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K-Ar AGES OF LATE CENOZOIC ROCKS OF THE CENTRAL AND EASTERN PARTS OF THE SPRINGERVILLE VOLCANIC FIELD, EAST-CENTRAL ARIZONA

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The late Cenozoic Springerville volcanic field is a Colorado Plateau-marginal volcanic field, approximately 3700 km² in area, north of the White Mountains in east-central Arizona (fig. 1). Detailed mapping has recently been completed by J. C. Aubele (eastern part), L. S. Crumpler (central part), and C. D. Condit (western part) under the auspices of the U.S. Geological Survey (Aubele and Crumpler, 1983; Condit, 1983). Three lithologic maps, compiled at the scale of 1:50,000 will eventually be published as U.S. Geological Survey I-series maps.

The entire field consists of approximately 400 vents and associated flows; major oxide whole rock analyses are available for every flow in the field. Based on the classification of Coombs and Wilkinson (1969), the dominant flow type is alkali olivine basalt, with lesser volumes of intermediate rocks ranging from hawaiite through mugearite to benmoreite. For mapping purposes, the flow units were divided into 12 lithologic types based on phenocryst type and abundance.

The western third of the field has been described by Condit (1984) and K-Ar dates for this part of the field have been previously reported by Condit and Shafiquallah (1985). They describe a range in age, for flows originating in the western third of the field, from 2.05 ± 0.10 to 0.486 ± 0.029 m.y. K-Ar dates have previously been reported for the central and eastern parts of the Springerville field by Laughlin and others (1979, 1980). They report a range in age, for units originating in the central and eastern thirds of the field, from 3.06 ± 0.08 to 0.75 ± 0.13 m.y.

New K-Ar dates by the University of Arizona Isotope Geochemistry Laboratory for samples collected in the central and eastern parts of the field are reported here. These dates expand the known period of active volcanism in the field with the youngest dated flow, occurring in the eastern third, at 0.308 ± 0.17 m.y. Based on flow surface morphology (Elston and others, 1976) this flow is believed to represent the youngest activity in the volcanic field. The 28 K-Ar dates now available for the entire field appear to show no orderly spatial or compositional progression.

Analytical data for the new K-Ar dates are given. Each sample is listed by a field number and by the University of Arizona Isotope Geochemistry Laboratory sample number (UAKA). The rock may also be related to an eruptive vent number. The vents in the field were numbered using a four-digit system devised for the San Francisco volcanic field by the U.S. Geological Survey. The first digit is the second number of the township in which the vent is located. The second digit is the second number of the range, and the third and fourth digits are the section number.

Representative chemical analyses of samples from the dated rocks are shown in table 1. Compositions were determined by XRF rapid-rock analysis by the U.S. Geological Survey, Branch of Analytical Laboratories. Field sample numbers differ for samples used for chemical analysis and K-Ar determinations because the samples were collected at different times and, in some cases, from different outcrops of the same flow unit.

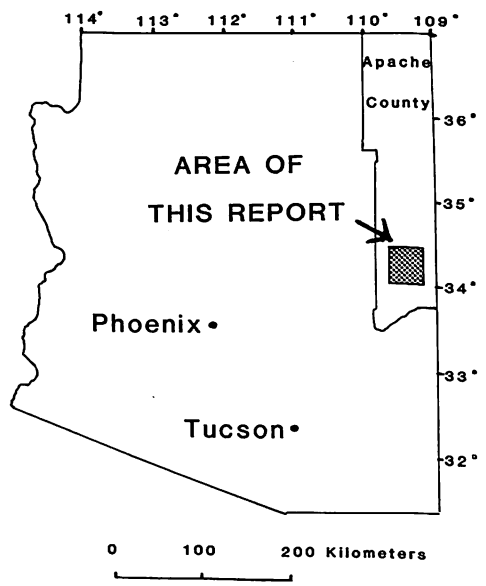

FIGURE 1. Location of this study. Box represents the generalized outline of the central and eastern Springerville volcanic field, Arizona. The dominantly Quaternary Springerville field extends to the west into adjacent Navajo County and is contiguous to the south with the dominantly Tertiary volcanic White Mountains—Mt. Baldy area.

The decay constants used in the age calculations are as follows: $\lambda\beta = 4.963 \times 10^{-10}$ yr^{-1}; $\lambda_\epsilon = 0.581 \times 10^{-10}$ yr^{-1}; $\lambda = 5.544 \times 10^{-10}$ yr^{-1}; and $^{40}K/K = 1.167 \times 10^{-4}$ atom/atom.

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TABLE 1. Representative major element analyses and normative mineralogy of dated rocks.

Sample Description No.	1	2	3	4	5	6	7	8
Field Sample No.	C80BB194[1]	C82V252[1]	C81CH222	C79WK74[1]	A79SN56[1]	A82LLS24[1]	A79SN51	A79SN46[1]
SiO_2	55.0	47.6	46.5	48.5	46.3	46.1	46.1	54.8
TiO_2	1.26	1.67	1.98	1.73	2.30	1.66	2.15	1.21
Al_2O_3	18.1	16.0	14.7	15.2	15.8	14.9	14.8	18.0
FeO_T	7.79	10.52	10.44	10.17	9.99	11.25	11.07	8.51
MgO	2.20	8.18	11.5	9.77	8.02	8.68	10.6	1.8
CaO	5.99	10.5	9.11	9.27	9.43	10.3	9.99	4.86
Na_2O	4.40	2.65	3.15	2.7	2.9	2.54	2.5	4.8
K_2O	2.41	0.84	1.26	1.15	1.71	0.83	0.94	2.50
P_2O_5	0.67	0.36	0.45	0.4	0.64	0.30	0.4	0.89
MnO	0.19	0.17	0.17	0.16	0.16	0.17	0.17	0.19
LOI	0.44	<0.01	<0.01	<0.01	0.360	1.30	<0.001	<0.001
Total	98.45	98.49	99.26	99.05	97.61	98.03	98.72	97.56
Q[2]	2.55	0.0	0.0	0.0	0.0	0.0	0.0	2.26
Or	14.5	5.0	7.5	6.9	10.37	5.06	5.62	15.13
Ab	37.9	22.7	17.9	23.0	20.56	21.57	19.40	41.54
An	22.9	29.7	22.3	26.2	25.70	27.65	26.67	18.75
Ne	0.0	0.0	4.9	0.0	2.50	0.33	1.08	0.0
Di	2.5	17.0	16.3	14.3	14.68	18.85	16.87	0.0
Hy	13.6	2.7	0.0	5.6	0.0	0.0	0.0	14.94
Ol	0.0	16.4	24.1	17.5	17.93	20.03	22.87	0.0
Mt	2.1	2.5	2.4	2.5	2.37	2.68	2.58	2.31
Il	2.4	3.2	3.8	3.3	4.49	3.25	4.13	2.36
Ap	1.6	0.8	1.0	0.9	1.52	0.72	0.93	2.10

Notes: Oxides are in weight percent; FeO_T + total iron as FeO; LOI = loss on ignition (900° C).
[1]Field sample for XRF analysis and field sample for K-Ar age determination were collected from different outcrops of the same flow unit.
[2]CIPW norm calculated by C.D. Condit.

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SAMPLE DESCRIPTIONS

1. *UAKA 82-190 (Field #C82BB273)* K-Ar
Plagioclase-hornblende benmoreite from dome of vent 9506 [Wolf Mountain] (34°11.65'N,109°44.45'W; elevation 2379 m; SW/4,NW/4,S7,T9N,R25E; Boundary Butte quad., Apache Co., AZ). *Analytical data:* %K = 2.078, 2.036, 2.044, 2.041, 2.056; $^{40}Ar_R \times 10^{-12}$ m/g = 5.498, 5.544, 5.476, 5.616, 5.542; $^{40}Ar/Ar$ = 60.3%, 59.4%, 59.4%, 59.2%, 59.6%. *Collected by:* M. Shafiquallah, D. Lynch, and L. S. Crumpler. *Comments:* One of the older and most differentiated rocks in the field, a dome intruding cinder of the same composition.
(whole rock, groundmass) 1.56 ± 0.05 m.y.

2. *UAKA 82-191 (Field #C82V275B)* K-Ar
Olivine basalt flow from undetermined vent, possibly vent 6523 (34°21.40'N,109°40.55'W; elevation 1992 m; NE/4,NE/4,S15,T11N,R25E; Vernon quad., Apache Co., AZ). *Analytical data:* %K = 0.7962, 0.7983, 0.7961, 0.7927; $^{40}Ar_R \times 10^{-12}$ m/g = 1.767, 1.802, 1.748, 1.794, 1.825, 1.840, 1.785; $^{40}Ar/Ar$ = 55.1%, 54.8%, 55.4%, 54.7%, 54.4%, 55.0%. *Collected by:* M. Shafiquallah, D. Lynch and L. S. Crumpler. *Comments:* One of the oldest flow units in the central part of the field, structurally warped.
(whole rock, groundmass) 1.30 ± 0.05 m.y.

3. *UAKA 82-192 (Field #C82CH276)* K-Ar
Picritic basalt flow of vent 1633 (34°17.48'N, 109°37.35'W; elevation 2073 m; SW/4,NW/4,S5, T10N,R26E; Cerro Hueco quad., Apache Co., AZ). *Analytical data:* %K = 1.405, 1.401, 1.399, 1.396, 1.401; $^{40}Ar_R \times 10^{-12}$ m/g = 2.912, 2.896, 2.883, 2.878, 2.906; $^{40}Ar/Ar$ = 65.8%, 65.9%, 65.6%, 66.8%, 66.3%. *Collected by:* M. Shafiquallah, D. Lynch, L. S. Crumpler. *Comments:* One of the younger structurally deformed flows in the central part of the field.
(whole rock, groundmass) 1.19 ± 0.04 m.y.

4. *UAKA 82-197 (Field #C82WK277)* K-Ar
Quartz-olivine basalt flow of vent 9626 [St. Peter's Dome] (34°8.9'N,109°34.85'W; elevation 2682 m; SW/4,NW/4,S27,T9N,R26E; Whiting Knoll quad., Apache Co., AZ). *Analytical data:* %K = 1.500, 1.501, 1.495, 1.496, 1.496, 1.495, 1.504, 1.503, 1.495; $^{40}Ar_R \times 10^{-12}$ m/g = 1.757, 1.728, 1.722, 1.700, 1.740, 1.786, 1.791, 1.703, 1.736; $^{40}Ar/Ar$ = 67.2%, 66.7%, 66.3%, 67.2%, 66.8%. *Collected by:* M. Shafiquallah, D. Lynch, and L. S. Crumpler. *Comments:* One of the younger flows in the central part of the field, large in areal extent and

suitable for correlative dating with numerous other units.

(whole rock, groundmass) 0.670 ± 0.022 m.y.

5. *UAKA 82-193 (Field #A82SN500)* K-Ar
Olivine-pyroxene-plagioclase basalt flow of vent 0727 (34°14.79'N,109°28.70'W; elevation 2125 m; NE/4,SW/4,S22,T10N,R27E; Springerville NW quad., Apache Co., AZ). *Analytical data:* %K = 1.782, 1.771, 1.776, 1.780; $^{40}Ar_R \times 10^{-12}$ m/g = 3.280, 3.161, 3.234; $^{40}Ar/Ar$ = 54.2%, 54.7%, 54.7%. *Collected by:* M. Shafiquallah, D. Lynch, and J. C. Aubele. *Comments:* Flow is upwarped by a major northwest trending fault which extends across the central and eastern parts of the field.

(whole rock, groundmass) 1.05 ± 0.04 m.y.

6. *UAKA 82-194 (Field #A82LLS501)* K-Ar
Olivine basalt of undetermined vent (34°21.65'N, 109°24.08'W; elevation 1943 m; SE/4,SW/4,S8, T11N,R28E; Lyman Lake SW quad., Apache Co., AZ). *Analytical data:* %K = 1.063, 1.063, 1.065, 1.064, 1.046, 1.035, 1.042; $^{40}Ar_R \times 10^{-12}$ m/g = 3.660, 3.602, 3.617, 3.635; $^{40}Ar/Ar$ = 51.8%, 52.0%, 51.8%, 51.8%. *Collected by:* M. Shafiquallah, D. Lynch, and J. C. Aubele. *Comments:* One of the oldest flow units in the eastern part of the field, caps mesa west of the Little Colorado River.

(whole rock, groundmass) 1.98 ± 0.6 m.y.

7. *UAKA 82-195 (Field #A82SN502)* K-Ar
Picritic basalt of vent 0833 (34°13.50'N, 109°24.05'W; elevation 2029 m; SE/4,NE/4,S32, T10N,R28E; Springerville NW quad., Apache Co., AZ). *Analytical data:* %K = 0.8114, 0.8117, 0.8112, 0.8072; $^{40}Ar_R \times 10^{-12}$ m/g = 0.432, 0.434, 0.423, 0.438, 0.412, 0.427, 0.458, 0.422, 0.449; $^{40}Ar/Ar$ = 94.8%, 94.9%, 95.1%, 95.1%, 95.1%, 95.0%, 94.8%. *Collected by:* M. Shafiquallah, D. Lynch, and J. C. Aubele. *Comments:* The youngest dated flow unit in the Springerville volcanic field. An earlier flow unit from the same vent was dated at 0.75 ± 0.13 m.y. by Laughlin and others (1980).

(whole rock, groundmass) 0.308 ± 0.070 m.y.

8. *UAKA 82-196 (Field #A82SN503)* K-Ar
Aphyric basalt of vent 9711 (34°12.55'N, 109°26.88'W; elevation 2195 m; SE/4,SE/4,S35, T10N,R27E; Springerville NW quad., Apache Co., AZ). *Analytical data:* %K = 2.264, 2.269, 2.288, 2.309, 2.305, 2.298, 2.264, 2.284; $^{40}Ar_R \times 10^{-12}$ m/g = 4.099, 4.165, 4.133, 4.132; $^{40}Ar/Ar$ = 67.0%, 65.8%, 66.6%, 66.9%. *Collected by:* M. Shafiquallah, D. Lynch, and J. C. Aubele. *Comments:* Intermediate age and wide areal extent, suitable for correlative dating with other units. Northeast-trending fissure vents of olivine-pyroxene basalt erupted through this dated flow unit.

(whole rock, groundmass) 1.04 ± 0.05 m.y.

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