K-Ar dates from Arizona, Montana, Nevada, Utah, and Wyoming

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K-AR DATES FROM ARIZONA, MONTANA, NEVADA, UTAH, AND WYOMING

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This paper reports the results of geochronometric investigations in several western states. These results were obtained between 1967 and 1973 at Yale University, have not yet been published, and are not certain to be included with full documentation in any papers planned or in progress. We feel that the information provided will be of use in future regional and local studies.

The K-Ar data were obtained using standard analytical techniques as described by Armstrong (1970a). Argon was determined by isotope dilution, potassium by atomic absorption spectrophotometry. The dates are computed using the following constants: K^{40} = 0.0119 atom percent; $K\lambda_\beta = 4.72 \times 10^{-10}\ yr^{-1}$, $K\lambda_\epsilon = 0.584 \times 10^{-10}\ yr^{-1}$. Analyses of standards indicate that calibrations are accurate within 2%. Uncertainties reported are for analytical error only and represent one standard deviation, or the standard error for averaged dates.

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SAMPLE DESCRIPTIONS

WESTERN NEVADA

A suite of samples, listed below in order of decreasing geologic age, was dated to supplement the information reported by Speed and Armstrong (1971). The results further document the predominantly Middle to Late Jurassic age of tectonic and magmatic events in that region. The dates will be utilized in local and regional tectonic studies by R. C. Speed and coworkers.

1. YU-Acme 30 K-Ar (biotite) 142 ± 3 m.y.

Dunlap Formation, metatuff (38°29′0″N, 118°20′10″W; SW/4NE/4NE/4 sec. 7, T7N, R33E; Mable Mountain quad.; Mineral Co., Brown biotite occurs in probable air-fall tuff unit about 100 m above horizon yielding only dated fossil (Toarcian) from the Dunlap Formation (Ferguson and Muller, 1949; S. W. Muller, written communication to R. Speed, 1971). The tuff is slightly recrystallized although the biotite appears fresh. The date is probably a minimum value for the time of crystallization, and perhaps reflects the time of recrystallization and regional tectonism. Analytical data: K = 5.30, 5.33%; $^*Ar^{40} = 31.3 \times 10^{-6}$ cc/gm (93% $\Sigma\ Ar^{40}$). Collected by: R. C. Speed, Northwestern U.; dated by: R. L. Armstrong and P. N. Taylor, Yale U.

2. YU-379 K-Ar (hornblende) 161 ± 3 m.y.
(biotite) 146 ± 3 m.y.

Humboldt lopolith, hornblende picrite (40°6′25″N, 118°20′30″W; SW/4NW/4SW/4 sec. 24, T26N, R32E; West Humboldt Range, Lovelock quad.; Pershing Co., NV). Sample from ultramafic differentiate in layered sheet that is the earliest emplaced body of the lopolith along its western margin (Speed, 1963). The rock is similar to specimen 2 (fig. 1, table 1) of Speed (1963). The hornblende separate contains about 30% intergrown hornblende and pyroxene grains. Other published dates for the lopolith range from 150 to 165 m.y. (Speed and Armstrong, 1971). The lower date for biotite probably reflects protracted cooling and/or complexities of emplacement and later tectonism. Analytical data: (hornblende) K = 0.398, 0.388%; $^{*}Ar^{40}$ = 2.66, 2.60 x 10^{-6} cc/gm (61, 11% Σ Ar^{40}); (biotite) K = 6.13, 6.12%; $^{*}Ar^{40}$ = 36.5, 37.6 x 10^{-6} cc/gm (87, 90% Σ Ar^{40}). Collected by: R. C. Speed, Northwestern U.; dated by: R. L. Armstrong and P. N. Taylor, Yale U.

3. YU-SW 312 K-Ar (plagioclase) 115 ± 3 m.y.

Olivine basalt (39°58′05″N, 118°9′10″W; SE/4SE/4SE/4 sec. 4, T24N, R34E; Humboldt Salt Marsh quad.; Churchill Co., NV). Fresh basalt lava occurs in a section of deformed fragmental mafic volcanic rocks and volcanic sedimentary rocks that constitute the roof of the Humboldt lopolith. The dated plagioclase has lost argon, judging by the dates for intrusive phases of the lopolith. See YU-379 (sample 2). Analytical data: K = 0.429, 0.427%; $^{*}Ar^{40}$ = 2.03 x 10^{-6} cc/gm (37% Σ Ar^{40}). Collected by: R. C. Speed, Northwestern U.; dated by: R. L. Armstrong and P. N. Taylor, Yale U.

4. YU-Rock Hill Syenite K-Ar (biotite) 139 ± 2 m.y.

Dike cutting metavolcanic rocks near Rock Hill (38°7′50″N, 117°58′40″W; SE/4NW/4NE/4 sec. 9, T3N, R36E; Rock Hill quad.; Esmeralda Co., NV). Olive-brown biotite occurs as a poikilitic phase in syenite dikes that invade a klippe of metavolcanic rocks (Rock Hill complex) originally assigned to the so-called Excelsior Formation (Ferguson and Muller, 1949; Speed, 1973). The dikes also intrude the lower plate rocks of the Palmetto Formation (Ordovician). The biotite date gives a minimum age of thrust emplacement of the klippe. See Rock Hill basalt (sample 5). Analytical data: K = 5.27, 5.32%; $^{*}Ar^{40}$ = 30.4, 30.7, 30.3 x 10^{-6} cc/gm (76, 44, 94% Σ Ar^{40}). Collected by: R. C. Speed, Northwestern U.; dated by: R. L. Armstrong and P. N. Taylor, Yale U.

5. YU-Rock Hill basalt K-Ar (whole rock) 73.6 ± 1.0 m.y.

Vesicular basalt(?) (38°9′15″N, 117°58′50″W; NE/4SE/4NE/4 sec. 27, T4N, R36E; Rock Hill quad.; Esmeralda Co., NV). Biotite-bearing, somewhat recrystallized basalt lies with apparent depositional contact on Palmetto Formation (Ordovician) at this locality. The basalt was included in the so-called Excelsior Formation by Ferguson and Muller (1949). The date may be much younger than the stratigraphic age of the unit. Analytical data: K = 5.61, 5.53%; $^{*}Ar^{40}$ = 16.3, 16.5, 17.3 x 10^{-6} cc/gm (87, 82, 84% Σ Ar^{40}). Collected by: R. C. Speed, Northwestern U.; dated by: R. L. Armstrong and P. N. Taylor, Yale U.

NORTHEASTERN NEVADA – NORTHWESTERN UTAH

Several volcanic rocks from the thesis area of A. R. Young were dated and three familiar events were recognized; basalt correlative with the Columbia episode (Watkins and Baksi, 1974), and rhyolites of early and late Idavada ages correlative with similar rocks in Idaho. In addition an anomalously old and very inaccurate result was obtained for a feldspar from another rhyolite unit. In that case the exceptionally large amount of atmospheric Ar obtained from a feldspar separate leads us to suspect Ar fractionation during pumpdown and bakeout (Baksi, 1974), a process that produces anomalously old dates. The dates are listed in order of increasing stratigraphic age.

6. YU-1A-AY (vitrophyre) K-Ar (feldspar) 8.6 ± 0.17 m.y.
YU-1-AY (devitrified) (feldspar) 8.2 ± 0.16 m.y.

Rhyolite porphyry (41°28′32″N, 113°59′15″(1A) and 13″(1)W; NE corner, SW/4NE/4 sec. 26, T9N, R19W; Lucin NW quad.; Box Elder Co., UT). Sample 1 from 23 m above an 18 m-thick black vitrophere (1A) that overlies bedded vitric tuff and massive tuff breccia. This unit is the same age as the rhyolite at Rhyolite Butte, northern Pilot Range (Armstrong, 1970a) and the rhyolite ash flows of the Goose Creek area and Cassia Mountains in Idaho (Armstrong and others, 1975). Analytical data: K = 7.39, 7.35%; $*Ar^{40}$ = 2.53 10^{-6} cc/gm (74% Σ Ar^{40}); K = 7.50, 7.50%; $*Ar^{40}$ = 2.46 x 10^{-6} cc/gm (66% Σ Ar^{40}). Collected by: A. R. Young, U. of Utah; dated by: R. L. Armstrong and P. N. Taylor, Yale U.

7. YU-3-AY K-Ar (feldspar) 13.1 ± 0.3 m.y.

(41°52′30″N, 113°54′57″W; SE/4SW/4NW/4 sec. 4, T13N, R18W; just N of Hardesty Creek, Cottom Thomas Basin quad.; Box Elder Co., UT). Sample from 3 m above base of a 10 m-thick rhyolite that unconformably overlies bedded vitric tuff. Sampled unit lies stratigraphically above YU-2-AY. These units are interbedded with the upper Salt Lake Formation of Mapel and Hail (1956). Analytical data: K = 6.86, 6.78%; $*Ar^{40}$ = 3.58 x 10^{-6} cc/gm (47% Σ Ar^{40}). Collected by: A. Y. Young, U. of Utah; dated by: R. L. Armstrong and P. N. Taylor, Yale U.

8. YU-2-AY K-Ar (feldspar) 19.9 ± 4.0 m.y.

(41°52′40″N, 113°56′55″W; sec. 6, T13N, R18W; about 1 km E of Simplot Grouse Creek Ranch, Cottom Thomas Basin quad.; Box Elder Co., UT). Sample from 5 m above a 12 m-thick vitrophyre that overlies vitric tuff with interbedded conglomerate and peat beds 30 to 50 m below the base of the vitrophyre. Age should be the same or only slightly older than sample YU-3-AY. The atmospheric argon yield was exceptionally large. Isotopic fractionation of this contaminating gas might easily explain the anomalously high date (Baksi, 1974). This date should be cited only with reservation because of its doubtful validity. Analytical data: K = 3.48, 3.50%; $*Ar^{40}$ = 2.80, 2.76 x 10^{-6} cc/gm (5.4% Σ Ar^{40}). Collected by: A. Y. Young, U. of Utah; dated by: R. L. Armstrong and P. N. Taylor, Yale U.

9. YU-4-AY K-Ar (whole rock) 16.3 ± 2.0 m.y.

Basalt (41°38′43″N, 114°5′45″W; NE/4SE/4NW/4 sec. 1, T43N, R69E; Dairy Valley quad.; Elko Co., NV). Flow about 15 m thick interbedded with conglomerate. Older than rhyolite YU-1-AY. The date suggests correlation with Columbia River Basalt, making this the easternmost known locality for basaltic lavas of that age. Analytical data: K = 1.04, 1.06%; $*Ar^{40}$ = 0.715, 0.652 x 10^{-6} cc/gm (7.6% Σ Ar^{40}). Collected by: A. R. Young, U. of Utah; dated by: R. L. Armstrong and P. N. Taylor, Yale U.

MISCELLANEOUS VOLCANIC UNITS – ARIZONA, NEW MEXICO, UTAH AND WYOMING

The following samples were dated to assist geologic work in progress and are reported here to insure that complete documentation becomes part of the public record.

10. YU-NR-LH K-Ar (biotite) 26.8 ± 0.4 m.y.

Needles Range Formation, Wah Wah Springs Tuff Member (38°52′50″N, 113°17′30″W; sec. 22, T22S, R13W; Millard Co., UT). Locality shows on USGS Misc. Field Inv. Map MF-633. Discussed by Best and others (1973). Analytical data: K = 4.48, 4.50%; $*Ar^{40}$ = 4.88, 4.81 x 10^{-6} cc/gm (63, 61% Σ Ar^{40}). Collected by: L. Hintze, Brigham Young U.; dated by: R. L. Armstrong and P. N. Taylor, Yale U.

11. YU-CP-LH K-Ar (biotite) 33.9 ± 0.5 m.y.
(feldspar) 39.0 ± 1.0 m.y.

Tunnel Spring Tuff at Crystal Peak (38°47′30″N, 113°36′0″W; sec. 24, T23S, R16W; Millard Co., UT). Locality shows on USGS Misc. Field Inv. Map MF-635. Discussed by Bushman (1973). Analytical data: (biotite) K = 5.96, 5.97%; $*Ar^{40}$ = 8.17, 8.09 x 10^{-6} cc/gm (62, 59% Σ Ar^{40}); (feldspar) K = 0.491, 0.517, 0.486, 0.498%; $*Ar^{40}$ = 0.771, 0.795 x 10^{-6} cc/gm (33, 23% Σ Ar^{40}). Collected by: L. Hintze, Brigham Young U.; dated by: R. L. Armstrong and P. N. Taylor, Yale U.

12. YU-179-PW | K-Ar | (whole rock) 9.7 ± 0.3 m.y.

Basalt, porphyritic, trachytic, fresh-looking (34°15'25"N, 114°0'45"W; SE/4NW/4SE/4 sec. 34, T11N, R17W; 8 km E of Colorado River, S of Bill Williams River, NE of Parker; Yuma Co., AZ). From the base of widespread flows that form prominent mesas north and south of the Bill Williams River. Analytical data: K = 0.659, 0.662%; $*Ar^{40}$ = 0.258, 0.255 x 10^{-6} cc/gm (22, 18% Σ Ar^{40}). Collected by: P. Wicklein, Colo. School Mines; dated by: R. L. Armstrong and P. N. Taylor, Yale U.

13. YU-MP 1 | K-Ar | (whole rock) 2.2 ± 0.3 m.y.

Basalt (35°27'18"N, 107°1'49"W; sec. 10, T14N, R2W; Sandoval Co., NM). From the middle of a 5 m thick series of flows that cover the Mesa Prieta. The age of the flow should represent the age of the Ortiz surface. Analytical data: K = 0.345, 0.335%; $*Ar^{40}$ = 0.0295 x 10^{-6} cc/gm (6.5% Σ Ar^{40}). Collected and dated by: W. Graustein, Yale U.

14. YU-JCD 1 | K-Ar | (whole rock) 2.6 ± 0.2 m.y.

Basalt (35°23'37"N, 106°32'44"W; sec. 32, T14N, R4E; Sandoval Co., NM). From a roadcut leading to Jemez Canyon dam from the south. Like the Mesa Prieta sample, this should represent the time at which a portion of the Ortiz surface was covered with basalt and preserved from erosion. Analytical data: K = 0.666, 0.680%; $*Ar^{40}$ = 0.068 x 10^{-6} cc/gm (11% Σ Ar^{40}). Collected and dated by: W. Graustein, Yale U.

15. YU-YAG222 | K-Ar | (whole rock) 42.3 ± 1.0 m.y.

Porphyritic amygdaloidal mafic volcanic (44°17'45"N, 109°12'00"W; NE promontory of Carter Mountain, S of Cody; Park Co., WY). Trout Peak Trachyandesite = Early basalt sheets of the Absaroka Mountains (Pierce, 1970). Enclosing sediments contain Eocene mammal faunas. The date is probably a bit low due to Ar loss from poorly retentive interstitial phases in the rock. Analytical data: K = 3.44, 3.46%; $*Ar^{40}$ = 5.90 x 10^{-6} cc/gm (52% Σ Ar^{40}). Collected by: E. L. Simons, Yale U.; dated by: R. L. Armstrong, Yale U.

PHILLIPSBURG BATHOLITH

One date was determined to establish the pre-Cenozoic age of structures cut by the batholith and thus more precisely pin down the age of orogenic deformation in Montana. The date is somewhat younger than concordant hornblende and biotite dates reported for the Phillipsburg batholith by Hyndman and others (1972). Jaffe and others (1959) reported a Pb-α date of 52 m.y. for a nearby locality. The K-Ar dates indicate a minimum age of Upper Cretaceous, and contemporaneity with the Boulder batholith (Robinson and others, 1968). Both granitic bodies crosscut fold thrust belt structures which must be thus of Cretaceous age – Seiver orogeny (Armstrong, 1967) and not Laramide in the sense used in Wyoming by Keefer and Love (1963).

A controversey exists concerning the dating of the fold and thrust belt in Canada and the U. S. (Armstrong and Oriel, 1965; Mountjoy, 1966; Oriel and Armstrong, 1966). Evidence for thrusting mostly during the Cretaceous is clear from southern California (Adams and others, 1967; Burchfiel, and Davis, 1971) through Nevada and Utah (Armstrong, 1968), Idaho and Wyoming (Armstrong and Oriel, 1965; Oriel and Armstrong, 1966) and into western Montana as indicated by the batholith dates.

The evidence that most of the foothills deformation in Canada predates the younger Paleocene Paskapoo-Porcupine Hills clastics ("the true eastern limit of foothills structure lies buried beneath the Paskapoo formation" – Fox, 1959; Bossart, 1957) is consistent with the concept of Cretaceous through Paleocene thrust times in the U. S. although the Canadian deformation may be slightly younger, as suspected by Oriel and Armstrong (1966). Available evidence does not support the assertion found in much Canadian literature (Nelson and others, 1964) that the Rocky Mountain – "Laramide" orogeny in Canada occurred in the Eocene.

16. YU-YAG 788 K-Ar (biotite) 65.6 ± 2.0 m.y.

Hornblende biotite granodiorite, Phillipsburg batholith (46°20'0"N, 113°15'25"W; E side of town of Granite, E of Phillipsburg; Granite Co., MT). Analytical data: K = 6.79, 6.80%; $*Ar^{40} = 18.11 \times 10^{-6}$ cc/gm (78% ΣAr^{40}). Collected and dated by: R. L. Armstrong, Yale U.

EASTERN NEVADA – METAMORPHIC ROCKS

The following three dates were determined for samples collected in 1961 and 1963 by R. L. Armstrong and dated many years later. The Precambrian date for the basement rocks exposed at Frenchman Mountain is in agreement with results for other basement rocks in southern Nevada and nearby California (Lanphere, 1964; Wasserburg and Lanphere, 1969). The Miocene date for a mylonitic gneiss is slightly older than dates on gneisses from structurally deeper settings in the Ruby – East Humboldt Mountains and vicinity (Armstrong and Hansen, 1966; Armstrong, 1970b; Kistler and Willden, 1969; Kistler and O'Niel, 1975; Thorman, 1966; Snoke, 1975). A Triassic date for a hornblende concentrate from McCoy Creek, in the Schell Creek Range is anomalous, perhaps due to incorporation of radiogenic Ar during Mesozoic regional metamorphism. Similar anomalies have been observed in other low-K chlorite, actinolite, and hornblende-bearing low-grade metamorphic rocks in several localities in Nevada and Idaho (Snoke, 1975; Armstrong, 1975). No special significance can be attached to such dates until they are confirmed or rejected by Rb-Sr mineral isochrons on the same rock units.

17. YU-31 K-Ar (biotite) 1385 ± 40 m.y.

Biotite-rich inclusion from pegmatitic microcline granite (115°0'10"N, 36°11'30"W; SW/4 Frenchman Mountain; sec. 24, T20S, R62E; Clark Co., NV). This result supercedes a date of 1375 m.y. obtained by neutron activation analysis for Ar from the same mineral separate and reported in Armstrong (1964). Analytical data: K = 7.20, 7.14%; $*Ar^{40} = 584 \times 10^{-6}$ cc/gm (96% ΣAr^{40}). Collected and dated by: R. L. Armstrong, Yale U.

18. YU-237 K-Ar (muscovite and quartz) 26.0 ± 0.8 m.y.

Micaceous mylonitic quartzite-gneiss (40°51'45"N, 115°14'10"W; NW/4 sec. 5, T34N, R60E; Secret Pass, Ruby – East Humboldt Range; Elko Co., NV). Analytical data: K = 3.49, 3.49%; $*Ar^{40} = 3.66 \times 10^{-6}$ cc/gm (61% ΣAr^{40}). Collected and dated by: R. L. Armstrong, Yale U.

19. YU-192A K-Ar hornblende (minor quartz and chlorite) 232 ± 6 m.y.

Amphibolite (39°22'15"N, 114°32'0"W; NW/4 sec. 3, T17N, R66E; McCoy Creek, Schell Creek Range; White Pine Co. NV). Anomalous date may be due to presence of excess Ar trapped during Mesozoic recrystallization. Analytical data: K = 0.196, 0.190, 0.185%; $*Ar^{40} = 1.87 \times 10^{-6}$ cc/gm (48% ΣAr^{40}). Collected and dated by: R. L. Armstrong, Yale U.

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