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K-AR DATES FOR VOLCANIC ROCKS, CENTRAL CASCADE RANGE OF OREGON

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Published estimates of age of Oregon High Cascade volcanic rocks and of associated rocks in the Western Cascades and in the Deschutes Basin (map area of Figure 1) reveal a wide divergence of viewpoint, based upon several distinct structural and stratigraphic interpretations (Thayer, 1936; Peck and others, 1964; Williams, 1957; Waters, 1968; Wheeler and Mallory, 1970). Radiometric ages and related analytical data are reported here for 31 rock units from this region. Andesitic volcanism was widespread in the central Cascade Range and in the adjacent Western Cascades and western Deschutes Basin, 16 to 3 million years ago. From 2.5 m.y. to the present, volcanic activity in this area consisted predominantly of basaltic andesite, chiefly confined to a High Cascade structural depression.

Samples were collected and chemically analysed by E. M. Taylor and P. O. Hales. K-Ar age determinations were performed by P. O. Hales, and D. J. Parker, P. N. Taylor, and R. L. Armstrong at Yale University. Analytical constants for K-Ar age calculations used were: $\lambda_{\epsilon} = 5.84 \times 10^{-11}$ /yr.; $\lambda_{\beta} = 4.72 \times 10^{-10}$ /yr.; and $K^{40} = 0.0119$ atom percent. Argon was determined by isotope dilution, potassium by atomic absorption spectrophotometry (Armstrong, 1970) and X-ray fluorescence. Uncertainties reported are for analytical error only and represent one standard deviation, or the standard error for averaged dates.

All of the K-Ar determinations were performed on whole-rock samples, except one separated hornblende. All specimens were free of alteration products visible in hand sample or thin section. However, in two young samples, low content of potassium, high content of atmospheric argon, and possible loss of radiogenic argon from groundmass glass produced small negative dates with large errors; these are not reported. The age of a few other samples is questioned (see comments, below) wherever their paleomagnetic polarity is in apparent conflict with the currently accepted chronology of geomagnetic reversals (Cox, 1969).

The Yale K-Ar dating laboratory was established with a grant from the Research Corporation and supported by NSF research grants GA1694 and GA26025. Supplemental petrographic and stratigraphic information for samples from the area southeast of Mount Jefferson may be found in Hales (1975).

SAMPLE DESCRIPTIONS

1. TS-137 K-Ar (whole rock) 0.04±0.1 m.y.
Basaltic andesite (SiO₂, 55%). Lava (44°07'18"N, 121°51'18"W; from saddle on S ridge of Husband Volcano, 6900' elev., 16 mi SE of McKenzie Bridge; Lane Co., OR). Paleomag. N. Analytical data: K = 0.531%, *Ar⁴⁰ = 0.0033 x 10⁻⁶ cc/gm (1.7% Σ Ar⁴⁰), -0.0016 cc/gm (-0.7% Σ Ar⁴⁰).
2. BT-72 K-Ar (whole rock) 0.2±0.9 m.y.
Holocrystalline dacite (SiO₂, 74%). (44°09'03"N, 121°34'00"W; summit of Three Creek Butte plug dome, 10 mi S of Sisters; Deschutes Co., OR). Analytical data: K = 2.86%, *Ar⁴⁰ = 0.0184 x 10⁻⁶ cc/gm

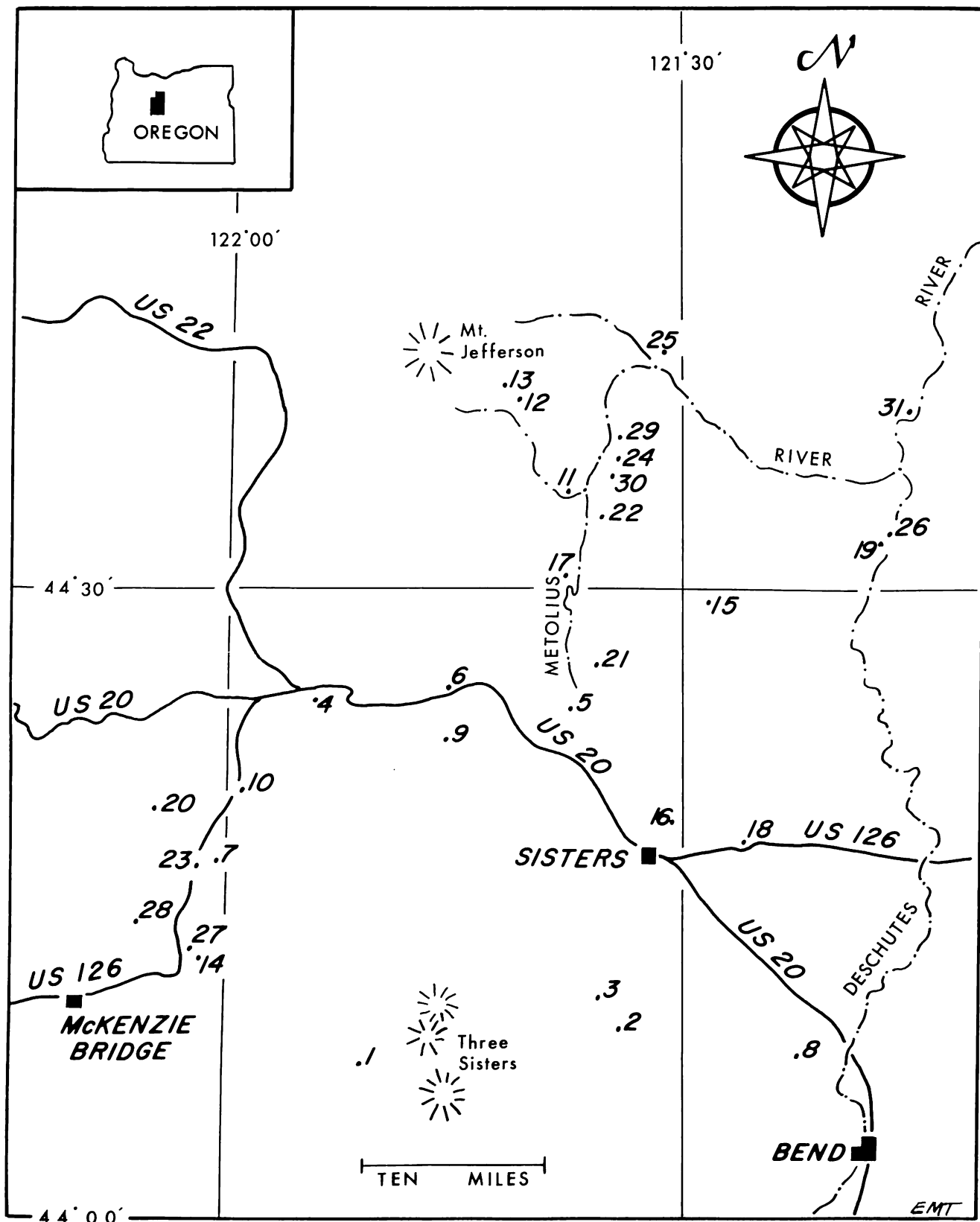


Figure 1. Map showing approximate locations of dated rock samples. Numbers on map refer to numbered sample descriptions in text.

(0.2% Σ Ar⁴⁰). Comment: One of a group of 3 dacite domes partially buried by lavas from the central High Cascades. Large standard error.

3. BT-31 K-Ar (whole rock) 0.4±0.4 m.y.
Holocrystalline dacite (SiO₂, 73%). (44°10'40"N, 121°36'08"W; summit of Melvin Butte plug dome, 8 mi S of Sisters; Deschutes, Co., OR). Analytical data: K = 3.04%, 3.11%, *Ar⁴⁰ = 0.0513 x 10⁻⁶ cc/gm (1.2% Σ Ar⁴⁰). Comment: One of a group of 3 dacite domes partially buried by lavas from the central High Cascades. Large standard error.
4. TFJ-321 K-Ar (whole rock) 0.43±0.12 m.y.
Basaltic andesite (SiO₂, 55%). (44°25'58"N, 121°55'28"W; lava from cut on Jackpine Road, W end of Potato Hill, 3 mi W of Santiam Pass; Linn Co., OR). Paleomag. N. Analytical data: K = 0.540%, *Ar⁴⁰ = 0.0096 x 10⁻⁶ cc/gm (3% Σ Ar⁴⁰), 0.0090 x 10⁻⁶ cc/gm (3% Σ Ar⁴⁰).
- 5A. S-23 K-Ar (whole rock) 0.45±0.2 m.y.
Basaltic andesite (SiO₂, 56%). (44°24'16"N, 121°37'42"W; lava from road cut, 5200' elev. on NE side of Black Butte, 9 mi NW of Sisters; Jefferson Co., OR). Paleomag. R. Analytical data: K = 0.266%, *Ar⁴⁰ = 0.0043 x 10⁻⁶ cc/gm (1% Σ Ar⁴⁰), 0.0056 x 10⁻⁶ cc/gm (2% Σ Ar⁴⁰). Comment: See 5B, below.
- 5B. S-80 K-Ar (whole rock) 0.45±0.3 m.y.
Basaltic andesite (SiO₂, 55%). Same unit as 5A (44°24'16"N, 121°37'42"W; lava from road cut, 5200' elev. on NE side of Black Butte, 9 mi NW of Sisters; Jefferson Co., OR). Analytical data: K = 0.141%, *Ar⁴⁰ = 0.0014 x 10⁻⁶ cc/gm (0.6% Σ Ar⁴⁰), 0.0036 x 10⁻⁶ cc/gm (1.5% Σ Ar⁴⁰). Comment: In spite of age agreement between S-23 and S-80, lavas of Black Butte are paleomagnetically reversed and therefore must be at least 0.7 m.y. old. The analytical errors are sufficiently large to make this possible.
6. TFJ-427 K-Ar (whole rock) 0.54±0.14 m.y.
Basaltic andesite (SiO₂, 56%). (44°25'10"N, 121°46'20"W; sixth lava flow up gully from U.S. 20, 4000' elev., opposite Blue Lake; Jefferson Co., OR). Paleomag. R. Analytical data: K = 0.515%, *Ar⁴⁰ = 0.0114 x 10⁻⁶ cc/gm (3% Σ Ar⁴⁰), 0.0109 x 10⁻⁶ cc/gm (3% Σ Ar⁴⁰). Comment: Unit is paleomagnetically reversed and therefore must be at least 0.7 m.y. old.
7. EM-77 K-Ar (whole rock) 0.68±0.05 m.y.
Basaltic andesite (SiO₂, 55%). (44°17'00"N, 122°00'48"W; lava in cut of U.S.F.S. road 1556, 2800' elev., 1.5 mi E of Trailbridge Reservoir on U.S. 126; Linn Co., OR). Paleomag. N. Analytical data: K = 0.748%, *Ar⁴⁰ = 0.0195 x 10⁻⁶ cc/gm (9% Σ Ar⁴⁰), 0.0212 x 10⁻⁶ cc/gm (12% Σ Ar⁴⁰).
8. B-4 K-Ar (whole rock) 0.5±0.9 m.y.
Dacite ash-flow tuff (SiO₂, 73%). Fresh core of large pumice bomb (44°08'06"N, 121°22'39"W; outcrop adjacent to Tyler Road, 6 mi NW of Bend; Deschutes Co., OR). Paleomag. N. Analytical data: K = 2.86%, *Ar⁴⁰ = 0.0923 x 10⁻⁶ cc/gm (0.7% Σ Ar⁴⁰). Comment: This unit is overlain by paleomagnetically reversed High Cascade lavas and the standard error is large. Therefore, minimum age is the end of the Jaramillo normal paleomagnetic event, 0.89 m.y.
9. TFJ-363 K-Ar (whole rock) 0.88±0.05 m.y.
Porphyritic basaltic andesite (SiO₂, 57%). (44°23'16"N, 121°46'00"W; lava 4845' elev. on NE ridge of Cache Mtn., 4.5 mi SE of Santiam Pass; Deschutes Co., OR). Paleomag. N. Analytical data: K = 0.921%, *Ar⁴⁰ = 0.329 x 10⁻⁶ cc/gm (13.8% Σ Ar⁴⁰), 0.0313 x 10⁻⁶ cc/gm (12.4% Σ Ar⁴⁰). Comment: Unit is a partially buried remnant of an older central High Cascade volcano, unrelated to the late Pleistocene cinder cones on Cache Mtn. summit.
- 10A. TFJ-256 K-Ar (whole rock) 1.1±0.2 m.y.
Basaltic andesite (SiO₂, 54%). (44°19'45"N, 121°59'38"W; lava in cuts of U.S. 126, 2820' elev., 0.6 mi SE of Carmen Reservoir; Linn Co., OR). Paleomag. R. Analytical data: K = 0.847%, *Ar⁴⁰ = 0.0348 x 10⁻⁶ cc/gm (5% Σ Ar⁴⁰), 0.0401 x 10⁻⁶ cc/gm (4% Σ Ar⁴⁰). Comment: See 10B, following page.

- 10B. TFJ-431 K-Ar (whole rock) 1.4±0.3 m.y.
 Basaltic andesite (SiO₂, 54%). Same unit as 10A (44°19'45"N, 121°59'38"W; lava in cuts of U.S. 126, 2820' elev., 0.6 mi SE of Carmen Reservoir; Linn Co., OR). Analytical data: K = 0.515%, *Ar⁴⁰ = 0.0227 x 10⁻⁶ cc/gm (4% Σ Ar⁴⁰), 0.0355 x 10⁻⁶ cc/gm (3% Σ Ar⁴⁰).
11. WR-11 K-Ar (whole rock) 1.6±0.3 m.y.
 Olivine-bearing basalt (SiO₂, 51%). (44°34'21"N, 121°38'22"W; lava intracanyon to N side Jefferson Creek valley, bench 3000' elev., 1 mi upstream from Metolius River; Jefferson Co., OR). Paleomag. R. Analytical data: K = 0.290%, *Ar⁴⁰ = 0.0188 x 10⁻⁶ cc/gm (5% Σ Ar⁴⁰), 0.0181 x 10⁻⁶ cc/gm (3.9% Σ Ar⁴⁰). Comment: This unit is older than the more extensive intracanyon basalt flows along the Metolius River.
12. WR-308 K-Ar (whole rock) 2.1±0.2 m.y.
 Porphyritic basaltic andesite (SiO₂, 57%). (44°39'12"N, 121°41'38"W; lava W of crest road, 6520' elev., 0.1 mi SE of Bald Peter summit, 5 mi E of Mt. Jefferson; Jefferson Co., OR). Analytical data: K = 0.980%, *Ar⁴⁰ = 0.0820 x 10⁻⁶ cc/gm (14% Σ Ar⁴⁰).
13. WR-311 K-Ar (whole rock) 2.1±0.2 m.y.
 Porphyritic olivine-bearing basaltic andesite (SiO₂, 54%). (44°39'12"N, 121°41'55"W; lava in W face of Bald Peter, 5240' elev., 5 mi E of Mt. Jefferson; Jefferson Co., OR). Paleomag. R. Analytical data: K = 0.915%, *Ar⁴⁰ = 0.0707 x 10⁻⁶ cc/gm (8% Σ Ar⁴⁰), 0.0806 x 10⁻⁶ cc/gm (7% Σ Ar⁴⁰).
- 14A. MB-110 K-Ar (whole rock) 2.1±0.1 m.y.
 Olivine basalt (SiO₂, 50%). (44°11'46"N, 122°00'50"W; lava from columnar-jointed flow, Scott Creek Road, 2480' elev., 8 mi E of McKenzie Bridge; Lane Co., OR). Paleomag. N. Analytical data: K = 0.374%, *Ar⁴⁰ = 0.0295 x 10⁻⁶ cc/gm (93.0% Σ Ar⁴⁰), 0.0335 x 10⁻⁶ cc/gm (12% Σ Ar⁴⁰), 0.0332 x 10⁻⁶ cc/gm (9% Σ Ar⁴⁰). Comment: See 14B, below.
- 14B. MB-132 K-Ar (whole rock) 2.6±0.2 m.y.
 Olivine basalt (SiO₂, 50%). Same unit as 14A (44°11'46"N, 122°00'50"W; lava from columnar-jointed flow, Scott Creek Road, 2480' elev., 8 mi E of McKenzie Bridge; Lane Co., OR). Analytical data: K = 0.374%, *Ar⁴⁰ = 0.0355 x 10⁻⁶ cc/gm (6% Σ Ar⁴⁰), 0.0403 x 10⁻⁶ cc/gm (10% Σ Ar⁴⁰). Comment: Both MB-110 and MB-132 probably Gauss paleomagnetic normal epoch, 2.43 - 2.8 m.y.
15. B-22 K-Ar (whole rock) 2.9±0.2 m.y.
 Basaltic andesite (SiO₂, 54%). (44°28'41"N, 120°28'34"W; lava from summit of Squaw Back Ridge, 14 mi N of Sisters; Jefferson Co., OR). Analytical data: K = 1.153%, *Ar⁴⁰ = 0.1303 x 10⁻⁶ cc/gm (12.3% Σ Ar⁴⁰), 0.1317 x 10⁻⁶ cc/gm (12.4% Σ Ar⁴⁰).
16. S-84 K-Ar (whole rock) 3.3±0.2 m.y.
 Basaltic andesite (SiO₂, 58%). (44°19'10"N, 121°31'02"W; lava from quarry on ridge W of Camp Polk Site, 2.5 mi NE of Sisters; Deschutes Co., OR). Paleomag. R. Analytical data: K = 0.852%, *Ar⁴⁰ = 0.1137 x 10⁻⁶ cc/gm (9.7% Σ Ar⁴⁰), 0.1080 x 10⁻⁶ cc/gm (10% Σ Ar⁴⁰). Comment: Probably Gilbert paleomagnetic reversed epoch, 3.32 - 3.70 m.y.
17. WR-189 K-Ar (whole rock) 4.5±0.4 m.y.
 Porphyritic olivine-bearing basaltic andesite (SiO₂, 54%). (44°30'13"N, 121°38'09"W; lava from crest of ridge, 3250' elev., 1.1 mi S of Wizard Falls, 0.2 mi W of Metolius River; Jefferson Co., OR). Paleomag. R. Analytical data: K = 0.850%, *Ar⁴⁰ = 0.142 x 10⁻⁶ cc/gm (6% Σ Ar⁴⁰), 0.169 x 10⁻⁶ cc/gm (16% Σ Ar⁴⁰).
18. HB-7 K-Ar (whole rock) 4.8±0.4 m.y.
 Basaltic andesite (SiO₂, 53%). (44°17'20"N, 121°24'38"W; lava, W rim of Deep Creek Canyon, U.S. 126 roadcut, 7 mi E of Sisters; Deschutes Co., OR). Paleomag. R. Analytical data: K = 0.783%, *Ar⁴⁰ = 0.1499 x 10⁻⁶ cc/gm (5.3% Σ Ar⁴⁰), 0.1484 x 10⁻⁶ cc/gm (8.2% Σ Ar⁴⁰).

19. M-2 K-Ar (whole rock) 4.9±0.5 m.y.
Olivine basalt (SiO₂, 51%). (44°31'02"N, 121°18'32"W; lava, W rim of Deschutes Canyon, 2600' elev., 0.8 mi SW of Deschutes Arm Bridge over Lake Chinook, 12 mi SW of Madras; Jefferson Co., OR). Analytical data: K = 0.265%, *Ar⁴⁰ = 0.0573 x 10⁻⁶ cc/gm (6% Σ Ar⁴⁰), 0.0454 x 10⁻⁶ cc/gm (9.6% Σ Ar⁴⁰).
20. EM-78 K-Ar (whole rock) 5.0±0.1 m.y.
Basaltic andesite (SiO₂, 56%). (44°19'32"N, 122°05'38"W; lava from crest of NE ridge, Bunchgrass Mtn., 4880' elev., 4 mi NW of Trailbridge Reservoir; Linn Co., OR). Paleomag. N. Analytical data: K = 0.956%, *Ar⁴⁰ = 0.188 x 10⁻⁶ cc/gm (46% Σ Ar⁴⁰), 0.194 x 10⁻⁶ cc/gm (22% Σ Ar⁴⁰).
21. S-74 K-Ar (whole rock) 5.0±0.2 m.y.
Basaltic andesite (SiO₂, 55%). (44°25'37"N, 121°35'59"W; lava from crest of S end Green Ridge, 4000' elev., 11 mi N of Sisters; Jefferson Co., OR). Paleomag. N. Analytical data: K = 0.913%, *Ar⁴⁰ = 0.197 x 10⁻⁶ cc/gm (17% Σ Ar⁴⁰), 0.184 x 10⁻⁶ cc/gm (17% Σ Ar⁴⁰), 0.188 x 10⁻⁶ cc/gm (17% Σ Ar⁴⁰), 0.160 x 10⁻⁶ cc/gm (10% Σ Ar⁴⁰).
22. WR-102 K-Ar (whole rock) 5.2±0.1 m.y.
Andesite (SiO₂, 61%). (44°33'20"N, 121°35'58"W; lava from crest of Green Ridge, 4520' elev., 1 mi E of Bridge 99 on Metolius River; Jefferson Co., OR). Analytical data: K = 1.27%, *Ar⁴⁰ = 0.2669 x 10⁻⁶ cc/gm (33% Σ Ar⁴⁰), 0.2598 x 10⁻⁶ cc/gm (26% Σ Ar⁴⁰).
23. EM-20 K-Ar (whole rock) 5.3±0.2 m.y.
Basaltic andesite ash-flow tuff (SiO₂, 54%). (44°16'39"N, 122°02'38"W; welded zone in road cut, U.S. 126, opposite Trailbridge Reservoir; Linn Co., OR). Paleomag. R. Analytical data: K = 0.656%, *Ar⁴⁰ = 0.147 x 10⁻⁶ cc/gm (23% Σ Ar⁴⁰), 0.172 x 10⁻⁶ cc/gm (22% Σ Ar⁴⁰), 0.127 x 10⁻⁶ cc/gm (15% Σ Ar⁴⁰), 0.113 x 10⁻⁶ cc/gm (10% Σ Ar⁴⁰).
24. WR-246 K-Ar (whole rock) 5.3±0.7 m.y.
Basaltic andesite (SiO₂, 54%). (44°36'10"N, 121°34'36"W; lava from crest of Green Ridge, 5000' elev., 1.4 mi E of confluence of Walker Creek and Metolius River; Jefferson Co., OR). Analytical data: K = 0.795%, *Ar⁴⁰ = 0.1739 x 10⁻⁶ cc/gm (6% Σ Ar⁴⁰), 0.1629 x 10⁻⁶ cc/gm (5% Σ Ar⁴⁰).
25. WR-328 K-Ar (whole rock) 5.7±0.6 m.y.
Andesite (SiO₂, 65%). (44°40'38"N, 121°32'08"W; lava, 3100' elev. on NE wall of Whitewater River Canyon, 0.7 mi NE of confluence, Whitewater and Metolius Rivers; Jefferson Co., OR). Analytical data: K = 1.13%, *Ar⁴⁰ = 0.2843 x 10⁻⁶ cc/gm (8% Σ Ar⁴⁰), 0.2348 x 10⁻⁶ cc/gm (6% Σ Ar⁴⁰).
26. M-8 K-Ar (whole rock) 5.8±1.0 m.y.
Olivine basalt (SiO₂, 49%). (44°31'22"N, 121°18'01"W; lava interbed in Deschutes Formation, 2050' elev., road cut 0.2 mi S of Deschutes Arm Bridge over Lake Chinook, 12 mi SW of Madras; Jefferson Co., OR). Analytical data: K = 0.120%, *Ar⁴⁰ = 0.0244 x 10⁻⁶ cc/gm (2.6% Σ Ar⁴⁰), 0.0313 x 10⁻⁶ (7.8% Σ Ar⁴⁰). Comment: This unit lies 550 stratigraphic feet below M-2 (4.9 m.y.).
27. MB-17 K-Ar (whole rock) 6.2±0.2 m.y.
Porphyritic basaltic andesite (SiO₂, 55%). (44°12'13"N, 122°02'00"W; lava in cut of Scott Creek Road, 2000' elev., 6.8 mi NE of McKenzie Bridge; Lane Co., OR). Paleomag. N. Analytical data: K = 0.873%, *Ar⁴⁰ = 0.2194 x 10⁻⁶ cc/gm (16% Σ Ar⁴⁰), 0.2155 x 10⁻⁶ cc/gm (33.6% Σ Ar⁴⁰).
28. MB-130 K-Ar (whole rock) 6.2±0.2 m.y.
Basalt porphyry (SiO₂, 51%). (44°13'10"N, 122°06'07"W; lava on crest of ridge 0.7 mi N of Frissell Point, 4.3 mi NE of McKenzie Bridge; Lane Co., OR). Analytical data: K = 0.715%, *Ar⁴⁰ = 0.170 x 10⁻⁶ cc/gm (32% Σ Ar⁴⁰), 0.179 x 10⁻⁶ cc/gm (32% Σ Ar⁴⁰).

- 29A. WR-143 K-Ar (whole rock) 7.3±0.1 m.y.
 Porphyritic hornblende andesite (SiO₂, 63%). (44°36'48"N, 121°34'36"W; lava from bench, 3900' elev., W face Green Ridge escarpment, 1.4 mi E of confluence Sheep Creek and Metolius River; Jefferson Co., OR). Paleomag. N. Analytical data: K = 1.205%, *Ar⁴⁰ = 0.3541 x 10⁻⁶ cc/gm (56% Σ Ar⁴⁰), 0.3472 x 10⁻⁶ cc/gm (45% Σ Ar⁴⁰). Comment: See 29B, below.
- 29B. WR-143-Hb K-Ar (hornblende) 8.1±0.6 m.y.
 Hornblende phenocrysts separated from andesite lava. Same unit as 29A (44°36'48"N, 121°34'36"W; lava from bench, 3900' elev., W face Green Ridge escarpment, 1.4 mi E of confluence Sheep Creek and Metolius River; Jefferson Co., OR). Analytical data: K = 0.370%, *Ar⁴⁰ = 0.1199 x 10⁻⁶ cc/gm (13% Σ Ar⁴⁰).
30. WR-248 K-Ar (whole rock) 9.2±0.6 m.y.
 Olivine-bearing basaltic andesite (SiO₂, 53%). (44°35'33"N, 121°35'01"W; lava from 4600' elev., W face of Green Ridge escarpment, 1.5 mi SE of confluence Walker Creek and Metolius River; Jefferson Co., OR). Analytical data: K = 0.730%, 0.720%, *Ar⁴⁰ = 0.2805 x 10⁻⁶ cc/gm (11.9% Σ Ar⁴⁰), 0.2499 x 10⁻⁶ cc/gm (10% Σ Ar⁴⁰).
31. M-9 K-Ar (whole rock) 15.9±3.0 m.y.
 Olivine basalt (SiO₂, 50%). (44°38'22"N, 121°16'06"W; lava interbedded in Deschutes Formation, 1600' elev., W wall of Deschutes River Canyon, 2.5 mi N of Round Butte Dam; Jefferson Co., OR). Analytical data: K = 0.223%, *Ar⁴⁰ = 0.1282 x 10⁻⁶ cc/gm (3.1% Σ Ar⁴⁰), 0.1564 x 10⁻⁶ cc/gm (4.1% Σ Ar⁴⁰). Comment: Near stratigraphic base of Deschutes Formation. Large standard error.

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