K-Ar ages of late Cenozoic silicic volcanic rocks. Southeast Oregon

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POTASSIUM-ARGON AGES OF LATE CENOZOIC SILICIC VOLCANIC ROCKS, SOUTHEAST OREGON

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K-Ar ages of 40 silicic volcanic rocks from southeastern Oregon are reported here. The sampled area, bounded on the west by the Cascade Range, extends eastward to Idaho and northward from the border with Nevada and California to lat. 44 N (figure 1). The ages were determined to help delineate intrusive bodies that are sufficiently young to be still hot at depth and that thus might provide geothermal heat sources within reach of modern drilling techniques. Interpretation of the geothermal significance of these ages is available elsewhere (MacLeod and others, in press).

Thirty-five of the samples are from silicic domes or their related flows, and five are from silicic ash-flow tuffs. Materials used for the K-Ar analyses include obsidian (18), cryptocrystalline rhyolite (3), plagioclase (9), sanidine (6), and biotite (4) mineral separates. Laboratory techniques for Ar analysis are similar to those described by Dalrymple and Lanphere (1969) and were carried out in the U. S. Geological Survey laboratory at Menlo Park, Calif., in 1973-75. Potassium was analyzed by flame photometer using a lithium internal standard. The estimated analytical uncertainties of the K-Ar ages are indicated at one standard deviation. Constants used in the calculation of the ages are: $\lambda_\epsilon = 0.585 \times 10^{-10}\,yr^{-1}$, $\lambda_\beta = 4.72 \times 10^{-10}\,yr^{-1}$, $K^{40}/K_{total} = 1.22 \times 10^{-4}$ gm/gm.

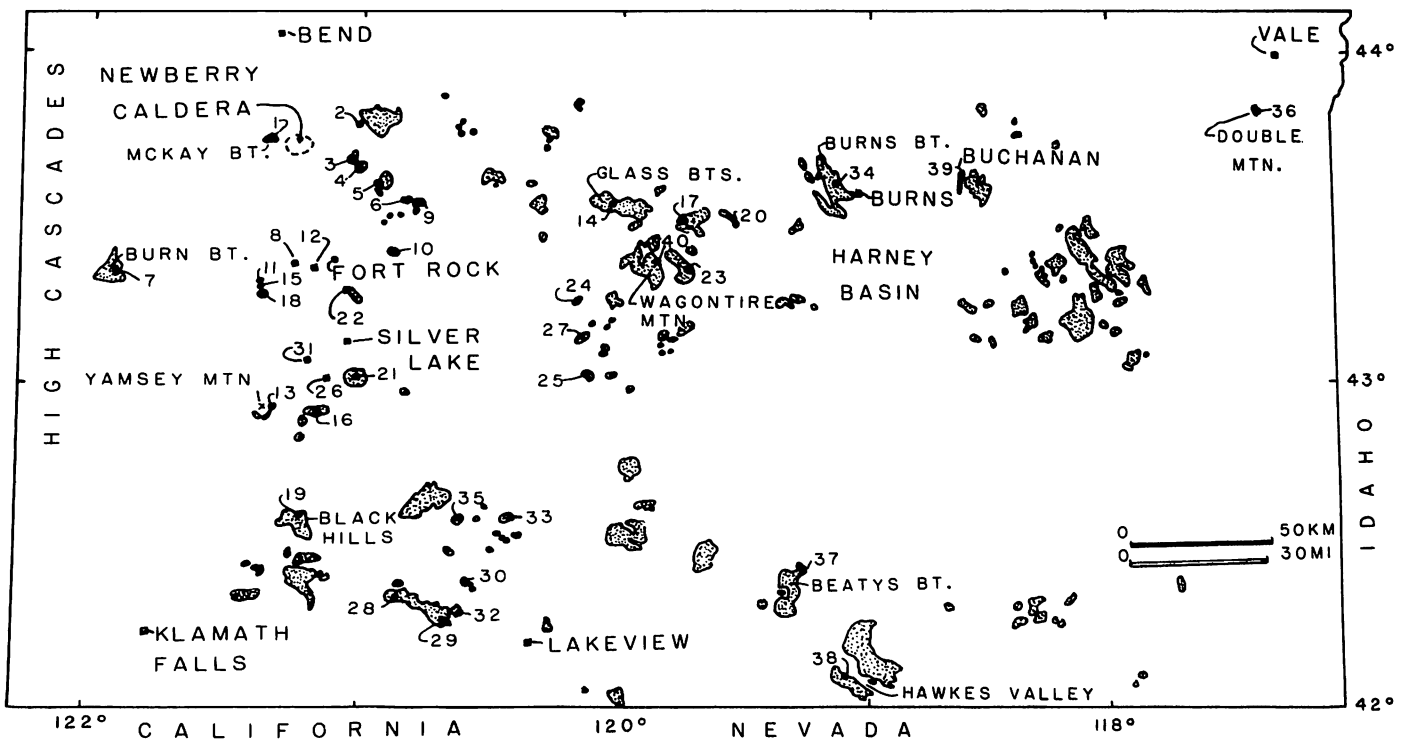

Figure 1. Map of southeastern Oregon east of the Cascade Range showing the location of dated rocks. Sample numbers are keyed to sample descriptions. The distribution of rhyolitic domes, indicated by dot patterns, is generalized from Walker (1973) and Peterson and McIntyre (1970).

SAMPLE DESCRIPTIONS

1. East McKay Butte — K-Ar — (obsidian) 0.58±0.10 m.y.
Rhyolitic dome (43°43.8′N, 121°21.6′W; Deschutes Co., OR). Analytical data: K_2O = 4.01%, $*Ar^{40}$ = 3.4419 x 10^{-12} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 10.2%; collected by: N. S. MacLeod, U. S. G. S., sample M4-16; dated by: E. H. McKee, U. S. G. S., lab. 4I563.

2. North of China Hat — K-Ar — (plagioclase) 0.7±0.7 m.y.
Rhyodacite ash-flow tuff (43°49.4′N, 121°1.1′W; Deschutes Co., OR). Analytical data: K_2O = 0.501%, $*Ar^{40}$ = 0.5476 x 10^{-12} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 0.05%; collected by: N. S. MacLeod, U. S. G. S., sample M3-99; dated by: E. H. McKee, U. S. G. S., lab. 4I623.

3. China Hat — K-Ar — (obsidian) 0.78±0.20 m.y.
Rhyolite dome (43°40.8′N, 121°3.0′W; Deschutes Co., OR). Analytical data: K_2O = 3.69%, $*Ar^{40}$ = 4.2764 x 10^{-12} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 7.2%; collected by: N. S. MacLeod, U. S. G. S., sample M3-53; dated by: E. H. McKee, U. S. G. S., lab. 3I575.

4. East Butte — K-Ar — (obsidian) 0.84±0.04 m.y.
Rhyolite dome (43°39.9′N, 120°59.6′W; Deschutes Co., OR). Analytical data: K_2O = 3.84%, $*Ar^{40}$ = 4.8229 x 10^{-12} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 22.8%; collected by: G. W. Walker, U. S. G. S., sample M073-29; dated by: E. H. McKee, U. S. G. S., lab. 3I531.

5. Quartz Mountain — K-Ar — (obsidian) 1.10±0.05 m.y.
Rhyolite dome (43°37.5′N, 120°53.3′W; Deschutes Co., OR). Analytical data: K_2O = 3.83%, 3.84%, $*Ar^{40}$ = 6.2684 x 10^{-12} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 36.4%; collected by: G. W. Walker, U. S. G. S., sample M073-31; dated by: E. H. McKee, lab. 3I318.

6. Long Butte — K-Ar — (sanidine) 2.29±0.32 m.y.
Rhyolite dome (43°33.5′N, 120°49.8′W; Lake Co., OR). Analytical data: K_2O = 7.34%, 7.43%, $*Ar^{40}$ = 2.5079 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 16.5%; collected by: N. S. MacLeod, U. S. G. S., sample N3-31; dated by: E. H. McKee, U. S. G. S., lab. 4I088.

7. Burn Butte — K-Ar — (plagioclase) 2.45±0.94 m.y.
Dacitic dome complex (43°19.2′N, 121°53.3′W; Klamath Co., OR). Analytical data: K_2O = 0.385%, $*Ar^{40}$ = 1.3946 x 10^{-12} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 4.6%; collected by: E. H. McKee, U. S. G. S., sample M4-127; dated by: E. H. McKee, U. S. G. S., lab. 4I615.

8. West of Fort Rock — K-Ar — (obsidian) 3.34±0.44 m.y.
Rhyolitic ash-flow (43°22.5′N, 121°17.3′W; Lake Co., OR). Analytical data: K_2O = 3.63%, $*Ar^{40}$ = 1.7969 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 15.8%; collected by: N. S. MacLeod, U. S. G. S., sample M4-48; dated by: E. H. McKee, U. S. G. S., lab. 4I567.

9. Squaw Ridge — K-Ar — (obsidian) 3.59±0.07 m.y.
Rhyolite dome (43°31.8′N, 120°46.8′W; Lake Co., OR). Analytical data: K_2O = 3.98%, $*Ar^{40}$ = 2.1157 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 53.5%; collected by: N. C. MacLeod, U. S. G. S., sample M3-33; dated by: E. H. McKee, U. S. G. S., lab. 3I608.

10. Cougar Mountain — K-Ar — (obsidian) 4.31±0.34 m.y.
Rhyolite dome (43°24.0′N, 120°53.0′W; Lake Co., OR). Analytical data: K_2O = 3.72%, 3.71%, $*Ar^{40}$ = 2.3689 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 24.7%; collected by: G. W. Walker, U. S. G. S., sample M073-32; dated by: E. H. McKee, U. S. G. S., lab. 3I351.

11. Bald Mountain area — K-Ar — (biotite) 4.43±0.18 m.y.
Rhyolitic dome (43°20.1′N, 121°22.8′W; Klamath Co., OR). Analytical data: K_2O = 6.81%, $*Ar^{40}$ = 4.4662 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 40.4%; collected by: N. S. MacLeod, U. S. G. S., sample M4-84; dated by: E. H. McKee, lab. 4I562.

12. West of Fort Rock K-Ar (plagioclase) 4.47±0.84 m.y.
Rhyolitic ash-flow tuff (43°21.7′N, 121°12.1′W; Lake Co., OR). Analytical data: K_2O = 0.598%, $*Ar^{40}$ = 3.9579 x 10^{-12} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 12.0%; collected by: N. S. MacLeod, U. S. G. S., sample M4-30; dated by: E. H. McKee, U. S. G. S., lab. 4I571.

13. Yamsey Mountain area K-Ar (whole rock) 4.67±0.17 m.y.
Rhyodacitic dome (42°56.6′N, 121°19.5′W; Lake Co., OR). Analytical data: K_2O = 2.414%, $*Ar^{40}$ = 1.6678 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 36.7%; collected by: E. H. McKee, U. S. G. S., sample M4-131; dated by: E. H. McKee, U. S. G. S., lab. 4I557.

14. Glass Buttes K-Ar (obsidian) 4.91±0.73 m.y.
Rhyolite dome (43°33.3′N, 120°0.4′W; Lake Co., OR). Analytical data: K_2O = 4.21%, 4.15%, $*Ar^{40}$ = 3.0384 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 16.9%; collected by: G. W. Walker, U. S. G. S., sample M073-33; dated by: E. H. McKee, U. S. G. S., lab. 3I319.

15. Bald Mountain area K-Ar (plagioclase) 4.88±0.59 m.y.
Rhyolitic dome (43°19.2′N, 121°22.5′W; Klamath Co., OR). Analytical data: K_2O = 0.826%, $*Ar^{40}$ = 5.9729 x 10^{-12} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 19.7%; collected by: N. S. MacLeod, U. S. G. S., sample M4-135; dated by: E. H. McKee, U. S. G. S., lab. 4I626.

16. Partin Butte K-Ar (whole rock) 5.01±0.20 m.y.
Rhyolitic dome (42°54.9′N, 121°8.5′W; Lake Co., OR). Analytical data: K_2O = 3.77%, $*Ar^{40}$ = 2.7983 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 39.5%; collected by: E. H. McKee, U. S. G. S., sample N4-130; dated by: E. H. McKee, U. S. G. S., lab. 4I601.

17. Squaw Butte K-Ar (obsidian) 5.12±0.08 m.y.
Rhyolite dome (43°30.0′N, 119°46.7′W; Harney Co., OR). Analytical data: K_2O = 4.22%, $*Ar^{40}$ = 3.2093 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 61.4%; collected by: N. S. MacLeod, U. S. G. S., sample M3-90; dated by: E. H. McKee, U. S. G. S., lab. 4I085.

18. Bald Mountain K-Ar (plagioclase) 5.07±0.64 m.y.
Rhyolitic dome (43°16.5′N, 121°21.3′W; Klamath Co., OR). Analytical data: K_2O = 0.862%, $*Ar^{40}$ = 6.4694 x 10^{-12} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 15.9%; collected by: N. S. MacLeod, U. S. G. S., sample M4-112; dated by: E. H. McKee, U. S. G. S., lab. 4I583.

19. Black Hills K-Ar (plagioclase) 5.38±0.54 m.y.
Rhyolitic dome (42°35.6′N, 121°13.4′W; Klamath Co., OR). Analytical data: K_2O = 0.930%, $*Ar^{40}$ = 7.4073 x 10^{-12} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 18.1%; collected by: N. S. MacLeod, U. S. G. S., sample M3-106; dated by: E. H. McKee, U. S. G. S., lab. 4I627.

20. East of Squaw Butte K-Ar (obsidian) 5.69±0.67 m.y.
Rhyolite dome (43°29.0′N, 119°32.1′W; Harney Co., OR). Analytical data: K_2O = 5.046%, $*Ar^{40}$ = 4.2580 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 75.1%; collected by: N. S. MacLeod, U. S. G. S., sample M3-70; dated by: E. H. McKee, U. S. G. S., lab. 4I070.

21. Hager Mountain K-Ar (obsidian) 5.90±0.09 m.y.
Rhyolite dome (43°0.6′N, 121°1.2′W; Lake Co., OR). Analytical data: K_2O = 4.06%, $*Ar^{40}$ = 3.5467 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 61.2%; collected by: N. S. MacLeod, U. S. G. S., sample M3-61; dated by: E. H. McKee, U. S. G. S., lab. 3I600.

22. Connley Hills K-Ar (whole rock) 6.18±0.63 m.y.
Rhyolite dome (43°17.2′N, 121°3.8′W; Lake Co., OR). Analytical data: K_2O = 3.63%, $*Ar^{40}$ = 3.3217 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 22.5%; collected by: N. S. MacLeod, U. S. G. S., sample M4-42; dated by: E. H. McKee, U. S. G. S., lab. 5I136.

23. Egli Ridge K-Ar (obsidian) 6.41±0.19 m.y.
Rhyolite dome (43°22.8′N, 119°51.0′W; Harney Co., OR). Analytical data: K_2O = 4.93%, $*Ar^{40}$ = 4.6723 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 44.9%; collected by: N. S. MacLeod, U. S. G. S., sample M3-86; dated by: E. H. McKee, U. S. G. S., lab. 4I068.

24. Elk Mountain K-Ar (biotite) 6.67±0.18 m.y.
Rhyolite dome (43°15.0′N, 120°10.5′W; I ake Co., OR). Analytical data: K_2O = 8.75%, $*Ar^{40}$ = 8.6407 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 48.4%; collected by: N. S. MacLeod, U. S. G. S., sample M3-60; dated by: E. H. McKee, U. S. G. S., lab. 4I108.

25. South of Horse Mountain K-Ar (sanidine) 6.83±0.22 m.y.
Rhyolite dome (43°2.8′N, 120°8.6′W; Lake Co., OR). Analytical data: K_2O = 6.50%, 6.52%, $*Ar^{40}$ = 6.589 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 44.7%; collected by: N. S. MacLeod, U. S. G. S., sample M3-57; dated by: E. H. McKee, U. S. G. S., lab. 4I109.

26. South of Silver Lake K-Ar (plagioclase) 6.77±1.10 m.y.
Rhyolitic ash-flow tuff (43°1.6′N, 121°6.9′W; Lake Co., OR). Analytical data: K_2O = 0.404%, $*Ar^{40}$ = 4.0496 x 10^{-12} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 12.0%; collected by: N. S. MacLeod, U. S. G. S., sample M4-74; dated by: E. H. McKee, U. S. G. S., lab. 4I570.

27. Horse Mountain K-Ar (obsidian) 6.91±0.14 m.y.
Rhyolite dome (43°9.1′N, 120°7.7′W; Lake Co., OR). Analytical data: K_2O = 4.38%, 4.43%, $*Ar^{40}$ = 4.510 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 67.6%; collected by: E. H. McKee, U. S. G. S., sample M073-41; dated by: E. H. McKee, U. S. G. S., lab. 3I326.

28. Owens Butte K-Ar (biotite) 7.11±0.94 m.y.
Rhyolite dome (42°19.7′N, 120°51.9′W; Lake Co., OR). Analytical data: K_2O = 6.55%, $*Ar^{40}$ = 6.8957 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 15.2%; collected by: E. H. McKee, U. S. G. S., sample M073-35; dated by: E. H. McKee, U. S. G. S., lab. 3I393.

29. Drews Ranch K-Ar (obsidian) 7.13±0.34 m.y.
Rhyolite dome (42°16.1′N, 120°43.8′W;Lake Co., OR). Analytical data: K_2O = 4.42%, 4.43%, $*Ar^{40}$ = 4.6760 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 31.9%; collected by: E. H. McKee, U. S. G. S., sample M073-34; dated by: E. H. McKee, U. S. G. S., lab. 3I349.

30. Thomas Creek K-Ar (sanidine) 7.19±0.32 m.y.
Rhyolite dome (42°23.8′N, 120°36.0′W; Lake Co., OR). Analytical data: K_2O = 11.69%, $*Ar^{40}$ = 1.2449 x 10^{-10} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 40.0%; collected by: E. H. McKee, U. S. G. S., sample M073-37; dated by: E. H. McKee, U. S. G. S., lab. 3I392.

31. West of Silver Lake K-Ar (plagioclase) 7.17±1.54 m.y.
Rhyolitic ash-flow tuff (43°5.2′N, 121°11.2′W; Lake Co., OR). Analytical data: K_2O = 0.335%, $*Ar^{40}$ = 3.5583 x 10^{-12} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 11.3%; collected by: N. S. MacLeod, U. S. G. S., sample M4-73; dated by: E. H. McKee, U. S. G. S., lab. 4I569.

32. Cougar Peak K-Ar (biotite) 7.27±0.50 m.y.
Silicic dome complex (42°18.3′N, 120°37.9′W; Lake Co., OR). Analytical data: K_2O = 7.99%, $*Ar^{40}$ = 8.6047 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 25.7%; collected by: E. H. McKee, U. S. G. S., sample M073-36; dated by: E. H. McKee, U. S. G. S., lab. 3I394.

33. Tucker Hill K-Ar (obsidian) 7.41±0.19 m.y.
Rhyolite dome (42°36.0′N, 120°25.3′W; Lake Co., OR). Analytical data: K_2O = 4.42%, $*Ar^{40}$ = 4.8539 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 55.0%; collected by: E. H. McKee, U. S. G. S., sample M073-40; dated by: E. H. McKee, U. S. G. S., lab. 3I395.

34. Burns Butte K-Ar (obsidian) 7.54±0.10 m.y.
Rhyolite dome (43°34.1'N, 119°8.2'W; Harney Co., OR). Analytical data: K_2O = 5.43%, $*Ar^{40}$ = 6.0653 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 72.2%; collected by: N. S. MacLeod, U. S. G. S., sample M3-79; dated by: E. H. McKee, U. S. G. S., lab. 4I071.

35. McComb Butte K-Ar (obsidian) 7.70±0.09 m.y.
Rhyolite dome (42°34.6'N, 120°37.1'W; Lake Co., OR). Analytical data: K_2O = 4.47%, 4.56%, $*Ar^{40}$ = 5.1516 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 76.0%; collected by: E. H. McKee, U. S. G. S., sample M073-39; dated by: E. H. McKee, U. S. G. S., lab. 3I321.

36. Double Mountain K-Ar (sanidine) 7.86±0.21 m.y.
Silicic dome (43°49.8'N, 117°20.4'W; Malheur Co., OR). Analytical data: K_2O = 7.75%, 7.61%, $*Ar^{40}$ = 8.9376 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 54.3%; collected by: N. S. MacLeod, U. S. G. S., sample M4-115; dated by: E. H. McKee, U. S. G. S., lab. 4I572.

37. Beatys Butte K-Ar (obsidian) 10.36±0.53 m.y.
Silicic dome complex (42°25.5'N, 119°18.8'W; Harney Co., OR). Analytical data: K_2O = 4.81%, $*Ar^{40}$ = 7.3861 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 37.0%; collected by: E. H. McKee, U. S. G. S., sample M073-43; dated by: E. H. McKee, U. S. G. S., lab. 3I352.

38. Hawkes Valley K-Ar (sanidine) 13.48±0.23 m.y.
Rhyolite dome (42°6.8'N, 119°7.5'W; Harney Co., OR). Analytical data: K_2O = 7.26%, $*Ar^{40}$ = 1.4513 x 10^{-10} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 64.9%; collected by: N. S. MacLeod, U. S. G. S., sample M4-117; dated by: E. H. McKee, U. S. G. S., lab. 4I595.

39. Buchanan K-Ar (sanidine) 14.74±0.50 m.y.
Silicic dome (43°38.9'N, 118°37.3'W; Harney Co., OR). Analytical data: K_2O = 7.94%, $*Ar^{40}$ = 1.7360 x 10^{-10} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 49.9%; collected by: N. S. MacLeod, U. S. G. S., sample M4-114; dated by: E. H. McKee, U. S. G. S., lab. 4I564.

40. Wagontire Mountain K-Ar (plagioclase) 14.70±1.10 m.y.
Silicic dome complex (43°22.5'N, 119°52.2'W; Harney Co., OR). Analytical data: K_2O = 0.584%, $*Ar^{40}$ = 1.2739 x 10^{-11} moles/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 29.1%; collected by: N. S. MacLeod, U. S. G. S., sample M3-88; dated by: E. H. McKee, U. S. G. S., lab. 4I628.

REFERENCES

Dalrymple, G. B., and Lanphere, M. A. (1969) Potassium-argon dating-principles, techniques and applications to geochronology: San Francisco, Calif., W. H. Freeman and Co.

MacLeod, N. S., Walker, G. W., and McKee, E. H. (in press) Geothermal significance of eastward increase in age of late Cenozoic rhyolitic domes in southeastern Oregon: Second United Nations Symposium of the Development and Use of Geothermal Resources, symposium volume.

Peterson, N. V., and McIntyre, J. R., Jr. (1970) The reconnaissance geology and mineral resources of eastern Klamath County and western Lake County, Oregon: Oregon Dept. Geol. and Mineral Industries Bull. 66.

Walker, G. W. (1973) Preliminary geologic and tectonic maps of Oregon east of the 121st Meridian: U. S. Geol. Survey Misc. Field Studies Map MF-495.

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