Potassium- Argon ages of plutonic rocks and associated vein and alternation minerals, northeast Sierra Nevada, California and Nevada

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POTASSIUM-ARGON AGES OF PLUTONIC ROCKS AND ASSOCIATED VEIN AND ALTERATION MINERALS, NORTHEAST SIERRA NEVADA, CALIFORNIA AND NEVADA[1]

LARRY J. GARSIDE
HAROLD F. BONHAM, JR. — *Nevada Bureau of Mines and Geology, Reno, NV 89557*
EDWIN H. McKEE — *U.S. Geological Survey, Menlo Park, CA 94025*

Seven new potassium-argon ages on granitic rocks, greisen-like alteration associated with granitic rocks and sericite adjacent to vein mineralization are reported here. The rocks were dated as part of regional mineral resource assessment studies by the Nevada Bureau of Mines and Geology and the U.S. Geological Survey. In this case, the studies were focused on areas north and west of Reno (fig. 1), in the Jurassic(?) Peavine sequence and in Cretaceous rocks of the Sierra Nevada batholith. Pluton emplacement and(or) mineralization are determined to be Cretaceous or, for sample 4558 (no. 7), Jurassic in age.

ANALYTICAL METHODS

The K-Ar sample preparation and analyses were done in the laboratories of the U.S. Geological Survey, Menlo Park, California. Analyses were by standard isotope dilution procedures as described by Dalrymple and Lanphere (1969). The mineral concentrates were made at the Nevada Bureau Mines and Geology using heavy-liquid, magnetic, electrostatic, and hand picking procedures. Potassium analyses were performed by lithium metaborate flux fusion flame photometry techniques, the lithium serving as an internal standard (Ingamells, 1970). Argon analyses were performed using a 15.2-cm-radius, Neir-type mass spectrometer or a five-collector mass spectrometer (Stacey and others, 1981). The precision of the data, shown as the ± value, is the estimated analytical uncertainty at one standard deviation. It represents uncertainties in the measurement of radiogenic ^{40}Ar and K_2O based on experience with hundreds of replicated analyses in the Menlo Park laboratories. Mass discrimination of the spectrometer is routinely determined on the basis of multiple analyses of purified air. The constants used in age determination are those from the subcommission on Geochronology (Steiger and Jaeger, 1977).

SAMPLE DESCRIPTIONS

1. *V-204* — K-Ar
Biotite-hornblende granodiorite (39°35′26″N, 119°59′39″W; NE¼ NE¼ NE¼, S19,T20N,R18E; NW flank of Peavine Peak, Verdi 7.5′ quad., Washoe Co., NV). *Analytical data:* K_2O = 8.56%; $^{40}Ar^*$ = 1.1467 × 10^{-9} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.890. *Collected by:* L. J. Garside. *Analyzed by:* E. H. McKee. *Comments:* Intrudes Jurassic(?) Peavine sequence metavolcanic rocks (Bell and Garside, 1987); the age is similar to 90 Ma granodiorite dated at Beckworth Pass 20 km to the north (Evernden and Kistler, 1970, p. 31, 36).
(biotite) 90.7 ± 2.9 Ma

2. *GCH-103* — K-Ar
Hornblende microdiorite porphyry (39°32′54″N, 120°04′26″W; NW¼ NW¼ NE¼, S34,T20N,R17E; 2 km southeast of Crystal Peak, Dog Valley 7.5′ quad., Sierra Co., CA). *Analytical data:* K_2O = 0.632; $^{40}Ar^*$ = 7.20759 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.609. *Collected by:* L. J. Garside. *Analyzed by:* E. H. McKee. *Comments:* On geologic evidence, the date is considered to be too young; the rock unit is interpreted as a subvolcanic intrusive associated with Jurassic(?) Peavine sequence metavolcanics exposed in the northern Verdi Range. The dated unit is apparently intruded by 90.7 Ma granodiorite (V-204), and aplite/pegmatite dikes cut it near the sampled site. The rock is locally epidotized and fine-grained secondary biotite is developed. The date is quite young for Sierra Nevada batholith ages from this area (Evernden and Kistler, 1970) as well. Considering the geologic relations and the generally older pluton dates in the area, the possibility of resetting by Mesozoic and(or) Tertiary heating events is considered likely.
(hornblende) 77.5 ± 2.3 Ma

3. *4504AD* — *K-Ar*
*Sericite (39°*44′15.7″N, 120°07′15.3″W; SW¼ SW¼, S19,T22N,R17E; N of Roberts Canyon, Evans Canyon 7.5′ quad., Lassen Co., CA). *Analytical data:* K_2O = 10.00%; $^{40}Ar^*$ = 1.30687 × 10^{-9} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.94. *Collected by:* L. J. Garside. *Analyzed by:* E. H. McKee. *Comments:* Coarse sericite occurs as local concentrations (possibly as sericitized wall rock fragments) in a vein with quartz, pyrite, and sparse black tourmaline. Wall rock is Jurassic(?) Peavine sequence meta-andesite. Molybdenite occurs in nearby similar quartz-tourmaline veins.
(sericite) 88.6 ± 3.0 Ma

4. *4509* — K-Ar
Sericite (39°44′6.2″N, 119°59′51.8″W; Center NE¼ NE¼, S31,T22N,R18E; Peterson Mountain, Reno NW 7.5′ quad., Washoe Co., NV). *Analytical data:* K_2O = 7.89%; $^{40}Ar^*$ = 1.02610 × 10^{-9} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.965. *Collected by:* L. J. Garside. *Analyzed by:* E. H. McKee. *Comments:* Coarse to fine sericite occurs as a hydrothermal alteration product in wall rock adjacent to a NW-trending quartz-black tourmaline vein at the Antelope Mine. Oxidized copper minerals and traces of gold and silver occur in the vein (Bonham, 1969); wall rock is metadacite hypabyssal(?) intrusive rock of the Jurassic(?) Peavine sequence.
(sericite) 88.1 ± 2.5 Ma

[1]age determination done under the U.S.G.S-N.B.M.G. cooperative program

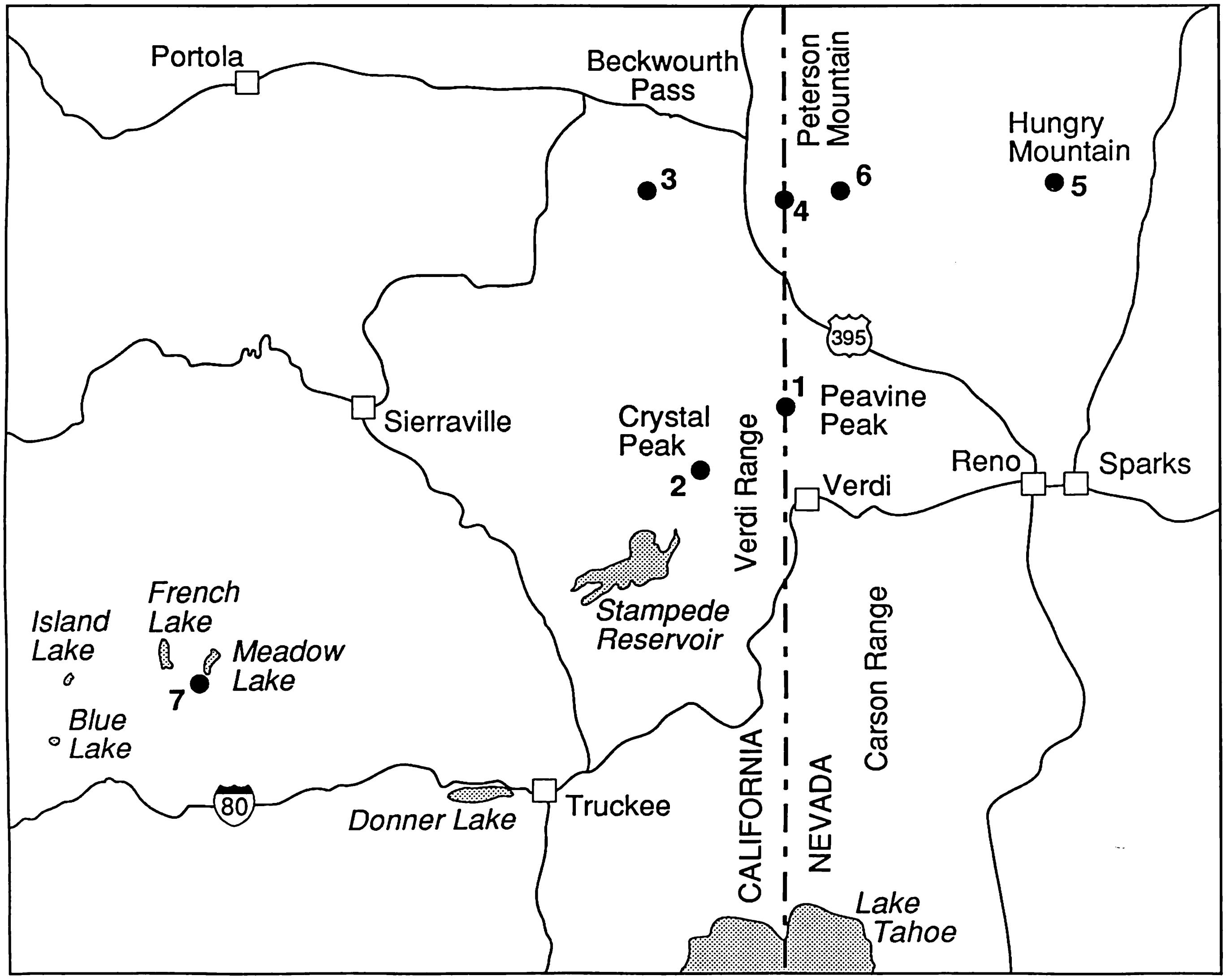

FIGURE 1. Index map for sample localities in the northeast Sierra Nevada, California and Nevada.

5. *3431AD* K-Ar
Muscovite (39°45′5.3″N, 119°45′54.2″W; NW¼ NE¼ NW¼, S29,T22N,R20E; E flank of Hungry Mountain, Bedell Flat 7.5′ quad., Washoe Co., NV). *Analytical data:* K_2O = 8.78%; $^{40}Ar^*$ = 1.12212 × 10^{-9} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.81. *Collected by:* L. J. Garside. *Analyzed by:* E. H. McKee. *Comments:* Greisen-like alteration (quartz-muscovite-rutile) associated with Ti mineralization in Cretaceous(?) hornblende-biotite granodiorite (Garside, in press).

(muscovite) 86.7 ± 3.0 Ma

6. *RNW-6* K-Ar
Quartz diorite of Peterson Mountain (39°44′34.5″N, 119°57′28.6″W; NW¼ NW¼ SW¼, S27, T22N,R18E; E flank of Peterson Mountain, Reno NW 7.5′ quad., Washoe Co., NV). *Analytical data:* K_2O = 8.92%; $^{40}Ar^*$ = 1.17798 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.91. *Collected by:* L. J. Garside. *Analyzed by:* E. H. McKee. *Comments:* Massive, medium- to coarse-grained, dark gray hornblende-biotite quartz diorite. Based on field relations, the unit is believed to be the oldest of a comagmatic group of plutons which become more mafic with increasing age (Garside, in press). Compare with sample V-204 (no. 1).

(biotite) 89.5 ± 3.0 Ma

7. *4558* K-Ar
Granodiorite of French Lake (39°23′41.5″N, 120°30′27.6″W; SW¼ NW¼ SW¼, S27, T18N,R13E; about 200 m southwest of the Excelsior mine, near the southwest end of Meadow Lake, English Mountain 7.5′ quad., CA. *Analytical data:* (biotite) K_2O = 8.89%; $^{40}Ar^*$ = 1.84938 × 10^{-9} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.93; (hornblende) K_2O = 0.517%; $^{40}Ar^*$ = 1.17543 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.65. *Collected by:* H. F. Bonham, Jr. *Analyzed by:* E. H. McKee. *Comments:* The granodiorite of French Lake (Schweickert and others, 1984, Fig. L8) was described by Bowman (1983) as a quartz diorite. The reason for the age discordance of

the biotite and hornblende determinations is not known, but argon loss due to reheating is suspected. Because granitic rocks of the Sierra Nevada are not known to have excess argon incorporated in the major minerals at the time of formation (Evernden and Kistler, 1970, p. 9), and because hornblende usually retains argon better than biotite, the older date is preferred. U-Pb age determinations on zircon of 163-172(?) Ma (Wracher and others, 1991) on older(?) parts of a plutonic complex which may include the granodiorite of French Lake also suggest that a Jurassic age is reasonable for the granodiorite. Additionally, the 151 Ma date compares favorably with the K-Ar age of a slightly older (154 and 157 Ma) granitic pluton exposed 26 km to the north near Chapman Creek Campground (Evernden and Kistler, 1970). For all of these reasons, the age of 151 Ma should be considered a minimum. In the vicinity of the Excelsior mine, the French Lake granodiorite is cut by copper- and gold-bearing quartz-tourmaline veins; if the age of the granodiorite is corectly dated at 115 Ma, this mineralization is at least somewhat younger. This mineralization is reported to be cut by Cretaceous (probably 100 Ma, see Evernden and Kistler, 1970) granodiorite (Bowman, 1983, p.106). Mineralization in fine-grained clastic rocks of the Sailor Canyon Formation adjacent to the northern margin of the pluton is interpreted to be related to the French Lake pluton. Copper- and molybdenum-bearing skarn mineralization at the Molly mine (Center E½ sec. 12,T18N,R12E) occurs immediately adjacent to the pluton, and late-stage(?) quartz veinlets cut both the pluton and Sailor Canyon Formation. A nearby massive, vein-like replacement deposit of pyrrhotite + magnetite + chalcopyrite is also interpreted as a metasomatic replacement deposit associated with the French Lake pluton.

(biotite) 139.0 ± 4.0 Ma
(hornblende) 151.4 ± 4.5 Ma

REFERENCES

Bell, J. W., and Garside, L. J., 1987, Geologic map of the Verdi Quadrangle, Nevada: Nevada Bureau of Mines and Geology Urban Series, Map 4Gg.

Bonham, H. F., Jr., 1969, Geology and mineral deposits of Washoe and Storey Counties, Nevada, *with a section on* industrial rock and mineral deposits by K. L. Papke: Nevada Bureau of Mines and Geology Bulletin 70, 140 p.

Bowman, J. K., 1983, Geology and mineralization of the Meadow Lake mining district, Nevada County, California: M.S. thesis, California State University, Hayward, 268 p.

Dalrymple, G. B., and Lanphere, M. A., 1969, Potassium-argon dating: San Francisco, W. H. Freeman Company, 258 p.

Evernden, J. F., and Kistler, R. W., 1970, Chronology of emplacement of Mesozoic batholithic complexes in California and western Nevada: U.S. Geological Survey Professional Paper 623, 43 p.

Garside, L. J., in press, Geologic map of the Bedell Flat Quadrangle, Nevada: Nevada Bureau of Mines and Geology Map.

Ingamells, C. O., 1970, Lithium metaborate flux in silicate analysis: Analytica Chimica Acta, V. 52, p. 323–334.

Schweickert, R. A., Harwood, D. S., Girty, G. H., and Hanson, R. E., 1984, Tectonics of the northern Sierra Nevada — Roadlog, *in* Lintz, J., Jr, Western geological excursions, v. 4: Geological Society of America and Department of Geological Sciences, University of Nevada, Reno, guidebook for the 1984 annual meetings of the Geological Society of America.

Stacey, J. S., Sherrill, N. D., Dalrymple, G. B., Lanphere, M. A., and Carpenter, N. V., 1981, A five-collector system for the simultaneous measurement of argon isotopic ratios in a static mass spectrometer: International Journal of Mass Spectrometry and Ion Physics, v. 39, p. 167–180.

Steiger, R. H., and Jaeger, E., 1977, Subcommission on geochronology-convention on the use of decay constants in geo- and cosmochronology: Earth and Planetary Science Letters, v. 36, p. 359–362.

Wracher, M. D., Girty, G. H., and Wardlaw, M. S., 1991, Deformation in the Shoo Fly Complex and the role of a Middle Jurassic plutonic complex, northern Sierra Nevada, California: Geological Society of America, Abstracts with Programs, v. 23, no. 2, p. 111.