K-Ar age bracket on the initiation of Basin and Range faulting in southeastern California

K.S. Murray

Isochron/West, Bulletin of Isotopic Geochronology, v. 33, pp. 3-8

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

K-Ar AGE BRACKET ON THE INITIATION OF BASIN AND RANGE FAULTING IN SOUTHEASTERN CALIFORNIA

KENT S. MURRAY *Department of Geology, University of California, Davis, CA 95616*

Initiation of late Miocene Basin and Range faulting in the Palo Verde Mountain volcanic field of southeastern California has been chronologically bracketed by K-Ar ages of volcanic rocks that clearly predate and post-date the tectonic event. Five whole rock, biotite and fresh glass separates were prepared from five samples collected from a series of pre- and post-tectonic volcanic formations. These relationships, supplemented by two previously published K-Ar age determinations (Table 1), permit an excellent opportunity to approximately delimit, by K-Ar method, the time span during which Basin and Range normal faulting took place. Analyses were completed by Kreuger Enterprises, Inc., Geochron Laboratories Division. Constants used are: $\lambda_e = 0.585 \times 10^{-10}$/year; $\lambda\beta = 4.72 \times 10^{-10}$/year; $K^{40}/K = 1.22 \times 10^{-4}$.

GEOLOGIC DISCUSSION

The volcanic stratigraphy of the Palo Verde Mountain volcanic field of southeastern California (Fig. 1) can be divided into a tripartite regional stratigraphy which is temporally well defined by K-Ar age determinations. A basal sequence (35–30 Ma.) of andesite to rhyolite lava flows, plugs, domes and extensive pyroclastic deposits rest unconformably on pre-Cenozoic basement rock (Fig. 2). The basal sequence is intruded by cogenetic Cenozoic rocks and overlain by basaltic to rhyolitic lava flows, dikes, and a second widespread assemblage of pyroclastic deposits, cumulatively referred to as the silicic sequence. The youngest part of the tripartite volcanic stratigraphy within the field includes olivine basalt flows and breccia which occur at scattered localities in the Palo Verde Mountains.

Crustal extension and subsequent Basin and Range faulting was initiated approximately 21 Ma. following termination of the silicic sequence of volcanism, and continued until shortly after eruption of basaltic volcanism approximately 17 Ma. (Murray, 1981).

Field and structural evidence suggest that the Palo Verde region also underwent an initial period of crustal deformation unrelated to Basin and Range faulting, in the Oligocene (post-34 m.y.). This deformational event lasting until approximately 30 Ma., appears to be regional in extent, affecting large portions of southeastern California (Murray, 1981), and southwestern Arizona (Scarborough, 1979).

Significant conclusions from these data are: (1) volcanism represented by the basal and silicic sequences, commenced in this part of California approximatley 35 Ma. and continued until 21 Ma. erupting copius amounts of andesite lava and rhyolite to rhyodacite pyroclastic material; (2) a probable period of crustal deformation lasting approximately 4 million years (34–30 Ma.), has been recognized in the Oligocene; (3) Basin and Range extensional faulting post-dates silicic volcanism, and continued until after the eruption of basaltic volcanism (21–17 Ma.).

TABLE 1. Potassium-argon age determination for the volcanic rocks of the Palo Verde Mountain Volcanic Field. See Figure 3. (Published ages from Crowe and others, 1979).

Stratigraphic unit and location	Material	Age	Sample location number
Hornblende rhyodacite plug, Tv_1; southeastern Palo Verde Mountains	Biotite	34.7 ± 1.3 my	f-9
	Whole rocks	30.0 ± 3.0 my	f-8
	Plagioclase	28.3 ± 3.9 my	PV-21
Olivine-augite andesite flows. Tv_2; Flattops, southern Palo Verde Mountains	Biotite	27.9 ± 9.0 my	f-1
	Biotite	25.6 ± 1.0 my	f-7
Biotite-sanidine rhyolite welded ignimbrite. Tv_2; southwestern Palo Verde Mountains	Plagioclase	25.2 ± 2.5 my	f-2
Perlite from plug-dome margin. Tv_2 near Thumb Peak, southwestern Palo Verde Mountains	Hornblende	21.1 ± 0.9 my	f-10
Rhyolite ignimbrite. Tv_2; southwestern Palo Verde Mountains	Plagioclase	22.1 ± 1.3 my	BH-3
Perlite from plug-dome margin. Tv_2 westernmost Black Hills	—	approx. 21 my	not shown
Ignimbrite, Tv_2; easternmost Black Hills	Plagioclase	56.4 ± 1.6 my*	PV-34
	Plagioclase	24.5 ± 1.7 my*	PV-33
Augite-hypersthene basalt flow. Tv_3; northeastern Palo Verde Mountains	Plagioclase	36.4 ± 4.0 my*	f-3

*These basalt flows have yielded three highly discordant ages. The older ages are inconsistent with age and stratigraphic determinations elsewhere within the Palo Verde Mountains.

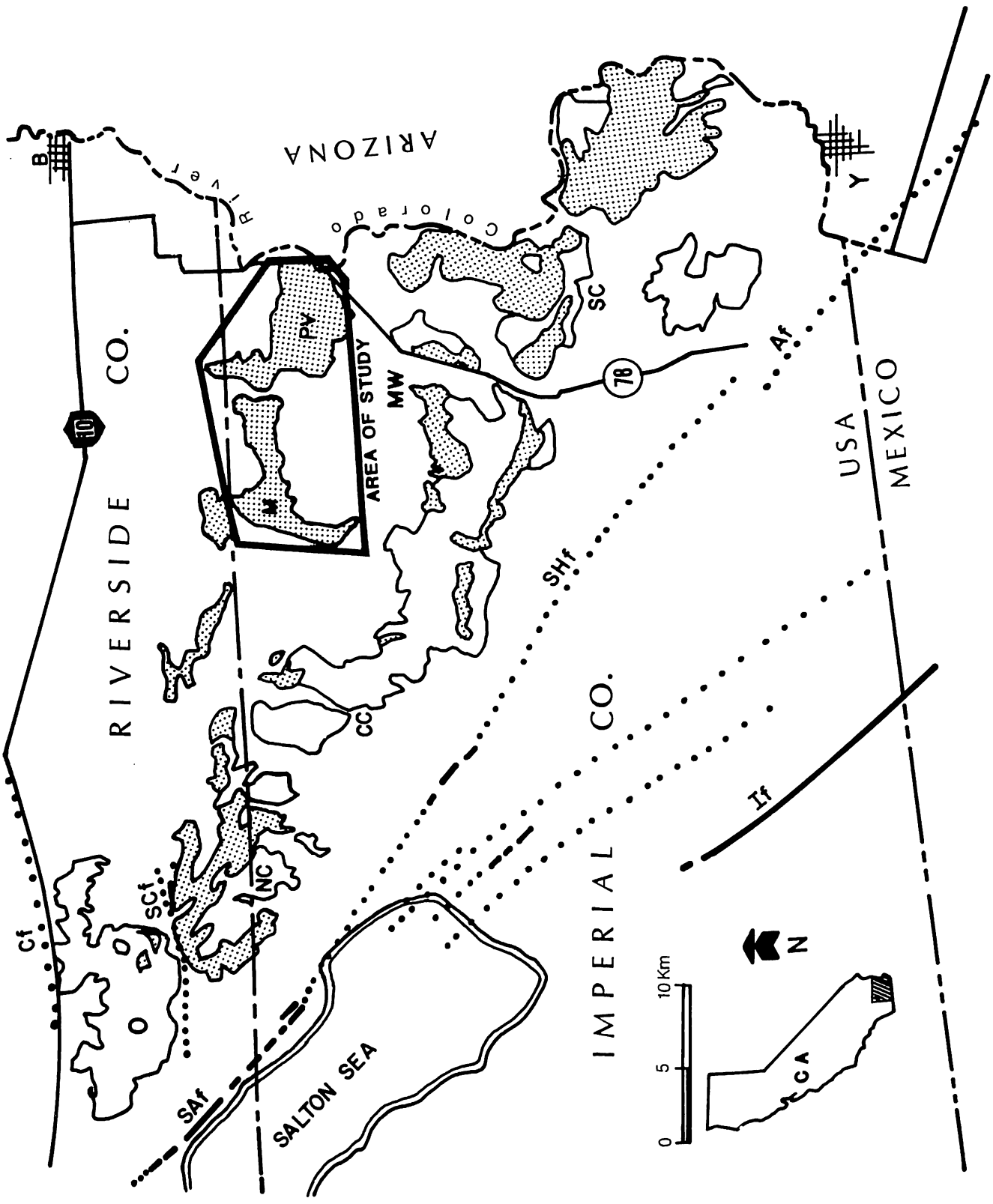

FIGURE 1. Location map of the Palo Verde Mountain volcanic field.

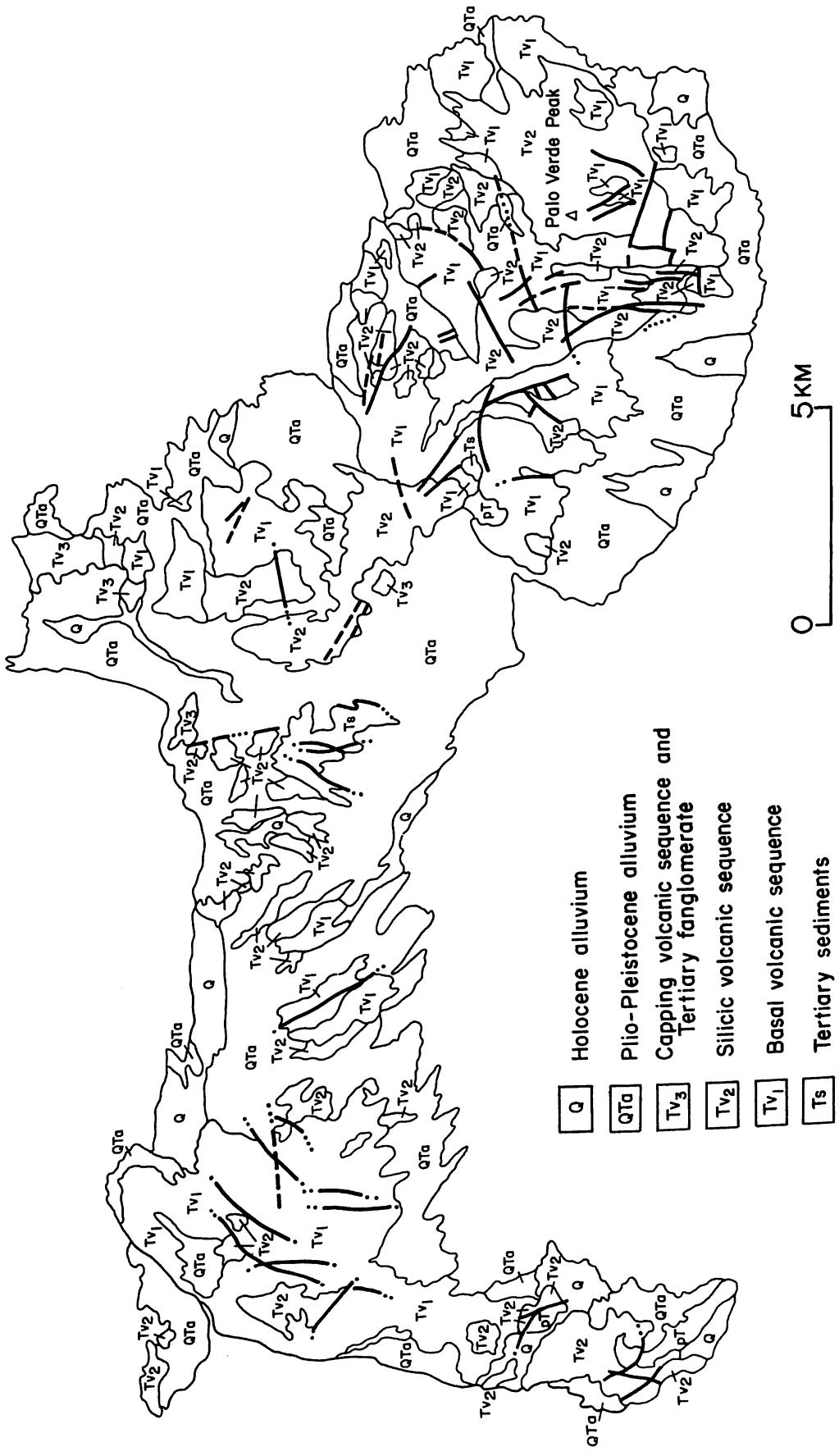

FIGURE 2. Generalized geologic map of the Palo Verde Mountain volcanic field.

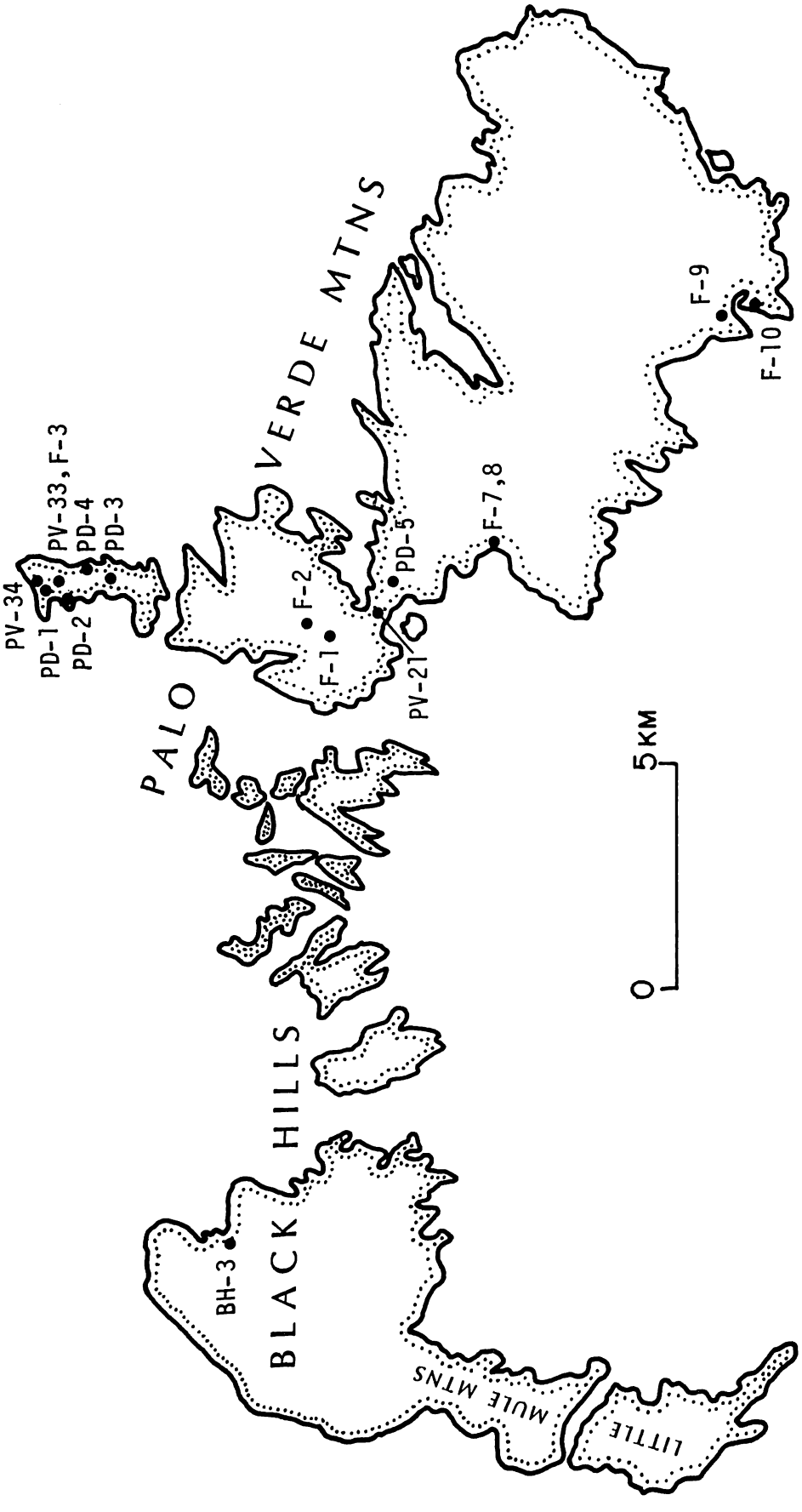

FIGURE 3. Schematic map showing location of samples collected for age-determination.

SAMPLE DESCRIPTIONS

1. *PD-1* K-Ar
Vesicular olivine basalt (northern Palo Verde Mountains; 33°26'55''N, 114°52'12''W; Palo Verde Mountains 15' quad; CA). Sparsely porphyritic microphenocryst phases include twinned aluminous pyroxene, 7 %; olivine, 6 %; plagioclase, 4 %; and hypersthene, 1 %. In the hypocrystalline groundmass, plagioclase represents 40 %, glass 10 %, iron oxides 12 %, and devitrification products 10 %. *Analytical data:* K = 1.380%; $*Ar^{40}$ = .001747 ppm; $*Ar^{40}$/total Ar^{40} = .209. *Collected by:* K. S. Murray, 1975.
(whole rock) 17.2 ± .9 m.y.

2. *PD-2* K-Ar
Olivine basalt (northern Palo Verde Mountains, 1.6 km SW of sample RD-6; 33°26'16''N, 114°52'39''W; Palo Verde Mountains 15' quad; CA). Petrography similar to PD-1; olivine microphenocrysts being replaced by serpentine, chlorite, and stilpnomelane. Pyroxenes arranged in subpoikilitic textures. Quartz xenocrysts noted. *Analytical data:* K = 1.482%; $*Ar^{40}$ = .001824 ppm; $*Ar^{40}$/total Ar^{40} = .160. *Collected by:* K. S. Murray, 1975.
(whole rock) 17.2 ± .9 m.y.

3. *PD-3* K-Ar
Glassy andesite (northern Palo Verde Mountains; 33°25'36''N, 114°52'08''W; Palo Verde Mountains 15' quad; CA). Nearly nonporphyritic, plagioclase microphenocrysts represent only 2 % by volume of the total rock. Vitric portion of the hypocrystalline groundmass still fresh. *Analytical data:* K = 3.210%; $*Ar^{40}$ = .005899 ppm; $*Ar^{40}$/total Ar^{40} = .448. *Collected by:* K. S. Murray, 1975.
(fresh glass shards) 25.0 ± 1.1 m.y.

4. *PD-4* K-Ar
Welded rhyolite ignimbrite (northern Palo Verde Mountains; 33°25'59''N, 114°51'53''W; Palo Verde Mountains 15' quad; CA). Crystal-rich air-fall deposit. Crystal phases include sanidine, 15 %; biotite, 12 %; orthoclase, 10 %; and hornblende, 5 %. Vitric constituents show well developed shard formation. *Analytical data:* K = 6.024%; Ar^{40} = .01018 ppm; $*Ar^{40}$/total Ar^{40} = .526. *Collected by:* K. S. Murray, 1975.
(biotite) 24.1 ± 1.0 m.y.

5. *PD-5* K-Ar
Vesicular olivine basalt (from the Flattops, south-central Palo Verde Mountains; 33°22'53''N, 114°52'08''; Palo Verde Mountains 15' quad; CA). Abundant olivine phenocrysts altered slightly to iddingsite, often associated with a hypersthene halo. Plagioclase sharp and fresh. Magnetite well developed and finely disseminated. Groundmass developed into distinctive pilotaxitic texture containing a minor vitric component. *Analytical data:* K = 1.162%; $*Ar^{40}$ = .002276 ppm; $*Ar^{40}$/total Ar^{40} = .214. *Collected by:* K. S. Murray, 1975.
(whole rock) 26.9 ± 1.4 m.y.

REFERENCES

Crowe, B. M., Crowell, J. C., and Krummenacher, D. (1979) Regional stratigraphy, K-Ar ages and tectonic implications of Cenozoic volcanic rocks, southeastern California: Am. Jour. Sci., v. 279, p. 186–216.

Murray, K. S. (1981) Tectonic implications of space-time patterns of Cenozoic volcanism in the Palo Verde Mountain volcanic field, southeastern California: Ph.D. thesis, University of California, Davis.

Scarborough, R. B. (1979) Cenozoic history and uranium in southern Arizona: Field notes, Ariz. Bur. of Geol. and Mineral Tech., v. 9, no. 3, p. 1–16.