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K-Ar AGES OF VOLCANIC ROCKS IN SOUTHWEST WASHINGTON

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GEOLOGIC BACKGROUND

Sampled rocks were collected primarily from the southern Cascade Mountains of Washington (fig. 1). In this region, the Cascades consist dominantly of upper Eocene through lower Miocene pyroxene-phric andesitic to dacitic lava flows, tuffs, and volcanioclastic sedimentary rocks. Quartz-phryic dacitic tuffs of late Oligocene through early Miocene age are locally present. Flows of the middle to upper Miocene Columbia River Basalt Group, which originated in southeast Washington and adjacent Idaho and Oregon, form important stratigraphic markers where present. The volcanic rocks have been folded about northwest- to north-trending axes and intruded by numerous Miocene dioritic to granodioritic plutons. Pliocene hypabyssal, possibly subvolcanic, intrusive activity is present in the Columbia River Gorge.

Quaternary volcanic activity has produced imposing andesitic to dacitic strato-volcanoes (Mount Rainier, Mount St. Helens, and Mount Adams) in this part of the Cascade Range; a Pliocene to Quaternary polygenetic volcanic complex is also present at Goat Rocks (fig. 1). Quaternary basaltic lava-flow fields characterized by shield volcanoes, cinder cones, and fissure systems are present at Indian Heaven. The Simcoe Mountains area contains Pliocene through early Pleistocene back-arc volcanic rocks characterized by voluminous olivine basalt flows with lesser amounts of basaltic andesite and rhyolite. Most of our K-Ar age determinations are from the upper Eocene to lower Miocene volcanic section. These strata, which range from 2 to more than 5 km in aggregate thickness, commonly lack areally extensive marker beds or regionsally. The K-Ar age determinations have served as a major factor in the division of the Cascade volcanic section into time-lithology units for the 1:250,000-scale state geologic map.

PROCEDURES

Rock alteration resulting from deep burial, contact metamorphism near intrusives, or hydrothermal systems is widespread in the southern Washington Cascades and complicates the interpretation of K-Ar ages. Because of alteration and the typical presence of glass or the products of devitrification of glass in the groundmass of hypocrystalline rocks, all our samples required treatment with dilute HF and/or HNO3.

Major and minor element concentrations were determined for all our samples except sample 35 by x-ray fluorescence. These data are presented in table 1. Volcanic rocks were named on the basis of the geochemical data following the classification of Zanettin (1984).

Samples were processed for K-Ar determinations by one of three laboratories. Samples 1 through 18 and sample 35 were run by Krueger Enterprises, Inc., Geochron Laboratories Division. For these samples, the whole rock was crushed and sieved through 80 and 200-mesh-size (0.180-0.075 mm) sieves. Material between 80 and 200 mesh was treated with dilute HF and HNO3 to remove alteration products and/or glass. Argon measurements were made by isotope dilution, and argon analyses were performed on a MS-10-type mass spectrometer. Potassium was measured by flame photometry. Analytical uncertainties for the calculated ages were based on both the estimated standard deviation of precision for the sample (Cox and Dalrymple, 1967) and extensive replication experiments at the laboratory (Hal Krueger, personal communication, 1986).

Samples 19 through 30 were processed at the College of Oceanography, Oregon State University under the direction of Kristine R. McElwee. Whole-rock samples were crushed and sieved through 10 and 30-mesh-size (2.00-0.6 mm) sieves. Material between 10 and 30 mesh was ultrasonically cleaned in distilled water, then treated with dilute HF and HNO3 to remove alteration products and/or volcanic glass. Sample 22 was a plagioclase separate prepared by removing the non-feldspar components of the rock with standard magnetic and heavy-liquid methods. The plagioclase was then washed in dilute HF for 10 minutes, followed by ultrasonic cleaning in distilled water. Argon measurements were made by isotope dilution, and argon analyses were performed by an AEI MS-10S mass spectrometer. Potassium concentrations were determined by atomic absorption. Analytical uncertainties for the calculated ages were based on the estimated standard deviation of precision (Cox and Dalrymple, 1967).

Teledyne isotopes processed samples 31 through 34. Whole-rock samples were crushed and sieved through 20 and 40 mesh-size (0.85-0.425 mm) sieves. Material between 20 and 40 mesh was treated with dilute HF to remove alteration products and/or volcanic glass. Argon measurements were made by isotope dilution, and argon analyses were performed on a MS-10-type mass spectrometer. Potassium concentrations were determined by flame photometry. Analytical uncertainties for the calculated ages are based upon the estimated standard deviation of precision (Cox and Dalrymple, 1967).

Teledyne isotopes processed samples 31 through 34. Whole-rock samples were crushed and sieved through 20 and 40 mesh-size (0.85-0.425 mm) sieves. Material between 20 and 40 mesh was treated with dilute HF to remove alteration products and/or volcanic glass. Argon measurements were made by isotope dilution, and argon analyses were performed on a MS-10-type mass spectrometer. Potassium concentrations were determined by flame photometry. Analytical uncertainties for the calculated ages are based upon the estimated standard deviation of precision (Cox and Dalrymple, 1967).

Constants used for all of the calculations are \( \lambda_2 = 4.962 \times 10^{-10} \text{ yr}^{-1} \), \( \lambda_0 = 0.581 \times 10^{-10} \text{ yr}^{-1} \), and \( {^{40}\text{K/K}}_{\text{total}} = 1.167 \times 10^{-4} \) atom percent (Steiger and Jager, 1977).

[ISOCHRONE/WEST, no. 47, December 1986]
Qu: Quaternary deposits, undifferentiated
Qv: Quaternary andesitic to dacitic pyroclastic flows, basalt to basaltic andesite lava flows,
and volcaniclastic sediments
QPc: Quaternary-Pliocene continental sedimentary rocks
QPv: Quaternary-Pliocene basaltic to andesitic lava flows, dacite and rhyolite domes, and tuffs
Pl: Pliocene intrusive rocks
Mf: Middle to upper Miocene Columbia River Basalt Group flood basalt lava flows and inter-
bedded continental sedimentary rocks
Mc: Lower to middle Miocene continental sedimentary rocks
Mv: Lower to middle Miocene andesite and basaltic andesite lava flows, andesitic to dacitic tuffs,
dacite plugs and flows, and volcaniclastic sedimentary rocks
Mi: Miocene granitic to dioritic intrusive rocks
Qm: Oligocene tuffaceous marine sedimentary rocks
Qv: Oligocene andesite and basaltic andesite lava flows, tuffs, and volcaniclastic sedimentary rocks
QEv: Oligocene-Eocene basaltic-andesite and andesite lava flows, tuffs, and volcaniclastic sedimentary rocks
Ec: Eocene continental sedimentary rocks
En: Middle to upper Eocene near-shore marine sedimentary rocks
Ev: Middle to upper Eocene basalt and basaltic andesite lava flows
pT: Pre-Tertiary sedimentary and igneous rocks

*15 K-Ar sample locality

FIGURE 1. Generalized geologic map of southwestern Washington showing location of K-Ar age
determination samples (modified from Walsh and others, in press).

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Analyses by XRF, Department of Geology, Washington State University.

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SAMPLE DESCRIPTIONS

1. KK0904855

Basaltic-andesite lava flow, Ov (45°46′58″N, 122°17′25″W; Squaw Butte, Clark Co., WA). Aphry- clase, clinopyroxene, and opaque minerals. Analytical data: K₀ᵣ = 0.342%, K₂O = 0.342%; ⁴⁰Ar ⁿ / ³⁷Ar = 1.475 × 10⁻¹⁰ moles/gm; ⁴⁰Ar* = 1.330 × 10⁻¹⁰ moles/gm; ⁴⁰Ar*/ ³⁷⁴Ar × 10⁰ = 22.4%. (whole rock) 28.1 ± 2.7 m.y.

2. BP0816851

Pyroxene basalt lava or sill, Ov (45°56′00″N, 122°14′11″W; Canyon Creek, Clark Co., WA). Porphyritic with sparse phenocrysts of plagioclase and clinopyroxene; plagioclase is broken and partially replaced by a zeolite; holocrystalline groundmass is trachytic and fine-grained with intergranular micro- clites of elongate plagioclase, clinopyroxene, and opaque minerals. Analytical data: K₀ᵣ = 0.427%, K₂O = 0.424%; ⁴⁰Ar* = 1.65 × 10⁻¹¹ moles/gm; ⁴⁰Ar*/ ³⁷⁴Ar × 10⁰ = 39.5%. (whole rock) 26.6 ± 2.3 m.y.

3. MM0903851

K-Ar Basaltic-andesite lava flow, Ov (45°37′31″N, 122°19′35″W; Washougal River valley, Clark Co., WA). Porphyritic with scattered, medium-grained phenocrysts of plagioclase and opaque minerals. Analytical data: K₀ᵣ = 0.45%, K₂O = 0.45%; ⁴⁰Ar* = 1.65 × 10⁻¹¹ moles/gm; ⁴⁰Ar*/ ³⁷⁴Ar × 10⁰ = 39.5%. (whole rock) 27.9 ± 1.9 m.y.

4. MK8586

Pyroxene basaltic andesite lava flow, Ov (46°02′30″N, 122°02′03″W; SE shore of Swift Reservoir, Skamania Co., WA). Porphyritic with coarse-grained phenocrysts of clinopyroxene and...
plagioclase; inclusions of hypersthene-bearing phan-
eritic rock; holocrystalline, very fine-grained, inter-
granular groundmass of opaque minerals, plagioclase, clinopyroxene, and patches of chloritic alteration. Analytical data: K$_2$O = 0.756%, K$_2$O = 0.729%; ^40Ar*/^39Ar = 3.073 x 10$^{-11}$ moles/gm, ^40Ar*/^39Ar = 3.063 x 10$^{-11}$ moles/gm; ^40Ar*/^39Ar x 100 = 54.3%, ^40Ar*/^39Ar x 100 = 56.0%.

(whole rock) 28.5 ± 1.8 m.y.

5. MK85817

Pyroxene andesite lava flow, Mv (46°32'11"N, 121°57'36"W; N of Randie, Lewis Co., WA). Porphyritic with abundant phenocrysts of plagioclase and clinopyroxene; hypocrystalline groundmass with intersertal plagioclase, clinopyroxene, opaque minerals, and dark brown glass. Analytical data: K$_2$O = 0.493%, K$_2$O = 0.482%; ^40Ar*/^39Ar = 1.085 x 10$^{-11}$ moles/gm, ^40Ar*/^39Ar = 1.18 x 10$^{-11}$ moles/gm; ^40Ar*/^39Ar x 100 = 15.0%, ^40Ar*/^39Ar x 100 = 17.6%.

(whole rock) 16.1 ± 1.8 m.y.

6. MK85814

Two-pyroxene andesite lava flow, Ov (46°33'30"N, 122°02'27"W; Kiona Creek, Lewis Co., WA). Porphyritic with coarse- to medium-grained phenocrysts of zoned plagioclase, clinopyroxene, and hyper-
thene; hypocrystalline, intersertal groundmass with brownish alteration products, opaque minerals, and plag-

(whole rock) 27.0 ± 1.8 m.y.

7. MK8578

Andesite flow(?) flow, Mv (46°28'33"N, 121°51'37"W; Lone Tree Mountain, Lewis Co., WA). Porphyritic with abundant, medium-grained plagioclase, clinopyroxene, and minor hyper-
thene; holocrystalline, subhedral-granular groundmass of plag-

(whole rock) 22.1 ± 1.3 m.y.

8. MK68415

Basaltic-andesite, Ov (46°02'30"N, 121°44'40"W; Bishop Mountain, Lewis Co., WA). Porphyritic with abundant, medium- to coarse-grained phenocrysts of plag-

(whole rock) 30.1 ± 2.2 m.y.

9. CC0827851

Olivine(?) basalt lava flow, Mv (46°43'40"N, 121°47'43"W; Lookout Mountain, Lewis Co., WA). Porphyritic with coarse-grained phenocrysts of inclusion-rich plagioclase, altered olivine(?), and clinopyroxene; holocrystalline, fine-grained ground-
mass with intergranular plagioclase, clinopyroxene, opaque minerals, and fuzzy patches of alteration products. Analytical data: K$_2$O = 0.824%, K$_2$O = 7.792%; ^40Ar*/^39Ar = 2.250 x 10$^{-11}$ moles/gm, ^40Ar*/^39Ar = 2.205 x 10$^{-11}$ moles/gm; ^40Ar*/^39Ar x 100 = 40.5%, ^40Ar*/^39Ar x 100 = 59.9%.

(whole rock) 19.1 ± 1.4 m.y.

10. TW061985D

Andesite flow or sill, Ov (46°45'53"N, 122°11'09"W; NW of Elbe, Pierce Co., WA). Porphyritic with abundant medium-grained phenocrysts of plagioclase, equant opaque minerals, hyper-
thene, and clinopyroxene; plagioclase is zoned with inclu-

(whole rock) 32.7 ± 1.5 m.y.

11. CC0712852

Andesite, Mv (46°50'00"N, 122°08'10"W; Lynch Creek area, Pierce Co., WA). Porphyritic with medium-grained phenocrysts of hypersthene, plag-

(whole rock) 35.5 ± 1.6 m.y.

12. MK8597

Clinopyroxene basaltic-andesite lava flow, Mv (45°51'45"N, 121°55'25"W; S of Big Butte, Skamania Co., WA). Porphyritic to seriate with plag-

(whole rock) 20.8 ± 1.2 m.y.

13. BP0604851

Basalt lava flow, Ev (46°19'10"N, 122°08'10"W; Toutle River bridge, Cowlitz Co., WA). Porphyritic with rare, medium-grained plagioclase and clots of green, isotopic material; fine-grained, holocrystalline, euhedral-granular groundmass of plagioclase, opaque minerals, clinopyroxene, and calcite. Analytical data: K$_2$O = 0.643%, K$_2$O = 0.671%; ^40Ar*/^39Ar = 3.408 x 10$^{-11}$ moles/gm, ^40Ar*/^39Ar = 3.405 x 10$^{-11}$ moles/gm; ^40Ar*/^39Ar x 100 = 46.6%, ^40Ar*/^39Ar x 100 = 44.1%.

(whole rock) 37.3 ± 2.2 m.y.
14. MK8589  
**K-Ar**  
Andesite lava flow, 0v (46°17‘21“N, 122°33‘11”W; Signal Peak, Cowlitz Co., WA). Porphyritic with abundant, medium-grained hypersthene, plagioclase and clinopyroxene phenocrysts; hypocrystalline groundmass of opaque minerals and greenish patches of birefringent mineral and euhedral zelites (devitrified glass?).  
**Analytical data:** $K_2O = 1.324\%$, $K_2O = 1.329\%$; $^{40}Ar* = 6.195 \times 10^{-11}$ moles/gm; $^{40}Ar* / ^{40}Ar \times 100 = 65.1\%$, $^{40}Ar* / ^{40}Ar \times 100 = 70.1\%$.  
(whole rock) $33.9 \pm 1.7$ m.y.

15. BP0814851  
**K-Ar**  
Two-pyroxene basaltic-andesite lava flow, 0Ev (46°10‘17”N, 122°25‘00”W; quarry W of Big Bull Mountain, Cowlitz Co., WA). Porphyritic with phenocrysts of plagioclase, hypersthene, and clinopyroxene; hypocrystalline groundmass with trachytic, interstitial texture composed of dark brown glass, tabular plagioclase, and abundant clinopyroxene.  
**Analytical data:** $K_2O = 0.646\%$, $K_2O = 0.648\%$; $^{40}Ar* = 3.050 \times 10^{-11}$ moles/gm; $^{40}Ar* / ^{40}Ar \times 100 = 49.3\%$, $^{40}Ar* / ^{40}Ar \times 100 = 23.1\%$, $^{40}Ar* / ^{40}Ar \times 100 = 50.6\%$.  
(whole rock) $36.3 \pm 2.2$ m.y.

16. BP0814856  
**K-Ar**  
Pyroxene-andesite basaltic-andesite lava flow, 0v (46°11‘36”N, 122°21‘12”W; NE of Big Bull Mountain, Cowlitz Co., WA). Sparser porphyritic with phenocrysts of plagioclase and clinopyroxene; hypocrystalline groundmass with interstitial, trachytic texture; composed of dark brown glass, skeletal opaque minerals, plagioclase, clinopyroxene, and patches or clumps of clay and opaque minerals.  
**Analytical data:** $K_2O = 0.380\%$, $K_2O = 0.380\%$; $^{40}Ar* = 1.740 \times 10^{-11}$ moles/gm; $^{40}Ar* / ^{40}Ar \times 100 = 29.7\%$, $^{40}Ar* / ^{40}Ar \times 100 = 47.7\%$.  
(whole rock) $32.9 \pm 2.6$ m.y.

17. HS0515852  
**K-Ar**  
Andesite lava flow, 0Ev (46°33‘28”N, 122°13‘35”W; Minnie Creek area, Lewis Co., WA). Porphyritic with abundant fine-grained phenocrysts of plagioclase, opaque minerals, and clinopyroxene; hypocrystalline, trachytic groundmass with opaque glass and weakly birefringent, greenish-gray 1.887%.  
**Analytical data:** $K_2O = 1.298\%$, $K_2O = 0.26 \times 10^{-11}$ moles/gm; $^{40}Ar* / ^{40}Ar \times 100 = 50.6\%$, $^{40}Ar* / ^{40}Ar \times 100 = 77.4\%$.  
(whole rock) $35.8 \pm 1.7$ m.y.

18. HSRH14623  
**K-Ar**  
Andesite lava flow, Mt (46°33‘22”N, 122°16‘56”W; with abundant, medium-grained phenocrysts of plagioclase, hypersthene, opaque minerals, clinopyroxene, and anhedral clots of chlorite; hypocrystalline, trachytic groundmass of plagioclase, andesite, brown glass. The age determination does not fit readily the regional stratigraphic framework and may be too young.  
**Analytical data:** $K_2O = 0.668\%$, $K_2O = 0.670\%$; $^{40}Ar* = 2.222 \times 10^{-11}$ moles/gm; $^{40}Ar* / ^{40}Ar \times 100 = 16.0\%$, $^{40}Ar* / ^{40}Ar \times 100 = 17.3\%$.  
(whole rock) $23.2 \pm 1.7$ m.y.

19. JA840057  
**K-Ar**  
Olivine basalt lava flow, QPv (45°50‘05”N, 121°03‘47”W; Klickitat River Canyon, Klickitat Co., WA). Olivine and plagioclase phenocrysts with hypocrystalline, interstitial groundmass of plagioclase, olivine(?) and dark brown glass.  
**Analytical data:** $K_2O = 0.963\%$, $^{40}Ar* = 3.999 \times 10^{-11}$ moles/gm; $^{40}Ar* / ^{40}Ar \times 100 = 67.1\%$.  
(whole rock) $2.88 \pm 0.05$ m.y.

20. JA840117  
**K-Ar**  
Biotite rhyolite flow, QPv (45°58‘47”N, 120°58‘42”W; Indian Rock, Klickitat Co., WA). Plagioclase-biotite-phryic with microcrystalline groundmass of quartz, plagioclase, and hornblende(?)  
**Analytical data:** $K_2O = 4.266\%$, $^{40}Ar* = 2.496 \times 10^{-11}$ moles/gm; $^{40}Ar* / ^{40}Ar \times 100 = 84.5\%$.  
(whole rock) $4.06 \pm 0.05$ m.y.

21. BP1004842  
**K-Ar**  
**Analytical data:** $K_2O = 0.243\%$, $^{40}Ar* = 1.219 \times 10^{-11}$ moles/gm; $^{40}Ar* / ^{40}Ar \times 100 = 63.2\%$.  
(plagioclase) $34.5 \pm 0.5$ m.y.

22. HS0612851  
**K-Ar**  
Two-pyroxene andesite lava flow or sill, Mt (46°45‘53”N, 121°03‘47”W; quarry E of Elbe, Thurston Co., WA).  
**Analytical data:** $K_2O = 1.542\%$, $^{40}Ar* = 3.576 \times 10^{-11}$ moles/gm; $^{40}Ar* / ^{40}Ar \times 100 = 43.7\%$.  
(whole rock) $20.7 \pm 0.3$ m.y.

23. MK85546  
**K-Ar**  
Two-pyroxene andesite lava flow, Mt (46°00‘10”N, 121°53‘20”W; SW of McClellan Meadows, Skamania Co., WA). Glomeroporphyritic with phenocrysts of plagioclase, clinopyroxene, hypersthene, and opaque minerals; hypocrystalline groundmass of yellow to green birefringent material and clay minerals (altered glass?); plagioclase, opaque minerals, and clinopyroxene.  
**Analytical data:** $K_2O = 0.427\%$, $^{40}Ar* = 1.229 \times 10^{-11}$ moles/gm; $^{40}Ar* / ^{40}Ar \times 100 = 47.9\%$.  
(whole rock) $19.9 \pm 0.4$ m.y.  
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25. **MK85635**
   K-Ar
   Pyroxene dacite lava flow, Mv (46°25'25"N, 121°55'13"W; NE of Iron Creek Butte, Lewis Co., WA). Porphyritic and plagioclase phenocrysts; hypocrystalline, trachytic groundmass of plagioclase microlites and brown glass. **Analytical data:** $K_2O = 0.463\%$; $^{40}Ar*/E^{40}Ar = 100 = 50.1\%$. (whole rock) 24.4 ± 1.2 m.y.

26. **MK85627**
   K-Ar
   Pyroxene andesite, Mv (46°47'15"N, 121°41'15"W; NW of Table Mountain, Skamania Co., WA). Porphyritic with phenocrysts of plagioclase, clinopyroxene, and possibly hypersthene; holocrystalline, intergranular groundmass with chloritic alteration. **Analytical data:** $K_2O = 0.960\%$; $^{40}Ar*/E^{40}Ar = 100 = 62.3\%$. (whole rock) 25.5 ± 0.4 m.y.

27. **MK85523**
   K-Ar
   Hornblende diorite porphyry stock, Pi (45°47'00"N, 121°40'25"W; Hauk Butte, Skamania Co., WA). Phaneritic; fine-grained, slightly porphyritic with subhedral granular texture; consists of zoned plagioclase, green hornblende, opaque minerals. **Analytical data:** $K_2O = 0.964\%$; $^{40}Ar* = 6.689 \times 10^{-11}$ moles/gm; $^{40}Ar*/E^{40}Ar \times 100 = 62.3\%$. (whole rock) 4.8 ± 0.1 m.y.

28. **MK8551**
   K-Ar
   Hypersthenebiotite-quartz diorite porphyry plug, Pl (45°43'07"N, 121°45'35"W; Wind Mountain, Skamania Co., WA). Phaneritic; porphyritic with phenocrysts of zoned and twinned plagioclase and hypersthene altered to biotite; subhedral granular size and altered groundmass with chloritic alteration. **Analytical data:** $K_2O = 0.898\%$; $^{40}Ar* = 0.789 \times 10^{-11}$ moles/gm; $^{40}Ar*/E^{40}Ar \times 100 = 66.6\%$. (whole rock) 4.9 ± 0.1 m.y.

29. **MK8555**
   K-Ar
   Pyroxene basaltic andesite flow, Mv (46°37'33"N, 122°17'31"W; tributary of Schultz Creek, Skamania Co., WA). Porphyritic with ubiquitous phenocrysts of plagioclase, clinopyroxene, and altered olivine(?); hypocrystalline, trachytic groundmass of plagioclase, clinopyroxene, opaque minerals, and glass. **Analytical data:** $K_2O = 0.768\%$; $^{40}Ar* = 0.789 \times 10^{-11}$ moles/gm; $^{40}Ar*/E^{40}Ar \times 100 = 46.7\%$. (whole rock) 12.2 ± 1.0 m.y.

30. **BPO619851**
   K-Ar
   Clinopyroxene basaltic andesite lava flow, Øv (46°21'44"N, 122°17'31"W; tributary of Schultz Creek, Skamania Co., WA). Porphyritic with sparse plagioclase, clinopyroxene and altered olivine(?); hypocrystalline, intergranular groundmass of plagioclase, clinopyroxene, opaque minerals, and chloritic alteration products; K-Ar age appears to be too old in terms of regional stratigraphic framework. **Analytical data:** $K_2O = 0.989\%$; $^{40}Ar* = 5.13 \times 10^{-11}$ moles/gm; $^{40}Ar*/E^{40}Ar \times 100 = 93.8\%$. (whole rock) 35.7 ± 1.6 m.y.

31. **BPO516851**
   K-Ar
   Basaltic andesite lava flow, Mv (46°29'07"N, 122°10'52"W; E end of Riffe Lake, Lewis Co., WA). Porphyritic with coarse-grained plagioclase phenocrysts; hypocrystalline, trachytic groundmass of opaque minerals, plagioclase and altered or devitrified brown glass. **Analytical data:** $K_2O = 0.518\%$, $K_2O = 0.530\%$; $^{40}Ar* = 1.874 \times 10^{-11}$ moles/gm, $^{40}Ar* = 1.829 \times 10^{-11}$ moles/gm; $^{40}Ar*/E^{40}Ar \times 100 = 53.0\%$, $^{40}Ar*/E^{40}Ar \times 100 = 62.3\%$. (whole rock) 23.6 ± 1.2 m.y.

32. **MM0904851**
   K-Ar
   Basaltic andesite lava flow, Mv (45°47'39"N, 121°59'53"W; Sedum Point, Skamania Co., WA). Aphyric to porphyric; rare phenocrysts of plagioclase, clinopyroxene, and hypocrystalline groundmass of plagioclase, opaque minerals, and brown, weakly birefringent material (altered glass?). **Analytical data:** $K_2O = 0.952\%$, $K_2O = 0.952\%$; $^{40}Ar* = 3.258 \times 10^{-11}$ moles/gm, $^{40}Ar* = 3.258 \times 10^{-11}$ moles/gm; $^{40}Ar*/E^{40}Ar \times 100 = 79.0\%$, $^{40}Ar*/E^{40}Ar \times 100 = 73.3\%$. (whole rock) 23.6 ± 1.2 m.y.

33. **HS011653**
   K-Ar
   Pyroxene basaltic andesite flow or sill, Ev (46°37'33"N, 122°37'50"W; South Fork of Newaukum River, Lewis Co., WA). Porphyritic with sparse, fine-grained phenocrysts of plagioclase, clinopyroxene, and altered olivine(?); hypocrystalline groundmass of plagioclase, clinopyroxene, opaque minerals, and zeolites(?). **Analytical data:** $K_2O = 0.603\%$, $K_2O = 0.590\%$; $^{40}Ar* = 0.936 \times 10^{-11}$ moles/gm, $^{40}Ar* = 0.936 \times 10^{-11}$ moles/gm; $^{40}Ar*/E^{40}Ar \times 100 = 51.6\%$, $^{40}Ar*/E^{40}Ar \times 100 = 55.3\%$. (whole rock) 38.8 ± 1.9 m.y.

34. **HS0117561A**
   K-Ar
   Pyroxene andesite flow or sill, Ev (46°34'15"N, 120°42'57"W; SW of Butler Creek, Klickitat Co., WA). Porphyritic with abundant, coarse- to medium-grained phenocrysts of plagioclase, clinopyroxene, and highly altered olivine(?); hypocrystalline groundmass with interstitial brown glass, plagioclase, opaque minerals, and clinopyroxene. **Analytical data:** $K_2O = 1.205\%$, $K_2O = 1.205\%$; $^{40}Ar* = 6.600 \times 10^{-11}$ moles/gm, $^{40}Ar* = 6.600 \times 10^{-11}$ moles/gm; $^{40}Ar*/E^{40}Ar \times 100 = 80.9\%$, $^{40}Ar*/E^{40}Ar \times 100 = 72.8\%$. (whole rock) 38.3 ± 1.9 m.y.

35. **JA85001**
   K-Ar
   Olivine basalt lava flow, QPV (45°57'21"N, 120°42'57"W; SW of Butler Creek, Klickitat Co., WA). Porphyritic olivine basalt with distinctive $K_2O$ and TiO$_2$ contents. **Analytical data:** $K_2O = 1.040\%$, $K_2O = 1.040\%$; $^{40}Ar* = 0.670 \times 10^{-11}$ moles/gm, $^{40}Ar* = 0.670 \times 10^{-11}$ moles/gm; $^{40}Ar*/E^{40}Ar \times 100 = 16.0\%$, $^{40}Ar*/E^{40}Ar \times 100 = 14.0\%$. (whole rock) 4.0 ± 0.4 m.y.

**REFERENCES**

Evarts, R. C., Ashley, R. P., and Smith, J. G. (in prep.)


