Zoning and chronology of hydrothermal events in the Humboldt Range, Pershing county, Nevada

P.G. Vikre and E.H. McKee

Isochron/West, Bulletin of Isotopic Geochronology, v. 44, pp. 17-24

This page is intentionally left blank to maintain order of facing pages.

ZONING AND CHRONOLOGY OF HYDROTHERMAL EVENTS IN THE HUMBOLDT RANGE, PERSHING COUNTY, NEVADA

PETER G. VIKRE — *ASARCO Inc., Reno, NV 89502*
EDWIN H. McKEE — *U.S. Geological Survey, Menlo Park, CA 94025*

The Humboldt Range, an elongate north-south horst in the west-central Great Basin of Nevada (fig. 1), abounds in a variety of hydrothermal mineral deposits (Johnson, 1977). The distribution of metal mines and prospects displays a spatial relation to both intrusive rocks and older stratigraphy. K-Ar dates for hydrothermal phases reported here indicate that most if not all deposits were formed during several Cretaceous intrusive events.

The Humboldt Range consists mainly of Triassic rocks (fig. 2). Lower Triassic volcanic rocks of the Koipato Group are overlain by limestones of the Star Peak Group which in turn are overlain by phyllite, partly Jurassic in age, of the Auld Lang Syne Group (Silberling and Wallace, 1967; Wallace and others, 1969a, 1969b). These lower Mesozoic strata are intruded by granitic rocks. The largest intrusion, the Rocky Canyon stock, has been dated by K-Ar methods at 71.4 ± 3.0 m.y. by Silberman and others (1973). Numerous other dikes and apophyses of coarse-grained granitic rocks, along with magnetic data, suggest that granitic intrusions underlie the entire central part of the range. The suspected position of buried Cretaceous intrusions is outlined on figure 3.

The distribution of ore deposits shows that tungsten, gold, silver, antimony, and mercury are concentrically concentrated around the Rocky Canyon stock and intrusive subcrop (fig. 3). Tungsten occurrences are somewhat scattered relative to coarse-grained intrusions, but the largest deposit borders the Rocky Canyon stock. With local exceptions, gold, silver, antimony, and mercury deposits are annularly distributed around the subsurface intrusive center with mercury occurrences distal. Gold and silver deposits occur in overlapping zones while antimony and mercury display a more regular circumferential relationship.

Stratigraphic control on both the type and size of metal deposit is evident when metal production is ranked against stratigraphy (fig. 4). The bulk of gold mineralization occurs in rhyolite and greenstone of the Lower Triassic Koipato Group. The large silver deposits are in rhyolites of the Koipato Group as well as in overlying limestones of the Star Peak Group. Antimony and mercury mines are found in rocks of various age, but are most abundant in carbonate and clastic rocks that are younger than the Star Peak Group. The relationship of metals to stratigraphy is reflected in the antiformal structure of the Humboldt Range. The uplifted core of the range, thought to consist largely of Cretaceous intrusions, is generally surrounded by strata that are progressively younger to the north, east, and south. Superpositioning stratigraphy (fig. 2) with metal distribution (fig. 3) largely explains the association of deposit type, size, and stratigraphy as seen on figure 4.

The timing of metal zonation has been established by radiometric dating of hydrothermal phases. The location of samples dated by K-Ar methods and the analytical data are listed in the Sample Descriptions section.

Age determination was done in the laboratories of the U.S. Geological Survey, Menlo Park, Calif., using standard isotope-dilution procedures as described by Dalrymple and Lanphere (1969). The analyses were performed on pure mineral concentrates (98% purity by grain count) prepared by heavy liquid, magnetic, electrostatic, and handpicking 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 60-sector, 15.2 cm-radius, Nier-type mass spectrometer or on 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 (σ). It represents uncertainty in the measurement of radiogenic ^{40}Ar and K_2O in the sample and is based on experience with replicated analyses in the Menlo Park laboratories. The decay constants used for ^{40}K are those adopted by the International Union of Geological Sciences Subcommission on Geochronology (Steiger and Jager, 1977).

The K-Ar ages range from 42.9 ± 1.2 m.y. to 103.4 ± 10 m.y. The four youngest dates, 42.9, 55.7, 57.9, and 63.4 m.y. are from microcline separates which have probably sustained significant argon loss and are consequently younger than the depositional age of the veins. The ages for white mica and biotite span 36 m.y. (fig. 5), suggesting that several intrusive events have altered rocks and produced mineral deposits in the Humboldt Range. The Cretaceous intrusive body apparently consists of nested or juxtaposed stocks, approximately 70 to 100 m.y. in age, ranging in composition from quartz monzonite to granodiorite.

K-Ar ages for coarse-grained, equigranular intrusive rocks in northern Nevada define two Cretaceous epochs (Smith and others, 1971; Silberman and McKee, 1971; Carlson and others, 1975). One epoch lasted from about 105 to 85 m.y. before present. The other event took place about 80 to 70 m.y. ago and includes intrusion of the Rocky Canyon stock (fig. 5). Ages of metal deposits in the Humboldt Range suggest that older intrusive rocks corresponding in age to the earlier epoch exist at depth.

The ages of vein and wall rock white mica clearly indicate that tungsten, gold, and silver deposits are related in time to these intrusive events. Although data are sparse, tungsten deposits formed 90 to 85 m.y. ago and gold deposits formed 75 to 70 m.y. ago. Silver mineralization may have taken place twice; once 100 to 85 m.y. ago and also 80 to 70 m.y. ago. The one mercury and one antimony deposit dated suggest that hydrothermal concentrations of these elements are coeval with older silver deposits. Irregularities in metal zonation (fig. 3) can be attributed to shifts in intrusion centers with time. The overall consistency of metal deposit distribution indicates that intrusions of individual granitic melt were restricted to a relatively cor ined pathway during the Late Cretaceous.

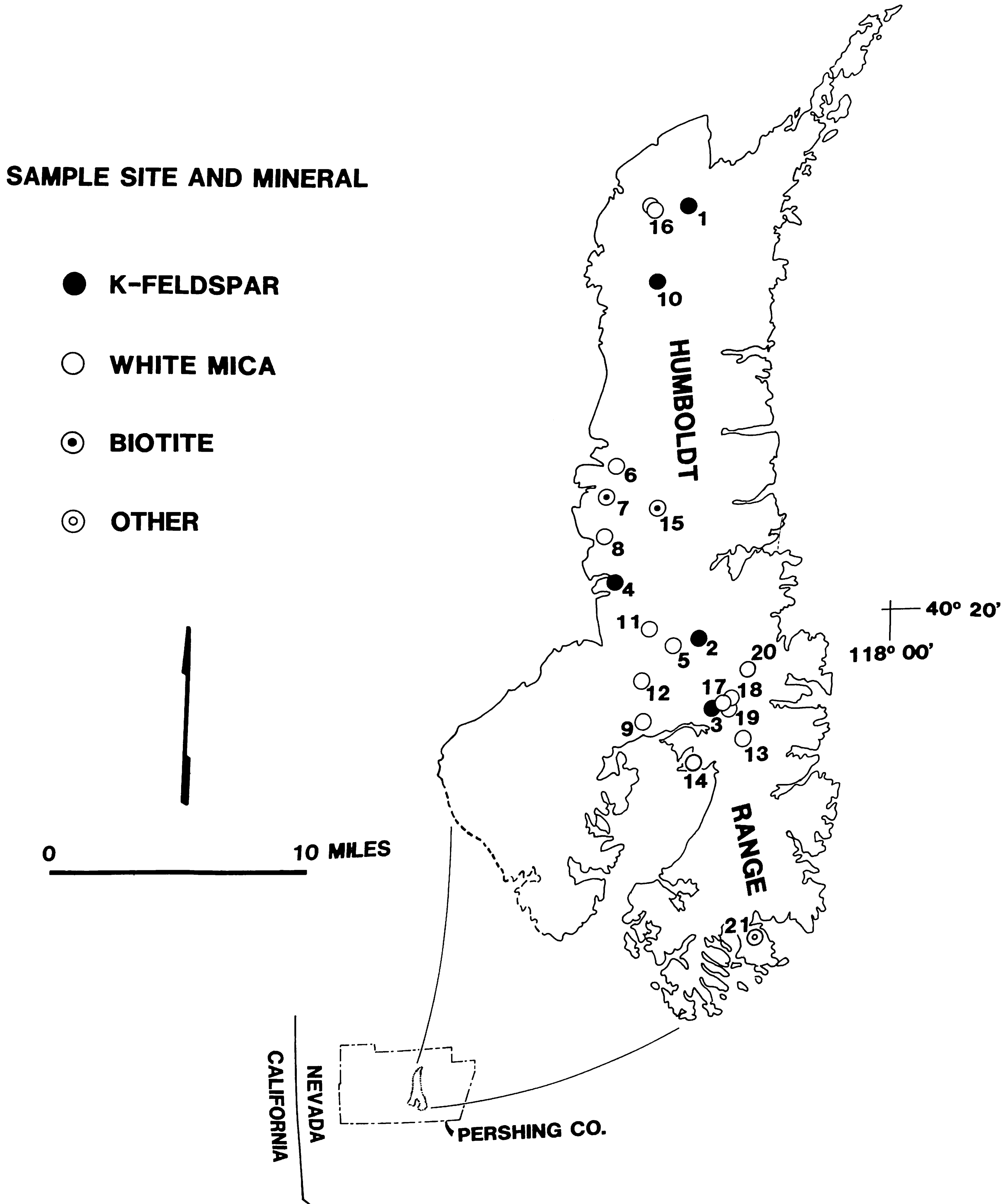

FIGURE 1. Location and type of K-Ar samples in the Humboldt Range.

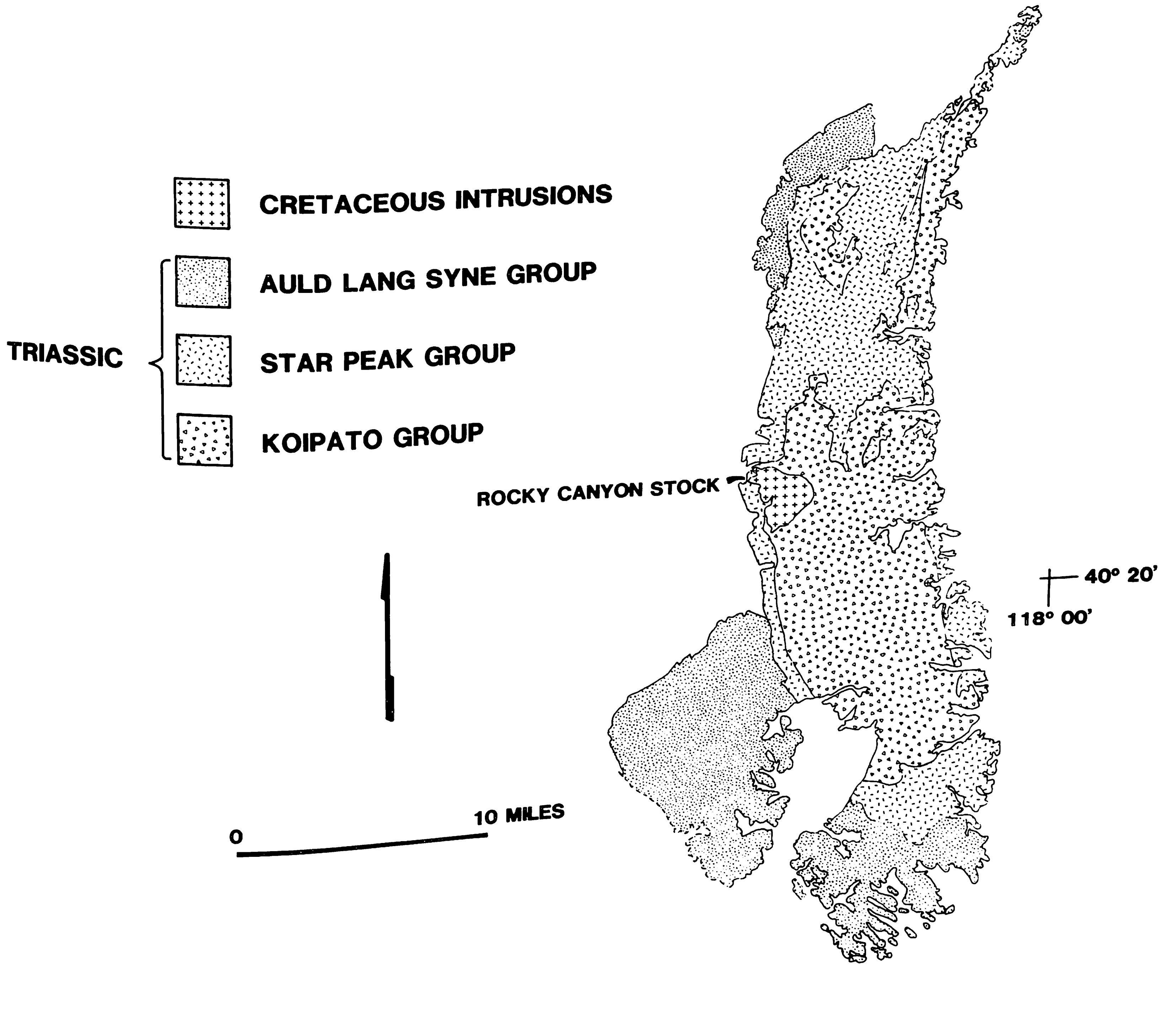

FIGURE 2. Geologic map of the Humboldt Range.

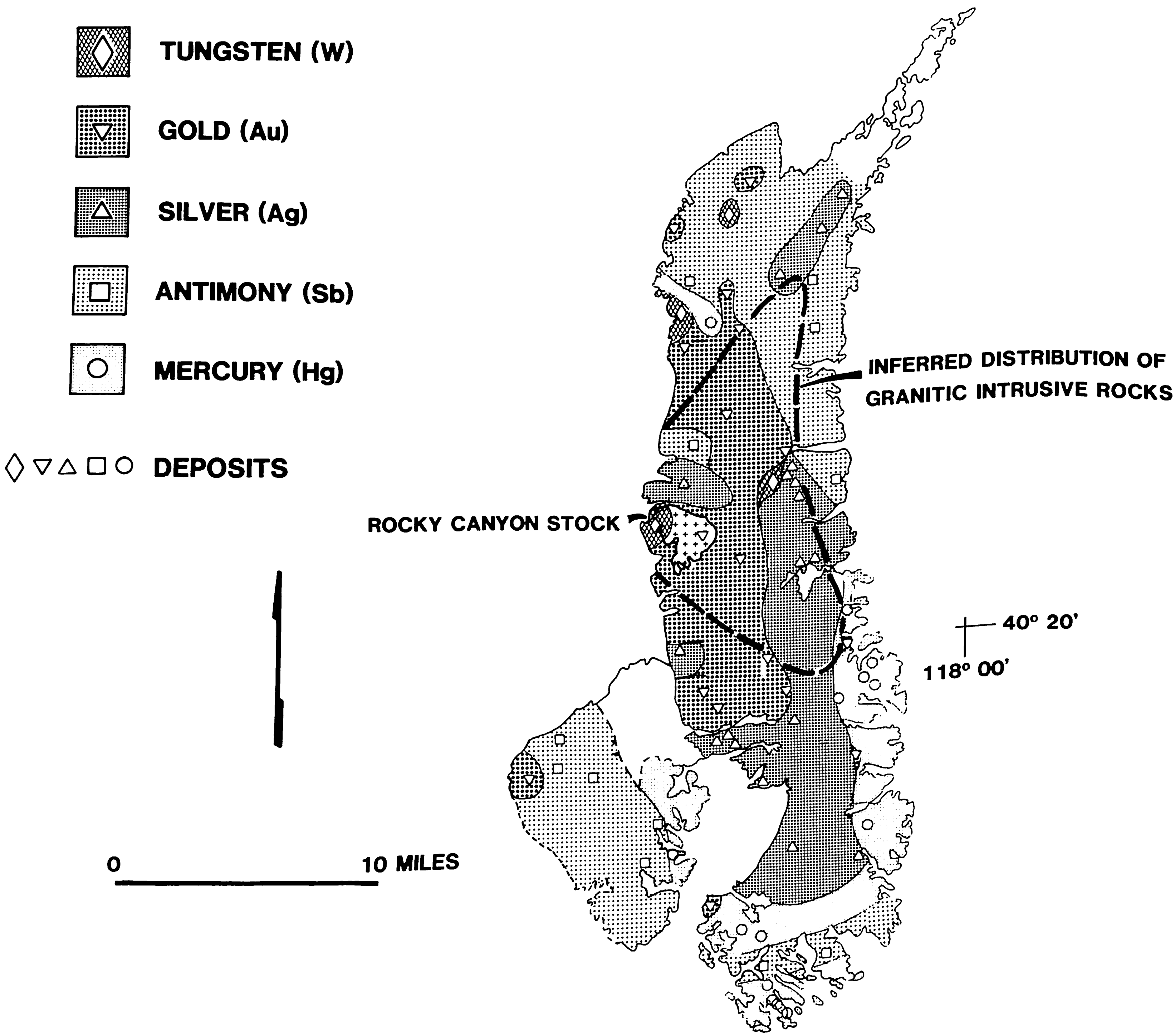

FIGURE 3. Distribution of metal deposits and granitic intrusive rocks.

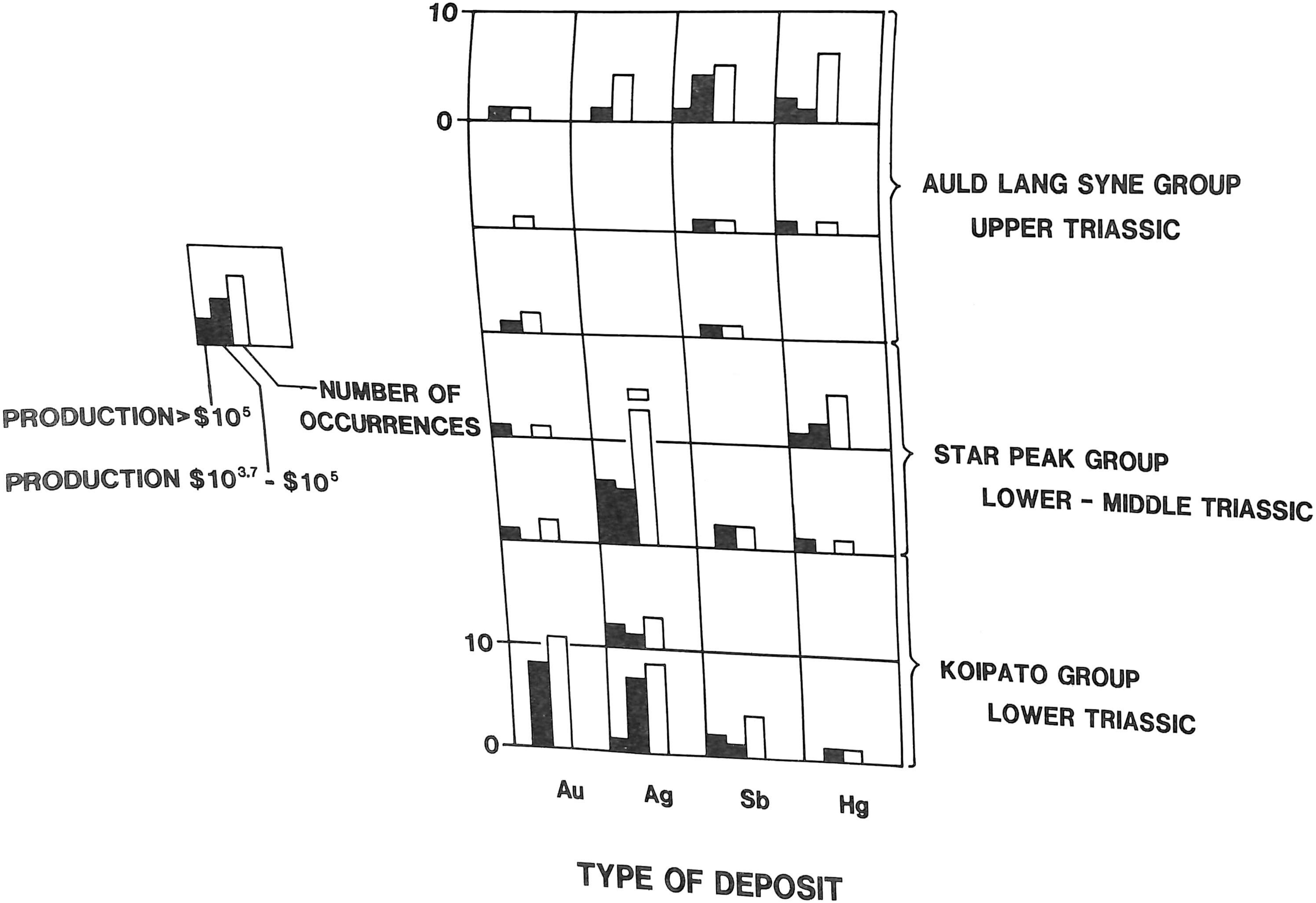

FIGURE 4. Production and frequency of metal deposits related to Mesozoic stratigraphy.

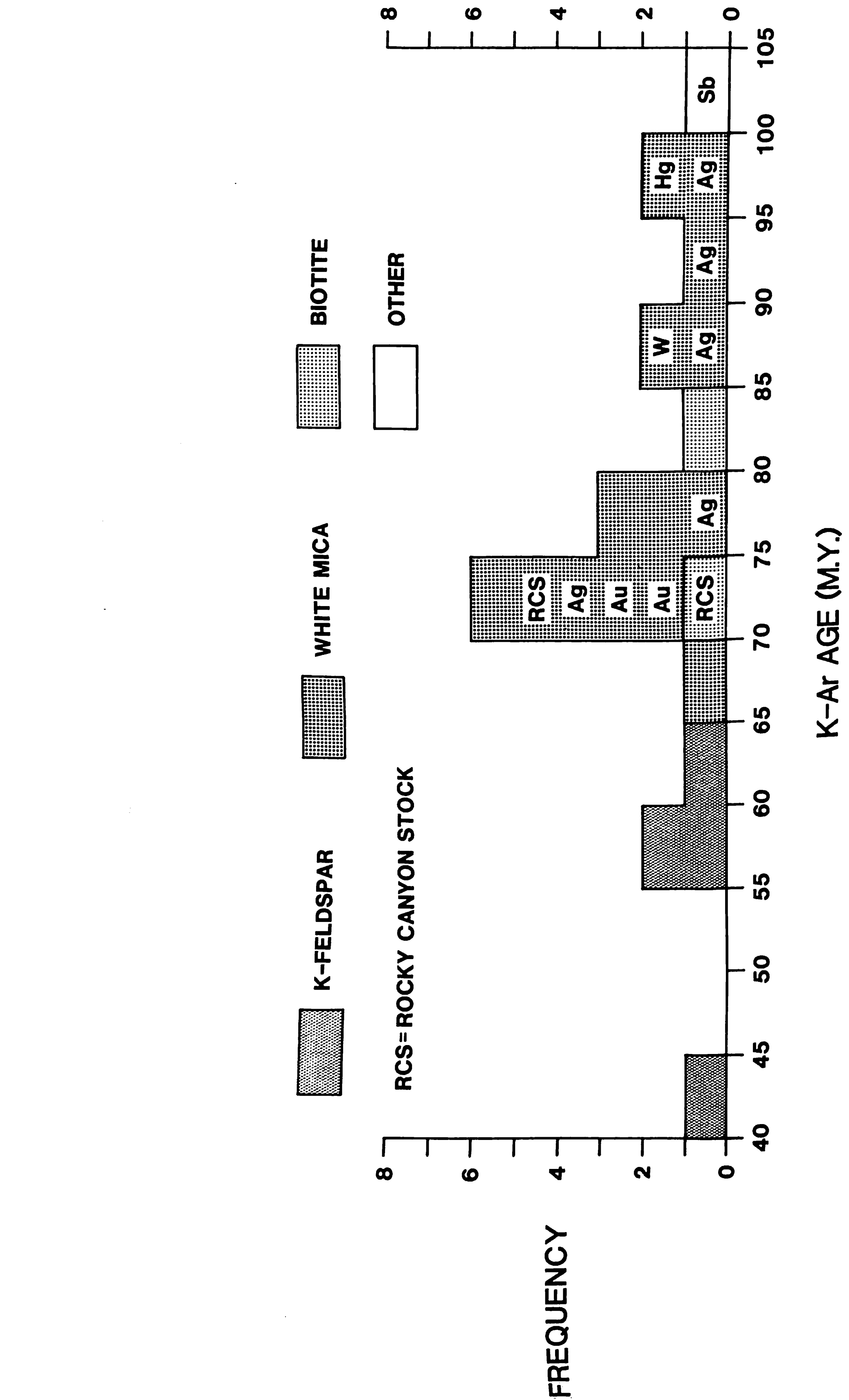

FIGURE 5. Age-frequency plots of K-Ar dates on rocks and hydrothermal minerals from the Humboldt Range.

SAMPLE DESCRIPTIONS

1. *HR79-104* — K-Ar
Quartz-sulfide–K-feldspar vein (NW/4 S5,T31N,R34E; upper Imlay Canyon; Pershing Co., NV). *Analytical data:* K_2O = 14.6%; $^{40}Ar^*$ = 9.1286 × 10^{-10} mol/g; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.872. *Comment:* Age considered anomalously young perhaps due to Ar loss or late-stage addition of K (note extremely high value of K_2O).
(K-feldspar) 42.9 ± 1.2 m.y.

2. *HR81-1* — K-Ar
Quartz-sulfide–K-feldspar vein (NW/4 S4,T28N,R34E; Hoover Mine, Limerick Canyon; Pershing Co., NV). *Analytical data:* K_2O = 15.4%; $^{40}Ar^*$ = 1.2550 × 10^{-9} mol/g; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.539. *Comment:* Age considered anomalously young perhaps due to Ar loss or late-stage addition of K (note extremely high value of K_2O).
(K-feldspar) 55.7 ± 2.2 m.y.

3. *F-22* — K-Ar
Quartz-sulfide–K-feldspar vein (SE/4 S16,T28N,R34E; Friedman level, Nenzel Hill; Pershing Co., NV). *Reference:* Vikre, 1981, table 3A.
(K-feldspar) 57.9 ± 2.9 m.y.

4. *HR80-10* — K-Ar
Quartz-sulfide–K-feldspar vein (NE/4 S23,T29N,R33E; Pole Canyon Mine, Pole Canyon; Pershing Co., NV). *Analytical data:* K_2O = 12.03%; $^{40}Ar^*$ = 1.1174 × 10^{-9} mol/g; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.642. *Comment:* Age considered anomalously young perhaps due to Ar loss.
(K-feldspar) 63.4 ± 2.3 m.y.

5. *RD82-2* — K-Ar
Quartz-sericite-dumortierite schist (NE/4 S1,T28N,R33E; Lone Mountain Ridge; Pershing Co., NV). *Analytical data:* K_2O = 5.04%; $^{40}Ar^*$ = 4.9623 × 10^{-10} mol/g; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.907.
(white mica) 67.2 ± 2.1 m.y.

6. *HR80-7* — K-Ar
Quartz-sulfide-sericite vein (NE/4 S2,T30N,R33E; Rye Canyon Agnes Mine, Panther Canyon; Pershing Co., NV). *Analytical data:* K_2O = 6.56%; $^{40}Ar^*$ = 6.8236 × 10^{-10} mol/g; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.766.
(white mica) 70.8 ± 2.1 m.y.

7. — K-Ar
Quartz monzonite (NW/4 S2,T29N,R33E; Rocky Canyon; Pershing Co., NV). *Reference:* Silberman and others, 1973; Vikre, 1981, table 3A.
(biotite) 71.4 ± 3.0 m.y.

8. *HR81-2* — K-Ar
Pegmatite in quartz monzonite (SE/4 S11,T29N,R33E; Wright Canyon; Pershing Co., NV). *Analytical data:* K_2O = 10.64%; $^{40}Ar^*$ = 1.1241 × 10^{-9} mol/g; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.909.
(white mica) 71.9 ± 2.1 m.y.

9. *LO-1* — K-Ar
Quartz-sulfide-gold vein (NW/4 S19,T19N,R34E; Looney Mine, Rochester Canyon; Pershing Co., NV). *Reference:* Vikre, 1981, table 3A.
(sericite) 72.5 ± 2.2 m.y.

10. *Black Canyon Mine* — K-Ar
Quartz–K-feldspar vein (SE/4 S19,T31N,R34E; Black Canyon Mine, Black Canyon; Pershing Co., NV). *Reference:* Silberman and others, 1973; Vikre, 1981, table 3A.
(K-feldspar) 73.2 ± 2.0 m.y.

11. *CM-1* — K-Ar
Quartz-sericite-dumortierite vein (SW/4 S36,T29E,R33E; Champion Mine, Rolands Canyon; Pershing Co., NV). *Reference:* Vikre, 1981, table 3A.
(sericite) 73.7 ± 2.2 m.y.

12. *OF-SD* — K-Ar
Quartz-sericite-andalusite-dumortierite schist (SE/4 S12,T28N,R33E; Tate's prospect, High Grade Canyon; Pershing Co., NV). *Reference:* Vikre, 1981, table 3A.
(sericite) 77.6 ± 2.3 m.y.

13. *POI-127* — K-Ar
Quartz-sericite schist (NE/4 S27,T28N,R34E; Black Ridge; Pershing Co., NV). *Analytical data:* K_2O = 4.89%; $^{40}Ar^*$ = 5.6369 × 10^{-10} mol/g; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.500.
(white mica) 78.3 ± 2.4 m.y.

14. *NP-CA* — K-Ar
Quartz-sulfide vein (SW/4 S28,T28N,R34E; Nevada Packard Mine; Pershing Co., NV). *Reference:* Vikre, 1981, table 3A.
(sericite) 78.8 ± 2.4 m.y.

15. *SP80-1* — K-Ar
Quartz-biotite vein (SE/4 S6,T29N,R34E; Stalin's Present Mine, Rocky Canyon; Pershing Co., NV). *Analytical data:* K_2O = 8.04%; $^{40}Ar^*$ = 9.6710 × 10^{-10} mol/g; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.740.
(biotite) 81.7 ± 2.4 m.y.

16. *HR79-56* — K-Ar
Quartz-diopside-sericite skarn (NW/4 S7,T31N,R34E; Starlight Mine, Humboldt Canyon; Pershing Co., NV). *Analytical data:* K_2O = 10.59%; $^{40}Ar^*$ = 1.3312 × 10^{-9} mol/g; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.932.
(white mica) 85.3 ± 2.5 m.y.

17. *BCV-1* — K-Ar
Quartz-sulfide-sericite vein (SW/4 S15,T28N,R34E; Crown Point level, Nenzel Hill; Pershing Co., NV). *Reference:* Vikre, 1981, table 3A.
(sericite) 85.7 ± 4.3 m.y.

18. *RD82-1* — K-Ar
Quartz-sericite-pyrite altered rhyolite (SW/4 S15,T28N,R34E; Pitt level, Nenzel Hill, 460 ft from E portal; Pershing Co., NV). *Analytical data:* K_2O = 10.25%; $^{40}Ar^*$ = 1.4339 × 10^{-9} mol/g; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.934.
(white mica) 94.6 ± 2.8 m.y.

19. *RD304-275* — K-Ar
Quartz-sulfide-sericite vein (SW/4 S15,T28N,R34E; DDH, Nenzel Hill; Pershing Co., NV). *Analytical data:* K_2O = 4.74%; $^{40}Ar^*$ = 6.8444 × 10^{-10} mol/g; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.615.
(white mica) 97.6 ± 3.0 m.y.

20. *SAC85-1* K-Ar
Sericitized fault zone (SW/4 S11,T28N,R34E; mercury prospect; Pershing Co., NV). *Analytical data:* K_2O = 0.88%; $^{40}Ar^*$ = 1.27169 × 10^{-10} mol/g; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.535. *Comment:* Pyrophyllite is a major component of the sample.
(pyrophyllite + quartz + white mica)
97.7 ± 2.9 m.y.

21. *HM85-1* K-Ar
Quartz-clinochlore-stibnite vein (SE/4 S2,T26N,R34E; Hollywood Mine; Pershing Co., NV). *Analytical data:* K_2O = 0.05%; $^{40}Ar^*$ = 7.66362 × 10^{-12} mol/g; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.094. *Comment:* Potassium occurs either in clinochlore or in an undetected phase.
(clinochlore) 103.4 ± 10 m.y.

REFERENCES

Carlson, J. E., Laird, D. W., Peterson, J. A., Schilling, J. H., Silberman, M. L., and Stewart, J. H. (1975) Preliminary map showing distribution and isotopic ages of Mesozoic and Cenozoic intrusive rocks in Nevada: U.S. Geological Survey Open-File Report 75-499.

Dalrymple, G. B., and Lanphere, M. A. (1969) Potassium-argon dating—principles, techniques, and applications to geochronology: San Francisco, W. H. Freeman Co., 258 p.

Ingamells, C. O. (1970) Lithium metaborate flux in silicate analysis: Analytica Chimica Acta, v. 52, no. 2, p. 323–334.

Johnson, M. G. (1977) Geology and mineral deposits of Pershing County, Nevada: Nevada Bureau of Mines and Geology Bulletin 89, 115 p.

Silberling, N. J., and Wallace, R. E. (1967) Geologic map of the Imlay Quadrangle, Pershing County, Nevada: U.S. Geological Survey Geologic Quadrangle Map GQ-666.

Silberman, M. L., Johnson, M. G., Koski, R. A., and Roberts, R. J. (1973) K-Ar ages of mineral deposits at Wonder, Seven Troughs, Imlay, Ten Mile, and Adelaide mining districts in central Nevada: Isochron/West, no. 8, p. 31–35.

Silberman, M. L., and McKee, E. H. (1971) K-Ar ages of granitic plutons in north-central Nevada: Isochron/West, no. 71-1, p. 15–20.

Smith, J. G., McKee, E. H., Tatlock, D. B., and Marvin, R. F. (1971) Mesozoic granitic rocks in northwestern Nevada—a link between the Sierra Nevada and Idaho batholiths: Geological Society of America Bulletin, v. 82, p. 2933–2944.

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 rations in a static mass spectrometer: International Journal of Mass Spectrometry and Ion Physics, v. 39, p. 167–180.

Steiger, R. H., and Jager, 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.

Vikre, P. G. (1981) Silver mineralization in the Rochester district, Pershing County, Nevada: Economic Geology, v. 76, p. 580–609.

Wallace, R. E., Silberling, N. J., Irwin, W. P., and Tatlock, D. B. (1969a) Geologic map of the Buffalo Mountain Quadrangle, Pershing and Churchill Counties, Nevada: U.S. Geological Survey Geologic Quadrangle Map GQ-821.

Wallace, R. E., Tatlock, D. B., Silberling, N. J., and Irwin, W. P. (1969b) Geologic map of the Unionville Quadrangle, Pershing County, Nevada: U.S. Geological Survey Geologic Quadrangle Map GQ-820.