

TOPICAL REPORT

MASTER

SUMMARY OF POTASSIUM/ARGON

AGE DATING - 1979

by

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ABSTRACT

During FY-79 the K/Ar dating laboratory at the Department of Geology and Geophysics of the University of Utah became operational. During the past calendar year forty-seven dates have been produced from areas predominantly in Utah. Dating has also been done in support of University of Utah Research Institute/Earth Sciences Laboratory programs on areas in Nevada and Montana through the State-Coupled program and Case Studies Support program.

Areas in which activity was concentrated include:

Cove Creek Domes/ Twin Peaks Area, SW Utah. Here volcanic activity spanned the time from 2.74 to 2.35 M.Y., with a mean age of 2.50 ± 0.14 M.Y.

Black Rock Desert, SW Utah. Two dates on a single flow indicate an age of 1.49 ± 0.08 M.Y. for a flow previously undated.

Wildcat Creek Area, SW Utah. Dating of rhyolite flows from this area gives a mean age of volcanism of 9.25 ± 0.16 M.Y., considerably older than previously inferred by the work of Haugh (1978).

Mineral Mountains Pluton, SW Utah. Twelve dates on phases of the pluton indicate a complex history of intrusion, and more work is indicated in order to derive a coherent picture of the magmatic events leading to the formation of this batholith.

Blackfoot Reservoir, Idaho. Two dates on rhyolite domes, previously undated, give ages of 1.56 ± 0.06 M.Y. and 1.28 ± 0.15 M.Y.

In addition to the previous dating activity, ages of units in areas of interest in Nevada have been obtained. These areas include

Beowawe, San Emidio, and Soda Lake. This work was done under the Industry Coupled Program. Four samples were also dated for the Montana Geological Survey as part of the State Coupled Program.

INTRODUCTION

The purpose of this summary report is to present radiometric ages produced as part of the geothermal research program at the University of Utah during the past year. Much of the age dating work comprises only a portion of larger geologic studies so it seems appropriate to summarize the geochronologic data here, leaving geologic interpretation to be included in separate reports on the individual projects.

The capability to produce potassium/argon age dates has only recently been acquired by the Department of Geology and Geophysics of the University of Utah. The system became fully operational during the spring of 1979. Most initial extractions were calibration runs, and the first actual dating of unknowns began late in the spring. Since that time about seventy-five dates have been produced by the lab, most of which pertain to geothermal research.

EXPERIMENTAL METHOD

In our laboratory the following procedure is followed for sample preparation and potassium and argon analyses:

Minerals and whole-rock samples are prepared in a mineral separation laboratory. Minerals are separated using standard techniques such as heavy liquids, shaker table and magnetic separators. Whole-rock samples are crushed, split and cleaned in phosphoric acid to remove surface contamination and calcite.

Potassium and argon analyses are performed on separate aliquots. Potassium is analysed using a potassium metaborate fusion technique

described in Ingamells (1964), Suhr and Ingamells (1966) and Nash and Crecraft (1977). This method takes samples into solution via a lithium metaborate flux, which also serves as an internal standard. The fusion beads are then dissolved and diluted to a standard volume. Potassium is then determined on a flame photometer using in-house standard rock powders and minerals.

Argon analyses are accomplished using isotope dilution techniques described by Dalrymple and Lanphere (1969). The procedure followed for extraction of argon from samples is that of Evernden and Curtis (1965) with minor modifications. Basically, a rock or mineral sample is fused using an R.F. induction furnace, the argon and other gases being released upon fusion. The reactive gases are removed as follows: Water is absorbed by zeolite; hydrogen is oxidized to water with a copper oxide furnace and then absorbed on zeolite; CO₂ is absorbed by a copper metal furnace, and nitrogen is absorbed by titanium/zirconium metals in a furnace operated at 450°C. The copper/copper oxide furnace is operated at 850°C. The inert gases that remain, principally argon, are collected on charcoal at liquid nitrogen temperature and removed from the extraction line with a glassblower's torch. Argon samples are attached then to the inlet system of the mass spectrometer and subsequently analysed for the amount of radiogenic argon present in each sample.

An attempt has been made to assess the precision and accuracy of age determinations in our laboratory. The precision of potassium analyses is about 0.5 percent of the amount present typically. Accuracy is satisfactory as determined by comparison of results with

that of other laboratories and data from Flanagan (1976). The precision of argon determinations appears to be around 0.5 to 1 percent of the amount present, based on the results from replicated samples. Accuracy is judged satisfactory based on comparison of dates produced in our laboratory with dates on the same rock units produced by others. These comparisons indicate on the order of 1-2 percent random discrepancy between our laboratory and other results from U.S.G.S. laboratories and the K/Ar laboratory of the University of California at Berkeley.

RESULTS TO DATE

1. Cove Creek Domes/Twin Peaks Area, SW Utah.

This area has been the subject of study for the last two years as part of a comparative study in conjunction with the extensive work at Roosevelt Hot Springs KGRA just to the south. Figure 1 shows the location of this area with respect to other important locations in the vicinity. Table 1 lists the dates thus far obtained on various rhyolitic units from this area. Briefly these dates indicate a complex history of magma evolution based on chemical data. This chemical data suggests a systematic change in magma composition representing successive tapings of a single magma chamber. The description of the geologic evolution of this area will be the subject of a separate report, but it is important to stress that the geochronologic constraints placed on the rock units of this region will play an extremely important role in delineating the space-time evolution of the magma system of the Cove Creek Domes/Twin Peaks

Figure 1. Index map of locations where samples were dated from Utah.

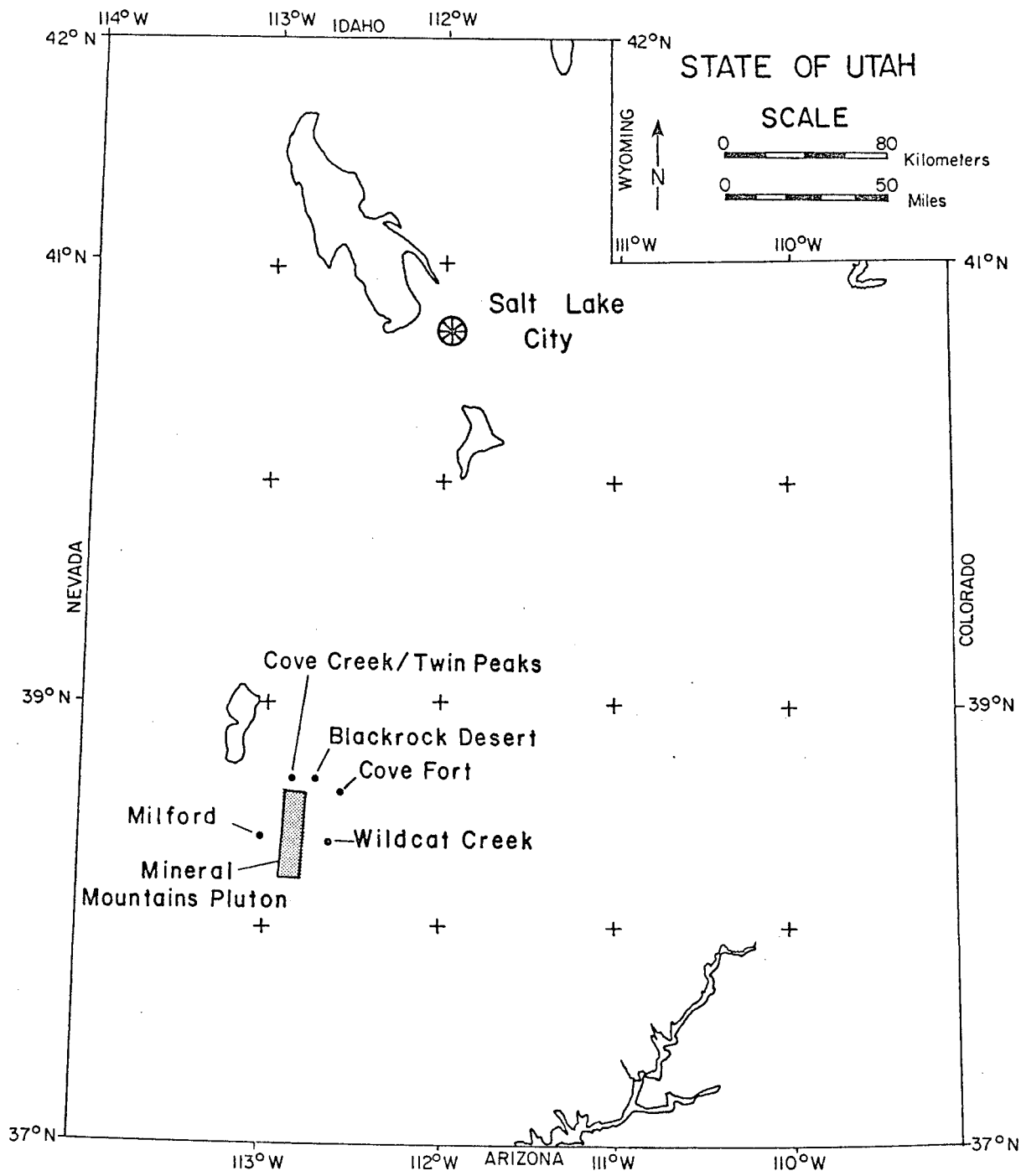


Table 1: Ages-Cove Creek Domes/Twin Peaks, SW Utah

Sample No.	Unit	Material Dated	Weight (gms).	%K	Moles/gm Ar ⁴⁰ _{Rad} (X10 ¹¹)	%Ar ⁴⁰ _{atm}	Age (M.Y.)
CC77-4	-	Sanidine	5.03561	7.56	3.175	24	2.35 ± 0.08
CC77-8	-	Sanidine	5.00946	9.38	3.830	24	2.35 ± 0.08
CC77-9	-	Obsidian	4.18221	4.36	1.986	46	2.63 ± 0.10
CC77-15	-	Sanidine	2.84346	4.91	2.335	38	2.74 ± 0.10
CC77-18	-	Obsidian	5.15987	3.99	1.758	42	2.54 ± 0.09
CC77-19	-	Obsidian	4.27443	4.11	1.733	66	2.43 ± 0.12
CC77-20	-	Sanidine	3.00774	8.523	3.720	21	2.51 ± 0.08
CC78-30	-	Sanidine	4.04411	8.267	3.491	22	2.43 ± 0.08
Mean Age (±one sigma)							2.50 ± 0.14

Constants Used:

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

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

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

region.

An important conclusion which can be reached independently of the magma systematics is that activity took place in the interval 2.74 M.Y. to 2.35 M.Y. ago with a mean age of volcanism of 2.50 ± 0.14 M.Y. No rhyolitic volcanic activity has been detected since this time. Therefore, the Cove Creek Domes/Twin Peaks area is of minimal importance as a source of high temperature geothermal fluids although low temperature resources are yet to be assessed adequately.

2. Black Rock Desert, SW Utah.

Two dates have been obtained on samples of basalt from the Black Rock Desert area just east of Cove Creek Domes/Twin Peaks (see Figure 1). This area has been under study by Nash (1979). Geologic mapping and petrologic study in this area is part of the program for geologic technique development and is important in completing the regional geologic picture of the environs of the Roosevelt Hot Springs and Cove Fort/Sulphurdale KGRA's as well as focusing on an area in which the most recent episodes of volcanism in Utah (800 years old) are found. This would indicate a possible potential for low temperature applications which are yet to be evaluated. The dates thus far obtained for this area are given in Table 2.

3. Wildcat Creek Area, SW Utah.

This area was the subject of a recent report (Haugh, 1978) in which the age of volcanism was speculated to be as recent as Quaternary. Dating of rocks from the area was undertaken so as to determine the age of the volcanics in order to assess any geothermal

Table 2: Ages - Blackrock Desert Basalts, SE Utah

Sample No.	Unit	Material Dated	Weight (gms).	%K	Moles/gm Ar ⁴⁰ _{Rad} (X10 ¹¹)	%Ar ⁴⁰ _{atm}	Age (M.Y.)
BRD77-20	-	Whole rock	2.73712	2.17	0.579	91	1.54 ± 0.22
BRD77-23	-	Whole rock	2.57650	2.25	0.558	81	1.43 ± 0.11

Constants Used:

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

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

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

potential that might be associated with the speculated Quaternary volcanic episode. Dates on samples collected are given in Table 3, and the location of the area is shown in Figure 1. As can be seen, the age of volcanism in this area is 9.25 ± 0.16 M.Y. This would indicate the area to be of low geothermal potential. Two samples, WCC77-3 and WCC77-8, have anomalously young ages, and detailed work indicates argon loss has been suffered by these samples upon weathering. Thus, it is felt that all volcanic units of this area are contemporary. An expanded report on this area including chemical data will be prepared at a later date.

4. Mineral Mountains Pluton, SW Utah.

Mapping of the pluton in the Mineral Mountains was undertaken two years ago by personnel of the University of Utah Research Institute/Earth Sciences Laboratory. Figure 1 shows the location of this area. In cooperation with this effort as well as an extension of field work done by personnel of the Department of Geology and Geophysics of the University of Utah (Bowers, 1978) dating of samples from the area have been undertaken. Four dates from the pluton done on material produced by departmental field work are given in Table 4. Table 5 lists dates completed for materials collected during University of Utah Research Institute/Earth Sciences Laboratory field work. No attempt will be made here to describe the ramifications of the dating. It is obvious that work to date indicates a complex history of magmatism in the Mineral Mountains area, and further work is anticipated in FY 80. To this end a cooperative program has been

Table 3: Ages of Wildcat Creek Rhyolite, SE Utah

Sample No.	Unit	Material Dated	Weight (gms).	%K	Moles/gm Ar ⁴⁰ _{Rad} (X10 ¹¹)	%Ar ⁴⁰ _{atm}	Age (M.Y.)
WCC 77-3	Rhyolite of Gillies Hill	Biotite	0.93724	6.41	7.747	67	6.96 ± 0.35
WCC 77-6	Vitrophyre	Sanidine	0.70982	8.35	13.672	28	9.42 ± 0.31
WCC 77-7	Rhyolite	Biotite	0.86234	6.78	10.869	68	9.22 ± 0.46
WCC 77-8	Rhyolite	Biotite	0.85650	7.01	9.758	56	8.00 ± 0.32
WCC 79-1	Rhyolite	Biotite	0.81178	7.11	11.266	79	9.11 ± 0.65
Mean age (± one sigma)							9.25 ± 0.16

Constants Used:

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

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

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

Table 4: Mineral Mountains Pluton.

Sample No.	Unit	Material Dated	Weight (gms).	%K	Moles/gm Ar ⁴⁰ _{Rad} (X10 ¹¹)	%Ar ⁴⁰ _{atm}	Age (M.Y.)
GC-2	Tqm	Biotite	0.39125	7.17	25.983	60	20.8 ± 0.4
GC-8	Tqm	Biotite	0.39957	7.17	18.333	57	14.7 ± 0.6
GC-10B	Tqm	Biotite	0.41048	6.86	19.832	35	16.6 ± 0.6
GR-II	Tg	Biotite	0.37862	7.74	20.490	54	15.2 ± 0.6

Constants Used:

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

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

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

Table 5: Mineral Mountains Pluton; Dates for ESL.

Sample No.	Unit	Material Dated	Weight (gms).	%K	Moles/gm Ar ⁴⁰ Rad (X10 ¹¹)	%Ar ⁴⁰ atm	Age (M.Y.)
UT/MM79-1	Tgr	Biotite	0.87306	6.61	13.736	28	11.9 ± 0.4
UT/MM79-2	Tmd	Actinolite	3.07359	0.24	2.251	64	53.1 ± 2.4
UT/MM79-3	Tmd	Biotite	0.88416	6.02	13.039	43	12.4 ± 0.5
		Hornblende	1.80856	1.57	5.134	49	18.8 ± 0.7
UT/MM79-5	Trd	Whole Rock	1.52316	4.10	6.462	50	9.06 ± 0.34
UT/MM79-7	PEn	Biotite	0.78108	7.40	12.925	58	9.80 ± 0.42
		Hornblende	3.40752	0.59	0.301	51	29.2 ± 1.1
UT/MM79-8	PEn	Biotite	0.78276	7.39	13.381	25	10.4 ± 0.4
		Hornblende	6.24152	0.78	2.964	35	21.8 ± 0.8
UT/MM79-10	PCbg	Biotite	0.77447	7.60	13.016	47	9.85 ± 0.36
UT/MM78-170	PCgn	Biotite	0.79213	7.40	12.666	50	9.86 ± 0.37
		Hornblende	3.36818	0.78	3.986	27	29.4 ± 1.0

Constants Used:

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

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

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

undertaken by University of Utah Research Institute/Earth Sciences Laboratory with U.S.G.S. personnel to obtain Rb/Sr geochronologic data which may prove invaluable in sorting out the magmatic events in the plutonic complex.

5. Blackfoot Reservoir, Idaho.

As part of a thesis project in the Department of Geology and Geophysics of the University of Utah (Hutsinpillar, 1979) dating of two rhyolite domes was undertaken. The location of this area is shown in Figure 2. The ages of these domes indicate that they are contemporaneous with other domes to the south lying within the Blackfoot Reservoir. Table 6 presents age data for the two domes.

6. Earth Sciences Laboratory Support.

In addition to the dating tabulated thus far, various samples have been dated as part of geologic support for Earth Sciences Laboratory programs such as the State Coupled program, Industry Coupled program, and the case study of Roosevelt Hot Springs KGRA.

Table 7 lists four samples dated for the Montana Geological Survey; Table 8 lists dates on samples from Beowawe Area, Nevada; Table 9 includes dates on samples from San Emidio, Nevada; and Table 10 includes dates on samples from Soda Lake, Nevada. As all the above work will be included in other reports originated by ESL, no further description is offered here.

CONCLUSIONS

The past year has seen the K/Ar laboratory brought on line with

Figure 2. Index map showing sample locations near Blackfoot Reservoir, Idaho.

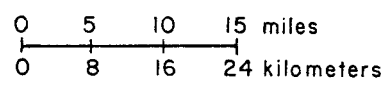
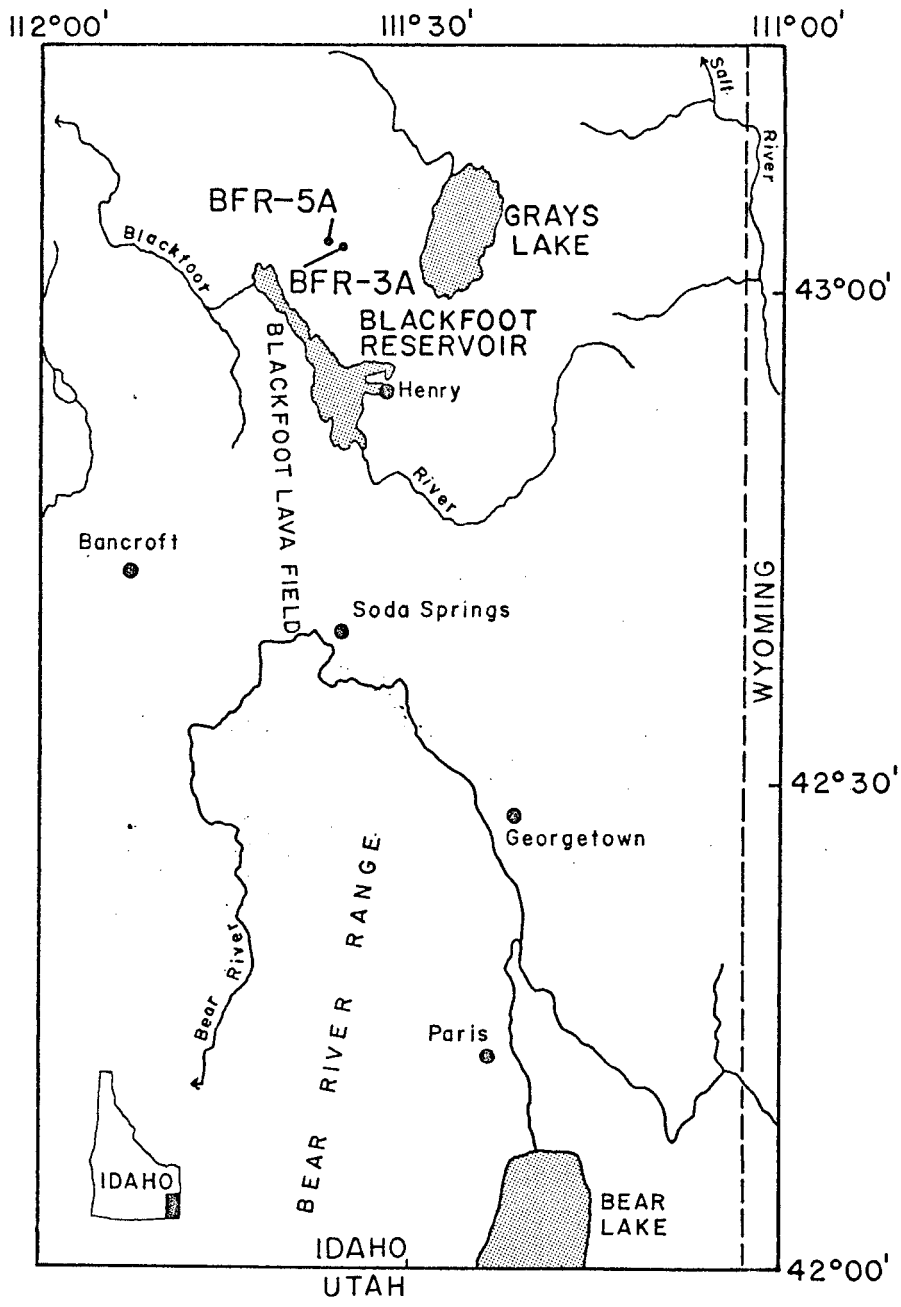


Table 6: Samples from Blackfoot Reservoir, Idaho

Sample No.	Unit	Material Dated	Weight (gms).	%K	Moles/gm Ar ⁴⁰ _{Rad} (X10 ¹¹)	%Ar ⁴⁰ _{atm}	Age (M.Y.)
BFR-3A	Rhyolite	Sanidine	0.79201	9.15	2.476	56	1.56 ± 0.06
BFR-5A	Rhyolite	Sanidine	0.92494	7.81	1.728	87	1.28 ± 0.15

Constants Used:

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

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

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

Table 7: Sample for Montana Geological Survey.

Sample No.	Unit	Material Dated	Weight (gms).	%K	Moles/gm Ar ⁴⁰ _{Rad} (X10 ¹¹)	%Ar ⁴⁰ _{atm}	Age (M.Y.)
URRL-1	Ash	Sanidine	3.87410	7.49	2.663	27	2.05 ± 0.07
URRL-2	Basalt	Whole Rock	7.91633	0.36	0.122	93	1.95 ± 0.35
URRL-3	Ash	Sanidine	2.50269	7.45	2.711	35	2.09 ± 0.07
LRRL-1	Basalt	Whole Rock	1.98774	1.53	8.222	54	30.8 ± 1.2

Constants Used:

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

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

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

Table 8: Samples from Beowawe, Nevada,

Sample No.	Unit	Material Dated	Weight (gms).	%K	Moles/gm Ar ⁴⁰ Rad (X10 ¹¹)	%Ar ⁴⁰ atm	Age (M.Y.)
615.11	-	Biotite	0.34495	6.71	45.610	24	38.8 ± 1.3
620-2(1)	-	Whole Rock	3.32479	1.27	3.659	53	16.6 ± 0.7
620-2(2)	-	Whole Rock	3.01703	1.27	3.692	61	16.7 ± 0.7
4/25-3	-	Whole Rock	5.06662	0.76	2.172	69	16.3 ± 0.8

Constants Used:

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

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

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

Table 9: Samples from San Emidio, Nevada.

Sample No.	Unit	Material Dated	Weight (gms).	%K	Moles/gm Ar ⁴⁰ _{Rad} (X10 ¹¹)	%Ar ⁴⁰ _{atm}	Age (M.Y.)
SEnev 1B-79	-	Amphibole	1.01336	2.41	6.527	66	15.5 ± 0.7
SEnev 1C-79	-	Amphibole	1.92342	0.55	1.708	50	17.7 ± 0.7
SEnev 7D-79	-	Amphibole	1.93671	0.54	1.485	84	15.7 ± 1.4
SEnev 34-79	-	Plagioclase	3.09707	0.66	1.879	28	16.2 ± 0.5

Constants Used:

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

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

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

Table 10: Samples from Soda Lake, Nevada.

Sample No.	Unit	Material Dated	Weight (gms).	%K	Moles/gm Ar ⁴⁰ Rad (X10 ¹¹)	%Ar ⁴⁰ atm	Age (M.Y.)
Nevco 79-1	Basalt	Whole Rock	16.35844	2.17	0.387	63	1.03 ± 0.05
Nevco 79-5	Basalt	Whole Rock	7.67900	1.28	1.546	76	6.96 ± 0.42

Constants Used:

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

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

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

the support of the Department of Energy. Recently, construction of a second extraction line was initiated and when operational will boost output considerably. It is anticipated that in the future adequate support will be available for all anticipated programs of both Earth Sciences Laboratory and the University of Utah. Turn-around time for individual samples will probably be on the order of two to three months until the present backlog is cleared this spring.

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