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POTASSIUM-ARGON AGES OF SOME MINERALS FROM IGNEOUS ROCKS OF WESTERN NEVADA

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Twelve new potassium-argon ages of minerals from Tertiary and Mesozoic (and Permian ?) rocks in the Dixie Valley and Mina regions of western Nevada are given below. Eleven of the analyses (sample nos. with YU prefixes) were made in 1969 at the geochronology laboratory of Yale University by Armstrong; one analysis was made (USGS(M) prefix) in 1968 at the Menlo Park laboratory by E. H. McKee and L. B. Schlocker of the U. S. Geological Survey. An additional date (I prefix) was determined in 1964 by R. Kologrivov, Isotopes, Inc.; cited elsewhere (Page, 1965), this date is presented here for completeness. Specimen collection and mineral separations were by Speed. The ages listed here were obtained as part of a continuing investigation of the tectonic evolution of western Nevada; we will employ them in local and regional tectonic studies to be presented elsewhere.

The new data were obtained using standard analytical techniques as described by Armstrong (1970). 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; $K\lambda_\beta = 4.72 \times 10^{-10}\,yr^{-1}$, $K\lambda_e = 0.584 \times 10^{-10}\,yr^{-1}$. 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

A. Intrusive Rocks -- Nevada

YU-SW341 K/Ar (hornblende) 156±2 m.y.

Humboldt lopolith. Hornblende gabbro (NE/4 SE/4 SE/4 Sec. 9, T. 24 N., R. 35 E.; 39°57'30"N., 118°02'30"W.; Stillwater Range; Churchill Co., NV) from a body which is relatively late in the sequence of gabbroic and ultramafic bodies that constitute the Humboldt lopolith (Speed, 1963, 1967); from near the center of the exposed part of the lopolith. Sample is medium-grained assemblage of labradorite (55%), clinopyroxene (5%), and poikilitic titaniferous brown hornblende (35%). A small amount of the brown hornblende was altered deuterically to green amphibole as was feldspar to epidote and albite; there has been no thermal metamorphism. Analytical data: K = 0.519, 0.507%; $\overset{*}{A}r^{40}$ = 0.00591 ppm (47% ΣAr^{40}), 0.00598 ppm (58% ΣAr^{40}); analyzed separate was 97.5% hornblende, 2.5% amphibole and epidote. Collected by: R. Speed, Northwestern Univ. Comment: Published K/Ar ages of 150±3 (biotite) and 145±5 and 165±5 (biotite-hornblende pair) from the Humboldt lopolith are from its eastern and western margins (Speed and Jones, 1969). See also YU-BV100 below.

YU-BV100 K/Ar (hornblende) 151±4 m.y.

Humboldt lopolith. Hornblende from a vein (NW/4 SE/4 SE/4 Sec. 4, T. 24 N., R. 34 E.; 39°59'30"N., 118°09'50"W.; 1/2 mi NW of Buena Vista Mine; Buena Vista Hills; Churchill Co., NV) which fills space created by late stage brecciation of scapolitite near the top center of the lopolith. The vein emplacement was perhaps the latest event in the magmatic and hydrothermal history of the lopolith. The vein also contains scapolite, magnetite, and chlorite. The hornblende is pale to greenish brown and occurs in grains 1 to 10 mm long; jackets of altered pale green and colorless amphibole occur on many hornblende grains. Analytical data: K = 0.209, 0.209%; Ar^{40} = 0.00232 ppm (22% Ar^{40}), 0.00235 ppm (28% Ar^{40}); analyzed sample is 96% hornblende, 4% altered amphibole. Collected by: R. Speed, Northwestern Univ. Comment: See YU-SW341 above.

YU-N1500 K/Ar (hornblende) 202±3 m.y.

Crow Springs pluton. Porphyritic granodiorite (NE/4 Sec. 34, T. 5 N., R. 39 E.; 38°15'N., 117°34'W.; 2 mi E of Crow Springs; southern Cedar Mtns.; Esmeralda Co., NV) from a body exposed over an area of less than one square mile. Granodiorite consists of plagioclase, quartz, 10-15% hornblende, and highly variable abundances of coarse potash feldspar phenocrysts. Analytical data: K = 0.414, 0.418%; $\overset{*}{A}r^{40}$ = 0.00630 ppm

(60% ΣAr^{40}), 0.00635 ppm (59% Ar^{40}); analyzed separate was >99% hornblende having a +100 mesh grain size. Collected by: R. Speed, Northwestern Univ. and J. Quade, Univ. of Nevada, Reno. Comment: This body and others in the vicinity intrude chert and greenstone which were originally assigned to the Triassic Excelsior Formation (Ferguson and Muller, 1949) but are believed to be correlative with Late Paleozoic Havallah and Pumpernickel Formations. The age of the granodiorite near Crow Springs is similar to age of granitic rocks in the vicinity of Lee-Vining, California, 60 miles southwest, which are thought by Evernden and Kistler (1970) to have constituted the first pulse of the long continued intrusive history of the Sierra Nevada batholith.

YU-CA140 K/Ar (biotite) 103±2 m.y.

Meadow Springs pluton. Medium-grained quartz monzonite (NE/4 SE/4 SW/4 Sec. 6, T. 21 N., R. 37 E.; 39°42'36"N., 117°51'24"W.; in Meadow Spring Canyon, Clan Alpine Mtns.; Churchill Co., NV) consisting of plagioclase, anhedral K feldspar and quartz, and 10-20% brown fresh euhedral biotite. Pluton crops out over 4 square miles. Analytical data: K = 7.23, 7.12%; $\overset{*}{A}r^{40}$ = 0.0539 ppm (83% ΣAr^{40}); analyzed separate was >99% biotite having a +80 mesh grain size. Collected by: R. Speed, Northwestern Univ. Comment: This pluton intrudes Upper Triassic clastic rocks and is locally overlain by Tertiary andesite (Willden and Speed, in press).

YU-CA150 K/Ar (biotite) 87.4±2 m.y.

Tungsten Mountain pluton. Fine- to medium-grained granodiorite (NE/4 SE/4 NW/4 Sec. 21, T. 21 N., R. 38 E.; 39°40'30"N., 117°43'W.; at Stone Canyon, Clan Alpine Mtns.; Churchill Co., NV) consisting of plagioclase, K feldspar, quartz, and 10-15% euhedral brown biotite. The pluton is exposed over an area of less than a square mile. Analytical data: K = 6.18, 6.08%; $\overset{*}{A}r^{40}$ = 0.0391 ppm (83% ΣAr^{40}); analyzed sample was > 99% biotite (grain size +80 mesh). Collected by: R. Speed, Northwestern Univ. Comment: This pluton invades Upper Triassic clastic rocks (Willden and Speed, in press, esp. fig. 12).

YU-WH23 K/Ar (biotite) 75.9±1.5 m.y.

Topog Peak pluton. Medium-grained quartz monzonite (NE/4 SW/4 NE/4 Sec. 31, T. 24 N., R. 30 E.; 39°54'30"N., 118°38'W.; one mi N of Topog Pk., southwest flank West Humboldt Range; Churchill Co., NV) consisting of 55% plagioclase, 10% K feldspar, 20% quartz, and 15% biotite and amphibole. The pluton is exposed over less than 1/4 square mile. Analytical data: K = 6.55, 6.59%; $\overset{*}{A}r^{40}$ = 0.0363 ppm (82% ΣAr^{40}); analyzed separate was 99% biotite (grain size +80 mesh). Collected by: R. Speed, Northwestern Univ. Comment: This pluton intrudes calcareous siltstone and

sandstone of probable Lower Jurassic age (Willden and Speed, in press). The widespread contact metamorphism of pre-Tertiary rocks from Topog Pk. northeast for 3 miles indicates that granitic rock occurs under most of this part of the West Humboldt Range at shallow depth. The dated quartz monzonite thus probably represents a small exposure of much more laterally extensive pluton.

USGS(M)-NKS7-3 K/Ar (biotite) 69±3 m.y.

New York Canyon pluton. Medium-grained biotite quartz monzonite (NW/4 SE/4 Sec. 11, T. 25 N., R. 35 E.; 40°02'57"N., 118°00'31"W.; Stillwater Range; Pershing Co., NV). Pluton crops out over about 2 square miles. Analytical data: K = 6.68, 6.57, 6.55, and 6.60%; $\overset{*}{A}r^{40}$ = 0.0274 ppm (83%ΣAr^{40}); analyzed fraction (lab no. RS-67-B-McK) was > 99% biotite (grain size +60 mesh). Collected by: N. K. Stablein, Northwestern Univ. Comment: Pluton intrudes Upper Triassic pelites (Willden and Speed, in press; Wallace, et al., 1969); the petrography and structure were studied by Stablein (1969).

I-SW193 K/Ar (biotite) 28±2 m.y.

IXL Canyon pluton. Quartz monzonite (floor of IXL Canyon, 200 yards upstream from mouth, T. 21 N., R. 34 E.; 39°41'27"N., 118°08'20"W.; Stillwater Range; Churchill Co., NV). Rock is fine- to coarse-grained plagioclase, K feldspar and quartz in variable quantities, and brown biotite. Analytical data: K = 6.91%; $\overset{*}{A}r^{40}$ = 0.0136 ppm (69%ΣAr^{40}); analyzed separate was > 99% biotite (grain size +80 mesh). Collected by: B. M. Page, Stanford Univ., and R. Speed, Northwestern Univ. Cited: Page, 1965. Comment: This large composite pluton (Page, 1965) invades and metamorphoses welded tuff of post-Triassic and probable Tertiary age; the intrusive and extrusive rocks are probably cogenetic.

B. Extrusive Rocks -- Nevada

YU-M1 K/Ar (hornblende) 252±3 m.y.

Andesite of Black Dyke Mountain. (SE/4 NE/4 NW/4 Sec. 26. T. 7 N., R. 34 E.; 38°26'26"N., 118°07'39"W.; Garfield Hills; Mineral Co., NV) from a one-foot diameter andesite pillow fragment in a clast-supported breccia with a matrix of fine unsorted tuff. The structure and lithic uniformity of the clasts indicates the breccia is primary and not sedimentary. The essential minerals are plagioclase, green-brown hornblende, and chlorite; hornblende occurs as unaltered acicular phenocrysts between 1 and 3 mm long. Spotty alteration of feldspar and sparse epidote spherules and veinlets suggest possible low-rank metamorphism but the freshness of the hornblende and similarity of ages of YU-M1 and YU-M2 (see below) indicates the absence of pervasive recrystallization or significant heating. Analytical data: K = 0.751, 0.769, 0.751%; $\mathring{A}r^{40}$ = 0.0145 ppm (63%ΣAr^{40}), 0.0145 ppm (74%ΣAr^{40}); analyzed fraction was 92% hornblende, 8% epidote and chlorite (grain size +100 mesh). Collected by: R. Speed, Northwestern Univ. Comment: The dated lithic unit consists predominantly of pyroxene and hornblende andesite pillow breccia and interbedded andesite-feldspar clastic sedimentary rocks. At Black Dyke Mtn., the unit lies with thrust contact above the Dunlap Formation (Toarcian) and Luning Formation (Upper Triassic). The andesite was originally included in the Triassic Excelsior Formation by Ferguson and Muller (1949) and was believed to be correlative with the middle member of the Luning Formation by Nielsen (1963). Current studies indicate the Excelsior Formation comprises several discrete rock stratigraphic units which have probable ages which range from Pennsylvanian to Jurassic. The andesite of Black Dyke Mtn., together with rocks of similar lithology at other places in the Garfield Hills and in the Excelsior Mtns. that have been assigned to the Excelsior and Dunlap Formations by Ferguson and Muller (1949), are here proposed to constitute a single allocthonous lithic unit of volcanic rocks of Lower Triassic to Upper Permian age. Samples YU-M2, YU-Exc68, and YU-Exc1 (below) are from three other localities in this newly delineated unit.

YU-M2 K/Ar (hornblende) 253±3 m.y.

Andesite of Black Dyke Mountain. (SE/4 SE/4 NW/4 Sec. 23, T. 7 N., R. 34 E.; 38°27'05"N., 118°07'56"W.; Garfield Hills; Mineral Co., NV) from a porphyritic andesite pillow in the same lithic unit from which YU-M1 (above) was obtained; YU-M2 is similar to YU-M1 except that the hornblendes in M2 are coarser, blockier prisms and average 6 mm in length. Analytical data: K = 0.592, 0.592%; $\mathring{A}r^{40}$ = 0.0114 ppm (68%ΣAr^{40}), 0.0145

ppm (65%ΣAr^{40}); analyzed separate was 98.3% brown hornblende, 1.7% epidote and chlorite (grain size +100 mesh). Collected by: R. Speed, Northwestern Univ. Comment: See also YU-M1 (above), and YU-Exc68 and YU-Exc1 (below).

YU-Exc68 K/Ar (hornblende) 253±3 m.y.

Andesite of central Excelsior Mts. (SE/4 NE/4 SE/4 Sec. 21, T. 5 N., R. 33 E.; 38°17'05"N., 118°18'30"W.; Excelsior Mts.; Mineral Co., NV) from a 5-inch diameter breccia fragment from a unit of breccia and interbedded volcanogenic clastic sedimentary rocks which are petrographically similar to andesites from which YU-M1 and YU-M2 (above) were obtained. The fragment consists of andesine, brown hornblende, epidote, chlorite, and iron oxide; the hornblende occurs as unaltered 5-10 mm acicular phenocrysts. The rock is virtually unmetamorphosed. Analytical data: K = 0.909, 0.929, 0.912%; $\ddot{A}r^{40}$ = 0.01782 ppm (73%ΣAr^{40}), 0.01752 ppm 82%ΣAr^{40}); analyzed separate was 96.0% hornblende, 4% other minerals, chiefly chlorite (grain size was +100 mesh). Collected by: R. Speed, Northwestern Univ. Comment: The andesite lies above the Dunlap Formation (Toarcian) and was originally included in the Dunlap by Ferguson and Muller (1949); it is here correlated with andesite (YU-M1 and YU-M2 above) in the Garfield Hills and is believed to have been thrust to its present position in post-Toarcian time (later than the emplacement of the Luning Formation on thrusts exposed in the Pilot Mtns. and Garfield Hills).

YU-Exc1 K/Ar (hornblende) 211±3 m.y.

Andesite of central Excelsior Mts. (SE/4 NE/4 SE/4 Sec. 21, T. 5 N., R. 33 E.; 38°17'00"N., 118°18'20"W.; Excelsior Mts.; Mineral Co., NV) from a homogenous, very feldspathic, hornblende-bearing breccia from the same lithic unit but 200 feet stratigraphically above YU-Exc68. The hornblende is mottled brownish green and occurs as stubby 3-4 mm long phenocrysts. Analytical data: K = 1.00, 1.03%; $\ddot{A}r^{40}$ = 0.0602 ppm (79%ΣAr^{40}), 0.01623 ppm (84%ΣAr^{40}); analyzed separate was 96.9% hornblende, 3% chlorite, epidote, and feldspar (grain size +100 mesh). Collected by: R. Speed, Northwestern Univ. Comment: The age difference YU-Exc1 and YU-Exc68 is believed to be due to alteration of the amphibole in YU-Exc1 and perhaps to some included feldspar. Field observations provide no basis for subdivision of the andesite into two units of significant age difference.

YU-Aug1 K/Ar (clinopyroxene) 24±5 m.y.

Andesite of southern Augusta Mts. (NE/4 NE/4 SW/4 Sec. 15, T. 24 N., R. 39 E.; 39°56'47"N., 117°34'36"W.; Augusta Mts.; Churchill Co., NV)

from porphyritic lava consisting of 70% plagioclase, 10% clinopyroxene, 5% brown hornblende, and 15% glass, and lying unconformably on Triassic rocks and below siliceous tuffs. Analytical data: K = 0.041, 0.042%; $\mathring{A}r^{40}$ = 0.000066 ppm (2.3% ΣAr^{40}), 0.000073 ppm (3.1% ΣAr^{40}); analyzed fraction was > 99% clinopyroxene (grain size -100 mesh). Collected by: R. Speed, Northwestern Univ.

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