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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Federal Center, Lakewood, Colorado 80225

SUMMARY OF CHEMICAL AND RADIOCHEMICAL MONITORING OF WATER FOR THE CANNIKIN EVENT, AMCHITKA ISLAND, ALASKA, FISCAL YEAR 1972

(Amchitka-38)
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Tracing (1) Amchitka Island, Alaska

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ABSTRACT

An increased dissolved-solids content was found immediately after the Cannikin event (November 6, 1971) at most of 10 locations in a water-sampling network established in 1967 and revised in September 1971. The observed dissolved-solids content increase was within the seasonal range that has been observed at these locations.

No measurable increase in radioactivity was detected as a result of the Cannikin event at the 72 locations monitored during fiscal year 1972. A measurable increase in gross beta/gamma activity was found in January 1972 which was correlated to a surface test of a nuclear device by a foreign nation.

INTRODUCTION

Amchitka Island is one of the westernmost islands comprising the Aleutian Island arc and is part of the State of Alaska. Amchitka's long axis trends northwest-southeast; the island is about 68 kilometers (42.5 miles) in length, and is about 7.2 kilometers (4.5 miles) in width at its widest point. The maximum elevation of Amchitka is about 365 meters (1,200 feet) at its highest point in the rugged mountains of the northwest part of the island. Amchitka was the site for three underground nuclear detonations. The Long Shot event was conducted on October 29, 1965, the Milrow event on October 2, 1969, and the Cannikin event on November 6, 1971.

A long-term monitoring program was established in 1967 to document the effect of nuclear testing on Amchitka Island by the U.S. Atomic Energy Commission. As part of the monitoring program a water-sampling network was established in 1967 and revised in September 1971 to aid in evaluating the effects of the Cannikin event on the hydrologic environment. The water-sampling network was sampled jointly by Teledyne Isotopes and the U.S. Geological Survey from 1967 through September 1971. The Geological Survey has conducted the water sampling since September 1971.

The network stations were sampled in September, November, and December 1971 and in January and April 1972. The surface- and shallow-ground-water samples were analyzed for tritium, gross alpha, and gross beta/gamma content; sea-water samples were analyzed for tritium. Water samples were collected at 10 island stations after the event for chemical analyses. Sea-water samples were collected from the shoreline to a distance of 6.4 kilometers (4.1 miles) from the island in August and November 1971 and April 1972 for tritium analysis. The techniques and procedures used for sample collection, identification, and analysis are described in Beetem, Washington, Janzer, and Schroder (1971) and in Schroder (1971). This report presents the chemical and radiochemical data from samples collected during fiscal year 1972.

HYDROLOGY

The annual precipitation on Amchitka is about 90 centimeters (35 inches). Most of the precipitation collects temporarily in the lakes and in thick ground cover and underlying peat before draining to the oceans via the streams.

The island has many small lakes and streams, and most of the land surface except for the steep-sided, rugged mountains on the northwest end has a rich growth of alpine-zone mosses and grasses. Most of the lakes are in the southeast part of the island and are confined by turf around the margins. Beds of silt and organic matter have reduced the permeability of the sides and bottoms of the lakes.

The water table is near the surface in most areas on the island. Water-level measurements made during hydraulic testing in shallow holes drilled at various locations on the island indicate that the bedrock is saturated.

HISTORIC DATA

Data obtained by the Geological Survey are reported in Beetem, Washington, Janzer, and Schroder (1971), Beetem, Young, Washington, and Schroder (1971); and Schroder and Ballance (1972a,b). Data obtained by Teledyne Isotopes, Palo Alto Laboratories are reported in Essington, Forslow, and Castagnola (1970, 1971).

Information contained in these reports indicates that the quality of surface and shallow ground water on the island has been affected only at the Long Shot site. Several months after the Long Shot event, the presence of tritium was detected in surface waters in the vicinity of the site. Further documentation of the effects of the Long Shot event on the tritium content in waters at the Long Shot site is reported by Castagnola (1969).

A comparison of the tritium content at the Long Shot site before and after the Cannikin event is given under the "Tritium" section of this report.

SAMPLING NETWORK

Figures 1, 2, and 3 show the locations of the sampling points in the network. Table 1 presents the radiochemical sampling stations, timetable, and types of analyses performed for the fresh water and shoreline sea-water sampling points. Table 2 presents the tritium sea-water sampling stations, and timetable for sample collection.

RESULTS

The quality-of-water data obtained by the Survey is presented in this report. Data related to the water-sampling network obtained by Eberline Instrument Corporation and Teledyne Isotopes, Westwood Laboratories, is summarized.

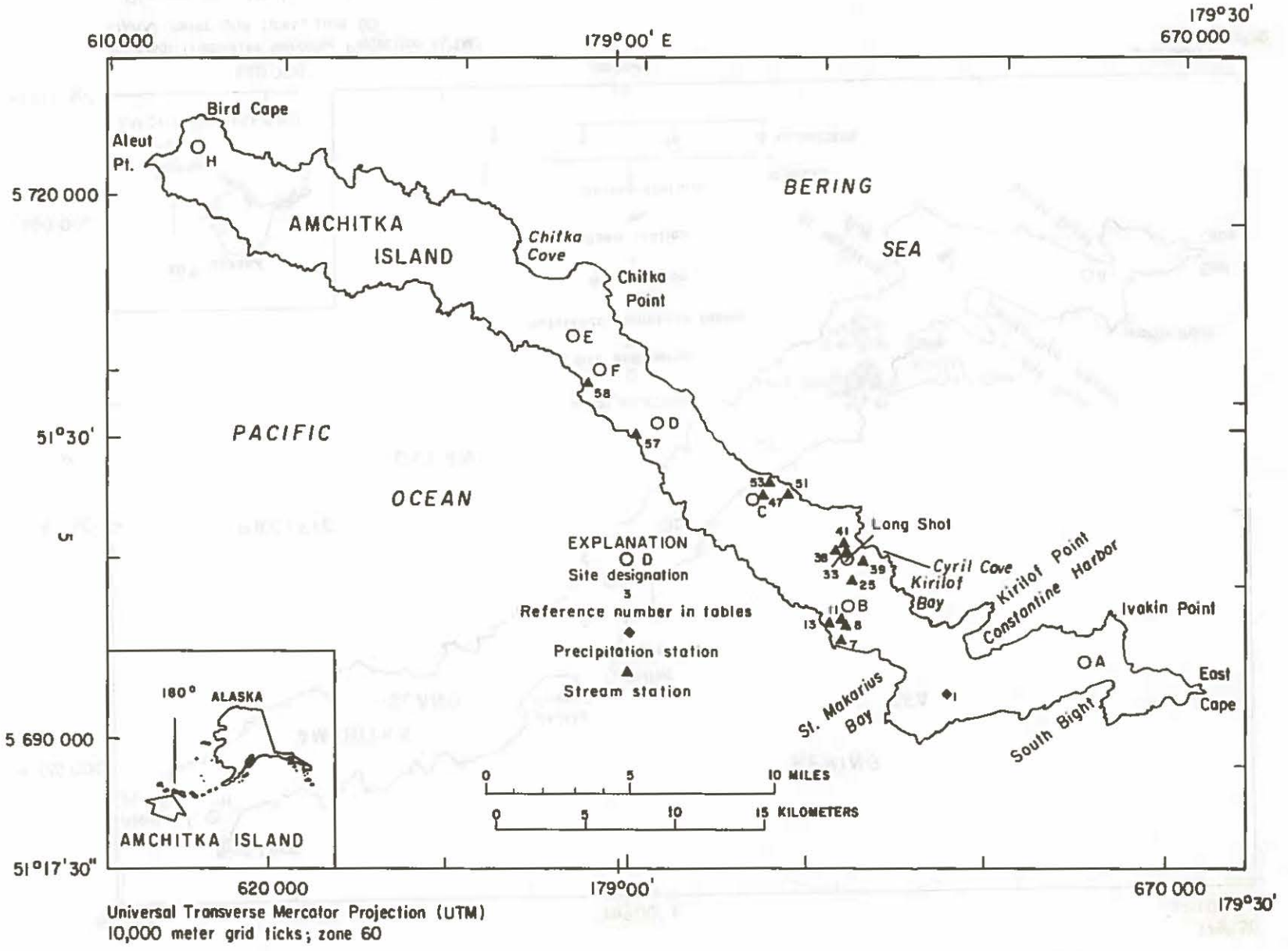

Figure 1.-- Precipitation and stream sampling stations for chemical and radiochemical monitoring, Amchitka Island, Alaska.

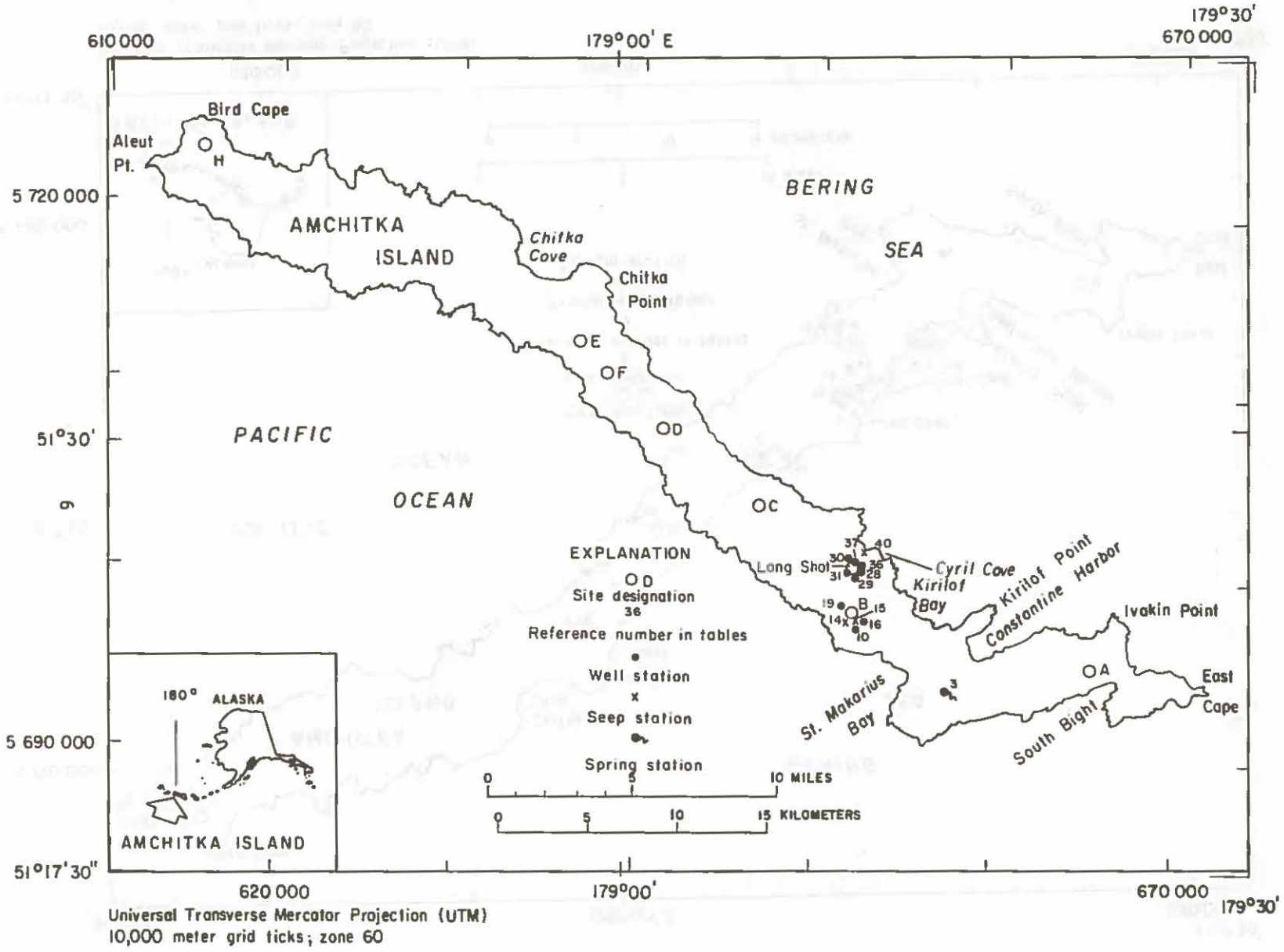

Figure 2.-- Well, spring, and seep sampling stations for chemical and radiochemical monitoring, Amchitka Island, Alaska.

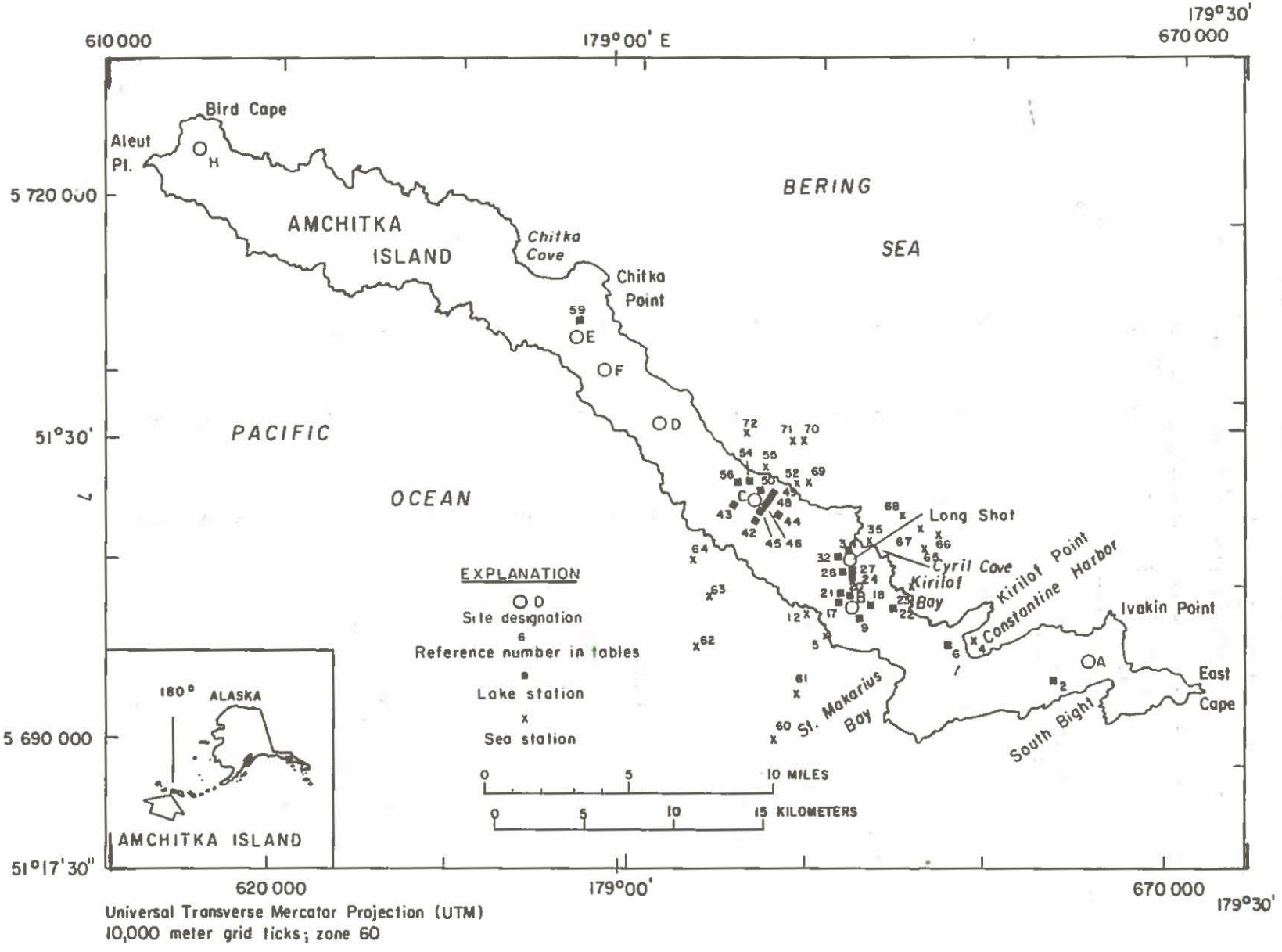

Figure 3.--Lake and sea sampling stations for chemical and radiochemical monitoring, Amchitka Island, Alaska.

Table 1.--Radiochemical sampling stations on Amchitka Island, Alaska, and collection timetable for Cannikin event

(S, stored; A, analyzed for gross alpha, gross beta/gamma, and tritium; T, analyzed for tritium; N, not collected; D, destroyed in shipment)

Ident. no.	Ref. no. 1/	Other identifying name	Collection timetable					
			Sept. D-60	Oct. D-15	Nov. D+15	Dec. D+30	Jan. D+60	Apr. D+120
PR93-57	1	Precipitation at South Hangar	S	S	T	T	T	T
LK94-62	2	Lake 145	S	N	A	A	A	A
SP94-56	3	Constantine Spring	S	T	A	A	A	A
OB96-58	4	Bering Sea	N	N	T	T	T	T
OP96-51	5	Pacific Ocean	N	N	T	N	T	T
LK96-57	6	Jones Lake	S	N	A	A	A	A
ST96-51	7	Clevenger Creek at road	S	N	A	A	A	A
ST97-51	8	Clevenger Creek at gage	S	T	A	A	A	A
LK97-52	9	Lake B-1	S	T	A	A	A	A
WE97-51	10	Well W-13	S	N	A	A	A	A
ST97-51A	11	Stream B-6	N	N	A	A	A	A
OP97-50	12	Pacific Ocean	N	N	T	T	T	T
ST97-50	13	Midden Creek	S	N	A	A	A	A
SE98-51	14	Seep B-13	S	N	A	A	A	A
SE98-51A	15	Seep B-18	S	N	N	A	N	A
WE98-51C	16	Well W-17	S	N	A	A	A	A
LK98-51B	17	Lake B-3	S	N	A	A	A	A
LK98-52A	18	Lake B-4	S	N	A	A	A	A
WE98-51K	19	Well W-11	S	N	A	A	T	A
LK98-51	20	Lake B-2	S	N	A	A	A	A
LK98-51A	21	Lake B-2A	S	N	A	A	A	A
LK98-53	22	Silver Salmon Lake	S	N	A	A	A	A
OB99-54	23	Bering Sea	N	N	T	T	T	T
LK00-52	24	Lake 130	S	T	N	N	N	N
ST00-51	25	Stream A-7	S	N	A	A	A	A
LK00-51B	26	Lake A-6	S	N	A	N	D	T
LK00-51A	27	Lake	S	N	A	A	A	A
WE00-51E	28	Well No. 10C	N	N	N	T	A	A
WE00-51	29	Well WL-2	S	N	T	T	A	A
WE00-51H	30	Well WL-1	T	N	T	N	A	A

Table 1.--Radiochemical sampling stations on Amchitka Island, Alaska, and collection timetable for Cannikin event--Continued

(S, stored; A, analyzed for gross alpha, gross beta/gamma, and tritium; T, analyzed for tritium; N, not collected; D, destroyed in shipment)

Ident. no.	Ref. no. 1/	Other identifying name	Collection timetable					
			Sept. D-60	Oct. D-15	Nov. D+15	Dec. D+30	Jan. D+60	Apr. D+120
WE00-51F	31	Well No. 8A	N	N	N	T	A	A
LK00-51	32	Lake	S	N	N	A	T	A
ST00-51B	33	Long Shot drainage ditch, A-2	S	N	A	A	A	A
LK00-51D	34	Long Shot mudpit, A-3	S	T	A	A	A	A
OB01-52A	35	Bering Sea (F-11)	N	N	T	T	T	T
WE00-51I	36	Well No. 3	T	N	N	N	N	N
WE00-51J	37	Well No. 7	T	N	N	N	N	N
ST01-51	38	Stream at weir 2	S	N	A	A	A	A
ST01-52	39	Stream at weir 1	S	N	A	A	A	A
SE01-52	40	Seep 3	N	N	A	A	T	A
ST01-51A	41	Bridge Creek at gage	S	T	A	A	A	A
LK02-46	42	Lake C-2	S	N	A	A	A	A
LK03-45	43	Lake	S	N	A	A	A	A
LK03-47	44	Lake	N	N	A	A	A	A
LK04-46C	45	Lake	N	N	A	A	A	A
LK04-46D	46	Lake	N	N	A	A	A	A
ST04-47A	47	White Alice Creek	N	N	A	A	N	N
LK04-46B	48	Lake	N	N	A	A	A	A
LK04-46F	49	Lake	N	N	A	A	A	A
LK04-46E	50	Lake	N	N	A	A	A	A
ST04-47	51	White Alice Creek at gage	S	T	A	A	A	A
OB05-47	52	Bering Sea at outlet of White Alice Creek	N	N	T	T	T	T
ST05-47	53	Stream	S	N	A	A	A	A
LK05-46	54	Lake	S	N	A	A	A	A
OB05-46	55	Bering Sea north of UA-1-HTH-1	N	N	T	T	T	T
LK05-45	56	Lake	S	N	A	A	A	A
ST07-40	57	Falls Creek at gage	N	T	T	N	A	A
ST09-36	58	Limpet Creek at gage	S	T	A	A	A	A
LK14-36	59	Lake E-2	N	N	A	A	A	A

1/ Reference numbers used for locations on figures 1, 2, and 3.

Table 2.--Offshore tritium sampling stations near Amchitka Island, Alaska, and collection timetable for Cannikin event

(T, analyzed for tritium; N, not collected or destroyed in shipment)

Ident. no.	Station no.	Ref. no. 1/	Collection timetable		
			August D-90	November D+15	April D+120
OP93-47	7	60	T	T	T
OP94-49	6	61	T	T	T
OP94-42	9	62	T	N	T
OP98-44	8	63	T	T	T
OP00-42	16	64	N	T	N
OB01-55	3	65	T	T	T
OB02-56	5	66	T	T	T
OB02-55	4	67	T	N	T
OB03-54	2	68	T	T	T
OP05-48	10	69	T	N	T
OB05-48	15	70	N	T	N
OB06-47	14	71	N	T	N
OB07-46	11	72	T	T	T

1/ Reference numbers used for locations on figures 1, 2, and 3.

Chemical Data

The chemical analyses reported in table 3 include some analyses of samples collected before fiscal year 1972 at each location for comparison. Samples were collected from 10 different locations after the Cannikin event, but only seven locations were sampled on a routine basis. Comparison of the data does not indicate any significant changes in the water quality. The stream and lakebed material was stirred by ground motion following the detonation, making this material available for circulation and leaching, and as expected, there was a slightly increased dissolved-solids content at the locations, except ST07-40 (Falls Creek), immediately after the event. However, the maximum observed increase of 40 percent was within the seasonal range normally found at these locations. Analyses of water samples collected in December 1971 (approximately 30 days after the event) indicated the chemical quality was no longer affected.

Gross Alpha

The gross alpha activity, natural uranium as calibrating standard, for the streams and lakes is graphically presented in figures 4 and 5; actual values are listed in table 4. Gross alpha activity in water on Amchitka Island after the event ranged from less than 0.1 to 2.6 pCi/l (picocuries per liter) which compares with a range of less than 0.1 to 23 pCi/l before the event, as reported by Beetem, Washington, Janzer, and Schroder (1971). Ninety-eight percent of the stream samples and 96 percent of the lake samples collected and analyzed after the event contained less than 2 pCi/l gross alpha activity.

Table 3.--Chemical analyses of water samples collected on Amchitka Island, Alaska

(Chemical analyses in milligrams per liter. <, less than)

Source and identification number	Ref. no. 1/	Latitude N.			Longitude E.			Date			Dissolved Silica (SiO_2)	Dissolved Aluminum (Al)	Dissolved Iron (Fe)	Dissolved Manganese (Mn)	Dissolved Magnesium (Mg)	Dissolved Calcium (Ca)	Dissolved Strontium (Sr)	Dissolved Lithium (Li)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Dissolved Sulfate (SO_4)	Dissolved Chloride (Cl)	Dissolved Fluoride (F)	Dissolved Nitrate (NO_3)	Dissolved Ortho Phosphate (PO_4)	Dissolved solids (residue at 180°C)	Hardness as $CaCO_3$		Specific conductance (micromhos/cm at 25°C)	pH (Units)
		Deg.	Min.	Sec.	Deg.	Min.	Sec.	M	D	Y																			Calcium, magnesium	Non carbonate		
SP94-56	3	51	22	43	179	14	59	04-25-70			12	<0.10	<0.15	0.01	3.6	2.7	<0.01	<0.10	51	4.6	88	0	7.1	41	0.3	<0.1	0.8	156	22	0	303	6.5
SP94-56	3	51	22	43	179	14	59	11-13-71			16	--	--	--	2.6	1.8	.02	.007	55	4.7	94	0	3.8	39	.4	.01	.31	178	15	0	299	7.0
SP94-56	3	51	22	43	179	14	59	12-08-71			17	<.01	.01	.02	3.0	1.7	<.01	<.01	57	4.8	96	0	8.8	40	.4	.01	.83	192	17	0	298	7.0
SP94-56	3	51	22	43	179	14	59	01-13-72			18	<.001	<.001	.01	2.8	1.6	<.001	<.001	58	4.9	97	0	9.0	40	.4	.06	.89	170	16	0	299	7.6
SP94-56	3	51	22	43	179	14	59	03-29-72			16	<.01	.01	.01	2.8	1.8	.01	<.01	55	5.1	96	0	8.6	41	.5	<.01	.33	210	16	0	302	6.7
LK96-57	6	51	24	11	179	16	09	10-05-69			.8	--	.49	.02	3.0	1.8	.03	<.1	48	2.5	77	0	5.6	39	12	.5	.1	152	17	0	257	7.9
LK96-57	6	51	24	11	179	16	09	12-08-71			7.5	<.001	.02	.01	2.9	2.6	.03	<.001	59	2.5	84	0	14	47	.4	.17	.03	174	18	0	316	7.4
LK96-57	6	51	24	11	179	16	09	01-13-72			5.3	<.01	.04	.04	4.5	3.4	.03	<.01	46	2.2	42	0	11	59	.2	<.01	<.01	178	27	0	284	7.0
LK96-57	6	51	24	11	179	16	09	03-29-72			.9	<.01	.12	<.01	2.7	2.6	.02	.01	54	2.3	78	0	11	50	.3	.02	.03	216	18	0	309	7.2
ST97-51	8	51	24	35	179	11	00	06-28-70			14	<.1	.14	1.7	4.6	7.8	.04	<.1	85	3.6	159	0	14	59	.1	<.1	< 1	269	39	0	465	7.8
ST97-51	8	51	24	35	179	11	00	11-12-71			14	--	--	--	4.2	6.3	.02	.013	110	3.8	152	0	23	79	.1	.01	.07	332	33	0	578	7.3
ST97-51	8	51	24	35	179	11	00	12-08-71			15	<.01	.02	.01	4.4	5.3	<.01	<.01	94	3.4	148	0	27	69	.3	<.01	.09	272	31	0	505	7.4
ST97-51	8	51	24	35	179	11	00	01-16-72			16	.40	.60	.08	5.1	5.5	--	--	93	3.4	137	0	27	73	.2	<.01	.15	294	35	0	504	7.5
ST97-51	8	51	24	35	179	11	00	03-30-72			12	<.01	.02	.02	3.5	4.5	.02	<.01	81	2.9	117	0	23	65	.3	<.01	.04	304	26	0	444	7.3
ST97-50	13	51	24	53	179	09	49	04-23-70			5.6	.10	.43	.02	3.7	4.0	.01	<.1	24	1.6	30	0	4.0	39	<.1	<.1	<.1	88	25	1	192	6.0
ST97-50	13	51	24	53	179	09	49	11-13-71			8.0	--	--	--	5.1	5.1	.17	.007	33	2.2	32	0	6.2	53	<.1	.01	.01	144	34	7	249	6.7
ST01-51A	41	51	26	54	179	10	57	06-19-70			15	.40	.14	.01	4.4	6.2	.07	<.1	30	2.0	52	0	5.4	40	<.1	<.1	<.1	136	34	0	230	6.9
ST01-51A	41	51	26	54	179	10	57	11-10-71			8.9	--	--	--	4.6	4.5	.09	.007	28	2.2	25	0	2.5	48	<.1	.02	.01	140	30	10	223	6.6
ST01-51A	41	51	26	54	179	10	57	01-14-72			24	<.01	.02	<.01	5.5	5.8	.06	<.01	39	2.6	66	0	8.4	48	<.1	.04	.03	180	37	0	271	7.1
ST01-51A	41	51	26	54	179	10	57	03-29-72			7.7	<.01	.08	.01	3.2	3.3	.02	<.01	24	1.5	22	0	6.2	40	.1	<.01	<.01	140	21	3	179	6.5
LK03-45	43	51	28	05	179	05	26	10-20-64			3.7	.27	.01	<.10	1.4	3.1	--	--	21	.7	15	0	5.9	31	.1	.1	<.1	79	19	7	140	6.9
LK03-45	43	51	28	05	179	05	26	11-10-71			3.7	--	--	--	3.3	4.3	.32	.009	25	1.1	11	0	22	45	<.05	.01	.01	110	24	15	195	6.4
ST04-47	51	51	28	41	179	07	34	06-26-70			16	<.10	.10	<.01	4.7	7.8	.04	<.1	30	1.1	51	0	4.9	44	<.1	<.1	<.1	137	39	0	235	7.5
ST04-47	51	51	28	41	179	07	34	11-11-71			17	--	--	--	3.6	6.1	<.01	.007	43	2.2	42	0	40	56	<.1	.02	.02	168	30	0	281	6.7
ST04-47	51	51	28	41	179	07	34	12-09-71			21	<.01	.03	.02	4.7	5.3	.06	<.01	37	2.4	55	0	7.7	44	.1	<.01	.03	142	33	0	247	7.3
ST04-47	51	51	28	41	179	07	34	01-15-72			18	<.01	.04	.02	5.4	5.8	.05	<.01	33	2.2	46	0	7.4	49	<.1	.05	.03	160	37	0	248	6.9
ST04-47	51	51	28	41	179	07	34	04-02-72			20	<.01	.07	<.01	4.5	5.0	.03	<.01	34	2.5	54	0	7.9	44	.2	<.01	<.01	176	31	0	242	6.8
ST05-47	53	51	28	47	179	07	16	06-26-70			16	<.10	.10	<.01	4.7	7.8	.04	<.10	30	1.1	51	0	4.9	44	<.1	<.1	<.1	137	39	0	235	7.5
ST05-47	53	51	28	47	179	07	16	11-11-71			14	--	--	--	4.7	4.7	<.01	.09	32	2.3	28	0	40	53	<.1	.01	.01	154	31	8	246	6.5
ST07-40	53	51	30	04	179	01	01	06-26-70			22	.3	.12	.02	4.1	10	.01	<.1	36	3.0	58	0	11	45	< 1	.1	--	209	42	0	250	7.4
ST07-40	53	51	30	04	179	01	01	01-14-72			31	<.001	.09	02	5.5	4.9	.04	<.001	33	3.0	42	0	8.2	47	<.1	<.01	.12	174	35	0	236	6.9
ST07-40	53	51	30	04	179	01	01	04-01-72			22	.10	.09	.03	2.8	4.3	.05	<.01	37	2.6	45	0	9.3	43	.1	<.01	<.01	198	22	0	234	6.9
ST09-36	58	51	31	32	178	58	24	06-25-70			28	<.10	.05	<.01	3.6	4.5	.05	<.1	18	1.4	32	0	5.2	41	<.1	<.1	<.1	112	26	0	200	7.4
ST09-36	58	51	31	32	178	58	24	11-10-71			20	--	--	--	4.2	4.1	.18	.009	29	2.3	19	0	6.5	51	<.1	.05	.02	140	28	12	221	6.8
ST09-36	58	51	31	32	178	58	24	12-08-71			21	<.01	.03	.01	3.9	3.4	.04	<.01	27	2.0	22	0	7.2	42	.1	< 01	<.01	120	25	7	193	7.1
ST09-36	58	51	31	32	178	58	24	01-14-72			29	<.01	.02	<.01	4.5	4.0	.05	<.01	30	2.5	32	0	8.3	45	.1	<.01	.03	120	28	2	217	7.0
ST09-36	58	51	31	32	178	58	24	03-31-72			21	<.01	.04	<.01	3.5	3.4	.05	<.01	26	2.0	24	0	7.3	42	.1	<.01	.01	158	23	3	193	6.6

Gross Beta/Gamma

The gross beta activity, cesium-137 as calibrating standard, in streams and lakes is graphically presented in figures 4 and 5; actual values are listed in table 4. The range of gross beta activity in water was 2.0 to 20 pCi/l after the event which compares with a range of less than 1.0 to 36 pCi/l before the event, as reported by Beetem, Washington, Janzer, and Schroder (1971). A measurable increase of the island background in gross beta/gamma activity was found in the water in January 1972; the activity in approximately 15 percent of the samples ranged from 15 to 20 pCi/l. Eberline Instrument Corporation reported an increase of the island background in the gross beta activity measured in the air at the same time the water samples were collected (written commun., K. W. Gustafson, May 1972). Eberline Instrument Corporation attributes the increase in gross beta activity in the air in January 1972 to a surface test of a nuclear device by a foreign nation in January 1972.

Tritium

Tritium analyses of water samples collected by the Geological Survey were made using liquid scintillation techniques. The sea samples (table 2) collected by Fisheries Research Institute, University of Washington, were analyzed using electrolytic enrichment and liquid scintillation or gas counting techniques. The data obtained by the Survey are presented in table 4.

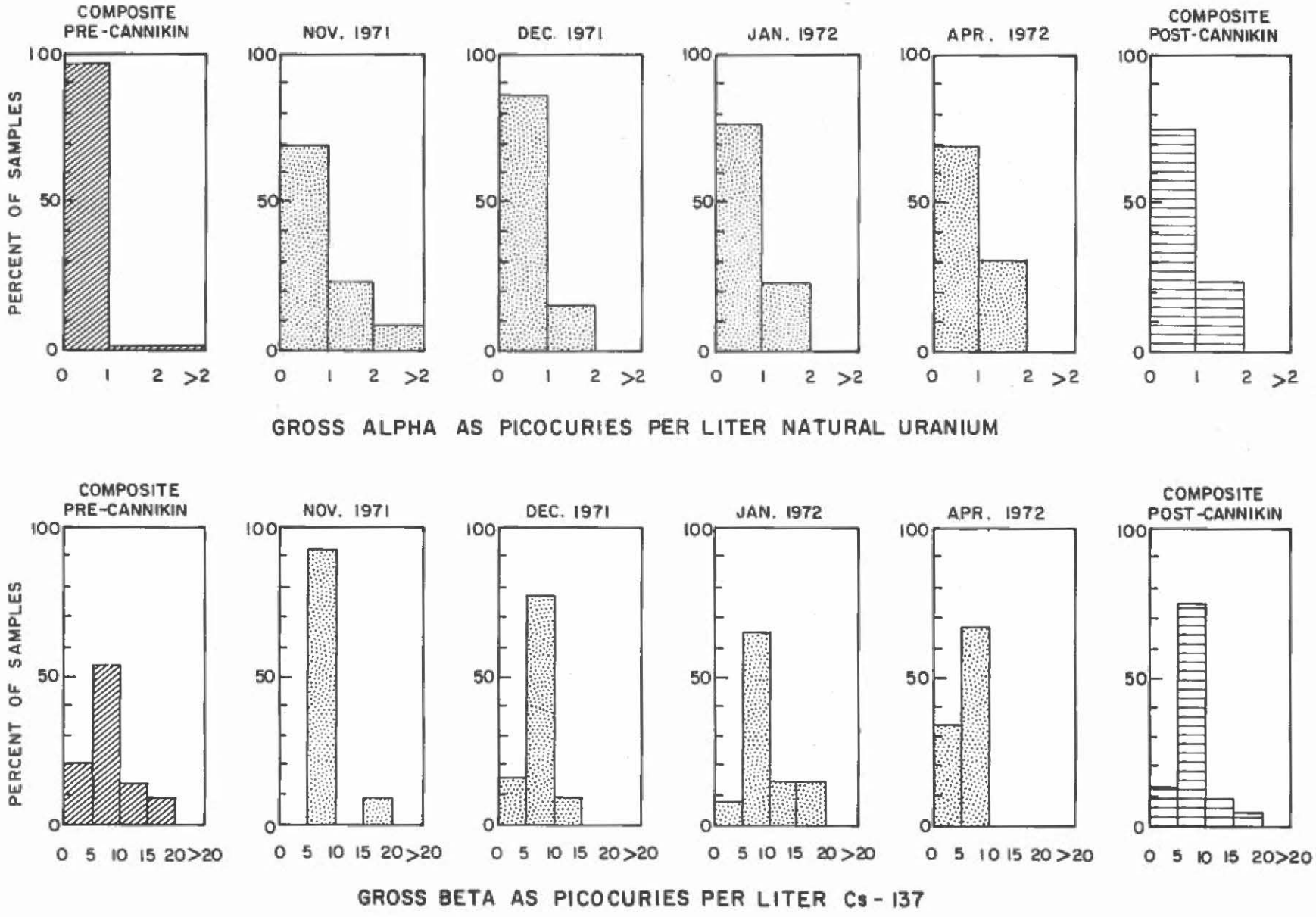

Figure 4.-- Radiochemical monitoring of streams on Amchitka Island, Alaska, 1964-72.

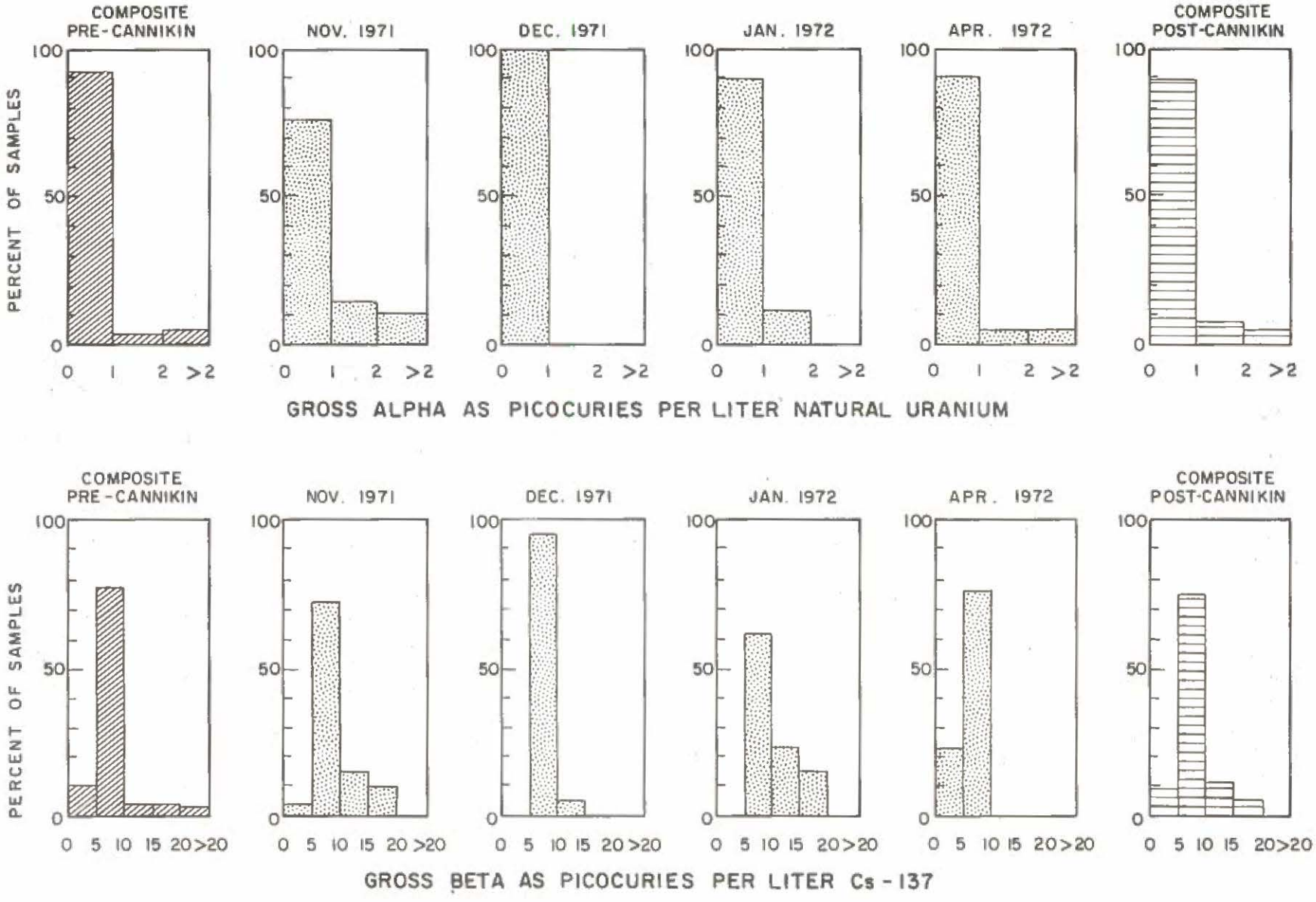

Figure 5.--Radiochemical monitoring of lakes on Amchitka Island, Alaska, 1964-72.

Table 4.--Radiochemical analyses of water samples collected on Amchitka Island, Alaska

(Gross beta, gross alpha, and tritium, reported in picocuries per liter; <, less than; --, not analyzed)

Ident. no.	Ref. no. 1/	Latitude N.			Longitude E.			Date			Time	Dissolved gross beta Cs-137	Dissolved gross alpha U natural	Tritium in water molecules
		Deg.	Min.	Sec.	Deg.	Min.	Sec.	M	D	Y				
PR93-57	1	51	22	25	-179	15	48	11	13	71	1945	--	--	<640
PR93-57	1	51	22	25	-179	15	48	12	09	71	--	--	--	<640
PR93-57	1	51	22	25	-179	15	48	01	16	72	1030	--	--	<640
PR93-57	1	51	22	25	-179	15	48	01	18	72	0935	--	--	<640
PR93-57	1	51	22	25	-179	15	48	02	20	72	0930	--	--	<640
PR93-57	1	51	22	25	-179	15	48	02	22	72	1430	--	--	<640
LK94-62	2	51	22	37	-179	20	25	11	13	71	1100	7.4	0.5	<640
LK94-62	2	51	22	37	-179	20	25	12	07	71	1655	7.6	<.3	<640
LK94-62	2	51	22	37	-179	20	25	01	13	72	0930	7.5	<.5	<640
LK94-62	2	51	22	37	-179	20	25	03	29	72	1040	7.2	<.4	<640
SP94-56	3	51	22	43	-179	14	59	10	31	71	1130	--	--	<640
SP94-56	3	51	22	43	-179	14	59	11	13	71	1145	5.1	<.5	<640
SP94-56	3	51	22	43	-179	14	59	12	08	71	1730	5.7	.7	<640
SP94-56	3	51	22	43	-179	14	59	01	13	72	1020	5.5	<.5	<640
SP94-56	3	51	22	43	-179	14	59	03	29	72	1120	6.5	<.7	<640
OB96-58	4	51	24	08	-179	16	32	11	12	71	1725	--	--	<640
OB96-58	4	51	24	08	-179	16	32	12	07	71	1720	--	--	<640
OB96-58	4	51	24	08	-179	16	32	01	13	72	1008	--	--	<640
OB96-58	4	51	24	08	-179	16	32	03	29	72	1105	--	--	<640
OP96-51	5	51	24	09	-179	10	17	11	12	71	1705	--	--	<640
OP96-51	5	51	24	09	-179	10	17	01	17	72	--	--	--	<640
OP96-51	5	51	24	09	-179	10	17	03	30	72	1530	--	--	<640
LK96-57	6	51	24	11	-179	16	09	11	13	71	1135	5.6	<.5	<640
LK96-57	6	51	24	11	-179	16	09	12	08	71	1710	5.6	<.6	<640
LK96-57	6	51	24	11	-179	16	09	01	13	72	0950	6.2	<.5	<640

Table 4.--Radiochemical analyses of water samples collected on Amchitka Island, Alaska--Continued

(Gross beta, gross alpha, and tritium, reported in picocuries per liter; <, less than; --, not analyzed)

Ident. no.	Ref. no. 1/	Latitude N.			Longitude E.			Date			Time	Dissolved gross beta Cs-137	Dissolved gross alpha U natural	Tritium in water molecules
		Deg.	Min.	Sec.	Deg.	Min.	Sec.	M	D	Y				
LK96-57	6	51	24	11	-179	16	09	03	29	72	1110	5.8	<0.7	<640
ST96-51	7	51	24	16	-179	10	19	11	12	71	1705	7.2	.9	<640
ST96-51	7	51	24	16	-179	10	19	12	09	71	1700	7.9	<.7	<640
ST96-51	7	51	24	16	-179	10	19	01	17	72	1530	18	<.6	<640
ST96-51	7	51	24	16	-179	10	19	03	30	72	1530	5.9	1.1	<640
ST97-51	8	51	24	35	-179	11	00	10	31	71	0945	--	--	<640
ST97-51	8	51	24	35	-179	11	00	11	07	71	1040	--	--	<640
ST97-51	8	51	24	35	-179	11	00	11	12	71	1550	5.9	<1.3	<640
ST97-51	8	51	24	35	-179	11	00	12	08	71	0955	5.1	<.9	<640
ST97-51	8	51	24	35	-179	11	00	01	16	72	1430	7.9	<1.5	<640
ST97-51	8	51	24	35	-179	11	00	03	30	72	1200	7.0	<.8	<640
LK97-52	9	51	24	43	-179	11	15	10	31	71	1100	--	--	<640
LK97-52	9	51	24	43	-179	11	15	11	12	71	1600	6.6	<.5	<640
LK97-52	9	51	24	43	-179	11	15	12	08	71	1000	6.6	<.4	<640
LK97-52	9	51	24	43	-179	11	15	01	16	72	1420	8.4	<.6	<640
LK97-52	9	51	24	43	-179	11	15	03	30	72	1225	7.1	<.4	<640
WE97-51	10	51	24	50	-179	10	58	11	12	71	1420	6.5	<1.4	<640
WE97-51	10	51	24	50	-179	10	58	12	09	71	1430	10	<1.1	<640
WE97-51	10	51	24	50	-179	10	58	01	10	72	1300	6.8	<1.4	<640
WE97-51	10	51	24	50	-179	10	58	03	30	72	1420	4.5	<.8	<640

Table 4.--Radiochemical analyses of water samples collected on Amchitka Island, Alaska--Continued

(Gross beta, gross alpha, and tritium, reported in picocuries per liter; <, less than; --, not analyzed)

Ident. no.	Ref. no. 1/	Latitude N.			Longitude E.			Date			Time	Dissolved gross beta Cs-137	Dissolved gross alpha U natural	Tritium in water molecules
		Deg.	Min.	Sec.	Deg.	Min.	Sec.	M	D	Y				
ST97-51A	11	51	24	51	-179	10	55	11	12	71	1420	2.9	<0.2	<640
ST97-51A	11	51	24	51	-179	10	55	12	09	71	1425	3.9	<.3	<640
ST97-51A	11	51	24	51	-179	10	55	01	16	72	1315	3.9	<.4	<640
ST97-51A	11	51	24	51	-179	10	55	03	30	72	1425	2.9	<.5	<640
OP97-50	12	51	24	52	-179	09	44	11	12	71	1655	--	--	<640
OP97-50	12	51	24	52	-179	09	44	12	09	71	1710	--	--	<640
OP97-50	12	51	24	52	-179	09	44	01	17	72	1610	--	--	<640
OP97-50	12	51	24	52	-179	09	44	03	30	72	1515	--	--	<640
ST97-50	13	51	24	53	-179	09	49	11	13	71	1655	7.7	<.5	<640
ST97-50	13	51	24	53	-179	09	49	12	09	71	1710	7.7	<.4	<640
ST97-50	13	51	24	53	-179	09	49	01	17	72	1550	17	1.2	<640
ST97-50	13	51	24	53	-179	09	49	03	30	72	1510	6.4	<.5	<640
SE98-51	14	51	24	56	-179	10	58	11	12	71	1420	2.1	<.4	<640
SE98-51	14	51	24	56	-179	10	58	12	09	71	1415	3.6	<.9	<640
SE98-51	14	51	24	56	-179	10	58	01	16	72	1325	7.7	.9	<640
SE98-51	14	51	24	56	-179	10	58	03	30	72	1435	3.0	.5	<640
SE98-51A	15	51	24	56	-179	10	56	12	09	71	1420	4.2	<.5	<640
SE98-51A	15	51	24	56	-179	10	56	03	29	72	1430	2.5	<.4	<640
WE98-51C	16	51	24	57	-179	11	03.5	11	12	71	1435	4.6	<.4	<640
WE98-51C	16	51	24	57	-179	11	03.5	12	09	71	1445	4.1	.7	<640

Table 4.--Radiochemical analyses of water samples collected on Amchitka Island, Alaska--Continued

(Gross beta, gross alpha, and tritium, reported in picocuries per liter; <, less than; --, not analyzed)

Ident. no.	Ref. no. 1/	Latitude N.			Longitude E.			Date			Time	Dissolved gross beta Cs-137	Dissolved gross alpha U natural	Tritium in water molecules
		Deg.	Min.	Sec.	Deg.	Min.	Sec.	M	D	Y				
WE98-51C	16	51	24	57	-179	11	03.5	01	16	72	1255	6.5	<0.7	<640
WE98-51C	16	51	24	57	-179	11	03.5	03	30	72	1415	2.3	<.4	<640
LK98-51B	17	51	25	01	-179	10	51	11	12	71	1350	4.6	<.4	<640
LK98-51B	17	51	25	01	-179	10	51	12	09	71	1405	12	<.5	<640
LK98-51B	17	51	25	01	-179	10	51	01	16	72	1345	11	<.8	<640
LK98-51B	17	51	25	01	-179	10	51	03	30	72	1450	8.6	2.3	<640
LK98-52A	18	51	25	03	-179	11	36	11	12	71	1525	6.1	<.3	<640
LK98-52A	18	51	25	03	-179	11	36	12	09	71	1455	6.7	<.6	<640
LK98-52A	18	51	25	03	-179	11	36	01	14	72	1650	15	1.5	<640
LK98-52A	18	51	25	03	-179	11	36	03	29	72	1645	5.1	<.3	<640
WE98-51K	19	51	25	04.5	-179	10	55	11	12	71	1445	6.3	<.4	<640
WE98-51K	19	51	25	04.5	-179	10	55	12	09	71	1400	12	<.4	<640
WE98-51K	19	51	25	04.5	-179	10	55	01	16	72	1340	--	--	<640
WE98-51K	19	51	25	04.5	-179	10	55	03	30	72	1440	9.7	1.2	<640
LK98-51	20	51	25	08	-179	10	59	11	12	71	1500	5.6	.7	<640
LK98-51	20	51	25	08	-179	10	59	12	09	71	1350	5.9	<.3	<640
LK98-51	20	51	25	08	-179	10	59	01	16	72	1235	6.7	<.6	<640
LK98-51	20	51	25	08	-179	10	59	03	30	72	1400	3.6	<.3	<640
LK98-51A	21	51	25	12	-179	10	59	11	12	71	1515	16	.8	<640
LK98-51A	21	51	25	12	-179	10	59	12	09	71	1500	5.6	.4	<640

Table 4.--Radiochemical analyses of water samples collected on Amchitka Island, Alaska--Continued

(Gross beta, gross alpha, and tritium, reported in picocuries per liter; <, less than; --, not analyzed)

Ident. no.	Ref. no. 1/	Latitude N.			Longitude E.			Date			Time	Dissolved gross beta Cs-137	Dissolved gross alpha U natural	Tritium in water molecules
		Deg.	Min.	Sec.	Deg.	Min.	Sec.	M	D	Y				
LK98-51A	21	51	25	12	-179	10	59	01	16	72	1210	10	0.6	<640
LK98-51A	21	51	25	12	-179	10	59	03	29	72	1435	6.9	<.4	<640
LK98-53	22	51	25	17	-179	12	48	11	13	71	0900	7.2	<.4	<640
LK98-53	22	51	25	17	-179	12	48	12	08	71	0900	6.1	<.5	<640
LK98-53	22	51	25	17	-179	12	48	01	17	72	1320	14	<.7	<640
LK98-53	22	51	25	17	-179	12	48	03	30	72	1245	6.6	<.5	<640
OB99-54	23	51	25	31	-179	13	28	11	13	71	0935	--	--	<640
OB99-54	23	51	25	31	-179	13	28	12	08	71	0915	--	--	<640
OB99-54	23	51	25	31	-179	13	28	01	17	72	1335	--	--	<640
OB99-54	23	51	25	31	-179	13	28	03	30	72	1300	--	--	<640
LK00-52	24	51	25	59	-179	11	16	10	31	71	1110	--	--	<640
ST00-51	25	51	26	11	-179	11	11	11	13	71	0820	5.9	<.3	<640
ST00-51	25	51	26	11	-179	11	11	12	09	71	0910	5.8	.3	<640
ST00-51	25	51	26	11	-179	11	11	01	14	72	1640	5.3	<.5	<640
ST00-51	25	51	26	11	-179	11	11	03	29	72	1535	5.7	<.4	<640
LK00-51B	26	51	26	12	-179	10	47	11	10	71	1730	9.4	.3	<640
LK00-51B	26	51	26	12	-179	10	47	03	29	72	1415	--	--	<640
LK00-51A	27	51	26	14	-179	11	00	11	10	71	1730	11	.4	<640
LK00-51A	27	51	26	14	-179	11	00	12	09	71	1535	9.9	.3	<640
LK00-51A	27	51	26	14	-179	11	00	01	17	72	1055	6.9	.5	<640

Table 4.--Radiochemical analyses of water samples collected on Amchitka Island, Alaska--Continued

(Gross beta, gross alpha, and tritium, reported in picocuries per liter; <, less than; --, not analyzed)

Ident. no.	Ref. no. 1/	Latitude N.			Longitude E.			Date			Time	Dissolved gross beta Cs-137	Dissolved gross alpha U natural	Tritium in water molecules
		Deg.	Min.	Sec.	Deg.	Min.	Sec.	M	D	Y				
LK00-51A	27	51	26	14	-179	11	00	03	29	72	1410	6.9	0.5	<640
WE00-51E	28	51	26	15	-179	10	59	12	10	71	0915	--	--	8.6×10^4
WE00-51E	28	51	26	15	-179	10	59	01	17	72	1015	9.6	<1.6	4.3×10^3
WE00-51E	28	51	26	15	-179	10	59	03	29	72	1345	11	<1.4	7.4×10^3
WE00-51	29	51	26	15	-179	10	56	11	13	71	0805	--	--	1.6×10^3
WE00-51	29	51	26	15	-179	10	56	12	10	71	1030	--	--	2.2×10^3
WE00-51	29	51	26	15	-179	10	56	01	17	72	1015	3.2	<1.2	2.8×10^3
WE00-51	29	51	26	15	-179	10	56	03	29	72	1400	2.3	<1.0	2.7×10^3
WE00-51H	30	51	26	16	-179	10	54	05	14	71	1520	--	--	<640
WE00-51H	30	51	26	16	-179	10	54	11	13	71	0810	--	--	<640
WE00-51H	30	51	26	16	-179	10	54	01	17	72	1030	6.9	<2.0	<640
WE00-51H	30	51	26	16	-179	10	54	03	29	72	1350	4.2	1.2	<640
WE00-51F	31	51	26	17	-179	10	58	12	09	71	1035	--	--	1.2×10^4
WE00-51F	31	51	26	17	-179	10	58	01	17	72	1100	13	<1.5	1.4×10^4
WE00-51F	31	51	26	17	-179	10	58	03	29	72	1500	6.2	<1.1	1.4×10^4
LK00-51	32	51	26	17	-179	10	45	12	09	71	1545	9.3	<.4	<640
LK00-51	32	51	26	17	-179	10	45	01	17	72	1120	--	--	<640
LK00-51	32	51	26	17	-179	10	45	03	29	72	1415	6.9	<.2	<640
ST00-51B	33	51	26	18	-179	11	04	11	10	71	1710	7.1	1.4	<640
ST00-51B	33	51	26	18	-179	11	04	12	09	71	1515	4.8	1.1	<640

Table 4.--Radiochemical analyses of water samples collected on Amchitka Island, Alaska--Continued

(Gross beta, gross alpha, and tritium, reported in picocuries per liter; <, less than; --, not analyzed)

Ident. no.	Ref. no. 1/	Latitude N.			Longitude E.			Date			Time	Dissolved gross beta Cs-137	Dissolved gross alpha U natural	Tritium in water molecules
		Deg.	Min.	Sec.	Deg.	Min.	Sec.	M	D	Y				
ST00-51B	33	51	26	18	-179	11	04	01	17	72	1000	13	<1.1	<640
ST00-51B	33	51	26	18	-179	11	04	03	29	72	1330	5.0	<.7	<640
LK00-51D	34	51	26	18	-179	11	01	10	31	71	1115	--	--	$6.3x10^3$
LK00-51D	34	51	26	18	-179	11	01	11	10	71	1700	4.2	<.6	$4.7x10^3$
LK00-51D	34	51	26	18	-179	11	01	12	09	71	1510	6.0	<.8	$6.4x10^3$
LK00-51D	34	51	26	18	-179	11	01	01	17	72	0950	4.6	<1.0	$5.5x10^3$
LK00-51D	34	51	26	18	-179	11	01	03	29	72	1340	2.0	<.5	$2.8x10^3$
OB01-52A	35	51	26	22	-179	11	59	11	12	71	1110	--	--	<640
OB01-52A	35	51	26	22	-179	11	59	12	09	71	--	--	--	<640
OB01-52A	35	51	26	22	-179	11	59	01	17	72	0920	--	--	<640
OB01-52A	35	51	26	22	-179	11	59	03	29	72	1440	--	--	<640
WE00-51I	36	51	26	26	-179	11	01	09	24	71	1520	--	--	<640
WE00-51I	36	51	26	26	-179	11	01	09	24	71	1530	--	--	<640
WE00-51J	37	51	26	27	-179	10	51	09	24	71	1010	--	--	<640
ST01-51	38	51	26	37	-179	10	47	11	12	71	1040	7.6	<.3	<640
ST01-51	38	51	26	37	-179	10	47	12	09	71	1555	7.9	<.6	<640
ST01-51	38	51	26	37	-179	10	47	01	14	72	1630	8.1	<.4	<640
ST01-51	38	51	26	37	-179	10	47	03	29	72	1515	5.6	<.5	<640
ST01-52	39	51	26	45	-179	11	32	11	12	71	1120	5.7	<.4	<640
ST01-52	39	51	26	45	-179	11	32	12	09	71	1630	4.7	<.3	<640

Table 4.--Radiochemical analyses of water samples collected on Amchitka Island, Alaska--Continued

(Gross beta, gross alpha, and tritium, reported in picocuries per liter; <, less than; --, not analyzed)

Ident. no.	Ref. no. 1/	Latitude N.			Longitude E.			Date			Time	Dissolved gross beta Cs-137	Dissolved gross alpha U natural	Tritium in water molecules
		Deg.	Min.	Sec.	Deg.	Min.	Sec.	M	D	Y				
ST01-52	39	51	26	45	-179	11	32	01	17	72	0950	14	<0.6	<640
ST01-52	39	51	26	45	-179	11	32	03	29	72	1430	5.3	<.4	<640
SE01-52	40	51	26	53	-179	11	40	11	12	72	1110	3.4	<.5	<640
SE01-52	40	51	26	53	-179	11	40	12	09	71	1640	7.7	1.4	<640
SE01-52	40	51	26	53	-179	11	40	01	17	72	0940	--	--	<640
SE01-52	40	51	26	53	-179	11	40	03	29	72	1450	5.4	<.8	<640
ST01-51A	41	51	26	54	-179	10	57	10	31	71	1120	--	--	<640
ST01-51A	41	51	26	54	-179	10	57	11	10	71	1655	9.2	<.4	<640
ST01-51A	41	51	26	54	-179	10	57	12	09	71	1620	6.9	.5	<640
ST01-51A	41	51	26	54	-179	10	57	01	14	72	1625	9.5	.8	<640
ST01-51A	41	51	26	54	-179	10	57	03	29	72	1520	6.6	<.3	<640
LK02-46	42	51	27	37	-179	06	32	11	10	71	1135	7.2	1.0	<640
LK02-46	42	51	27	37	-179	06	32	12	09	71	1615	8.0	<.4	<640
LK02-46	42	51	27	37	-179	06	32	01	13	72	1625	10	<.4	<640
LK02-46	42	51	27	37	-179	06	32	03	30	72	1635	5.5	<.2	<640
LK03-45	43	51	28	05	-179	05	26	11	10	71	1108	5.1	.4	<640
LK03-45	43	51	28	05	-179	05	26	12	08	71	1545	5.5	<.2	<640
LK03-45	43	51	28	05	-179	05	26	01	13	72	1600	8.3	<.8	<640
LK03-45	43	51	28	05	-179	05	26	03	20	72	1625	3.6	<.1	<640
LK03-47	44	51	28	08	-179	07	12	11	12	71	0915	6.0	.4	<640

Table 4.--Radiochemical analyses of water samples collected on Amchitka Island, Alaska--Continued

(Gross beta, gross alpha, and tritium, reported in picocuries per liter; <, less than; --, not analyzed)

Ident. no.	Ref. no. 1/	Latitude N.			Longitude E.			Date			Time	Dissolved gross beta Cs-137	Dissolved gross alpha U natural	Tritium in water molecules
		Deg.	Min.	Sec.	Deg.	Min.	Sec.	M	D	Y				
LK03-47	44	51	28	08	-179	07	12	12	09	71	1125	5.9	0.2	<640
LK03-47	44	51	28	08	-179	07	12	01	15	72	1615	20	<.8	<640
LK03-47	44	51	28	08	-179	07	12	04	01	72	1410	6.4	<.3	<640
LK04-46C	45	51	28	12	-179	06	42	11	11	71	1005	5.8	.8	<640
LK04-46C	45	51	28	12	-179	06	42	12	09	71	0935	7.0	<.7	<640
LK04-46C	45	51	28	12	-179	06	42	01	15	72	1340	9.0	<.7	<640
LK04-46C	45	51	28	12	-179	06	42	01	15	72	1250	6.6	<.9	<640
LK04-46D	46	51	28	14	-179	06	46	11	11	71	1540	7.6	2.6	<640
LK04-46D	46	51	28	14	-179	06	46	12	09	71	0930	5.8	.6	<640
LK04-46D	46	51	28	14	-179	06	46	01	15	72	1330	8.4	<.8	<640
LK04-46D	46	51	28	14	-179	06	46	04	01	72	1255	3.6	.5	<640
ST04-47A	47	51	28	21	-179	06	59	11	11	71	1555	16	2.3	<640
ST04-47A	47	51	28	21	-179	06	59	12	09	71	0950	12	1.2	<640
LK04-46B	48	51	28	25	-179	06	55	11	11	71	1605	17	2.2	<640
LK04-46B	48	51	28	25	-179	06	55	12	09	71	0940	9.9	.4	<640
LK04-46B	48	51	28	25	-179	06	55	01	15	72	1345	20	1.7	<640
LK04-46B	48	51	28	25	-179	06	55	04	01	72	1315	6.7	.5	<640
LK04-46F	49	51	28	27	-179	06	49	11	11	71	1550	9.9	.9	<640
LK04-46F	49	51	28	27	-179	06	49	12	09	71	0940	10	<.5	<640
LK04-46F	49	51	28	27	-179	06	49	01	15	72	1335	16	<1.0	<640

Table 4.--Radiochemical analyses of water samples collected on Amchitka Island, Alaska--Continued

(Gross beta, gross alpha, and tritium, reported in picocuries per liter; <, less than; --, not analyzed)

Ident. no.	Ref. no. 1/	Latitude N.			Longitude E.			Date			Time	Dissolved gross beta Cs-137	Dissolved gross alpha U natural	Tritium in water molecules
		Deg.	Min.	Sec.	Deg.	Min.	Sec.	M	D	Y				
LK04-46F	49	51	28	27	-179	06	49	04	01	72	1310	7.3	<0.3	<640
LK04-46E	50	51	28	36	-179	06	50	11	11	71	1155	11	.9	<640
LK04-46E	50	51	28	36	-179	06	50	12	09	71	1005	9.6	.5	<640
LK04-46E	50	51	28	36	-179	06	50	01	15	72	1400	12	.5	<640
LK04-46E	50	51	28	36	-179	06	50	04	01	72	1335	6.5	<.2	<640
ST04-47	51	51	28	41	-179	07	34	10	19	71	1705	--	--	<640
ST04-47	51	51	28	41	-179	07	34	11	07	71	0930	--	--	<640
ST04-47	51	51	28	41	-179	07	34	11	08	71	1430	--	--	<640
ST04-47	51	51	28	41	-179	07	34	11	11	71	1105	5.5	<.4	<640
ST04-47	51	51	28	41	-179	07	34	12	09	71	1040	5.1	<.3	<640
ST04-47	51	51	28	41	-179	07	34	01	15	72	1420	6.0	<.5	<640
ST04-47	51	51	28	41	-179	07	34	04	02	72	1430	4.7	<.5	<640
OB05-47	52	51	28	47	-179	07	35	11	11	71	1045	--	--	<640
OB05-47	52	51	28	47	-179	07	35	12	09	71	1040	--	--	<640
OB05-47	52	51	28	47	-179	07	35	01	15	72	1530	--	--	<640
OB05-47	52	51	28	47	-179	07	35	04	02	72	1505	--	--	<640
ST05-47	53	51	28	47	-179	07	16	11	11	71	1120	7.1	<.5	<640
ST05-47	53	51	28	47	-179	07	16	12	09	71	1020	9.2	1.1	<640
ST05-47	53	51	28	47	-179	07	16	01	15	72	1345	8.3	<.5	<640
ST05-47	53	51	28	47	-179	07	16	04	01	72	1355	4.8	<.6	<640

Table 4.--Radiochemical analyses of water samples collected on Amchitka Island, Alaska--Continued

(Gross beta, gross alpha, and tritium, reported in picocuries per liter; <, less than; --, not analyzed)

Ident. no.	Ref. no. 1/	Latitude N.			Longitude E.			Date			Time	Dissolved gross beta Cs-137	Dissolved gross alpha U natural	Tritium in water molecules
		Deg.	Min.	Sec.	Deg.	Min.	Sec.	M	D	Y				
LK05-46	54	51	28	57	-179	06	23	11	10	71	1035	15	1.1	<640
LK05-46	54	51	28	57	-179	06	23	12	08	71	1455	7.4	<.2	<640
LK05-46	54	51	28	57	-179	06	23	01	15	72	1145	9.3	<.6	<640
LK05-46	54	51	28	57	-179	06	23	03	30	72	1615	8.0	1.3	<640
OB05-46	55	51	29	00	-179	06	47	11	11	71	1430	--	--	<640
OB05-46	55	51	29	00	-179	06	47	12	08	71	1530	--	--	<640
OB05-46	55	51	29	00	-179	06	47	01	15	72	1215	--	--	<640
OB05-46	55	51	29	00	-179	06	47	04	02	72	1015	--	--	<640
LK05-45	56	51	29	01	-179	05	55	11	10	71	1050	6.5	.8	<640
LK05-45	56	51	29	01	-179	05	55	12	08	71	1545	5.3	.5	<640
LK05-45	56	51	29	01	-179	05	55	01	15	72	1150	8.5	.9	<640
LK05-45	56	51	29	01	-179	05	55	03	30	72	1620	5.0	.8	<640
ST07-40	57	51	30	04	-179	01	01	10	28	71	1420	--	--	<640
ST07-40	57	51	30	04	-179	01	01	11	07	71	1105	--	--	<640
ST07-40	57	51	30	04	-179	01	01	01	14	72	1345	6.2	1.0	<640
ST07-40	57	51	30	04	-179	01	01	04	01	72	1305	4.7	1.6	<640
ST09-36	58	51	31	32	-178	58	24	10	29	71	1450	--	--	<640
ST09-36	58	51	31	32	-178	58	24	11	10	71	1600	7.3	1.0	<640
ST09-36	58	51	31	32	-178	58	24	12	08	71	1345	6.3	<.3	<640
ST09-36	58	51	31	32	-178	58	24	01	14	72	1030	6.2	<.4	<640

Table 4.--Radiochemical analyses of water samples collected on Amchitka Island, Alaska--Continued

(Gross beta, gross alpha, and tritium, reported in picocuries per liter; <, less than; --, not analyzed)

Ident. no.	Ref. no. 1/	Latitude N.			Longitude E.			Date			Time	Dissolved gross beta Cs-137	Dissolved gross alpha U natural	Tritium in water molecules
		Deg.	Min.	Sec.	Deg.	Min.	Sec.	M	D	Y				
ST09-36	58	51	31	32	-178	58	24	01	14	72	1125	6.4	1.1	<640
LK14-36	59	51	33	58	-178	58	23	11	10	71	0930	8.7	1.1	<640
LK14-36	59	51	33	58	-178	58	23	12	08	71	1250	5.2	.3	<640
LK14-36	59	51	33	58	-178	58	23	01	13	72	1420	13	<1.1	<640
LK14-36	59	51	33	58	-178	58	23	03	31	72	1015	4.2	<.3	<640

1/ Reference numbers used for location on figures 1, 2, and 3.

Data obtained from water samples at the Long Shot site are given in table 5. Tritium values less than 640 pCi/1 have been observed in a drainage ditch (STOO-51B) and well WL-1 (WEOO-51H) since the Cannikin event but may have higher values during the summer dry season. The tritium activity in water at the Long Shot site appears to correlate to the available precipitation which dilutes the surface and shallow ground water.

Sea sampling locations (fig. 3) are intended to monitor any release of contaminated ground water to the ocean. Tritium analyses of the sea waters (table 6) around Amchitka Island are typical of normal seasonal variations in shallow sea water.

Krypton-85 and Strontium-90

Teledyne Isotopes collected and analyzed samples for krypton-85, a negatron-emitting fission product, from February 15 through February 23, 1973. The following sample analysis information was obtained (U.S. Atomic Energy Comm., written commun., 1972).

"1. Three free-air samples were collected in the crater area, there was no Kr detected above ambient level.

2. Four soil-gas samples were collected from barrels emplaced around the GZ area. No Kr levels above background were detected in the two samples analyzed.

3. Three bodies of water in the crater area were sampled for dissolved gases, using the countercurrent water stripper. No Kr values above ambient levels were detected in the one sample analyzed."

Table 5.--Summary of tritium analyses of water samples from selected sampling locations at the Long Shot site, Amchitka Island , Alaska

(Tritium in water molecules reported in picocuries per liter)

Ident. no.	Ref. no. 1/	Other identifying name	Tritium pre-Cannikin 2/			Tritium post-Cannikin		
			High	Average	Low	High	Average	Low
WE00-51E	28	Well No. 10c	3.0×10^{5}	1.1×10^{5}	5.4×10^{3}	8.6×10^{4}	3.2×10^{4}	4.3×10^{3}
WE00-51	29	Well WL-2	2.8×10^{3}	2.4×10^{3}	2.0×10^{3}	2.8×10^{3}	2.3×10^{3}	1.6×10^{3}
WE00-51H	30	Well WL-1	1.2×10^{4}	7.4×10^{3}	2.9×10^{3}	No values above 6.4×10^{2}		
WE00-51F	31	Well No. 8A	2.3×10^{4} --Only one sample			1.4×10^{4}	1.3×10^{4}	1.2×10^{4}
ST00-51B	33	Long Shot drainage ditch	5.1×10^{3}	2.6×10^{3}	8.0×10^{2}	No values above 6.4×10^{2}		
LK00-51D	34	Long Shot mudpit	7.4×10^{3}	4.3×10^{3}	6.1×10^{2}	6.4×10^{3}	5.1×10^{3}	2.8×10^{3}

1/ Reference numbers used for locations on figures 1, 2, and 3.

2/ Values determined from published USGS and Teledyne Isotopes, Inc. reports.

Table 6.--Tritium analyses of sea-water samples collected near Amchitka Island, Alaska

(Tritium analyses as tritium in water molecules and tritium in water molecules, counting error)

Ident. no.	Ref. no. 1/	Latitude N. Deg.	Min.	Sec.	Longitude E. Deg.	Min.	Sec.	Date M	D	Y	Depth below water surface meters	Tritium Tritium units
OP93-47	60	51	22	42	-179	06	54	08	08	71	0	18±1
OP93-47	60	51	22	42	-179	06	54	08	08	71	64	19±1
OP93-47	60	51	22	42	-179	06	54	11	17	71	0	44±3
OP93-47	60	51	22	42	-179	06	54	11	17	71	25.5	51±4
OP93-47	60	51	22	42	-179	06	54	11	17	71	51	68±3
OP93-47	60	51	22	42	-179	06	54	04	28	72	25.5	<11
OP93-47	60	51	22	42	-179	06	54	04	28	72	51	<12
OP93-47	60	51	22	42	-179	06	54	04	28	72	77	<9
OP94-49	61	51	23	06	-179	08	30	08	08	71	0	105±6
OP94-49	61	51	23	06	-179	08	30	08	08	71	12	32±1
OP94-49	61	51	23	06	-179	08	30	11	17	71	0	112±5
OP94-49	61	51	23	06	-179	08	30	11	17	71	11	113±16
OP94-49	61	51	23	06	-179	08	30	11	17	71	22	101±5
OP94-49	61	51	23	06	-179	08	30	04	28	72	11	33±5
OP94-49	61	51	23	06	-179	08	30	04	28	72	22	22±3
OP94-49	61	51	23	06	-179	08	30	04	28	72	33	20±3
OP94-42	62	51	24	00	-179	03	00	08	08	71	0	76±4
OP94-42	62	51	24	00	-179	03	00	08	08	71	64	112±3
OP94-42	62	51	24	00	-179	03	00	04	28	72	26	<12
OP94-42	62	51	24	00	-179	03	00	04	28	72	51	<9
OP94-42	62	51	24	00	-179	03	00	04	28	72	77	<8
OP98-44	63	51	25	12	-179	04	18	08	08	71	0	18±1
OP98-44	63	51	25	12	-179	04	18	08	08	71	23	20±3
OP98-44	63	51	25	12	-179	04	18	11	17	71	0	54±4
OP98-44	63	51	25	12	-179	04	18	11	17	71	13	92±3
OP98-44	63	51	25	12	-179	04	18	11	17	71	25.5	55±4
OP98-44	63	51	25	12	-179	04	18	04	28	72	11	11±5
OP98-44	63	51	25	12	-179	04	18	04	28	72	24	<8
OP98-44	63	51	25	12	-179	04	18	04	28	72	37	<9
OP00-42	64	51	26	30	-179	03	00	11	17	71	0	113±5

Table 6.--Tritium analyses of sea-water samples collected near Amchitka Island, Alaska--Continued

(Tritium analyses as tritium in water molecules and tritium in water molecules, counting error)

Ident. no.	Ref. no. 1/	Latitude N.			Longitude E.			Date			Depth below water surface	Tritium
		Deg.	Min.	Sec.	Deg.	Min.	Sec.	M	D	Y	meters	Tritium units
OP00-42	64	51	26	30	-179	03	00	11	17	71	7	78±4
OB01-55	65	51	26	36	-179	14	18	08	06	71	0	27±4
OB01-55	65	51	26	36	-179	14	18	11	15	71	0	93±2
OB01-55	65	51	26	36	-179	14	18	11	15	71	5.5	60±3
OB01-55	65	51	26	36	-179	14	18	11	15	71	11	119±5
OB01-55	65	51	26	36	-179	14	18	04	25	72	5.5	12±5
OB01-55	65	51	26	36	-179	14	18	04	25	72	11	13±5
OB01-55	65	51	26	36	-179	14	18	04	25	72	16.5	15±5
OB02-56	66	51	27	00	-179	15	18	08	07	71	0	69±3
OB02-56	66	51	27	00	-179	15	18	08	07	71	55	37±2
OB02-56	66	51	27	00	-179	15	18	11	15	71	0	104±3
OB02-56	66	51	27	00	-179	15	18	11	15	71	27.5	94±4
OB02-56	66	51	27	00	-179	15	18	11	15	71	55	92±5
OB02-56	66	51	27	00	-179	15	18	04	25	72	15	12±5
OB02-56	66	51	27	00	-179	15	18	04	25	72	55	<9
OB02-56	66	51	27	00	-179	15	18	04	25	72	86	<10
OB02-55	67	51	27	06	-179	14	09	08	07	71	0	20±1
OB02-55	67	51	27	06	-179	14	09	08	07	71	46	56±3
OB02-55	67	51	27	06	-179	14	09	04	25	72	4	<11
OB02-55	67	51	27	06	-179	14	09	04	25	72	8	<8
OB02-55	67	51	27	06	-179	14	09	04	25	72	13	<8
OB03-54	68	51	27	36	-179	13	00	08	06	71	0	34±2
OB03-54	68	51	27	36	-179	13	00	11	15	71	0	100±3
OB03-54	68	51	27	36	-179	13	00	11	15	71	11	84±3
OB03-54	68	51	27	36	-179	13	00	11	15	71	22	67±3
OB03-54	68	51	27	36	-179	13	00	04	25	72	11	<10
OB03-54	68	51	27	36	-179	13	00	04	25	72	22	<11
OB03-54	68	51	27	36	-179	13	00	04	25	72	33	<10
OP05-48	69	51	28	12	-179	08	30	08	10	71	0	87±4
OP05-48	69	51	28	12	-179	08	30	08	10	71	21	49±2

Table 6.--Tritium analyses of sea-water samples collected near Amchitka Island, Alaska--Continued

(Tritium analyses as tritium in water molecules and tritium in water molecules, counting error)

Ident. no.	Ref. no. 1/	Latitude N. Deg.	Min.	Sec.	Longitude E. Deg.	Min.	Sec.	Date M	D	Y	Depth below water surface meters	Tritium Tritium units
OP05-48	69	51	28	12	-179	08	30	04	19	72	0	23±5
OP05-48	69	51	28	12	-179	08	30	04	19	72	4	<11
OP05-48	69	51	28	12	-179	08	30	04	19	72	7	<10
OP05-48	69	51	28	12	-179	08	30	04	19	72	11	16
OB05-48	70	51	29	15	-179	08	45	11	15	71	0	45±3
OB05-48	70	51	29	15	-179	08	45	11	15	71	16.5	49±3
OB05-48	70	51	29	15	-179	08	45	11	15	71	33	82±4
OB06-47	71	51	29	30	-179	08	30	11	15	71	0	90±5
OB06-47	71	51	29	30	-179	08	30	11	15	71	20	72±4
OB06-47	71	51	29	30	-179	08	30	11	15	71	40	72±4
OB07-46	72	51	30	00	-179	06	30	08	10	71	0	16±1
OB07-46	72	51	30	00	-179	06	30	08	10	71	23.5	14±1
OB07-46	72	51	30	00	-179	06	30	11	15	71	0	27±3
OB07-46	72	51	30	00	-179	06	30	11	15	71	9	45±3
OB07-46	72	51	30	00	-179	06	30	11	15	71	18.5	17±3
OB07-46	72	51	30	00	-179	06	30	04	19	72	0	43±9
OB07-46	72	51	30	00	-179	06	30	04	19	72	10	<8

1/Reference numbers used for locations on figures 1, 2, and 3.

Water samples were collected by the Survey on November 11, 1971, from ponds in the collapse area around the Cannikin site. These samples were analyzed for strontium-90 produced in the mass 90 fission chain. The strontium-90 values ranged from 0.9 to 2.5 pCi/l.

The absence of detectable amounts of krypton-85 and the low value of strontium-90 present indicate that there was no detectable release of radioactive material to the atmosphere by the Cannikin event.

SUMMARY

The effects of the Cannikin event on the chemical and radiochemical quality of the surface and shallow ground water are not significant. Minor chemical quality changes were found in the streams and lakes which were monitored, but quality returned to the norm within 1 month after the event. The radiochemical quality of water as monitored by the gross alpha, gross beta/gamma, and tritium analyses, was not affected by the event. Tritium analyses of the sea waters around Amchitka Island are typical of normal seasonal variations in shallow sea water.

The krypton-85 and strontium-90 analyses indicate there was no detectable release of radioactive material to the atmosphere by the Cannikin event.

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