 S., R. 23 E.; Cassia Co., ID). Analytical data: K = 8.47, 8.28, 8.35%; $*Ar^{40} = 7.24 \times 10^{-6}$ cc/gm (42% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

ALMO PLUTON

1. McDowell, 1971 K-Ar (biotite) 23.1±0.7 m.y.
(muscovite) 24.5±0.7 m.y.
L-1039 Cassia batholith, medium-grained muscovite-biotite granodiorite (42°4.1′N, 113°42.2′W; SE corner sec. 36, T. 15 S., R. 23 E.; Cassia Co., ID). 5 mi W of Almo. Analytical data: K = 7.04%; $*Ar^{40} = 2.86 \times 10^{-10}$ moles/gm (79% ΣAr^{40}) K = 8.25%; $*Ar^{40} = 3.61 \times 10^{-10}$ moles/gm (81% ΣAr^{40}); collected and dated by: F. W. McDowell, Columbia U.

2. Almo Pluton Rb-Sr ($\lambda = 1.42$) (W.R. isochron, including all except 797, 817)
Armstrong and Hills, 1967 28.6±1.0 m.y.
Initial $Sr^{87}/Sr^{86} = 0.7098 \pm 0.0006$
(W.R. isochron, all samples) 28.3±1.0 m.y.
Initial $Sr^{87}/Sr^{86} = 0.7103 \pm 0.0005$
both McIntyre and others, 1966 model III isochron

	Specimen	N Latitude	W Longitude	County	State
* 1	796 Bi. Adamellite	42°05′15″	113°43′50″	Cassia	ID

2. (continued)

Specimen	N Latitude	W Longitude	County	State
* 2 797 Musc.-Bi. Adamellite	42°04′00″	113°42′15″	Cassia	ID
* 3 814 (Alb 1186) Bi. Granodiorite	42°02′30″	113°43′00″	Cassia	ID
4 816 (Alb 1187) Musc. Adamellite	42°04′05″	113°42′30″	Cassia	ID
* 5 817 (Alb 1188) Musc. Adamellite	42°04′35″	113°43′05″	Cassia	ID
* 6 820 (Alb 1191) Bi. Granodiorite	42°08′40″	113°40′10″	Cassia	ID
7 821 (Alb 1192) Leuco Adamellite	42°09′05″	113°40′05″	Cassia	ID
* 8 Alb 2233 Faintly Lineated Bi. Musc. Adamellite	42°07′12″	113°44′30″	Cassia	ID
* 9 Alb 2235 Lineated, Faintly Foliated, Bi. Adamellite	42°07′10″	113°44′45″	Cassia	ID
*10 Alb 2240 Faintly Lineated Musc.-Bi. Adamellite	42°07′14″	113°44′50″	Cassia	ID

Analytical data:	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
1	78	437	0.178	0.7104
2	110	214	0.514	0.7127
3	86	330	0.26	0.7094
4	261	5.5	47.5	0.765
5	126	131	0.96	0.7125
6	111	360	0.31	0.7093
7	190	18	10.6	0.724
8	152	76	2.01	0.7147
9	91	474	0.19	0.7082
10	96	172	0.56	0.7096

3. YU-797

(W.R.-mineral isochron) 23±0.4 m.y.
Initial Sr^{87}/Sr^{86} = 0.7120±0.00006
(W.R.-biotite isochron) 19±2 m.y.
Initial Sr^{87}/Sr^{86} = 0.7123
(W.R.-muscovite isochron) 25±2 m.y.
Initial Sr^{87}/Sr^{86} = 0.7122

Specimen	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
* Rock 979	110	214	0.514	0.7127
* Plagioclase (minor Kspar and Quartz)	51	385	0.132	0.7119
* K Feldspar (Microcline)	317	284	1.12	0.7132
* Biotite	600	35	17.1	0.7259
* Muscovite	457	16	28.6	0.7414

4. YU-816

(W.R.-mineral isochron) 24.6±0.3 m.y.
Initial Sr^{87}/Sr^{86} = 0.7162±0.0002

Specimen	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
Rock 816	261	5.5	47.5	0.765
* Plagioclase (Minor Quartz)	45	7.5	6.0	0.7223
* K Feldspar (Microcline)	752	9.8	76.7	0.7914
* Muscovite	958	1.26 (I.D.)	760	1.497

* New sample or new analysis, not in reference cited.

Collected and dated by: R. L. Armstrong, Yale U.

5. YU-796 K-Ar (biotite) 22.7±0.7 m.y.

Biotite granodiorite, Almo Pluton (42°05′15″N, 113°43′50″W; S½sec. 26, T. 15 S., R. 23 E.; Cassia Co., ID). Analytical data: K = 7.67, 7.72%; $^*Ar^{40} = 7.03 \times 10^{-6}$ cc/gm (65% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

6. YU-797 K-Ar (biotite) 21.5±0.6 m.y.
Armstrong and Hills, 1967 (muscovite) 24.5±0.7 m.y.
Muscovite-biotite adamellite, (City of Rocks) Almo Pluton (42°04'00"N, 113°42'15"W; NE¼sec. 1, T. 16 S., R. 23 E.; Cassia Co., ID). Probably same locality as L1039 of McDowell. Analytical data: K = 6.92, 6.84%; $^{*}Ar^{40} = 5.94 \times 10^{-6}$ cc/gm (55% ΣAr^{40}) K = 8.70, 8.72%; $^{*}Ar^{40} = 8.55 \times 10^{-6}$ cc/gm (65% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

7. YU-814 K-Ar (biotite) 20.8±0.6 m.y.
Armstrong and Hills, 1967
Alb 1186 Biotite granodiorite, (City of Rocks) Almo Pluton (42°02'30"N, 113°43'00"W; SW¼sec. 12, T. 16 S., R. 23 E.; Cassia Co., ID). Analytical data: K = 7.24, 7.29%; $^{*}Ar^{40} = 6.08 \times 10^{-6}$ cc/gm (58% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

8. YU-816 K-Ar (muscovite) 23.3±0.7 m.y.
Armstrong and Hills, 1967
Alb 1187 Muscovite adamellite, (City of Rocks) Almo Pluton (42°04'05"N, 113°42'30"W; SE¼sec. 36, T. 15 S., R. 23 E.; Cassia Co., ID). Analytical data: K = 8.73, 8.62%; $^{*}Ar^{40} = 8.10 \times 10^{-6}$ cc/gm (38% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

9. YU-817 K-Ar (*biotite–8% chlorite) 16.0±0.5 m.y.
Armstrong and Hills, 1967 (muscovite) 24.3±0.7 m.y.
Alb 1188 Muscovite adamellite, (City of Rocks) Almo Pluton (42°04'35"N, 113°43'05"W; W½sec. 36, T. 15 S., R. 23 E.; Cassia Co., ID). Analytical data: *K = 5.38, 5.32%; $^{*}Ar^{40} = 3.39, 3.45 \times 10^{-6}$ cc/gm (32, 35% ΣAr^{40}) K = 8.60, 8.46%; $^{*}Ar^{40} = 8.35 \times 10^{-6}$ cc/gm (54% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.; * New result, not in reference cited.

10. YU-820 K-Ar (biotite) 22.3±0.6 m.y.
Armstrong and Hills, 1967
Alb 1191 Biotite granodiorite, (City of Rocks) Almo Pluton (42°08'40"N, 113°40'10"W; SE¼sec. 5, T. 15 S., R. 24 E.; Cassia Co., ID). Analytical data: K - 7.47, 7.19, 7.31%; $^{*}Ar^{40} = 6.58 \times 10^{-6}$ cc/gm (56% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

11. YU-821 K-Ar (biotite) 20.8±0.6 m.y.
Armstrong and Hills, 1967 (*muscovite) 24.1±0.7 m.y.
Alb 1192 Leuco adamellite, (City of Rocks) Almo Pluton (42°09'05"N, 113°40'05"W; NE¼sec. 5, T. 15 S., R. 24 E.; Cassia Co., ID). Analytical data: K = 7.19, 7.25%; $^{*}Ar^{40} = 6.00 \times 10^{-6}$ cc/gm (58% ΣAr^{40}) K = 8.14, 8.09%; $^{*}Ar^{40} = 7.87 \times 10^{-6}$ cc/gm (56% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.
* New result, not in reference cited.

12 YU-Alb 2235 K-Ar (biotite) 20.1±0.6 m.y.
Lineated, faintly foliated medium to fine grained biotite adamellite, Almo Pluton (42°07'10"N, 113°44'45"W; E½sec. 15, T. 15 S., R. 23 E.; Cassia Co., ID). Analytical data: K = 6.58, 6.71%; $^{*}Ar^{40} = 5.37 \times 10^{-6}$ cc/gm (58% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.

13. YU-813 K-Ar (muscovite) 24.0±0.7 m.y.
Armstrong and Hills, 1967 (*K feldspar–orthoclase) 27.5±0.8 m.y.
Muscovite-quartz-K feldspar pegmatite, (City of Rocks) Almo Pluton (42°05'28"N, 113°42'00"W; NW¼sec. 30, T. 16 S., R. 24 E.; Cassia Co., ID). Analytical data: K = 8.75, 8.76%; $^{*}Ar^{40} = 8.42 \times 10^{-6}$ cc/gm (82% ΣAr^{40}) K = 10.85, 10.88%; $^{*}Ar^{40} = 12.02 \times 10^{-6}$ cc/gm (77% ΣAr^{40}); collected and dated by: R. L. Armstrong, Yale U.; * New result, not in reference cited.

14. YU-815 Rb-Sr ($\lambda = 1.42$) (feldspar-muscovite isochron) 28±0.5 m.y.
Pegmatite, Almo Pluton Initial $Sr^{87}/Sr^{86} = 0.7141 \pm 0.0003$

Specimen	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
1 Perthitic Feldspar (Microcline)	316	34	9.3	0.7248

14. (continued)

Specimen	ppm Rb	ppm Sr	Rb/Sr	Sr^{87}/Sr^{86}
2 Feldspar (Microcline)	566	15	37.7	0.7559
3 Muscovite	554	3.0	185	0.9299

Collected and dated by: R. L. Armstrong, Yale U.

15. YU-815 K-Ar (muscovite) 24.8±0.7 m.y.
Armstrong and Hills, 1967 (*K feldspar–microcline) 31.9±1.0 m.y.
Muscovite-quartz-K Feldspar pegmatite, (City of Rocks) Almo Pluton (42°03'55"N, 113°43'40"W; NE¼sec. 2, T. 16 S., R. 23 E.; Cassia Co., ID). Analytical data: K = 8.86, 8.85%; $*Ar^{40}$ = 8.81 x 10^{-6} cc/gm (58% Σ Ar^{40}) K = 10.13, 10.27%; $*Ar^{40}$ = 13.03, 13.14 x 10^{-6} cc/gm (67, 77% Σ Ar^{40}); collected and dated by: R. L. Armstrong, Yale U.; * New result, not in reference cited.

16. YU-818 K-Ar (muscovite) 25.2±0.8 m.y.
Armstrong and Hills, 1967 (*K feldspar–microcline) 24.6±0.7 m.y.
Alb 1190 Muscovite-quartz-K feldspar pegmatite, (City of Rocks) Almo Pluton (42°04'10"N, 113°42'10"W; SE corner sec. 36, T. 15 S., R. 23 E.; Cassia Co., ID). Analytical data: K = 8.78, 8.70%; $*Ar^{40}$ = 8.87 x 10^{-6} cc/gm (86% Σ Ar^{40}) K = 11.02, 10.53%; $*Ar^{40}$ = 10.67 x 10^{-6} cc/gm (66% Σ Ar^{40}); collected and dated by: R. L. Armstrong, Yale U.; * New result, not in reference cited.

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