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K-AR AGES OF PLUTONISM, VOLCANISM, AND MINERALIZATION, SILVER CITY REGION, OWYHEE COUNTY, IDAHO

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The data and conclusions reported in this paper are from a Ph.D. thesis at the Colorado School of Mines (Pansze, 1971). With one exception, all the samples dated were collected by the author in the course of field work during the summers of 1968, 1969, and 1970; one sample was collected by Ora H. Rostad of AMAX Exploration, Inc. I would like to thank AMAX Exploration, Inc. for financing the thesis work and for permission to publish the resulting data. I would also like to thank Richard L. Armstrong, Yale University, for providing most of the age dates reported here.

Age determinations by Yale University dating laboratory were performed in 1970 and used standard analytical techniques as described by Armstrong (1970). K was determined by atomic absorption spectrophotometry and Ar by isotope dilution. Constants used to compute the dates are: K^{40} = 0.0119 atom percent; $\lambda_p = 4.72 \times 10^{-10}$ yr^{-1}; $\lambda_\epsilon = 0.584 \times 10^{-1}$ 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.

Two of the reported dates were determined by Geochron Laboratories, Inc. for AMAX Exploration, Inc. in 1969. Constants used in these calculations were: $K^{40}/K_{total} = 1.22 \times 10^{-4}$ g./g.; $\lambda_p = 4.72 \times 10^{-10}$ yr^{-1}; $\lambda_\epsilon = 0.585 \times 10^{-10}$ yr^{-1}.

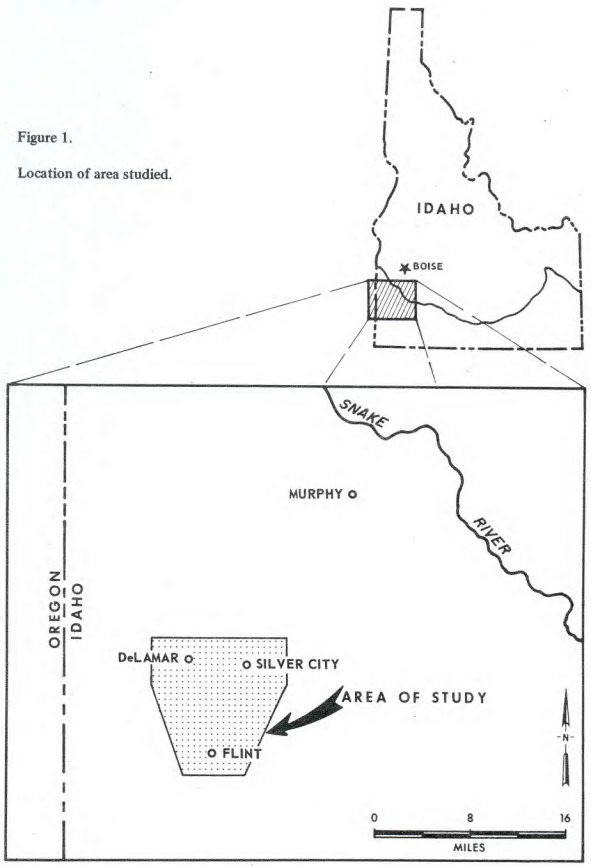

Figure 1.
Location of area studied.

GEOLOGIC DISCUSSION

The Silver City region is in the Owyhee volcanic field on the southern margin of the Snake River Plain in southwestern Idaho (Fig. 1). Gold and silver valued at $40 million were mined from epithermal veins in the area during the years 1863-1914 (Lindgren, 1900; Piper and Laney, 1926; Asher, 1968). The portion of the volcanic field studied was built in Miocene time on a surface of moderate relief developed on a Cretaceous-Tertiary granodiorite pluton dated by K-Ar methods at 62-66 m.y. Volcanic activity began in Middle Miocene with fissure eruptions of a series of alkali-olivine basalt flows which were followed by emplacement of local flows, flow breccias, tuff breccias, dikes, and domes of quartz latite and rhyolite. Eruptive centers for the silicic volcanic rocks are numerous exogenous domes which were localized by a strong north-northwest fault system which developed in early Miocene time. These structures are high-angle, oblique-slip faults which have been active throughout the Cenozoic since their formation. Development of this fault set, and of the bimodal basalt-rhyolite volcanic assemblage, is tentatively attributed to large-scale tectonic rifting in the adjacent Snake River Plain during early Miocene time, coupled with crustal extension in the Basin and Range Province to the south (Christiansen and Lipman, 1970; Lipman, Prostka, and Christiansen, 1970).

During and after the late stages of silicic volcanism, thermal fluids of probable volcanic origin were diluted by meteoric waters, ascended favorable structures, altered the surrounding wall rocks, deposited epithermal gold-silver-quartz veins, and occasionally surfaced to form siliceous hot-spring deposits. Field relationships and K-Ar dates demonstrate that the

veins (14.8 - 15.2 ± 0.6 m.y. on adularia) are closely associated with late rhyolitic volcanism (15.6 - 15.7 ± 0.3 m.y.) in both space and time. Interpretation of gangue minerals and of hydrothermal alteration assemblages indicates that the ore fluids were probably of the sodium-chloride type (White, 1957 a,b). The mineralization postdates most of the volcanic activity.

SAMPLE DESCRIPTIONS

A. Intrusive Rocks

1. YU-PZ(A346) K-Ar (muscovite) 62.1 ± 1.2 m.y.

Granodiorite of Silver City region (NE¼, NW¼, Sec. 4, T5S, R3W; on N side of War Eagle Mtn., Owyhee Co., ID); medium-to-coarse-grained, slightly porphyritic; composed of biotite (largely chloritized), muscovite, quartz, microcline, orthoclase, and plagioclase (oligoclase). Analytical data: K = 8.29, 8.32%; $\overset{*}{Ar}^{40}$ = 20.94 x 10^6 cc (STP); air correction = 17%. Collected by: A. J. Pansze; dated by: R. L. Armstrong, Yale Univ.

2. G-M1416(A384) K-Ar (muscovite) 65.6 ± 2.0 m.y.

Granodiorite of Silver City region (NW¼, NE¼, Sec. 5, T5S, R3W; on W side of War Eagle Mtn., Owyhee Co., ID); lithologic description is the same as that for Sample 1. Analytical data: K = 8.130, 8.197%; $\overset{*}{Ar}^{40}$ = 0.0374, 0.0404 ppm; $\overset{*}{Ar}^{40}$/total Ar^{40} = 0.701, 0.738; muscovite concentrate 99% pure. Collected by: A. J. Pansze, dated by: Geochron Laboratories, Inc., for AMAX Exploration, Inc.

3. YU-PZ(A56) K-Ar (muscovite) 66.8 ± 1.3 m.y

Granodiorite of Silver City region (SW¼, SE¼, Sec. 5, T5S, R3W; near Ruth Ann Mine on War Eagle Mtn., Owyhee Co., ID); lithologic description is the same as that for Sample 1. Analytical data: K = 8.44, 8.41%; $\overset{*}{Ar}^{40}$ = 22.88 x 106 cc (STP); air correction = 21%. Collected by: A. J. Pansze; dated by: R. L. Armstrong, Yale Univ.

4. YU-PZ(A326) K-Ar (whole rock) 27.5 ± 0.5 m.y. (a)
25.8 ± 0.5 m.y. (b)

Dacite porphyry dike. Green, fine-grained, biotite dacite porphyry (NW¼, NE¼, Sec. 9, T5S, R3W, from dike S of Oro Fino Mine, War Eagle Mtn., Owyhee Co., ID); 50% phenocrysts of sanidine, quartz, biotite (chloritized), hornblende (chloritized), and plagioclase (andesine, slightly altered to calcite and sericite) in a felsitic groundmass. Analytical data: K = 2.71, 2.67%; (a) $\overset{*}{Ar}^{40}$ = 2.98 x 10^6 cc(STP), air correction = 32%; (b) $\overset{*}{Ar}^{40}$ = 2.79 x 10^6 cc (STP), air correction = 33%. Collected by: A. J. Pansze; dated by: R. L. Armstrong, Yale Univ.

B. Volcanic Rocks

5. YU-PZ(A350) K-Ar (whole rock) 16.6 ± 4.3 m.y. (a)
12.8 ± 5.3 m.y. (b)
13.0 ± 5.2 m.y. (c)

Lower basalt unit. Slightly porphyritic, hyalocrystalline, alkali-olivine basalt (from unit near base of flows, NW¼, SE¼, Sec. 34, T5S, R4W; along Silver City-Flint road, Owyhee Co., ID). Analytical data: K = 0.437, 0.446%; (a) $\overset{*}{Ar}^{40}$ = 0.295 x 10^6 cc (STP), air correction = 96.2%; (b) $\overset{*}{Ar}^{40}$ = 0.226 x 10^6 cc (STP), air correction = 97.6%; (c) $\overset{*}{Ar}^{40}$ = 0.230 x 10^6 cc (STP), air correction = 97.5%. Collected by: A. J. Pansze; dated by: R. L. Armstrong, Yale Univ. Comment: date believed to be erroneous based on definite stratigraphic relationship with upper rhyolite unit which yields consistent dates of 15.6 - 15.7 ± 0.3 m.y. Lower basalt date definitely too young although 16.6 m.y. date may be near true age.

6. YU-PZ(A34) K-Ar (biotite) 19.2 ± 0.3 m.y. (a)
17.3 ± 0.5 m.y. (b)
17.2 ± 0.3 m.y. (c)

Upper rhyolite unit. From a brecciated exogenous dome of fine-grained rhyolite porphyry (SW¼, NE¼, Sec. 16, T5S, R4W; Owyhee Co., ID); 15% phenocrysts of biotite, sanidine, plagioclase, and quartz in a groundmass of alternating vitric and felsitic layers; unaltered, with minor (<1%) lithic fragments. Analytical data: K = 6.06, 6.04%; (a) $^{*}Ar^{40}$ = 4.66 x 10^{6} cc (STP), air correction = 39%, (b) $^{*}Ar^{40}$ = 4.20 x 10^{6} cc (STP), air correction = 60%; (c) $^{*}Ar^{40}$ = 4.18 x 10^{6} cc (STP), air correction = 48%. Collected by: A. J. Pansze; dated by: R. L. Armstrong, Yale Univ. Comment: date believed to be erroneous (too old), probably due to inclusion of lithic fragment(s) of lower basalt unit; basis for this is consistent age range of other upper rhyolite samples.

7. YU-PZ(A45) K-Ar (whole rock) 14.9 ± 0.3 m.y. (a)
16.2 ± 0.3 m.y. (b)

Upper rhyolite unit. From an exogenous dome of rhyolite porphyry (NE¼, NW¼, Sec. 11, T5S, R4W, Owyhee Co., ID); fine-grained phenocrysts of biotite, sanidine, quartz, and plagioclase (andesine) in a vitric and felsitic groundmass; unaltered with minor (<1%) lithic fragments. Analytical data: K = 3.89, 3.87%; (a) $^{*}Ar^{40}$ = 2.43 x 10^{6} cc (STP), air correction = 13%; (b) $^{*}Ar^{40}$ = 2.62 x 10^{6} cc (STP), air correction = 35%. Collected by: A. J. Pansze; dated by: R. L. Armstrong, Yale Univ.

8. YU-PZ(A26) K-Ar (whole rock) 15.5 ± 0.3 m.y. (a)
15.6 ± 0.3 m.y. (b)

Upper rhyolite unit. From an exogenous dome of rhyolite porphyry (SW¼, NE¼, Sec. 10, T5S, R4W; Owyhee Co., ID); fine-grained phenocrysts of magnetite, biotite, quartz, and sanidine in a groundmass of vitric and felsitic material with minor (<1%) lithic fragments, unaltered. Analytical data: K = 3.89, 3.87%; (a) $^{*}Ar^{40}$ = 2.41 x 10^{6} cc (STP), air correction = 19%; (b) $^{*}Ar^{40}$ = 2.44 x 10^{6} cc (STP), air correction = 11%. Collected by: A. J. Pansze; dated by: R. L. Armstrong, Yale Univ.

9. YU-PZ(A345) K-Ar (biotite) 15.6 ± 0.3 m.y. (a)
15.9 ± 0.3 m.y. (b)

Upper rhyolite unit. From a poorly exposed exogenous dome (NE¼, SE¼, Sec. 12, T5S, R4W; in Long Gulch W of Silver City, Owyhee Co., ID); dark reddish-brown rhyolite porphyry with 40-50% phenocrysts of plagioclase, biotite, quartz, and sanidine, in a felsitic groundmass, no alteration or lithic fragments, flow brecciated. Analytical data: K = 6.73, 6.81%; (a) $^{*}Ar^{40}$ = 4.25 x 10^{6} cc (STP), air correction = 39%; (b) $^{*}Ar^{40}$ = 4.33 x 10^{6} cc (STP), air correction = 39%. Collected by: A. J. Pansze; dated by: R. L. Armstrong, Yale Univ.

10. YU-PZ(A98) K-Ar (sanidine) 15.6 ± 0.3 m.y.

Upper rhyolite unit. Rhyolite porphyry (NW¼, SE¼, Sec. 13, T5S, R4W; at head of Sawpit Gulch, Owyhee Co., ID); black, rhyolite vitrophyre with 25-35% phenocrysts of quartz and sanidine, unaltered; no lithic fragments or devitrification. Analytical data: K = 7.32, 7.36%; $^{*}Ar^{40}$ = 4.58 x 10^{6} cc (STP), air correction = 16%. Collected by: A. J. Pansze; dated by: R. L. Armstrong, Yale Univ.

11. YU-PZ(A325) K-Ar (sanidine) 15.7 ± 0.3 m.y.

Upper rhyolite unit. Rhyolite porphyry exogenous dome (NE¼, SW¼, Sec. 6, T5S, R4W; S of Wagontown and E of Jordan Creek, Owyhee Co., ID); grey, flow-layered rhyolite with 25-30% phenocrysts of quartz and sanidine in a devitrified, felsitic groundmass; no lithic fragments noted. Analytical data: K = 4.21, 4.18%; $^{*}Ar^{40}$ = 2.64 x 10^{6} cc (STP), air correction = 37%. Collected by: A. J. Pansze; dated by: R. L. Armstrong, Yale Univ.

C. Veins

12. YU-PZ(A43) K-Ar (adularia) 15.2 ± 0.3 m.y. (a)
15.1 ± 0.3 m.y. (b)

Oro Fino vein. Epithermal Au-Ag-SiO_2 vein (SW¼, SE¼, Sec. 4, T5S, R3W; on War Eagle Mtn., Owyhee Co., ID); adularia gangue in vein. Analytical data: K = 12.48, 12.61%; (a) $\overset{*}{Ar}^{40}$ = 7.62 x 10^6 cc (STP), air correction = 39%; (b) $\overset{*}{Ar}^{40}$ = 7.61 x 10^6 cc (STP), air correction = 27%. Collected by: A. J. Pansze; dated by: R. L. Armstrong, Yale Univ.

13. G-F1415(A383) K-Ar (adularia) 14.8 ± 0.6 m.y.

Vein on Florida Mountain. Epithermal Au-Ag-SiO_2 vein (SE¼, Sec. 12, T5S, R4W; in Long Gulch, W of Silver City, on the S side of Florida Mtn., Owyhee Co., ID); adularia gangue in vein. Analytical data: K = 11.269, 11.323%; $\overset{*}{Ar}^{40}$ = 0.0119, 0.0121 ppm; $\overset{*}{Ar}^{40}$/total Ar^{40} = 0.584, 0.689. Collected by: O. H. Rostad, AMAX Exploration, Inc.; dated by: Geochron Laboratories, Inc., for AMAX Exploration, Inc.

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