

Potassium-argon ages from Klamath Falls area, south-central Oregon

Pickthorn, L.B.G., Sherrod, D.R.

Isochron/West, Bulletin of Isotopic Geochronology, v. 55, pp. 13-17

Downloaded from: <https://geoinfo.nmt.edu/publications/periodicals/isochronwest/home.cfml?Issue=55>

Isochron/West was published at irregular intervals from 1971 to 1996. The journal was patterned after the journal *Radiocarbon* and covered isotopic age-dating (except carbon-14) on rocks and minerals from the Western Hemisphere. Initially, the geographic scope of papers was restricted to the western half of the United States, but was later expanded. The journal was sponsored and staffed by the New Mexico Bureau of Mines (now *Geology*) & Mineral Resources and the Nevada Bureau of Mines & Geology.



ISOCHRON/WEST
A Bulletin of Isotopic Geochronology

All back-issue papers are available for free: <https://geoinfo.nmt.edu/publications/periodicals/isochronwest>

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

POTASSIUM-ARGON AGES FROM KLAMATH FALLS AREA, SOUTH-CENTRAL OREGON

LEDA BETH G. PICKTHORN }
DAVID R. SHERROD }

U.S. Geological Survey, Menlo Park, CA 94025

INTRODUCTION

Eleven new K-Ar age determinations from the west half of the Klamath Falls 1° × 2° sheet (table 1) range from about 6.88 to 2.80 Ma and are from rock units once considered partly or entirely Pleistocene in age (Wells and Peck, 1961; Peterson and McIntyre, 1970). The new ages, in conjunction with our regional mapping, redefine and limit the extent of Quaternary volcanism in the Basin and Range province of south-central Oregon (fig. 1). They also date the Yonna Formation of Newcomb (1958).

Ten samples were collected from basalt and basaltic andesite lava flows. Of these, six samples were sufficiently fresh to date as whole rocks; whereas four were prepared as plagioclase separates to remove devitrified glass and alteration minerals. An eleventh sample (S5-4) consists of plagioclase from pumice lumps in a monolithologic pumiceous volcanic debris-flow deposit that we interpret as a medial primary deposit.

Sample preparation and analytical procedures were conducted at U.S. Geological Survey laboratories in Menlo Park, California. Most whole rock samples were crushed to between 9 and 60 mesh and used directly. Sample S5-9, however, was crushed to between 100 and 150 mesh and treated with 5% HF for 2 minutes followed by 14% HNO₃ for 30 minutes to remove fine-grained alteration minerals and glass. The finer grain size allowed better access by the acid. The sample was then placed in an ultrasonic bath for a short period to remove any clinging products resulting from the acid treatment, rinsed in water, and dried. Plagioclase separates were between 60 and 140 mesh in size, and underwent the same acid treatment to remove adhering glass and alteration minerals.

Potassium analyses on powdered splits were performed using flame photometry as described in Ingamells (1970). Argon analyses were made by standard isotope dilution procedures as discussed in Dalrymple and Lanphere (1969).

Table 1 lists weighted mean ages, weighted by the inverse of the variances of individual runs. Reported errors are weighted mean standard deviations. The variances were calculated by the methods described in Cox and Dalrymple (1967), except that error in spectrometer mass discrimination and occasionally additional sources of error were also taken into account.

DISCUSSION

The following discussion introduces the few constraining geologic relations and previously determined radiometric ages that bear on the interpretation of our results. It proceeds generally from youngest to oldest.

The youngest sample (S5-1) has an age of 2.8 ± 0.06 Ma and is probably at about the same stratigraphic position as a sample with an age of 1.9 ± 0.5 Ma (whole rock) as dated by O'Brien and Benson (1981). Their 1.9-Ma sample had low radiogenic argon (2.23%) and consequently a large standard error compared to our results. On the basis of stratigraphic relations developed from our mapping, we interpret these ages to indicate that very few volcanic

rocks in the west half of the Klamath Falls 1° × 2° sheet are Quaternary in age (fig. 1). The exceptions include rocks and deposits near the Cascade Range and a few volcanoes of uncertain age to the east.

Ages of 3.44 ± 0.13 Ma (S5-3) and 3.68 ± 0.08 Ma (S5-2) from the Calimus Butte area suggest that most of the lava flows there were emplaced between 3 and 4 Ma. The younger basalt of Knot Tableland was erupted about 3.0 ± 0.9 Ma and filled a broad valley that was incised into lava near Calimus Butte. The basalt of Knot Tableland now forms a bench about 300 ft above the modern floor of the Sprague River valley, owing to topographic inversion. Its basal contact is more nearly at grade with an older lava (S5-8, 3.61 ± 0.14 Ma) than with the modern valley floor. These relations rule out a Quaternary age for the basalt of Knot Tableland, the date from which has a large standard error because of the sample's low K₂O (0.164%) and radiogenic argon (1.3%).

Geologic relations shed light on the relative ages of samples S5-3, S5-4, and S5-5, whose K-Ar determinations are indistinguishable within the limits of error. Samples S5-4 and S5-5 are from older and younger deposits and rocks, respectively, in a gently (< 5°) west-dipping stratigraphic sequence exposed along the Sprague River. These units are unconformably overlain by lava flows of the Calimus Butte area, which are similar in age to sample S5-3.

A lava flow (S5-12) exposed in a roadcut south of Klamath Falls has an age of 4.47 ± 0.28 Ma (plagioclase). This lava is interbedded with sandstone, siltstone, and diatomite that form a sequence of mainly sedimentary rocks that were assigned to the Yonna Formation by Peterson and McIntyre (1970).

Radiometric ages and stratigraphic relations generally agree for rocks exposed north of the Sprague River at the east edge of figure 1. The oldest unit exposed there includes lava flows about 5.78 ± 0.12 Ma (S5-7). These rocks are overlain by pumiceous lapilli tuff erupted from rhyolite domes, one of which has a previously determined K-Ar age of 5.52 ± 0.55 Ma (plagioclase) (McKee and others, 1976, as recalculated in Fiebelkorn and others, 1983). Sedimentary rocks of the Yonna Formation overlie the lapilli tuff and are overlain by a lava flow now forming a sinuous narrow ridge as the result of topographic inversion; its age is 3.61 ± 0.14 Ma (S5-8, whole rock).

Ages of 6.88 ± 0.60 Ma (S5-10, plagioclase) and 6.16 ± 0.13 Ma (S5-9, whole rock) are from lava flows assigned by McKee and others (1983) to the basalt of Devils Garden (California). The basalt of Devils Garden, characterized by diktytaxitic, low-potassium tholeiite, was emplaced mostly between 9 and 6 Ma (McKee and others, 1983). Basalt of Devils Garden commonly is quite fresh and resembles younger basalt flows throughout the map area.

AGE OF YONNA FORMATION

These new and previously determined K-Ar ages help to define the age of the Yonna Formation (Newcomb, 1958), a sequence of continental sedimentary rocks interbedded

TABLE 1. New K-Ar ages from the west half of the Klamath Falls 1° × 2° sheet, south-central Oregon.

Sample number	Location		Rock type	Material dated	K ₂ O (wt %) ¹	⁴⁰ Ar _{rad} (10 ⁻¹¹ mol/g)	Percent ⁴⁰ Ar _{rad}	Calculated age (Ma) ²	Weighted mean age (Ma) ³
	Lat. (N)	Long. (W)							
S5-1	42°23.8'	121°48.6'	Basalt	Whole rock	(2.233)	0.8855	40.8	2.75±0.08	2.80±0.06
					2.231				
					2.230				
					2.244				
					2.228				
S5-6	42°30.9'	121°18.9'	Basalt	Whole rock	(0.164)	0.07139	1.33	3.0±0.9	3.0±0.9
					0.162				
					0.170				
					0.163				
					0.160				
S5-3	42°39.7'	121°34.8'	Basalt	Whole rock	(0.932)	0.4433	14.0	3.30±0.19	3.44±0.13
					0.929				
					0.931				
					0.934				
					0.935				
S5-4	42°33.6'	121°39.3'	Pumiceous lahar	Plagioclase	(0.352)	0.1771	16.9	3.49±0.21	3.62±0.12
					0.359				
					0.357				
					0.345				
					0.348				
S5-8	42°33.3'	121°06.1'	Basalt	Whole rock	(0.178)	0.09538	7.94	3.72±0.21	3.61±0.14
					0.176				
					0.177				
					0.179				
					0.179				
S5-2	42°54.8'	121°31.2'	Basalt	Whole rock	(1.137)	0.6027	44.7	3.68±0.11	3.68±0.08
					1.133				
					1.136				
					1.138				
					1.142				
S5-12	42°12.6'	121°47.2'	Basalt	Plagioclase	(0.216)	0.1472	7.14	4.73±0.50	4.47±0.28
					0.208				
					0.217				
					0.215				
					0.223				
S5-5	42°33.6'	121°40.0'	Basalt	Plagioclase	(0.074)	0.05131	6.64	4.77±0.70	4.56±0.57
					0.074				
					0.078				
					0.067				
					0.068				
S5-7	42°33.4'	121°05.9'	Basalt	Plagioclase	(0.557)	0.4664	26.4	5.81±0.17	5.78±0.12
					0.560				
					0.560				
					0.551				
					0.551				
S5-9	42°20.0'	121°09.1'	Basalt	Whole rock	(0.917)	0.8047	25.8	6.08±0.18	6.16±0.13
					0.930				
					0.928				
					0.894				
					0.894				
S5-10	42°16.0'	121°20.7'	Basalt	Plagioclase	(0.132)	0.1271	19.7	6.69±0.89	6.88±0.60
					0.130				
					0.137				
					0.141				
					0.121				
					0.140				
					0.122				
					0.122				

Notes:

¹For multiple determinations, value in parentheses is arithmetic mean used in age calculation.
²K-Ar ages were calculated using the constants for the radioactive decay and abundance of ⁴⁰K recommended by the International Union of Geological Sciences Subcommission on Geochronology (Steiger and Jäger, 1977).
 These constants are:

$$\lambda_{\epsilon} = 0.580 \times 10^{-10} \text{ yr}^{-1}, \lambda_{\beta} = 4.962 \times 10^{-10} \text{ yr}^{-1}, \text{ and } ^{40}\text{K}/\text{K}_{\text{total}} = 1.167 \times 10^{-4} \text{ mol/mol.}$$

³Mean ages are weighted by the inverse of the variance of individual runs. Errors are the estimates of standard deviation of analytical error.

with volcanic rocks throughout the west half of the Klamath Falls 1° × 2° sheet. Near Beatty (fig. 1) the Yonna Formation is underlain by basalt lava flows, silicic domes, and associated pyroclastic flows that range in age from 6.88 ± 0.60 (S5-10) to 5.52 ± 0.55 Ma (McKee and others, 1976); it is overlain by 3.61 ± 0.14 -Ma basalt (S5-8). Near Klamath Falls, a lava flow with an age of 4.47 ± 0.28 Ma (S5-12) is interbedded with the Yonna Formation. Near Wildhorse Ridge (west of Yamsay Mountain), conglomerate and sandstone in the Yonna Formation are overlain by 3.68 ± 0.08 -Ma basalt lava (S5-2). Thus, on the basis of these exposures, most sedimentary rocks in the Yonna Formation are between 6.0 Ma and 3.3 Ma in age (at the 99 percent confidence interval). This indicates a latest Miocene to early Pliocene age for mammalian and fish fossil localities of Newcomb (1958).

ACKNOWLEDGMENTS

We thank L. Espos, S. Neil, M. Dyslin, T. Fries, and S. MacPherson for K_2O analyses. The manuscript was reviewed and improved by J. Smith and B. Turrin.

SAMPLE DESCRIPTIONS

1. *S5-1* K-Ar
Roadcut, second lava flow from top of Klamath escarpment (NW¼ S6,T37S,R8E; Forest Rd 9718, 5080 ft elevation, Modoc Point 15' quad., Klamath Co., OR). Porphyritic intergranular basalt; 5-7% clinopyroxene phenocrysts; 1% olivine phenocrysts; seriate plagioclase.
2. *S5-6* K-Ar
Roadcut in lava flow that forms Knot Tableland (SE¼ S20,T35S,R12E; Ivory Pines Rd, 4480 ft elevation, Fuego Mountain 15' quad., Klamath Co., OR). Equigranular diktytaxitic basalt; $\leq 1\%$ olivine phenocrysts.
3. *S5-3* K-Ar
Roadcut in lava flow (SW¼ S31,T33S,R10E; County Rd 600 [Williamson River Rd] at junction with Forest Rd 4552, 2 mi NW of Calimus Butte, 5160 ft elevation, Calimus Butte 15' quad., Klamath Co., OR). Porphyritic intergranular basalt; 5-7% olivine phenocrysts; 3-5% plagioclase phenocrysts; 1-2% fresh glass in groundmass.
4. *S5-4* K-Ar
Outcrop, (SW¼ S4,T35S,R9E; N side County Rd 858 [Sprague River Hwy] near S'Ocholis campground, 4280 ft elevation, Calimus Butte 15' quad., Klamath Co., OR). Medium gray to light brownish gray sandy pumiceous laharic deposit. Sample was collected as pumiceous lumps 4-6 in. across from pumiceous breccia ~ 20 in. thick that formed by aggregation of large lapilli and bombs at top of deposit during emplacement.
5. *S5-8* K-Ar
Outcrop (north-center S7,T35S,R14E; 1000 ft SW of S5-8, 4800 ft elevation, Riverbed Butte 15' quad., Klamath Co., OR). Subophitic to diktytaxitic basalt; $\leq 1\%$ olivine phenocrysts. Lava flow originally filled sinuous valley; erosion has inverted topography.
6. *S5-1* K-Ar
Outcrop of lava flow (NW¼ S3,T31S,R10E; W of Forest Rd 7646, ½ mi S of junction with Forest Rd 4922, 4800 ft elevation, Klamath Marsh 15' quad., Klamath Co., OR). Porphyritic intergranular basalt; 25% plagioclase phenocrysts; 7-10% olivine phenocrysts.
7. *S5-12* K-Ar
Roadcut through sandstone and lava flow (NW¼ S5,T39S,R9E; U.S. Hwy 97, ½ mi S of Klamath Falls city center offramp, 4200 ft elevation, Klamath Falls 15' quad., Klamath Co., OR). Porphyritic basalt; 10% plagioclase phenocrysts; 5-8% olivine phenocrysts, 5-10% clay-altered. From lava flow, which has baked sedimentary rocks beneath it but not above it. Lava and sandstone are faulted against diatomite at SW end of roadcut.
8. *S5-5* K-Ar
Outcrop of lava flow (SE¼ S5,T35S,R9E; S of County Rd 858 [Sprague River Hwy] ½ mi W of S5-4, 4280 ft elevation, Calimus Butte 15' quad., Klamath Co., OR). Porphyritic intergranular basalt; 10-15% plagioclase phenocrysts; 1-2% olivine phenocrysts; 1-2% clinopyroxene phenocrysts.
9. *S5-7* K-Ar
Roadcut in deeply weathered, spheroidally weathered lava flow (on E-W section line between S6 and 7, T35S,R14E; Forest Rd 3312, 4800 ft elevation, Riverbed Butte 15' quad., Klamath Co., OR). Subophitic basalt; seriate plagioclase.
10. *S5-9* K-Ar
Roadcut in lava flow (west-center of S26,T37S,R13E; Forest Rd 3726 [Keno Rd], at NW end of Gerber Rim, 5000 ft elevation, Bly 15' quad., Klamath Co., OR). Pilotaxitic basalt; 2-3% olivine phenocrysts; $\leq 1\%$ plagioclase phenocrysts.
11. *S5-10* K-Ar
Outcrop of lava flow (NW¼ S19,T38S,R12E; N of Forest Rd 3726 [Keno Rd], N slope of Canyon Creek, 4800 ft elevation, Beatty 15' quad., Klamath Co., OR). Porphyritic basalt; 10% plagioclase phenocrysts; 1% olivine phenocrysts; $\leq 1\%$ clinopyroxene phenocrysts.

REFERENCES

- Cox, Allan, and Dalrymple, G. B. (1967) Statistical analysis of geomagnetic reversal data and the precision of potassium-argon dating: *Journal of Geophysical Research*, v. 72, no. B10, p. 2603.
- Dalrymple, G. B., and Lanphere, M. A. (1969) Potassium-argon dating: San Francisco, W. H. Freeman and Co.
- Fiebelkorn, R. B., Walker, G. W., MacLeod, N. S., McKee, E. H., and Smith, J. G. (1983) Index to K-Ar age determinations for the state of Oregon: *Isochron/West*, no. 37, p. 2.
- Ingamells, C. O. (1970) Lithium metabolate flux in silicate analysis: *Analytica Chimica Acta*, v. 52, p. 323.
- McKee, E. H., MacLeod, N. S., and Walker, G. W. (1976) Potassium-argon ages of Late Cenozoic silicic volcanic rocks, southeastern Oregon: *Isochron/West*, no. 15, p. 37.
- McKee, E. H., Duffield, W. A., and Stern, R. J. (1983) Late Miocene and early Pliocene basaltic rocks and their implications for crustal structure, northeastern California and southern Oregon: *Geological Society of America Bulletin*, v. 94, no. 2, p. 292.

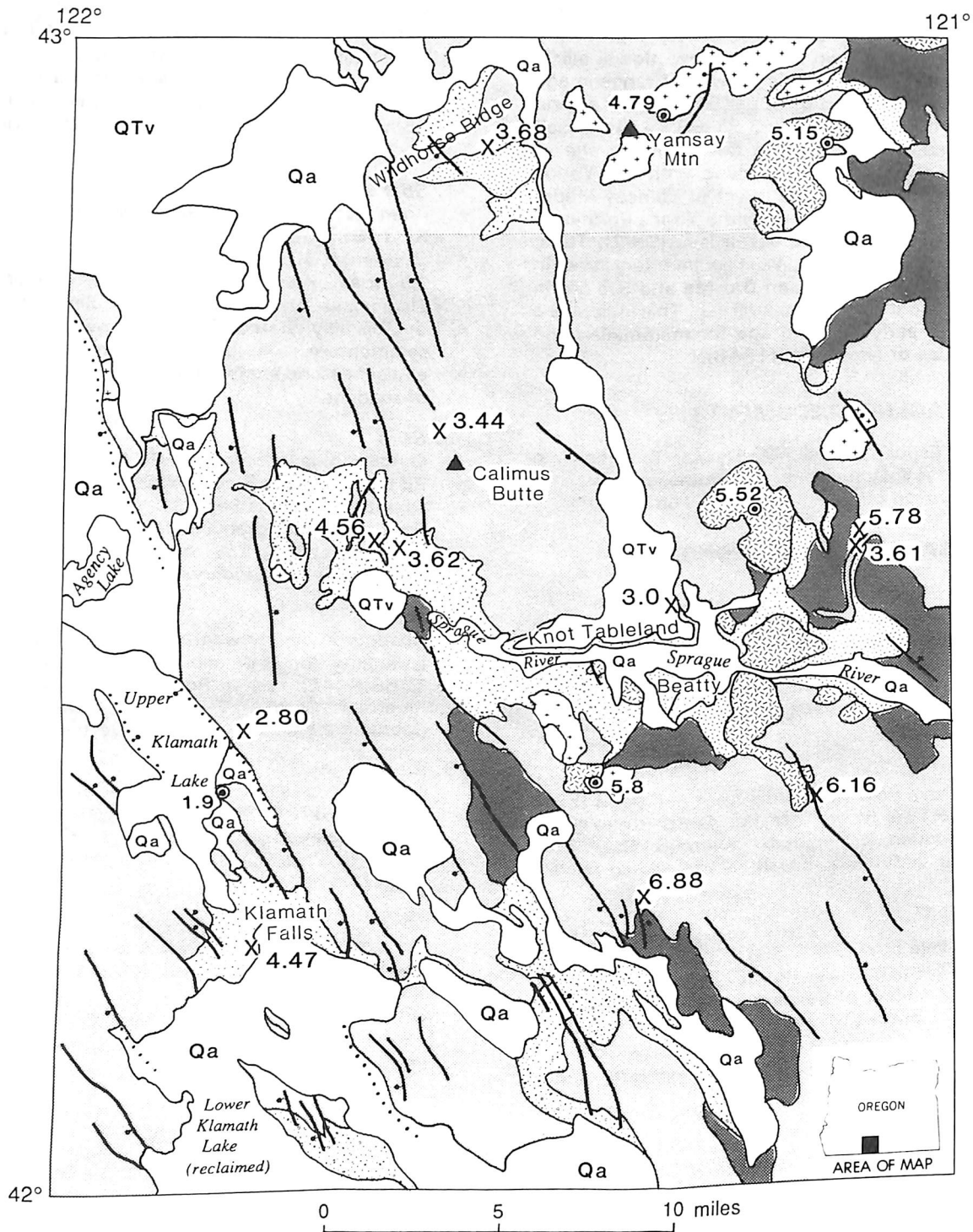














FIGURE 1. Generalized geologic map showing locations and ages of K-Ar samples from the west half of Klamath Falls 1° by 2° sheet, south-central Oregon (from Sherrod and Pickthorn, in press).

- Newcomb, R. C. (1958) Yonna Formation of the Klamath River Basin, Oregon: Northwest Science, v. 32, no. 2, p. 41.
- O'Brien, Maura, and Benson, Sally (1981) Subsurface geology of three geothermal wells, Klamath Falls, Oregon: Lawrence Berkeley Laboratories Report no. 11240.
- Peterson, N. V., and McIntyre, J. R. (1970) The reconnaissance geology and mineral resources of eastern Klamath County and western Lake County, Oregon: Oregon Department of Geology and Mineral Industries Bulletin 66.

- Sherrod, D. R., and Pickthorn, L. G. (in press) Geologic map of the west half of Klamath Falls 1° by 2° sheet, south-central Oregon: U.S. Geological Survey Miscellaneous Investigations Map, scale 1:250,000.
- Steiger, R. H., and Jager, E. (1977) Subcommittee on geochronology: Convention on the use of decay constants in geo- and cosmochronology: Earth and Planetary Science Letters, v. 36, p. 359.
- Wells, F. G., and Peck, D. L. (1961) Geologic map of Oregon west of the 121st meridian: U.S. Geological Survey Miscellaneous Geologic Investigations Map 1-325.

-  Alluvium (Quaternary)
-  Volcanic rocks of the High Cascades (Holocene to Pliocene)—Includes minor basalt in Basin and Range
-  Younger basalt and basaltic andesite of the Basin and Range (Pliocene and Miocene)
-  Sedimentary rocks (Pliocene and Miocene)
-  Andesite and dacite (Pliocene and Miocene)
-  Rhyodacite and rhyolite (Miocene)
-  Tuff (Miocene)
-  Older basalt and basaltic andesite of the Basin and Range (Miocene)

-  Contact—Approximately located
-  Fault—Dotted where concealed. Ball and bar on downthrown side
-  X^{6.7} Age (Ma)—This report
-  e^{5.52} Other K-Ar ages (see text)