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AMCHITKA RADIOBIOLOGICAL PROGRAM PROGRESS REPORT JANUARY 1975 TO DECEMBER 1975

By

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ABSTRACT

Begun in 1970, the Amchitka Radiobiological Program is a continuing program to collect biological and environmental samples for radiometric analyses. An account of the program from July, 1970, to December, 1974, has been given in five previous progress reports: Held (1971), Held (1972), Held *et al.* (1973), Nelson and Seymour (1974), and Nelson and Seymour (1975). This report is an account of the program for Calendar Year 1975.

Results of analyses for samples collected in August, 1975, have been added to the tables in Nelson and Seymour (1975) that summarize the results of analyses of samples collected from 1970 to 1975 and include analyses for: (1) gamma-emitting radionuclides in air filters, freshwater, birds, lichens, marine algae, marine invertebrates, fish, aufwuchs, and freshwater moss and plants; (2) strontium-90 (^{90}Sr) in rats, birds, and soil; (3) $^{239,240}Pu$ in sand, soil, marine algae and fish; and (4) tritium (^{3}H) in seawater, freshwater, and biological organisms. Monitoring of background radiation with survey instruments was added to the Laboratory's program in 1974 and the results of the 1974 and 1975 surveys are included in this report.

Conclusions from the results of the recent analyses are a reiteration of the results stated in Nelson and Seymour (1975a); namely, "1) no new radionuclides are present; 2) the most abundant radionuclides are naturally occurring beryllium-7 (^{7}Be) and potassium-40 (^{40}K); 3) the trace quantities of fission products, induced radionuclides, and ^{3}H present are from world fallout; and 4) a trace of ^{3}H contamination remains in some Long Shot ponds, as previously reported." It is concluded from the results of analyses of samples collected between September 1969 and August, 1975, as reported in this and the five previous progress reports, that there were no radionuclides of Milrow or Cannikin origin in the water, plants, or animals of Amchitka Island.

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1. INTRODUCTION

The present Amchitka radiobiological program began in 1970 but was preceded by the Long Shot radiobiological program in 1965. A relevant description of the present program is given in the 1972 Progress Report (Held et al., 1973), and selected portions from that report follow.

> "The present Amchitka Radiobiological Program was initiated in July, 1970, by the University of Washington's Laboratory of Radiation Ecology at the request of the U.S. Atomic Energy Commission, Nevada Operations Office. The program is designed to provide a periodic documentation of radionuclides, both naturally occurring and man-made, in biological and environmental samples from Amchitka and its environs. Seafoods and radionuclides potentially available to man through the food web are emphasized. However, organisms other than food organisms are also collected and analyzed. These indicator organisms are species that significantly concentrate one or more radionuclides. Concentrations of radionuclides other than those potentially hazardous to man are measured as a means of providing clues to the origin of radionuclides at Amchitka. Unexpected combinations or concentrations of radionuclides would indicate the presence of newly added radionuclides to the environment, presumably from fresh fallout, nuclear-powered vessels, or from nuclear detonations at Amchitka Island."

The first two Amchitka Radiobiological Program Progress Reports covered the period July 1970 to February 1972. These reports have been summarized by Held (1972), who concluded, "Artificial or man-made radionuclides (found at Amchitka) did not originate at Amchitka except for tritium, which has previously been reported to be present in pond water and test holes near the Long Shot SGZ site."

The third, fourth and fifth progress reports reiterated the above conclusion and extended the account of the program through December, 1974. Major conclusions of the fifth report, as stated by Nelson and Seymour (1975a) are as follows:

> "a. Some of the ponds in the immediate vicinity of the Long Shot Surface Ground Zero remain contaminated with ^{3}H.
>
> "b. An extensive search with sensitive instruments for radionuclides in biological and environmental samples--marine, terrestrial, freshwater--collected during the first 38 months after the Cannikin detonation of November 6, 1971, indicates that no other radionuclides have escaped to the surface environment."

In this, the sixth progress report, the format is the same as for the fifth progress report except for minor changes as follows: (1) two tables were deleted as there were no 1975 data; (2) new data from the analyses of the samples collected in August, 1975, were added to the appropriate tables of the previous report; and (3) two new tables were added to the report, Table 14, "Gamma-emitting Radionuclides in Sand and Soil collected at Amchitka Island in August, 1975," and Table 18, "Plutonium-239-240 in *Fucus*, Greenling, Sand and Soil collected at Amchitka Island in August, 1975."

Radiological data from the August 1975 radiation survey and the results of the tritium analysis of water samples have been previously given in the 1975 Task Force Report on Bioenvironmental Studies at Amchitka Island, Alaska, (Nelson, 1975) but these data are repeated in the sixth progress report for completeness. Information has also been given in Nelson (1975) on the number of adult pink salmon in Amchitka streams, Dolly Varden in Cannikin Lake, fungus in the reseeded grass plots, and on the general bioenvironmental state of Amchitka during the August-September 1975 field program.

Figure 1 of the sixth progress report shows the geographical location of Amchitka Island. Figure 2 shows general collection sites for the radiobiological program, while Figures 3 through 6 present the specific collection sites for the shaded areas shown in Figure 2.

2. METHODS

Most samples collected prior to July, 1972, and fish, marine invertebrates, and birds collected through 1974 were analyzed by gamma spectrometry with systems using 3x3-inch NaI (Tl) crystals and 200-channel, pulse-height analyzers. Samples (except fish, marine invertebrates, and birds as noted above) collected since July, 1972, have been analyzed with systems using Ge(Li) diode detectors and 4096-channel, pulse-height analyzers. To determine the ^{90}Sr content of selected samples, ^{90}Y was chemically separated from ^{90}Sr, collected on filter paper and counted with a low-level beta counting system. Plutonium was extracted by ion exchange, electroplated on platinum discs, and analyzed by alpha spectrometry with systems using surface barrier alpha detectors and pulse-height analyzers. Chemical yield was determined by use of ^{242}Pu as a tracer. Tritium in seawater and freshwater samples was determined by vacuum distillation of the samples and liquid scintillation counting of the distillate, as discussed in Held et al.(1973); free and bound ^{3}H in water samples from fish, ptarmigan, and aquatic plant samples was determined by azeotropic distillation and liquid scintillation counting. A discussion of the procedure for processing biological samples for analysis of ^{3}H in bound water was given in Nelson and Seymour (1975a).

Changes made in the combustion and drying unit described in the above report include replacement of the stainless steel sample holder with a fused silica sample holder (Vycor) and replacement of the single large furnace with two smaller furnaces with separate temperature controls. These equipment changes were made to permit greater visibility and better temperature control during the drying and combustion of the samples. Also, refrigeration units have been added to the system to maintain the ethylene glycol and water mixture in the cooling dewars at -45 C without adding liquid nitrogen. The system can now be operated with greater temperature control and with less staff attention than previously required.

Slight changes in the drying and combustion procedure were made after the equipment modifications were completed. Three important changes are as follows: (1) the samples were freeze-dried until extraction of free water ceased; (2) the samples were heated for one to two hours at 100-200 C, with the copper oxide at 600 C, until the volatile gases were combusted; and (3) the temperature of the sample was then raised in stages to 600 C. Previously, samples had been dried at 50 to 150 C and combusted at the same high temperature as the copper oxide, since both the sample and the copper oxide were in the same furnace. These procedural changes have resulted in a better separation of free and bound water

and in less contamination of the water fractions with organic material. As before, samples of free or bound water were azeotropically distilled and the purified water was analyzed for ^{3}H by the liquid scintillation method used to analyze freshwater and seawater samples.

Freshwater samples (50 liters or more) for analyses of radionuclides other than ^{3}H were collected from four lakes or ponds. The water was evaporated and the residue counted for gamma-emitting radionuclides.

All data presented in the tables have been corrected to the date of collection; this correction will introduce little or no error in the calculated values except for ^{95}Nb if the ^{95}Zr in the sample was produced at various unknown times and is not in equilibrium with its daughter, ^{95}Nb. In this case, an accurate decay correction factor cannot be made for ^{95}Nb, and the application of the standard decay correction factor for ^{95}Zr to the amount of ^{95}Nb present at the time of counting gives an estimate of the maximum possible amount of ^{95}Nb present at the time of collection. The problems of ^{95}Zr-^{95}Nb analysis have been discussed in Held *et al.* (1973).

The error term in radionuclide concentration values for single samples is the combined counting error for the background, standard, and sample; hence, the term "propagated error." The error limits for the gamma-emitting radionuclides in single samples are "two-sigma" or two-standard deviation counting errors, while for the ^{3}H, Pu and ^{90}Sr data, error limits are one-standard deviation counting errors. The error term for the mean of more than one sample is one-standard deviation of the mean. This statistical error disregards counting error.

Environmental radiation surveys of selected areas on Amchitka Island were made in August, 1974 and 1975, with an Eberline survey meter, Model E-510. A pancake probe with a 2 mg/cm^{2} window was used on both surveys.

3. RESULTS AND DISCUSSION

The results of the analyses of the samples collected in 1975 are presented in Tables 2 through 18. These tables also contain data for samples collected and analyzed from 1970 through 1974. Results of these earlier analyses were presented in greater detail in the five previous progress reports.

The air sampling program at Amchitka which had been continuous since February, 1972, was discontinued in August, 1973, prior to closing the camp in September. One air particulate sampler (three were formerly used) was reactivated for an eight-day period during the August-September 1974 field trip. No radionuclides were detected by gamma-spectrum analysis of this sample (Table 2). Air samples were not collected during the August-September 1975 field trip.

Results of the analyses of biological samples are given in Tables 3 through 13, and in 17 and 18. The concentration of many of the gamma-emitting fallout radionuclides in the biological samples collected in August, 1975, was less than in 1974, but often greater than values for similar samples collected in 1973. Radionuclides usually detected in the 1975 samples of freshwater moss, *Fontinalis*, (Table 3) and the freshwater plant, *Ranunculus*, (Table 4) were the naturally occurring radionuclides ^{7}Be and ^{40}K and the fallout radionuclides ^{95}Zr, ^{95}Nb, ^{103}Ru, ^{106}Ru. ^{125}Sb, ^{137}Cs, ^{144}Ce, and ^{155}Eu. Of these radionuclides,

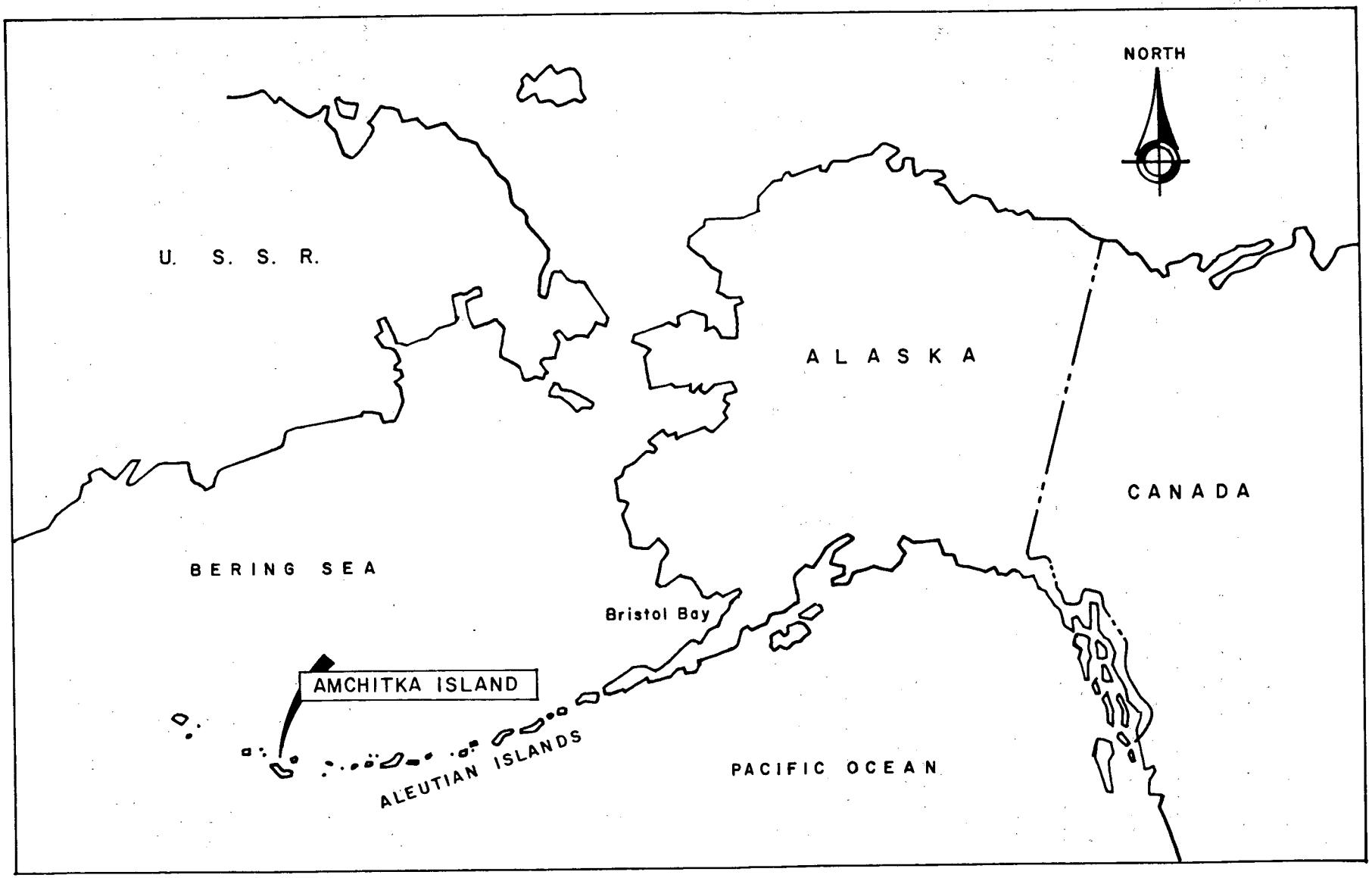

FIGURE 1. Location Map

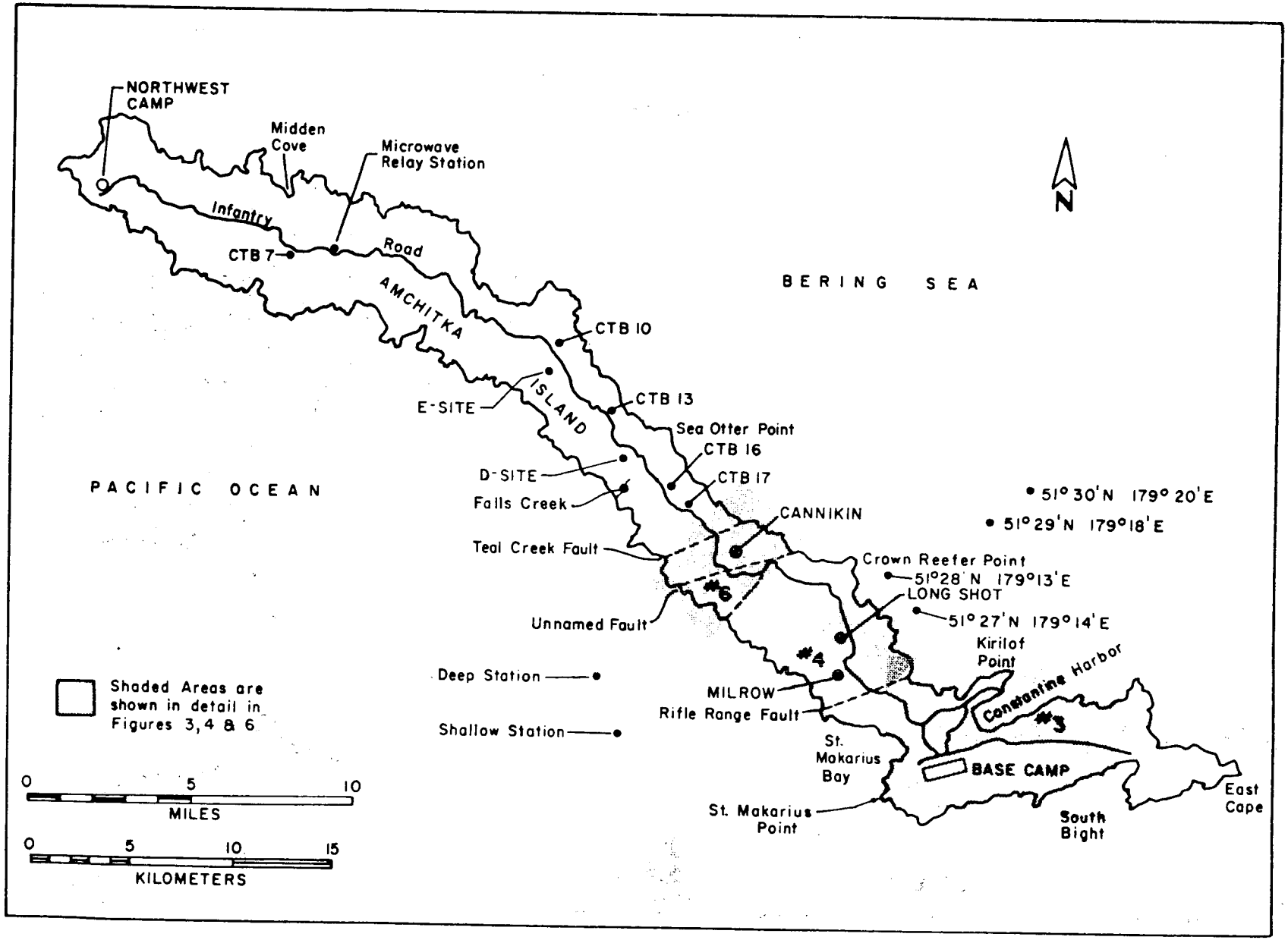

FIGURE 2. Location of Collection Sites on and near Amchitka Island, Alaska

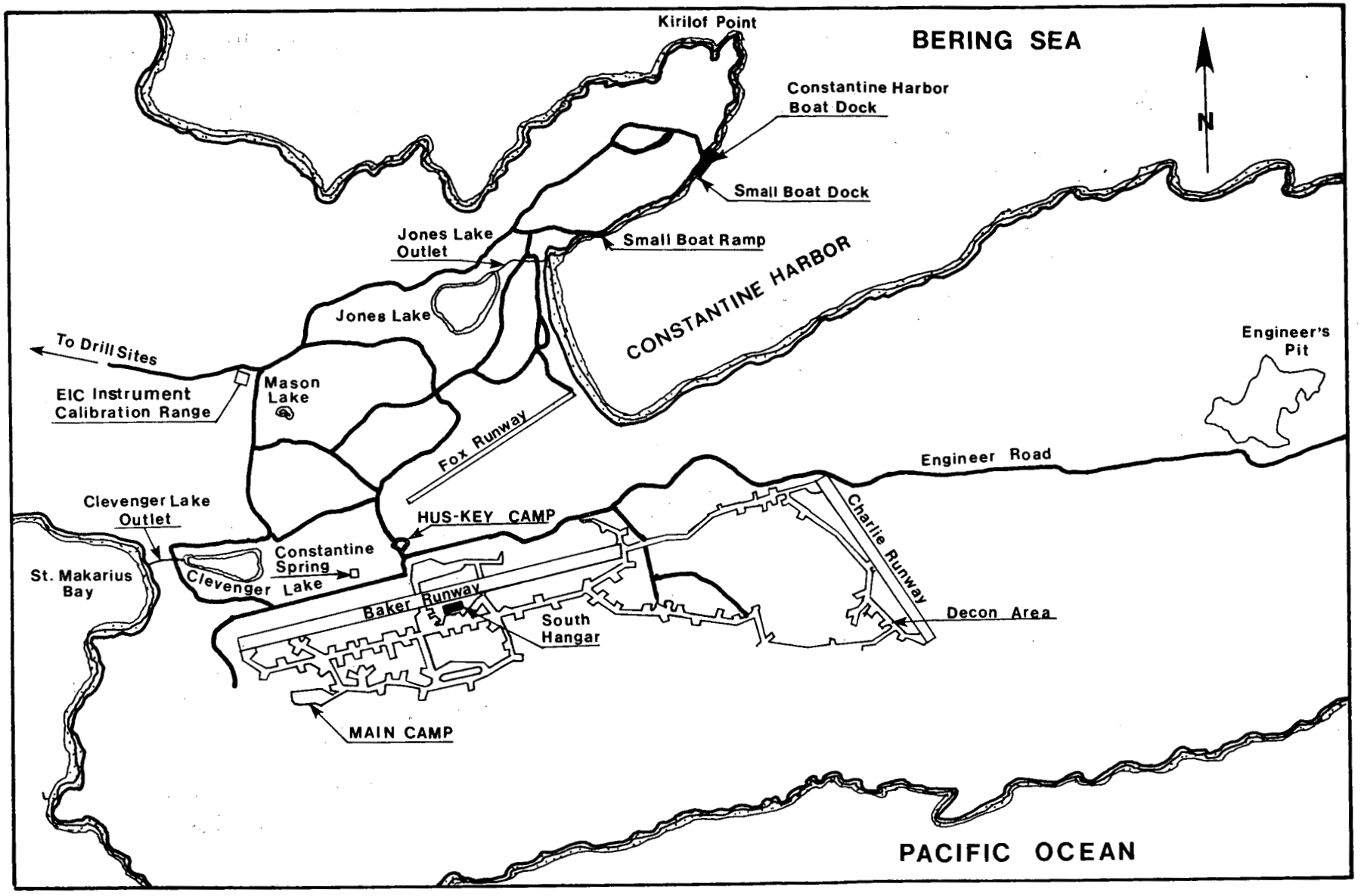

FIGURE 3. Collection Sites and Other Prominent Features in the Amchitka Island Base Camp Area

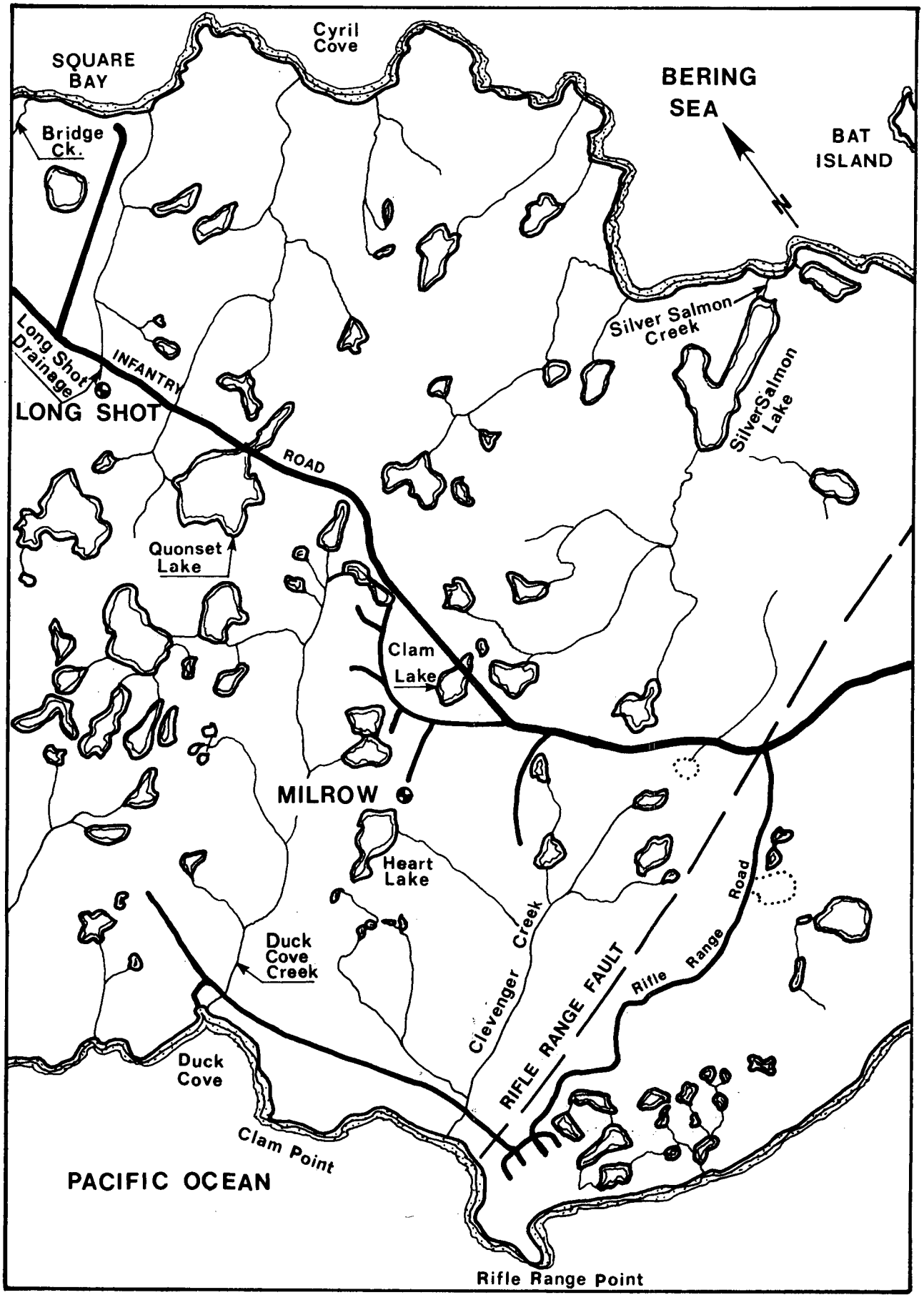

FIGURE 4. Collection Sites and Other Prominent Features in the Milrow Area.

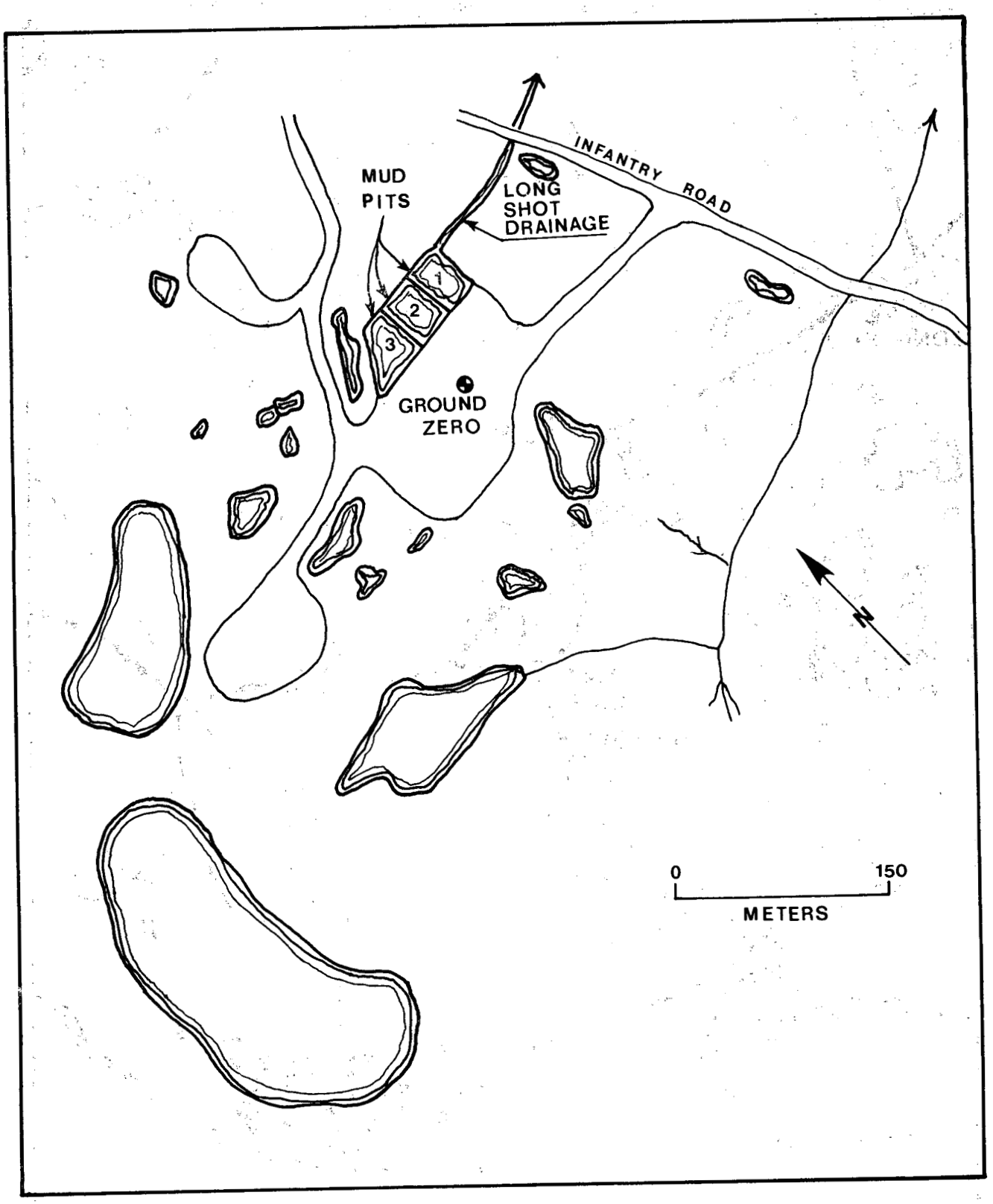

FIGURE 5. Collection Sites and Other Prominent Features in the Long Shot Ground Zero Vicinity.

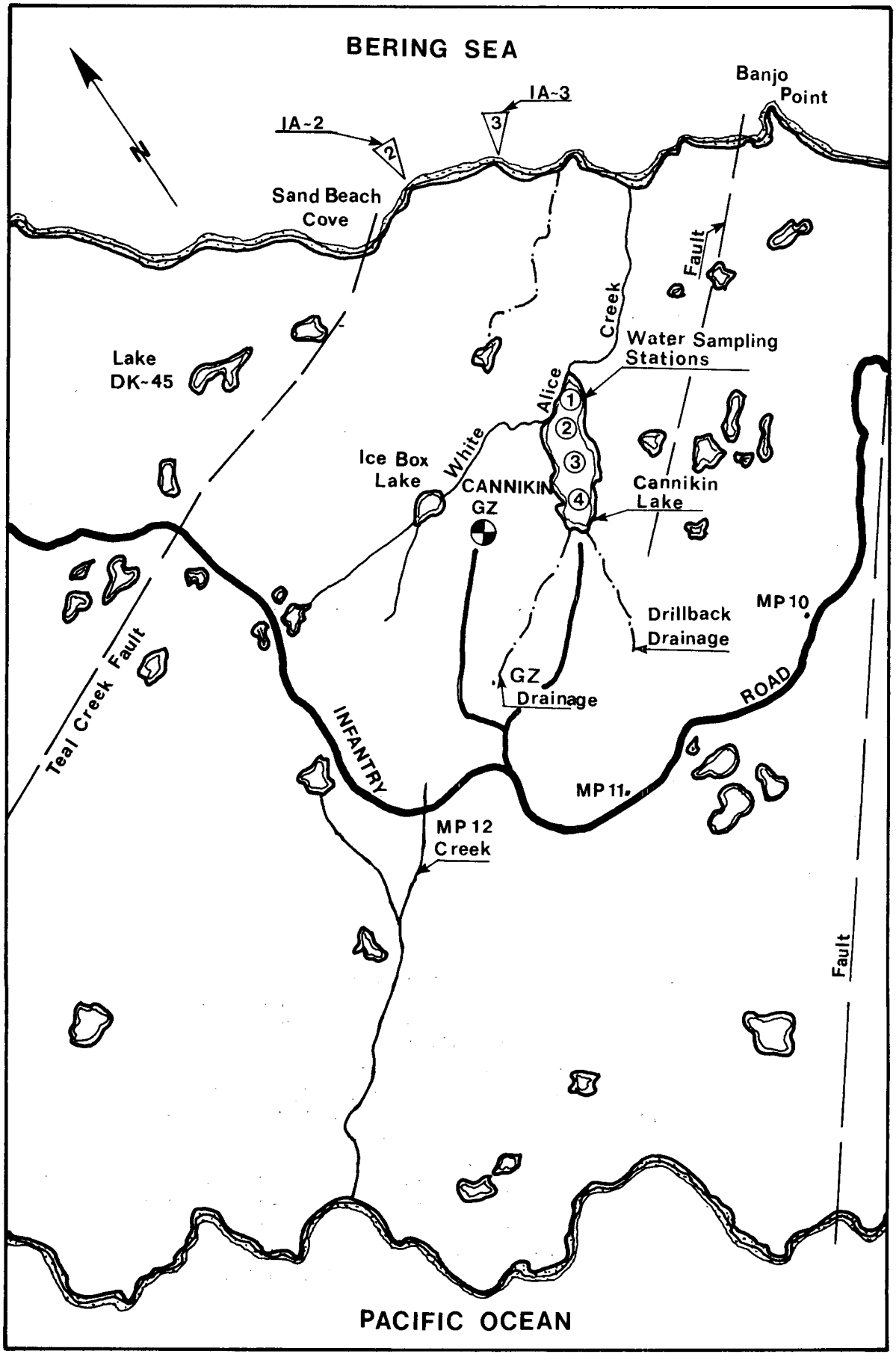

FIGURE 6. Collection Sites and Other Prominent Features in the Cannikin Area.

^{7}Be and ^{40}K were present in the greatest concentration (1 to 21 pCi/g, dry tissues). Radionuclides commonly detected in aquatic vegetation samples collected prior to 1973, but only sporadically in 1974 and 1975, include ^{54}Mn and ^{60}Co. The radionuclide species and concentration values for *Fontinalis* and *Ranunculus* samples in 1974 were also seen in aufwuchs and filamentous algae (Table 5) and in the lichens (Table 6), except that higher concentrations of ^{144}Ce (4.6 to 5.5 pCi/g, dry) and ^{137}Cs (8 to 11 pCi/g, dry) were present in the lichen samples and lower concentrations of ^{155}Eu were in the aufwuchs. Cesium-137 levels in the *Ranunculus*, aufwuchs, and lichen samples collected from the Cannikin area in 1975 were slightly higher than ^{137}Cs levels in similar samples collected elsewhere on Amchitka; ptarmigan and soil from the Cannikin area also exhibited this same trend. These higher ^{137}Cs levels may be due to a local increase in world fallout prior to our sampling trip, since several short-lived radionuclides such as ^{95}Zr and ^{95}Nb are also present in higher concentrations in some samples (i.e., soil and aufwuchs) from the Cannikin area compared to samples from other areas of Amchitka. It is unlikely that the elevated ^{137}Cs level in some Cannikin area samples is due to leakage from the Cannikin detonation, since ^{3}H levels in water samples from this area are comparable to ^{3}H levels in water from other areas on Amchitka. Increased ^{3}H levels are expected to be the first indicator of leakage from a test site on Amchitka. Further sampling will be required to determine the significance of the elevated ^{137}Cs levels in the Cannikin area.

The marine algae, *Fucus*, had fewer fallout radionuclides present and at lower concentrations than freshwater and terrestrial vegetation samples (Table 7). The naturally occurring radionuclide, ^{40}K, was present in concentrations that ranged from 32 to 38 pCi/g, dry, which is from 20 to over 100 times greater than the values for either of the two fallout radionuclides, ^{95}Nb and ^{137}Cs, detected in *Fucus* samples.

Radionuclide values for the green sponge, a marine invertebrate, in terms of pCi per gram of dry sample were <0.75 for ^{95}Nb and ^{144}Ce, <1.2 for ^{7}Be, and 7.7 to 10 for ^{40}K (Table 8).

As in previous years, naturally occurring ^{40}K and fission-produced ^{137}Cs were two of the predominant radionuclides detected in fish (Tables 9-11). No ^{55}Fe analyses were performed on fish collected in 1975. In the three species analyzed--halibut, Dolly Varden, and greenling--^{137}Cs concentrations were higher (0.05 to 0.49 pCi/g, dry) in muscle tissue than in the viscera. Potassium-40 was, as in 1974, the predominant radionuclide in all fish samples analyzed and was usually present in concentrations 50 to 250 times higher than ^{137}Cs concentrations. An exception was the lower ratio for muscle of the Jones Lake fish, caused by a low ^{40}K level (4.4 ± 0.9 pCi/g, dry). The original steps in the preparation of this sample were checked and the sample recounted. A potassium-40 value of 5.7 ± 1.4 pCi/g, dry weight, was calculated for the recounted sample. The low ^{40}K level thus appears to be a real variation and it is not due to a sample preparation or counting error.

The ^{137}Cs level in the Dolly Varden collected in DK-45 Lake in 1972 was significantly higher than expected, although we have no other samples of land-locked Dolly Varden from that time period for comparison. The land-locked races of these fish may have been exposed to different ^{137}Cs concentrations than the anadromous races of Dolly Varden from other sites on Amchitka.

Other than fish, ptarmigan and rats were the two vertebrates that were analyzed. Potassium-40, ^{137}Cs and ^{90}Sr were the predominant radionuclides in birds (Tables 12 and 13) and although ^{137}Cs values increased slightly in ptarmigan collected at C-site in 1975, ^{40}K and ^{90}Sr concentrations were usually still greater than ^{137}Cs concentrations by a factor of ten or more. Rat bone samples had ^{90}Sr concentrations (Table 13) of 0.5 to 1.6 pCi/g, dry, levels similar to those in 1973 and 1974 samples.

Surface (0-2.5 cm) soil samples were taken from the main camp and Cannikin areas. Besides the naturally occurring radionuclides ^{40}K, ^{226}Ra, and ^{228}Th, the fallout radionuclides ^{141}Ce, ^{144}Ce, ^{90}Sr, and $^{239,240}Pu$ were detected in both soil samples (Tables 13, 14 and 18). Traces of ^{95}Zr, ^{95}Nb, ^{106}Ru, and ^{137}Cs were also detected in the soil from the Cannikin area. The same naturally occurring radionuclides, plus ^{238}U, were present in samples of beach sand from Constantine Harbor and Sand Beach Cove. Cerium-144, ^{137}Cs and $^{239,240}Pu$ in the sample from Sand Beach Cove were the only fallout radionuclides present in the sand samples. Similar types and levels of fallout radionuclides were seen in soil samples collected in Washington State during 1974 and 1975 (Nelson and Seymour, 1975b).

Water samples for gamma-spectrum analysis were collected differently in 1975 than in previous years. This year, whole water samples were evaporated and the residue counted, while, previously, samples were filtered and the radionuclides which had collected on the filter paper or in the resin beds were measured. In addition, no seawater samples were analyzed for gamma-emitting radionuclides. Of the four freshwater sites, Heart Lake and Long Shot Mud Pit No. 1 had the highest concentration of fallout radionuclides in water samples (Table 15). As previously reported by Held (1972), the Long Shot Mut Pits have an unusually high concentration of suspended organic material which may accumulate radionuclides by adsorption.

Although the radionuclides present in the water samples could be due to site-related factors, the amount and number of radionuclides detected in the water samples also seemed to be related to rainfall and surface runoff during the collection period. No rainfall occurred while the Cannikin Lake sample was taken and ^{137}Cs was the only radionuclide detected. Rainfall began during the collection of the Jones Lake sample, peaked during the collection of the Heart Lake sample and declined to morning showers, but with high runoff during the Long Shot sample collection. The amount and number of radionuclides also peaked in the Heart Lake sample, was less in the Jones Lake and Long Shot Mud Pit No. 1, and was least in the Cannikin Lake sample. Additional sampling will be needed to delineate the effect of rainfall and runoff on the radionuclide content of Amchitka surface waters.

The ^{3}H values in seawater and freshwater samples collected in August, 1975, remained about the same as the 1974 values (Table 16). Seawater values averaged less than 48 pCi/liter (15 tritium units), while freshwater samples, excluding those from the Long Shot area, averaged 110 pCi/liter. In the Long Shot Mud Pits and drainage system, ^{3}H values ranged from about 2800 pCi/liter in Mud Pit #3 to 264 pCi/liter, 500 meters downstream in the drainage system. Values were about 350 pCi/liter at the mouth of the creek which drains the Long Shot Mud Pits. Comparing the tritium values within the Long Shot drainage system, the concentration of ^{3}H in the sample from Mud Pit #1 in August, 1975, is lower

than expected (400 pCi/liter vs. 2800 pCi/liter in Pit #3). The Mud Pit #1 sample was taken from the south side of the pit. This side is furthest from the point where water enters Mud Pit #1 from Mud Pits #2 and #3 and is also furthest from the outlet of Mud Pit #1. Thus, much of the water from the upper mud pits could pass through the north end of Mud Pit #1 without reaching the south side of Mud Pit #1 where the sample was taken. Water in this area is likely to be a mixture of surface runoff from recent rainfall (low tritium value) and Mud Pit #3 water (high tritium value), resulting in a lower tritium value than measured in Mud Pit #3 or in the drainage ditch just below Mud Pit #1. Tritium concentrations in water samples from stations other than the Long Shot area are within the range of values expected for tritium in rainwater collected at other locations at the same latitude as Amchitka. Tritium values in the Long Shot Mud Pits continue to decrease from levels measured in previous years.

Table 16 indicates that the mean yearly values approached 2050 TU in Mud Pit #1 and 3500 TU in Mud Pit #3 during the early 70's and have now (1975) declined to a lower level. As Seymour and Nelson (in prep.) note, "Although some single values exceeded 5000 TU, all the values are considerably less than the guidelines for ^{3}H in water for continuous occupational exposure (9×10^{6} TU), for individual members of the population at large (9×10^{5} TU), and for the average for the general population (3×10^{5} TU). The Maximum Permissible Concentration (MPC) of ^{3}H in water for continuous occupational exposure is 3×10^{-2} $\mu Ci/cm^{3}$, equivalent to 9×10^{6} TU, and was established by the International Commission on Radiological Protection (ICRP, 1959) and the U.S. National Committee on Radiation Protection (NCRP, 1959). For an individual member of the population at large in an uncontrolled area, the Radiation Protection Guide (RPG) value is 1/10 the MPC for continuous occupational exposure or 3×10^{-3} $\mu Ci/cm^{3}$ for ^{3}H which is equivalent to 9×10^{5} TU (ERDA, 1975). The average value for the general population is less than the value for the individual and for isotopes that concentrate in organs other than the gonads, a value 1/30 of the MPC value for continuous occupational exposure or 10^{-3} μCi of ^{3}H (3×10^{5} TU) has been established by the ICRP (1964). Another perspective on the significance of ^{3}H in the Amchitka samples is obtained by a comparison of the maximum values of 5000+ TU at Amchitka to values for ^{3}H in rainfall at other areas. At Adak, Aleutian Islands, in 1963 the monthly maximum value was 3900 TU and the annual mean was 1860 TU (IAEA, 1971)." At Vienna, a continental site, in 1963 the tritium values in precipitation ranged from 800 to almost 6000 TU (Schell et al.,1974).

Samples of aquatic vegetation, greenling, and Dolly Varden were analyzed for ^{3}H in free water and bound hydrogen. The results of the analyses are presented in Table 17. Except for the *Fontinalis* sample from the Long Shot drainage system, ^{3}H values in free water from Dolly Varden (85±52, 126±39* pCi/liter) and *Fontinalis* (126±91 pCi/liter) from three freshwater collection sites were similar to the mean ^{3}H value (110±45 pCi/liter) in water samples from 29 freshwater sites on Amchitka which were also sampled in August 1975. The *Fontinalis* samples from the Long Shot drainage system had a free water ^{3}H level (275±45 pCi/liter) which reflected the tritium level (333±65 pCi/liter) in the lower 500 meters of the Long Shot drainage system. The ^{3}H values in free water from greenling (<45, <65±6, <65±3 pCi/liter), *Fucus* (<113±58,< 84±39,<68±3 pCi/liter)

* These two errors are one-sigma counting errors. All other free water errors are one-standard deviation of the mean of two or more values.

and a Dolly Varden (51±6 pCi/liter) from the intertidal area off the mouth of Bridge Creek were also similar to the mean ^{3}H values, <48±39* pCi/liter, in water samples from six salt water collection sites around Amchitka.

Thus, as expected, there appears to be a sufficiently rapid exchange of the free water in the organisms so that the ^{3}H levels in the free water reflect the ^{3}H level of the water surrounding the organism. This rapid exchange of ^{3}H in the free water has also been noted by many other authors, including Bruner (1973), Robertson (1973) and Feinendegen (1967). They listed ^{3}H turnover half-times ranging from 1 to 20 days in free water of tissues from a variety of animal species.

The ^{3}H incorporated into the organically bound hydrogen of the tissues was recovered by a combustion procedure, as noted earlier. The concentration of this bound ^{3}H in the Amchitka sample was two to five times higher than the concentration of ^{3}H in the free water from the same sample. If a half-time of a few months or longer exists for the bound ^{3}H in the Amchitka samples, the bound ^{3}H could represent ^{3}H levels in the environment at some earlier time. Schell et al. (1974) has shown that ^{3}H levels in precipitation during the Spring-Summer fallout peak can be five to six times higher than ^{3}H levels in the Fall and Winter for both a marine site (Valentia, Ireland) and a continental site (Vienna, Austria). At Amchitka, the mean tritium level in 22 freshwater samples collected in May, 1974, was almost twice the mean ^{3}H level in water collected in late August, 1974, and the difference was a factor of five at one site. Thus, if the turnover rate of bound ^{3}H is low, the Spring ^{3}H levels could be sufficiently high to account for the higher level of ^{3}H in the bound hydrogen. Half-times for organically bound ^{3}H of from 110 to 300 days have been noted for animals (Robertson, 1973; Harrison et al.,1i73) and up to 2.7 years for plants (Stewart et al.,1970). Bogen and Welford (1976) also found that bound ^{3}H levels were higher than ^{3}H levels in free water by a factor of 3 to 4 for plants and 1.5 to 3 for animal tissues, while Rosenthal and Stewart (1973) noted a factor of 4 difference in the zooplankton, *Daphnia*, and Cohen and Kneip (1973) measured a tenfold increase of bound ^{3}H versus free ^{3}H in the roots of the aquatic plant, *Potamogeton*. The elevated ^{3}H levels noted by these authors were attributed to ^{3}H uptake during a period of higher environmental ^{3}H levels.

Thus, it seems likely that the ^{3}H in the bound hydrogen of the Amchitka samples represents ^{3}H incorporated into the tissues at some earlier time when the ^{3}H level in the environment was higher than it was during August, 1975, when the samples were collected, although concentration of ^{3}H by the tissues cannot be excluded as a possibility.

Soil, sand, *Fucus*, and greenling samples were also analyzed for $^{239,240}Pu$ (Table 18). Concentrations (<0.002 to 0.016 pCi/g, dry) of $^{239,240}Pu$ in sand and soil from Amchitka were similar to concentrations (0.005 to 0.012 pCi/g, dry) in soil collected in the coastal area of Washington State in September, 1974 (LRE unpublished data). The brown alga, *Fucus distichus*, from Amchitka Island had less $^{239,240}Pu$ (2 dpm/kg, wet wt.) by a factor of ten than did *Sargassum sp.* collected in 1970 from the Atlantic Ocean but more than in *Fucus*

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* These two errors are one-sigma counting errors. All other free water errors are one-standard deviation of the mean of two or more values.

vessaculosus (0.14 dpm/kg, wet wt.) collected at Woods Hole in 1971 (Noshkin *et al.* ,1973) or in *Pelagophycus porra* (0.3 dpm/kg, wet wt.) collected along the California Coast in 1971 (Wong, Hodge and Folsom, 1972). The surface tissue of *P. porra* had a higher ^{239}Pu concentration (4.8 dpm/kg, wet wt.) than the average concentration of either the entire *P. porra* from California or the *F. distichus* from Amchitka. Muscle tissue of greenling from Amchitka had less than 0.001 pCi of $^{239,240}Pu$ per gram of dry weight, our limits of detection for the sample size and counting time used in these analyses.

The $^{239,240}Pu$ in the Washington soil and in the Atlantic and California algae was assumed to be from worldwide fallout, and the similariy of levels in soil and algae at Amchitka and these other sites points to the same source for the $^{239,240}Pu$ at Amchitka.

Results of the radiation survey are given in Table 19. The survey was performed with an Eberline survey meter (Model E-510), using a probe with a window thickness of less than 2 mg/cm^2. Measurements were made with an unshielded probe. This instrument was capable of detecting beta energies down to 40 keV and has a gamma sensitivity of about 5000 cpm/mR/hr for ^{60}Co. Tritium, which has a beta energy of about 19 keV, was not detectable with this probe. The 13 locations surveyed were between Charlie Runway and E-site and included the Long Shot, Milrow, and Cannikin surface ground zeros and adjacent areas. The Cannikin drill-back site and Sand Beach Cove were also surveyed. Maximum values recorded while holding the survey instrument one meter above the ground ranged from 0.03 to 0.05 mR/hr without a beta shield. Average levels at all sites were about 0.01 mR/hr or less. These values are similar to results of comparable surveys in other areas of the United States.

The additions to the old tables, plus the new tables, extend the record of radiological data from July 1970 through August 1975. These data in no way change the major conclusions of the previous progress reports; namely, the radionuclides present in the biological and environmental samples analyzed are not of Cannikin or Milrow origin, and only some ponds, mud pits and their drainage system in the immediate vicinity of the Long Shot surface ground zero remain contaminated with ^{3}H. The amounts and types of fission products and induced radionuclides detected point to their origin from worldwide fallout.

4. SUMMARY AND CONCLUSIONS

The present program for periodical collection of biological and environmental samples at Amchitka and for analyses of these samples for radionuclide content began in July 1970. Five previous progress reports give an account of the results of this program through 1974, 38 months after the Cannikin detonation. In this, the sixth progress report, the account of the program is extended through August 1975. In addition, the results of radiation surveys performed in August 1974 and 1975 are given.

Concentrations of gamma-emitting fallout radionuclides in samples collected in 1975 were generally less than concentrations in samples collected in 1974, and were less than the values for naturally occurring ^{40}K. This re-established a trend of decreasing abundance which had been evident from 1970 to 1973, but

had been reversed in 1974, due to an increase in worldwide fallout. Levels of naturally occurring ^{7}Be and ^{40}K in 1975 were similar to levels present in 1974. The new data acquired during 1975 do not change the important conclusions of the previous progress reports, namely:

a. Naturally occurring ^{7}Be and ^{40}K were the most abundant radionuclides present in most sample types.

b. Trace quantities of fission products, induced radionuclides and plutonium have been detected in amounts that would be expected from world fallout at that latitude.

c. No unexpected radionuclides or radionuclide ratios have been detected.

d. Tritium values in seawater and freshwater are not significantly different than the values that would be expected at island stations at the same latitude in the northern hemisphere.

e. Some of the ponds and mud pits in the vicinity of the Long Shot Surface Ground Zero remain contaminated with ^{3}H. The drainage from the mud pits is also contaminated. The concentration is less than the amount of ^{3}H in the rainfall at Vienna, Austria, in 1963, and about twice as great as the amount in rainwater samples from Valentia, Ireland, in the same year.

f. An extensive search with sensitive instruments for radionuclides in biological and environmental samples--marine, terrestrial, and freshwater--collected during the first 45 months after the Cannikin detonation of November 6, 1971, indicates that no radionuclides from the Cannikin or Milrow events have escaped to the surface environment.

TABLE 1

Scientific and Common Names and Wet Weight to Dry Weight Ratios of Some Amchitka Island Organisms

Species	Tissue	Wet/Dry Ratio	Standard Deviation
	VERTEBRATES		
MAMMALS			
Rattus norvegicus Rat	Bone	____	____
FISH[a]			
Salvelinus malma Dolly Varden	Muscle	3.62	0.70
	Viscera	4.20	0.42
Oncorhynchus gorbuscha Pink Salmon	Gonad	4.51	____
	Muscle	4.33	____
	Liver	4.49	0.69
Hippoglossus stenolepis Halibut	Muscle	4.01	0.58
	Liver	3.63	0.04
Hexagrammos lagocephalus Rock Greenling	Liver	3.43	0.41
	Muscle	4.83	0.14
	Viscera	2.13	0.04
BIRDS			
Lagopus mutus Rock Ptarmigan	Liver	3.52	0.32
	Muscle	3.54	0.08
	INVERTEBRATES		
Sponge (green)	Entire	9.5	____
	MARINE ALGAE		
Fucus distichus Marine algae	Entire	4.94	1.4
	FRESHWATER VEGETATION		
Cladophora sp. Filamentous algae	Entire	5.1	____
Fontinalis sp. Moss	Entire	4.83	0.89
Ranunculus sp. Freshwater plant	Entire	12.2	4.10

TABLE 1 (continued)

Species	Tissue	Wet/Dry Ratio	Standard Deviation
	AUFWUCHS		
Periphyton and other organisms	Entire	7.27	2.40
	TERRESTRIAL VEGETATION		
Cladonia sp. Lichens	Entire	3.75	0.87
Empetra sp. Crowberry	Entire	____	_____

(a) Names are from "Common and Scientific Names of Fishes from the United States and Canada" (Third Edition), 1970 American Fisheries Society Special Pub. No. 6.

Table 2

Some Gamma-Emitting Radionuclides on Air Filters at Ground Level at the Amchitka Island Base Camp

Collection Period	n[b]	Mean Volume $10^3 m^3$	Gamma-Emitting Radionuclides (pCi/thousand cubic meters)[a] ^{7}Be	^{95}Zr	^{95}Nb	^{103}Ru	^{137}Cs	^{144}Ce
Pre-Cannikin								
1970-71	28	24.5 ± 3.7	20 ± 9	2.8 ± 2.1	5.9 ± 4.5	0.7 ± 1.1	0.7 ± 0.3	NA
Post-Cannikin								
1972	45	11.3 ± 1.6	17 ± 11	0.7 ± 1.2	1.3 ± 1.6	0.37 ± 0.59	0.24 ± 0.24	NA
1973	34	11.1 ± 1.4	16 ± 10	---	0.04 ± 0.09	0.04 ± 0.07	0.16 ± 0.13	0.42 ± 0.53
1974	1	~ 3	---	---	---	---	---	---

a. Single sample (n=1) errors are two-sigma, propagated, counting errors, while the error shown for more than one sample (n>1) is one standard deviation of the mean. Dashes in the table indicate the sample count is not significant and NA indicates the radionuclide was not included in the gamma-spectrum analysis.

b. Number of pooled samples.

Table 3

Gamma-Emitting Radionuclides in the Freshwater Moss Fontinalis Sp.
Collected at Amchitka Island

Location and Date	n	Gamma-Emitting Radionuclides (pCi/g, dry)[a]									
		^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	^{155}Eu
Clevenger Creek											
1970-71[b]	4	8 ± 4	5.8±3.0	1.4±1.0	2.9 ±2.3	0.28±0.54	3.2 ±1.2	1.4 ±.6	4.0±1.5	NA	NA
1971-72	5	2.7± 4.3	6.2±2.1	0.6±0.3	2.0 ±2.0	0.67±0.87	0.54±0.75	0.18±.4	1.9±1.2	1.1 ±1.6	---
1973	2	4.5± 1.1	5.4±0.2	---	0.15±0.21	0.07±0.10	0.74±0.18	0.23±.03	2.3±1.1	0.84±0.37	0.22±.01
May '74	1	17 ±11	3.9±1.8	2.4±1.2	3.4 ±0.8	---	3.1 ±0.9	0.55±.16	1.2±0.1	2.8 ±0.3	0.26±.10
Aug '74	1	4.3± 1.9	5.7±1.4	0.7±0.3	1.5 ±0.2	---	2.5 ±0.5	0.31±.10	1.5±0.1	3.9 ±0.3	0.27±.06
Aug '75	1	4.2± 2.0	6.3±1.4	---	0.44±0.18	---	0.88±0.47	0.17±.09	0.7±0.1	2.3±0.3	0.08±.06
Bridge Creek											
1970-71[b]	3	10 ± 5	7.3±3.2	1.7±1.4	3.9 ±3.1	---	4.4 ±2.5	1.2 ±.8	4.1±3.0	NA	NA
1971-72	5	6.2± 2.8	6.8±1.0	1.0±0.6	2.2 ±1.5	0.6 ±0.8	1.1 ±1.3	0.4 ±.6	3.3±1.3	0.52±1.2	---
1973	2	5.1± 1.4	5.8±0.4	---	0.08±0.11	---	---	0.14±.19	2.3±1.9	1.1 ±0.5	0.11±.15
May '74	1	5.2± 0.9	7.9±1.6	2.1±0.2	4.4 ±0.2	0.24±0.10	3.5 ±0.6	0.33±.11	1.9±0.1	4.5 ±0.3	0.18±.06
Aug '74	1	3.6± 2.5	5.2±1.8	1.0±0.3	2.1 ±0.3	---	2.3 ±0.7	0.20±.15	1.0±0.1	4.6 ±0.4	0.23±.09
Aug '75	1	3.3± 2.2	5.8±1.7	0.3±0.3	0.6 ±0.23	---	1.7 ±0.7	0.25±.14	1.1±0.1	3.1 ±0.4	0.10±.08
Duck Cove Creek											
1970-71[b]	3	8 ± 3	6.6±2.6	1.3±1.1	2.7 ±2.3	0.5 ±0.6	2.8 ±1.5	1.4 ±.5	2.6±1.1	NA	NA
1971-72	5	6.4± 5.4	6.1±0.8	0.5±0.2	1.3 ±0.8	0.9 ±1.2	1.2 ±1.0	1.1 ±.5	1.7±0.9	0.32±0.72	---
1973	2	7.1± 7.0	6.4±0.4	---	---	---	0.65±0.92	0.32±.23	1.2±0.5	0.9 ±1.3	0.09±.13
May '74	1	7.4± 1.0	5.4±1.2	1.6±0.2	3.5 ±0.2	0.36±0.11	3.4 ±0.6	0.53±.13	2.2±0.1	5.7 ±0.3	1.16±.05
Aug '74	1	1.4± 0.8	<6	---	0.21±0.08	---	0.29±0.19	---	0.8±0.1	0.34±0.1	---
Aug '75	1	1.9± 1.2	5.4±1.1	0.2±0.2	0.65±0.15	---	0.69±0.44	0.26±.09	0.8±0.1	2.4 ±0.26	0.09±.05
Long Shot Drainage											
Aug '75	1	4.4± 1.2	4.0±1.3	0.2±0.1	0.61±0.13	---	2.3 ±0.4	0.27±.01	1.2±0.1	3.2 ±0.2	0.2 ±.08
Mp-12 Creek											
1973	2	9.0± 8.6	4.7±2.0	---	0.17±0.23	---	0.7 ±0.9	0.12±.17	2.0±1.2	1.4 ±0.8	0.09±.12
May '74	1	13 ± 1.0	6.0±1.1	1.4±0.13	3.4 ±0.18	0.20±0.05	4.1 ±0.6	0.23±.10	2.1±0.1	6.0 ±0.3	0.16±.04
Aug '74	1	4.5± 2.0	5.8±1.2	0.8±0.3	1.3 ±0.3	---	1.9 ±0.6	---	0.7±0.1	3.9 ±0.3	0.13±.06
Aug '75	1	6.5± 1.8	4.5±1.7	0.3±0.2	0.67±0.18	---	2.7 ±0.7	---	0.5±0.1	5.2 ±0.3	0.21±.11

Table 3 (continued)

Location and Date	n	Gamma-Emitting Radionuclides (pCi/g, dry)[a]									
		^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	^{155}Eu
Ice Box Lake Inlet											
1973	2	4.1±0.8	5.7±1.0	---	0.08±0.11	---	0.5±0.0	0.28±.06	1.5±0.6	0.87±.12	0.17±.08
May '74	1	3.7±0.6	5.0±1.0	0.70±.09	1.2 ±0.11	---	1.0±0.4	0.20±.09	3.1±0.1	2.4 ±.21	0.13±.04
Aug '74	1	2.3±0.8	5.9±0.5	0.17±.14	0.6 ±0.1	---	0.9±0.3	0.23±.08	1.0±0.1	1.6 ±.2	---
Aug '75	1	---	4.7±1.3	---	0.27±0.16	---	0.7±0.5	0.20±.11	1.3±0.1	1.8 ±.3	0.09±.07
Cannikin Lake Outlet											
1973	2	7.3±0.5	6.2±0.7	0.09±.12	0.16±0.23	0.07±.09	0.6±0.8	0.30±.18	3.9±4.6	1.1 ±.4	0.15±.21
May '74	1	10 ±1.0	2.4±0.6	1.2 ±.12	2.7 ±0.15	0.24±.13	2.2±0.3	0.29±.05	1.1±0.1	6.3 ±.2	0.13±.03
Aug '74	1	---	4.2±0.6	1.2 ±.15	2.3 ±0.17	0.21±.11	2.6±0.5	0.33±.12	1.6±0.1	6.4 ±.3	---
Aug '75	1	7.9±1.9	5.1±1.1	---	0.52±0.16	---	1.8±0.5	0.24±.09	2.0±0.1	2.1 ±.3	---

a. Single sample (n=1) errors are two-sigma, propagated, counting errors, while the error shown for more than one sample (n>1) is one standard deviation of the mean. Dashes in the table indicate that the sample count is not significant and NA indicates the radionuclide was not included in the gamma-spectrum analysis.

b. Pre-Cannikin.

Table 4

Gamma-Emitting Radionuclides in the Freshwater Plant Ranunculus Sp.
Collected at Amchitka Island

Location and Date	n	Gamma-Emitting Radionuclides (pCi/g, dry)[a] ^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	^{155}Eu
Clevenger Creek											
1970-71[b]	4	4.1± 4.7	21 ±4	0.6 ±0.8	1.3 ±1.6	---	1.9 ±1.8	0.3 ±.6	1.7 ±1.1	NA	NA
1971-72	5	5.0± 8.7	16 ±1.6	0.36±0.49	0.99±0.96	0.54±0.53	0.6 ±0.8	0.5 ±.54	1.6 ±0.7	NA	NA
1973	2	1.9± 2.7	22 ±3.5	---	---	---	---	---	0.8 ±0.5	0.3 ±0.4	---
May '74	1	3.1± 0.6	24 ±1.6	0.80±0.10	1.8 ±0.1	0.12±0.08	1.0 ±0.4	0.14±.09	0.87±0.07	2.3 ±0.2	---
Aug '74	1	1.4± 1.4	15 ±1.3	---	---	---	---	---	0.24±0.07	0.5 ±0.3	---
Aug '75	1	---	19 ±2.3	---	---	---	---	---	0.52±0.09	0.34±0.3	---
Bridge Creek											
1970-71[b]	3	8.4± 5.8	17 ±3	1.0 ±0.4	2.3 ±1.0	---	2.1 ±0.5	0.5 ±.5	3.2 ±0.2	NA	NA
1971-72	5	3.6± 5.0	21 ±7.6	0.36±0.22	0.78±0.48	0.19±0.30	0.62±0.91	0.3 ±.4	2.2 ±1.4	NA	NA
1973	1	4.7± 1.5	29 ±2.3	---	---	---	---	---	1.2 ±0.1	0.7 ±0.2	0.15±0.10
May '74	1	3.8± 0.8	19 ±2.5	1.1 ±0.2	2.4 ±0.2	0.15±0.09	1.5 ±0.6	0.23±.12	1.6 ±0.1	3.4 ±0.3	---
Aug '74	1	2.0± 0.8	19 ±0.8	0.4 ±0.1	0.7 ±0.1	---	0.94±0.32	0.16±.08	0.85±0.06	1.7 ±0.2	---
Aug '75	1	2.5± 1.2	21 ±2.2	---	0.35±0.13	---	0.67±0.46	---	1.2 ±0.1	1.0 ±0.23	---
Duck Cove Creek											
1970-71[b]	2	4.0± 3.5	15 ±8	0.41±0.15	0.86±0.32	---	1.0 ±1.0	0.7 ±.5	1.3 ±0.4	NA	NA
1971-72	5	6.2± 8.9	20 ±5	0.42±0.24	0.94±0.57	0.52±0.66	0.87±0.80	0.6 ±.4	1.6 ±0.9	NA	NA
1973	1	6.0± 1.5	20 ±1.5	---	---	---	---	0.26±.09	2.9 ±0.1	0.9 ±0.2	0.14±0.08
May '74	1	3.1± 0.7	14 ±1.5	0.46±0.09	1.2 ±0.1	0.16±0.08	0.81±0.36	---	4.0 ±0.2	1.8 ±0.2	---
Aug '74	1	---	21 ±2	---	0.47±0.19	---	---	---	0.67±0.08	0.78±0.22	---
Aug '75	1	---	13 ±1.8	---	---	---	0.63±0.43	---	1.6 ±0.13	0.85±0.24	---
Clevenger Creek Outlet											
1970-71[b]	2	2.5± 2.2	5.3±3.5	0.39±0.07	0.81±0.16	0.4 ±0.5	0.5 ±0.6	0.6 ±.1	0.6 ±0.8	NA	NA
1971-72	5	12 ±14	10 ±9	0.78±0.86	2.5 ±2.4	0.9 ±1.3	1.2 ±0.4	0.1 ±.2	1.1 ±0.1	NA	NA

Table 4 (continued)

Location and Date	n	Gamma-Emitting Radionuclides (pCi/g, dry)[a]									
		^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	^{155}Eu
Clevenger Creek Outlet (cont)											
1973	1	3.4± 1.0	20 ±2.1	---	---	---	---	---	0.3 ±0.1	---	---
Aug '74	1	---	24 ±1.1	0.45±0.20	0.80±0.19	---	---	---	0.7 ±0.1	1.4 ±0.3	---
Aug '75	1	1.9± 0.7	18 ±1.5	---	0.07±0.07	---	0.5±0.3	---	0.8 ±0.1	0.6 ±0.2	---
Long Shot Drainage											
Aug '75	1	5.3±2.4	19 ±3.0	---	0.42±0.26	---	1.3±0.8	---	1.0 ±0.1	1.4 ±0.4	---
Cannikin Lake Outlet											
May '74	1	13 ± 1.2	17 ±1.8	1.6 ±0.2	3.9 ±0.2	0.45±0.13	3.4±0.6	---	1.3 ±0.1	6.4 ±0.3	0.20±0.06
Aug '74	1	3.5± 1.3	28 ±3.3	0.31±0.19	0.60±0.16	---	1.2±0.8	---	1.4 ±0.1	2.0 ±0.3	---
Aug '75	1	2.3± 0.9	10 ±1.5	---	0.18±0.09	---	---	0.22±0.1	2.9 ±0.2	1.5 ±0.2	0.14±0.06

a. Single sample (n=1) errors are two-sigma, propagated, counting errors, while the error shown for more than one sample (n>1) is one standard deviation of the mean. Dashes in the table indicate that the sample count is not significant and NA indicates the radionuclide was not included in the gamma-spectrum analysis.

b. Pre-Cannikin

Table 5

Gamma-Emitting Radionuclides in Freshwater Aufwuchs and Filamentous Algae Collected at Amchitka Island[a]

Location and Date	n	Gamma-Emitting Radionuclides (pCi/g, dry)[b]								
		^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce
Long Shot Pond										
1970-71[c]	7	15 ±12	9 ±4	3.1 ±1.9	6.7 ±3.9	2.1 ±2.7	5.8 ±4.1	1.5 ±0.9	1.8 ±0.9	NA
1971-72	5	3.2± 3.4	10 ±1.4	0.8 ±1.0	2.2 ±2.9	0.3±0.56	0.2 ±0.4	0.4 ±0.3	0.5 ±0.1	1.1 ±1.6
1973	2	3.7± 2.1	9.8±0.4	---	0.09±0.12	---	---	---	0.27±0.02	0.42±0.26
May '74	1	26 ± 9	4.9±1.4	---	4.6 ±1.0	---	2.5 ±0.8	0.39±0.13	0.40±0.07	7.7 ±0.6
Aug '74	1	3.4± 1.0	9.4±0.8	0.55±0.15	0.92±0.14	---	1.3 ±0.4	0.24±0.09	0.34±0.05	1.2 ±0.2
Aug '75	1	2.8± 1.8	9.8±1.6	---	0.28±0.19	---	---	0.21±0.09	0.19±0.05	1.4 ±0.3
MP-12 Creek										
July '72	1	7.8± 1.7	5.2±0.5	3.5 ±0.4	6.4 ±0.5	1.7 ±0.3	0.76±0.28	---	2.0 ±0.2	3.8 ±0.4
Aug '73	1	8.3± 0.9	9.6±1.6	0.29±0.11	0.34±0.08	0.24±0.09	---	---	2.7 ±0.1	0.36±0.17
May '74	1	9.1± 1.1	8.9±1.6	4.0 ±0.2	7.6 ±0.3	0.28±0.13	2.9 ±0.7	0.79±0.13	2.5 ±0.2	12 ±0.5
Aug '75	1	13 ± 1.2	6.2±1.5	0.36±0.11	0.97±0.12	---	2.3 ±0.5	0.26±0.10	2.3 ±0.1	3.2 ±0.2
White Alice Inlet to Cannikin Lake										
Aug '73	1	23 ±1.5	6.1±1.4	0.59±0.13	1.1 ±0.14	0.91±0.15	---	---	0.72±0.09	1.4 ±0.2
Aug '74	1	12 ±1.2	9.8±0.6	0.99±0.14	2.0 ±0.15	0.43±0.08	1.7 ±0.4	---	1.1 ±0.08	4.3 ±0.2
Aug '75	1	3.8±0.9	5.1±1.3	---	0.2 ±0.08	---	0.89±0.4	0.16±0.09	0.75±0.09	2.0 ±0.3

a. Aufwuchs samples were collected from Long Shot Pond and MP-12 Creek, while the algae samples were collected from White Alice Inlet to Cannikin Lake.

b. Single sample (n=1) errors are two-sigma, propagated, counting errors, while the error shown for more than one sample (n>1) is one standard deviation of the mean. Dashes in the table indicate the sample count is not significant and NA indicates the radionuclide was not included in the gamma-spectrum analysis.

c. Pre-Cannikin.

Table 6

Gamma-Emitting Radionuclides in Lichens Collected at Amchitka Island

Location and Date	n	Gamma-Emitting Radionuclides (pCi/g, dry)[a]									
		^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	^{155}Eu
Clam Lake											
1970-71[b]	7	15 ±6.1	4.5±6.4	1.0 ±1.0	2.1±1.9	1.5 ±3.1	5.4±3.2	5.6 ±7.2	37±39	NA	NA
1971-72	5[c]	9.7±8.2	6.2±5.5	0.7 ±0.7	1.7±1.4	0.5 ±0.7	3.6±3.8	3.4 ±3.5	27±23	9 ±0.4	1.5 ±0.14
1973	3	5.3±0.5	3.5±0.3	0.03±0.05	0.1±0.1	0.03±0.06	1.1±0.2	0.60±0.12	7±6.9	3.7±1.3	0.56±0.32
May '74	1	4.5±0.9	2.4±0.9	0.48±0.09	1.2±0.1	---	1.4±0.5	0.56±0.11	12±0.3	4.0±0.3	0.38±0.05
Aug '74	1	5.2±1.2	3.7±0.4	0.23±0.18	0.9±0.1	---	1.3±0.4	0.33±0.09	9±0.2	4.1±0.2	0.33±0.09
Aug '75	1	4.6±1.7	2.5±1.1	---	0.5±0.1	---	1.0±0.6	0.28±0.14	6±0.2	5.5±0.4	0.23±0.08
Ice Box Lake											
Oct '72	1	---	2.8±1.2	0.7 ±0.1	1.4±0.3	3.8 ±2.0	---	2.6 ±0.7	14±0.2	NA	NA
1973	2	5.7±0.3	0.6±0.8	---	---	---	1.3±0.1	0.86±0.12	16±0.7	4.3±1.1	0.63±0.18
May '74	1	8.6±1.1	1.4±0.9	0.80±0.12	2.1±0.2	---	2.1±0.5	0.59±0.13	13±0.3	8.1±0.4	0.40±0.06
Aug '74	1	5.7±1.5	1.3±0.5	0.49±0.19	0.8±0.1	---	2.2±0.5	0.64±0.13	9±0.2	6.0±0.3	0.43±0.07
Aug '75	1	5.2±1.5	1.9±1.6	---	0.4±0.1	---	1.5±0.6	0.48±0.14	11±0.3	5.4±0.3	0.38±0.13
Cannikin Lake											
July '72	1	5.3±1.7	2.0±0.7	0.7 ±0.1	1.6±0.1	0.6 ±0.3	---	0.2 ±0.4	21±0.2	NA	NA
1973	2	5.3±1.3	2.3±0.1	---	---	0.07±0.09	1.3±0.1	0.90±0.06	16±0.7	4.1±1.6	0.73±0.17
May '74	1	6.7±0.6	1.6±0.6	0.62±0.07	1.6±0.1	0.09±0.06	1.6±0.3	0.65±0.08	11±0.2	5.8±0.2	0.39±0.03
Aug '74	1	5.1±1.3	2.5±0.6	0.30±0.15	0.7±0.1	---	1.7±0.5	0.34±0.12	8±0.2	4.3±0.3	0.30±0.06
Aug '75	1	6.1±2.1	---	---	0.4±0.2	---	1.4±0.5	0.40±0.10	7±0.2	4.6±0.3	0.26±0.11

a. Single sample (n=1) errors are two-sigma, propagated, counting errors, while the error shown for more than one sample (n>1) is a one-standard deviation of the mean. Dashes in the table indicate the sample count is not significant, and NA indicates that the radionuclide was not included in the gamma-spectrum analysis.

b. Pre-Cannikin.

c. n equals 1 for ^{144}Ce and ^{155}Eu.

Table 7

Some Gamma-Emitting Radionuclides in the Marine Alga Fucus Collected at Amchitka Island

Location and Date	n	Gamma-Emitting Radionuclides (pCi/g, dry)[a]					
		^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{137}Cs	^{144}Ce
Constantine Harbor							
1970-71[b]	3	0.52±0.18	25±6	0.10±0.08	0.21±0.17	0.05±0.02	NA
1972	4	2.5 ±2.0	34±2	0.04±0.04	0.07±0.08	---	---
1973	2	---	34±0.7	---	---	0.03±0.04	---
May '74	1	1.0 ±0.4	32±2.0	0.36±0.04	0.73±0.09	0.05±0.03	1.5 ±0.2
Aug '75	1	1.7 ±1.3	32±2.3	---	---	0.04±0.04	---
Duck Cove							
1970-71[b]	3	0.8 ±0.3	23±2	0.07±0.04	0.15±0.10	0.04±0.02	NA
1971-72	5	1.9 ±1.5	35±4.5	0.05±0.03	0.10±0.07	0.01±0.03	---
1973	3	0.47±0.41	35±9.9	---	---	0.03±0.05	0.08±0.14
May '74	1	---	38±1.2	0.08±0.06	0.22±0.05	0.07±0.02	0.91±0.10
Aug '74	1	---	36±2.3	---	---	0.07±0.04	0.35±0.21
Aug '75	1	---	33±2.3	---	---	---	---
Square Bay							
Aug '75	1	---	38±2.4	---	---	---	---
Sand Beach Cove							
1970-71[b]	5	0.09±0.09	26±6	0.08±0.06	0.17±0.14	0.06±0.03	NA
1971-72	6	3.8 ±3.2	26±4.6	0.22±0.20	0.45±0.43	0.01±0.02	---
1973	2	---	35±2.1	---	---	---	0.16±0.23
May '74	1	0.61±0.45	39±2.3	0.23±0.09	0.34±0.08	---	0.92±0.19
Aug '74	1	---	27±1.4	---	---	---	0.25±0.19
Aug '75	1	---	34±2.2	---	0.16±0.12	0.04±0.04	---

a. Single sample (n=1) errors are two-sigma, propagated, counting errors, while the error shown for more than one (n>1) is one standard deviation of the mean. Dashes in the table indicate that the sample count is not significant and NA indicates the radionuclide was not included in the gamma-spectrum analysis.

b. Pre-Cannikin.

Table 8

Some Gamma-Emitting Radionuclides in Green Sponge Collected at Amchitka Island

Location and Date	n	Gamma-Emitting Radionuclides (pCi/g, dry)[a]				
		^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{144}Ce
Duck Cove						
1971-72	4	2.7±2.7	11 ±3	0.05±0.07	0.11±0.14	NA
1973	2	1.5±0.6	9.8±0.1	---	---	0.42±0.04
May '74	1	1.0±0.4	10 ±1.5	0.16±0.07	0.36±0.07	1.1 ±0.17
Aug '74	1	---	7.2±1.3	---	---	1.2 ±0.23
Aug '75	1	---	7.7±1.4	---	---	0.73±0.20
Sand Beach Cove						
June '72	1	---	6.8±1.7	0.24±0.13	0.54±0.28	NA
April '73	1	---	12 ±1.7	---	---	0.31±0.17
May '74	1	1.1±0.4	9.0±1.5	0.10±0.07	0.26±0.07	0.60±0.16
Aug '74	1	---	9.6±1.4	---	---	1.2 ±0.2
Aug '75	1	---	10.0±1.6	---	---	0.56±0.2
Square Bay						
1973	2	0.7±0.9	9.7±0.5	---	---	0.35±0.12
Aug '75	1	1.2±0.9	9.5±1.7	---	0.11±0.09	0.61±0.20

a. Single sample (n=1) errors are two-sigma, propagated, counting errors, while the error shown for more than one (n>1) is one standard deviation of the mean. Dashes in the table indicate that the sample count is not significant and NA indicates the radionuclide was not included in the gamma-spectrum analysis.

Table 9

^{40}K and ^{137}Cs in Halibut Collected off Amchitka Island

Location and Date	Tissue	n[b]	Gamma-Emitting Radionuclides (pCi/g, dry)[2] ^{40}K	^{137}Cs
Bering Sea (Off C-Site)				
1971[c]	Muscle	4/4	18 ± 1.7	0.06 ± 0.08
1971-72	"	9/9	17 ± 1.7	0.02 ± 0.03
1973	"	5/5	18 ± 1.1	0.11 ± 0.02
Aug '75	"	1/1	18 ± 1.6	0.06 ± 0.04
1971[c]	Liver	4/4	13 ± 5.9	0.27 ± 0.28
1971-72	"	8/8	6.7 ± 2.1	---
1973	"	5/5	6.9 ± 1.3	0.04 ± 0.05
Aug '75	"	1/8	11 ± 1.5	0.05 ± 0.03
(Constantine Harbor)				
Aug '74[d]	Liver	5/5	7.5 ± 2.6	0.06 ± 0.07
(Midden Cove)				
Aug '75	Muscle	2/2	19 ± 1.9	0.05 ± 0.04
" "	Liver	4/4	10 ± 1.5	---

a. Values are given as the mean ± one standard deviation. The dashes in the body of the table indicate the mean was not significant; i.e., all the net sample counts in that group were less then their two-sigma, propagated, counting errors.

b. Number of pooled samples/total number of fish in all samples.

c. Pre-Cannikin

d. Cobalt-60 was present (0.03 ± 0.02 pCi/g, dry) in one liver sample.

Table 10

^{40}K and ^{137}Cs in Greenling Collected off Amchitka Island

Location and Date	Tissue	n[b]	Gamma-Emitting Radionuclides (pCi/g, dry)[a] ^{40}K	^{137}Cs
Constantine Harbor				
1971[c]	Muscle	2/19	16 ± 0.7	0.37 ± 0.42
1971-72	"	15/29	15 ± 1.3	0.04 ± 0.04
1973	"	2/9	17 ± 2.8	0.05 ± 0.06
May '74	"	1/5	18 ± 1.5	0.06 ± 0.03
Aug '74	"	1/5	16 ± 0.8	0.07 ± 0.05
Aug '75	"	1/4	21 ± 2.5	0.49 ± 0.07
1971[c]	Viscera	2/19	13 ± 0.7	0.15 ± 0.05
Dec '71	Liver	1/10	13 ± 1.6	0.21 ± 0.12
1973	Viscera	1/4	9.1 ± 0.6	---
May '74	"	1/5	15 ± 1.0	0.03 ± 0.02
Aug '74	"	1/5	9.2± 0.8	---
Aug '75	"	1/4	11 ± 2.2	0.06 ± 0.05
Sand Beach Cove				
1971[c]	Muscle	3/27	15 ± 1.2	0.07 ± 0.02
1971-72	"	15/26	15 ± 1.6	0.03 ± 0.05
1973	"	2/12	17 ± 1.4	0.05 ± 0.06
May '74	"	1/5	21 ± 1.9	0.05 ± 0.04
Aug '74[d]	"	1/4	15 ± 0.7	---
Aug '75	"	1/8	25 ± 2.7	0.08 ± 0.06
1971[c]	Viscera	3/27	13 ± 0.6	0.02 ± 0.02
1972	Liver	1/6	21 ± 2.9	---
1973	Viscera	1/6	11 ± 0.4	---
1973	Liver	1/6	13 ± 0.6	---
May '74	Viscera	1/5	9.1 ± 1.1	---
Aug '74	"	1/4	8.1 ± 2.1	---
Aug '75	"	1/8	6.3 ± 1.4	0.06 ± 0.04
Square Bay				
Aug '75	Muscle	1/5	16 ± 1.6	---
Aug '75	Viscera	1/5	7.8 ± 1.4	0.07 ± 0.04

Table 10 (continued)

Location and Date	Tissue	n[b]	Gamma-Emitting Radionuclides (pCi/g, dry)[a] ^{40}K	^{137}Cs
Duck Cove				
1972	Muscle	8/14	16 ± 1.1	0.06 ± 0.06
1973	"	2/8	15 ± 2.8	0.08 ± 0.01
May '74	"	1/3	18 ± 1.6	0.06 ± 0.03
Aug '74[e]	"	2/6	15 ± 1.8	0.07 ± 0.02
Aug '75	"	1/6	17 ± 1.8	0.09 ± 0.04
1973	Viscera	1/4	12 ± 0.5	0.13 ± 0.03
May '74	"	1/3	7.7 ± 0.8	0.04 ± 0.02
Aug '74	"	2/6	9.5 ± 0.1	0.15 ± 0.05
Aug '75	"	1/6	9.5 ± 1.2	0.04 ± 0.03

a. Single sample (n=1) errors are two-sigma, propagated, counting errors, while the error shown for more than one sample (n>1 is one standard deviation of the mean. Dashes in the table indicate that the sample count is not significant.

b. Number of pooled samples/total number of fish in all samples.

c. Pre-Cannikin

d. Cobalt-60 (0.07 ± 0.04 pCi/g) was also detected in this sample.

e. Cobalt-60 (0.03 ± 0.02 pCi/g) was also detected in this sample.

Table 11

• ^{40}K and ^{137}Cs in Dolly Varden collected at Amchitka Island

Collection Date	Location	Tissue	n[b]	Gamma-Emitting Radionuclides (pCi/g, dry)[a] ^{40}K	^{137}Cs
1971[c]	Jones Lake	Muscle	1/1	15 ± 0.8	0.35 ± 0.05
1972	DK-45 Lake	"	3/8	16 ± 1.0	5.7 ± 3.9
1973	Jones Lake	"	1/2	16 ± 0.5	0.28 ± 0.03
1973	Bridge Creek	"	1/1	15 ± 0.9	0.13 ± 0.06
1973	Silver Salmon Outlet	"	1/4	16 ± 0.4	0.13 ± 0.02
May '74	Jones Lake	"	1/5	14 ± 1.7	0.28 ± 0.05
Aug '74	Cannikin Lake	"	1/9	14 ± 0.5	0.31 ± 0.03
Aug '74	Jones Lake	"	3/10	13 ± 0.9	0.17 ± 0.10
Aug '74	Duck Cove	"	1/4	17 ± 0.5	0.35 ± 0.03
Aug '75	Jones Lake	"	1/5	4.4± 0.9	0.10 ± 0.03
"	Cannikin Lake	"	1/6	12 ± 1.6	0.25 ± 0.05
"	Bridge Creek	"	1/1	16 ± 2.2	0.33 ± 0.07
"	Duck Cove Creek[d]	"	1/3	14 ± 1.7	0.10 ± 0.04
"	Clevenger Creek[d]	"	1/4	13 ± 1.7	0.05 ± 0.04

a. Single sample (n = 1) errors are two-sigma, propagated, counting errors, while the error shown for more than one (n > 1) is one standard deviation of the mean. Dashes in the table indicate that the sample count if not significant and NA indicates the radionuclide was not included in the gamma-spectrum analysis.

b. Number of pooled samples/total number of fish in all samples.

c. Pre-Cannikin.

d. Collected from the intertidal area at the mouths of these streams.

Table 12

Some Gamma-Emitting Radionuclides in Rock Ptarmigan
Collected at Amchitka Island

Collection Date	Collection Location	Tissue	Number of Birds	Radionuclides (pCi/g, dry)[a] ^{40}K	^{137}Cs
1970-71[b]	South Bight	Muscle	4	11 ± 0.5	1.0 ± 0.6
1971-72	C-Site	"	3	11 ± 1.6	0.70 ± 0.04
1973	c	"	5	11 ± 0.8	0.43 ± 0.25
May '74	C-Site	"	2	11 ± 1.2	0.42 ± 0.05
Aug '74	C-Site	"	4	11 ± 1.5	0.90 ± 0.35
Aug '75	C-Site	"	4	14 ± 2	3.4 ± 0.2
Aug '75	Mile 8	"	2	11 ± 2	1.4 ± 0.1
Aug '75	Milrow area	"	2	12 ± 2	1.8 ± 0.6
1970-71[b]	South Bight	Liver	1	---	---
Aug '74	C-Site	Viscera	4	13 ± 1.2	1.6 ± 0.8

a. Values are given as the mean ± one-standard deviation. The dashes in the body of the table indicate the sample counts were not significant for that group of samples.

b. Pre-Cannikin

c. One each from Mason Lake, C-Site, and Mile 16; two from Mile 5.

Table 13

Strontium-90 in Bone from Rats and Ptarmigan, and in Soil Collected at Amchitka Island.

Collection Date	Location	Sample Type	pCi ^{90}Sr/g, dry[a]
Oct 1971[b]	Sand Beach Cove	Rat, bone	0.7 ± 0.2
Oct 1971[b]	" " "	"	2.5 ± 0.2
Dec 1971	" " "	"	10.1 ± 0.4
Dec 1971	" " "	"	1.6 ± 0.2
April 1973	" " "	"	1.9 ± 0.5
Aug 1973	Main Dump	"	1.8 ± 0.1
Aug 1974	Main Dump	"	0.8 ± 0.7
Aug 1974	Duck Cove	"	2.3 ± 0.7
Aug 1975	Constantine Harbor	"	1.6 ± 0.8
Aug 1975	Duck Cove	"	1.2 ± 0.9
Aug 1975	Sand Beach Cove	"	0.5 ± 0.1
Nov 1971[b]	Clevenger Creek	Ptarmigan, bone	27.0 ± 0.8
Nov 1971[b]	Baker Runway	"	35.2 ± 1.0
Dec 1971	Base Camp	"	18.3 ± 0.5
Dec 1971	C-Site	"	30.7 ± 0.9
Aug 1973	Silver Salmon Lake	"	13.9 ± 0.2
Sept 1973	Clam Lake	"	11.0 ± 0.2
Aug 1974	Mile Post 8	"	16.1 ± 2.3
Aug 1975	Milrow Area	"	13.8 ± 0.7
Aug 1975	Mile Post 8	"	19.2 ± 1.4
Aug 1975	Cannikin Area	"	12.5 ± 0.5
Aug 1975	Main Camp	Soil	0.03± 0.01
Aug 1975	Cannikin Area	"	<0.16

a. Errors are one-sigma, propagated, counting errors for a single sample.

b. Pre-Cannikin.

Table 14.

Gamma-emitting Radionuclides in Sand and Soil Collected at Amchitka Island in August 1975

Sample Type	Collection Location	pCi/g, dry[a]				
		^{40}K	^{137}Cs	^{141}Ce	^{144}Ce	Other[b]
Soil	Main Camp	8.0±1.2	---	0.20±0.13	0.14±0.13	---
Soil	Cannikin Area	11 ±1.3	0.32±0.05	0.22±0.15	0.97±0.18	c
Sand	Constantine Harbor	13 ±1.2	0.07±0.03	---	---	---
Sand	Sand Beach Cove	9.8±1.1	0.06±0.03	---	0.2 ±0.1	---

a. Errors are two-sigma, propagated, counting errors for a single sample. Dashes in the body of the table indicate the sample count was not significant.

b. Radium-226, ^{228}Th, and ^{238}U in the sand samples and ^{226}Ra and ^{228}Th in the soil samples were present in concentrations of less than 0.5 pCi/g, dry.

c. Zirconium-95 (0.16±0.14 pCi/g, dry), ^{95}Nb (0.18±0.07 pCi/g, dry) and ^{106}Ru (0.42±0.30 pCi/g, dry) were also present in this sample.

Table 15

Gamma-Emitting Radionuclides in Samples Collected from Lakes on Amchitka Island

Location and Date	Liters Sampled	Fraction	n	Gamma-Emitting Radionuclides (pCi/liter)[a] ^{7}Be	^{95}Zr	^{95}Nb	^{137}Cs
Jones Lake							
1971[b]	278±240	Particulate	4	---	0.05 ±0.04	0.11 ±0.08	0.02 ±0.04
"	"	Soluble	4	---	0.01 ±0.01	0.02 ±0.02	0.02 ±0.02
1971-72	154±103	Particulate	5	0.2 ±0.3	0.008±0.011	0.02 ±0.02	0.004±0.009
"	"	Soluble	5	1.3 ±2.9	0.07 ±0.15	0.16 ±0.33	0.05 ±0.10
1973	172±30	Particulate	2	---	---	---	0.042±0.015
"	"	Soluble	2	---	---	---	---
May '74[c]	53	Particulate	1	---	0.084±0.062	0.19 ±0.06	0.039±0.029
"	"	Soluble	1	---	---	---	---
Aug '74	413	Particulate	1	---	---	---	---
"	"	Soluble	1	---	---	---	---
Aug '75	56	Entire	1	1.1 ±0.3	---	0.05 ±0.03	0.12 ±0.03
Heart Lake							
Aug '75[d]	52	Entire	1	2.3 ±0.4	0.09 ±0.05	0.15 ±0.04	0.25 ±0.04
Cannikin Lake							
1972	9± 1.4	Particulate	2	---	0.17 ±0.23	0.34 ±0.48	---
1973	84±16	Particulate	2	---	---	---	0.04 ±0.057
"	"	Soluble	2	---	---	---	0.08 ±0.11
May '74[e]	314	Particulate	1	---	0.20 ±0.04	0.25 ±0.03	0.019±0.013
"	"	Soluble	1	---	---	---	---
Aug '74	99	Particulate	1	---	---	---	---
"	"	Soluble	1	---	---	---	---
Aug '75	53	Entire	1	---	---	---	0.21 ±0.04

Table 15 (continued)

Location and Date	Liters Sampled	Fraction	n	Gamma-Emitting Radionuclides (pCi/liter)[a] ^{7}Be	^{95}Zr	^{95}Nb	^{137}Cs
Long Shot Mud Pit No. 1							
1970-71[b]	418±398	Particulate	6	4.0 ± 4.7	0.4 ±0.6	0.9 ±1.2	0.02 ±0.03
"	"	Soluble	6	11 ±18	0.002±0.003	0.006±0.009	0.08 ±0.18
1971-72	56±41	Particulate	5	1.2 ± 1.3	0.25 ±0.29	0.48 ±0.55	0.03 ±0.07
"	"	Soluble	5	0.44± 0.98	---	---	---
1973	35±5	Particulate	2	2.0 ± 1.0	---	---	0.04 ±0.06
"	"	Soluble	2	---	---	---	---
May '74[f]	48	Particulate	1	4.0 ± 0.7	1.3 ±0.1	2.7 ±0.2	0.034±0.028
"	48	Soluble	1	---	---	---	---
Aug '74	189	Particulate	1	0.7 ± 0.2	0.06 ±0.03	0.14 ±0.02	---
"	189	Soluble	1	---	---	0.21 ±0.10	---
Aug '75[g]	50	Entire	1	1.2 ± 0.3	---	---	0.08 ±0.03

a. Single sample error values are two-sigma, propagated, counting errors, while the value given for more than one sample is the mean ± standard deviation. Dashes in the table indicate the sample count was not significant.

b. Pre-Cannikin.

c. Cerium-144 also present, 0.44 ± 0.14 pCi/liter.

d. Ruthenium-106 (0.45±0.25 pCi/liter), ^{125}Sb (0.09±0.06 pCi/liter) and ^{144}Ce (0.24±0.11 pCi/liter) were also present in this sample.

e. Cerium-144 also present, 0.41 ± 0.07 pCi/liter.

f. Cerium-144 also present, 4.9 ± 0.3 pCi/liter.

g. Barium-140 also present, 0.43 ± 0.37 pCi/liter.

Table 16. Tritium Concentration in Water Samples Collected at Amchitka Island, 1970-1975.

Date	Collection Site	Number of Samples	Tritium Units[a]	pCi/liter[b]
I Seawater				
1970-71[c]	d	10	32 ± 19	103 ± 61
1972	d	16	28 ± 25	90 ± 81
1973	d	6	22 ± 13	71 ± 42
1974	d	6	<13	<42
1975	d	6	<15	<48
August 1975	Constantine Harbor	1	18 ± 12	57 ± 40
"	Square Bay	1	17 ± 12	56 ± 40
"	Sand Beach Cove	1	<13	<42
"	St. Makarius Bay	1	<13	<42
"	Rifle Range Pt.	1	<13	<42
"	Duck Cove	1	<13	<42
II Freshwater, except Long Shot Area				
1970-71[c]	d	12	92 ± 46	298 ± 149
1972	d	18	49 ± 14	158 ± 45
1973	d	46	50 ± 17	162 ± 55
1974	d	44	32 ± 18	103 ± 58
1975	d	29	34 ± 14	110 ± 45
August 1975	South Hangar(rainfall)	1	33 ± 13	106 ± 43
"	Constantine Spring	1	56 ± 13	182 ± 41
"	Jones Lake Outlet	1	28 ± 12	89 ± 40
"	Clevenger Lake Outlet	1	51 ± 13	165 ± 41
"	Clevenger Creek (mouth)	1	30 ± 12	98 ± 40
"	Clevenger Creek (headwaters)	1	26 ± 12	84 ± 40
"	Heart Lake	1	<13	<42
"	Clam Lake	1	24 ± 12	78 ± 38
"	Duck Cove Creek (mouth)	1	41 ± 13	132 ± 38
"	Seep-Duck Cove	1	47 ± 13	151 ± 41
"	Quonset Creek (at road)	1	24 ± 13	78 ± 43
"	Bridge Creek (at road)	1	55 ± 13	177 ± 41
"	Mile Post 12 Creek	1	40 ± 12	129 ± 38

Table 16(continued)

Date	Collection Site	Number of Samples	Tritium Units[a]	pCi/liter[b]
II. Freshwater (cont)				
August 1975	Cannikin Lake Inlet from Ground Zero	1	<13	<42
"	Cannikin Lake Inlet from Drillback	1	53 ± 13	173 ± 41
"	Cannikin Lake White Alice Inlet	1	41 ± 13	133 ± 41
"	Cannikin Lake Station #1 Surface	1	21 ± 10	67 ± 33
"	Cannikin Lake Station #1 Bottom	1	27 ± 10	87 ± 34
"	Cannikin Lake Station #2 Surface	1	<13	<42
"	Cannikin Lake Station #2 Bottom	1	38 ± 12	124 ± 38
"	Cannikin Lake Station #3 Surface	1	47 ± 11	151 ± 34
"	Cannikin Lake Station #3 Bottom	1	36 ± 10	115 ± 34
"	Cannikin Lake Station #4 Surface	1	46 ± 11	148 ± 34
"	Cannikin Lake Station #4 Bottom	1	33 ± 10	108 ± 34
"	Cannikin Lake Outlet	1	19 ± 12	63 ± 40
"	Ice Box Lake Inlet[e]	1	31 ± 12	102 ± 40
"	Ice Box Lake Outlet[e]	1	57 ± 13	183 ± 41
"	DK-45 Lake	1	<13	<42
"	Seep-Sand Beach Cove	1	45 ± 13	144 ± 41
III. Long Shot Mud Pits				
1970-71[c]	Mud Pit #3	3	3500 ± 460	11300 ± 1500
1974	"	1	2900 ± 460	9400 ± 160
August 1975	"	1	867 ± 19	2802 ± 61
1970-71[c]	Mud Pit #1	3	1800 ± 260	5800 ± 840
1972	"	4	2050 ± 240	6600 ± 780
1973	"	2	1900 ± 420	6100 ± 1400
1974	"	2	1300 ± 250	4200 ± 810
August 1975	"	1	122 ± 11	395 ± 36

Table 16 (continued)

Date	Collection Site	Number of Samples	Tritium Units[a]	pCi/liter[b]
IV. Long Shot Mud Pit Drainage				
August 1975	3 meters below Mud Pit #1	1	872 ± 19	2817 ± 61
"	Infantry Road	1	666 ± 16	2153 ± 52
"	100 meters below road	1	424 ± 15	1369 ± 47
"	500 " " "	1	82 ± 13	264 ± 42
"	200 " above Sq. Bay	1	121 ± 13	390 ± 44
"	Mouth of creek	1	107 ± 13	347 ± 43

a. The error shown for single samples is a one-sigma counting error, while the error for more than one sample is a one-standard deviation of the mean.

b. One TU equals 3.23 pCi/liter.

c. *Pre-Cannikin.*

d. Mean of all collection sites.

e. A small lake formed in the north fork of While Alice Creek after surface subsidence occurred at the Cannikin site.

Table 17

Tritium Concentration in Free Water and Bound Hydrogen from Biological Samples Collected at Amchitka Island in August 1975.

Organism	Tissue	Collection Site	n[b]	Tritium Units[a] Free(F)	Tritium Units[a] Bound(B)	pCi/liter[a] Free	pCi/liter[a] Bound	Ratio B/F
Fucus	Entire	Constantine Harbor	2	<35 ± 18	167 ± 14	<113 ± 58	539 ± 45	> 4.8
"	"	Square Bay	3	<26 ± 12	49 ± 12	<84 ± 39	158 ± 39	> 1.9
"	"	Sand Beach Cove	2	<21 ± 1	49 ± 12	<68 ± 3	158 ± 39	> 2.3
Greenling	Muscle	Constantine Harbor	1	<14	52 ± 18	<45	168 ± 58	> 3.7
"	"	Square Bay	4	<20 ± 2	63 ± 12	<65 ± 6	203 ± 39	> 3.2
"	"	Sand Beach Cove	2	<20 ± 1	80 ± 19	<65 ± 3	258 ± 61	> 4.0
Dolly Varden	"	Bridge Creek[c]	2	16 ± 2	73 ± 11	51 ± 6	235 ± 36	4.6
"	"	Jones Lake	4	26 ± 16	81 ± 11	85 ± 52	261 ± 37	3.1
"	"	Cannikin Lake	1	39 ± 12	92 ± 12	126 ± 39	297 ± 39	2.4
Fontinalis	Entire	White Alice Creek	2	39 ± 28	180 ± 13	126 ± 91	580 ± 40	4.6
"	"	Long Shot Drainage	2	85 ± 14	248 ± 20	275 ± 45	801 ± 65	2.9

a. The error term for single samples (all bound samples, plus free samples where n equals 1) is a one-sigma counting error, while the error for free samples where n is greater than 1 is one standard deviation of the mean.
b. n equals the number of free water samples from a single tissue sample.
c. Intertidal area at the mouth of the creek.

Table 18. Plutonium-239,240 in *Fucus*, Greenling, Sand and Soil Collected at Amchitka Island in August, 1975.

Sample Type	Collection Location	pCi/g, dry[a]	dpm/kg, wet
Fucus, entire	Sand Beach Cove	0.007 ± 0.001	3.5 ± 0.5
Fucus, entire	Constantine Harbor	0.004 ± 0.001	1.4 ± 0.4
Greenling, muscle	Sand Beach Cove	<0.001	<0.4
Greenling, muscle	Constantine Harbor	<0.001	<0.4
Sand, surface[b]	Sand Beach Cove	0.005 ± 0.001	-
Sand, surface	Constantine Harbor	<0.002	-
Soil, surface	Cannikin Area	0.016 ± 0.002	-
Soil, surface	Main Camp	0.002 ± 0.001	-

a. Errors are one-sigma, propagated, counting errors for a single sample.

b. Surface samples were the 0 to 2.5 cm layer.

Table 19. Radiation Survey of Selected Sites on Amchitka Island

Location	Radiation Level[(a)], mR/hr			
	Average Reading		Maximum Reading	
	Aug. 1974	Aug. 1975	Aug. 1974	Aug. 1975
Decon Facility	0.01	0.01	0.05	0.04
Inside "D" Barracks	0.01	<0.01	0.04	0.04
Husky Camp	<0.01	0.01	0.04	0.05
Jones Creek Effluence	<0.01	<0.01	0.04	0.04
EIC Calibration Range	<0.01	0.01	0.04	0.04
Rifle Range Target Area	0.01	0.01	0.04	0.05
Duck Cove	<0.01	<0.01	0.03	0.04
Milrow SGZ & Vicinity	<0.01	0.01	0.04	0.04
Long Shot SGZ & Vicinity	0.01	0.01	0.05	0.05
Cannikin SGZ & Vicinity	0.01	0.01	0.04	0.04
Cannikin Drillback	0.01	0.01	0.05	0.04
Sand Beach Cove	<0.01	<0.01	0.04	0.04
D-Site	0.01	<0.01	0.05	0.03
E-Site	0.01	<0.01	0.03	0.04

(a) Eberline G-M detector, Model 510, probe window thickness less than 2 mg/cm^2.

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6. TABLE AND MAP INDEX

Collection Site	Figure No.(s)	Table No.(s)	Remarks
Baker Runway	3	13	Part of Base Camp
Base Camp	2 & 3	2, 13, 19	
Bering Sea	1 & 2	9, 11	Collection sites located:
Bridge Creek	4	3, 4, 11, 16, 17	a) Off C-Site
Cannikin Lake Inlet From Drillback	6	16	
Cannikin Lake	6	6, 11, 15, 16, 17	
Cannikin Lake Outlet	6	3, 4, 16, 17	
Cannikin Lake Inlet From GZ	6	16	
Cannikin Lake Inlet From White Alice Inlet	6	5, 16	
Cannikin Site	2 & 6	12, 13, 14, 18, 19	
Chapel Cove Stream	2	11	
Clam Lake	4	6, 13, 16	
Clevenger Creek	4	3, 4, 11, 13, 16	
Clevenger Lake Outlet	3	4, 16	
Constantine Harbor	2 & 3	7, 9, 10, 13, 14, 16, 17, 18	
Crown Reefer Point	2 & 4	7	
D-Site	2	19	
Decon Area	3	19	
Duck Cove	4	7, 8, 10, 11, 13	
Duck Cove Creek	4	3, 4, 11, 16	
E-Site	2	19	
EIC Calibration Range	3	19	
Heart Lake	4	15, 16	
Hus-Key Camp	3	19	
IA-2	6	None	
IA-3	6	"	
Ice Box Lake	6	6, 16	Lake 05-46
Ice Box Lake Inlet	6	3, 16, 17	
Infantry Road	2,4-6	None	
Jones Lake	3	11, 15, 16, 17, 18	
Jones Lake Outlet	3	16, 19	
Lake DK-45	6	11	
Lake DK-45 Outlet	6		
Long Shot	2, 4, 5	5, 15, 16, 19	Collection sites located at: a) Mud Pits Nos. 1, 2 & 3;
Long Shot Drainage	4 & 5	3, 4, 16	
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Midden Cove	2	9	

TABLE AND MAP INDEX (continued)

Collection Site	Figure No.(s)	Table No.(s)	Remarks
Milrow	2 & 4	12, 19, 13	
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Rifle Range Target Area	4	19	
Sand Beach Cove	6	7, 8, 10, 13, 14, 16, 17, 19	
Signal Cove Stream	2	1	
Silver Salmon Lake	4	13	
Small Boat Dock	3		Located in Constantine Harbor
South Bight	2	12	
South Hangar	3	16	
Square Bay	4	7, 8, 10, 16,17	

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