MASTER

SUMMARY OF POTASSIUM/ARGON DATING - 1981

by

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and
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Topical Report

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ABSTRACT

This report summarizes the analytical results for the last fiscal year effort in potassium/argon dating in support of U. S. Department of Energy programs. Nearly 100 new dates have been generated, the vast majority of which were for the Oregon Department of Geology and Mineral Industries. Other institutions which also received dating services were: Earth Science Laboratory, University of Utah Research Institute; Department of Geology and Geophysics, University of Utah; Montana Geological Survey; Portland State University; and Southland Royalty Company.

Recalibration of the argon extraction tables resulted in refinement of values for tracer ratios and depletion constants for our two extraction lines. Tracer ratios are $(^{36}\text{Ar}/^{38}\text{Ar})_T = 0.0308$ and 0.0000449 ; $(^{40}\text{Ar}/^{38}\text{Ar})_T = 0.0501$ and 0.0014 for extraction tables 1 and 2, respectively. Tracer depletion constants are -0.0002250 and -0.0005501 for tables 1 and 2, respectively. Initial values for the argon tracer pipettes are 3.2522×10^{-11} moles and 3.9329×10^{-11} moles for tables 1 and 2, respectively.

INTRODUCTION

The purpose of this report is to tabulate the results of the potassium/argon dating program which has been supported by the U.S. Department of Energy during Fiscal Year 1981. This dating program has supported numerous other DOE programs including the Geothermal Exploration and Assessment Technology Program, the State Coupled Low Temperature Resource Evaluation Program, and the Industry Coupled Case Studies Program.

During FY-81 about 100 samples were dated. In addition, calibration and spectrometer discrimination checks were made. It appears that the system constants in the K/Ar laboratory are well established.

One critical constant that is required for argon analysis is the depletion constant for the ^{38}Ar tracer pipette. Each of the two extraction lines in our laboratory has a tracer pipette and the form of the equation which describes the quantity of ^{38}Ar released in each spike is:

$$^{38}\text{Ar}_s = ^{38}\text{Ar}_0 \exp [- \delta X] , \quad (1)$$

where $^{38}\text{Ar}_s$ is the number of moles of ^{38}Ar in a specific spike, $^{38}\text{Ar}_0$ is the value of ^{38}Ar in the first spike drawn from the pipette, δ is the depletion constant and X is the sequential number of the spike. During the initial calibration of each extraction line, $^{38}\text{Ar}_0$ was determined using a special pipette calibrated to yield a specific number of moles of atmospheric argon.

This known amount of atmospheric argon was then used to calculate the amount of ^{38}Ar in the spike from the following formula:

$$^{38}\text{Ar}_T = ^{40}\text{Ar}_A \left\{ (^{40}\text{Ar}/^{38}\text{Ar})_M - (^{40}\text{Ar}/^{38}\text{Ar})_T - \left[\frac{1 - (^{38}\text{Ar}/^{36}\text{Ar})_M (^{36}\text{Ar}/^{38}\text{Ar})_T}{(^{38}\text{Ar}/^{36}\text{Ar})_M (^{36}\text{Ar}/^{38}\text{Ar})_A - 1} \right] \right\}$$

$$\left[(^{40}\text{Ar}/^{38}\text{Ar})_A - (^{40}\text{Ar}/^{38}\text{Ar})_M \right]^{-1}, \quad (2)$$

where $^{40}\text{Ar}_A$ is the known quantity of ^{40}Ar introduced from the atmosphere in the special pipette, and the other subscripts indicate: T= tracer; M= measured; A= atmosphere. The values presently in use in the laboratory are:

$$(^{36}\text{Ar}/^{38}\text{Ar})_A = 5.35$$

$$(^{40}\text{Ar}/^{38}\text{Ar})_A = 1581$$

$$(^{36}\text{Ar}/^{38}\text{Ar})_T = 0.0308 \text{ (Extraction Line 1)}$$

$$= 0.0000449 \text{ (Extraction Line 2)}$$

$$(^{40}\text{Ar}/^{38}\text{Ar})_T = 0.0521 \text{ (Extraction Line 1)}$$

$$= 0.0014 \text{ (Extraction Line 2).}$$

The different values for the tracer ratios for the two tables reflect the difference in purity of ^{38}Ar used for the tracer reservoirs (for table 1; $^{38}\text{Ar} \approx 95\%$, for table 2; $^{38}\text{Ar} \approx 99.9\%$). The values for $(^{36}\text{Ar}/^{38}\text{Ar})_T$ and $(^{40}\text{Ar}/^{38}\text{Ar})_T$ were determined by analyzing small quantities of tracer gas split from the reservoirs when each was initially filled. The initial calibrations of our two extraction lines resulted in values for $^{38}\text{Ar}_T$ of 3.2522×10^{-11} moles and 3.9329×10^{-11} moles for lines 1 and 2, respectively. These calibrations also utilized the special air pipette. Successive checks of the depletion constants for the lines over the last two years have established values of

0.0002250 and 0.0005501 for lines 1 and 2, respectively. The resulting equations for calculating individual tracer spikes are:

$$^{38}\text{Ar}_T = 3.2522 \times 10^{-11} \exp(-0.0002250) \quad (\text{Line 1})$$

$$^{38}\text{Ar}_T = 3.9329 \times 10^{-11} \exp(-0.0005501) \quad (\text{Line 2}).$$

Details of the utilization of tracer reservoirs are to be found in Dalrymple and Lanphere (1969).

Ages presented in this report are calculated using,

$$T = \frac{1}{\lambda_e + \lambda_\beta} \ln \left[\frac{\lambda_e + \lambda_\beta}{\lambda_e} \frac{{}^{40}\text{Ar}_{\text{rad}}}{{}^{40}\text{K}} + 1 \right] \quad (3)$$

$$= 1.804 \times 10^9 \ln \left[9.540 \frac{{}^{40}\text{Ar}_{\text{rad}}}{{}^{40}\text{K}} + 1 \right] \quad (4)$$

where the currently recommended values for the decay constants given by Steiger and Jäger (1978) have been substituted.

These values are:

$$\begin{aligned} \lambda_\beta &= 4.962 \times 10^{-10} / \text{yr.} \\ \lambda_e &= 0.581 \times 10^{-10} / \text{yr.} \end{aligned}$$

Note also that in determining the amount of ${}^{40}\text{K}$ in our samples a value of ${}^{40}\text{K}/\text{TotK} = 1.167 \times 10^{-4}$ atom/atom has been used (Steiger and Jäger, 1978).

RESULTS

During the past year samples were dated from a number of western states. As the states form convenient geographic entities, the dates obtained will be reported below for each state.

Utah

Samples from study areas near the Roosevelt Known Geothermal Resource Area comprised the bulk of the material dated from Utah (see Figure 1 for specific areas). Seven samples from the Cove Fort-Black Rock Desert-Twin Peaks study areas are reported in Table 1. These dates were done as part of a continuing study by Dr. W. P. Nash of the Department of Geology and Geophysics, University of Utah. A detailed discussion of the geology in the form of a Topical Report is now under preparation by W. P. Nash.

Four volcanic units, listed in Table 2, from the rhyolitic volcanics associated with the Roosevelt K.G.R.A. were dated to detail completely the eruptive history in this area. These four samples (MR76-9, 76-10, 76-13 and 79-12) and additional data from Lipman et al. (1978) indicate that at least two distinct episodes of Quaternary volcanism occurred in the Mineral Mountains. One around 0.8 m.y. ago resulted in the formation of two flows and one small dome and the second episode around 0.5 to 0.6 m.y. ago brought about the eruption of 12-15 rhyolitic domes (Lipman et al., 1978).

The fifth sample listed in Table 2 (AV80-1) is a small dome on the southern extreme of the Mineral Mountains near the town of Adamsville. This sample was dated to see if this volcanic unit correlated with activity in the Mineral Mountains or with some other episode. An age of 7.31 m.y. seems to indicate a correlation with the Blue Ribbon Summit rhyolitic event of Rowley et al. (1978).

Figure 1. Index Map of Study Areas in the State of Utah.

Table 1. Samples from the Black Rock Desert/Twin Peaks Area, Utah.

Sample No.	Material Dated	Weight (gms).	%K	Moles/gm Ar ⁴⁰ _{Rad} (X10 ¹¹)	%Ar ⁴⁰ _{atm}	Age (M.Y.)
TP 80-1/UT-205	Whole Rock	4.01977	0.56	0.367	90	3.77 ± 0.54
TP 80-2/UT-255	Anorthoclase	0.70734	2.90	1.888	88	3.75 ± 0.43
BRD 79-2/UT-257	Whole Rock	2.52644	1.10	0.424	94	2.22 ± 0.51
BRD 79-3/UT-256	Whole Rock	2.50791	1.51	0.2051	94	0.78 ± 0.18
BRD 79-5/AH-80	Whole Rock	2.51484	1.09	0.399	92	2.11 ± 0.36
BRD 81-21/AH-81	Whole Rock	2.50432	0.98	0.157	95	0.92 ± 0.26
BRD 81-26/AH-82	Whole Rock	2.53442	1.05	0.125	98	0.69 ± 0.48

Constants Used:

$$\lambda_{\beta} = 4.962 \times 10^{-10}/\text{yr.}$$

$$\lambda_{\epsilon} = 0.581 \times 10^{-10}/\text{yr.}$$

$$^{40}\text{K}/\text{K}_{\text{Tot.}} = 1.167 \times 10^{-4} \text{ atom/atom}$$

Table 2. Samples from the Mineral Mountains and Vicinity, Utah.

Sample No.	Unit Dated	Material	Weight (gms.)	%K	Moles/gm Ar ⁴⁰ _{Rad} (X10 ¹¹)	%Ar ⁴⁰ _{atm}	Age (M.Y.) $\pm 1\sigma$
MR76-9/UT-130	So. Tw. Flat Mtn.	Sanidine	6.13746	7.328	0.771	40	0.61 $\pm$ 0.04
MR76-10/AH-33	So. Tw. Flat Mtn.	Sanidine	2.42887	7.320	0.779	65	0.61 $\pm$ 0.03
MR76-13/AH-41	No. Tw. Flat Mtn.	Sanidine	2.53325	8.137	0.931	55	0.66 $\pm$ 0.03
MR79-12/AH-39	Big Cedar Cove	Sanidine	2.00266	8.595	1.154	70	0.77 $\pm$ 0.04
AV80-1/AH-28	Adamsville Rhyolite	Sanidine	0.60230	8.950	11.371	40	7.31 $\pm$ 0.26

Constants Used:

$$\lambda_{\beta} = 4.962 \times 10^{-10}/\text{yr.}$$

$$\lambda_{\theta} = 0.581 \times 10^{-10}/\text{yr.}$$

$$^{40}\text{K}/\text{K}_{\text{Tot.}} = 1.167 \times 10^{-4} \text{ atom/atom}$$

The last area from which samples were dated is Grouse Creek in northwestern Utah. This area was of interest because the Geothermal Resources of Utah map (UGMS, 1980) shows warm springs present near some rhyolite domes whose ages were unknown. This area was under study by Dr. D. W. Fiesinger of Utah State University who furnished the rhyolites that were dated. All of the samples dated are concordant and show that, with an age of 12 m.y., these rhyolites could not serve as a heat source for any present geothermal activity.

Nevada

Three study areas in the state of Nevada were sample dated as an aid to geologic interpretation. Figure 2 is an index map giving the location of the three study areas. In the Dixie Valley K.G.R.A. a study done under DOE's Industry Coupled Program, involving Southland Royalty Company and a student from the University of Nevada, Reno, resulted in five samples being submitted for dating. These dates are listed in Table 4 and a detailed discussion of the data as well as sample locations are found in Nosker (1981).

Two areas have been under study at the Earth Science Laboratory, University of Utah Research Institute, the McCoy and Tuscarora thermal areas. Table 5 lists seven dates from ash-flow tuffs from McCoy and Table 6 gives results from Tuscarora. The McCoy study is presently being completed as a masters thesis by M. Adams of the Earth Science Laboratory. The Tuscarora area has been described in a detailed report by Sibbett (1981) to which the reader is referred for additional information and sample locations.

Idaho

Three samples were dated from Idaho as part of a study of the Magic Reservoir area. The location of Magic Reservoir is shown in Figure 3. Table 7 contains the analytical data which also appear in an extensive discussion of

Table 3. Samples from The Grouse Creek Area, Utah.

Sample No.	Unit	Material Dated	Weight (gms.)	%K	Moles/gm $\text{Ar}^{40}_{\text{Rad}} (\times 10^{11})$	% $\text{Ar}^{40}_{\text{atm}}$	Age (M.Y.) $\pm 1\sigma$
EV79-3/AH-13	Rhy.	Biotite	0.80665	7.19	15.240	45	12.2 $\pm$ 0.4
EV79-3/AH-25	Rhy.	Sanidine	0.50186	8.95	19.080	42	12.3 $\pm$ 0.4
EV79-4/UT-208	Rhy.	Sanidine	0.30913	8.53	17.834	58	12.0 $\pm$ 0.5
EV79-5/UT-202	Rhy.	Sanidine	0.50631	8.00	16.951	40	12.2 $\pm$ 0.4

Constants Used:

$$\lambda_{\beta} = 4.962 \times 10^{-10} / \text{yr.}$$

$$\lambda_{\epsilon} = 0.581 \times 10^{-10} / \text{yr.}$$

11 $^{40}\text{K}/\text{K}_{\text{Tot.}} = 1.167 \times 10^{-4} \text{ atom/atom}$

Figure 2. Index Map of Study Areas in the State of Nevada.

Table 4. Samples from the Dixie Valley Known Geothermal Resource Area, Nevada.

Sample No.	Unit	Material Dated	Weight (gms.)	%K	(Moles/gm) Ar ⁴⁰ _{Rad} (X10 ¹¹)	%Ar ⁴⁰ _{atm}	Age (M.Y.) ± 1σ
K/AR-2/UT-196	Basalt	Whole Rock	3.02031	0.79	2.0415	64	14.8 ± 0.7
K/AR-3/UT-213	Ash Flow	Sanidine	0.50218	9.18	21.414	40	13.4 ± 0.5
K/AR-4/UT-201	Basalt	Whole Rock	3.00565	1.14	3.440	58	17.3 ± 0.7
K/AR-5/AH-16	Basalt	Whole Rock	2.57454	1.06	2.468	56	13.4 ± 0.5
K/AR-7/AH-20	Basalt	Whole Rock	3.05873	0.64	1.916	68	17.2 ± 0.8

Constants Used:

$$\lambda_{\beta} = 4.962 \times 10^{-10}/\text{yr.}$$

$$\lambda_{\epsilon} = 0.581 \times 10^{-10}/\text{yr.}$$

$$^{40}\text{K}/\text{K}_{\text{Tot.}} = 1.167 \times 10^{-4} \text{ atom/atom}$$

Table 5. Samples from the McCoy Thermal Area, Nevada.

Sample No.	Unit	Material Dated	Weight (gms.)	%K	Moles/gm		Age (M.Y.) $\pm 1\sigma$
					Ar ⁴⁰ _{Rad} (X10 ¹¹)	%Ar ⁴⁰ _{atm}	
ESL McNev/AH-66	A	Anorthoclase	0.45887	4.34	22.159	64	29.2 $\pm$ 1.3
ESL McNev/AH-67	B	Anorthoclase	0.60551	1.97	10.240	47	29.8 $\pm$ 1.1
ESL McNev/AH-71	C	Anorthoclase	0.47872	4.80	27.122	56	32.3 $\pm$ 1.3
ESL McNev/AH-68	D	Sanidine	0.43218	8.31	42.786	44	29.4 $\pm$ 1.1
ESL McNev/UT-245	E	Anorthoclase	0.50037	4.50	24.553	57	31.2 $\pm$ 1.3
ESL McNev/UT-244	F	Anorthoclase	0.40181	4.62	24.622	54	30.5 $\pm$ 1.2
ESL McNev/UT-246	5	Anorthoclase	0.54113	4.35	22.704	44	29.8 $\pm$ 1.1

Constants Used:

$$\lambda_{\beta} = 4.962 \times 10^{-10}/\text{yr.}$$

$$\lambda_{\epsilon} = 0.581 \times 10^{-10}/\text{yr.}$$

$$^{40}\text{K}/\text{K}_{\text{Tot.}} = 1.167 \times 10^{-4} \text{ atom/atom}$$

Table 6. Samples from the Tuscarora Thermal Area, Nevada.

Sample No.	Material Dated	Weight (gms.)	%K	Moles/gm		Age (M.Y.) $\pm 1\sigma$
				Ar ⁴⁰ _{Rad} ($\times 10^{11}$)	%Ar ⁴⁰ _{atm}	
NVT-32/UT-220	Plagioclase	2.05082	0.623	4.458	20	40.8 $\pm$ 1.3
NVT-41/AH-26	Biotite	0.50165	7.01	46.924	42	38.2 $\pm$ 1.4
NVT-42/UT-219	Plagioclase	1.03473	0.90	2.617	77	16.7 $\pm$ 1.1
NVT-43/AH-38	Sanidine	0.50447	6.30	16.254	48	14.8 $\pm$ 0.6
NVT-45/UT-203	Biotite	0.51397	6.68	45.440	23	38.8 $\pm$ 1.3

Constants Used:

$$\lambda_{\beta} = 4.962 \times 10^{-10}/\text{yr.}$$

$$\lambda_{\epsilon} = 0.581 \times 10^{-10}/\text{yr.}$$

$$^{40}\text{K}/\text{K}_{\text{Tot.}} = 1.167 \times 10^{-4} \text{ atom/atom}$$

Figure 3. Index Map for the Magic Reservoir Area, Idaho.

Table 7. Samples from the Magic Reservoir Area, Idaho.

Sample No.	Unit	Material Dated	Weight (gms.)	%K	Moles/gm		Age (M.Y.) $\pm 1\sigma$
					Ar ⁴⁰ _{Rad} (X10 ¹¹)	%Ar ⁴⁰ _{atm}	
ID/BE-10C-80/AH-45	Tmr ₄	Anorthoclase	0.21614	7.86	7.699	53	5.64 $\pm$ 0.23
ID/BE-21A-80/AH-44	Tmr _i	Sanidine	0.20200	6.19	5.123	75	4.77 $\pm$ 0.29
ID/BE-115-80S/AH-223	TOV	Anorthoclase	0.21061	4.58	4.626	88	5.81 $\pm$ 0.69

Constants Used:

$$\lambda_{\beta} = 4.962 \times 10^{-10}/\text{yr.}$$

$$\lambda_{\epsilon} = 0.581 \times 10^{-10}/\text{yr.}$$

$$^{40}\text{K}/\text{K}_{\text{Tot.}} = 1.167 \times 10^{-4} \text{ atom/atom}$$

the geology and geothermal setting reported by Struhsacker et al. (1981).

Montana

Table 8 records results of the dating of three samples for the Montana Geological Survey. This work was done in support of the State Coupled Program. No sample locations were furnished for these samples.

Washington

Table 9 lists the dating results for five samples for Dr. Paul Hammond of Portland State University. He is participating in a program sponsored by the Washington Geological Survey as part of the State Coupled Program. His project involves mapping in the Washington Cascades, and the dating was done to aid in geologic interpretation.

Oregon

During the past year an extensive dating program has been underway as part of the detailed geologic study of the Cascades by the Oregon Department of Geology and Mineral Industries. The results of this dating program are listed in Table 10. Figure 4 gives the location of various study areas listed in Table 10. Latitude and longitude of each sample are listed in Table 11 to aid in their location. Because of the importance of this large body of data and its potential use by geologists, the data will be published separately as an article for the journal "Isochron West" and will eventually be published as an extensive article outlining stratigraphic relations and geologic interpretation co-authored with personnel from the Oregon Department of Geology and Mineral Industries.

Table 8. Samples Dated for the Montana Geological Survey.

Sample No.	Unit	Material Dated	Weight (gms.)	%K	Ar ⁴⁰ _{Rad} (X10 ⁻¹¹)	%Ar ⁴⁰ _{atm}	Age (M.Y.) ± 1σ
8/9/80-2/UT-243	-	Biotite	0.50318	6.71	55.865	24	47.4 ± 1.6
7/19/80-3/AH-76	-	Anorthoclase	0.10117	5.16	34.618	90	38.3 ± 5.3
7/19/80-4/UT-252	-	Plagioclase	0.36422	0.68	5.620	74	47.0 ± 2.7

Constants Used

$$\lambda_B = 4.962 \times 10^{-10}/\text{yr.}$$

$$\lambda_E = 0.581 \times 10^{-10}/\text{yr.}$$

$$^{40}\text{K}/\text{K}_{\text{Tot.}} = 1.167 \times 10^{-4} \text{ atom/atom}$$

Table 9. Samples Dated for Portland State University, Oregon.

Sample No.	Unit	Material Dated	Weight (gms.)	%K	Moles/gm $\text{Ar}^{40}_{\text{Rad}} (\times 10^{11})$	% $\text{Ar}^{40}_{\text{atm}}$	Age (M.Y.) $\pm 1\sigma$
KA-6/UT-231	Ltl. Deer Pt.	W. R. Basalt	4.21810	0.540	0.087	98.4	0.93 ± 0.82
KA-7/AH-61	County Pk.	W. R. Basalt	3.00477	0.643	0.027	99.5	0.24 ± 0.71
KA-9/AH-52	Gilmore Cr.	W. R. Basalt	4.32458	0.498	0.152	95.0	1.76 ± 0.50
KA-10/AH-43	N. W. Lake	W. R. Basalt	Negative Age	---	---	---	---
KA-13/AH-53	Bear Prairie	W. R. Basalt	4.22626	0.838	0.223	89.0	1.53 ± 0.20

Constants Used:

$$\lambda_{\beta} = 4.962 \times 10^{-10}/\text{yr.}$$

$$\lambda_{\epsilon} = 0.581 \times 10^{-10}/\text{yr.}$$

$$^{40}\text{K}/\text{K}_{\text{Tot.}} = 1.167 \times 10^{-4} \text{ atom/atom}$$

Table 10. Samples Dated for Oregon Department of Geology and Mineral Industries.

Sample No.	Material Dated	Weight (gms.)	%K	Moles/gm Ar ⁴⁰ _{Rad} (X10 ¹¹)	%Ar ⁴⁰ _{atm}	Age (M.Y.) ± 1σ
<u>South Harney Basin Group</u>						
SH-105/UT-204	Whole Rock	0.53530	3.590	7.025	63	11.2 ± 0.5
SH-106/UT-194	Whole Rock	5.06988	0.502	0.959	89	11.0 ± 1.3
SH-106A(100)/AH-19	Whole Rock	2.52715	0.647	1.054	84	9.37 ± 0.80
SH-111/UT-214	Anorthoclase	0.91696	2.35	6.316	50	15.4 ± 0.6
SH-112/AH-35	Anorthoclase	0.61303	2.62	6.357	77	13.9 ± 0.9
SH-113/AH-15	Whole Rock	3.07666	0.743	1.035	84	8.01 ± 0.68
SH-12 (re-run)/UT-209	Whole Rock	3.13717	0.266	0.113	95	2.45 ± 0.72
<u>Rider Creek Group</u>						
Cougar Dam	Whole Rock	6.01058	0.237	0.669	87	16.2 ± 1.8
East/UT-193						
RI-28/AH-86	Whole Rock		0.52	0.734	95	8.1 ± 2.3
RI-85/AH-17	Plagioclase	2.91937	0.349	0.838	74	13.8 ± 0.8
RI-112/AH-14	Plagioclase	6.33873	0.208	0.414	65	11.4 ± 0.5
23 Tmw-Top/AH-18	Whole Rock	3.01778	1.12	1.726	39	8.80 ± 0.34
TmwL/AH-60	Whole Rock	2.14034	0.440	0.950	93	12.4 ± 2.5
Tpb/UT-198	Whole Rock	3.01174	0.365	0.529	61	8.34 ± 0.36
<u>Mosquito Creek Group</u>						
Foley Ridge/UT-200	Whole Rock	2.53109	0.548	0.193	95	2.03 ± 0.52
MO-159/UT-220	Whole Rock	2.51606	0.332	0.392	92	6.80 ± 1.18
MO-160/AH-49	Whole Rock	3.52186	0.357	0.476	89	7.67 ± 0.96
MO-ENG.-B/UT-232	Whole Rock	3.04494	0.191	0.340	86	10.2 ± 1.0
MO-ENG.-B/UT-241	Whole Rock	3.00675	0.191	0.319	81	9.6 ± 1.5
MB-133/UT-222	Whole Rock	2.50105	0.432	0.167	91	2.23 ± 0.37
<u>Powell Buttes</u>						
Pb-1/UT-216	Plagioclase	5.42370	0.125	0.192	91	8.83 ± 1.36
Pb-2/UT-210	Whole Rock	2.78989	0.295	0.305	96	5.95 ± 2.08
Pb-5/AH-34	Anorthoclase	0.74821	4.39	21.718	32	28.3 ± 1.0
DOGAMI-Bas81-1/UT-226	Whole Rock	3.01456	0.531	0.141	97	1.53 ± 0.77
DOGAMI-Bas81-2/UT-225	Whole Rock	0.61559	0.980	5.153	41	30.1 ± 1.1

Table 10. Cont.

Sample No.	Material Dated	Weight (gms.)	%K	Moles/gm Ar ⁴⁰ _{Rad} (X10 ¹¹)	%Ar ⁴⁰ _{atm}	Age (M.Y.) ± 1σ
<u>Burnt Bridge Group</u>						
BB-16/AH-79	Whole Rock	0.50396	0.810	3.489	83	24.7 ± 2.0
BB-30/UT-242	Whole Rock	1.01203	0.515	1.970	89	21.9 ± 2.9
BB-PAT-MT/AH-63	Whole Rock	2.00168	0.100	0.145	98	8.3 ± 5.5
BB-NSH/AH-62	Whole Rock	2.00336	0.241	0.668	97	15.9 ± 7.6
BB-Tpba/AH-64	Whole Rock	2.99927	1.18	0.114	95	0.56 ± 0.16
Stack/UT-199	Whole Rock	3.00758	0.540	2.074	65	22.0 ± 1.0
<u>Mount Hood Group</u>						
OMF-7A-3750/UT-224	Hornblende	4.22402	0.191	0.309	85	9.30 ± 0.87
MH-10/UT-227	Whole Rock	2.06258	0.793	1.469	64	10.6 ± 0.5
MH-19/AH-47	Whole Rock	1.20498	0.784	1.300	95	9.5 ± 2.4
MH-20/UT-228	Whole Rock	0.54535	1.89	3.983	90	12.1 ± 1.7
LCM/UT-240	Whole Rock	3.00043	0.801	1.495	68	10.7 ± 0.5
LCM/AH-48	Whole Rock	3.50450	0.801	1.460	52	10.5 ± 0.4
<u>Pinto Creek Group</u>						
P-Notch/UT-239	Whole Rock	3.00645	0.863	0.147	96	0.98 ± 0.34
P-22/AH-73	Whole Rock	1.00579	0.71	0.244	89	1.98 ± 0.25
P-319/UT-260	Whole Rock		0.43	1.299	66	1.73 ± 0.8
P-324/AH-85	Whole Rock		0.94	0.903	81	5.53 ± 0.41
<u>Tumblebug Creek Group</u>						
T-10/UT-254	Whole Rock	0.81442	1.10	2.984	53	15.6 ± 0.6
T-14/UT-247	Whole Rock	0.99846	0.66	1.957	72	17.0 ± 0.9
T-208/AH-74	Whole Rock	2.12096	0.62	0.083	95	0.77 ± 0.21
T-210/AH-75	Whole Rock	2.40220	0.81	0.024	99	0.17 ± 0.48
T-211/UT-251	Whole Rock	2.50101	0.68	0.115	97	0.97 ± 0.46
T-FIZZ/UT-250	Whole Rock	1.09376	0.80	1.964	74	14.1 ± 0.8

Constants Used:

$$\lambda_{\beta} = 4.962 \times 10^{-10}/\text{yr.}$$

$$\lambda_{\epsilon} = 0.581 \times 10^{-10}/\text{yr.}$$

$$40\text{K}/\text{K}_{\text{Tot.}} = 1.167 \times 10^{-4} \text{ atom/atom}$$

Figure 4. Index Map of Study Areas in the State of Oregon.
MH; Mount Hood, Ri; Rider Creek, Mo; Mosquito Creek, Pb;
Powell Buttes, BB; Burnt Bridge, P; Pinto Creek, Tj;
Tumblebug Creek, SH; South Harney.

Table 11. Latitude and Longitude of Samples Dated for
Oregon Department of Geology and Mineral and Industries.

South Harney Basin

SH-105/UT-204	43°14'45" N, 118°30'55" W
SH-106/UT-194	43°31'53" N, 118°30'54" W
SH-106A/AH-19	43°21'45" N, 118°30'05" W
SH-111/UT-214	43°44'15" N, 118°31'38" W
SH-112/AH-35	43°35'27" N, 118°31'38" W
SH-113/AH-15	43°08'13" N, 118°53'06" W
SH-12/UT-209	43°15'40" N, 118°50'22" W

Rider Creek Group

Cougar Dam East/UT-193	44°07'44" N, 122°14'10" W
RI-28/AH-86	44°07'05" N, 122°12'54" W
RI-85/AH-17	44°06'13" N, 122°17'40" W
RI-112/AH-14	44°06'59" N, 122°11'41" W
Tmw-Top/AH-18	44°12'12" N, 122°11'41" W
Tmw1/AH-60	44°06'31" N, 122°13'33" W
Tpb/UT-298	44°12'26" N, 122°11'30" W

Mosquito Creek Group

Foley Ridge/UT-200	45°10'47" N, 122°16'37" W
MO-159/UT-220	44°04'30" N, 122°00'47" W
MO-160/AH-49	44°04'32" N, 122°01'09" W
MO-ENG.-B/UT-232	44°04'02" N, 122°03'28" W
MO-ENG.-B/UT-241	44°04'02" N, 122°03'28" W
MB-133/UT-222	44°10'28" N, 122°06'12" W

Powell Buttes

Pb-1/UT-216	44°14'28" N, 121°03'08" W
Pb-2/UT-210	44°15'42" N, 121°04'47" W
Pb-5/AH-34	44°11'36" N, 121°00'11" W
DOGAMI-Bas81-1/UT-226	44°09'35" N, 121°03'06" W
DOGAMI-Bas81-2/UT-225	44°11'39" N, 121°03'06" W

Table 11. Cont.

Burnt Bridge Group

BB-16/AH-79	43°48'01" N,	122°31'44" W
BB-30/UT-242	43°48'45" N,	122°33'30" W
BB-PAT-MT/AH-63	43°45'40" N,	122°37'25" W
BB-NSH/AH-62	43°49'30" N,	122°31'50" W
OB-Tpba/AH-64	43°50'16" N,	122°37'02" W
Stack/UT-199	43°48'53" N,	122°32'10" W

Mount Hood Group

OMF-7A-3750/UT-224	45°23'46" N,	121°48'26" W
MH-10/UT-227	45°23'49" N,	121°48'14" W
MH-19/AH-47	45°23'43" N,	121°52'01" W
MH-20/UT-228	45°23'42" N,	121°52'01" W
LCM/UT-240	45°23'42" N,	121°52'01" W
LCM/AH-48	45°23'50" N,	121°49'51" W

Pinto Creek Group

P-Notch/UT-239	43°33'53" W,	122°11'35" W
P-22/AH-73	43°36'07" W,	122°13'53" W
P-319/UT-260	43°32'49" W,	122°15'01" W
P-324/AH-86	43°32'57" W,	122°17'09" W

Tumblebug Creek Group

T-10/UT-254	43°28'19" W,	122°17'00" W
T-14/UT-247	43°30'58" W,	122°16'32" W
T-208/AH-74	43°29'06" W,	122°18'06" W
T-210/AH-75	43°29'30" W,	122°15'41" W
T-211/UT-251	43°28'53" W,	122°15'35" W
T-FIZZ/UT-250	43°29'17" W,	122°16'25" W

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