K-Ar ages of intrusive rocks of the Pilot Range, Nevada and Utah

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Isochron/West, Bulletin of Isotopic Geochronology, v. 30, pp. 21-22

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K-AR AGES OF INTRUSIVE ROCKS OF THE PILOT RANGE, NEVADA AND UTAH

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This report presents K-Ar isotopic ages obtained as part of a larger study of the structure, stratigraphy, and petrology of the Pilot Range, northern Nevada and Utah. Potassium analyses were performed by B. Lai and M. Taylor by flame photometry using lithium metaborate fusion, the lithium serving as an internal standard (Ingamells, 1970). Argon was analyzed by standard isotope dilution and mass spectrometry techniques described by Dalrymple and Lanphere (1969); the analyst was W. C. Hoggatt. Mineral separates were prepared by D. H. Sorg. Uncertainties in reported ages are the estimated standard deviations of analytical precision (Cox and Dalrymple, 1967). Constants used in the calculations are $\lambda_\epsilon + \lambda'_\epsilon = .581 \times 10^{-10}$ year^{-1}, $\lambda_\beta = 4.962 \times 10^{-10}$ year^{-1}, and K^{40}/Ktotal = 1.167 x 10^{-4} mol/mol.

We thank M. D. Crittenden, Jr. and M. L. Silberman for their reviews of the manuscript.

GEOLOGIC DISCUSSION

Rocks in the Pilot Range are divided by a decollement into an upper sequence of unmetamorphosed Upper Cambrian to Permian strata and a lower sequence of parautochthonous metamorphosed Proterozoic Z and Lower Cambrian rocks (Fig. 1). Both sequences contain bedding-plane faults that eliminate section and in places are associated with SE-vergent folds. The parautochthon is locally complexly folded by at least three sets of folds, the last set of which is apparently related to gravitationally induced low-angle faulting in response to arching. Metamorphism in the greenschist facies accompanied ductile deformation and was followed by pervasive retrogression to lowest greenschist facies.

Four groups of intrusive rocks are identified: (1) folded and foliated muscovite granite dikes concordant to foliation in parautochthonous marble, (2) slightly deformed to undeformed granitic dikes that crosscut ductile structures and low-angle faults but tend to occupy low-angle fault zones, (3) a slightly foliated pluton similar in composition to group 2 rocks that also crosscuts ductile structures, and (4) an undeformed porphyritic granite body that intrudes and occupies part of the decollement.

All of the igneous rocks yielded Tertiary apparent ages with the exception of the foliated pluton (3), which yielded discordant Late Cretaceous and Tertiary ages on hornblende and biotite, respectively. The gneissic muscovite granite dike (1) yields a muscovite age of 56.2 m.y. which probably represents partial retention of argon from an older metamorphic event. The slightly deformed granitic dikes (2) and petrographically similar larger body (3) near Bettridge Creek are tentatively considered to represent a single intrusive event. The dikes yielded a mean age of 30.1 m.y. (biotite), and the larger body gave discordant ages from biotite and hornblende of 27.0 and 91.2 m.y., respectively. We therefore interpret the intrusive age of the granitic body, and probably the dikes, as Cretaceous or older; the younger ages from biotite represent differential loss of argon, most likely during the Oligocene. The porphyritic granite (4) yielded a biotite age of 36.6 m.y., which is interpreted as the intrusive age. This age is compatible with a calculated lead-α age of 30 ± 10 m.y. for the pluton but not with the 31 ± 0.6 m.y. K-Ar age on biotite reported by Coats and others (1965).

We interpret the data in terms of a two-stage thermal history for the Pilot Range. The prograde metamorphic event and contemporaneous folding and low-angle faulting

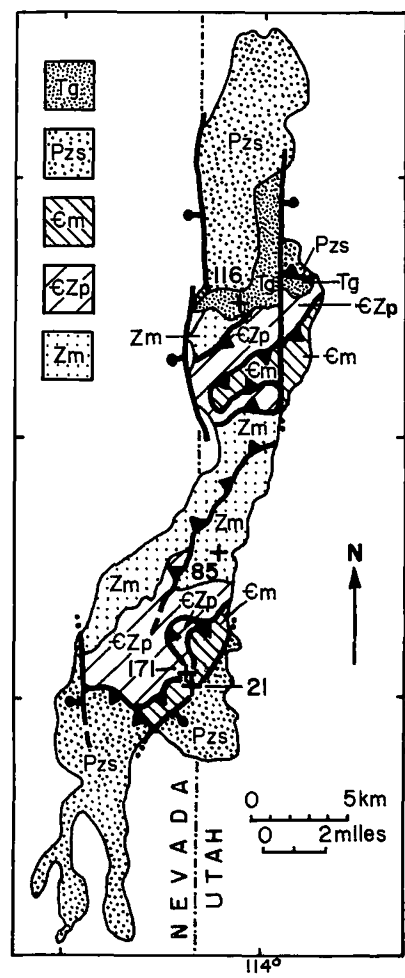

FIGURE 1. Generalized map of pre-Miocene geology of the Pilot Range. Tg = granodiorite of Patterson Pass (Tertiary), Pzs = Paleozoic sedimentary strata, Єm = Middle and Lower Cambrian(?) schist and marble, ЄZp = Prospect Mountain Quartzite (Cambrian and Proterozoic Z), Zm = McCoy Creek Group (Proterozoic Z) of Misch and Hazzard (1962). Sawteeth on upper plate of low-angle faults; bar and ball on downthrown block of high-angle faults. Locations of K-Ar samples shown.

must be Cretaceous or older. Cretaceous(?) dikes and plutons were emplaced at the close of this thermal event. A thermal episode that included plutonism in the Oligocene apparently caused widespread differential loss of argon in biotite and muscovite.

SAMPLE DESCRIPTIONS

1. *M79PR-171* K-Ar

Muscovite syenogranite dike. (41°01'17"N, 114°01' 52"W; SE¼ NW¼, S33,T4N,R19W; Pilot Peak 7.5' quad; Elko Co., NV, and Box Elder Co., UT). White, medium grained; potassium feldspar, plagioclase, muscovite, and biotite. Accessory apatite, sphene, zircon, garnet(?). *Analytical data:* (muscovite) K_2O = 10.63%, 10.66%, 10.59%, 10.60%; $*Ar^{40}$ = 8.729 x 10^{-10} mole/gm; $*Ar^{40}/\Sigma Ar^{40}$ = 79.2%. *Collected by:* D. M. Miller. *Comment:* Dike is moderately foliated and lineated and nearly concordant with layering and foliation in enclosing Cambrian(?) marble. Quartz, muscovite, and biotite recrystallized.

(muscovite) 56.2 ± 0.8 m.y.

2. *M79PR-21* K-Ar

Biotite-hornblende granodiorite(?) dike. (41°01'27"N, 114°02'24"W; NE¼ S16,T4N,R19W; Pilot Peak 7.5' quad., Elko Co., NV, and Box Elder Co., UT). Groundmass is aphanitic near margins of dike, where it is medium gray and contains phenocrysts of all major phases. Where sampled in the interior of the dike, rock is equigranular, medium grained, chalky white. Zoned plagioclase, potassium feldspar, biotite, hornblende, and quartz are major constituents, minor ones are sphene, zircon, and apatite. Hornblende highly altered; plagioclase partially sericitized. Quartz poor. Extinction in quartz is undulatory. *Analytical data:* (biotite) K_2O = 9.13%, 9.16%, 9.11%, 9.10%; $*Ar^{40}$ = 4.080 x 10^{-10} mole/gm, 3.876 10^{-10} mole/gm; $*Ar^{40}/\Sigma Ar^{40}$ = 68.6%, 70.9%. *Collected by:* D. M. Miller. *Comment:* Weak lineation trends N40E, plunges 5° NE, and is defined by aligned mafic minerals. Lineation is transverse to prominent elongation lineation in neighboring schist, marble, and quartzite. Occupies low-angle fault zone separating Lower Cambrian from Middle Cambrian(?) rocks with intervening thin slice of metamorphosed Pioche Formation.

(biotite) 30.1 ± 0.5 m.y.

3. *M79PR-85* K-Ar

Granodiorite of Bettridge Creek area. (41°03'57"N, 114°01'31"W; NE¼ S32,T4N,R19W; Pilot Peak 7.5' quad., Elko Co., NV, and Box Elder Co., UT). Biotite granodiorite. Equigranular, coarse grained, light to medium gray. Potassium feldspar, plagioclase, quartz, hornblende, and biotite; minor apatite and zircon. Quartz and biotite have undulatory extinction. *Analytical data:* (biotite) K_2O = 8.96%, 8.98%, 8.96%, 8.95%; $*Ar^{40}$ = 3.546 x 10^{-10} mole/gm, 3.490 x 10^{-10} mole/gm; $*Ar^{40}/\Sigma Ar^{40}$ = 69.4%, 66.6%; (hornblende) K_2O = 0.898%, 0.900%, 0.899%, 0.896%, $*Ar^{40}$ = 1.210 x 10^{-10} mole/gm; $*Ar^{40}/\Sigma Ar^{40}$ = 67.5%. *Collected by:* D. M. Miller. *Comment:* Intrusive body is indistinctly foliated in most locations; foliation and rare lineation are not consistently oriented and are therefore probably caused by the emplacement of the pluton. Pluton occupies tear fault zone related to major low-angle faults.

(biotite) 27.1 ± 0.5 m.y.
(hornblende) 91.2 ± 1.5 m.y.

4. *M79PR-116* K-Ar

Granodiorite of Patterson Pass. (41°11'41"N, 114°0' 32"W; C S34,T6N,R19W; Patterson Pass 7.5' quad., Elko Co., NV, and Box Elder Co., UT). Porphyritic biotite granodiorite. Potassium feldspar phenocrysts. Pale-gray coarse-grained groundmass of quartz, plagioclase, potassium feldspar, biotite, and, rarely, hornblende. Accessory zircon, sphene, apatite, and xenotime(?). Biotite is reddish brown; some books are partially altered to pale-green chlorite. *Analytical data:* (biotite) K_2O = 8.60%, 8.57%, 8.58%, 8.57%; $*Ar^{40}$ = 4.565 x 10^{-10} mole/gm; $*Ar^{40}/\Sigma Ar^{40}$ = 84.2%. *Collected by:* D. M. Miller.

(biotite) 36.6 ± 0.5 m.y.

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