New K-Ar dates for late Miocene to early Pliocene mafic volcanic rocks in the Lake Mead area, Nevada and Arizona

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NEW K-Ar DATES FOR LATE MIOCENE TO EARLY PLIOCENE MAFIC VOLCANIC ROCKS IN THE LAKE MEAD AREA, NEVADA AND ARIZONA

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We report the results of 13 new K-Ar radiometric ages for basaltic andesites from the Callville Mesa volcanic field on the north shore of Lake Mead, Nevada, and basalts from the Fortification Hill volcanic field, Arizona and Nevada (fig. 1). These volcanic fields are located in the northernmost part of the Colorado River extensional corridor, an area of extensive Miocene igneous activity and upper crustal extension (e.g., Longwell and others, 1965; Anderson, 1971; Anderson and others, 1972; Bohannon, 1984; Smith and others, 1990).

CALLVILLE MESA VOLCANIC FIELD

The Callville Mesa (CM) volcanic field is exposed primarily on Black and Callville Mesas north of Lake Mead. Basaltic andesite erupted from compound cinder cones on Callville Mesa and in West End Wash between 10.46 to 8.49 Ma. These dates are slightly younger than the whole rock K-Ar dates of 11.3 ± 0.3 Ma and 11.1 ± 0.5 reported by Anderson and others (1972) for basaltic andesite of Callville Mesa.

Basaltic andesite of Callville Mesa locally overlies and is interbedded with the Red Sandstone unit (Bohannon, 1984), sandstone and conglomerate that was deposited in a structurally controlled basin in the upper plate of the Saddle Island detachment (Duebendorfer and others, 1990; Duebendorfer and Wallin, 1991). The basin and extensional allochthon are bounded to the north by the Las Vegas Valley Shear Zone (Duebendorfer and Wallin, 1991) (fig. 1). Callville Mesa basaltic andesite was erupted during the late stages of development of the Red Sandstone basin and represents the only volcanism during active upper

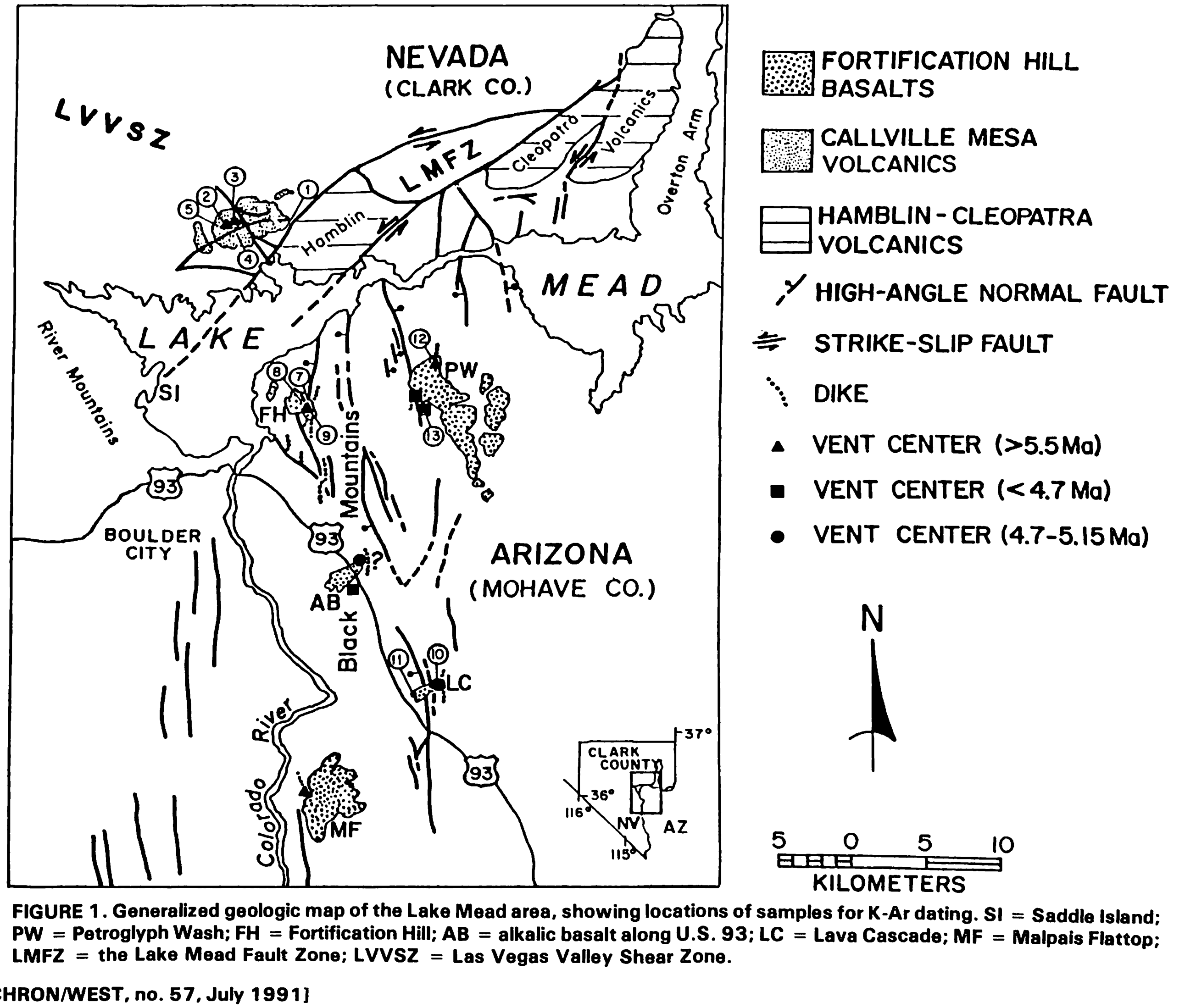

FIGURE 1. Generalized geologic map of the Lake Mead area, showing locations of samples for K-Ar dating. SI = Saddle Island; PW = Petroglyph Wash; FH = Fortification Hill; AB = alkalic basalt along U.S. 93; LC = Lava Cascade; MF = Malpais Flattop; LMFZ = the Lake Mead Fault Zone; LVVSZ = Las Vegas Valley Shear Zone.

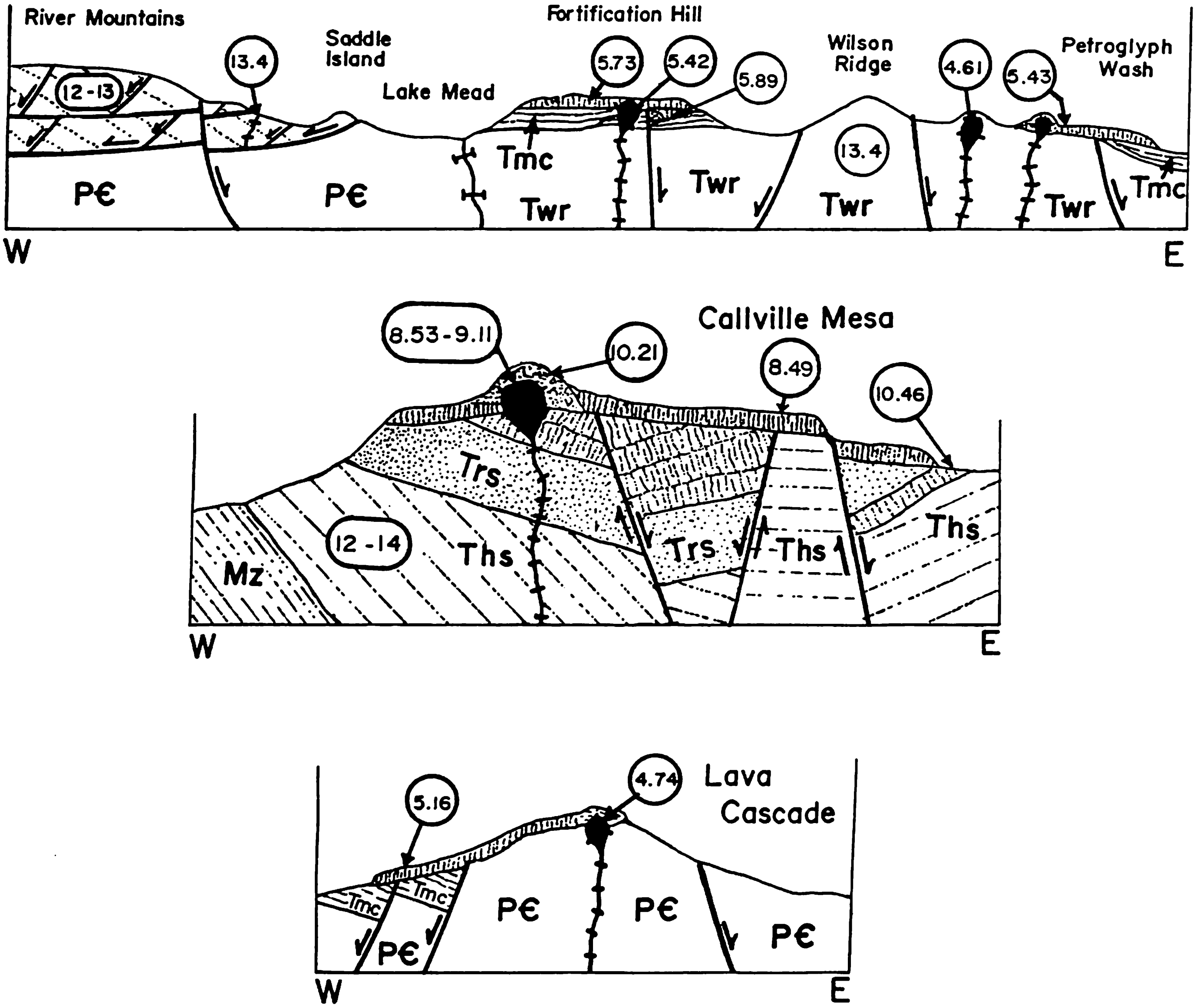

FIGURE 2. Cartoon cross sections showing stratigraphic relationships and major structures. The River Mountains are primarily intermediate volcanic flows and intrusive rock (Smith, 1982). Dates for the River Mountains from Anderson and others (1972) and Weber and Smith (1987). Tmc = Muddy Creek Formation (Late Tertiary clastic sediments). Trs = the Red Sandstone Unit (Tertiary clastic sediments); Ths = Tertiary Horse Spring Formation. Dates for the Horse Spring Formation from Bohannon (1984); Twr = Tertiary Wilson Ridge intrusive rocks. Date from Larson and Smith (1990); Mz = Mesozoic sediments; PЄ = undifferentiated Precambrian rock.

crustal extension and stratal tilting in the Lake Mead area. Since basaltic andesite dated at 10.46 Ma is tilted and younger units (10.21 to 8.7 Ma) are not, the major phase of tilting related to motion on the Saddle Island detachment occurred after 10.46 Ma (fig. 2). In other parts of the Lake Mead area, stratal tilting may have occurred as early as 13 Ma (Bohannon, 1984).

FORTIFICATION HILL BASALT

The Fortification Hill basalt field comprises at least eight volcanoes that occur in a 75 km long north-northeast trending zone that extends from Malpais Flattop, Arizona to Black Point, Nevada. Tholeiite, calc-alkalic and alkalic basalt periodically erupted from 6.02 (this study) to 4.3 Ma (Anderson and others, 1972). The Fortification Hill basalts form the uppermost part of the Muddy Creek Formation (Longwell and others, 1965; Bohannon, 1984).

Subalkalic and alkalic basalts occur in the Fortification Hill field (FH). We divide FH basalt into three groups (table 1; refer to fig. 1 for locations): (1) Tholeiitic two-pyroxene basalt (6.02–5.71 Ma) (SAB) at Black Point and Malpais Flattop and subalkalic basalt at Fortification Hill (lower part of the section). (2) Alkali basalt (5.42 to 4.74 Ma) (OAB) at Fortification Hill (upper section), Petroglyph Wash and Lava Cascade. (3) Alkali basalt (4.61, this study; to 4.3 Ma, Anderson and others, 1972) (YAB) along U.S. 93 near Hoover Dam, Saddle Island and in Petroglyph Wash.

TABLE 1. The subalkalic and alkalic suites of mafic lavas in the Lake Mead area. Abbreviations are defined in the text.

Alkalic	*Sub-alkalic*	*Age (Ma)*
	Callville Mesa (CM)	10.46-8.49
	Black Point (SAB)	6.02
	Malpais Flattop (SAB)	5.8
Fortification Hill (OAB)	Fortification Hill (SAB)	5.89-5.42
Petroglyph Wash (OAB)		5.43
Lava Cascade (OAB)		5.16-4.74
Young Alkalic Basalt (YAB)		4.61-4.3

The transition from subalkalic to alkalic volcanism occurred during eruptions at Fortification Hill and occurred just prior to 5.42 Ma.

ANALYTICAL TECHNIQUES

All dates were obtained from groundmass plagioclase separates. Analytical procedures discussed by Damon and others (1983) were used in this study (constants: λ_β = 4.963 × 10^{-10} yr^{-1}, λ_ϵ = 0.581 × 10^{-10} yr^{-1}, λ = 6.544 × 10^{-10} yr^{-1}, $^{40}K/K$ = 1.167 × 10^{-4} atom/atom).

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SAMPLE DESCRIPTIONS

Callville Mesa (CM)

1. *F8-24-100-LN* K-Ar
Olivine-pyrosene basalt flow (36°10′19″N, 114°42′30″W; just W of Callville Wash, Clark County, NV). *Analytical data:* K = 0.969, 0.951, 0.942, 0.963%; $^*Ar^{40}$ = 17.61, 17.33, 17.44, 17.15 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 62.2, 61.5, 61.3, 60.3%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah. *Comment:* This flow is interbedded with tilted Red Sandstone and represents the oldest activity associated with volcanism at Callville Mesa.
(plagioclase) 10.46 ± 0.23 Ma

2. *F8-24-88-LN* K-Ar
Basaltic andesite plug (36°10′33″N, 114°44′16″W; within volcanic center on Callville Mesa, Clark County, NV). *Analytical data:* K = 1.952, 1.978, 1.981, 1.952%; $^*Ar^{40}$ = 31.73, 31.50, 30.83, 30.37 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 41.5, 41.0, 40.4, 39.6%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah. *Comment:* This plug contains plagioclase megacrysts and xenocrysts of quartz.
(plagioclase) 9.11 ± 0.30 Ma

3. *F8-24-90-LN* K-Ar
Basaltic andesite plug (36°10′29″N, 114°43′52″W; within volcanic center on the W side of West End Wash, Clark County, NV). *Analytical data:* K = 1.794, 1.805, 1.819, 1.805%; $^*Ar^{40}$ = 26.52, 26.64, 27.10, 26.83 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 77.3, 77.4, 78.4, 78.0%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah.
(plagioclase) 8.53 ± 0.22 Ma

4. *F8-24-85-LN* K-Ar
Basaltic andesite flow (36°09′51″N, 114°43′57″W; upper flow on Callville Mesa, S of volcanic center, Clark County, NV). *Analytical data:* K = 2.070, 2.075, 2.081, 2.067, 2.071%; $^*Ar^{40}$ = 30.214, 30.474, 30.684, 30.870 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 79.0, 79.9, 80.4, 80.3. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah. *Comment:* This sample contains xenocrysts of quartz and alkali-feldspar and is the youngest rock dated in the Callville Mesa volcanic field.
(plagioclase) 8.49 ± 0.20 Ma

5. *88-24-146-LN* K-Ar
Basaltic andesite flow (36°10′37″N, 114°44′39″; flow on flank complex cinder cone on Callville Mesa, S of volcanic center, Clark Cunty, NV). *Analytical data:* K = 2.230, 2.227, 2.234, 2.242%; $^*Ar^{40}$ = 39.65, 39.34, 40.48, 39.04 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 88.4, 88.2, 92.4, 87.8%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah.
(plagioclase) 10.21 ± 0.23 Ma

Fortification Hill (SAB)

6. *87-10-129-LN* K-Ar
Olivine-pyroxene basalt flow (36°24′43″N, 114°23′02″W; flow directly E of feeder dike at Black Point, Clark County, NV). *Analytical data:* K = 0.655, 0.634, 0.639, 0.643%; $^*Ar^{40}$ = 6.93, 6.70, 6.84, 6.67 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 10.5, 10.1, 10.3, 10.1%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah. *Comment:* Rocks from this exposure contain hypersthene and pigeonite as well as augite and olivine phenocrysts.
(plagioclase) 6.02 ± 0.39 Ma

7. *F7-38-13-LN* K-Ar
Olivine basalt flow (36°03′45″N, 114°40′56″W; lowest flow at Fortification Hill, Mohave County, AZ). *Analytical data:* K = 0.935, 0.922, 0.943, 0.927, 0.931%; $^*Ar^{40}$ = 9.446, 9.512, 9.616, 9.562 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 52.3, 52.6, 53.3, 52.9%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah. *Comment:* Located at the north end of Fortification Hill.
(plagioclase) 5.89 ± 0.18 Ma

8. *87-38-142-LN* K-Ar
Olivine-plagioclase-pyroxene basalt flow (36°03′18″N, 114°40′54″W; flow erupted from cinder cones on Fortification Hill, Mohave County, AZ). *Analytical data:* K = 0.932, 0.925, 0.953%; $^*Ar^{40}$ = 9.45, 9.31, 9.22, 9.32 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 49.5, 48.5, 48.2, 48.7%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah. *Comment:* This flow lies stratigraphically above F7-38-13-LN.
(plagioclase) 5.73 ± 0.13 Ma

Fortification Hill (OAB)

9. *87-38-143-LN* K-Ar
Olivine-plagioclase-pyroxene basalt plug (36°03′02″N 114°40′37″W; one of many plugs that intrude cinder cones on Fortification Hill, Mohave County, AZ) *Analytical data:* K = 1.275, 1.268, 1.280, 1.256% $^*Ar^{40}$ = 11.85, 11.98, 12.02, 11.96 × 10^{-12} mol/gm; $^*Ar^{40}/\Sigma Ar^{40}$ = 44.4, 44.5, 44.7, 44.3%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah.

Comment: A sample of a basalt plug that represents the youngest volcanism at Fortification Hill.

(plagioclase) 5.42 ± 0.13 Ma

10. *87-57-131-LN* K-Ar
Olivine basalt plug (35°52′38″N, 114°35′15″W; plug intruding vent center at Lava Cascase, Mohave County, AZ). *Analytical data:* K = 0.810, 0.793, 0.836%; $*Ar^{40}$ = 6.69, 6.63, 6.75, 6.69 × 10^{-12} mol/gm; $*Ar^{40}/\Sigma Ar^{40}$ = 46.3, 46.0, 46.8, 46.1%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah. *Comment:* Collected from a plug within the vent of the Lava Cascade at the summit of the Black Mountains.

(plagioclase) 4.74 ± 0.12 Ma

11. *87-57-132-LN* K-Ar
Olivine basalt flow (35°52′26″N, 114°36′06″W; distal end of flow at Lava Cascade, Mohave County, AZ). *Analytical data:* K = 0.857, 0.874, 0.892, 0.878%; $*Ar^{40}$ = 8.00, 7.82, 7.74, 7.78 × 10^{-12} mol/gm; $*Ar^{40}/\Sigma Ar^{40}$ = 37.2, 35.9, 35.7, 35.8%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah. *Comment:* This sample was collected just east of U.S. 93.

(plagioclase) 5.16 ± 0.14 Ma

12. *F8-42-82-LN* K-Ar
Olivine basalt flow (36°04′37″N, 114°35′44″W; flow at from cinder cone at Petroglyph Wash, Mohave County, AZ). *Analytical data:* K = 1.298, 1.268, 1.240, 1.267%; $*Ar^{40}$ = 11.68, 12.01, 12.03, 12.14 × 10^{-12} mol/gm; $*Ar^{40}/\Sigma Ar^{40}$ = 52.3, 53.4, 53.5, 53.8%. *Collected by:* D. L. Feuerbach; *dated by:* M. Shafiqullah. *Comment:* The cinder cone is located just south of Gilbert Wash near the junction with James Bay Wash.

(plagioclase) 5.43 ± 0.16 Ma

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