403163

1975 BIKINI ~~SURVEY PROGRAM~~

Bikini Soil and Gamma Exposure Rate ~~Survey Program~~

Purpose: Soil Survey

The soil sampling program is designed ~~to determine the geographical~~ distribution of the activity of various radionuclides in the soil on Bikini and Eneu Islands of the Bikini Atoll. Every possible effort will be made to integrate this sampling program with previous programs to avoid undue duplication of effort. The actual number of samples and their specific collection sites will be a function of (1) the expected activity levels, (2) future home-construction plans, (3) future agricultural plans, (4) the aerial survey results or any other measure of the variability in the gamma exposure rates, and (5) the number and locations of recent soil samples collected by other programs.

Methods and Measurements:

Two types of soil samples will be collected for analysis: (1) a 15-cm-deep surface core sample of 60 cm^2 area, and (2) a profile collection based upon sidewall sampling in a trench in which samples of 100 cm^2 area are collected at 15 cm depth increments to a total depth of 90 cm. For purposes of planning the survey, Bikini Island may be divided into the north, central, and south sections along the respective second base line roads. Eneu may be divided into the north and south sections divided by the airstrip. The approximate numbers of surface and profile samples to be collected within these sections are shown in Table 1. Note that a major fraction of the surface samples will be collected within the central section of Bikini Island. This is due to the relatively higher and more variable gamma exposure rates in this area and to the fact that a major fraction of the returning Bikinians will most likely reside within this section. Only a few profile samples are planned in this area because several samples have already been collected during previous surveys. The north and south sections of Bikini Island and all of Eneu exhibit relatively lower contamination levels; hence, the sampling density is lower. Special emphasis, however, will be given to the lagoon side of Eneu since future homes may be erected in this area.

Table 1. Number of soil sample locations on each island.

	No. of Sample Locations	
	Surface (0-15 cm)	Profiles (0-90 cm)
Bikini		
North of second Baseline N	25	2
Central Section	200	4
South of second Baseline S	25	2
Eneu		
North of airstrip	60	2
South of airstrip	40	2
TOTAL	350	12 (6 samples each)

The exact soil sampling locations will actually be determined by a random selection process to obtain statistically meaningful and unbiased results. Special samples will also be collected within "hot spot" areas or other areas of specialized interest. The samples will be placed in plastic bags with appropriate identification tags and readied for shipment to LLL, where they will undergo preprocessing and gamma-spectral analysis. It is anticipated that analyses for other radionuclides of interest, such as, plutonium-239 and strontium-90, will be performed at a contractor laboratory.

Purpose: Gamma-Exposure Rate Survey

The gamma-ray exposure measurements program conducted on the ground is designed to supplement the EG&G aerial survey by providing detailed examination of the geographical variability of the exposure rates within selective areas, and to provide overall verification of all exposure rate measurements made during this survey.

Methods and Measurements:

The program utilizes the Baird-Atomic scintillation detector which consists of a 2.5-cm-diam x 3.8-cm-long NaI crystal with ratemeter readout. The instrument is calibrated with a ^{137}Cs point source on the primary calibration range of the National Environmental Research Center, Las Vegas, Nevada. While the response of this instrument is energy-dependent, our experience at Eneweta showed that this was not a serious limitation because of the dominance of ^{137}Cs in the radiation background on the atoll. We will also utilize the Reuter-Stokes high pressure ionization chamber. The current produced by the radiation induced ionization within the chamber is measured by a sensitive electrometer with digital readout. The instrument exhibits a flat energy response over all gamma-ray energies of interest to this survey. It is capable of measuring exposure rates from about 1 μR/hr to 200 μR/hr with an accuracy of about 5%. Thus, the results derived from this instrument may be chosen as a reference to which measurements obtained by other techniques can be compared.

Measurements of the exposure rate at 1 m above the ground will be made with the NaI scintillator at each of the soil sampling locations on both islands. The ionization chamber will be primarily used for measurements within the central section of Bikini Island with additional measurements to be made at "hot spot" areas revealed by the aerial survey. Thus, a fairly comprehensive picture of the gamma-ray exposure rates will be available for both islands from this program for comparison and validation of the aerial survey results.

Bikini-Ground Water Program

Purpose: To establish a network of well locations on Bikini and Eneu Islands in order to assess the ground water quality and to systematically study the hydrology and geochemistry of radionuclides, major and trace elements in the ground water system. Water movement and residence times will be assessed to deduce the transport rates and mechanisms for radionuclides deposited in the soil zone or taken up by vegetation.

Methods and Measurements:

Approximately 7 holes will be drilled with a ground power auger at selected locations along the center lines of Bikini and Eneu Islands. Pits will be dug with a back hoe to a maximum depth since the ground water reservior surface will be approximately 2 meters below the ground surface. We must emphasize that the progress of this program will be seriously hampered if a back hoe is not available to support our effort. The auger will penetrate the ground water lens to a depth of approximately 3 to 5 feet. Each hole will be cased with slotted 2" diameter PVC pipe and the pipe will be extended to the soil surface. The pit will be back filled to essentially provide no environmental impact on the area.

The first hole will be located near the island center. The salinity of the water will be measured with an in-situ conductivity probe. 2 holes will then be drilled to bracket the center hole and the salinity will be measured in each. We will continue drilling up to 7 holes on each island proceeding in the direction toward the freshest indicated ground water; this will provide the maximum number of well sites having the freshest water for potential utilization. Water will be pumped from the wells, filtered and sampled. Radionuclides, major elements, nutrients and bacteria measurements will be made at the laboratory to provide data for water quality. Specific wells (to be defined in the field) will be pumped continuously over a day and serially sampled, to follow the changes in water quality as a function of usage. Recommendations will be made on the potential usefulness of the ground water reservior for agriculture, household or drinking purposes. Two closely spaced wells, located in high Cs137 disturbed and undisturbed soils, will be sampled to assess the impact of disturbed soil columns on the local ground water quality. Soil leaching and lysimeter experiments are also planned. The well locations, drilling and sampling, however, are our first priorities during the two weeks allotted for this program.

Assessment of the fresh water residence time will be made from the data. The well network, once established, will be available for resampling on subsequent trips we plan to the Atoll to thoroughly assess the dynamics of radionuclide cycling in the ground water reservior and to maintain a surveillance on the water quality. The program operation will be fashioned after our Enewetak ground water study and comparison of the data from both atolls should be especially valuable for predicting the mechanisms and rates of constituents in ground water at Pacific atolls. The U. of Hawaii (Dr. R. Buddemeier) will have the analytical responsibility for major element analysis and LLL (V. E. Noshkin) will have the responsibility for radionuclide assessment. We will determine the concentrations of Cs137, Sr90, and Plutonium in all samples by radio chemical techniques. Gamma emitters present in a ferric hydroxide precipitate, will be identified and the levels assessed from the spectrometry data. Tritium will be measured on selected samples.

Plant/Soil Sampling Program

Purpose: The main thrust of the program will be to determine radionuclide concentrations in food species, to correlate these with soil concentrations at various depths, to determine nuclide availability to plants in the coral soil zone of [illegible]

soils, and to relate the food-species radioactivity to other indigenous non-food species which may have indicator species potential. The unique information that this survey will provide is:

1. Soil-to-plant, and soil-to-fruit concentration factors for detectable radionuclides.

2. The relationship between food species and non-food species at the same location.

3. The relationship between total soil radioactivity and the radioactivity which is available to the plant in the soil solution at the time of sampling.

4. The relationship of vegetation, soil, soil water, litter and humus in the overall cycling of radionuclides in mature food crops.

5. The relationship of lens water radioactivity to that in soil water and plants growing above the lens zone in order to determine the rate of loss (time dependent information) from the coral atoll environment.

6. Intra-island variability in vegetation radionuclide concentrations.

7. Supply the data base for assessment of terrestrial food chain transfer of radioactivity from the soil to man for long term dose evaluation upon rehabilitation of the atoll.

Methods and Measurements:

The sampling program will therefore consist of integrated sample series composed of food species and soil profile samples which will be obtained on an ad hoc, species available basis. A broader sampling program which will be based upon a widely available species, probably Messerschmidia or Scaevola, will also be carried out to determine the intra-island variations in vegetation radioactivity. These data will be valuable in recommending future agricultural sites and to correlate with the broad soil radioactivity survey and the aerial survey.

An attempt will be made to correlate some sampling sites with the ground-water survey to provide data on the cycling of radionuclides at the given site. All food species presently growing and fruiting on Bikini will be sampled in triplicate if the quantity of material permits. Soil profiles (2/tree) will be obtained in the root zone of the tree sampled to determine the concentration of radioactivity in the soil, the soil water and the organic fraction. A large sample of soil (3 kg.) from the organic zone of the soil (1-30 cm. depth) will be taken to make a leaching measurement of soil solution radioactivity. Both leaves and fruit will be sampled to permit leaf-to-fruit transfer coefficients to be calculated. Non-food species will also be sampled in the vicinity of the food species to provide information on species variation in radionuclide uptake, and to evaluate the use of non-food species concentrations in predictive assessment of human

intake when no food products are available for analysis. This approach was used in the Eneweta survey because of the paucity of food species on the atoll.

This program along with the ground water program will supply the data base for assessing the long term dose committment via food chains upon rehabitation of the atoll and inclusion of coconut, pandanus fruit, breadfruit, bananas and papayas in the diet.

Bikini Air Sampling Program

Purpose: The concentrations of radionuclides in air at the Bikini Atoll are expected to be very low, therefore, the air sampling program is designed to emphasize the determination of the mass loading (concentration of total suspended particulates) on the islands of Bikini and Eneu. The mass loading approach has been used in the past to predict the long term expected concentration in air of radionuclides (particularly ^{239}Pu) by use of the relationship

$$\left(\frac{pCi}{g}\right)_{soil} \times \left(\frac{10^{-4}g}{m^3}\right)_{air} = \left(\frac{pCi}{m^3}\right)_{air}$$

This relationship assumes that all of the suspended particulate matter in air is derived from the soil surface and that the average mass loading of the atmosphere is 100 $\mu g/m^3$. Both assumptions are believed to be conservative for small Pacific islands as perhaps a large part of the total suspended particulates may be derived from the ocean, and it is likely that actual mass loadings are lower than 100 $\mu g/m^3$ on these small islands. To our knowledge, however, such mass loading measurements have never been made.

The air sampling program is designed to achieve the following objectives:

1. Measure the daily mass loading with associated wind velocity measurements.
2. Measure the concentration in air averaged over the total sampling period of all gamma-emitting radionuclides, ^{90}Sr, ^{239}Pu, and ^{241}Am.
3. Determine the distribution of these radionuclides and mass with particle size.
4. Determine the pCi/g of total suspended particulates, so that this concentration may be compared to that of the soil.

Methods and Measurements:

The exact details of how this will be accomplished are not definitive at the present time because the availability of sampler housings and generators is not precisely known. However, both the minimum program and probable maximum program can be formulated. Two types of samplers will be used, 20 cfm cascade impactors and 60 cfm high-volume samplers. The cascade impactors will be operated continuously during the course of the study without

a change of the collection media. The filters for the high volume samplers will be changed daily. Gravimetric analysis of all collection media will be done in order to determine mass collection. The collection surfaces from the cascade impactors will be submitted for radionuclide analysis. The high volume filters may be analyzed depending upon the amount of collected mass, the results from the cascade impactors, and the priority for available funds. Measurements of wind velocity will be made and recorded on both Bikini and Eneu Islands; it is anticipated that additional meteorological measurements will be available from the USNS Chauvenet. Air sampling will also be conducted on the USNS Chauvenet, and will be used as "background" measurements.

The following sampler deployments are anticipated.

I. Minimum Program

A. Bikini Island: 2 cascade impactors, 2 high-volume samplers.

B. Eneu Island: 1 cascade impactor, 1 high-volume sampler.

C. USNS Chauvenet: 1 cascade impactor, 1 high-volume sampler.

II. Probable Maximum Program

A. Bikini Island: 2 cascade impactors, 4 high-volume samplers.

B. Eneu Island: 2 cascade impactors, 2 high-volume samplers.

C. USNS Chauvenet: 2 cascade impactors, 2 high-volume samplers.

In addition, a few personal air samplers may be worn by those personnel anticipated to experience the maximum dusty conditions while performing the soil sampling program.

END

6/3/75
Copy
McCaw

Brief Summary of Medical Findings in the Marshallese Accidentally Exposed to Radioactive Fallout in 1954

The accidental exposure occurred on March 1, 1954 following detonation of a thermonuclear devise on Bikini in the Pacific Proving Grounds. A shift in wind resulted in fallout on the following inhabited islands:

Island	Distance from Bikini	No. of People	Estimated Gamma dose
Rongelap	105 miles	64	175 rads
Ailingnae	110 "	18	69 "
Rongerik	135 "	28*	70 "
Utirik	275 "	158	14 "

* American Service men

There were no deaths but certain acute effects were noted, particularly in the Rongelap people. Transcient depression of blood cells was followed by recovery to near normal levels by one year. Fallout deposited on the body resulted in skin burns and spotty loss of hair in the Rongelap, Ailingnae and Rongerik groups. The burns healed and the hair regrew without complications in several months. Urine analyses revealed that internal absorption of radioactive material had occurred from inhalation and ingestion of contaminated food and water but no acute effects were observed from this source (as will be seen below late effects did occur).

Follow-up examinations during the first decade showed few findings that could be related to radiation exposure. Possibly related was the occurrence of about twice the number of miscarriages and stillbirths in the exposed compared with unexposed Rongelap women. This difference was not seen after 5 years.

During the second decade there have been more serious developments. Some Rongelap children showed growth retardation which was later realized to be associated with a hypothyroid condition due to radiation injury to the thyroid gland largely from radioactive iodine absorbed at the time of the fallout. The thyroid dose was estimated to be 335 rads for Rongelap adults and 700-1400 rads for children, the higher dose in children being due to the smaller size of their thyroid glands.

In 1963 tumors of the thyroid began to appear in Rongelap children and to a lesser extent in adults. These tumors have continued to develop in ensuing years until at the present time 29 of 86 Rongelap and Ailingnae people (about 1/3) have developed abnormalities of the thyroid gland, the majority in children.

Group	Age at Exposure	No.	Thyroid Abnormalities	Surgery	Cancer
Rongelap	< 10	22*	18 (82%)	16	1
	> 10	45	5 (11%)	4	2
Ailingnae	< 10	7**	2 (29%)	1	0
	> 10	12	4 (36%)	3	0
Combined	< 10	29	20 (70%)	17	1
	< 10	86	29 (34%)	7	2

* 3 of these were exposed in utero, one of whom had non-malignant thyroid tumors removed.

** 1 of these was exposed in utero.

The table shows that 24 have had thyroid surgery in the United States with three of the tumors proving to be cancer. No recurrence of tumors has been noted following surgery. A low incidence of thyroid tumors has also been noted in the unexposed Rongelap control and in the low exposure Utirik groups.

The exposed Rongelap people have been treated with thyroid hormone for the past 10 years and this treatment has successfully maintained normal thyroid status in the affected people and enhanced growth and development in retarded children.

In 1972 a 19 year old Rongelap man who had been exposed at one year of age died of acute leukemia in spite of ~~the~~ extensive treatment at the Clinical Center of the National ~~Cancer Institute~~ Institutes of Health. The illness may have been induced by radiation.

The annual medical examinations of the exposed Marshallese people continue with a team of highly qualified medical specialists. In addition we now have a resident physician stationed in the Marshall Islands who makes at least quarterly visits for health care to the exposed people on the outer islands.