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**GEOHERMAL RESOURCE ASSESSMENT IN THE
ALEUTIAN ISLANDS AND ALASKA PENINSULA**

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by

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Whole Rock Chemical Analyses

Thirty-five samples were selected and prepared in Fairbanks for X-ray fluorescence spectroscopy at U.C. Santa Cruz, as discussed in our previous quarterly report. Analytical work is in progress and we expect to have the results in time for the next quarterly report.

K-Ar Dating

We have now completed dating work on 20 rock samples. Analytical results for the dated samples are given in the enclosed table. The results are generally in good agreement with observed stratigraphic relationships and provide a well-constrained time framework for the eruptive history of this volcanic area.

The youngest, valley-filling flows (Qrf) from Mt. Recheshnoi proved too young for us to date, but three of the upper cone-building flows, (Qra) from this volcano yielded ages of 75,000, 121,000 and 110,000 years. Lower in the Qra section, we obtained an age of 258,000 years from the NE side of Geyser Creek Valley, and ages of 285,000 and 478,000 years from flows sampled above Hot Springs Cove.

Basal Recheshnoi flows sampled on the SW side of Geyser Creek Valley gave ages of 489,000, 534,000 and 499,000 years. We thus have radiometric ages for Mt. Recheshnoi flows extending from $75,000 \pm 11,000$ to $534,000 \pm 13,000$ years at the base of the section.

One sample (88GPU07) from a rhyolite plug intruding the Qra unit at Russian Bay has yielded datable biotite. The argon extraction and potassium analyses are completed and the argon sample is awaiting mass spectrometry.

A sample from the quartz-olivine andesite flow unit (Qrq) overlying Qra above Hot Springs Cove was dated at $176,000 \pm 11,000$ years.

The volcanic flows of central Umnak (QTV) underlie the Qra unit. Their attitudes indicate source vents north of Geyser Creek Valley. Five samples from the QTV unit

range from $786,000 \pm 21,000$ in the upper part of the section to $1,124,000 \pm 48,000$ at the base of the section. An additional sample near the top of the section above Hot Springs Cove yielded a minimum age of 426,000 years.

Pyroclastic rocks (QTvp) at Stepanof Cove, presumed to be equivalent in part to the QTV unit, yielded ages of $1,099,000 \pm 33,000$ and $1,368,000 \pm 54,000$ years. These ages are in good agreement with our ages from the basal part of the QTV unit at the southwest side of Geyser Creek Valley.

Two thin dikes intruding the pyroclastic (QTvp) unit at Stepanof Cove gave ages of $1,365,000 \pm 41,000$ and $1,613,000 \pm 56,000$ years. It appears that these quickly-cooled samples may contain excess argon.

A sample of the plutonic rock (Tdp) that underlies the dated volcanic unit is in progress for dating and is expected to yield biotite and hornblende ages. We expect all K-Ar dating for this project to be completed in time for the next quarterly report.

In addition to documenting the eruptive history of Umnak volcanoes, the K-Ar ages will provide a time framework for the chemical evolution of the magmatic system, when combined with the rock chemistry analyses presently in progress at U.C., Santa Cruz.

Table 1: Analytical Data for K-Ar Age Determinations. Samples listed in approximate stratigraphic order.

Youngest Valley-Filling Rechesnoi Flows (Qrf)

Lab No.	Field No.	Project	Mineral	
88115	88CNU19	Geyser	WR	Insufficient radiogenic ^{40}Ar for age determination.
88115B	88CNU19	Geyser	WR	Insufficient radiogenic ^{40}Ar for age determination.

Upper Cone Building Flows, S. Flank Rechesnoi (Qra)

Lab No.	Field No.	Project	Mineral	K ₂ O (wt%)	Sample Weight (g)	^{40}Ar RAD (mol/g) $\times 10^{-11}$	$\frac{^{40}\text{Ar RAD}}{^{40}\text{K}} \times 10^{-3}$	% ^{40}Ar RAD	Age $\pm$ Sigma (M.Y.)
88101	88CNU85	Geyser	WR	.601 .617 Mean = .613	12.2853	.0057	.0038	.77	.065 $\pm$.011
88101B	88CNU85	Geyser	WR	.610 .617 Mean = .613	12.2853	.0076	.0050	1.02	$\bar{x}_2 =$.086 $\pm$.013 .075 $\pm$.011
88084	88CNU83	Geyser	WR	.877 .860 Mean = .869	11.5900	.0158	.0074	5.77	.127 $\pm$.006
88084B	88CNU83	Geyser	WR	.877 .860 Mean = .869	11.5900	.0146	.0068	5.34	$\bar{x}_2 =$.116 $\pm$.006 .121 $\pm$.006
88102	88CNU80	Geyser	WR	.880 .870 Mean = .875	11.7469	.0141	.0065	2.70	.112 $\pm$.010 Minimum Age
88102B	88CNU80	Geyser	WR	.880 .870 Mean = .875	11.7469	.0136	.0063	2.59	$\bar{x}_2 =$.108 $\pm$.008 .110 $\pm$.007 Minimum Age

Recheshnoi Flows, NE Side Geyser Creek Valley (Qra)

Lab No.	Field No.	Project	Mineral	K ₂ O (wt%)	Sample Weight (g)	⁴⁰ Ar RAD (mol/g) X 10 ⁻¹¹	$\frac{^{40}\text{Ar RAD}}{^{40}\text{K}} \times 10^{-3}$	% ⁴⁰ Ar RAD	Age ± Sigma (M.Y.)
88099Q	88CNU06	Geyser	WR	Mean = $\frac{1.223}{1.240}$ 1.232	10.0537	.0486	.0159	1.43	.274 ± .051
88099B	88CNU06	Geyser	WR	Mean = $\frac{1.223}{1.240}$ 1.232	10.0537	.0420	.0138	1.24	.237 ± .041
88099C	88CNU06	Geyser	WR	Mean = $\frac{1.223}{1.240}$ 1.232	10.0537	.0471	.0154	1.39	$\bar{x}_3 = \frac{.265 \pm .049}{.258 \pm .035}$

Recheshnoi Flows, Ridge Above Hot Springs Cove (Qra)

Lab No.	Field No.	Project	Mineral	K ₂ O (wt%)	Sample Weight (g)	⁴⁰ Ar RAD (mol/g) X 10 ⁻¹¹	$\frac{^{40}\text{Ar RAD}}{^{40}\text{K}} \times 10^{-3}$	% ⁴⁰ Ar RAD	Age ± Sigma (M.Y.)
88073	88CNU56	Geyser	WR	Mean = $\frac{1.553}{1.540}$ 1.547	10.2845	.0616	.0161	2.85	.277 ± .008
88073B	88CNU56	Geyser	WR	Mean = $\frac{1.553}{1.540}$ 1.547	10.2845	.0656	.0171	3.03	$\bar{x}_2 = \frac{.294 \pm .010}{.285 \pm .009}$
88100	88CNU57	Geyser	WR	Mean = $\frac{1.440}{1.460}$ 1.450	10.5823	.1014	.0282	6.34	.486 ± .015
88100B	88CNU57	Geyser	WR	Mean = $\frac{1.440}{1.460}$ 1.450	10.5823	.0983	.0274	6.15	$\bar{x}_2 = \frac{.471 \pm .014}{.478 \pm .012}$

Basal Recheshnoi Flows, SW Side Geyser Creek Valley (Qra)

Lab No.	Field No.	Project	Mineral	K ₂ O (wt%)	Sample Weight (g)	⁴⁰ Ar RAD (mol/g) X 10 ⁻¹¹	$\frac{^{40}\text{Ar RAD}}{^{40}\text{K}} \times 10^{-3}$	% ⁴⁰ Ar RAD	Age ± Sigma (M.Y.)
N/A	DT88-10 (540' Above Base)	Geyser	N/A	Dating in Progress	N/A	N/A	N/A	N/A	N/A
88107B	DT8814 (300' Above Base)	Geyser	WR	Mean = $\frac{1.653}{1.680}$ 1.667	9.0659	.1173	.0284	7.31	.489 ± .015
88107C	DT8814	Geyser	WR	Mean = $\frac{1.653}{1.680}$ 1.667	9.0659	.1173	.0284	7.31	$\bar{x}_2 = .489 \pm .015$.489 ± .015
88103	DT8816 (20' Above Base)	Geyser	WR	Mean = $\frac{1.200}{1.223}$ 1.212	10.3391	.0915	.0305	5.26	.525 ± .016
88103B	DT8816	Geyser	WR	Mean = $\frac{1.200}{1.223}$ 1.212	10.3391	.0945	.0315	5.43	$\bar{x}_2 = .542 \pm .016$.534 ± .013
88108	DT8817 (Base of Qra)	Geyser	WR	Mean = $\frac{1.190}{1.187}$ 1.189	10.8868	.0840	.0285	3.96	.491 ± .015
88108B	DT8817	Geyser	WR	Mean = $\frac{1.190}{1.187}$ 1.189	10.8868	.0867	.0294	4.09	$\bar{x}_2 = .506 \pm .015$.499 ± .012

Biotite Rhyolite Plugs Intruding Qra, Russian Bay (Qr)

Lab No.	Field No.	Project	Mineral	K ₂ O (wt%)	Sample Weight (g)	⁴⁰ Ar RAD (mol/g) X 10 ⁻¹¹	$\frac{^{40}\text{Ar RAD}}{^{40}\text{K}} \times 10^{-3}$	% ⁴⁰ Ar RAD	Age ± Sigma (M.Y.)
N/A	88GPU07	Geyser	N/A	Dating in Progress	N/A	N/A	N/A	N/A	N/A

Quartz-Olivine Andesite Flows Overlying Qra Above Hot Springs Cove (Qrq)

Lab No.	Field No.	Project	Mineral	K ₂ O (wt%)	Sample Weight (g)	⁴⁰ Ar RAD (mol/g) X 10 ⁻¹¹	$\frac{^{40}\text{Ar RAD}}{^{40}\text{K}} \times 10^{-3}$	% ⁴⁰ Ar RAD	Age ± Sigma (M.Y.)
88105	88CNU55	Geyser	WR	Mean = $\frac{1.250 + 1.270}{1.260}$	10.2996	.0340	.0109	1.96	.188 ± .009
88105B	88CNU55	Geyser	WR	Mean = $\frac{1.250 + 1.270}{1.260}$	10.2996	.0297	.0095	1.71	$\bar{x}_2 = \frac{.164 \pm .009 + .176 \pm .011}{2}$

Volcanic Flows of Central Umnak, Above Hot Springs Cove (QTV)

Lab No.	Field No.	Project	Mineral	K ₂ O (wt%)	Sample Weight (g)	⁴⁰ Ar RAD (mol/g) X 10 ⁻¹¹	$\frac{^{40}\text{Ar RAD}}{^{40}\text{K}} \times 10^{-3}$	% ⁴⁰ Ar RAD	Age ± Sigma (M.Y.)
88106Q	88CNU59 (Near top of QTV Section)	Geyser	WR	Mean = $\frac{1.543 + 1.557}{1.550}$	10.0698	.0950	.0247	14.04	.426 ± .013
88106B	88CNU59	Geyser	WR	Mean = $\frac{1.543 + 1.557}{1.550}$	10.0698	.0951	.0248	14.04	$\bar{x}_2 = \frac{.426 \pm .013 + .426 \pm .013}{2}$

Volcanic Flows of Central Umnak, NE Side Geyser Creek Valley (QTV)

Lab No.	Field No.	Project	Mineral	K ₂ O (wt%)	Sample Weight (g)	⁴⁰ Ar RAD (mol/g) X 10 ⁻¹¹	⁴⁰ Ar RAD ⁴⁰ K X 10 ⁻³	% ⁴⁰ Ar RAD	Age ± Sigma (M.Y.)
88076	88CNU02	Geyser	WR	.690 Mean = $\frac{.700}{.695}$	12.1284	.0805	.0468	6.74	.805 ± .024
88076B	88CNU02	Geyser	WR	.690 Mean = $\frac{.700}{.695}$	12.1284	.0768	.0446	6.42	$\bar{x}_2 = \begin{matrix} .767 \pm .023 \\ .786 \pm .021 \end{matrix}$
88104B	88CNU04	Geyser	WR	.653 Mean = $\frac{.643}{.648}$	10.7349	.0776	.0483	19.32	.832 ± .025
88104C	88CNU04	Geyser	WR	.653 Mean = $\frac{.643}{.648}$	10.7349	.0782	.0487	19.42	$\bar{x}_2 = \begin{matrix} .838 \pm .025 \\ .835 \pm .025 \end{matrix}$
88077	88CNU03	Geyser	WR	.770 Mean = $\frac{.780}{.775}$	12.1601	.0974	.0507	13.66	.873 ± .026
88077B	88CNU03	Geyser	WR	.770 Mean = $\frac{.780}{.775}$	12.1601	.0933	.0486	13.12	$\bar{x}_2 = \begin{matrix} .836 \pm .025 \\ .854 \pm .022 \end{matrix}$

Volcanic Flows of Central Unmak, SW Side Geyser Creek Valley (QTV)

Lab No.	Field No.	Project	Mineral	K ₂ O (wt%)	Sample Weight (g)	⁴⁰ Ar RAD (mol/g) X 10 ⁻¹¹	$\frac{^{40}\text{Ar RAD}}{^{40}\text{K}} \times 10^{-3}$	% ⁴⁰ Ar RAD	Age ± Sigma (M.Y.)
88110	DT885	Geyser	WR	.757 Mean = $\frac{.760}{.759}$	11.3441	.1234	.0657	7.33	1.130 ± .034
88110B	DT885	Geyser	WR	.757 Mean = $\frac{.760}{.759}$	11.3441	.1166	.0620	6.92	$\bar{x}_2 = \frac{1.068 \pm .048}{1.104 \pm .037}$
88111	DT887 (Base of QTV)	Geyser	WR	.713 Mean = $\frac{.720}{.717}$	6.1810	.1223	.0689	5.18	1.185 ± .036
88111B	DT887	Geyser	WR	.757 Mean = $\frac{.760}{.759}$	6.1810	.1102	.0621	4.66	$\bar{x}_2 = \frac{1.069 \pm .032}{1.124 \pm .048}$

Pyroclastic Rocks of Central Umnak, Stepanof Cove (QTVp)

Lab No.	Field No.	Project	Mineral	K ₂ O (wt%)	Sample Weight (g)	⁴⁰ Ar RAD (mol/g) X 10 ⁻¹¹	$\frac{^{40}\text{Ar RAD}}{^{40}\text{K}} \times 10^{-3}$	% ⁴⁰ Ar RAD	Age ± Sigma (M.Y.)
88113	88CNU53	Geyser	WR	.960 Mean = $\frac{.963}{.962}$	11.8437	.1522	.0639	21.41	1.099 ± .033
88117	DT8836	Geyser	WR	1.090 Mean = $\frac{1.083}{1.087}$	7.1607	.2247	.0835	8.09	1.436 ± .043
88117B	DT8836	Geyser	WR	1.090 Mean = $\frac{1.083}{1.087}$	7.1607	.2043	.0759	7.35	$\bar{x}_2 = \frac{1.306 \pm .039}{1.368 \pm .054}$

Dikes Intruding Pyroclastic Rocks of Central Umnak, Stepanof Cove

Lab No.	Field No.	Project	Mineral	K ₂ O (wt%)	Sample Weight (g)	⁴⁰ Ar RAD (mol/g) X 10 ⁻¹¹	⁴⁰ Ar RAD / ⁴⁰ K X 10 ⁻³	% ⁴⁰ Ar RAD	Age ± Sigma (M.Y.)
88114	DT8830	Geyser	WR	Mean = $\frac{1.070}{1.073}$ 1.072	10.8711	.2102	.0792	10.28	1.363 ± .041
88114B	DT8830	Geyser	WR	Mean = $\frac{1.070}{1.073}$ 1.072	10.8711	.2108	.0794	10.31	$\bar{x}_2 = 1.366 \pm .041$ 1.365 ± .041
88116	DT8830P	Geyser	WR	Mean = $\frac{1.080}{1.090}$ 1.085	5.7325	.2570	.0956	3.99	1.645 ± .060
881146B	DT8830P	Geyser	WR	Mean = $\frac{1.080}{1.090}$ 1.085	5.7325	.2454	.0913	3.81	$\bar{x}_2 = 1.571 \pm .077$ 1.613 ± .056

Plutonic Rocks, E Side of Geyser Bight (Tdp)

Lab No.	Field No.	Project	Mineral	K ₂ O (wt%)	Sample Weight (g)	⁴⁰ Ar RAD (mol/g) X 10 ⁻¹¹	⁴⁰ Ar RAD / ⁴⁰ K X 10 ⁻³	% ⁴⁰ Ar RAD	Age ± Sigma (M.Y.)
N/A	DT88-1A	Geyser	Biotite Hornblende	Dating in Progress	N/A	N/A	N/A	N/A	N/A

RAD = radiogenic, Sigma = standard deviation, WR = Whole Rock

Decay Constants: $\lambda_{\epsilon} + \lambda_{\epsilon 1} = 0.581 \times 10^{-10}/\text{yr.}$

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

⁴⁰K/K total = 1.167×10^{-4} mol/mol