New ages for volcanic rocks, western Elko County, Nevada

A.R. Wallace, E.H. McKee, M.L. Zoback, and R.A. Zimmerman

Isochron/West, Bulletin of Isotopic Geochronology, v. 55, pp. 3-5

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

NEW AGES FOR VOLCANIC ROCKS, WESTERN ELKO COUNTY, NEVADA

ALAN R. WALLACE — *U.S. Geological Survey, Denver, CO 80225*
E. H. McKEE, MARY LOU ZOBACK — *U.S. Geological Survey, Menlo Park, CA 94025*
R. A. ZIMMERMAN — *U.S. Geological Survey, Denver, CO 80225*

Western Elko County in northern Nevada is underlain by an extensive Miocene volcanic field which hosts precious-metal deposits at the Midas district and numerous smaller prospects. Studies of the volcanic rocks (Wallace, 1988; Wallace, in press), mineral deposits (Wallace and others, 1988), and tectonics (Zoback, 1978; Zoback and Thompson, 1978; Wallace, 1989) have required geochronologic data on the volcanic rocks. These papers have reported ages for six volcanic units exposed in the area; this paper provides the analytical data for the new age determinations, as well as recalculations of some ages based upon new standards and recalibration of fission track standards. Five ages were determined by the K-Ar method; one was determined by the fission track method. Sample locations are shown in figure 1.

GEOLOGIC SETTING

The Miocene volcanic rocks overlie both Paleozoic sedimentary rocks and Oligocene volcanic rocks (Coats, 1987; A. Wallace, unpubl. mapping, 1989). The rocks can be divided into three sequential packages: (1) basalt to basaltic andesite flows with minor felsic tuffs and flows; (2) rhyolite to dacite flows, domes, and welded tuffs; and (3) basalts.

The early basalts and basaltic andesites were erupted from linear, north-northwest-trending vents during early west-southwest-directed extension between about 16 and 15 m.y. (15.2 ± 1.6 m.y. along Midas trough: Zoback, 1978; sample SW-5B). Rhyolitic welded tuffs and flows were erupted in several places, especially Midas, during a brief hiatus in mafic volcanism.

Between about 15 and 13 m.y., the early rocks were blanketed by rhyolitic to dacitic flows, domes, and tuffs (felsic volcanic rocks of figure 1) that were erupted from several volcanic centers. The oldest of these rocks include crystal-poor rhyolite welded tuffs and basaltic tuffs and flows. Crystal-rich flows were subsequently erupted from north-northwest-trending dikes between 14.3 ± 0.8 m.y. (Sawtooth dike: Zoback and Thompson, 1978; sample SW-B) and 13.4 ± 0.4 m.y. (rhyolite of Kelly Creek Mountain: Wallace, 1988; sample 5LHW-90). Several hundred meters of rhyolite to rhyodacite flows cap Jake Creek Mountain on the north side of the Midas trough; they overlie flows related to the Sawtooth dike and underlie the rhyolite of Kelly Creek Mountain (Wallace, in press). Continued extension during volcanic activity produced a major north-northwest-trending graben. Extensive high-temperature flows of the rhyolite of the Little Humboldt River were erupted into this developing basin at 13.0 ± 1.7 m.y. (Wallace, 1988; sample 5LHW-92); they overlie the Jake Creek Mountain volcanic rocks. Despite the slightly older age for the rhyolite of Kelly Creek Mountain, field relations show that it overlies the rhyolite of the Little Humboldt River (Wallace, 1988).

The last volcanic activity produced widespread basalt flows of the Big Island Formation which were erupted from low-profile shield volcanoes at 9.8 ± 2.5 m.y. (Wallace, 1988; sample 5LHW94. Minor basalt flows (young basalt of figure 1) on the floor of the Midas trough have an age of 6.4 ± 2.3 m.y. (Zoback, 1978; Zoback and Thompson, 1978; sample SW-3A).

Precious-metal deposits formed in the older basaltic sequence at about 15 m.y. throughout the northern Great Basin (Noble and others, 1989). The volcanic-hosted ores at Midas were deposited at 15.0 ± 0.4 m.y. (McKee and others, 1974), and were buried by the younger volcanic rocks. The youngest mineralized volcanic rock unit at Midas is the basal rhyolite of the felsic volcanic rock suite.

The extension direction shifted to the northwest sometime between 10 and 6.3 m.y. (Zoback and Thompson, 1978). This extension created east-northeast-trending grabens, such as the Midas trough, and the horsts and grabens of the present-day basin-and-range physiography. Extension-related normal faulting exposed volcanic-hosted precious-metal deposits of Miocene age as well as older deposits in pre-Tertiary sedimentary rocks.

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 sanidine concentrates were made by heavy-liquid, magnetic, electrostatic, and hand picking procedures. The basalt samples were ground to 80–100 mesh, leached in HNO_3 and HF solutions, immediately washed and dried before loading in the high-vacuum gas extraction system. 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, Nier-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 (Cox and Dalrymple, 1967). 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 Jager, 1977).

The zircon concentrates were made by heavy-liquid, magnetic, and hand picking procedures. Irradiation and counting was done at the U.S. Geological Survey laboratories in Denver, Colorado. Procedures and calculation of standard deviation followed the methods described by Naeser (1976).

SAMPLE DESCRIPTIONS

1. *SW-3A* (Zoback, 1978) K-Ar
Basalt flow (41°08'N, 116°56.5'W; Jake Creek Mountain 7.5' quad.; Elko Co., NV); outcrop from vesicular to massive flow on floor of Midas trough. *Analytical data:* K_2O = 0.235 wt. %; $^{40}Ar^*$ = 2.1536 x 10^{-12} mol/gm, $^{40}Ar^*/\Sigma^{40}Ar$ = 4.0%. *Collected by:* M. L. Zoback.
(whole rock) 6.4 ± 2.3 m.y.

2. *5LHW-94* (Wallace, 1988) K-Ar
Eroded neck of basalt shield volcano (41°26.5'N, 116°50.5'W; Haystack Peak 7.5' quad.; Elko Co., NV); massive basalt outcrop at Haystack Peak. *Analytical data:* K_2O = 0.289 wt. %; $^{40}Ar^*$ = 4.09351 x 10^{-12} mol/gm, $^{40}Ar^*/\Sigma^{40}Ar$ = 1.67%. *Collected by:* A. R. Wallace.
(whole rock) 9.8 ± 2.5 m.y.

3. *5LHW-90* (Wallace, 1988) K-Ar
Rhyolite of Kelly Creek Mountain (41°17.1'N, 116°57.3'W; Rodear Flat 7.5' quad., Elko Co., NV); uppermost of several flow units. Rhyodacite to rhyolite with pigeonite as the major mafic mineral. Emplaced as a lava flow, but relict textures suggest a tuffaceous origin, similar to high-temperature rhyolites in southwestern Idaho (Ekren and others, 1984; Bonnichsen and Kauffman, 1987). Reported as 13.7 ± 2.0 Ma in Wallace (1988); revised age based upon recounting with new calibration. *Analytical data:* No. of grains: 10; track density (tracks counted) $10^5/cm^2$: fossil: 7.71 (364); induced: 19.9 (939). Neutron dosimetry via NBS 962 using muscovite as an external detector. Detector density 2.02x10^5 tracks/cm^2; 1,800 tracks counted. Neutron dose 1.09 x 10^{15} nt/cm^2. Zeta factor = 331.52. *Collected by:* A. R. Wallace.
(zircon) 13.0 ± 1.7 m.y.

4. *5LHW-90* (Wallace, 1988) K-Ar
Rhyolite of Kelly Creek Mountain (41°17.1'N, 116°57.3'W; Snowstorm Mountain 7.5' quad., Elko Co., NV); uppermost of multiple porphyritic, crystal-rich rhyolite flows on the top of Kelly Creek Mountain. *Analytical data:* K_2O = 7.77 wt. %; $^{40}Ar^*$ = 1.49831 x 10^{-10} mol/gm, $^{40}Ar^*/\Sigma^{40}Ar$ = 50.7%. *Collected by:* A. R. Wallace.
(sanidine) 13.4 ± 0.4 m.y.

5. *SW-B* (Zobach, 1978) K-Ar
Rhyolite dike (Sawtooth dike of Zoback and Thompson, 1978) (41°11.6'N, 116°55.7'W; Jake Creek Mountain 7.5' quad., Elko Co., NV); crystal-rich, porphyritic rhyolite; dike trends NNW. *Analytical data:* K_2O = 6.59 wt. %; $^{40}Ar^*$ = 1.3584 x 10^{-10} mol/gm, $^{40}Ar^*/\Sigma^{40}Ar$ = 21.0%. *Collected by:* M. L. Zoback.
(sanidine) 14.3 ± 0.8 m.y.

6. *SW-3A* (Zoback, 1978) K-Ar
Basaltic andesite lava flow (41°11.8'N, 116°55.4'W; Jake Creek Mountain 7.5' quad., Elko Co., NV). *Analytical data:* K_2O = 0.884 wt. %; $^{40}Ar^*$ = 1.9369 x 10^{-11} mol/gm, $^{40}Ar^*/\Sigma^{40}Ar$ = 16.9%. *Collected by:* M. L. Zoback.
(whole rock) 15.2 ± 1.6 m.y.

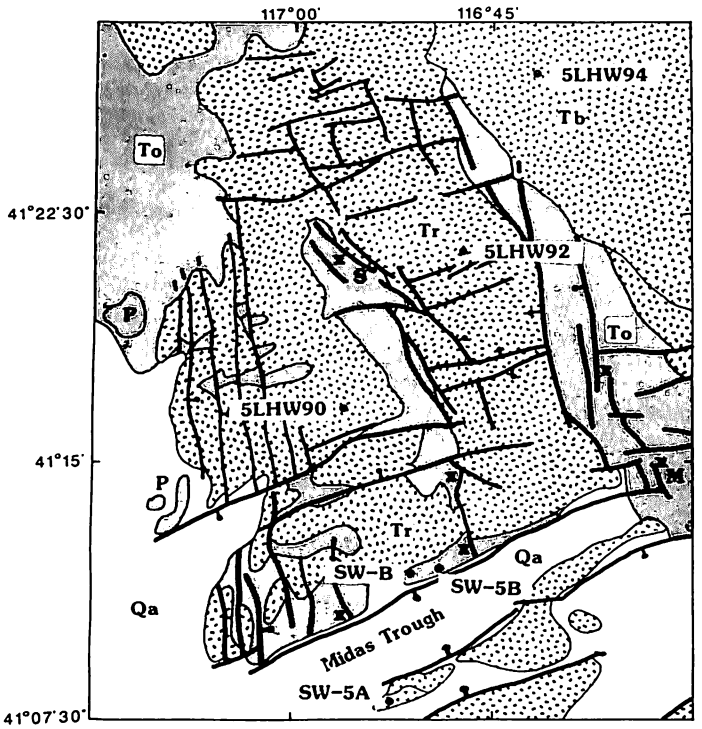

FIGURE 1. Generalized geology of the Midas-Snowstorm Mountains area, showing the location of dated samples. M, Midas; S, Snowstorm Mountain; x, precious metal deposit or occurrence. Qa, Quaternary alluvial deposits; Tb, Big Island Formation; Tr, rhyolite to dacite flows, domes, and tuffs; To, older basalts and basaltic andesites; P, Paleozoic sedimentary rocks. Heavy lines are normal faults with ball and bar on downthrown side. Gold mineralization was contemporaneous with map unit To.

REFERENCES

Bonnichsen, Bill, and Kauffman, D. F. (1987) Physical features of rhyolite lava flows in the Snake River Plain volcanic province, southwestern Idaho: Geological Society of America Special Paper 212, p. 119.

Coats, R. R. (1987) Geology of Elko County, Nevada: Nevada Bureau of Mines and Geology Bulletin 101.

Cox, Allan, and Dalrymple, G. B. (1967) Statistical analysis of geomagnetic reversal data and the precision of potassium-argon dating: Journal of Geophysical Research, v. 72, no. 10, p. 2603.

Dalrymple, G. B., and Lanphere, M. D. (1969) Potassium-argon dating: San Francisco, W. H. Freeman and Co.

Ekren, E. B., McIntyre, D. H., and Bennett, E. H. (1984) High-temperature, large-volume, lavalike ash-flow tuffs without calderas in southwestern Idaho: U.S. Geological Survey Professional Paper 1272.

Ingamells, C. O. (1970) Lithium metaborate flux in silicate analysis: Anal. Chim. Acta, v. 52, p. 32.

McKee, E. H., Tarshis, A. L., and Marvin, R. F. (1974) Summary of radiometric ages of Tertiary volcanic and selected plutonic rocks in Nevada—Part V: Northeastern Nevada: Isochron/West, no. 16, p. 15.

Naeser, C. W. (1976) Fission track dating: U.S. Geological Survey Open-File Report 76-190.

Noble, D. C., McCormack, J. K, McKee, E. H., Silberman, M. L., and Wallace, A. B. (1988) Time of mineralization in the evolution of the McDermitt caldera complex, Nevada-Oregon, and the relation of middle Miocene mineralization in the northern Great Basin to coeval regional basaltic magmatic activity: Economic Geology, v. 83, p. 859.

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 Mass Spectrometry Ion Physics, v. 39, p. 167.

Steiger, R. H., and Jager, E. (1977) Subcommission of geochronology—Conventions on the use of decay constants in geocosmochronology: Earth and Planetary Science Letters, v. 36, p. 359.

Wallace, A. R. (1988) Geologic map of the Little Humboldt River wilderness study area, Elko County, Nevada: U.S. Geological Survey Miscellaneous Field Studies Map MF-2053.

_____ (1989) Coeval Miocene volcanism, extension, and precious-metal mineralization in northern Nevada [abs.]: Geological Society of America Abstracts with Programs, v. 21, no. 5, p. 155.

Wallace, A. R. (in press) Geologic map of the Jake Creek Mountain quadrangle, Elko County, Nevada: U.S. Geological Survey Geologic Quadrangle Map GQ-1672.

Wallace, A. R., Turner, R. L., Graugh, V. J. S., Plesha, J. L., Krohn, M. D., Duval, J. S., and Gabby, P. N. (1988) Mineral resources of the Little Humboldt River wilderness study area, Elko County, Nevada: U.S. Geological Survey Bulletin 1732.

Zoback, M. L. C. (1978) Mid-Miocene rifting in north-central Nevada—A detailed study of late Cenozoic deformation in the northern Basin and Range: Stanford University, PhD thesis.

Zoback, M. L., and Thompson, G. A. (1978) Basin and Range rifting in northern Nevada: clues from a mid-Miocene rift and its subsequent offsets: Geology, v. 6, p. 111.