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UCRL-51879 Part 3

# EVALUATION OF THE RADIONUCLIDE CONCENTRATIONS IN SOIL AND PLANTS FROM THE 1975 TERRESTRIAL SURVEY OF BIKINI AND ENEU ISLANDS

C. S. Colsher, W. L. Robison, and P. H. Gudiksen

January 21, 1977

Prepared for U.S. Energy Research & Development Administration under contract No. W-7405-Eng-48

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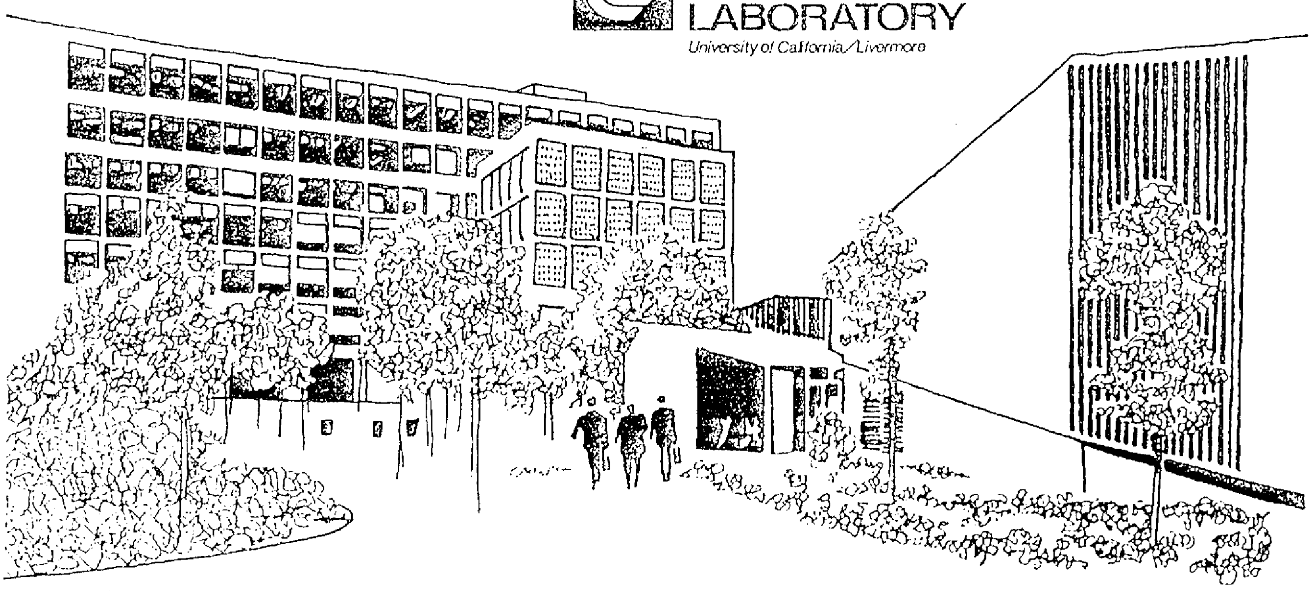

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Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
Price: Printed Copy $ ; Microfiche $3.00

| Page Range | Domestic Price | Page Range | Domestic Price |
|---|---|---|---|
| 001–025 | $ 3.50 | 326–350 | 10.00 |
| 026–050 | 4.00 | 351–375 | 10.50 |
| 051–075 | 4.50 | 376–400 | 10.75 |
| 076–100 | 5.00 | 401–425 | 11.00 |
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# EVALUATION OF THE RADIONUCLIDE CONCENTRATIONS IN SOIL AND PLANTS FROM THE 1975 TERRESTRIAL SURVEY OF BIKINI AND ENEU ISLANDS

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# EVALUATION OF THE RADIONUCLIDE CONCENTRATIONS IN SOIL AND PLANTS FROM THE 1975 TERRESTRIAL SURVEY OF BIKINI AND ENEU ISLANDS


## Abstract

In June 1975, personnel from LLL and from other laboratories and agencies conducted a radiological survey of the terrestrial environment of Bikini and Eneu Islands (Bikini Atoll) to evaluate the potential radiation dose to the returning Bikini population. In this report, we present measurements of the radionuclide concentration in soil profiles and in dominant species of edible and nonedible, indicator plants. We also describe the use of these data to derive relationships to predict the plant uptake of radionuclides from soil.

Approximately 620 soil and vegetation samples from Bikini and Eneu Islands were analyzed by Ge(Li) gamma spectrometry and by wet chemistry. The predominant radionuclides in these samples are $^{60}$Co, $^{90}$Sr, $^{137}$Cs, $^{239,240}$Pu, $^{241}$Pu, and $^{241}$Am. In general, the radionuclide concentrations in soil from Eneu Island and from the four areas of Bikini Island appear to approximate log-normal distributions. The median surface-soil concentrations (pCi/g) of Eneu Island (0.067 for $^{60}$Co, 4.1 for $^{90}$Sr, 2.9 for $^{137}$Cs, 0.25 for $^{239,240}$Pu, and 0.22 for $^{241}$Am) are ten times lower than those measured on Bikini Island (0.86 for $^{60}$Co, 76 for $^{90}$Sr, 43 for $^{137}$Cs, 3.0 for $^{239,240}$Pu, and 2.4 for $^{241}$Am). We found that radioactivity is unevenly distributed over the surface of these islands and that the distribution of activity with soil depth varies greatly in different parts of the islands. Concentrations in the soil of $^{90}$Sr and $^{137}$Cs are greater than concentrations of $^{241}$Am and $^{239,240}$Pu which, in turn, are greater than concentrations of $^{60}$Co.

To quantitatively evaluate the plant uptake of $^{90}$Sr, $^{137}$Cs, and $^{239,240}$Pu, we develop soil-plant concentration factors as well as leaf-leaf and fruit-leaf concentration ratios for indicator and edible plant species from the same location. In general, the concentration factors for $^{137}$Cs in terrestrial vegetation are greater than those for $^{90}$Sr. The concentration factors for both of these nuclides exceed those for $^{239,240}$Pu by one to two orders of magnitude (10 to 100 times). For $^{90}$Sr and $^{239,240}$Pu, nuclide uptake by fruit is less than that by mature leaves; however, the opposite is true for $^{137}$Cs. The relative contribution of the individual plant species to the internal dose to man

varies with the nuclide under consideration. Thus, we also describe the use of concentration factors and concentration ratios to predict nuclide concentrations in fruit from those observed in soil or leaves.

## Introduction

Since the termination of nuclear testing on Bikini Atoll in 1958, periodic environmental surveys have been conducted to evaluate the radiological status of the atoll. The early surveys of Bikini Atoll as well as the recent survey and assessment at nearby Enewetak Atoll indicate that concentrations of radionuclides in certain terrestrial foods are relatively high, suggesting that the terrestrial foodchain could be a major exposure pathway.[1-4] In June 1975, Bikini Atoll was resurveyed to determine the residual radioactivity in the terrestrial environments of Bikini and Eneu Islands, the two main islands of the atoll (Fig. 1). The 1975 survey included measurement of environmental gamma-ray exposure rates and the collection and analysis of samples of soil, ground water, cistern water, and vegetation for use in assessing the internal dose via various ingestion pathways. (The dose from external gamma exposure and the radionuclide concentrations in cistern and ground water have been previously reported.[5,6])

The longer-lived fission and activation products are the nuclides of primary concern at Bikini Atoll. Previous studies have shown that because of their long half-lives and large inventories, $^{90}Sr$, $^{137}Cs$, and $^{239,240}Pu$ contribute nearly all the population dose from the terrestrial pathway.[7,8] In this study, our major emphasis is on $^{90}Sr$, $^{137}Cs$, and $^{239,240}Pu$. However, the results obtained for $^{60}Co$ and $^{241}Am$ are also included because $^{60}Co$ is widely distributed and is present in the marine pathway and because the concentration of $^{241}Am$ is still increasing slightly due to the decay of $^{241}Pu$.

In this report, we describe the results of the soil and vegetation studies of the 1975 survey. We also discuss the use of the data to derive relationships that predict the plant uptake of nuclides from soil on Bikini Atoll. Geometric mean values of $^{60}Co$, $^{90}Sr$, $^{137}Cs$, $^{239,240}Pu$, and $^{241}Am$ surface-soil concentrations are developed for Eneu Island and for each of the four areas into which Bikini Island was divided. We also



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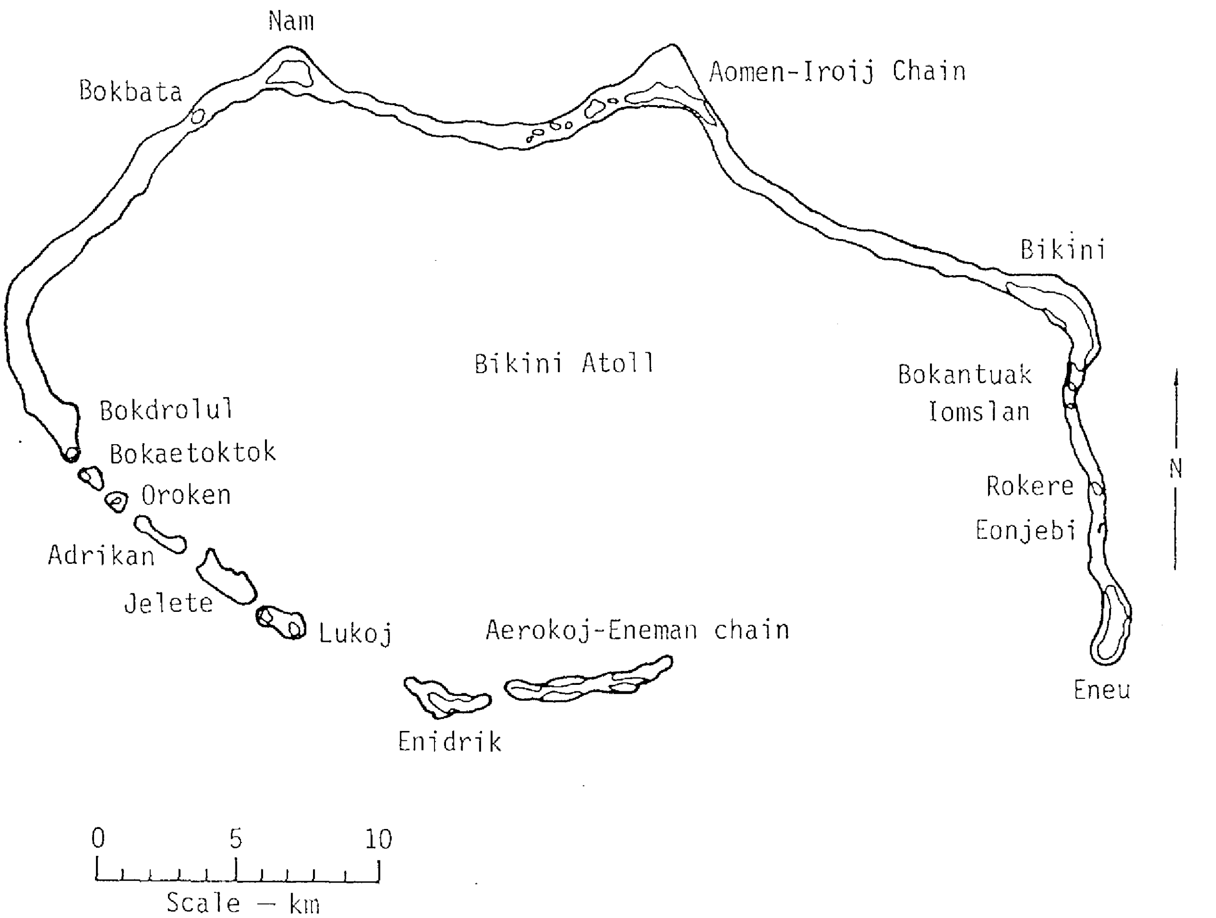


Fig. 1. The Bikini Atoll.

analyzed soil profiles to investigate the distribution of activity with soil depth.

Soil-plant concentration factors and soil-plant regression equations, together with leaf-leaf and leaf-fruit concentration ratios, are calculated for $^{90}Sr$, $^{137}Cs$, and $^{239,240}Pu$ in edible and indicator plants as well as in soil from the associated sampling site. From our evaluation of these data, a method is developed for predicting the nuclide concentrations in edible plants at a given location from the determined nuclide concentrations in soil at the same location. The predicted nuclide concentrations in edible plants subsequently serve as input data to predict the internal dose from ingested terrestrial foods. This dose assessment is presented in a separate report.[9]

At Bikini Atoll, the uptake by plants of radioactive material from the soil is the principal source of foodchain contamination. Thus, soil is both the convenient and the logical starting point for a prediction of radionuclide concentration in terrestrial plants. Soil-plant concentration factors or soil-plant regression equations are commonly used for a quantitative comparison of the capacity of different plant species and various plant organs to accumulate radionuclides through soil-root uptake.[10] Prediction of radionuclide uptake by edible plants is needed to convert the measured environmental soil concentrations into the potential dose to man from the soil-plant pathway. Where fruit samples are not available, correlations between the concentrations in leaves and fruit of a particular plant species or between concentrations in leaves of indicator and edible plant species enable us to predict plant uptake from soil.

## Methods

### ENVIRONMENTAL SAMPLING AND LABORATORY ANALYSIS

The objective of the surface-soil survey was to define the distribution of radioactivity within the soil on Bikini and Eneu Islands. This survey was conducted in a manner similar to that used at Enewetak Atoll.[1] The number of soil samples collected on each island and within specific areas on the island was a function of the anticipated radioactivity levels, the various housing locations under consideration, and the expected living patterns of the future inhabitants. Thus, Eneu Island, because of its low and homogeneous activity levels was sampled less densely than Bikini Island. Bikini Island has elevated and more variable activities and was divided into four distinct areas, each of which could be used for future village sites. Sampling sites were selected by superimposing a rectangular-grid network over an aerial photograph of each island and randomly choosing the grid squares to be sampled within each specific area of interest. The surface-sample locations for the islands are shown in Fig. 2. These samples were taken with a coring tool (a steel pipe, 30 $cm^2$ in cross-section) to a depth of 15 cm. The surrounding soil was scraped away and a cutting tool (a flat piece of steel) was inserted underneath the cover, freeing the sample.

In addition to the surface-soil sampling program, vegetation and associated soil profiles (soil profiles taken from the same location as the plant) were collected wherever suitable plant species were located on Bikini and Eneu Islands (see Fig. 3, Appendices A and B). Leaves, fruit, roots, litter, and stems of edible (*Pandanus*, breadfruit, coconut, papaya, banana, and squash) and non-edible indicator (*Scaevola* and *Messerschmidia*) plants were collected when available. We attempted to take at least one soil profile, and preferably as many as three, through the root zone of each sampled plant. In addition to the soil profiles taken through the root zone of sampled vegetation, other soil profiles were collected on a random basis on both Bikini and Eneu Islands. The geographical locations of these profiles are also shown in Fig. 3.

All profile samples were taken from pits dug with a backhoe. After the pit was dug, the sidewalls were carefully cut back a few centimeters to ensure a clean, undisturbed profile. For each profile, 100-$cm^2$ samples were collected from the sidewall at increments of 5 cm in the upper part and of 10 to 20 cm through the lower part of the profile. Total depth for profile samples varied from 25 to 105 cm.

Vegetation and litter samples were carefully selected and classified by age. For example, collected leaves were classified as young, mature, and senescent. Two ages of litter were readily identifiable and were collected accordingly. However, fruit samples representing different stages of growth were unavailable.

All samples were handled separately, placed in plastic bags, and sent to LLL for processing and analysis. All soil and vegetation samples were analyzed both by Ge(Li) gamma spectrosocopy and by wet chemistry for the following radionuclides (see Ref. 12): $^{40}K$, $^{55}Fe$, $^{60}Co$, $^{90}Sr$, $^{106}Ru$, $^{102m}Rh$, $^{110m}Ag$, $^{125}Sb$, $^{133}Ba$, $^{137}Cs$, $^{144}Ce$, $^{152}Eu$, $^{155}Eu$, $^{207}Bi$, $^{228}Ra$, $^{235}U$, $^{238}Pu$, $^{239}Pu$, $^{240}Pu$, $^{241}Pu$, and $^{241}Am$.

## DATA ANALYSIS

The surface-soil (0 to 15 cm) activities appear to approximate log-normal distributions and thus, we calculated geometric means of $^{60}Co$, $^{90}Sr$, $^{137}Cs$, $^{239,240}Pu$, and $^{241}Am$ concentrations in soil for Eneu Island as a whole and for the four areas of interest on Bikini Island. For each profile collected, we plotted (on semilog paper) the concentrations of the selected nuclides as a function of depth. The profile data were compared in an attempt to characterize the different areas of the islands (see Appendices A and B).

Because they are the major contributors to the dose from ingestion of terrestrial foods (Refs. 1, 7, 8), $^{90}Sr$, $^{137}Cs$, and $^{239,240}Pu$ were selected for more detailed analysis. We calculated concentration factors for these nuclides from measured



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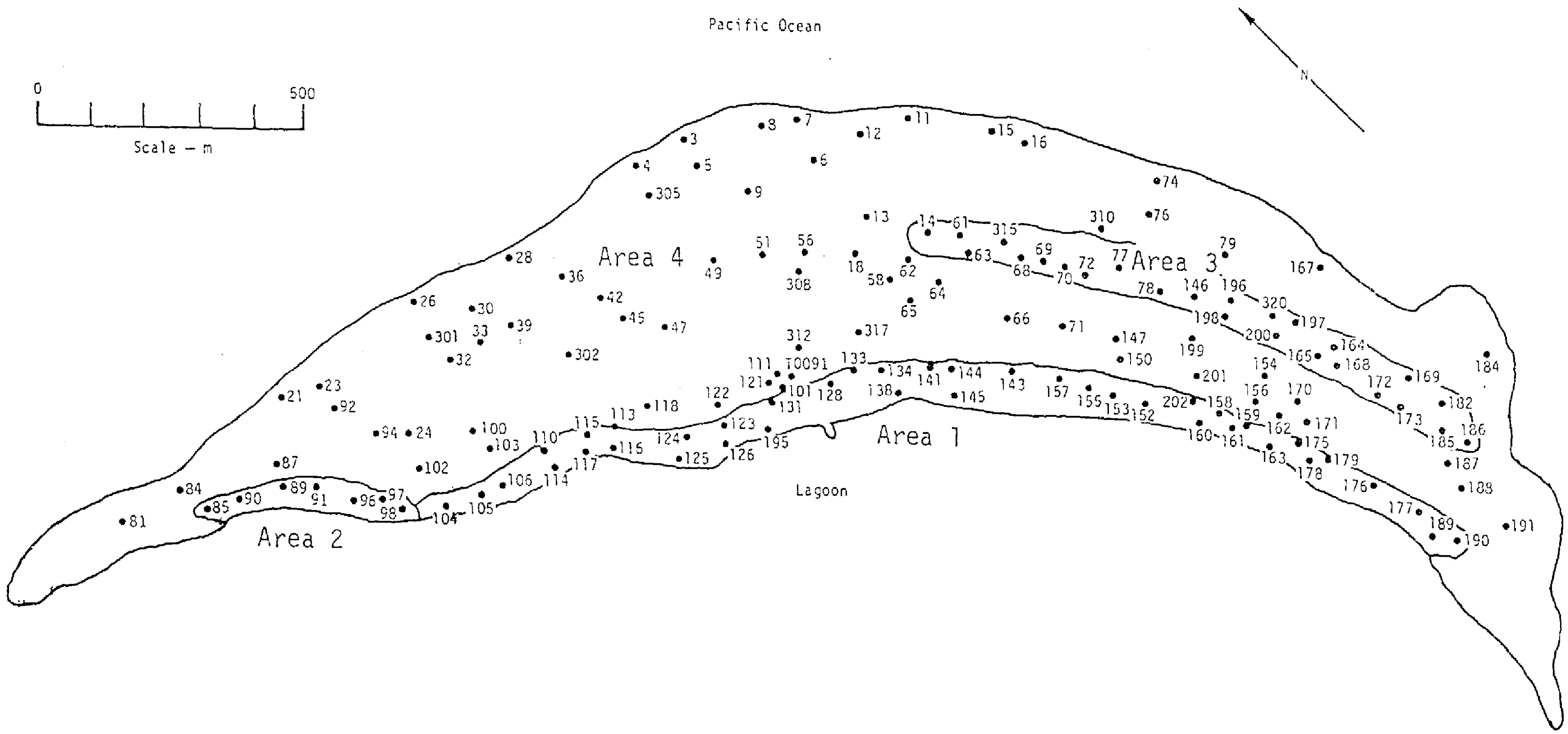
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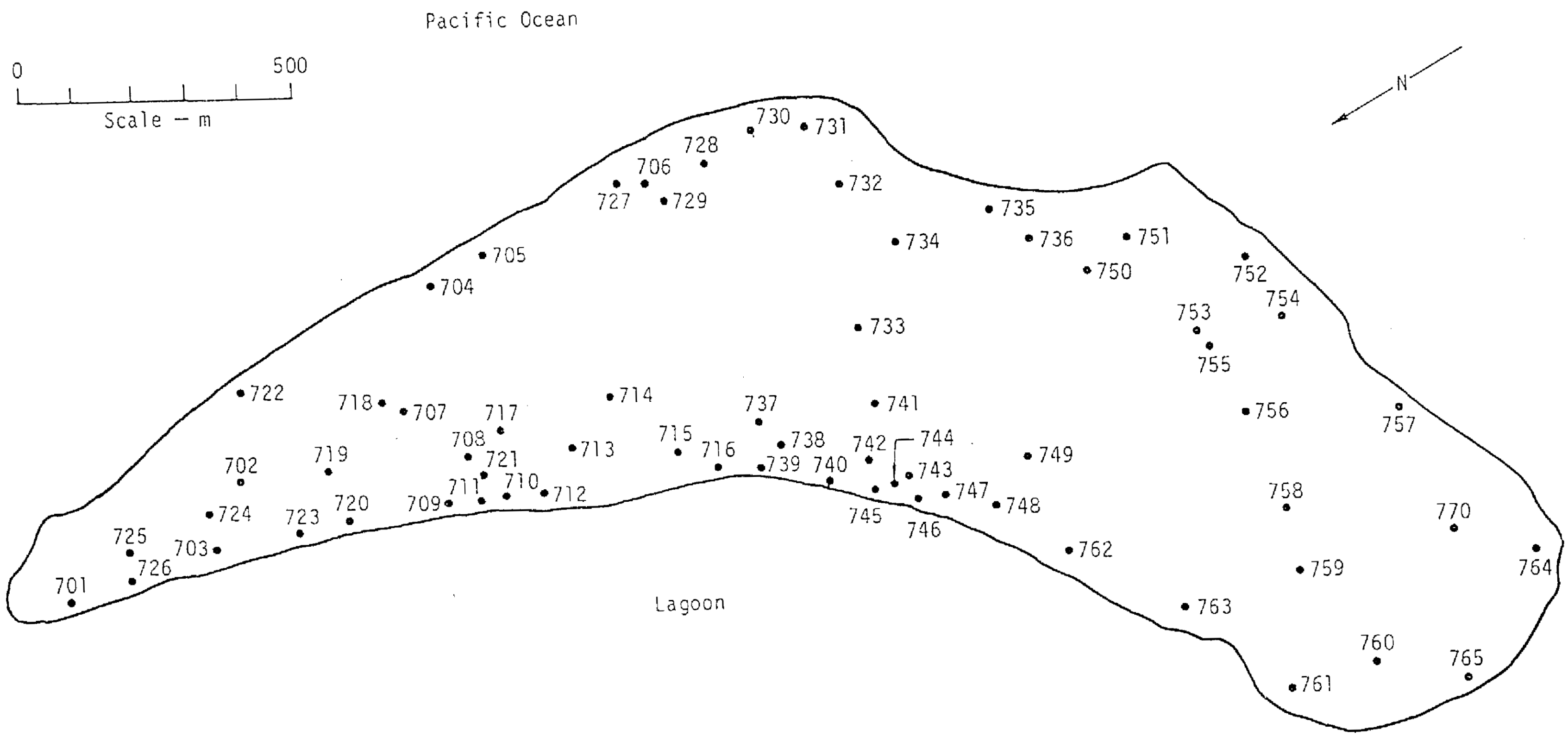


Fig. 2. Sampling sites of the Bikini (a) and Eneu (b) surface-soil sampling program.

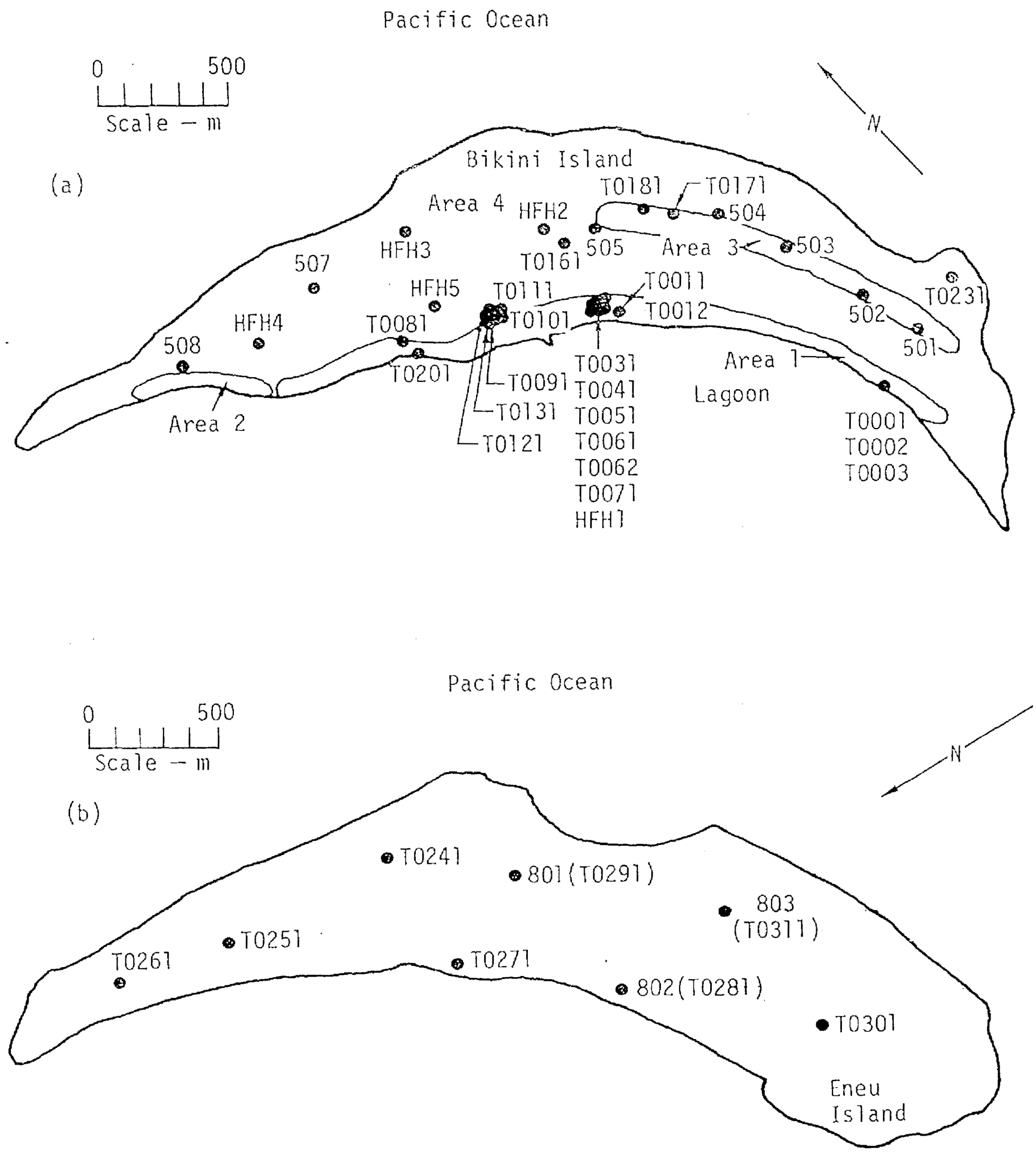


Fig. 3. Sampling sites of the Bikini (a) and Eneu (b) soil profile and vegetation samples.



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concentrations in plant samples and from the average measured concentration in the associated 0- to 25-cm soil profile. We define the concentration factor, CF, as

$$CF = \frac{\text{pCi/g dry plant}}{\text{pCi/g dry soil}} .$$

To reduce the variability in average soil concentrations (used to calculate the concentration factor), we used a 0- to 25-cm soil profile that encompasses a large fraction of the effective absorptive root zone rather than the deeper 0- to 55-cm profile that encompasses the entire root zone. Concentration factors calculated on the basis of the average soil concentration in the upper 25 cm of the profile are somewhat greater but do not differ substantially from those based on the deeper profiles (Tables 1 and 2). All concentration factors reported here are therefore those derived from average 0- to 25-cm soil concentrations.

The average 0- to 25-cm soil concentration is calculated as the weighted geometric mean for the separate concentrations, measured at various increments throughout the profile. Concentration values less than the minimum detection limit are set equal to the detection limit, following the U.S. Environmental Protection Agency technique.

Whenever the number of samples is large enough, soil concentrations are plotted against concentrations in plants from the same sampling site; the results are analyzed with linear regression methods. These linear regression results are "statistically significant" at the 0.1-level of a standard F test. For each combination of nuclide, plant organ, and species considered, statistically significant regression equations are compared to the median of the calculated concentration factors and a single representative concentration factor is assigned.

Predictions of radionuclide levels in foodstuffs can be made from concentration factors if measured soil concentrations are available; however, concentration ratios are also needed if the only available data are from mature leaf samples. The concentration ratio is defined as the ratio of the concentration in fruit to the concentration in leaves of the same species; or, as the concentration in leaves of one species to the concentration in leaves of another species. We calculted preliminary ratios for all available species from the 1975 Bikini survey. However, because of the small number of samples involved, a statistical analysis of these results was not possible.

Table 1. Average radionuclide concentration for 0- to 25-cm and deeper soil profiles.

| Location[a] | Average Soil Concentration, pCi/g dry weight | | | |
|---|---|---|---|---|
| | $^{90}Sr$ | $^{137}Cs$ | $^{239}Pu$ | $^{240}Pu$ |
| T0001 (0-25)[b] | 81 | 45 | 4.3 | 4.7 |
| (0-40) | 70 | 27 | 1.6 | 1.8 |
| T0051 (0-25) | 202 | 150 | 9.2 | 10 |
| (0-45) | 208 | 165 | 9.2 | 10 |
| T0061 (0-25) | 42 | 28 | 1.4 | 1.6 |
| (0-55) | 150 | 85 | 5.1 | 5.7 |
| T0062 (0-25) | 67 | 31 | 2.3 | 2.5 |
| (0-45) | 80 | 37 | 1.3 | 1.5 |
| T0081 (0-25) | 126 | 43 | 2.2 | 2.5 |
| (0-45) | 70 | 15 | 0.53 | 0.64 |
| T0121 (0-25) | 89 | 50 | 2.0 | 2.2 |
| (0-55) | 34 | 25 | 0.52 | 0.60 |
| T0161 (0-25) | 27 | 34 | 1.5 | 1.7 |
| (0-55) | 30 | 25 | 1.1 | 1.2 |
| T0181 (0-25) | 94 | 13 | 2.4 | 2.8 |
| (0-55) | 62 | 5 | 0.56 | 0.70 |
| T0191 (0-25) | 36 | 23 | 0.99 | 1.2 |
| (0-55) | 28 | 18 | 0.87 | 1.0 |
| T0241 (0-25) | 3.7 | 3.3 | 0.42 | 0.46 |
| (0-45) | 4.7 | 2.8 | 0.49 | 0.47 |
| T0251 (0-25) | 7.3 | 7.9 | 0.24 | 0.27 |
| (0-45) | 9.8 | 5.7 | 0.42 | 0.45 |
| T0261 (0-25) | 7.8 | 4.6 | 0.41 | 0.47 |
| (0-45) | 6.8 | 1.8 | 0.23 | 0.38 |
| T0271 (0-25) | 1.0 | 0.88 | 0.12 | 0.14 |
| (0-45) | 0.62 | 0.40 | ---c | --- |
| T0301 (0-25) | 16 | 10 | 1.1 | 1.2 |
| (0045) | 20 | 12 | 1.6 | 1.5 |

[a] Sample locations are shown in Fig. 2.

[b] Depth of soil profile in centimeters.

[c] Not detected.

Table 2. Soil-mature leaf concentration factors calculated for 0- to 25-cm and deeper soil profiles.

| Location[a] | | Concentration Factor, (pCi/g dry leaf)/(pCi/g dry soil) $^{90}Sr$ | $^{137}Cs$ | $^{239}Pu$ | $^{240}Pu$ |
|---|---|---|---|---|---|
| T0001 | (0-25) | 1.0 | 17 | 0.01 | 0.01 |
| | (0-40) | 1.2 | 29 | 0.038 | 0.01 |
| T0051 | (0-25) | 0.94 | 0.30 | 0.050 | 0.0053 |
| | (0-40) | 0.92 | 0.27 | 0.050 | 0.0052 |
| T0061 | (0-25) | 5.3 | 2.5 | 0.043 | 0.045 |
| | (0-55) | 0.15 | 0.82 | 0.012 | 0.013 |
| T0062 | (0-25) | 2.8 | 2.2 | 0.049 | 0.045 |
| | (0-55) | 3.3 | 1.9 | 0.028 | 0.013 |
| T0081 | (0-25) | 1.4 | 0.79 | 0.019 | 0.0494 |
| | (0-45) | 2.4 | 2.3 | 0.078 | 0.029 |
| T0121 | (0-25) | 1.2 | 2.9 | 0.030 | 0.021 |
| | (0-55) | 2.5 | 5.9 | 0.066 | 0.084 |
| T0161 | (0-25) | 0.22 | 13 | 0.018 | 0.014 |
| | (0-55) | 0.19 | 18 | 0.024 | 0.054 |
| T0181 | (0-25) | 0.11 | 35 | 0.012 | 0.018 |
| | (0-55) | 0.17 | 9.3 | 0.051 | 0.0245 |
| T0191 | (0-25) | 0.56 | 17 | 0.025 | 0.013 |
| (litter) | (0-55) | 0.72 | 23 | 0.029 | 0.051 |
| T0251 | (0-25) | 0.30 | 1.1 | ---[b] | --- |
| | (0-45) | 0.19 | 1.3 | --- | --- |
| T0261 | (0-25) | 0.16 | 3.9 | 0.010 | 0.013 |
| | (0-45) | 0.12 | 5.4 | 0.0059 | 0.069 |
| T0261 | (0-25) | 0.099 | 2.6 | --- | --- |
| | (0-45) | 0.20 | 6.6 | --- | --- |
| T0271 | (0-25) | --- | 16 | --- | --- |
| | (0-45) | --- | 36 | --- | --- |
| T0301 | (0-25) | 0.11 | 2.3 | --- | --- |
| | (0-45) | 0.085 | 2.0 | --- | --- |

[a] Sample locations are shown in Fig. 2.

[b] No data.



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# Results and Discussion

SURFACE SOIL SURVEY

Although more samples are available from the 1975 Bikini survey than from any previous survey (Table 3), there is little consistency in the geographical distribution of $^{60}$Co, $^{90}$Sr, $^{137}$Cs, $^{239,240}$Pu, and $^{241}$Am on Bikini and Eneu Islands (see Appendix C). The maps and overlays in Appendix C present the activities of these radionuclides in picocuries per gram of dry soil over the sites from which the samples were collected. A list of concentrations of all detectable nuclides for each sampling site is given in Appendix D (microfiche included in pocket on inside back cover). A dry-soil density of 1.5 g/cm$^3$ may be used to convert the integrated profile data into activity per unit area. However, some caution must be exercised in such calculations because a significant fraction of the total activity may be located below the sampling depth.

Table 4 presents the means of the surface-soil concentrations of the dominant nuclides for Eneu Island and for the four areas of interest on Bikini Island. The values for Eneu are consistently ten times lower than concentrations for any part of Bikini Island. As expected, on Bikini Island, Area 1 shows the lowest soil concentration, since it is an exposed beach area that has been cleared for housing. Data from Bikini[8] and Enewetak[12] have revealed that soil activity is directly related to the amount of vegetation present in the area surrounding the sampling site. One possible reason for this is that a heavy vegetative cover can protect the underlying soil, minimizing the effects of weathering processes (e.g., wind and rain erosion) that transport surface activity through the soil column to the water lens. Follow-up field work at Enewetak Atoll has also shown that, in heavily vegetated areas, litter increases the soil retention of radionuclides.[13]

Although soil concentrations of radionuclides in Area 2 appear to be higher for $^{90}$Sr and $^{239,240}$Pu than in any other area on Bikini, statistical analysis of the $^{90}$Sr concentrations for each of the four areas on Bikini, using the Mann-Whitney nonparametric test, shows no significant difference between the concentrations in the various areas. However, a more extensive analysis is needed to better define the real differences in concentrations in the various areas.

Table 3. Number of vegetation and soil samples in various Bikini surveys.

| | Number of Samples | | | | | |
|---|---|---|---|---|---|---|
| | $^{90}Sr$ | | $^{137}Cs$ | | $^{239,240}Pu$ | |
| Species, Organ | 64-74[a] Survey | 1975[b] Survey | 64-74 Survey | 1975 Survey | 64-74 Survey | 1975 Survey |
| *Pandanus,* leaves[c] | | 6 (6)[d] | | 6 (6) | | 5 (5) |
| fruit | 6 | 1 (1) | 4 | 1 (1) | | 1 (1) |
| Papaya, leaves | | 8 (4) | | 8 (4) | | 8 (4) |
| fruit | | 4 (4) | | 4 (4) | | 4 (4) |
| Breadfruit, leaves | | 2 (2) | | 2 (2) | | 2 (2) |
| fruit | 0 | 1 (1) | 0 | 1 (1) | | 1 (1) |
| Banana, leaves | | 3 (3) | | 3 (3) | | 3 (3) |
| Coconut, leaves | | 22 (8) | | 22 (8) | | 22 (8) |
| fruit | 5 | 6 (6) | 48 | 6 (6) | | 6 (6) |
| *Scaevola,* leaves | | 8 (2) | | 8 (2) | | 8 (2) |
| fruiting body | | 1 (1) | | 1 (1) | | 1 (1) |
| *Messerschmidia,* leaves | | 6 (3) | | 6 (3) | | 6 (3) |
| Soil Profiles | 5 | 42 | 22 | 42 | | 42 |
| Soil, top 15 cm | 21 | 196 | 176 | 196 | | 196 |

[a] Data from 1974 Bikini draft (unpublished).

[b] Data from this report.

[c] Leaves include both mature and young specimens.

[d] Number of samples that have directly associated soil profiles.

Table 4. Median surface soil concentrations (0 to 15 cm).

| | Soil Concentration, pCi/g dry weight | | | | | |
|---|---|---|---|---|---|---|
| Nuclide | Area 1 | Area 2 | Area 3 | Area 4 | Bikini Island[a] | Eneu Island |
| $^{60}$Co | 0.59 (51)[b] | 0.98 (6) | 0.94 (32) | 0.92 (87) | 0.86 (176) | 0.067 (66) |
| $^{90}$Sr | 41 (35) | 126 (5) | 69 (18) | 68 (70) | 76 (128) | 4.1 (73) |
| $^{137}$Cs | 34 (51) | 43 (6) | 48 (33) | 48 (88) | 43 (178) | 2.9 (68) |
| $^{239,240}$Pu | 2.3 (70) | 4.5 (10) | 2.1 (34) | 3.0 (140) | 3.0 (254) | 0.25 (146) |
| $^{241}$Am | 1.8 (51) | 3.7 (6) | 2.7 (31) | 2.7 (87) | 2.4 (175) | 0.22 (68) |

[a] Arithmetic average of soil concentration in Areas 1-4 on Bikini Island.

[b] Number of samples taken.

SOIL PROFILES

Soil profiles from different parts of Bikini and Eneu Islands show a wide range of activity distributions with depth. (A listing of the concentrations measured for each profile is given in Appendix A and the data are presented graphically in Appendix B.) As noted by Held,[14] different plant-soil environments exhibit different vertical patterns of nuclide migration. The nearly complete disruption of the upper soil layers at Bikini Atoll by clearing, construction, and testing over the past 30 years as well as by agricultural practices initiated more recently has created a variety of plant-soil environments. Thus, the inhomogenity of the soil on these islands is not surprising. However, because of this inhomogenity, generalizations are not very meaningful, and these islands cannot be characterized by "average vertical profiles" with which to formulate cleanup criteria and to estimate dose.

The four basic types of profiles delineated at Enewetak Atoll[12] are all present on Bikini Island (see Fig. 4). Although we could not identify any particular profile type for extensive areas on Bikini Island, specific locations can be assigned "typical" profiles for predictive purposes. For example, on Bikini Island a group of samples taken in close proximity to one another (T0091, T0101, T0111, T0121, and T0131) show generally decreasing activity levels with depth despite

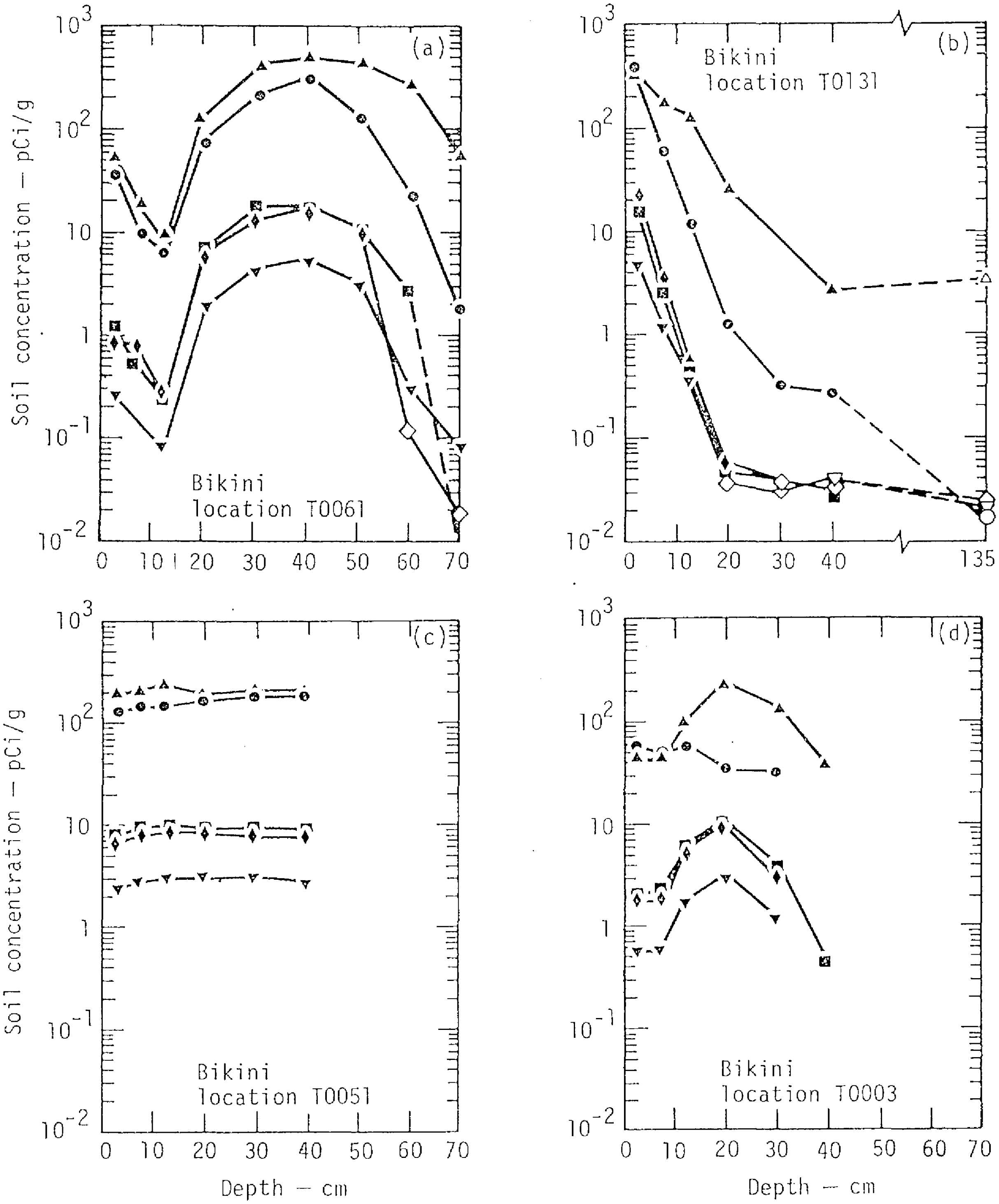


Fig. 4. Basic profile types from Gudiksen[11]: (a) erratic, (b) sharp drop-off, (c) uniform throughout, and (d) increasing then decreasing.



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some variability in pattern in the upper parts of the profiles (see Figs. 5-9; Appendices A and B). Other locations, limited in area, can be assigned different "typical" profiles.

In general, profiles from Bikini Island show decreasing activity levels with depth. In contrast, those from Eneu Island exhibit a pattern of uniform or slowly decreasing activity levels from surface to total-sampled depth. The variations seen in the profiles on Bikini may be the result of the location of organic layers in the profile. Because organic matter tends to concentrate radioactivity,[15] nonuniform patterns of radionuclide concentration may result from organic layers that have been buried recently by construction and rehabilitation activities.

Although it is difficult to generalize about patterns of activity distribution, the relative concentrations of the dominant nuclides show a consistent trend: $^{90}$Sr and $^{137}$Cs >

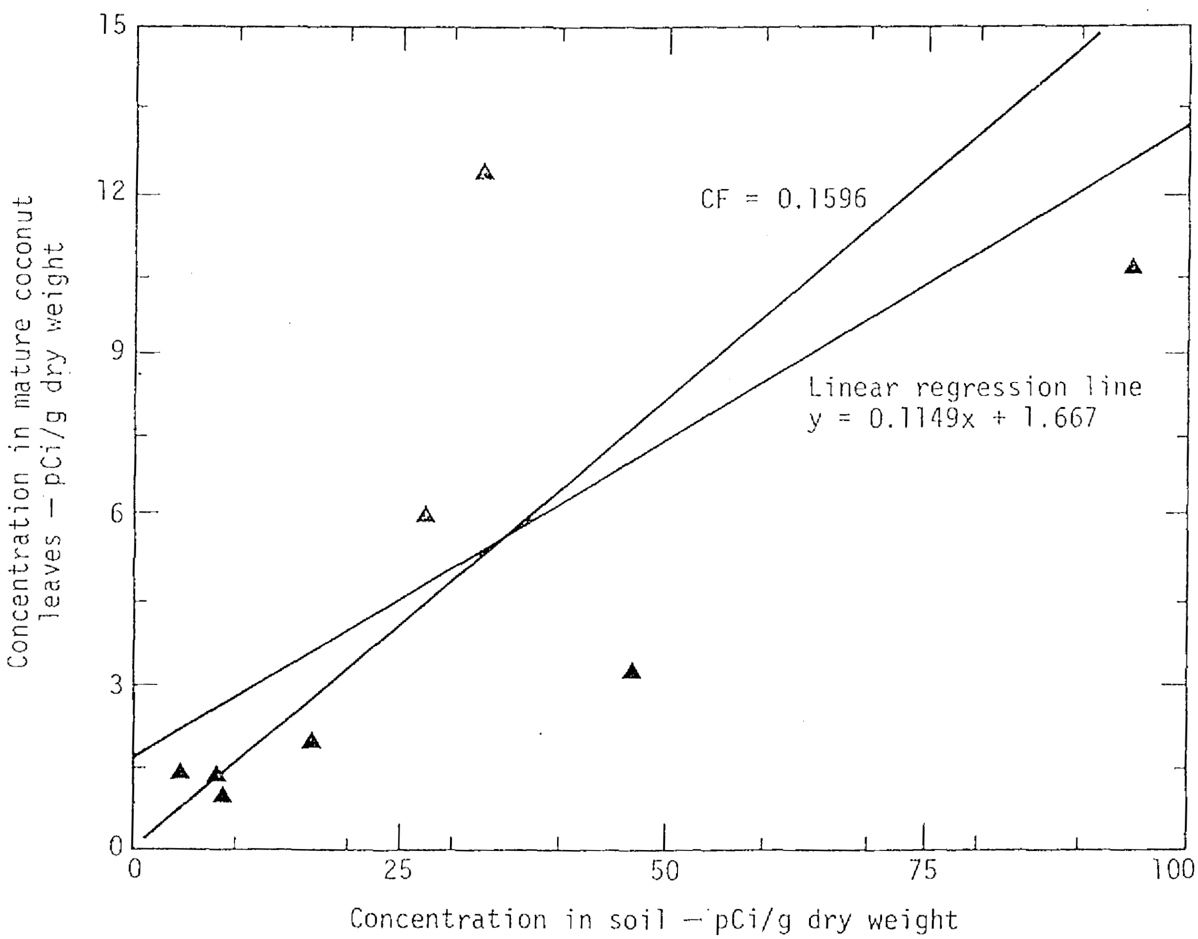


Fig. 5. Correlation of the $^{90}$Sr concentration in mature coconut leaves with the concentration of $^{90}$Sr in the soil at the same site.

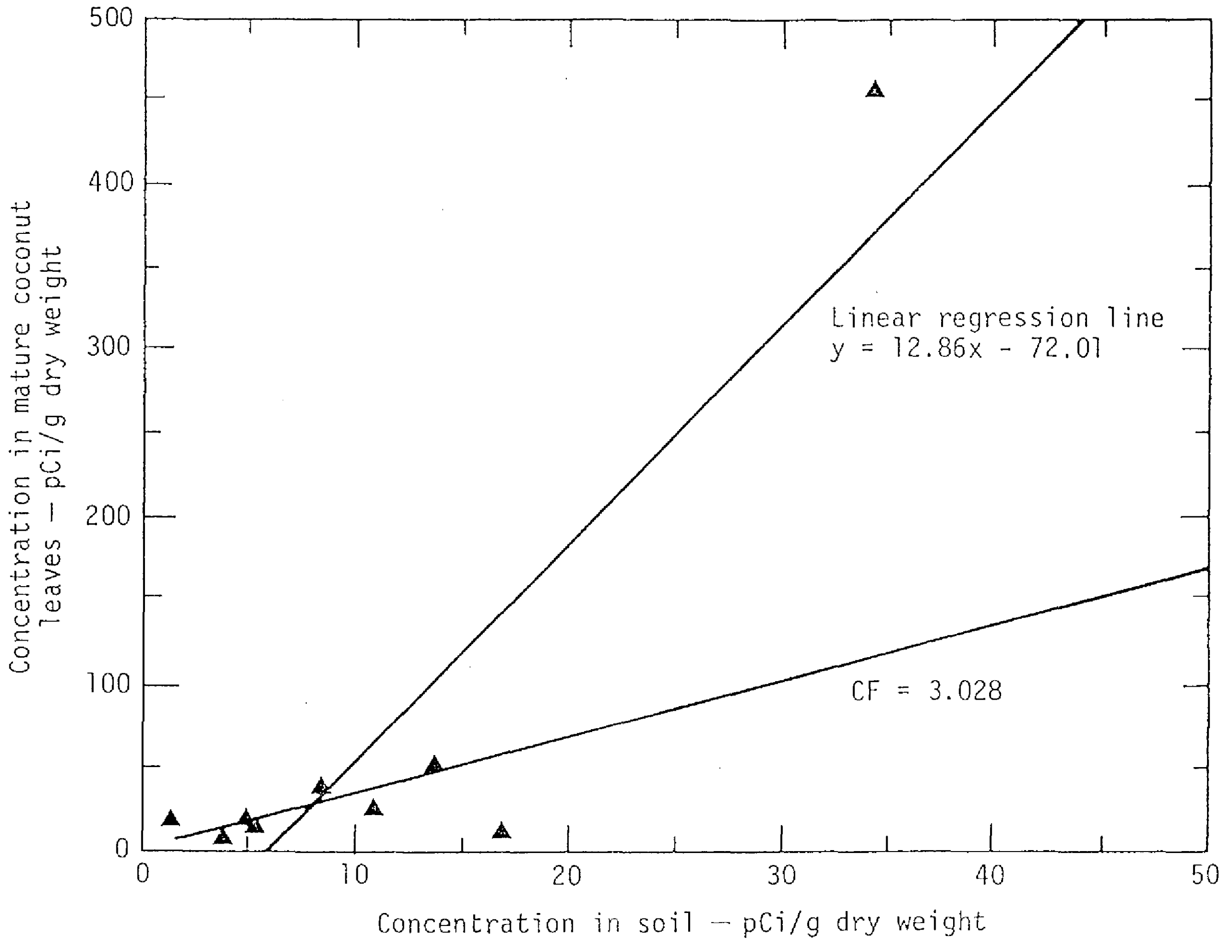


Fig. 6. Correlation of the $^{137}Cs$ concentration in mature coconut leaves with the concentration of $^{137}Cs$ in the soil at the same site.

$^{239,240}Pu$ and $^{241}Am$ > $^{60}Co$. The concentration of $^{90}Sr$ on Bikini Island is usually twice that of $^{137}Cs$, ten times that of $^{239,240}Pu$ and $^{241}Am$, and thirty to forty times that of $^{60}Co$ (Table 4). As mentioned previously, soil concentrations on Eneu are about ten times lower than those on Bikini Island for all the radionuclides considered.

## PREDICTION OF PLANT UPTAKE

Average concentrations in the 0- to 25-cm portions of the soil profiles are combined with measured concentrations in plants to predict the uptake of various radionuclides from the soil. In general, these plant-soil relationships from the 1975 Bikini survey confirm the results of previous surveys; however, the relationships are often statistically insignificant.

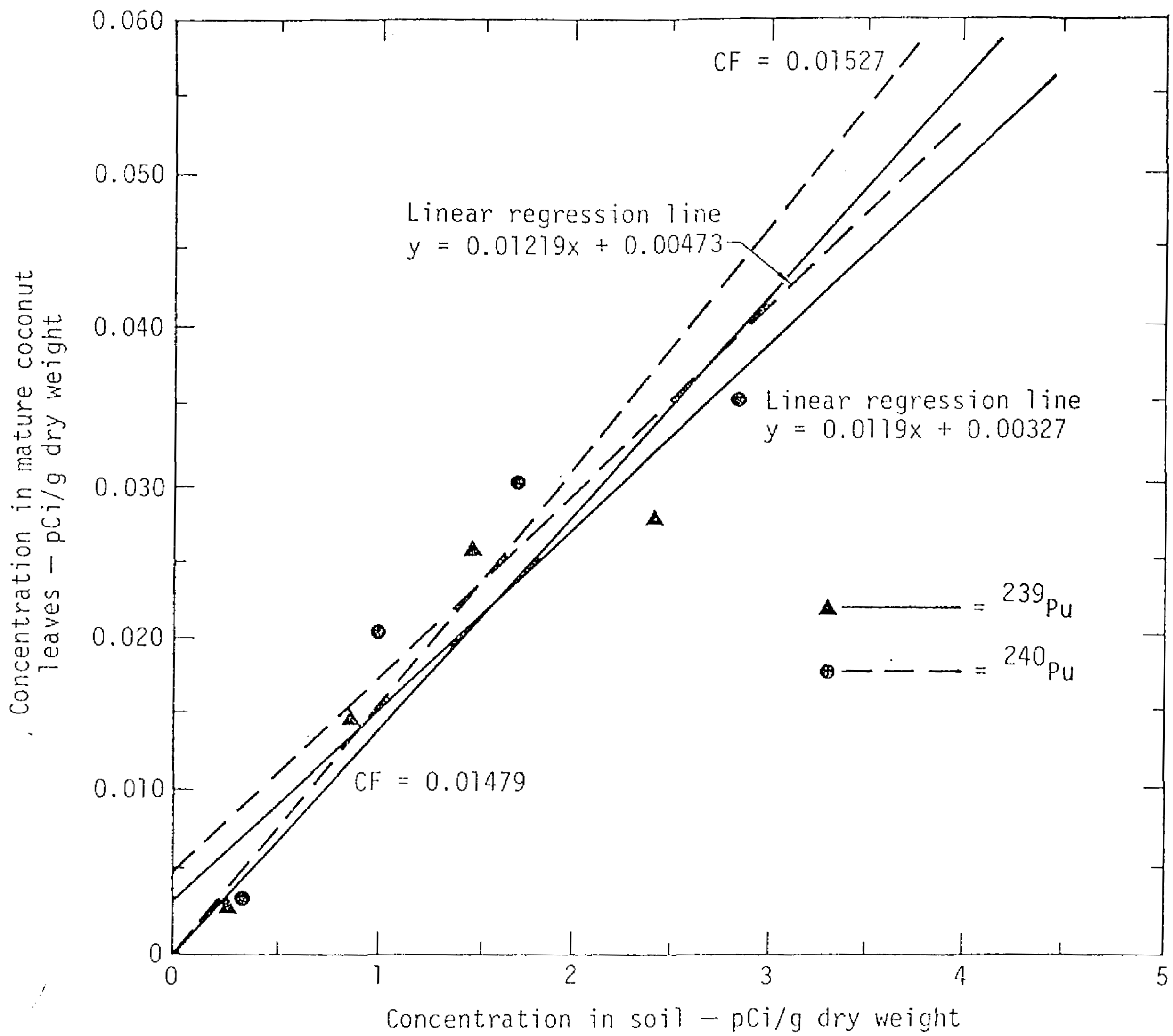


Fig. 7. Correlation of the $^{239,240}$Pu concentration in mature coconut leaves with the concentration of $^{239,240}$Pu in the soil at the same site.

In surveys where the number of samples considered for any one case is small, relationships that appear to be statistically insignificant are often extremely significant, since sampling errors may dominate the explanatory variables. Although statistical analysis of a larger number of samples is necessary to verify the results, we recommend the use of the general plant-soil relationships developed in this study for subsequent dose assessments.

## Concentration Factors

Soil profiles with uniform patterns of nuclide migration are seldom found at Bikini Atoll as a

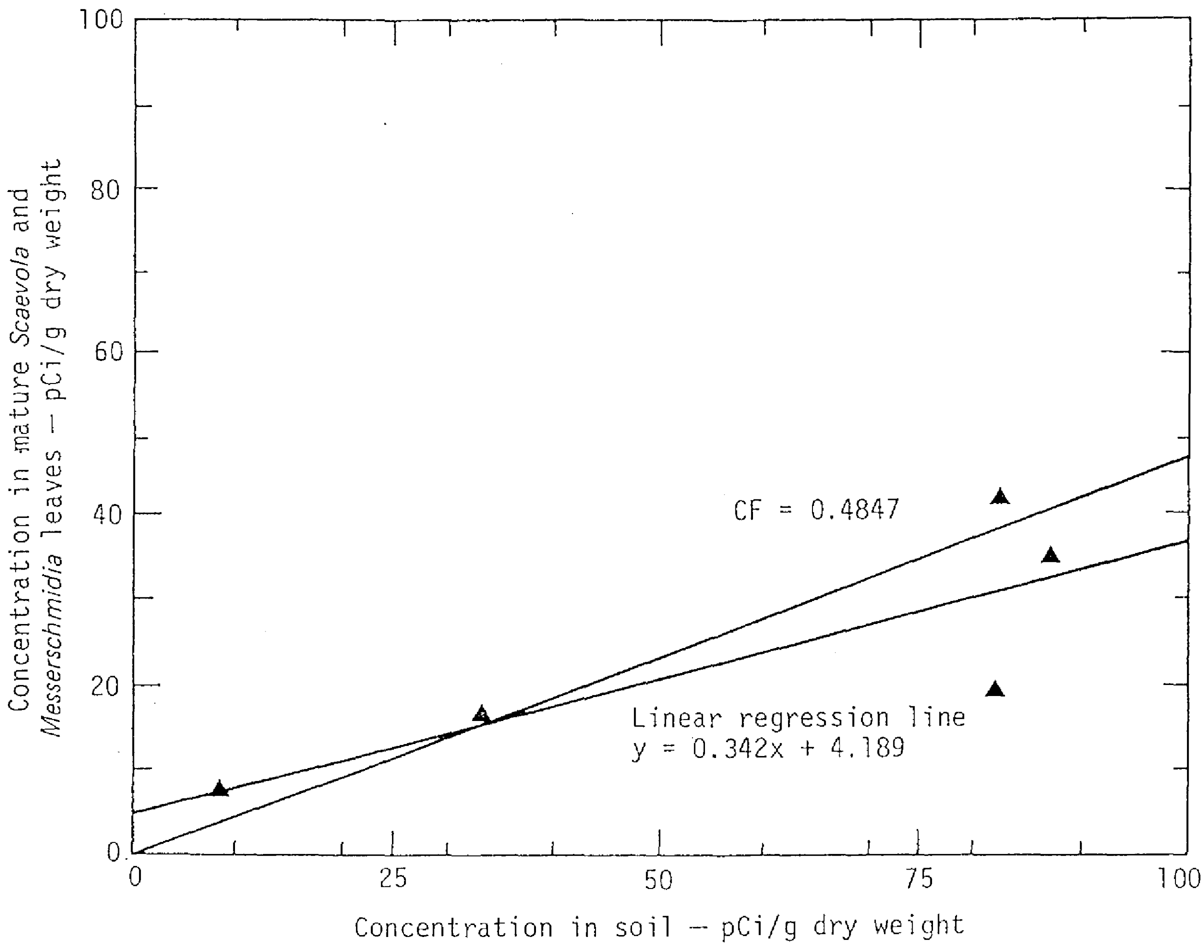


Fig. 8. Correlation of the $^{90}Sr$ concentration in mature *Scaevola* and *Messerschmidia* leaves with the concentration of $^{90}Sr$ in the soil at the same site.

result of the complete disruption of the upper soil layers by clearing, construction, and testing over the past 30 years as well as by more recent agricultural practices. To determine the soil concentrations of nuclides that are actually available to the root system of a specific plant, we sampled soil profiles in direct contact with the root system. The two replicate samples of soil profiles show minimal variation, regardless of the side of the plant from which they were taken (Table 5). In contrast, profiles in the general area but not in direct contact with the root system of the plant sample are highly variable (Table 6).

Tables 7 and 8 present the range and median values of concentration factors calculated for vegetation and soil sampled from the same location. Table 9 compares the information from these tables with the same information

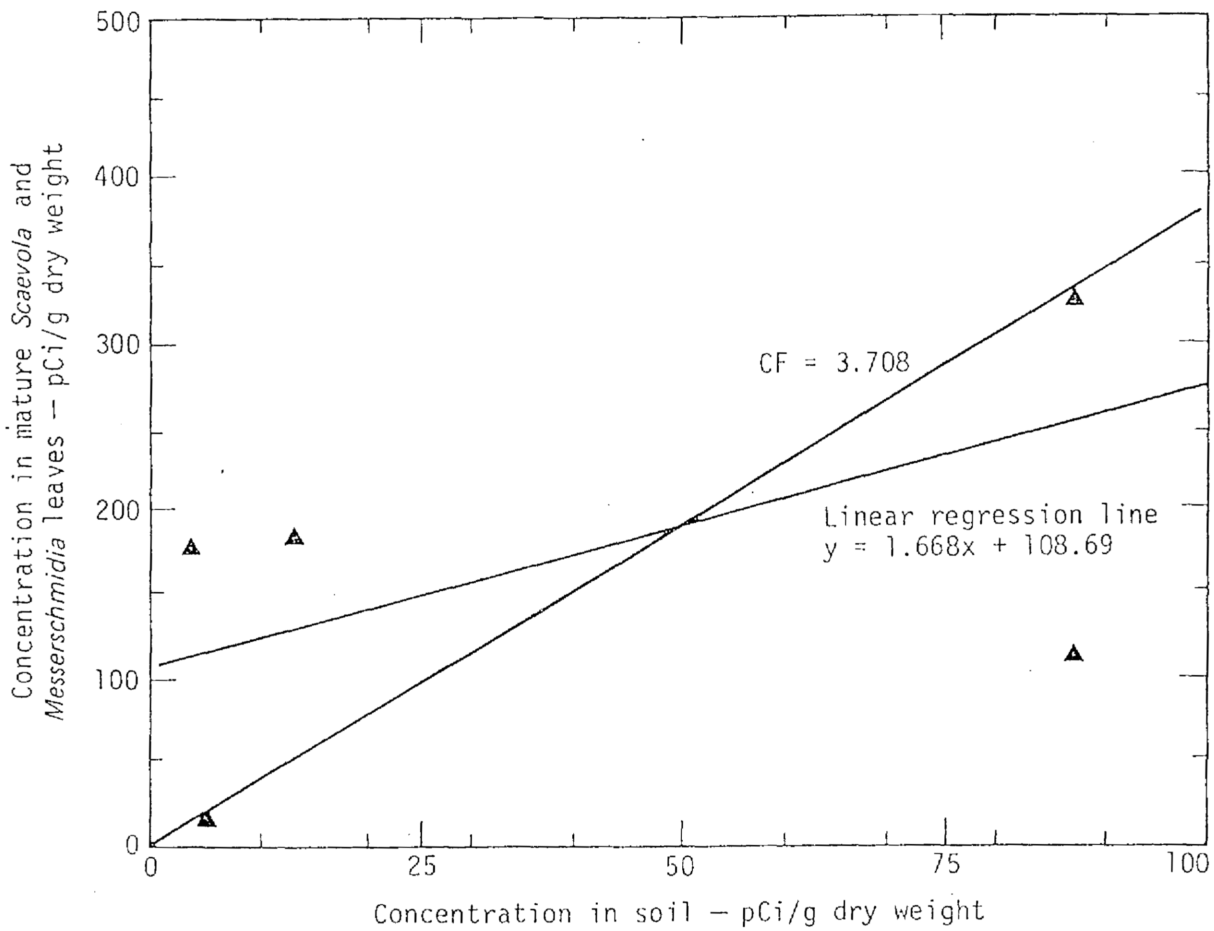


Fig. 9. Correlation of the $^{137}Cs$ concentration in mature *Scaevola* and *Messerschmidia* leaves with the concentration of $^{137}Cs$ in the soil at the same site.

for concentration factors calculated for mature *Scaevola* and coconut leaf samples for which no soil samples from the same location are available. We selected mature *Scaevola* and coconut leaves for this comparison because they provide the largest number of samples in both the associated and unassociated categories. A comparison of the ranges in Table 9 shows the importance of using associated plant-soil data (data from the same sampling site). Concentration factors calculated from unassociated plant and soil factors show a variation of three orders of magnitude in the case of $^{137}Cs$ uptake by mature *Scaevola* leaves while concentration factors calculated from associated data vary by one order of magnitude or less. These results agree with the wide range of concentration factors calculated in previous surveys from unassociated plant and soil samples.[1,4]



[redacted] 

Table 5. Radionuclide concentrations in replicate 0- to 25-cm soil profiles.

| Location[a] | Average Soil Concentration, pCi/g dry weight | | | |
|---|---|---|---|---|
| | $^{90}Sr$ | $^{137}Cs$ | $^{239}Pu$ | $^{240}Pu$ |
| Group 1 | | | | |
| T0001 | 81 | 45 | 4.3 | 4.7 |
| T0002 | 92 | 29 | 4.6 | 5.1 |
| T0003 | 101 | 44 | 5.0 | 5.5 |
| Group 2 | | | | |
| T0061 | 42 | 28 | 1.4 | 1.6 |
| T0062 | 68 | 31 | 2.6 | 2.5 |

[a]Sampling sites are shown in Fig. 2.

Table 6. Radionuclide concentrations in 0- to 25-cm soil profiles taken from the same general area.

| Location[a] | Average Soil Concentration, pCi/g dry weight | | | |
|---|---|---|---|---|
| | $^{90}Sr$ | $^{137}Cs$ | $^{239}Pu$ | $^{240}Pu$ |
| Group 1 | | | | |
| T0091 | 81 | 55 | 2.5 | 2.8 |
| T0101 | 32 | 35 | 0.27 | 0.29 |
| T0111 | 81 | 87 | 3.3 | 3.7 |
| T0121 | 89 | 50 | 2.0 | 2.2 |
| T0131 | 86 | 13 | 0.53 | 0.64 |
| Group 2 | | | | |
| T0031 | 6.8 | 8.6 | 0.18 | 0.20 |
| T0041 | 35 | 26 | 0.58 | 0.69 |
| T0051 | 202 | 150 | 9.2 | 10 |
| T0061 | 42 | 28 | 1.2 | 1.6 |
| T0071 | 127 | 86 | 4.6 | 5.1 |

[a] Sampling sites are shown in Fig. 2.

Table 7. Soil-to-plant uptake of $^{90}Sr$ and $^{137}Cs$ from plants and soils sampled at the same location.

| | Concentration Factor, (pCi/g dry plant)/(pCi/g dry soil) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $^{90}Sr$ | | | | $^{137}Cs$ | | | |
| Species, Organ | No. of Samples | Minimum | Maximum | Median | No. of Samples | Minimum | Maximum | Median |
| *Scaevola*, mature leaves | 2 | 0.24 | 0.41 | 0.33 | 2 | 1.3 | 14 | 7.4 |
| *Messerschmidia*, mature leaves | 3 | 0.48 | 0.86 | 0.52 | 3 | 2.1 | 50 | 3.7 |
| Pooled *Scaevola* & *Messerschmidia*, mature leaves | 5 | 0.24 | 0.86 | 0.48 | 5 | 1.3 | 50 | 3.7 |
| Coconut, mature leaves | 7 | 0.099 | 0.38 | 0.16 | 8 | 1.1 | 16 | 3.0 |
| Coconut, "fruit" | 2 | 0.024 | < 0.018 | --- | 2 | 1.4 | 3.6 | 2.5 |
| Coconut, meat | 2 | < 0.019 | 0.026 | --- | 2 | 7.3 | 9.8 | 8.6 |
| Coconut, milk[a] | 2 | < 0.0084 | < 0.012 | --- | 2 | 0.90 | 1.4 | |
| *Pandanus*, mature leaves | 5 | 0.71 | 2.4 | 0.91 | 5 | 2.9 | 25 | 15 |
| *Pandanus*, green fruit | 1 | ---[b] | --- | 0.53 | 1 | --- | --- | 0.054 |
| Papaya, mature leaves | 4 | 0.62 | 4.0 | 1.3 | 4 | 0.30 | 5.9 | 3.1 |
| Papaya, fruit | 4 | 0.12 | 0.85 | 0.43 | 4 | 1.9 | 18 | 8.2 |
| Breadfruit, mature leaves | 2 | 1.4 | 2.3 | 1.8 | 2 | 0.79 | 2.4 | 1.6 |
| Breadfruit, mature fruit | 1 | --- | --- | 0.76 | 1 | --- | --- | 7.0 |
| Banana, mature leaves | 2 | 0.48 | 1.1 | 0.73 | 2 | 0.33 | 0.54 | 0.42 |
| Squash, whole plant | 1 | --- | --- | 3.4 | 1 | --- | --- | 26 |
| Squash, seeds | 1 | --- | --- | 0.15 | 1 | --- | --- | 56 |

[a] Coconut milk was measured and reported in pCi/ml wet weight which, for calculation of the concentration factor, was assumed to equal pCi/g wet weight. Thus, the concentration factor for coconut milk is in (pCi/g wet weight)/(pCi/g dry soil).

[b] No data.



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Table 8. Soil-to-plant uptake of $^{239,240}Pu$ from plants and soils sampled at the same location.

| | Concentration Factor, (pCi/g dry plant)/(pCi/g dry soil) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $^{239}Pu$ | | | | $^{240}Pu$ | | | |
| Species, Organ | No. of Samples | Minimum | Maximum | Median | No. of Samples | Minimum | Maximum | Median |
| *Scaevola*, mature leaves | 1 | ---[a] | --- | 0.0047 | 1 | --- | --- | 0.0051 |
| *Messerschmidia*, mature leaves | 2 | 0.024 | 0.11 | 0.067 | 2 | 0.045 | 0.12 | 0.081 |
| Pooled *Scaevola* & *Messerschmidia*, mature leaves | 3 | 0.0047 | 0.11 | 0.024 | 3 | 0.0051 | 0.12 | 0.045 |
| Coconut, mature leaves | 4 | 0.010 | 0.022 | 0.015 | 4 | 0.0113 | 0.021 | 0.015 |
| *Pandanus*, mature leaves | 4 | 0.0044 | 0.030 | 0.016 | 4 | 0.0043 | 0.015 | 0.014 |
| Papaya, mature leaves | 4 | 0.0013 | 0.037 | 0.037 | 4 | 0.0053 | 0.041 | 0.026 |
| Papaya, fruit | 2 | 0.0013 | 0.0021 | 0.0017 | 2 | 0.0013 | 0.0023 | 0.0018 |
| Breadfruit, mature leaves | 2 | 0.0063 | 0.019 | 0.013 | 2 | 0.0213 | 0.062 | 0.042 |
| Banana, mature leaves | 2 | 0.0017 | 0.0054 | 0.0036 | 2 | 0.0018 | 0.0066 | 0.0042 |

[a] No data

Table 9. Soil-mature leaf concentration factors calculated from associated[a] and unassociated[b] data.

| | Concentration Factor, (pCi/g dry plant)/(pCi/g dry soil) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Associated | | | | Unassociated | | | |
| Nuclide, Species | No. of Samples | Minimum | Maximum | Median | No. of Samples | Minimum | Maximum | Median |
| $^{90}Sr$, *Scaevola* | 2 | 0.24 | 0.41 | 0.33 | 4 | 0.048 | 4.3 | 1.8 |
| $^{90}Sr$, coconut | 7 | 0.099 | 0.38 | 0.16 | 15 | 0.041 | 0.74 | 0.29 |
| $^{137}Cs$, *Scaevola* | 2 | 1.3 | 14 | 7.5 | 4 | 0.073 | 39 | 7.7 |
| $^{137}Cs$, coconut | 8 | 1.1 | 16 | 3.0 | 15 | 0.53 | 18 | 2.6 |
| $^{239}Pu$, coconut | 4 | 0.011 | 0.022 | 0.015 | 12 | 0.0036 | 0.14 | 0.016 |
| $^{240}Pu$, coconut | 4 | 0.011 | 0.021 | 0.015 | 12 | 0.0021 | 0.15 | 0.016 |

[a] Plant and soil data sampled from the same site.

[b] Plant and soil data sampled from different sites in the same general area.



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Because the range of concentration factors in only two combinations of nuclide, plant part, and species from the associated soil-plant data (pooled *Scaevola-Messerschmidia* leaves for $^{137}Cs$ and papaya leaves for $^{239}Pu$) varied by more than a factor of 20 (Table 10), we use the median concentration factors derived from the associated data in our predictive model.

Several reasons explain the variation of concentration factors calculated from associated plant and soil data, including differences in the physiochemical properties of the radionuclides under consideration, in soil type and chemical characteristics, in soil management practices, in irrigation practices, and in the physiology, age, and prior history of the plants sampled. It is impossible

Table 10. Maximum-to-minimum ratios of associated soil-plant concentration factors.

| Species, Organ | Maximum-to-Minimum Ratio | | | |
|---|---|---|---|---|
| | $^{90}Sr$ | $^{137}Cs$ | $^{239}Pu$ | $^{240}Pu$ |
| *Scaevola,* mature leaves | 1.7 | 10 | ---[a] | --- |
| *Messerschmidia,* mature leaves | 1.8 | 23 | 4.9 | 2.6 |
| Pooled *Scaevola* and *Messerschmidia,* mature leaves | 3.6 | 39 | 23 | 2.0 |
| *Pandanus,* mature leaves | 3.3 | 8.4 | 6.9 | 3.6 |
| Coconut, mature leaves | 3.8 | 14 | 2.1 | 1.8 |
| Coconut, "fruit"[b] | < 7.2 | 2.6 | --- | --- |
| Papaya, mature leaves | 6.5 | 20 | 30 | 7.9 |
| Papaya, fruit | 7.4 | 9.5 | 1.7 | 1.8 |
| Banana, mature leaves | 2.3 | 1.6 | 3.2 | 3.8 |
| Breadfruit, mature leaves | 1.7 | 3.0 | 3.0 | 2.9 |

[a] Not detected.

[b] "Fruit" includes both meat and milk.



[redacted]

to identify the specific cause of each variation but the variation can be reduced by carefully controlling sampling techniques and by increasing the number of samples.

Where fruit data are unavailable, concentration factors calculated from mature leaf data are used as the basis for predicting concentrations of radionuclides in food available to the returning Bikini population. Mature leaf concentration factors in conjunction with correlations between various species and between leaves and fruit of the same species enable us to predict concentrations in fruit from measured concentrations in leaves of indicator or edible plants.

We only report concentration factors for $^{90}Sr$, $^{137}Cs$, and $^{239,240}Pu$. As predicted from previous studies, the most effectively transferred radionuclide in the terrestrial environment is $^{137}Cs$, although $^{90}Sr$ is often present in larger quantities in the soil of the atoll. This is partly explained by the differential solubilities of $^{90}Sr$ and $^{137}Cs$ in soil. Strontium-90 appears to be tied up as insoluble carbonates in the atoll soil and is thus less available to the plant. Cesium-137 is more soluble in the nonclay atoll soil; thus $^{137}Cs$ is more easily leached through the soil. Although $^{137}Cs$ is leached through the soil at a faster rate than $^{90}Sr$, $^{137}Cs$ is also readily absorbed and accumulated in organified soil horizons where there is a proliferation of plant roots and litter. This accumulation of $^{137}Cs$ in organified soil horizons renders it more available than $^{90}Sr$ for uptake in plants.

The concentration factors discussed in the subsequent paragraphs generally reflect this relationship between the uptake of $^{90}Sr$ and $^{137}Cs$. For *Pandanus*, coconut, *Scaevola*, and *Messerschmidia* leaves and for the fruit of all species, low concentration factors are observed for $^{90}Sr$ as compared to $^{137}Cs$. However, leaves of papaya, banana, and breadfruit show concentration factors for $^{90}Sr$ as high or higher than those for $^{137}Cs$. Concentration factors for $^{239,240}Pu$ are generally 10 to 100 times lower than those for either $^{90}Sr$ or $^{137}Cs$. Although they are often measured in soil, $^{60}Co$, $^{241}Pu$, and $^{241}Am$ are only occasionally detected in vegetation. For this reason, we did not calculate concentration factors for these three nuclides.

In the following sections, we discuss the specific concentration factors assigned to each species. Concentration factors are assigned solely on the basis of the median calculated concentration factors except for coconut and for pooled *Scaevola* and *Messerschmidia* leaves.



[redacted]

For these last two cases, we had enough samples to justify analysis by linear regression methods. Thus, the regression results are compared with the median concentration factor and a representative value is chosen for our models. The relationships between the relative uptake of different species are considered in a separate section on concentration ratios.

Coconut. Coconut is the most abundant species on Bikini and Eneu Islands and thus it was sampled more extensively than any other plant in the 1975 survey. Unfortunately, few coconut trees were bearing fruit so the bulk of these samples are leaves. Regression analysis comparing mature coconut leaves and soil sampled from the same location shows correlations that are significant at the 0.1 to 0.05 level for $^{90}$Sr, at the 0.005 level for $^{137}$Cs, and at the 0.1 level for $^{239,240}$Pu (Figs. 5-7). Combining the results of this regression analysis with the median calculated concentration factors (Table 11), we obtain final concentration factors for mature coconut leaves of 0.16 for $^{90}$Sr, 3.0 for $^{137}$Cs, and 0.015 for $^{239,240}$Pu.

Concentrations in both coconut milk and coconut meat were analyzed for the two samples from Bikini. When compared on a wet/wet or a dry/dry basis, there are no definitive patterns in the radionuclide concentrations of meat and milk taken from the same location.* Because the 1972 Enewetak data show no consistent differences in the uptake of $^{90}$Sr and $^{137}$Cs by coconut milk and meat, the $^{90}$Sr and $^{137}$Cs concentrations in fresh coconut meat and fresh coconut milk are assumed to be equal. The concentration factors from the Bikini data (Table 11) are within the range of those from the Enewetak survey,[1] so until more conclusive data are available, we have assigned a conservative concentration factor of 0.024 for $^{90}$Sr and 2.5 for $^{137}$Cs to both coconut meat and milk.

*Pandanus* -- Although the number of samples of mature *Pandanus* leaves is insufficient for statistical analysis, the concentration factors calculated from associated leaf-soil data for Bikini are within the range of those from Enewetak.[1] The median concentration factors of 0.91 for $^{90}$Sr and 15.2 for $^{137}$Cs are assigned to mature *Pandanus* leaves. The concentration factor calculated for the one green *Pandanus* fruit available from the Bikini survey (0.50 for $^{90}$Sr and 5.4 for $^{137}$Cs) is comparable to values from previous surveys and therefore, we

*Following the example of the Enewetak survey,[1] results are given in wet weight for coconut milk and in dry weight for coconut meat; coconut milk is assumed to be 95% water and coconut meat is assumed to be 50% water.

Table 11. Comparison of soil-root and soil-leaf concentration factors.

| | Concentration Factor, (pCi/g dry plant)/(pCi/g dry soil) | | | | | |
|---|---|---|---|---|---|---|
| | $^{90}$Sr | | $^{137}$Cs | | $^{239,240}$Pu | |
| Species | Roots | Leaves | Roots | Leaves | Roots | Leaves |
| *Pandanus* | 0.88 | 1.0 | 23 | 17 | 0.44 | 0.015 |
| | 0.77 | 1.2 | 26.1 | 2.9 | 0.45 | 0.022 |
| *Messerschmidia* | 0.59 | 0.48 | 33 | 50 | 0.44 | 0.35 |
| Coconut | 0.16 | 0.11 | 3.4 | 2.3 | 0.085 | --- |
| | 0.89 | ---[b] | 16 | 0.88 | 0.11 | --- |
| | 0.30 | 0.30 | 5.7 | 1.1 | 0.081 | --- |
| | 0.89 | --- | 5.0 | --- | 0.38 | --- |
| Banana | 0.42[a] | 1.10 | 0.026 | 0.54 | 0.027 | 0.006 |

[a] Root and crown.

[b] Below minimum detection limit.

consider it to be a valid sample and have used it in our dose predictions.

Breadfruit — Breadfruit were not available on Enewetak Atoll. Thus, data from the two samples collected during the 1975 Bikini survey provide the first directly measured concentration factors. As expected from the 1972 Bikini survey[16] and from the stable element analysis of potassium and calcium in the Enewetak survey,[1] uptake of $^{90}$Sr and $^{137}$Cs by breadfruit is high and comparable to uptake by *Pandanus*. Preliminary concentration factors of 1.8 for $^{90}$Sr, 1.6 for $^{137}$Cs, and 0.027 for $^{239,240}$Pu are assigned to mature breadfruit leaves. The concentration factors for the one mature fruit sampled from this species are 0.76 for $^{90}$Sr and 7.0 for $^{137}$Cs.

Papaya — The ratio of maximum-to-minimum concentration factors calculated for mature papaya leaves is small; median concentration factors are 1.3 for $^{90}$Sr, 3.1 for $^{137}$Cs, and 0.0018 for $^{239,240}$Pu. Concentration factors of 0.43 for $^{90}$Sr, 8.2 for $^{137}$Cs, and 0.0018 for $^{239,240}$Pu are calculated for the four papaya fruit available.

Banana — The only data from the 1975 Bikini survey on radionuclide concentrations in banana are for mature leaves. The two available samples suggest tentative concentration factors of 0.73 for $^{90}$Sr, 0.42



[redacted]

for $^{137}$Cs, and 0.0039 for $^{239,240}$Pu in mature banana leaves. Unpublished data for banana fruit and soil samples from the same area collected in the 1972 Bikini survey yield concentration factors of < 0.058 for $^{90}$Sr and <0.00028 for $^{239,240}$Pu.[17] Because no data are currently available for concentration factors for $^{137}$Cs in bananas, we have assigned the conservative value of the $^{137}$Cs concentration factor in mature banana leaves to banana fruit.

*Messerschmidia and Scaevola* — As discussed in the Enewetak survey,[1] the data from these two indicator plants show a significant correlation between leaves and soil on both an individual and a pooled basis. The number of samples from the Bikini survey does not warrant individual statistical analysis of these species. However, the pooled data show a correlation between leaves and soil that is significant at the 0.1 level for $^{90}$Sr (Fig. 8) but is not significant for $^{137}$Cs (Fig. 9). Cesium-137 does show a significant correlation between leaves and soil in the Enewetak results and probably would do so for Bikini if the number of samples were larger. Based on the median calculated concentration factors and on the results of the regression analysis, concentration factors of 0.49 for $^{90}$Sr, 3.7 for $^{137}$Cs, and 0.035 for $^{239,240}$Pu were assigned to mature *Scaevola* and *Messerschmidia* leaves.

Squash — One sample of summer squash and its seeds was available from the 1975 survey. This is the first time measured radionuclide concentrations in garden vegetables from Bikini Atoll have been available. Squash uptake of $^{90}$Sr and $^{137}$Cs is greater than that of any other plant sampled. Other workers also have observed high concentrations of $^{137}$Cs in garden vegetables as compared to concentrations in other edible and indicator plants. Lynch *et al.*[7] notes that in field studies, the $^{137}$Cs concentration in lettuce leaves is an order of magnitude greater than the concentrations measured in other edible portions of food plants. In laboratory experiments to determine the uptake of $^{137}$Cs by squash, Walker *et al.* report $^{137}$Cs concentrations in squash that are higher than those measured in *Messerschmidia, Scaevola,* and *Pandanus* grown in the same Rongelap Atoll soil.[18] However, from Walker's experiments it appears that with the application of fertilizer, the concentrations in squash can be reduced to levels comparable to those found in other edible plants.

## Concentration Ratios

Radionuclides that are taken up from the soil through roots are either retained in the roots or transported to the aboveground plant organs. At Bikini, the concentrations of $^{90}Sr$ in the aboveground plant organs of a species are comparable to the concentrations retained in the roots of that species. However, concentrations of $^{137}Cs$ and $^{239,240}Pu$ are lower in the aboveground plant organs than in roots (Table 11). In addition, there are differences in uptake among the various aboveground plant organs. Within any one species, concentrations of $^{90}Sr$ and $^{239,240}Pu$ are generally smaller in edible plant parts (e.g., fruit) than in nonedible organs (e.g., leaves); the opposite is true for $^{137}Cs$ (Table 12).

Because leaves are more often available for sampling than are fruit, we developed fruit-leaf concentration ratios to allow prediction of radionuclide concentrations in fruit from those measured in leaves of the same species (Table 13). The small number of samples makes it impossible to statistically evaluate these ratios; we will do this as more data become available. We also calculated leaf-leaf and fruit-fruit concentration ratios between different species for

Table 12. Summary of median soil-plant concentration factors.

| | Concentration Factor, (pCi/g dry plant)/(pCi/g dry soil) | | | | | |
|---|---|---|---|---|---|---|
| | $^{90}Sr$ | | $^{137}Cs$ | | $^{239,240}Pu$ | |
| Species | Mature Leaves | Fruit | Mature Leaves | Fruit | Mature Leaves | Fruit |
| Pooled *Scaevola* & *Messerschmidia* | 0.48 | ---[a] | 3.7 | --- | 0.035 | --- |
| Coconut | 0.16 | 0.024 | 3.0 | 2.5 | 0.015 | --- |
| *Panadanus* | 0.91 | 0.50 | 15.0 | 5.4 | --- | --- |
| Papaya | 1.00 | 0.43 | 3.1 | 8.2 | 0.016 | 0.002 |
| Breadfruit | 1.80 | 0.76 | 1.6 | 7.0 | 0.027 | --- |
| Banana | 0.73 | 0.058[b] | 0.42 | --- | 0.004 | 0.0003[b] |
| Squash | 3.40[c] | 0.15[d] | 26.0[c] | 56.0[d] | --- | --- |

[a] Not detected.

[b] 1974 unpublished plant and soil data from the same vicinity.[17]

[c] Whole plant.

[d] Seeds.



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Table 13. Fruit-leaf concentration ratios.

| Species | Nuclide | Concentration, pCi/g dry weight: Fruit | Concentration, pCi/g dry weight: Mature Leaves | Fruit/Leaf Concentration Ratio |
|---|---|---|---|---|
| *Pandanus* | $^{90}Sr$ | 40[a] | 8 | 0.50 |
| | $^{137}Cs$ | 2.7 | 146 | 0.02 |
| Breadfruit | $^{90}Sr$ | 61 | 190 | 0.33 |
| | $^{137}Cs$ | 384 | 132 | 3.00 |
| Coconut "fruit" | $^{90}Sr$ | 0.79 | 12 | 0.06[c] |
| | | 1.9 | 2.9 | |
| | $^{137}Cs$ | 60 | 7.1 | 4.00[c] |
| | | 14 | 9.7 | |
| | | 54 | 15 | |
| Coconut meat/milk | $^{90}Sr$ | 0.41/0.18 | 1.7 | 0.33 |
| | $^{137}Cs$ | 76/9.3 | 24 | 3.00 |
| Papaya | $^{90}Sr$ | 18 | 264 | 0.20[c] |
| | | 22[a] | 22 | |
| | | 49 | 191 | |
| | | 47 | 221 | |
| | $^{137}Cs$ | 865[b] | 189 | 5.00 |
| | | 160[a] | 156 | |
| | | 281 | 45 | |
| | | 303 | 69 | |
| | $^{239,240}Pu$ | 0.014[b] | 0.049 | 0.03 |
| | | 0.0023 | 0.067 | |

[a] Green fruit.

[b] Fallen fruit.

[c] Based on all available data.

prediction of concentrations in fruit of one species from those in fruit or leaves of another species. These ratios show that distribution patterns for each nuclide are consistent within a particular species. However, we must remember that the importance of the contribution of each nuclide to the internal dose to man varies with different species.

The fruit-fruit and fruit-leaf concentration ratios are calculated from a comparison of the concentration factors of three plant groups (plants within each group were sampled from the same general location) and from comparisons of the median concentration ratios of all associated plant-soil samples (Table 14). Analysis of the concentration ratios for mature leaves and fruit suggests that some species concentrate a given nuclide to a much greater extent than do others (Tables 15-19). For $^{90}$Sr in mature leaves, the concentration decreases in the order: breadfruit and papaya > *Pandanus* and banana > *Messerschmidia* and *Scaevola* > coconut (Tables 15 and 18). These results agree with those of Welander.[10]

The relative uptake of $^{137}$Cs by the various species differs slightly from that of $^{90}$Sr. For $^{137}$Cs in mature leaves, the concentration appears to decrease with *Pandanus* > *Scaevola* > *Messerschmidia,* coconut, and papaya > breadfruit > banana. A comparison of $^{137}$Cs uptake by fruit yields the pattern: papaya > *Pandanus* and breadfruit > coconut (Tables 16 and 19). The data for the uptake of $^{239,240}$Pu by mature leaves are much more limited than data for $^{90}$Sr and $^{137}$Cs, but preliminary results suggest: *Messerschmidia* > breadfruit > *Pandanus* and coconut > papaya > *Scaevola* and banana (see Table 17). Although no concentration ratios are calculated, the uptake of $^{90}$Sr and $^{137}$Cs by unfertilized summer squash exceeds that of all other edible plants sampled.

## Summary and Conclusions

The radionuclide concentration in surface soil samples (0 to 15 cm) varies greatly throughout both Bikini and Eneu Islands. In addition to the inhomogeneity observed in surface soil concentrations, profile data indicate that radionuclide concentration as a function of soil depth is quite variable. (In some cases, the concentration at depths as great as 120 cm exceeds that in the top 2.5 cm.) As a result of the variability in surface soil concentrations with location and with depth, conclusions regarding dose reduction via soil removal must be exercised with great care. It is nearly impossible to generalize about remedial measures

Table 14. Associated soil-plant concentration factors for plant species sampled from the same location.

| | Concentration Factor, (pCi/g dry plant)/(pCi/g dry soil) | | |
|---|---|---|---|
| Species, Organ | $^{90}Sr$ | $^{137}Cs$ | $^{239,240}Pu$ |
| Group 1[a] | | | |
| Papaya, mature leaves | 1.6 | 3.9 | 0.012 |
| Papaya, mature leaves | 0.62 | 5.9 | 0.037 |
| Papaya, mature leaves | 0.94 | 0.30 | 0.0051 |
| Papaya, mature leaves | 4.0 | 2.9 | 0.027 |
| Banana, mature leaves | 0.48 | 0.33 | 0.0017 |
| Banana, mature leaves | 1.1 | 0.41 | 0.0060 |
| Group 2[b] | | | |
| Breadfruit, mature leaves | 2.3 | 2.4 | 0.063 |
| *Pandanus,* mature leaves | 1.2 | 2.9 | 0.022 |
| *Messerschmidia,* mature leaves | 0.48 | 87 | 0.035 |
| *Messerschmidia,* mature leaves | 0.52 | 3.7 | ---[d] |
| *Scaevola,* mature leaves | 0.24 | 1.3 | 0.0049 |
| *Scaevola,* mature leaves | 0.41 | 14 | --- |
| Breadfruit, fruit | 0.76 | 7.0 | --- |
| *Pandanus,* green fruit | 0.53 | 5.4 | --- |
| *Scaevola,* fruit | 0.14 | 1.4 | 0.00096 |
| Group 3[c] | | | |
| *Scaevola,* mature leaves | 4.3 | 39 | 0.024 |
| Coconut, mature leaves | 0.67 | 14 | 0.026 |
| Coconut, mature leaves | 0.27 | 7.3 | 0.020 |

[a] Group 1 includes samples T0010, T0030, T0040, T0050, T0060, T0070.

[b] Group 2 includes samples T0090, T0100, T0110, T0120, and T0130.

[c] Group 3 includes samples T0150 and T0160.

[d] Not detected.

Table 15. Strontium-90 leaf-leaf concentration ratios.

| | Leaf-Leaf Concentration Ratio | | | | | | |
|---|---|---|---|---|---|---|---|
| Species | Bread-fruit | Papaya | *Pandanus* | Banana | *Messer-schmidia* | *Scaevola* | Coconut |
| Breadfruit | 1.0 | 1.5 | 2.0 | 2.5 | 3.5 | 6.0 | 12 |
| Papaya | 0.66 | 1.0 | 1.3 | 1.7 | 2.5 | 4.0 | 8.0 |
| *Pandanus* | 0.50 | 0.77 | 1.0 | 1.3 | 1.8 | 3.0 | 6.0 |
| Banana | 0.40 | 0.59 | 0.77 | 1.0 | 1.4 | 2.2 | 4.4 |
| *Messerschmidia* | 0.29 | 0.40 | 0.56 | 0.71 | 1.0 | 1.6 | 3.2 |
| *Scaevola* | 0.17 | 0.25 | 0.33 | 0.45 | 0.63 | 1.0 | 2.0 |
| Coconut | 0.08 | 0.12 | 0.17 | 0.23 | 0.31 | 0.50 | 1.0 |

Table 16. Cesium-137 leaf-leaf concentration ratios.

| | Leaf-Leaf Concentration Ratio | | | | | | |
|---|---|---|---|---|---|---|---|
| Species | *Panadanus* | *Scaevola* | *Messer-schmidia* | Coconut | Papaya | Bread-fruit | Banana |
| *Pandanus* | 1.0 | 2.0 | 4.0 | 5.0 | 5.0 | 10.0 | 35 |
| *Scaevola* | 0.50 | 1.0 | 2.0 | 2.5 | 2.5 | 5.0 | 18 |
| *Messerschmidia* | 0.25 | 0.50 | 1.0 | 1.3 | 1.3 | 2.4 | 8.8 |
| Coconut | 0.20 | 0.40 | 0.80 | 1.0 | 1.0 | 2.0 | 7.0 |
| Papaya | 0.20 | 0.40 | 0.80 | 1.0 | 1.0 | 2.0 | 7.5 |
| Breadfruit | 0.10 | 0.20 | 0.40 | 0.50 | 0.50 | 1.0 | 3.8 |
| Banana | 0.03 | 0.06 | 0.12 | 0.14 | 0.13 | 0.26 | 1.0 |

entailing soil removal without first detailing the area and pathways that will be involved.

For example, the soil profile data (Appendices A and B) for Eneu and for some areas on Bikini indicate that removal of the top 10 cm of soil should do very little to reduce gamma exposure unless the removed soil is replaced with clean soil, thus shielding the deeper contaminated soil. There would also be very little impact upon uptake by plants because the soil concentration is essentially identical through the root zone up to depths of 40 cm.

However, there are other areas on Bikini Island, (Appendices A and B, locations 501, 502, 503, and 504,

Table 17. Plutonium-239,240 leaf-leaf concentration ratios.

| | Leaf-Leaf Concentration Ratio | | | |
|---|---|---|---|---|
| Species | *Messerschmidia* | Breadfruit[a] | Papaya | *Scaevola*[b] |
| *Messerschmidia* | 1.0 | 4.5 | 10 | 15 |
| Breadfruit[a] | 0.22 | 1.0 | 2.2 | 3.3 |
| Papaya | 0.10 | 0.45 | 1.0 | 1.5 |
| *Scaevola*[b] | 0.07 | 0.30 | 0.67 | 1.0 |

[a] Also includes *Pandanus* and coconut.

[b] Also includes banana.

Table 18. Strontium-90 fruit-fruit concentration ratios.

| | Fruit-Fruit Concentration Ratios | | |
|---|---|---|---|
| Species | Breadfruit | *Pandanus*[a] | Coconut |
| Breadfruit | 1.0 | 1.5 | 3.0 |
| *Pandanus*[a] | 0.67 | 1.0 | 2.0 |
| Coconut | 0.33 | 0.50 | 1.0 |

[a] Also includes papaya.

Table 19. Cesium-137 fruit-fruit concentration ratios.

| | Fruit-Fruit Concentration Ratio | | | |
|---|---|---|---|---|
| Species | Papaya | Breadfruit | *Pandanus* | Coconut |
| Papaya | 1.0 | 1.3 | 1.6 | 3.2 |
| Breadfruit | 0.75 | 1.0 | 1.4 | 2.8 |
| *Pandanus* | 0.63 | 0.71 | 1.0 | 2.0 |
| Coconut | 0.30 | 0.36 | 0.50 | 1.0 |



[redacted]

respectively) where removal of the top 10 cm of soil would reduce soil concentrations by approximately five-fold. This of course would result in reduced external exposure and reduced uptake in plants grown in such areas.

Although considerable variation in soil radionuclide concentration is observed on both islands, the soil concentrations on Bikini Island are approximately ten times those on Eneu Island. In addition, the relative radionuclide soil concentrations are very consistent; concentrations of $^{90}$Sr and $^{137}$Cs are ten to twenty times greater than those of $^{239,240}$Pu and $^{241}$Am which, in turn, are two to three times greater than $^{60}$Co concentrations. Therefore, generalizations can safely be made from the soil data to the effect that inhabitants on Bikini Island will be exposed to higher doses than those on Eneu Island. Also, on both islands, $^{90}$Sr and $^{137}$Cs are the radionuclides of primary importance.

In the past, concentrations in terrestrial foodstuffs at Bikini Atoll have been predicted from soil concentrations measured in the field and from concentration factors taken from the literature. This approach was adopted because vegetation sampling programs were limited in the early surveys. However, the terrestrial sampling program of the 1975 Bikini survey included sufficient vegetation samples to allow preliminary prediction of concentrations in nearly all components of the postulated Bikini diet. These predicted concentrations are based on soil-plant concentration factors and on fruit-leaf, leaf-leaf, or fruit-fruit concentration ratios calculated from the 1975 field data. The predicted concentrations compare favorably with the available measured concentrations. A more extensive survey of Bikini Atoll with larger sample sizes is needed to statistically verify these preliminary results. In the meantime, potential future concentrations in foodstuffs from Bikini can be predicted from our concentration factors if measured soil concentrations are available and from our concentration ratios if only vegetation samples are available. Estimates of the dose commitment expected from various projected lifestyles from our predicted concentrations are reported in Part 5 of this report series.[9]

The predominant nuclides in the terrestrial foodchain are $^{90}$Sr and $^{137}$Cs, followed by $^{239,240}$Pu, and will constitute the major internal dose to man from this pathway. In general, within a given species, $^{137}$Cs uptake by fruit and leaves is one order of magnitude greater than $^{90}$Sr uptake which, in turn, exceeds $^{239,240}$Pu uptake by one to two orders of magnitude. Uptake by mature leaves of papaya, banana, and breadfruit varies slightly from this general pattern; in these cases, the measured uptake of $^{90}$Sr is equal to that of $^{137}$Cs. However, more samples are needed to verify the pervasiveness of these exceptions to the overall patterns observed. The distribution of $^{90}$Sr, $^{137}$Cs, and $^{239,240}$Pu in fruit and leaves follows similar patterns in the various species studied. In a given species, $^{90}$Sr and $^{239,240}$Pu uptake by mature leaves is two to ten times greater than that by fruit. The $^{137}$Cs uptake measured in this study shows a different trend; uptake by fruit exceeds uptake by mature leaves by a factor of two to five.

A comparison of the uptake of $^{90}$Sr, $^{137}$Cs, and $^{239,240}$Pu shows that, in general, the relative order of uptake is: squash (high; breadfruit, *Pandanus*, and papaya (intermediate); and banana and coconut (low). Slight variations occur, depending on the radionuclide under consideration. A more quantitative ordering can be made after greater numbers of all tissues of plants are sampled in future surveys.

## Acknowledgment

We greatly appreciate the invaluable comments of Yook Ng and John Holdren in reviewing this manuscript. We thank John Koshiver for his aid in statistical analysis of the data and Ora Lowe and Bill Burke for their technical assistance.

The field portion of the June 1975 radiological survey of Bikini and Eneu Islands of Bikini Atoll was accomplished by a very intense and thorough effort of 21 people representing six different organizations. The number of samples collected and the amount of information obtained during the ten-day survey is a direct result of the cooperation and diligent effort of the following individuals: Wayne Bliss (Environmental Protection Agency, Las Vegas, Nevada), Bruce Clegg (Lawrence Livermore Laboratory), Dave Coles (Lawrence Livermore Laboratory), Tom Crites (Lawrence Livermore Laboratory), Rod Eagle (Lawrence Livermore Laboratory), Harley Erwicker (Trust Territory of the Pacific Islands), Nat Greenhouse (Brookhaven National Laboratory), Paul Gudiksen (Lawrence Livermore Laboratory), Gale Holladay (Lawrence Livermore Laboratory), Bob Keller (Nevada Operations Office, ERDA), Dennis McBreen (Trust Territory of the Pacific Islands), Tommy McCraw (Division of Operational Safety, ERDA), Ben Mendoza (Lawrence Livermore Laboratory), Vic Nelson (University of Washington), Vic Noshkin (Lawrence Livermore Laboratory), Frank Reed (Environmental Protection Agency, Las Vegas, Nevada), Jim Schweiger (Lawrence Livermore Laboratory), Robert

Spies (Lawrence Livermore Laboratory), John Stewart (Nevada Operations Office, ERDA), and Marshall Stuart (Lawrence Livermore Laboratory).

We extend thanks to the following people for the superb job done in the processing of all soil and vegetation samples collected during the survey: Jim Schweiger (Lawrence Livermore Laboratory), Ben Mendoza (Lawrence Livermore Laboratory), Greg Calvaird (RECO), Elizabeth Fletcher (RECO), Nancy Sawley (Lawrence Livermore Laboratory), Cynthia Tafoya (Lawrence Livermore Laboratory), and Marshall Stuart (Lawrence Livermore Laboratory).

We are also grateful to the following people from McClellan Central Laboratory for the excellent effort in the wet chemistry analysis of the soil, vegetation, and animal samples: A. Ackland, R. Aduddel, L. Alexander, H. Aning, D. Beach, M. Beckinger, P. Carlson, W. Clark, R. Draper, W. Dunlap, D. Efurd, H. Erdman, D. Fletcher, W. Fuqua, C. Gay, J. Gholson, D. Griswold, R. Grogg, J. Hadl, H. Hamilton, R. Haslett, E. Henry, L. Hume, R. Jefferies, R. Johnson, M. Kantelo, P. Leciejewski, J. Lucas, R. Mayhew, C. McBrearty, G. Merrill, J. Miles, J. Miner, M. Mount, W. Myers, T. Nibarger, T. Opiela, R. Osborne, A. Paglione, J. Phelps, J. Phillips, C. Rheault, J. Riggs, R. San Miguel, B. Scholl, R. Schwarting, D. Seymour, J. Sexton, P. Sparman, W. Summers, W. Tracey, R. Wagoner, W. Washer, L. Williams, and J. Wright.

We thank the following Lawrence Livermore Laboratory personnel involved in the gamma spectrometry of all the samples: Jesse Meadows, Mike Allen, Ruth Anderson, and Robert Wikkerink.

William Phillips has done a fine job in establishing, writing, updating, and correcting the rather extensive data bank generated by the analytical efforts.

The survey crew extends its thanks to Dr. Guy Haywood for medical support during the survey operation and to the Nevada Operations Office and Pacific Area Support Office for support services which enabled a smooth and efficient survey. Support from the Kwajalein Missile Range and the site contractor, Global Associates, as well as from the crew of the R.V. Liktanur is greatly appreciated.

The outstanding cooperation of personnel from the Trust Territory of the Pacific Islands and from the Office of the District Administrator of the Marshall Islands as well as that of the Bikini people played an important part in the successful completion of the survey.



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# Appendix A. Soil Profiles of Bikini and Eneu Islands

The following tables present the concentration of eight selected radionuclides ($^{60}$Co, $^{90}$Sr, $^{137}$Cs, $^{155}$Eu, $^{239}$Pu, $^{240}$Pu, $^{241}$Pu, and $^{241}$Am) with depth in the soil profile. Sample locations on the islands are given in Figs. 2 and 3. These data are also presented graphically in Appendix B.



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PROFILE BIKINI 501

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 4.351E+00 | 2.370E+02 | 2.260E+02 | 5.744E+00 | 1.311E+01 | 1.449E+01 | 2.607E+02 | 1.373E+01 | 01048131 |
| 005-010 | 5.869E+00 | 3.271E+02 | 1.365E+02 | 7.946E+00 | 1.698E+01 | 1.866E+01 | 3.387E+02 | 2.053E+01 | 01048234 |
| 010-020 | 3.853E+00 | 2.942E+02 | 8.473E+01 | 4.734E+00 | 1.112E+01 | 1.251E+01 | 2.330E+02 | 1.253E+01 | 01048371 |
| 020-030 | 6.261E-02 | 2.046E+02 | 3.219E+01 | <9.144E-02 | 6.748E-01 | 7.455E-01 | 1.312E+01 | <1.539E-01 | 01048472 |
| 030-040 | 9.230E-02 | 8.815E+01 | 1.305E+01 | <4.716E-02 | 4.586E-02 | 5.455E-02 | - | <9.032E-02 | 01048573 |

PROFILE BIKINI 502

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 4.658E+00 | 2.871E+02 | 2.946E+02 | 7.270E+00 | - | - | - | 1.780E+01 | 01054531 |
| 005-010 | 5.477E+00 | 4.493E+02 | 3.130E+02 | 7.649E+00 | 2.193E+01 | 2.409E+01 | 4.346E+02 | 2.040E+01 | 01054634 |
| 010-020 | 8.122E-01 | 1.111E+02 | 4.146E+01 | 6.851E-01 | 1.770E+00 | 2.009E+00 | 3.883E+01 | 1.950E+00 | 01054771 |
| 020-030 | 9.194E-02 | 6.932E+00 | 2.365E+00 | <2.469E-02 | 3.724E-02 | 4.734E-02 | - | <4.260E-02 | 01054872 |

PROFILE BIKINI 503

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 1.045E+00 | 6.869E+01 | 8.617E+01 | 1.398E+00 | 3.327E+00 | 3.718E+00 | 7.527E+01 | 3.495E+00 | 01052331 |
| 005-010 | 8.748E-01 | 1.204E+02 | 7.378E+01 | 2.061E-01 | 9.770E-01 | 1.229E+00 | 2.556E+01 | 1.164E+00 | 01052434 |
| 010-020 | 1.426E-01 | 7.036E+01 | 9.719E+00 | <4.423E-02 | 1.212E-01 | 1.466E-01 | 2.700E+00 | <8.077E-02 | 01052571 |

PROFILE BIKINI 504

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 4.100E+00 | 2.208E+02 | 2.224E+02 | 5.545E+00 | 1.262E+01 | 1.396E+01 | 2.523E+02 | 1.446E+01 | 01049231 |
| 005-010 | 3.942E+00 | 2.458E+02 | 1.880E+02 | 5.514E+00 | 1.153E+01 | 1.297E+01 | 2.345E+02 | 1.435E+01 | 01049334 |
| 010-020 | 3.188E-01 | 2.826E+01 | 2.687E+01 | 1.696E-01 | 6.860E-01 | 7.982E-01 | 1.660E+01 | 6.306E-01 | 01049471 |
| 020-030 | 5.468E-02 | 7.973E+00 | 8.955E+00 | <2.961E-02 | 1.236E-01 | 1.593E-01 | - | <5.721E-02 | 01049572 |
| 030-040 | <3.114E-02 | - | 5.532E+00 | <2.473E-02 | - | - | - | <4.291E-02 | 01049673 |
| 040-050 | <4.314E-02 | - | 5.198E+00 | <3.410E-02 | - | - | - | <5.550E-02 | 01049774 |

PROFILE BIKINI 505

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 1.996E+00 | 1.157E+02 | 1.653E+02 | 2.619E+00 | 6.117E+00 | 6.766E+00 | 1.256E+02 | 6.590E+00 | 01053431 |
| 005-010 | 1.142E+00 | 1.000E+02 | 7.968E+01 | 1.559E+00 | 5.369E+00 | 5.878E+00 | 1.427E+02 | 4.559E+00 | 01053534 |
| 010-020 | 1.918E+00 | 1.226E+02 | 6.955E+01 | 2.973E+00 | 7.162E+00 | 7.793E+00 | 2.045E+02 | 7.532E+00 | 01053671 |
| 020-030 | <2.893E-02 | 4.148E+00 | 1.689E+00 | <2.291E-02 | 7.428E+00 | 8.171E+00 | 1.482E+02 | <4.132E-02 | 01053772 |
| 030-040 | <2.561E-02 | - | 4.266E-01 | <1.949E-02 | - | - | - | <3.436E-02 | 01053873 |
| 040-050 | <1.698E-02 | - | 8.275E-01 | <4.015E-02 | - | - | - | <6.041E-02 | 01053974 |

PROFILE BIKINI 506

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 2.672E+00 | 1.937E+02 | 1.295E+02 | 3.092E+00 | 6.842E+00 | 7.554E+00 | 1.444E+02 | 7.671E+00 | 01055631 |
| 005-010 | 2.360E+00 | 2.143E+02 | 1.328E+02 | 2.805E+00 | 7.243E+00 | 8.027E+00 | 1.469E+02 | 7.293E+00 | 01055734 |
| 010-020 | 3.164E+00 | 1.940E+02 | 1.694E+02 | 3.525E+00 | 6.640E+00 | 7.360E+00 | 1.565E+02 | 9.707E+00 | 01055871 |
| 020-030 | 1.851E+00 | 1.585E+02 | 9.811E+01 | 2.016E+00 | 5.176E+00 | 5.712E+00 | 1.030E+02 | 4.883E+00 | 01055972 |
| 030-040 | 1.601E+00 | 1.529E+02 | 9.995E+01 | 2.102E+00 | 5.063E+00 | 5.595E+00 | 1.120E+02 | 5.428E+00 | 01056073 |
| 040-050 | 1.695E+00 | 1.426E+02 | 8.899E+01 | 1.988E+00 | 4.622E+00 | 5.113E+00 | 9.288E+01 | 4.870E+00 | 01056174 |
| 050-060 | 2.452E-01 | 6.311E+01 | 9.919E+00 | 1.314E-01 | 4.178E-01 | 4.694E-01 | 1.058E+01 | 5.378E-01 | 01056275 |

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PROFILE BIKINI 507

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 3.411E+00 | 2.681E+02 | 1.337E+02 | 4.358E+00 | 1.000E+01 | 1.086E+01 | 1.960E+02 | 1.151E+01 | 01050331 |
| 005-010 | 1.583E+00 | 1.687E+02 | 8.410E+01 | 1.849E+00 | 4.368E+00 | 4.730E+00 | 8.851E+01 | 4.554E+00 | 01050434 |
| 010-020 | 1.180E-01 | 1.824E+01 | 2.149E+01 | <5.153E-02 | 2.189E-01 | 2.571E-01 | - | 1.836E-01 | 01050571 |
| 020-030 | <3.806E-02 | 8.901E-01 | 3.829E+00 | <3.120E-02 | - | - | - | <5.239E-02 | 01050672 |

PROFILE BIKINI 508

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 2.768E+00 | 1.990E+02 | 1.113E+02 | 3.413E+00 | 7.554E+00 | 8.095E+00 | 1.468E+02 | 8.730E+00 | 01051431 |
| 005-010 | 3.582E+00 | 2.325E+02 | 1.344E+02 | 4.273E+00 | 9.514E+00 | 1.023E+01 | 1.886E+02 | 1.046E+01 | 01051534 |
| 010-020 | 3.898E+00 | 2.979E+02 | 1.395E+02 | 4.450E+00 | 9.802E+00 | 1.062E+01 | 1.900E+02 | 1.148E+01 | 01051671 |
| 020-030 | 5.626E+00 | 4.192E+02 | 1.489E+02 | 7.095E+00 | 1.492E+01 | 1.597E+01 | 2.886E+02 | 1.795E+01 | 01051772 |
| 030-040 | 2.150E+00 | 1.970E+02 | 7.590E+01 | 2.925E+00 | 7.036E+00 | 7.365E+00 | 1.359E+02 | 6.604E+00 | 01051873 |
| 040-050 | 1.673E-01 | 9.770E+01 | 1.122E+01 | <4.595E-02 | 2.141E-01 | 2.634E-01 | 5.775E+00 | <8.477E-02 | 01051974 |

5010124

PROFILE ENEU 801

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 1.000E-01 | 4.200E+00 | 8.680E+00 | 1.623E-01 | 3.222E-01 | 3.506E-01 | 6.770E+00 | 2.783E-01 | 06088031 |
| 005-010 | 6.883E-02 | 3.518E+00 | 3.870E+00 | 7.050E-02 | 2.194E-01 | 2.392E-01 | - | 2.321E-01 | 06088134 |
| 010-020 | 1.415E-01 | 5.977E+00 | 4.374E+00 | 4.174E-01 | 8.347E-01 | 1.013E+00 | - | 7.667E-01 | 06088271 |
| 020-030 | 6.721E-02 | 2.405E+00 | 8.590E-01 | <3.649E-02 | 1.694E-01 | 1.960E-01 | - | 1.122E-01 | 06088372 |
| 030-040 | 4.028E-02 | 2.245E+00 | 1.206E-01 | <3.123E-02 | - | - | - | <5.536E-02 | 06088473 |

PROFILE ENEU 802

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | <1.049E-02 | 1.376E+00 | 1.389E+00 | <2.058E-02 | 2.554E-02 | 2.933E-02 | 7.396E-01 | <3.750E-02 | 06090431 |
| 005-010 | <2.291E-02 | 1.447E+00 | 1.280E+00 | <2.386E-02 | 2.053E-02 | 1.977E-02 | - | <3.769E-02 | 06090534 |
| 010-020 | <8.991E-03 | 1.031E+00 | 1.236E+00 | <2.459E-02 | 1.764E-02 | 1.949E-02 | 3.985E-01 | <5.288E-02 | 06090671 |
| 020-030 | <3.527E-02 | 6.838E-01 | 2.068E+00 | <5.450E-02 | 6.005E-02 | 6.842E-02 | 1.354E+00 | <9.734E-02 | 06090772 |
| 030-040 | 7.243E-02 | 9.779E-01 | 2.668E+00 | <5.842E-02 | 1.198E-01 | 1.388E-01 | - | <9.838E-02 | 06090873 |

PROFILE ENEU 803

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 2.489E-01 | 1.692E+01 | 1.073E+01 | 4.559E-01 | 1.160E+00 | 1.250E+00 | 2.267E+01 | 1.021E+00 | 06094631 |
| 005-010 | 2.432E-01 | 1.571E+01 | 1.034E+01 | 4.613E-01 | 1.160E+00 | 1.237E+00 | 2.396E+01 | 9.847E-01 | 06094734 |
| 010-020 | 2.591E-01 | 2.397E+01 | 8.743E+00 | 6.631E-01 | 1.279E+00 | 1.433E+00 | - | 1.318E+00 | 06094871 |
| 020-030 | 3.052E-01 | 2.930E+01 | 9.946E+00 | 6.743E-01 | 1.559E+00 | 1.654E+00 | - | 1.290E+00 | 06094972 |
| 030-040 | 3.271E-01 | 3.192E+01 | 1.109E+01 | 7.995E-01 | 1.939E+00 | 2.099E+00 | 4.055E+01 | 2.090E+00 | 06095073 |
| 040-050 | 2.232E-01 | 1.747E+01 | 1.035E+01 | 5.473E-01 | 1.138E+00 | 1.249E+00 | 3.631E+01 | 1.255E+00 | 06095174 |

PROFILE HFH2

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 1.116E-01 | 5.662E+00 | 2.991E+01 | 1.628E-01 | 3.957E-01 | 4.429E-01 | - | 4.267E-01 | 01056790 |
| 005-010 | 1.504E-01 | 6.041E+00 | 2.989E+01 | 1.928E-01 | 4.797E-01 | 5.338E-01 | 1.036E+01 | 5.622E-01 | 01056891 |
| 010-015 | 1.409E-01 | 5.333E+00 | 1.937E+01 | 1.912E-01 | 3.909E-01 | 4.464E-01 | 1.139E+01 | 4.100E-01 | 01056992 |
| 015-025 | 6.829E-02 | 6.243E+00 | 3.800E+00 | 1.177E-01 | 3.090E-01 | 3.637E-01 | 9.086E-01 | 2.738E-01 | 01057093 |
| 025-035 | 1.985E-01 | - | 3.576E+00 | 2.465E-01 | - | - | - | 6.279E-01 | 01057194 |
| 035-045 | 1.086E-01 | - | 2.969E+00 | 1.741E-01 | - | - | - | 2.814E-01 | 01057295 |

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5010126

PROFILE HFH3

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 1.895E-01 | 1.735E+01 | 1.162E+01 | 2.850E-01 | 6.937E-01 | 7.545E-01 | - | 4.229E-01 | 01031390 |
| 005-010 | 1.132E-01 | 1.183E+01 | 5.315E+00 | 1.165E-01 | 2.838E-01 | 3.074E-01 | 5.950E+00 | 2.601E-01 | 01031491 |
| 010-015 | 1.927E-01 | 1.065E+01 | 8.117E+00 | 1.804E-01 | 3.960E-01 | 4.470E-01 | - | 3.490E-01 | 01031592 |
| 015-025 | 1.309E+00 | 7.730E+01 | 6.653E+01 | 1.892E+00 | 4.743E+00 | 5.293E+00 | 1.113E+02 | 4.577E+00 | 01031693 |
| 035-045 | 1.070E-01 | 1.352E+01 | 8.400E-01 | 2.966E-02 | 6.319E-02 | 7.293E-02 | - | 4.264E-02 | 01031895 |
| 045-055 | 1.158E-01 | - | 3.307E-01 | <5.743E-02 | - | - | - | <6.302E-02 | 01031996 |

A-8

PROFILE HFH4

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 8.838E-01 | 6.500E+01 | 4.275E+01 | 8.599E-01 | 2.024E+00 | 2.272E+00 | 5.622E+01 | 2.331E+00 | 01058390 |
| 005-010 | 4.177E-01 | 3.671E+01 | 1.656E+01 | 2.847E-01 | 9.162E-01 | 1.086E+00 | 2.071E+01 | 1.079E+00 | 01058491 |
| 010-015 | 1.708E-01 | 1.649E+01 | 5.072E+00 | <3.336E-02 | 2.391E-01 | 3.150E-01 | 6.176E+00 | 1.974E-01 | 01058592 |
| 015-025 | 1.048E-01 | 1.809E+01 | 2.542E+00 | <2.357E-02 | 1.740E-01 | 2.317E-01 | - | 1.860E-01 | 01058693 |
| 025-035 | <2.822E-02 | - | <2.429E-02 | <1.896E-02 | - | - | - | <3.231E-02 | 01058794 |
| 035-045 | <1.782E-02 | - | 2.241E-01 | <3.842E-02 | - | - | - | <5.667E-02 | 01058895 |

PROFILE HFH5

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 1.654E+00 | 1.149E+02 | 8.162E+01 | 2.752E+00 | 6.545E+00 | 7.162E+00 | 1.287E+02 | 5.707E+00 | 01029890 |
| 005-010 | 7.423E+00 | 3.219E+02 | 1.401E+02 | 1.283E+01 | 3.202E+01 | 3.351E+01 | 5.959E+02 | 2.841E+01 | 01029991 |
| 010-015 | 3.173E+00 | 2.350E+02 | 1.284E+02 | 4.301E+00 | 1.031E+01 | 1.117E+01 | 2.867E+02 | 9.477E+00 | 01030092 |
| 015-025 | 6.541E-02 | 4.793E+01 | 4.761E+00 | <2.122E-02 | 4.883E-02 | 5.730E-02 | 1.162E+00 | <3.274E-02 | 01030193 |
| 025-035 | <3.274E-02 | - | 4.241E-01 | <2.227E-02 | - | - | - | <3.768E-02 | 01030294 |
| 035-045 | <3.041E-02 | - | 4.824E-01 | <2.189E-02 | - | - | - | <3.730E-02 | 01030496 |

PROFILE TS0001

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 8.829E-01 | 6.338E+01 | 5.414E+01 | 1.562E+00 | 3.391E+00 | 3.683E+00 | 6.572E+01 | 4.173E+00 | 01000190 |
| 005-010 | 8.554E-01 | 6.230E+01 | 4.883E+01 | 1.381E+00 | 3.114E+00 | 3.478E+00 | 8.288E+01 | 3.548E+00 | 01000291 |
| 010-015 | 1.176E+00 | 8.554E+01 | 4.676E+01 | 1.814E+00 | 4.206E+00 | 4.667E+00 | 8.613E+01 | 5.239E+00 | 01000392 |
| 015-020 | 1.814E+00 | 1.175E+02 | 4.770E+01 | 2.951E+00 | 6.464E+00 | 7.198E+00 | 1.327E+02 | 6.604E+00 | 01000401 |
| 020-025 | 1.463E+00 | 8.770E+01 | 3.266E+01 | 1.851E+00 | 4.923E+00 | 5.131E+00 | 9.563E+01 | 4.069E+00 | 01000501 |
| 025-030 | 2.264E+00 | 1.201E+02 | 2.271E+01 | 3.908E+00 | 8.928E+00 | 9.550E+00 | 1.762E+02 | 7.928E+00 | 01000601 |
| 030-040 | <3.828E-02 | 3.669E+01 | 8.041E+00 | <6.559E-02 | 6.198E-02 | 7.230E-02 | - | <1.328E-01 | 01000701 |
| 040-045 | - | 2.453E+01 | - | - | 6.743E-02 | 9.185E-02 | - | - | 01000801 |

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PROFILE TS0002

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 9.536E-01 | 4.797E+01 | 4.923E+01 | 1.385E+00 | 3.344E+00 | 3.672E+00 | 6.820E+01 | 2.979E+00 | 01006301 |
| 005-010 | 9.221E-01 | 5.743E+01 | 3.216E+01 | 1.187E+00 | 3.257E+00 | 3.642E+00 | 6.982E+01 | 2.749E+00 | 01006401 |
| 010-015 | 8.777E-01 | 6.022E+01 | 1.780E+01 | 1.383E+00 | 3.398E+00 | 3.778E+00 | 7.003E+01 | 3.202E+00 | 01006501 |
| 015-025 | 2.162E+00 | 2.015E+02 | 2.724E+01 | 3.900E+00 | 7.626E+00 | 8.378E+00 | 1.528E+02 | 8.122E+00 | 01006601 |
| 025-035 | 2.447E-01 | 6.541E+01 | 3.598E+00 | 2.014E-01 | 4.905E-01 | 5.252E-01 | 1.194E+01 | 4.284E-01 | 01006701 |

PROFILE TS0003

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 5.748E-01 | 4.389E+01 | 5.568E+01 | 8.554E-01 | 2.042E+00 | 2.300E+00 | 3.881E+01 | 1.818E+00 | 01106701 |
| 005-010 | 5.914E-01 | 4.040E+01 | 4.644E+01 | 8.811E-01 | 2.319E+00 | 2.543E+00 | 4.743E+01 | 1.814E+00 | 01106801 |
| 010-015 | 1.779E+00 | 9.928E+01 | 5.802E+01 | 3.255E+00 | 6.090E+00 | 6.779E+00 | 1.222E+02 | 6.946E+00 | 01006901 |
| 015-025 | 3.173E+00 | 2.433E+02 | 3.406E+01 | 4.352E+00 | 1.024E+01 | 1.127E+01 | 2.538E+02 | 9.432E+00 | 01007001 |
| 025-035 | 1.142E+00 | 1.400E+02 | 3.318E+01 | 1.321E+00 | 3.831E+00 | 3.981E+00 | 7.662E+01 | 2.945E+00 | 01007101 |
| 035-045 | - | 3.404E+01 | - | - | 4.277E-01 | 5.050E-01 | - | - | 01007201 |

PROFILE TS0012

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 1.830E+00 | 1.911E+02 | 1.243E+02 | 2.649E+00 | 6.595E+00 | 7.293E+00 | 1.397E+02 | 5.464E+00 | 01010901 |
| 005-010 | 2.324E+00 | 1.961E+02 | 1.021E+02 | 3.145E+00 | 7.410E+00 | 8.203E+00 | 1.574E+02 | 8.811E+00 | 01011101 |
| 015-020 | 2.381E+00 | 2.034E+02 | 9.572E+01 | 3.791E+00 | 9.176E+00 | 9.964E+00 | 1.851E+02 | 1.060E+01 | 01011201 |
| 020-033 | 9.140E-01 | 8.869E+01 | 4.946E+00 | 1.301E+00 | 2.948E+00 | 3.395E+00 | 7.964E+01 | 2.772E+00 | 01011301 |
| 036-051 | 1.062E+00 | 3.014E+02 | 9.955E+01 | 9.631E-01 | 2.460E+00 | 2.671E+00 | 4.856E+01 | 2.131E+00 | 01011401 |
| 056-102 | 1.800E-02 | 1.207E+00 | 1.742E+00 | <1.035E-02 | 1.338E-02 | 1.500E-02 | - | <1.667E-02 | 01011501 |

PROFILE TS0031

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 2.331E-01 | 2.757E+01 | 2.193E+01 | 2.991E-01 | 5.833E-01 | 6.883E-01 | 1.429E+01 | 7.045E-01 | 01004590 |
| 005-010 | 6.568E-01 | 5.527E+01 | 4.224E+01 | 5.595E-01 | 1.606E+00 | 1.845E+00 | 3.701E+01 | 1.945E+00 | 01004691 |
| 010-015 | 2.483E-01 | 3.643E+01 | 2.295E+01 | 1.774E-01 | 5.149E-01 | 5.712E-01 | - | 5.297E-01 | 01004792 |
| 015-025 | 1.741E-02 | 5.081E-01 | 1.498E+00 | <1.814E-02 | - | - | - | <2.913E-02 | 01004893 |
| 025-035 | <2.910E-02 | - | 1.262E-01 | <1.509E-02 | - | - | - | <2.558E-02 | 01004994 |
| 035-045 | <2.288E-02 | <9.009E-01 | 1.103E-01 | <1.581E-02 | 8.491E-04 | 7.667E-04 | - | <2.886E-02 | 01005095 |

PROFILE TS0041

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 2.516E-01 | 1.973E+01 | 1.734E+01 | 2.541E-01 | 6.761E-01 | 7.626E-01 | - | 6.126E-01 | 01002090 |
| 005-010 | 1.127E+00 | 4.950E+01 | 6.401E+01 | 1.318E+00 | 3.278E+00 | 3.691E+00 | 6.671E+01 | 2.936E+00 | 01002191 |
| 010-015 | 1.270E+00 | 3.368E+01 | 7.009E+01 | 1.242E+00 | 3.627E+00 | 4.234E+00 | - | 2.983E+00 | 01002292 |
| 015-025 | 2.064E-01 | 4.088E+01 | 1.295E+01 | <7.730E-02 | 9.041E-02 | 1.130E-01 | - | <1.106E-01 | 01002393 |
| 025-035 | <7.041E-02 | 5.653E+00 | 1.022E+01 | <4.092E-02 | 3.256E-02 | 3.532E-02 | - | <6.505E-02 | 01002494 |
| 035-045 | <4.441E-02 | <9.009E-01 | 4.104E+00 | <2.522E-02 | 4.905E-03 | 6.302E-03 | - | <3.990E-02 | 01002595 |

PROFILE TS0051

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 2.416E+00 | 1.950E+02 | 1.229E+02 | 3.636E+00 | 7.878E+00 | 8.770E+00 | - | 6.892E+00 | 01003590 |
| 005-010 | 2.932E+00 | 2.032E+02 | 1.410E+02 | 3.870E+00 | 9.477E+00 | 1.050E+01 | 2.013E+02 | 8.329E+00 | 01003691 |
| 010-015 | 3.166E+00 | 2.420E+02 | 1.437E+02 | 4.426E+00 | 9.973E+00 | 1.117E+01 | - | 8.905E+00 | 01003792 |
| 015-025 | 3.004E+00 | 1.882E+02 | 1.748E+02 | 4.216E+00 | 9.302E+00 | 1.043E+01 | - | 9.054E+00 | 01003893 |
| 025-035 | 3.200E+00 | 2.097E+02 | 1.907E+02 | 4.432E+00 | 9.622E+00 | 1.068E+01 | - | 8.797E+00 | 01003994 |
| 035-045 | 2.865E+00 | 2.186E+02 | 1.824E+02 | 3.988E+00 | 9.288E+00 | 1.036E+01 | 2.137E+02 | 8.324E+00 | 01004095 |

PROFILE TS0061

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 2.722E-01 | 5.122E+01 | 3.674E+01 | 5.059E-01 | 1.031E+00 | 1.142E+00 | 2.340E+01 | 9.284E-01 | 01008790 |
| 005-010 | 1.588E-01 | 1.769E+01 | 1.171E+01 | 3.266E-01 | 6.511E-01 | 7.159E-01 | 1.760E+01 | 7.197E-01 | 01008891 |
| 010-015 | 7.739E-02 | 7.518E+00 | 6.360E+00 | 1.100E-01 | 2.480E-01 | 2.801E-01 | - | 2.527E-01 | 01008992 |
| 015-025 | 1.855E+00 | 1.350E+02 | 8.252E+01 | 2.759E+00 | 6.198E+00 | 6.829E+00 | 1.294E+02 | 6.014E+00 | 01009093 |
| 025-035 | 4.626E+00 | 4.087E+02 | 2.190E+02 | 6.743E+00 | 1.657E+01 | 1.831E+01 | 3.330E+02 | 1.336E+01 | 01009194 |
| 035-045 | 5.604E+00 | 4.761E+02 | 3.393E+02 | 8.369E+00 | 1.729E+01 | 1.909E+01 | 3.495E+02 | 1.794E+01 | 01009295 |
| 045-055 | 3.285E+00 | 4.311E+02 | 1.350E+02 | 5.432E+00 | 1.104E+01 | 1.217E+01 | 2.263E+02 | 1.159E+01 | 01009396 |
| 055-065 | 3.212E-01 | 2.700E+02 | 2.432E+01 | <7.117E-02 | 2.686E-01 | 2.943E-01 | - | <1.116E-01 | 01009497 |
| 065-075 | 8.162E-02 | 5.324E+01 | 1.571E+00 | 2.708E-02 | 8.563E-03 | 1.001E-02 | 1.787E-01 | <1.875E-02 | 01009598 |

PROFILE TS0062

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 8.162E-01 | 7.838E+01 | 5.833E+01 | 1.091E+00 | 2.539E+00 | 2.812E+00 | 5.252E+01 | 3.146E+00 | 01001190 |
| 005-010 | 5.387E-01 | 3.867E+01 | 2.744E+01 | 7.554E-01 | 1.744E+00 | 2.008E+00 | - | 1.979E+00 | 01001291 |
| 010-015 | 1.159E-01 | 7.892E+01 | 3.134E+00 | 4.191E-01 | 6.077E-01 | 6.563E-01 | 1.196E+01 | 5.081E-01 | 01001392 |
| 015-025 | 1.329E+00 | 7.622E+01 | 7.694E+01 | 2.023E+00 | 4.689E+00 | 5.167E+00 | 9.694E+01 | 4.054E+00 | 01001493 |
| 025-035 | 1.577E+00 | 1.493E+02 | 1.354E+02 | 1.767E+00 | 4.703E+00 | 5.347E+00 | - | 4.779E+00 | 01001594 |
| 035-045 | 1.575E-01 | 6.608E+01 | 1.616E+01 | <8.284E-02 | 7.842E-02 | 1.021E-01 | - | <1.245E-01 | 01001695 |

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PROFILE TS0071

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 1.074E+00 | 1.071E+02 | 6.622E+01 | 1.412E+00 | 3.150E+00 | 3.594E+00 | 7.365E+01 | 3.610E+00 | 01005590 |
| 005-010 | 1.238E+00 | 1.140E+02 | 6.734E+01 | 1.600E+00 | 3.971E+00 | 4.382E+00 | 7.892E+01 | 4.716E+00 | 01005691 |
| 010-015 | 1.123E+00 | 1.046E+02 | 6.018E+01 | 1.667E+00 | 3.486E+00 | 3.886E+00 | 7.225E+01 | 4.079E+00 | 01006292 |
| 015-025 | - | 1.686E+02 | - | - | 6.662E+00 | 7.455E+00 | 1.429E+02 | 7.779E+00 | 01005792 |
| 025-035 | - | 7.943E+01 | - | - | 2.800E-01 | 3.616E-01 | 8.450E+00 | - | 01005893 |
| 035-045 | - | 4.963E+00 | - | - | 3.534E-02 | 4.308E-02 | 1.492E+00 | - | 01005994 |



PROFILE TS0081

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 6.707E-01 | 5.977E+01 | 3.821E+01 | 1.008E+00 | 1.952E+00 | 2.207E+00 | 4.640E+01 | 2.355E+00 | 01007490 |
| 005-010 | 2.109E+00 | 1.461E+02 | 8.149E+01 | 3.045E+00 | 7.108E+00 | 8.050E+00 | 1.769E+02 | 8.775E+00 | 01007591 |
| 010-015 | 2.968E+00 | 3.504E+02 | 1.036E+02 | 3.758E+00 | 1.036E+01 | 1.161E+01 | 2.409E+02 | 1.334E+01 | 01007692 |
| 015-025 | 3.510E-01 | 1.012E+02 | 2.183E+01 | 2.151E-01 | 5.883E-01 | 7.090E-01 | 1.410E+01 | 6.072E-01 | 01007793 |
| 025-035 | 7.757E-02 | 4.752E+01 | 6.144E+00 | <3.423E-02 | 9.982E-02 | 1.282E-01 | - | <6.086E-02 | 01007894 |
| 035-045 | 9.833E-02 | 2.414E+01 | 2.506E+00 | <1.721E-02 | 7.910E-02 | 1.058E-01 | - | 8.779E-02 | 01007995 |
| 105-115 | 1.275E+00 | 9.991E+01 | 5.613E+01 | 2.305E+00 | 4.073E+00 | 4.391E+00 | 8.239E+01 | 4.354E+00 | 01008601 |

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PROFILE TS0091

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 7.054E-01 | 4.389E+01 | 7.604E+01 | 1.126E+00 | 2.590E+00 | 2.943E+00 | 7.986E+01 | 3.207E+00 | 01028690 |
| 005-010 | 1.547E+00 | 8.883E+01 | 9.464E+01 | 1.925E+00 | 5.333E+00 | 5.964E+00 | 1.075E+02 | 6.054E+00 | 01028791 |
| 010-015 | 2.241E+00 | 1.301E+02 | 8.869E+01 | 3.482E+00 | 8.207E+00 | 9.212E+00 | 2.026E+02 | 9.464E+00 | 01028892 |
| 015-025 | 4.847E-01 | 8.356E+01 | 2.818E+01 | 3.001E-01 | 9.059E-01 | 1.073E+00 | - | 9.955E-01 | 01028993 |
| 025-035 | 1.619E-01 | 5.275E+01 | 7.072E+00 | <7.311E-02 | 2.614E-01 | 3.117E-01 | 6.874E+00 | 2.877E-01 | 01029094 |
| 035-045 | <3.901E-02 | 6.243E+00 | 2.636E+00 | <2.936E-02 | 2.947E-02 | 3.685E-02 | - | <4.653E-02 | 01029195 |
| 045-055 | <2.391E-02 | - | 1.309E+00 | <2.023E-02 | - | - | - | <3.097E-02 | 01029296 |

PROFILE TS0101

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 3.694E-01 | 7.905E+01 | 5.640E+01 | 4.937E-01 | 1.185E+00 | 1.319E+00 | 2.447E+01 | 1.374E+00 | 01035290 |
| 005-010 | 2.548E-01 | 4.991E+01 | 3.317E+01 | 2.854E-01 | 7.279E-01 | 8.441E-01 | 2.003E+01 | 7.991E-01 | 01035391 |
| 010-015 | 1.422E-01 | 3.244E+01 | 1.438E+01 | 7.946E-02 | 2.578E-01 | 2.864E-01 | 4.959E+00 | 2.747E-01 | 01035492 |
| 015-025 | <3.252E-02 | 1.850E+01 | <1.404E-01 | <3.933E-02 | - | - | - | <6.144E-02 | 01035593 |
| 025-035 | <3.123E-02 | 6.302E+00 | 8.468E-01 | <2.423E-02 | 1.060E-02 | 1.334E-02 | - | <4.078E-02 | 01035694 |
| 035-045 | <2.829E-02 | 3.993E+00 | 2.062E-01 | <2.292E-02 | - | - | - | <3.812E-02 | 01035795 |

PROFILE TS0111

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 6.153E-01 | 6.396E+01 | 7.946E+01 | 7.667E-01 | 2.147E+00 | 2.385E+00 | 5.162E+01 | 2.677E+00 | 01011990 |
| 005-010 | 9.784E-01 | 9.523E+01 | 9.968E+01 | 1.637E+00 | 3.474E+00 | 3.869E+00 | 7.977E+01 | 4.039E+00 | 01012091 |
| 010-015 | 1.600E+00 | 8.194E+01 | 1.271E+02 | 2.015E+00 | 5.356E+00 | 5.973E+00 | 1.143E+02 | 6.631E+00 | 01012192 |
| 015-025 | 1.074E+00 | 8.338E+01 | 7.086E+01 | 1.038E+00 | 3.150E+00 | 3.577E+00 | - | 2.554E+00 | 01012293 |
| 025-035 | 3.204E-02 | 3.616E+01 | 3.063E+00 | <1.523E-02 | 2.776E-02 | 3.598E-02 | - | <3.155E-02 | 01012394 |
| 035-045 | <2.958E-02 | 7.306E+00 | 2.603E+00 | <2.286E-02 | - | - | - | <3.926E-02 | 01012495 |

PROFILE TS0121

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 1.691E+00 | 1.380E+02 | 1.10[illegible] | 2.341E+00 | 5.590E+00 | 6.185E+00 | 1.245E+02 | 6.131E+00 | 01032990 |
| 005-010 | 1.932E+00 | 2.343E+02 | 1.091E+02 | 2.818E+00 | 6.860E+00 | 7.590E+00 | 1.403E+02 | 9.671E+00 | 01033091 |
| 010-015 | 3.823E+00 | 3.183E+02 | 1.777E+02 | 6.059E+00 | 1.400E+01 | 1.514E+01 | 2.673E+02 | 1.874E+01 | 01033192 |
| 015-025 | 2.137E-01 | 2.304E+01 | 1.197E+01 | <6.131E-02 | 2.422E-01 | 2.827E-01 | - | 2.601E-01 | 01033293 |
| 025-035 | 5.032E-01 | 1.240E+02 | 3.888E+01 | 1.783E-01 | 8.865E-01 | 1.087E+00 | 2.259E+01 | 9.811E-01 | 01033394 |
| 035-045 | 1.347E-01 | 1.231E+01 | 9.739E+00 | <4.802E-02 | 1.281E-01 | 1.487E-01 | - | 1.958E-01 | 01033495 |
| 045-055 | 6.243E-02 | 2.493E+00 | 6.977E+00 | <1.455E-02 | 4.323E-02 | 4.955E-02 | 1.122E+00 | <2.944E-02 | 01033596 |

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PROFILE TS0131

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 5.689E+00 | 3.421E+02 | 3.404E+02 | 7.559E+00 | 1.806E+01 | 2.033E+01 | 3.914E+02 | 2.383E+01 | 01034190 |
| 005-010 | 1.164E+00 | 1.689E+02 | 6.374E+01 | 1.081E+00 | 2.488E+00 | 2.886E+00 | 5.275E+01 | 3.433E+00 | 01034291 |
| 010-015 | 3.530E-01 | 1.279E+02 | 1.269E+01 | <1.073E-01 | 4.047E-01 | 4.892E-01 | 8.950E+00 | 4.577E-01 | 01034392 |
| 015-025 | <3.644E-02 | 2.570E+01 | 1.263E+00 | <3.121E-02 | 4.860E-02 | 6.153E-02 | 1.272E+00 | <5.234E-02 | 01034493 |
| 025-035 | <2.962E-02 | - | 3.174E-01 | <1.845E-02 | - | - | - | <3.118E-02 | 01034594 |
| 035-045 | <3.832E-02 | 2.725E+00 | 2.770E-01 | <2.029E-02 | 3.036E-02 | 3.586E-02 | - | <3.728E-02 | 01034695 |
| 125-145 | <1.[illegible]E-02 | <3.604E+00 | <1.614E-02 | <1.365E-02 | - | - | - | <2.359E-02 | 01035101 |

PROFILE TS0161

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 4.068E-01 | 1.944E+01 | 5.658E+01 | 4.068E-01 | 1.114E+00 | 1.251E+00 | 2.686E+01 | 1.236E+00 | 01038290 |
| 005-010 | 5.977E-01 | 2.055E+01 | 3.322E+01 | 6.437E-01 | 1.442E+00 | 1.740E+00 | - | 1.655E+00 | 01038391 |
| 010-015 | 7.341E-01 | 3.382E+01 | 3.213E+01 | 7.821E-01 | 1.917E+00 | 2.118E+00 | 4.065E+01 | 2.209E+00 | 01038492 |
| 015-025 | 5.964E-01 | 3.122E+01 | 2.689E+01 | 6.284E-01 | 1.485E+00 | 1.675E+00 | 3.185E+01 | 1.641E+00 | 01038593 |
| 025-035 | 4.734E-01 | 4.104E+01 | 3.369E+01 | 5.829E-01 | 1.315E+00 | 1.482E+00 | 3.336E+01 | 1.498E+00 | 01038694 |
| 035-045 | 1.659E-01 | 2.481E+01 | 1.014E+01 | 1.391E-01 | 3.845E-01 | 4.383E-01 | 1.019E+01 | 4.236E-01 | 01038795 |
| 045-055 | 3.183E-01 | 3.909E+01 | 2.145E+01 | 5.077E-01 | 1.167E+00 | 1.273E+00 | 2.499E+01 | 1.112E+00 | 01038896 |
| 055-065 | 7.311E-02 | 2.249E+01 | 9.734E+00 | <4.160E-02 | 2.327E-01 | 2.412E-01 | - | 1.661E-01 | 01038997 |
| 065-075 | 2.418E-01 | 2.220E+01 | 1.492E+01 | 2.116E-01 | 6.077E-01 | 6.869E-01 | - | 5.977E-01 | 01039098 |
| 075-085 | 1.774E-01 | 1.888E+01 | 1.039E+01 | 1.616E-01 | 4.384E-01 | 4.784E-01 | 1.011E+01 | 4.946E-01 | 01039199 |
| 085-095 | 1.251E-01 | 2.479E+01 | 1.273E+01 | 3.405E-01 | 8.041E-01 | 8.928E-01 | - | 8.658E-01 | 01039201 |
| 095-105 | <4.389E-02 | 1.454E+01 | 7.014E+00 | <3.660E-02 | 1.622E-01 | 1.760E-01 | - | <6.667E-02 | 01039301 |
| 105-125 | 9.941E-01 | 4.429E+01 | 3.491E+01 | 1.295E+00 | 3.373E+00 | 3.727E+00 | 6.842E+01 | 3.258E+00 | 01039401 |
| 125-145 | 3.273E+00 | 1.808E+02 | 4.892E+01 | 4.644E+00 | 1.023E+01 | 1.087E+01 | 1.972E+02 | 1.178E+01 | 01039501 |
| 145-165 | <6.432E-02 | 1.095E+01 | 6.964E+00 | <3.911E-02 | 6.586E-02 | 8.216E-02 | 1.937E+00 | <7.113E-02 | 01039601 |
| 165-185 | <3.620E-02 | <3.153E-01 | 1.146E+00 | <2.190E-02 | - | - | - | <3.980E-02 | 01039701 |

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PROFILE TS0171

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 1.533E+00 | 1.360E+01 | 9.595E+01 | 2.206E+00 | 5.491E+00 | 6.212E+00 | 1.300E+02 | 6.667E+00 | 01027390 |
| 005-010 | 2.712E-01 | 5.063E+01 | 2.153E+01 | <7.523E-02 | 4.748E-01 | 5.986E-01 | - | 5.423E-01 | 01027491 |
| 010-015 | 1.953E-01 | 4.138E+01 | 1.719E+01 | <6.581E-02 | 3.323E-01 | 4.413E-01 | 8.955E+00 | 3.982E-01 | 01027592 |
| 015-025 | 1.796E-01 | 3.558E+01 | 4.095E+00 | <5.441E-02 | - | - | - | 4.563E-01 | 01027693 |
| 025-035 | 7.023E-02 | 3.690E+00 | 1.407E+00 | <3.935E-02 | - | - | - | <6.851E-02 | 01027794 |
| 035-045 | 6.275E-02 | 3.438E+00 | 1.118E+00 | <1.987E-02 | - | - | - | 1.592E-01 | 01027895 |

PROFILE TS0181

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 1.939E+00 | 1.202E+02 | 2.838E+01 | 2.257E+00 | 6.050E+00 | 6.640E+00 | 1.350E+02 | 6.010E+00 | 01062690 |
| 005-010 | 1.001E+00 | 9.784E+01 | 2.225E+01 | 9.557E-01 | 2.481E+00 | 2.800E+00 | 4.946E+01 | 2.605E+00 | 01062791 |
| 010-015 | 2.397E+00 | 1.732E+02 | 3.165E+01 | 2.836E+00 | 6.842E+00 | 7.617E+00 | 1.385E+02 | 7.218E+00 | 01062892 |
| 015-025 | 5.609E-01 | 6.063E+01 | 5.205E+00 | 1.433E-01 | 8.968E-01 | 1.134E+00 | - | 9.761E-01 | 01062993 |
| 025-035 | 1.479E-01 | 4.141E+01 | 1.398E+00 | <3.397E-02 | 1.641E-01 | 2.128E-01 | 4.117E+00 | 1.614E-01 | 01063094 |
| 035-045 | 1.068E-01 | 3.374E+01 | 1.266E+00 | <3.360E-02 | 1.545E-01 | 2.051E-01 | 3.832E+00 | <6.023E-02 | 01063195 |
| 045-055 | 1.560E-01 | 6.252E+01 | 1.517E+01 | 5.523E-02 | 1.734E-01 | 2.326E-01 | - | 1.739E-01 | 01063296 |
| 055-065 | <4.328E-02 | 2.918E+01 | 1.005E+01 | <4.523E-02 | 7.932E-02 | 1.025E-01 | 1.910E+00 | <7.878E-02 | 01063397 |
| 065-085 | <5.306E-02 | 3.470E+00 | 1.503E+00 | <2.426E-02 | - | - | - | <4.505E-02 | 01063401 |

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PROFILE TS0191

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 8.743E-01 | 4.950E+01 | 6.207E+01 | 1.181E+00 | 2.682E+00 | 3.135E+00 | 3.365E+01 | 3.109E+00 | 01060090 |
| 005-010 | 6.950E-01 | 5.117E+01 | 3.766E+01 | 1.044E+00 | 2.262E+00 | 2.529E+00 | 4.451E+01 | 2.420E+00 | 01060191 |
| 010-015 | 6.680E-01 | 4.806E+01 | 3.782E+01 | 8.104E-01 | 1.492E+00 | 1.697E+00 | 3.727E+01 | 2.013E+00 | 01060292 |
| 015-025 | 1.404E-01 | 2.204E+01 | 8.203E+00 | 1.249E-01 | 3.218E-01 | 4.127E-01 | - | 3.175E-01 | 01060393 |
| 025-035 | 2.829E-01 | 2.595E+01 | 2.228E+01 | 3.545E-01 | 8.635E-01 | 9.617E-01 | 1.800E+01 | 8.644E-01 | 01060494 |
| 035-045 | 1.614E-01 | 1.119E+01 | 5.955E+00 | 1.973E-01 | 4.388E-01 | 4.986E-01 | - | 4.842E-01 | 01060595 |
| 045-055 | 4.577E-01 | 4.060E+01 | 2.106E+01 | 4.901E-01 | 1.285E+00 | 1.475E+00 | - | 1.323E+00 | 01060696 |
| 055-065 | 8.595E-01 | 6.559E+01 | 4.649E+01 | 7.793E-01 | 2.006E+00 | 2.252E+00 | 4.323E+01 | 2.183E+00 | 01060797 |
| 065-075 | 1.712E+00 | 1.155E+02 | 5.023E+01 | 2.156E+00 | 4.946E+00 | 5.428E+00 | - | 4.869E+00 | 01060898 |
| 075-085 | 8.392E-01 | 8.829E+01 | 2.723E+01 | 6.964E-01 | 2.051E+00 | 2.380E+00 | 4.423E+01 | 2.159E+00 | 01060999 |
| 085-095 | 1.254E-01 | 3.598E+01 | 2.389E+01 | 1.231E-01 | 3.367E-01 | 3.762E-01 | 6.167E+00 | 4.027E-01 | 01061001 |
| 095-105 | 5.140E-02 | 9.279E+00 | 1.433E+01 | 5.739E-02 | 1.872E-01 | 2.080E-01 | 3.787E+00 | 2.439E-01 | 01061101 |
| 105-115 | 1.687E-01 | 1.499E+01 | 2.808E+01 | 1.776E-01 | 4.467E-01 | 5.207E-01 | - | 3.863E-01 | 01061201 |
| 115-125 | <2.271E-02 | 2.384E+00 | 3.481E+00 | <1.979E-02 | 4.568E-03 | 5.766E-03 | - | <3.873E-02 | 01061301 |

PROFILE TS0201

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 9.937E-01 | 3.451E+01 | 5.027E+01 | 1.241E+00 | 2.926E+00 | 3.515E+00 | 7.482E+01 | 3.645E+00 | 01061590 |
| 005-010 | 1.149E+00 | 4.500E+01 | 2.882E+01 | 1.275E+00 | 3.740E+00 | 4.563E+00 | 8.973E+01 | 4.022E+00 | 01061691 |
| 010-015 | 4.761E-01 | 2.486E+01 | 1.514E+01 | 3.756E-01 | 9.673E-01 | 1.155E+00 | 2.188E+01 | 1.126E+00 | 01061792 |
| 015-025 | 5.455E-02 | 2.057E+01 | 1.002E+01 | <3.528E-02 | - | - | - | <6.568E-02 | 01061893 |
| 025-035 | <5.225E-02 | 1.723E+01 | 7.171E+00 | <3.464E-02 | - | - | - | <7.027E-02 | 01061994 |
| 035-045 | <2.385E-02 | - | 1.063E+00 | <2.079E-02 | - | - | - | <3.775E-02 | 01062095 |
| 045-055 | <2.560E-02 | - | 5.964E-01 | <1.922E-02 | - | - | - | <3.550E-02 | 01062196 |



PROFILE TS0231

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 5.856E-01 | 2.997E+01 | 3.506E+01 | 7.239E-01 | 1.700E+00 | 1.896E+00 | 4.806E+01 | 1.957E+00 | 01036790 |
| 005-010 | 5.329E-02 | 1.078E+01 | 1.651E+01 | <4.887E-02 | 2.152E-01 | 2.436E-01 | 5.856E+00 | <8.464E-02 | 01036891 |
| 010-015 | <8.532E-02 | 9.788E+00 | 4.106E+01 | <6.437E-02 | 1.377E-01 | 1.532E-01 | - | <1.167E-01 | 01036992 |
| 015-025 | <3.628E-02 | 1.275E+01 | 4.408E+00 | <3.018E-02 | 1.475E+00 | 1.653E+00 | 3.179E+01 | <5.923E-02 | 01037093 |
| 025-035 | <4.251E-02 | 1.088E+01 | 1.886E+00 | <3.301E-02 | 2.904E-02 | 3.756E-02 | - | <5.369E-02 | 01037194 |
| 035-045 | <2.038E-02 | 3.343E+00 | 1.454E+00 | <4.443E-02 | 8.559E-03 | 1.040E-02 | - | <6.500E-02 | 01037295 |

5010140

PROFILE TS0241

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 6.473E-02 | 3.286E+00 | 6.068E+00 | 1.444E-01 | 1.826E+00 | 2.212E+00 | 3.336E+01 | 2.109E-01 | 06067890 |
| 005-010 | 6.014E-02 | 3.555E+00 | 2.915E+00 | 1.394E-01 | 2.663E-01 | 2.789E-01 | 5.622E+00 | 2.445E-01 | 06067991 |
| 010-015 | 8.766E-02 | 4.617E+00 | 2.336E+00 | 1.518E-01 | 3.093E-01 | 3.371E-01 | 7.775E+00 | 2.302E-01 | 06068092 |
| 015-025 | 9.320E-02 | 3.643E+00 | 3.020E+00 | 1.667E-01 | 2.982E-01 | 3.159E-01 | - | 3.940E-01 | 06068193 |
| 025-035 | 1.498E-01 | 5.432E+00 | 2.487E+00 | 2.574E-01 | 3.571E-01 | 3.917E-01 | 8.090E+00 | 5.050E-01 | 06068294 |
| 035-045 | 1.157E-01 | 7.428E+00 | 2.229E+00 | 1.952E-01 | 5.545E-01 | 5.955E-01 | 9.608E+00 | 4.475E-01 | 06068395 |

PROFILE TS0251

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 1.780E-01 | 8.779E+00 | 1.258E+01 | 1.778E-01 | 3.723E-03 | 4.977E-03 | - | 4.207E-01 | 06066490 |
| 005-010 | 1.893E-01 | 7.572E+00 | 7.356E+00 | 2.686E-01 | 4.577E-01 | 5.086E-01 | - | 4.323E-01 | 06066591 |
| 010-015 | 2.064E-01 | 8.239E+00 | 6.185E+00 | 4.306E-01 | 5.140E-01 | 5.577E-01 | 1.019E+01 | 8.505E-01 | 06066692 |
| 015-025 | 1.609E-01 | 6.207E+00 | 7.320E+00 | 2.743E-01 | 9.198E-01 | 1.048E+00 | - | 6.198E-01 | 06066793 |
| 025-035 | 2.093E-01 | 1.104E+01 | 3.476E+00 | 4.122E-01 | 6.662E-01 | 5.500E-01 | - | 9.329E-01 | 06066894 |
| 035-045 | 3.101E-01 | 1.797E+01 | 4.063E+00 | 6.306E-01 | 1.124E+00 | 1.282E+00 | 2.529E+01 | 1.451E+00 | 06066995 |

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5010141

PROFILE TS0261

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 1.595E-01 | 4.689E+00 | 7.892E+00 | 1.339E-01 | 4.147E-01 | 4.775E-01 | - | 4.250E-01 | 06065290 |
| 005-010 | 1.714E-01 | 6.419E+00 | 3.718E+00 | 2.119E-01 | 4.304E-01 | 5.108E-01 | 1.099E+01 | 4.833E-01 | 06065391 |
| 010-015 | 1.820E-01 | 7.320E+00 | 3.703E+00 | 1.273E-01 | 5.171E-01 | 6.045E-01 | - | 4.396E-01 | 06065492 |
| 015-025 | 1.195E-01 | 1.137E+01 | 4.421E+00 | <5.077E-02 | 3.477E-01 | 4.014E-01 | - | 3.377E-01 | 06065593 |
| 025-035 | 7.167E-02 | 8.608E+00 | 1.776E+00 | <4.514E-02 | 5.689E-02 | 6.640E-02 | - | <1.351E-02 | 06065694 |
| 035-045 | <2.022E-02 | 4.395E+00 | 1.572E-01 | <3.395E-02 | - | - | - | <6.234E-02 | 06065795 |
| 045-055 | <2.555E-02 | 2.903E-01 | <2.413E-02 | <1.532E-02 | - | - | - | <2.670E-02 | 06065896 |
| 055-065 | <1.574E-02 | 3.916E-01 | <1.870E-02 | <1.470E-02 | 2.965E-03 | 3.395E-03 | - | <2.626E-02 | 06065901 |
| 065-085 | <2.278E-02 | <3.153E-01 | <1.787E-02 | <2.003E-02 | - | - | - | <3.491E-02 | 06066001 |
| 085-105 | <1.685E-02 | <4.505E-01 | <1.304E-02 | <1.706E-02 | - | - | - | <7.113E-02 | 06066101 |
| 105-125 | <1.386E-02 | <2.703E-01 | <1.129E-02 | <1.441E-02 | - | - | - | <2.522E-02 | 06066201 |
| 125-145 | <2.914E-02 | <2.928E-01 | <2.610E-02 | <1.732E-02 | - | - | - | <3.130E-02 | 06066301 |

PROFILE TS0271

CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 1.185E-01 | 2.428E+00 | 4.257E+00 | 9.541E-02 | 3.604E-01 | 4.093E-01 | 7.315E+00 | 2.480E-01 | 06089190 |
| 005-010 | <3.403E-02 | 1.789E+00 | 1.605E+00 | 1.008E-01 | 3.768E-01 | 4.354E-01 | 8.505E+00 | 2.150E-01 | 06089291 |
| 010-015 | 1.109E-01 | 1.533E+00 | 1.121E+00 | 1.192E-01 | 4.159E-01 | 4.711E-01 | 9.383E+00 | 2.951E-01 | 06089392 |
| 015-025 | <3.383E-02 | 4.123E-01 | 2.725E-01 | <5.347E-02 | - | - | - | <9.086E-02 | 06089493 |
| 025-035 | 5.716E-02 | <3.153E-01 | 1.800E-01 | <5.288E-02 | - | - | - | <9.261E-02 | 06089594 |
| 035-045 | <3.791E-02 | <3.604E-01 | 1.194E-01 | <5.671E-02 | 6.563E-03 | 6.946E-03 | - | <8.766E-02 | 06089695 |

5010142

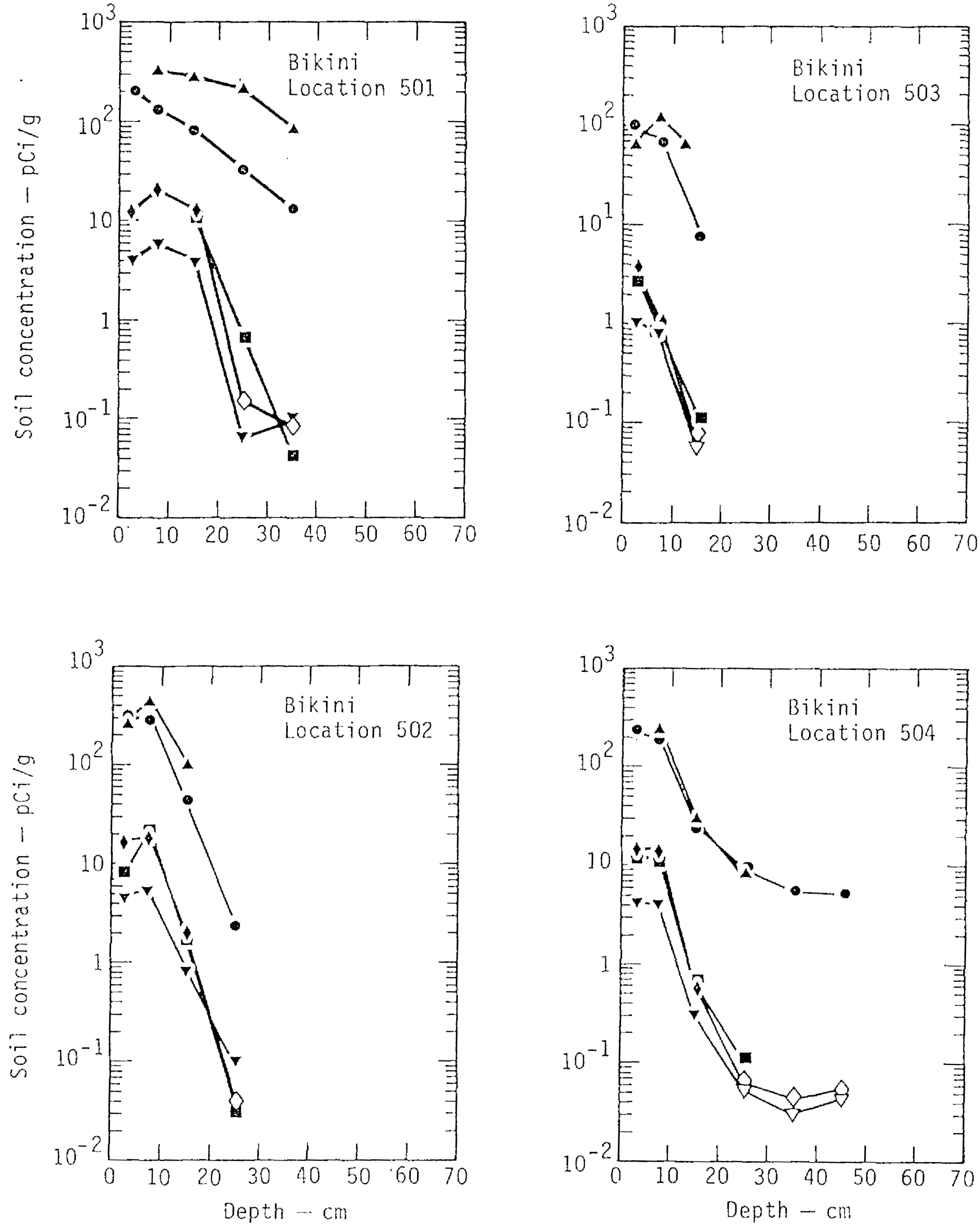
PROFILE TS0301

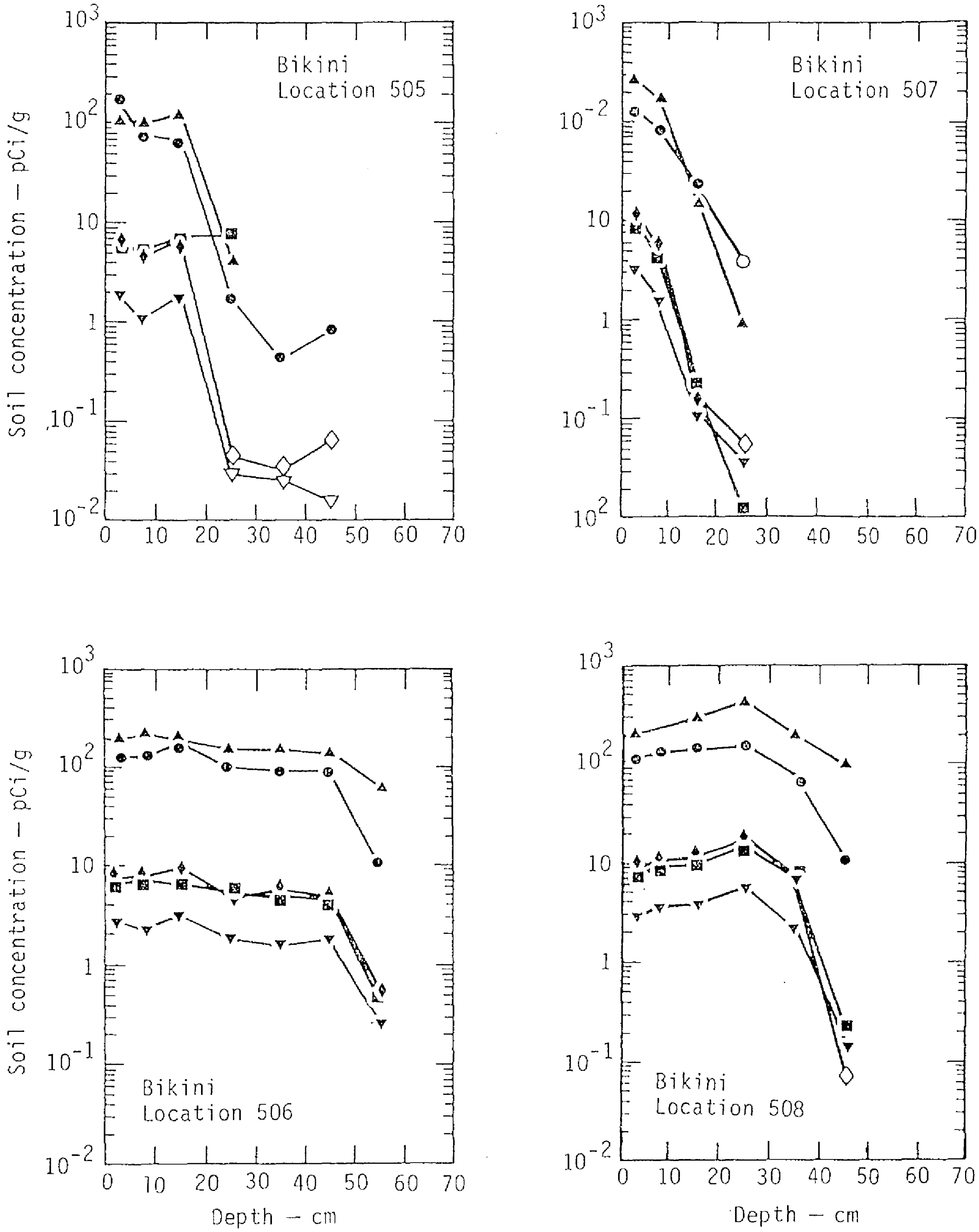
CONCENTRATIONS IN PCI/GM. MINUS FOR NO DATA. LESS THAN SIGN INDICATES INSTRUMENTAL DETECTION LIMIT

| DEPTH(CM) | 27 CO 60 | 38 SR 90 | 55 CS 137 | 63 EU 155 | 94 PU 239 | 94 PU 240 | 94 PU 241 | 95 AM 241 | MASTER LOG |
|---|---|---|---|---|---|---|---|---|---|
| 000-005 | 2.592E-01 | 1.776E+01 | 1.136E+01 | 5.649E-01 | 1.344E+00 | 1.444E+00 | 2.413E+01 | 1.023E+00 | 06093290 |
| 005-010 | 3.294E-01 | 1.574E+01 | 9.599E+00 | 4.761E-01 | 1.102E+00 | 1.218E+00 | - | 9.770E-01 | 06093391 |
| 010-015 | 3.338E-01 | 1.499E+01 | 9.770E+00 | 5.149E-01 | 1.093E+00 | 1.160E+00 | 2.315E+01 | 1.036E+00 | 06093492 |
| 015-025 | 2.459E-01 | 1.611E+01 | 1.055E+01 | 4.775E-01 | 1.023E+00 | 1.111E+00 | 2.023E+01 | 1.155E+00 | 06093593 |
| 025-035 | 5.541E-01 | 3.409E+01 | 1.778E+01 | 1.276E+00 | 2.888E+00 | 3.083E+00 | 5.658E+01 | 3.002E+00 | 06093694 |
| 035-045 | 3.004E-01 | 2.146E+01 | 9.856E+00 | 6.081E-01 | 1.244E+00 | 1.350E+00 | - | 9.235E-01 | 06093795 |

# Appendix B. The Distribution of Radionuclides with Depth in Soil Profiles of Bikini and Eneu Islands

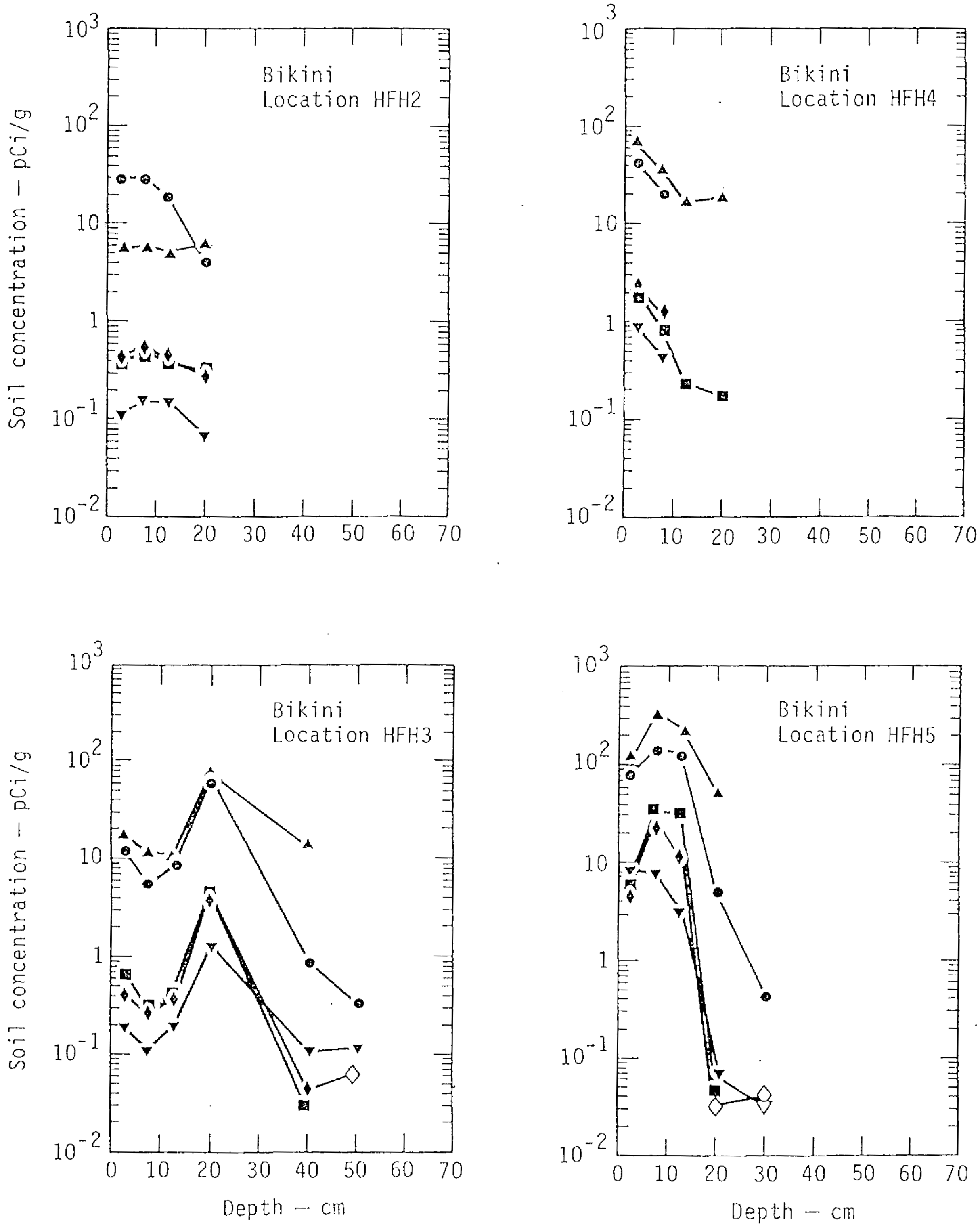
The following figures graphically present the concentrations of five selected radionuclides ($^{60}$Co, $^{90}$Sr, $^{137}$Cs, $^{239}$Pu, and $^{231}$Am) with depth of soil. One graph is given for each sample location of the islands (see Figs. 2, 3) and each corresponds to the tabular presentation of the same data in Appendix A. Throughout, open symbols indicate detection limits and solid symbols indicate measured values: ▼ = $^{60}$Co, ▲ = $^{90}$Sr, ● = $^{137}$Cs, ◘ = $^{239}$Pu, and ♦ = $^{241}$Am. Figures are grouped according to general location of the samples.

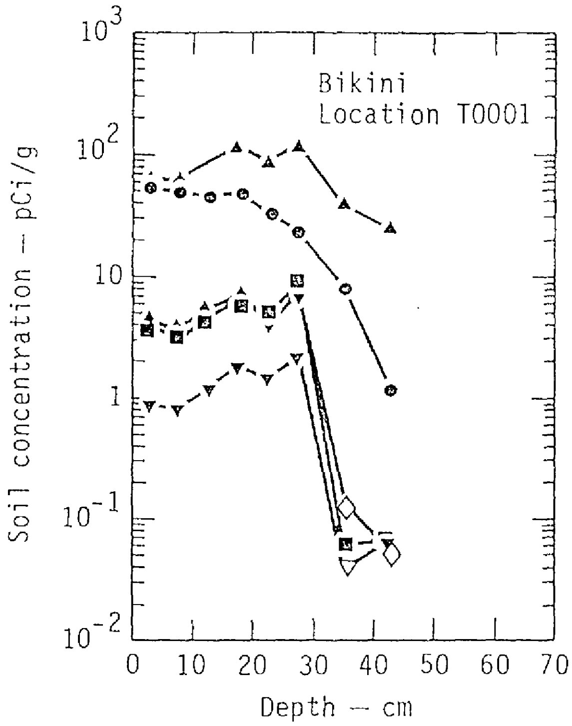

Bikini
Location 501
Bikini
Location 503
Bikini
Location 502
Bikini
Location 504
Soil concentration — pCi/g
Depth — cm
$10^3$
$10^2$
10
1
$10^{-1}$
$10^{-2}$
0
10
20
30
40
50
60
70

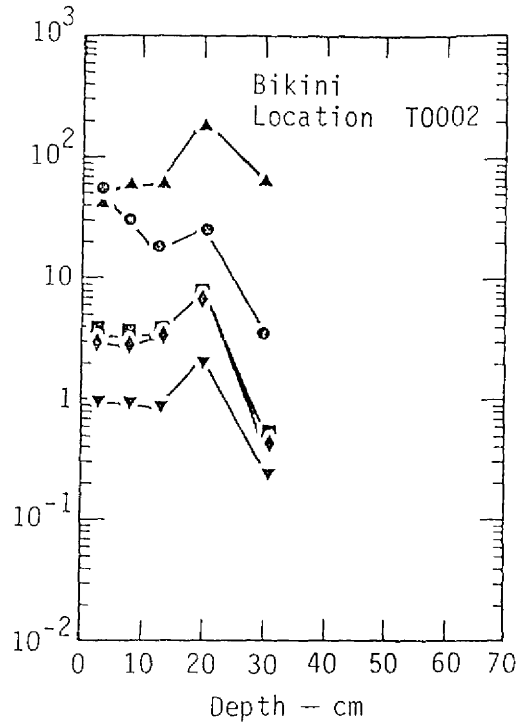


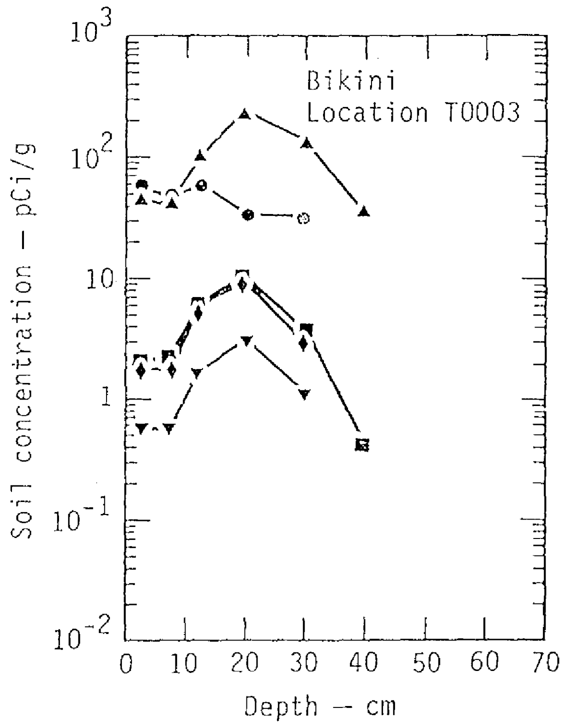



[redacted] 5010145


Bikini
Location HFH2
Bikini
Location HFH4
Bikini
Location HFH3
Bikini
Location HFH5
Soil concentration — pCi/g
Soil concentration — pCi/g
Depth — cm
Depth — cm

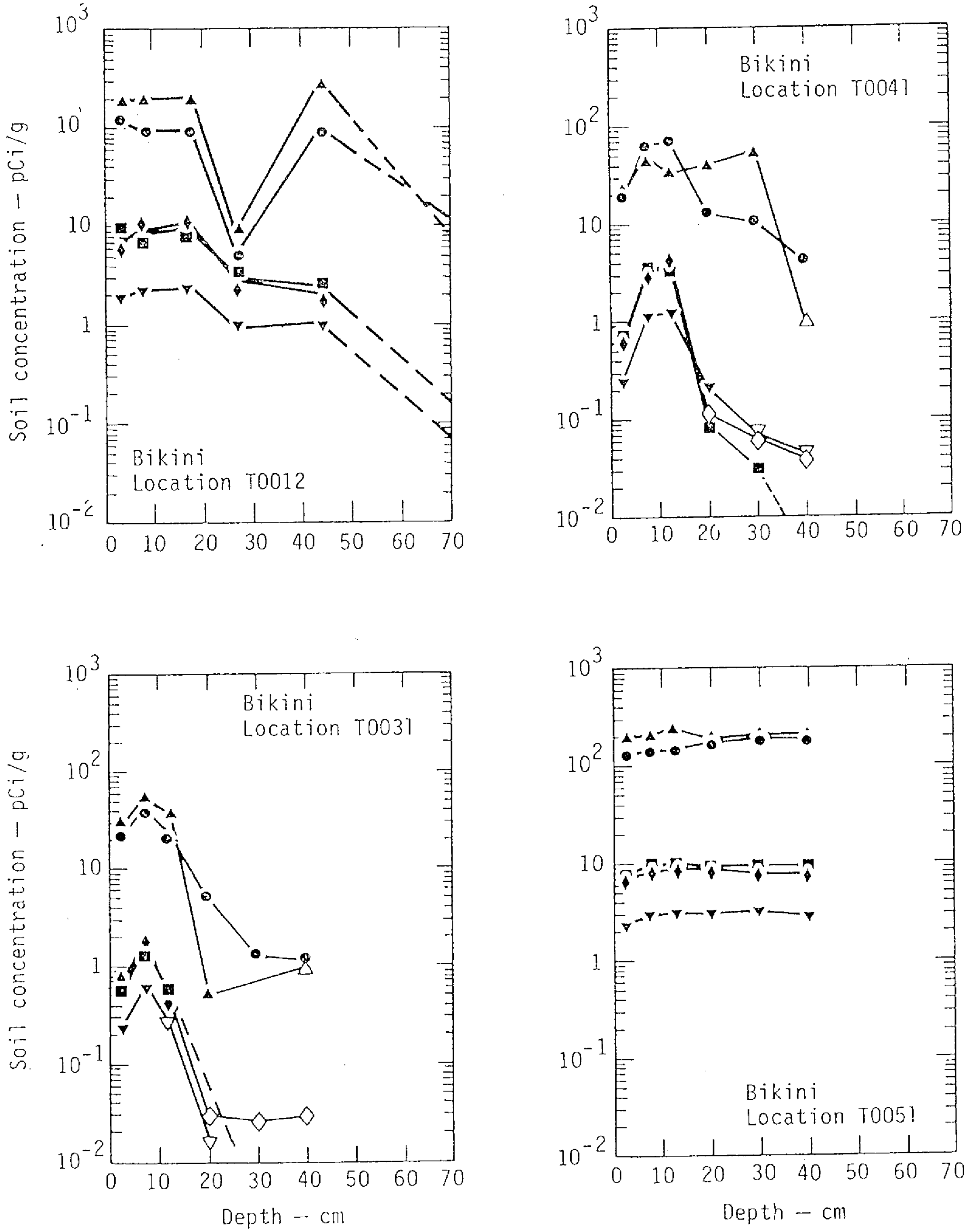


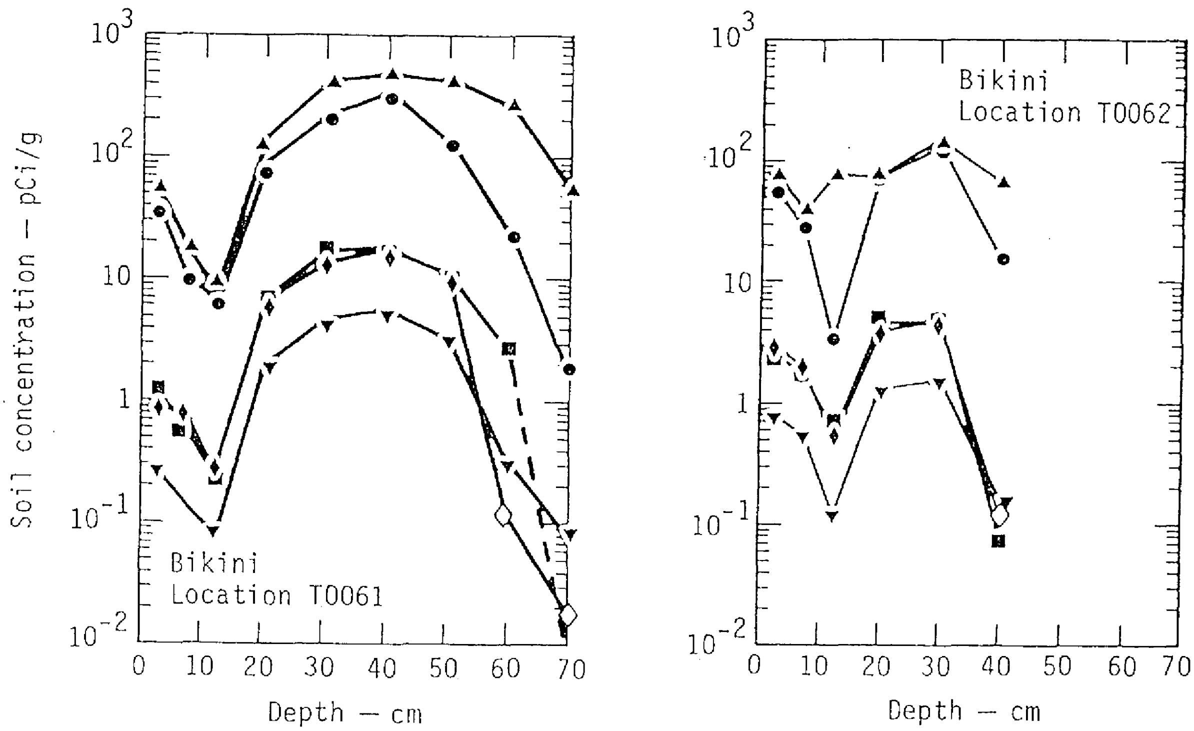





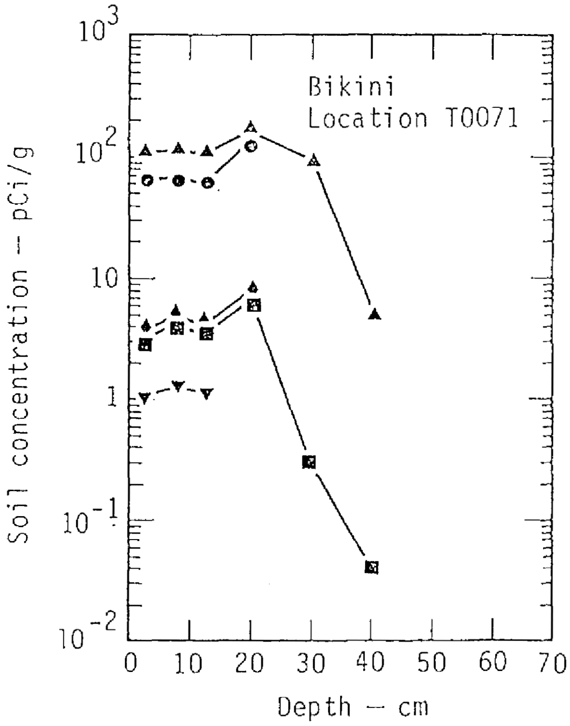

[redacted] 5010147

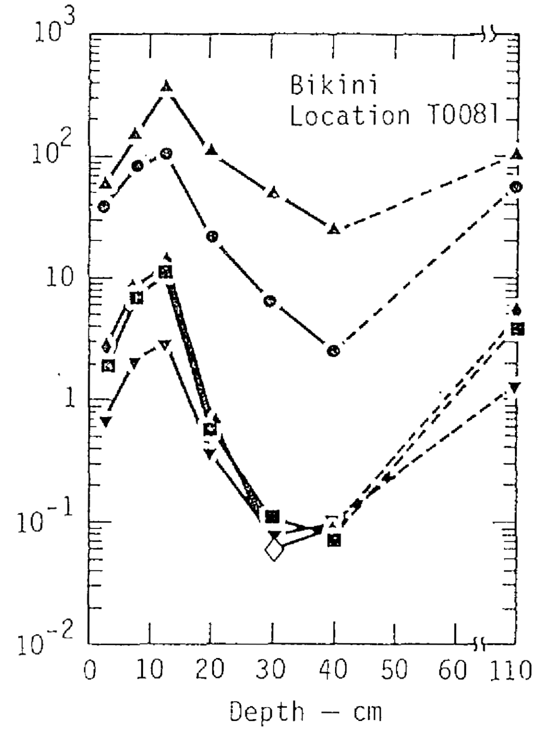

Bikini
Location T0012
Bikini
Location T0041
Bikini
Location T0031
Bikini
Location T0051
Soil concentration — pCi/g
Depth — cm
10^3
10^2
10
1
10^-1
10^-2
0
10
20
30
40
50
60
70

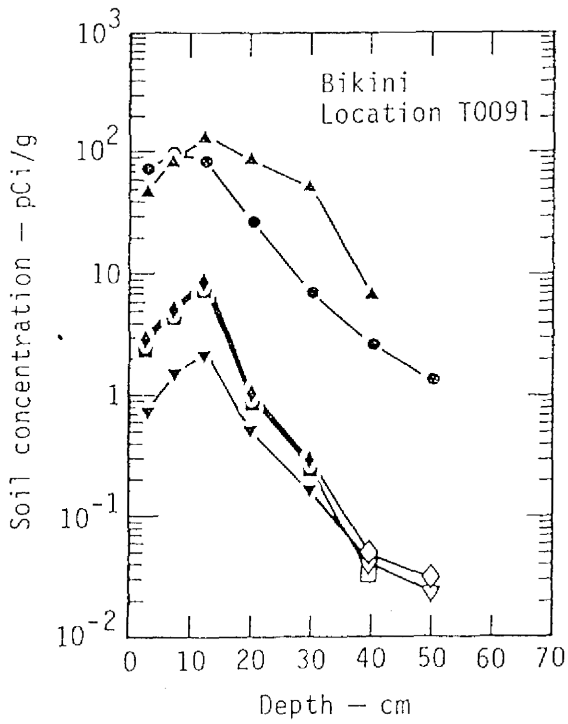





[redacted] 5010149

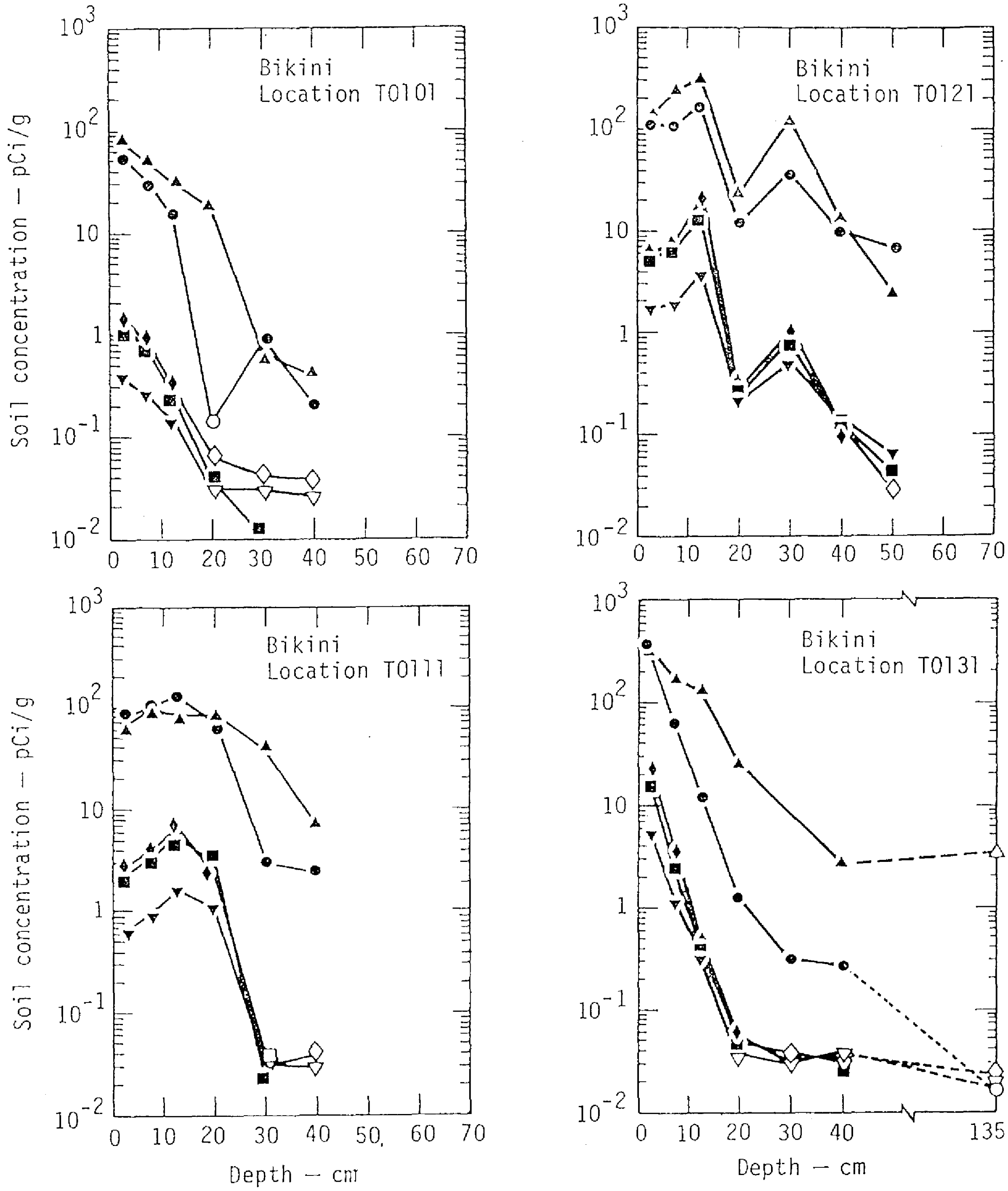


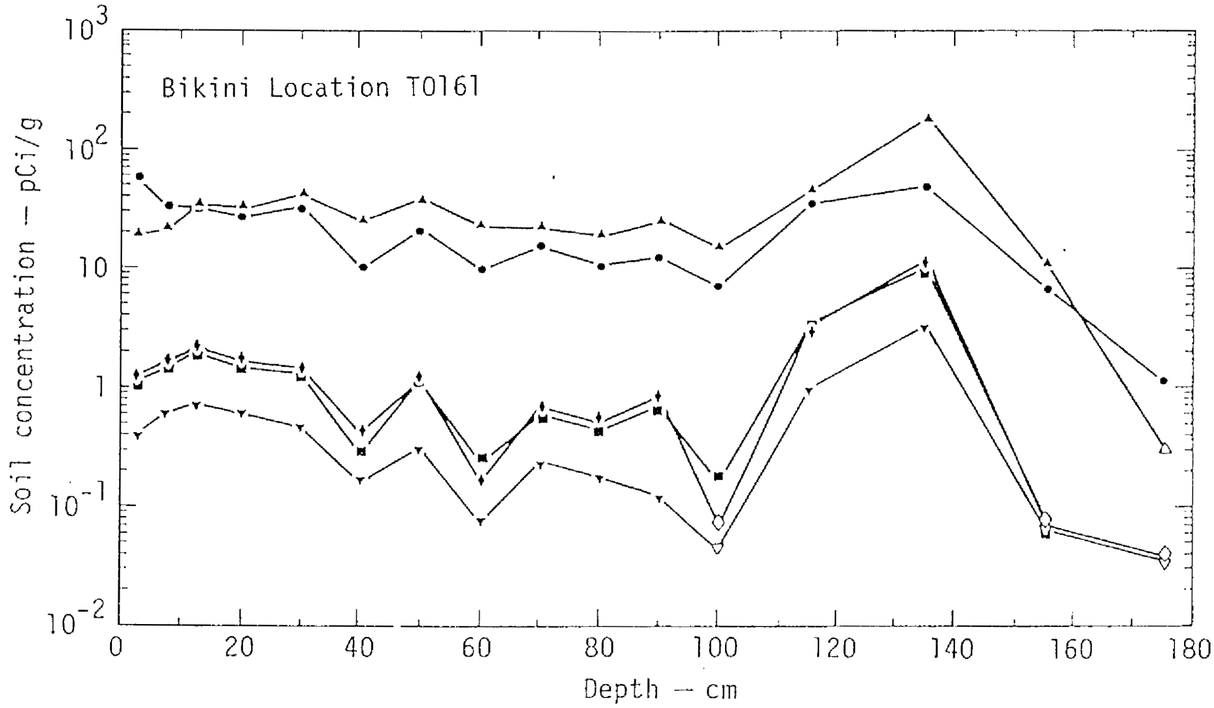





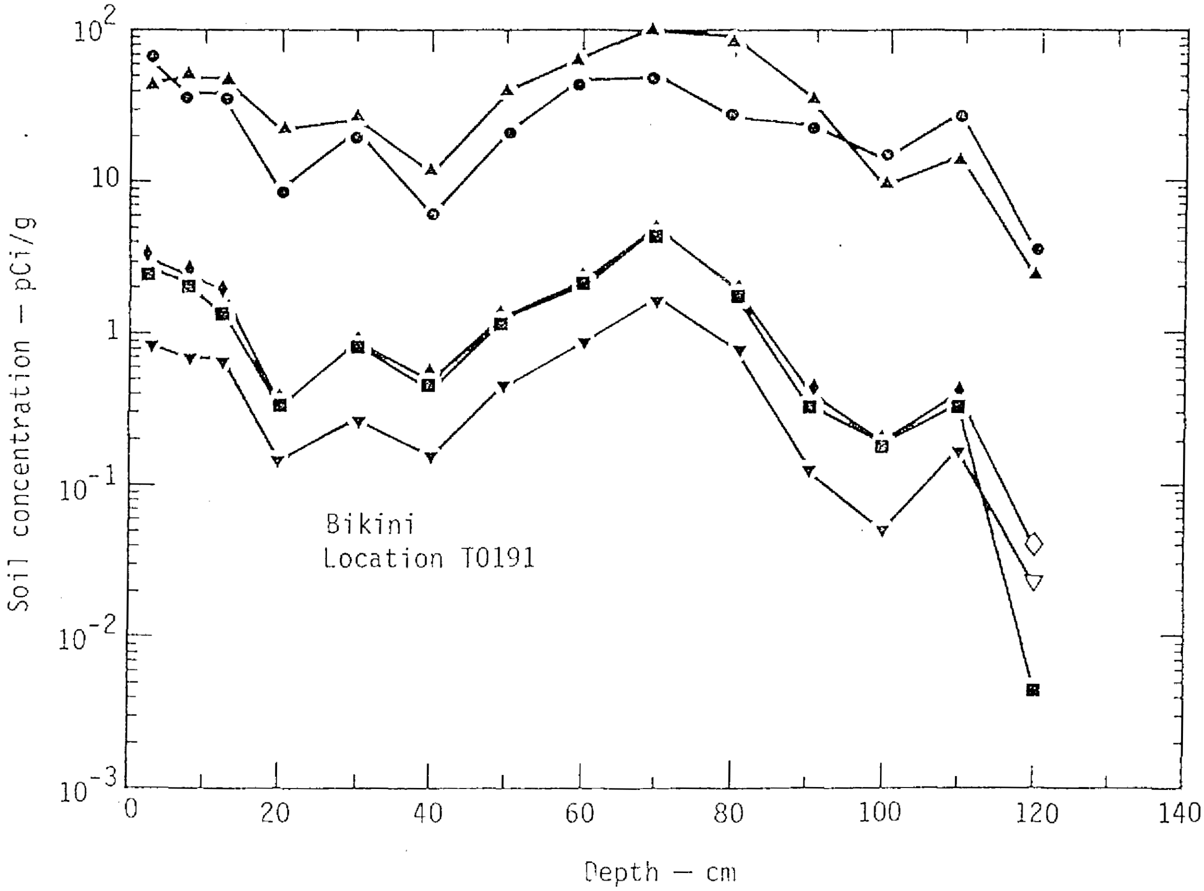

5010150[redacted]

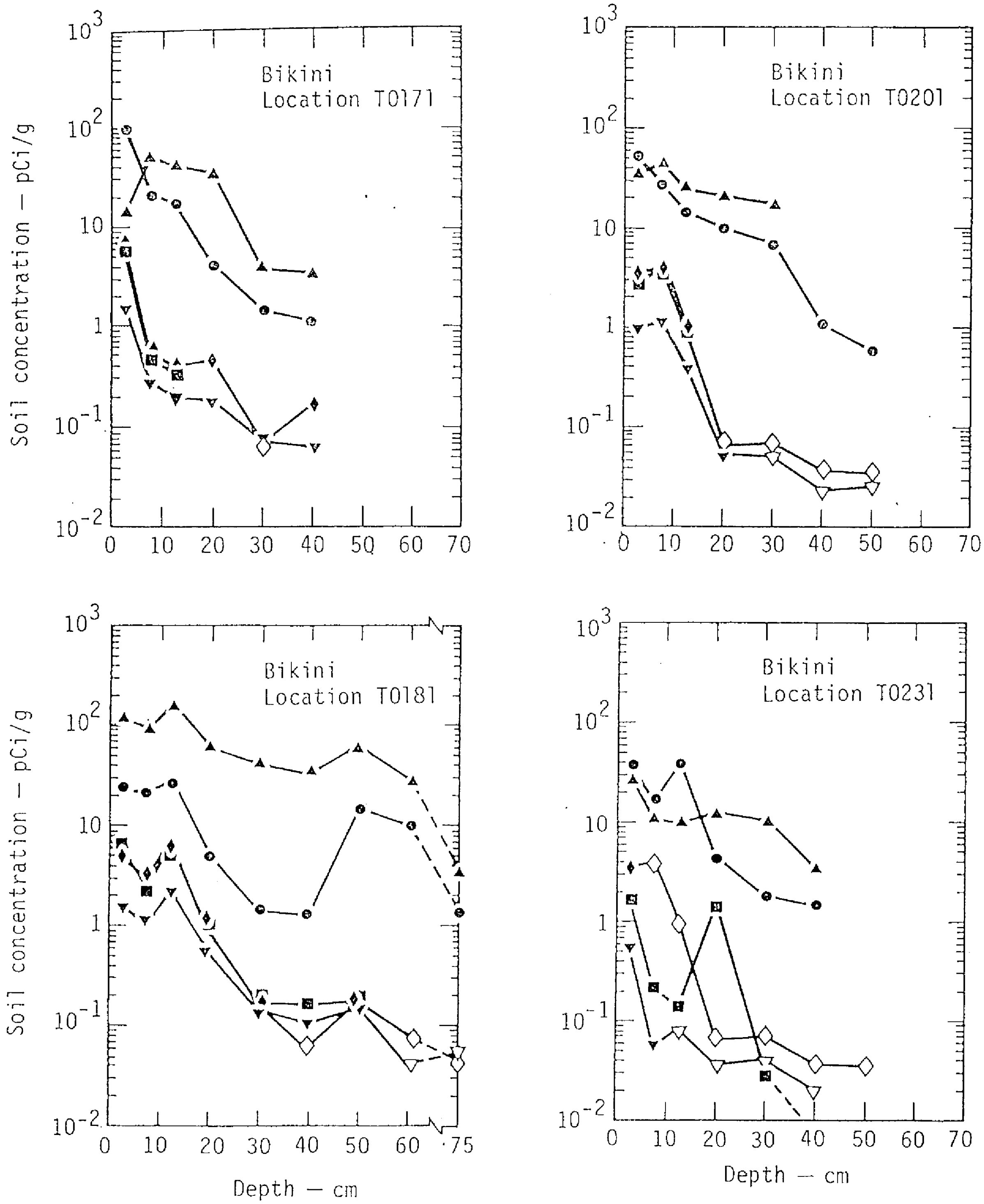

Bikini
Location T0101
Bikini
Location T0121
Bikini
Location T0111
Bikini
Location T0131
Soil concentration — pCi/g
Soil concentration — pCi/g
Depth — cm
Depth — cm
10^3
10^2
10
1
10^-1
10^-2
0 10 20 30 40 50 60 70
0 10 20 30 40 135





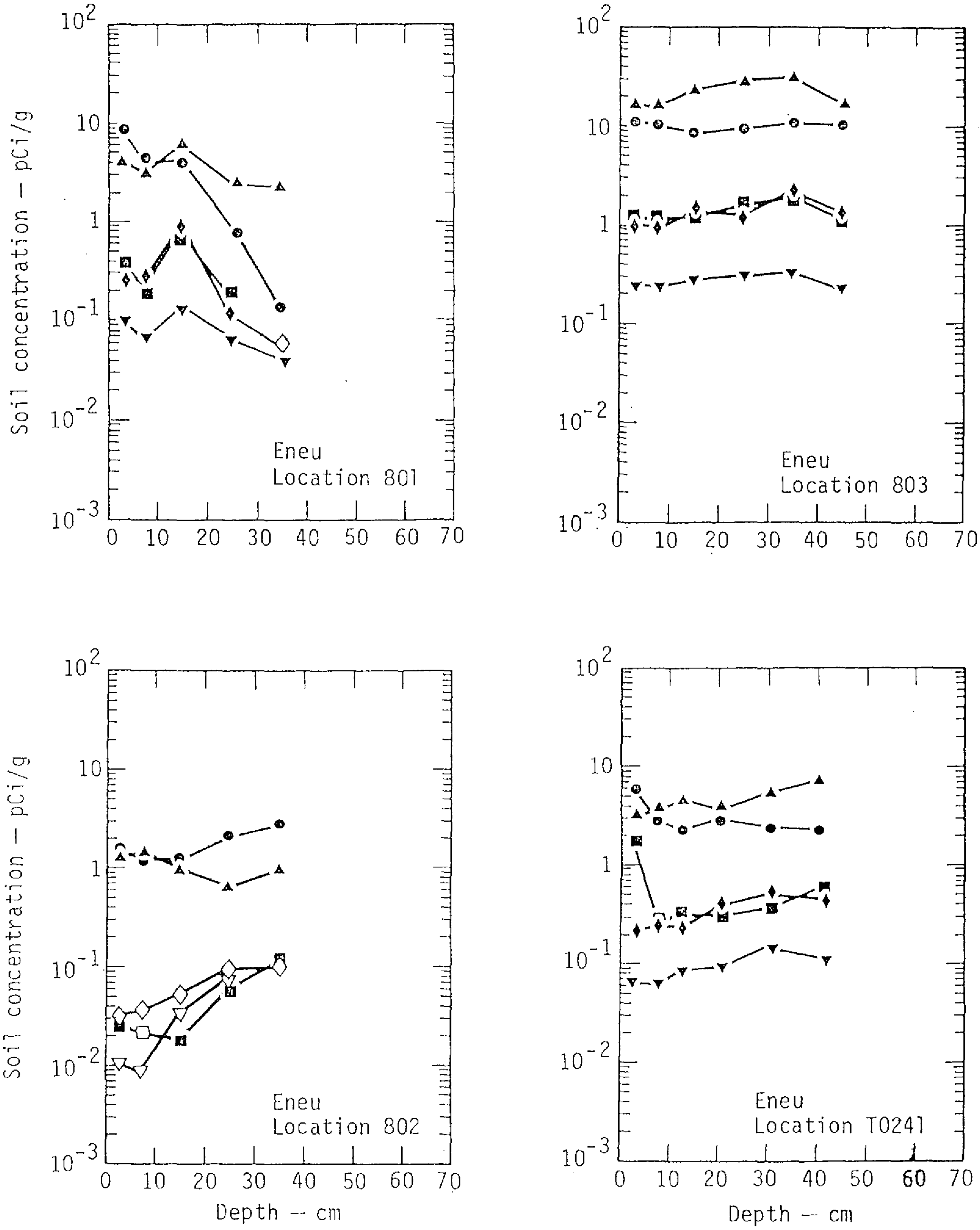

[redacted] 5010152


Bikini
Location T0191
Soil concentration — pCi/g
Depth — cm
10^2
10
1
10^-1
10^-2
10^-3
0
20
40
60
80
100
120
140



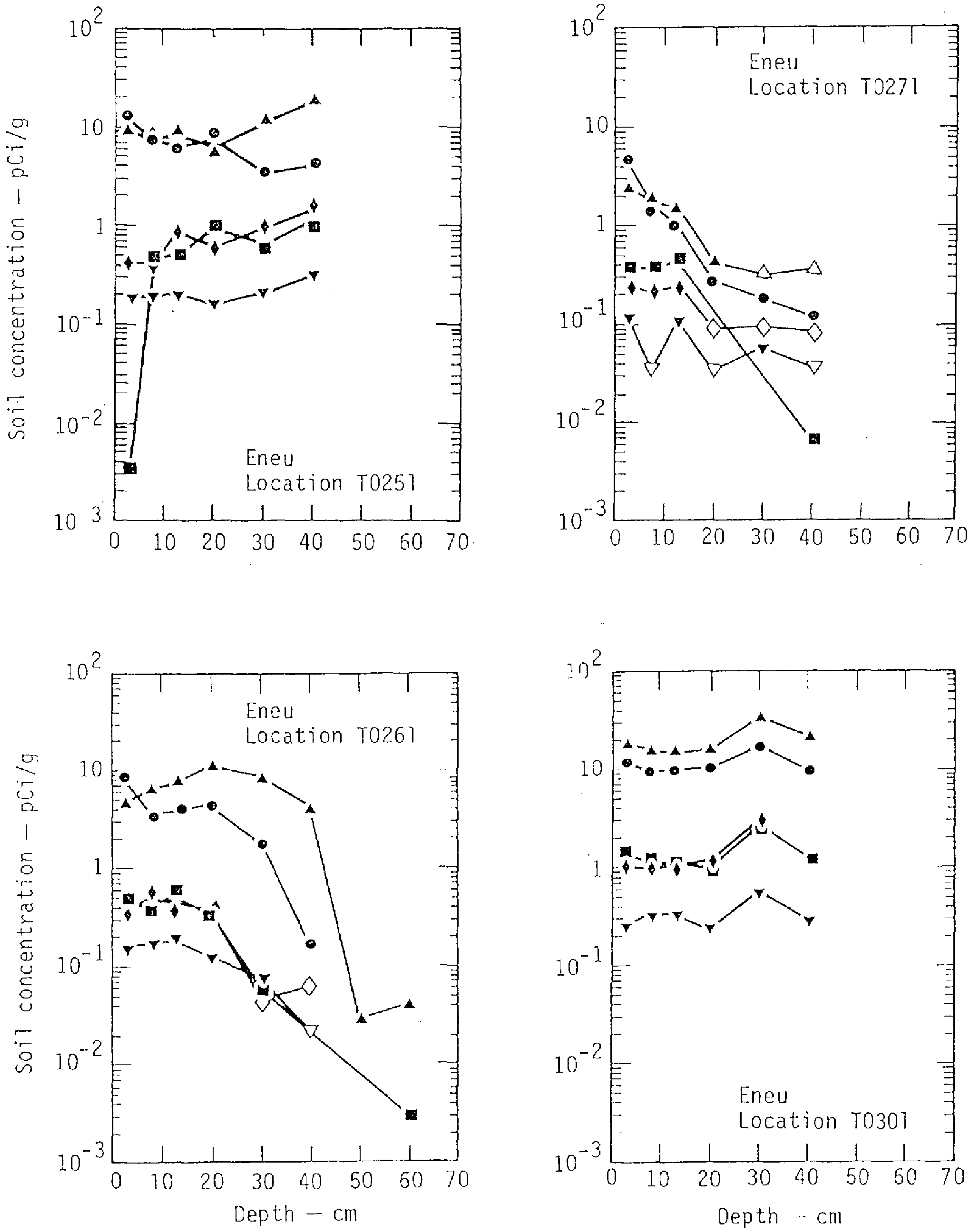



[redacted] 5010154






[redacted] 5010155



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# Appendix C. Geographical Distribution of Radioactivity in the Surface Soil (0 to 15 cm) of Bikini and Eneu Islands

The following maps present the concentrations of $^{60}Co$, $^{90}Sr$, $^{137}Cs$, $^{239}Pu$, $^{240}Pu$, and $^{241}Am$ (pCi/g dry weight) at the various samplings sites of the top 15 cm of soil on Bikini and Eneu Islands.

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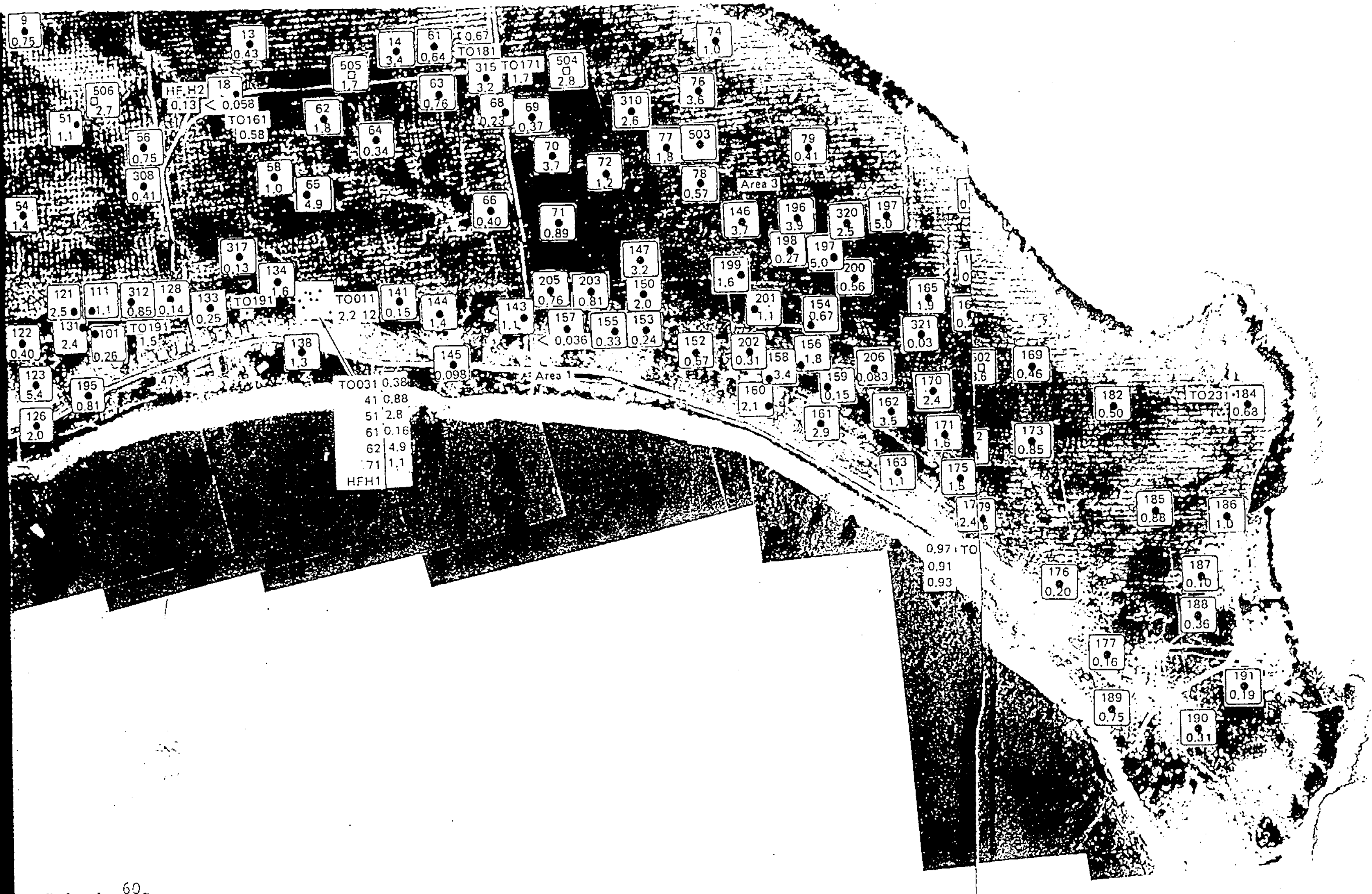


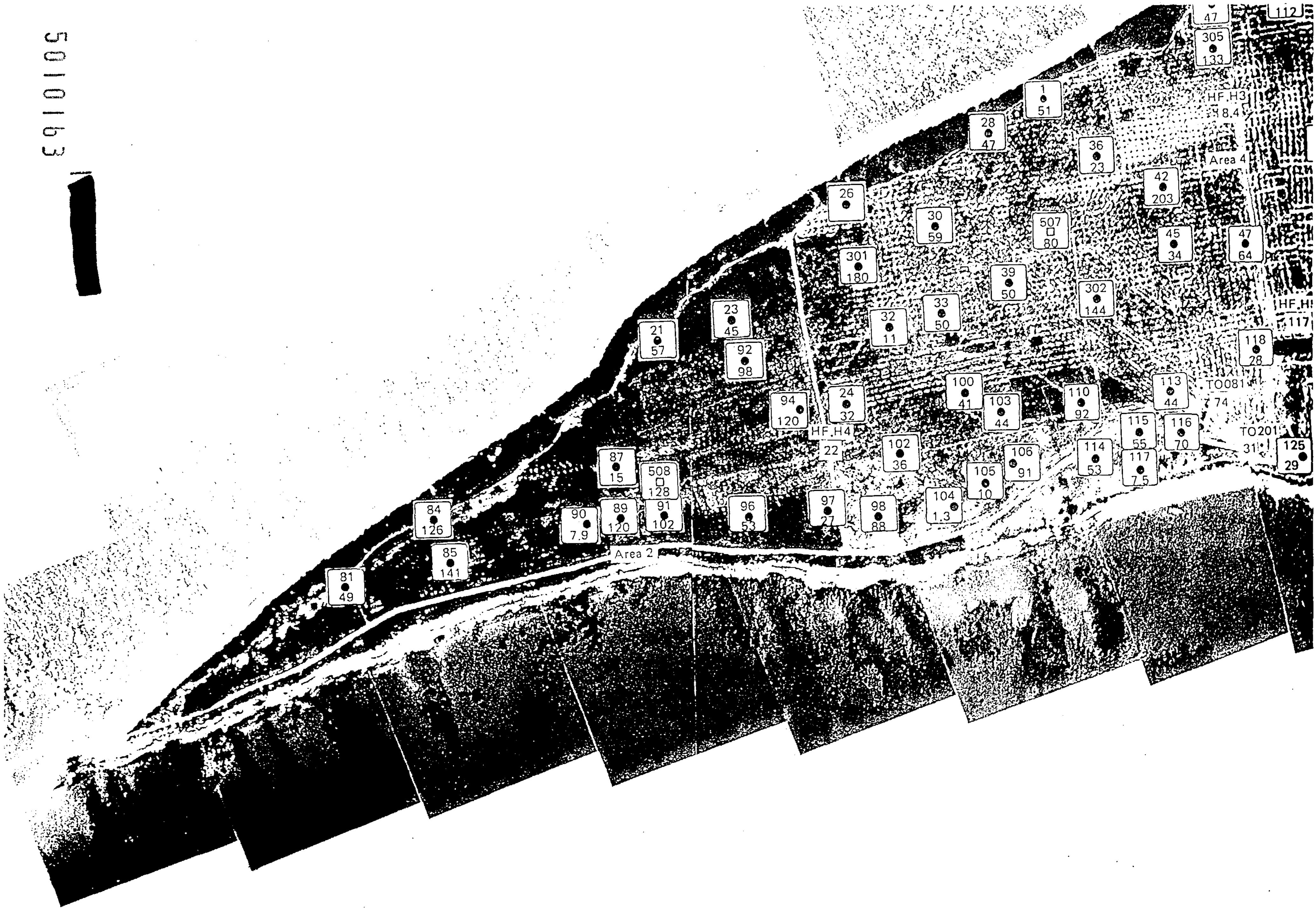

ni Island, $^{60}$Co


Area 2
Area 4
HF H3
13
HF H4
39
HF H5
224
TO081
187
TO201
35
331
305
267
9
45
1
239
28
36
94
49
261
42
116
26
43
30
56
507
152
45
370
47
148
54
230
301
39
42
302
23
29
32
14
33
38
21
50
92
118
29
122
43
100
97
110
235
113
64
94
31
24
171
103
211
123
160
115
76
116
124
54
126
106
102
58
106
145
114
117
125
46
87
16
508
105
104
84
261
90
30
89
217
91
264
96
97
126
98
130
85
81
69

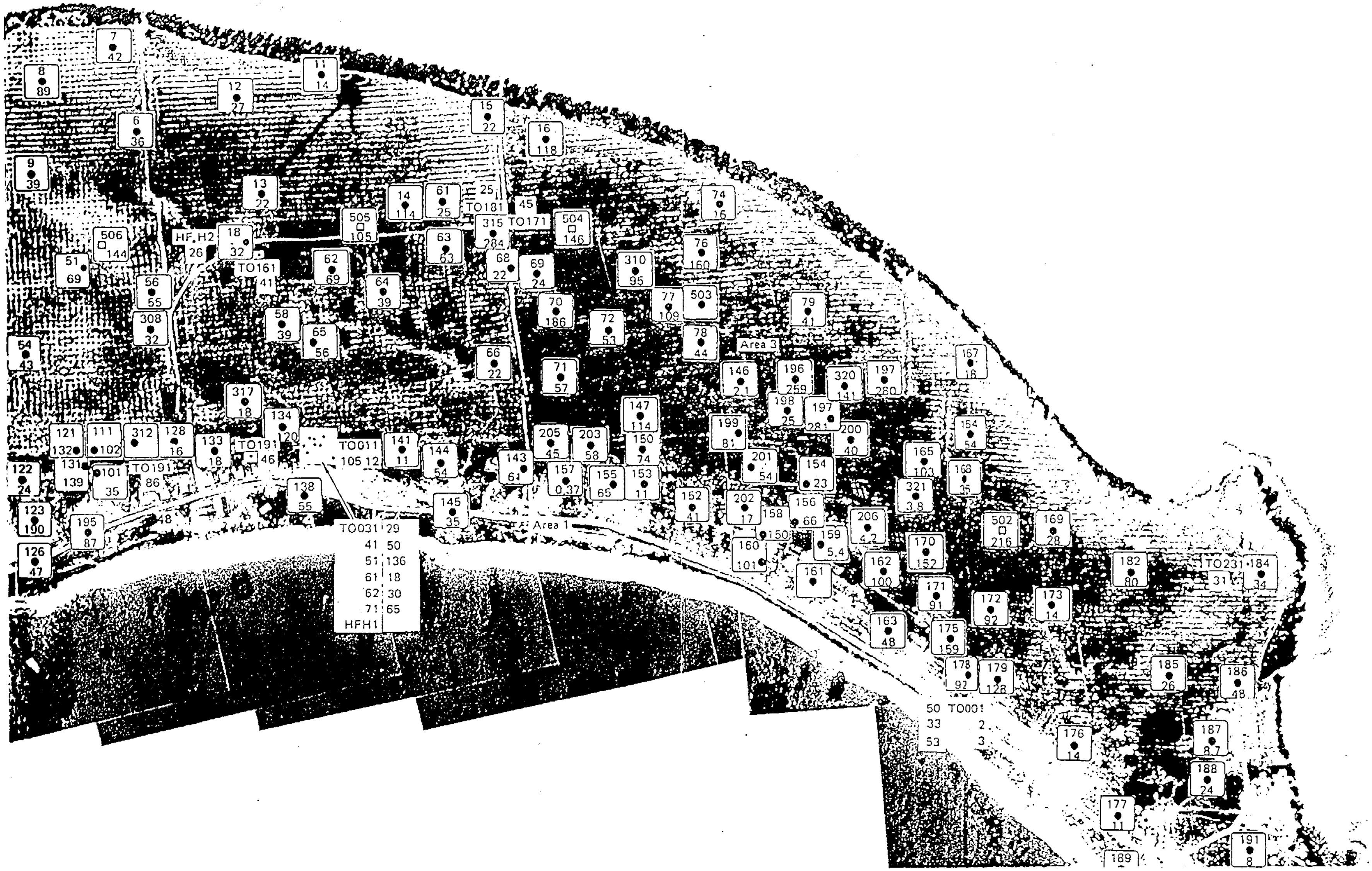
Bikini I

C-

7 35
11 15
12 32
6
15
16 183
13 23
14
61 58
130
TO181
74 84
505 113
315 296
TO171 35
504 165
506 201
HF H2 57
18 19
63
76 254
62 207
TO161 25
68 76
69 31
310 176
64 26
56 49
70 272
77
503 96
79 62
308 25
58
72
65
78
Area 3
66
167 36
71 100
146 291
196
320
197 317
317
198 52
197
147 311
134 146
199 108
200 18
164 82
111 81
312 33
128 10
133 19
TO19 50
TO011 198 12
141 12
144 104
205 105
203
150 119
201
165 127
154 62
168 29
143 91
157
155
153 21
321 4.6
101 14
TO191 87
138 38
145 19
Area 1
152
202
158
156 201
206
502 283
169 70
195 43
70
TO031 40
41 34
51 213
61 25
62 65
71 108
HFH1
159
160 163
170 200
182 96
TO231 17
184 32
162 316
161
171 123
172
173 30
163 71
175
178
179 114
185 50
186
70 TO001
55 2
61 3
176 19
187
188 15
177
191 10
189


47
112
305 133
1 51
HF H3 8.4
28 47
36 23
Area 4
42 203
26
30 59
507 80
45 34
47 64
301 180
39 50
302 144
HF H
117
23 45
33 50
32 11
21 57
92 98
118 28
94 120
24 32
100 41
103 44
110 92
113 44
TO081 74
HF H4
22
102 36
115 55
116 70
TO201 31
125 29
87 15
508 128
106 91
114 53
117 7.5
105 10
84 126
90 7.9
89 120
91 102
96 53
97 27
98 88
104 1.3
Area 2
85 141
81 49

Biki

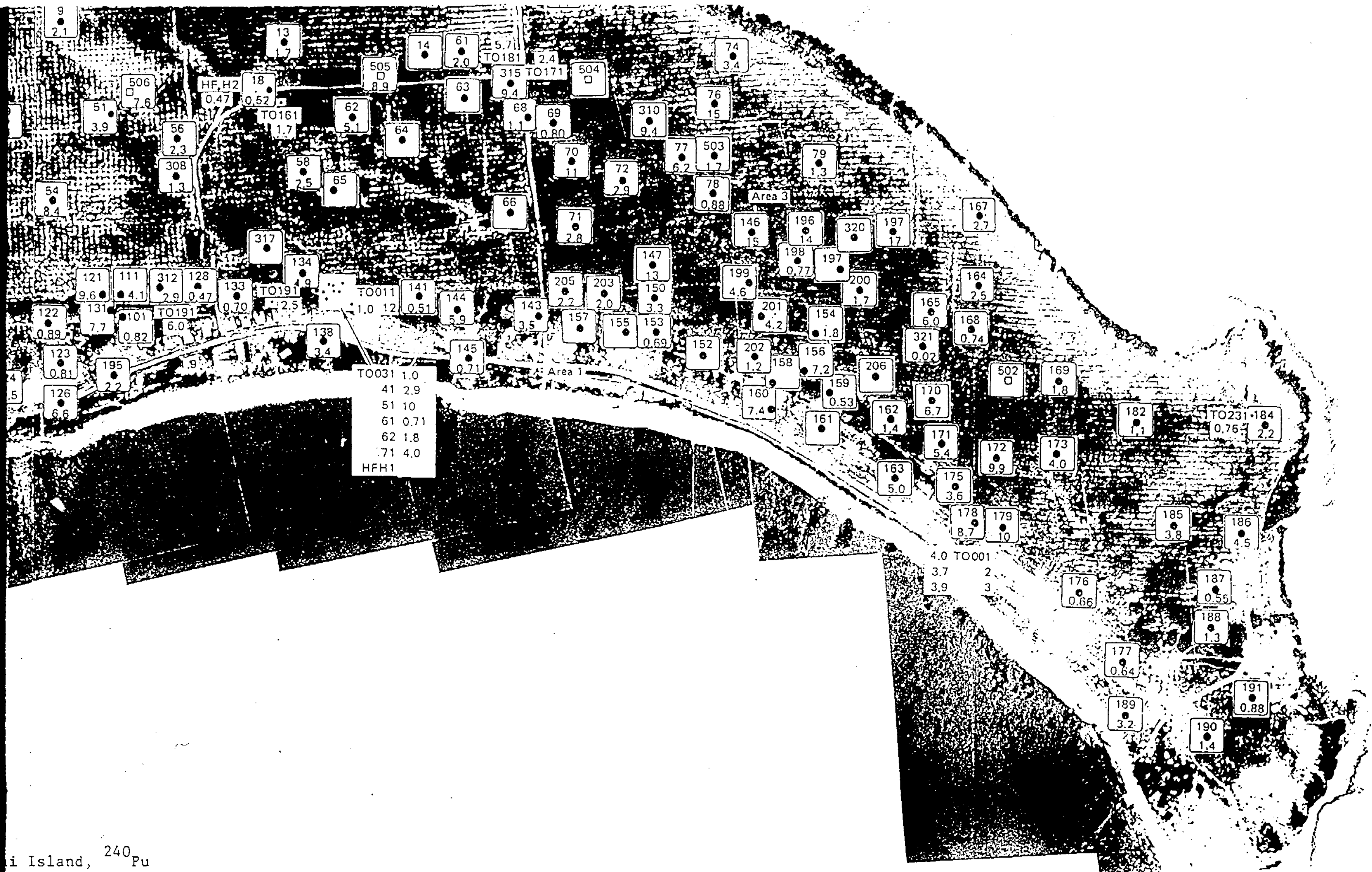


7 42
8 89
11 14
12 27
6 36
15 22
16 118
9 39
13 22
14 114
61 25
25 TO181
45 TO171
74 16
505 105
315 284
504 146
506 144
HF,H2 26
18 32
63 63
76 160
51 69
TO161 41
62 69
68 22
69 24
310 95
56 55
64 39
77 109
503
79 41
308 32
58 39
70 186
72 53
78 44
54 43
65 56
66 22
Area 3
167 18
146 2.1
196 259
320 141
197 280
71 57
317 18
198 25
197 281
147 114
134 120
199 81
200 40
154 54
121 132
111 102
312
128 16
133 18
TO191 46
TO011 105 12
141 11
144 54
205 45
203 58
150 74
165 103
122 24
131 139
101 35
TO191 86
143 61
157 0.37
155 65
153 11
201 54
154 23
168 35
138 55
145 35
152 41
202 17
156 66
321 3.8
123 190
48
158 150
206 4.2
502 216
169 28
195 87
TO031 29
41 50
51 136
61 18
62 30
71 65
HFH1
Area 1
159 5.4
160 101
170 152
126 47
161
162 100
182 80
TO231 31
184 34
171 91
172 92
173 14
163 48
175 159
178 92
179 128
185 26
186 48
50 TO001
33 2
53 3
176 14
187 8.7
188 24
177 11
191 8
189


4 14
5
9 1.9
305 9.4
1 2.6
HF,H3 0.46
28 4.9
49 10
36 2.5
Area 4
42 14
26 1.4
30 1.8
507 4.9
45 4.8
47 4.3
54 7.6
301
39 2.5
302
HF,H5 16
23 2.1
33 2.6
32 0.42
21 2.6
92
118 1.9
122 0.77
100 1.2
110 6.3
113 1.0
TO081 6.5
123 11
94 11
24 6.1
103 3.6
124 2.3
HF,H4 1.1
115 0.48
116
TO201 2.5
126 5.7
102 1.2
106 9.3
114
117
125 0.12
87 0.88
508 9.0
105 0.17
104 0.05
97 1.6
98 5.8
96
84 9.6
90 1.6
89 8.2
91 13
Area 2
85
81 3.4

Bikini Isla

7 2.6
11 0.51
12 2.7
15
16 13
6
13 1.5
14
61 1.8
5.1 TO181
2.1 TO171
504 8.3
74 3.0
506 6.9
HF,H2 0.42
18 0.46
505 6.2
63
315 8.4
68 0.93
69 0.73
310 8.3
76 14
TO161 1.5
62 4.4
64 1.0
56 2.1
70 10
72
77 5.6
503 1.5
79 1.1
308 1.1
58 2.1
65
66
78 0.74
Area 3
167 2.4
71 2.4
146 13
196 13
320
197 16
317
198 0.64
197
147 11
199 4.1
164 2.1
111 3.7
312 2.6
128 0.41
134 3
133 0.63
TO191 2.1
TO011 7.7 12
141 0.45
144 5.7
205 1.8
203 1.7
150 2.9
200 1.5
165 5.3
101 0.49
TO191 5.3
143 1.8
157
155
153 0.60
201 3.7
154 1.6
168 0.66
138 2.8
145 0.63
152
202 1.1
158
156 6.4
321 0.02
206
502
169 1.6
95 1.8
TO031 0.90
41 2.5
51 9.1
61 0.64
62 1.6
71 3.5
HFH1
Area 1
160 6.7
159 0.48
170 5.8
162 13
182 0.94
TO231 0.68
184 2.0
161
171 4.8
172 8.9
173 3.2
163 5.0
175 3.3
178 8.1
179 8.9
185 3.4
186 3.9
3.6 TO001
3.3 2
3.5 3
176 0.61
187 0.50
188 1.1
177 0.56
191 0.79
189 2.9
190




i Island, $^{240}Pu$

[redacted]

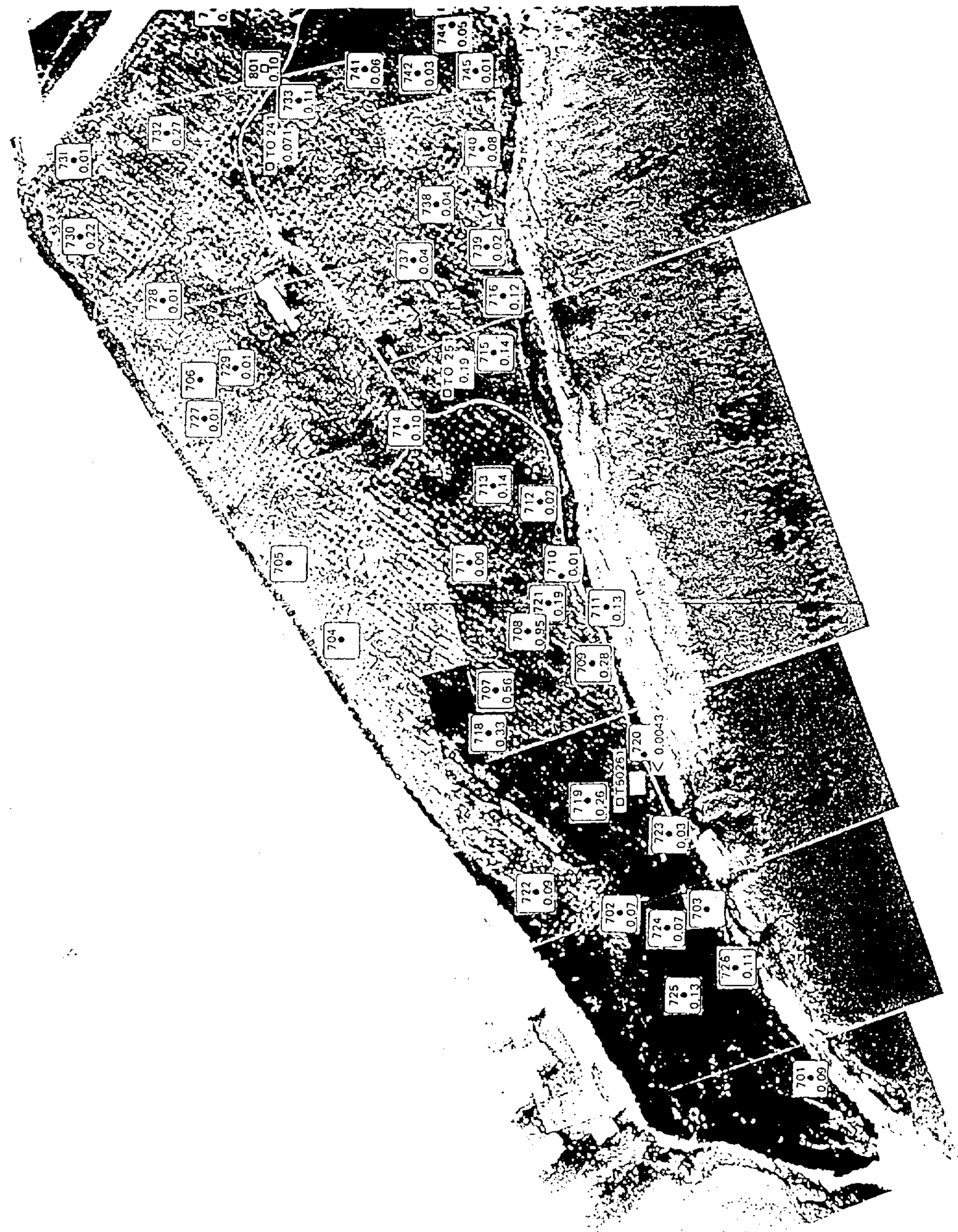

Bik

2.7
305 12
9 2.2
1 7.3
HF H3 0.34
28 5.4
36 1.7
49 13
Area 4
42 12
26
30 1.9
507 5.4
45 3.4
47 4.8
54 4.2
301 11
39 2.7
302 10
HF H5 1.6
23 2.1
33 2.1
32 0.35
21 2.6
92 11
118 1.6
122 0.72
123 11
100 2.9
103 2.9
110 10
113 2.2
TO081 7.9
24 6.1
94 9.8
HF H4 1.2
124 2.0
126 6.4
115 2.4
116 7.8
TO201 2.9
125 0.70
102 1.3
106 5.6
114 3.3
117 0.21
87 0.91
508 10
105 0.15
104 < 0.03
84 8.2
89 8.9
91 14
90 1.1
96 3.4
97 0.87
98 6.9
85 8.3
Area 2
81 3.6

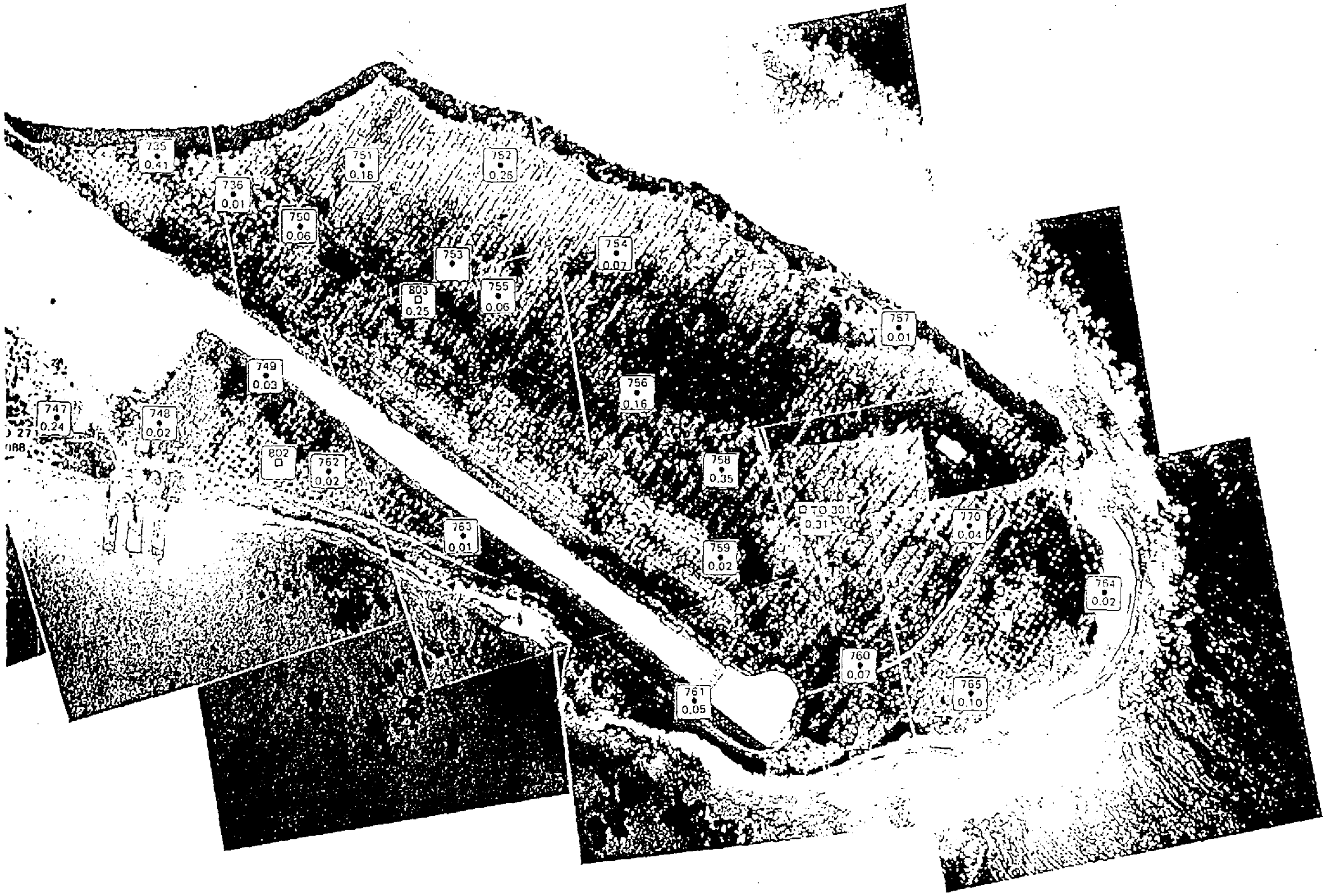

Bikini Isl.


Area 3
Area 1
TO031
HFH1
TO001
TO011
TO161
TO171
TO181
TO191
TO231
HF,H2

$^{241}Am$

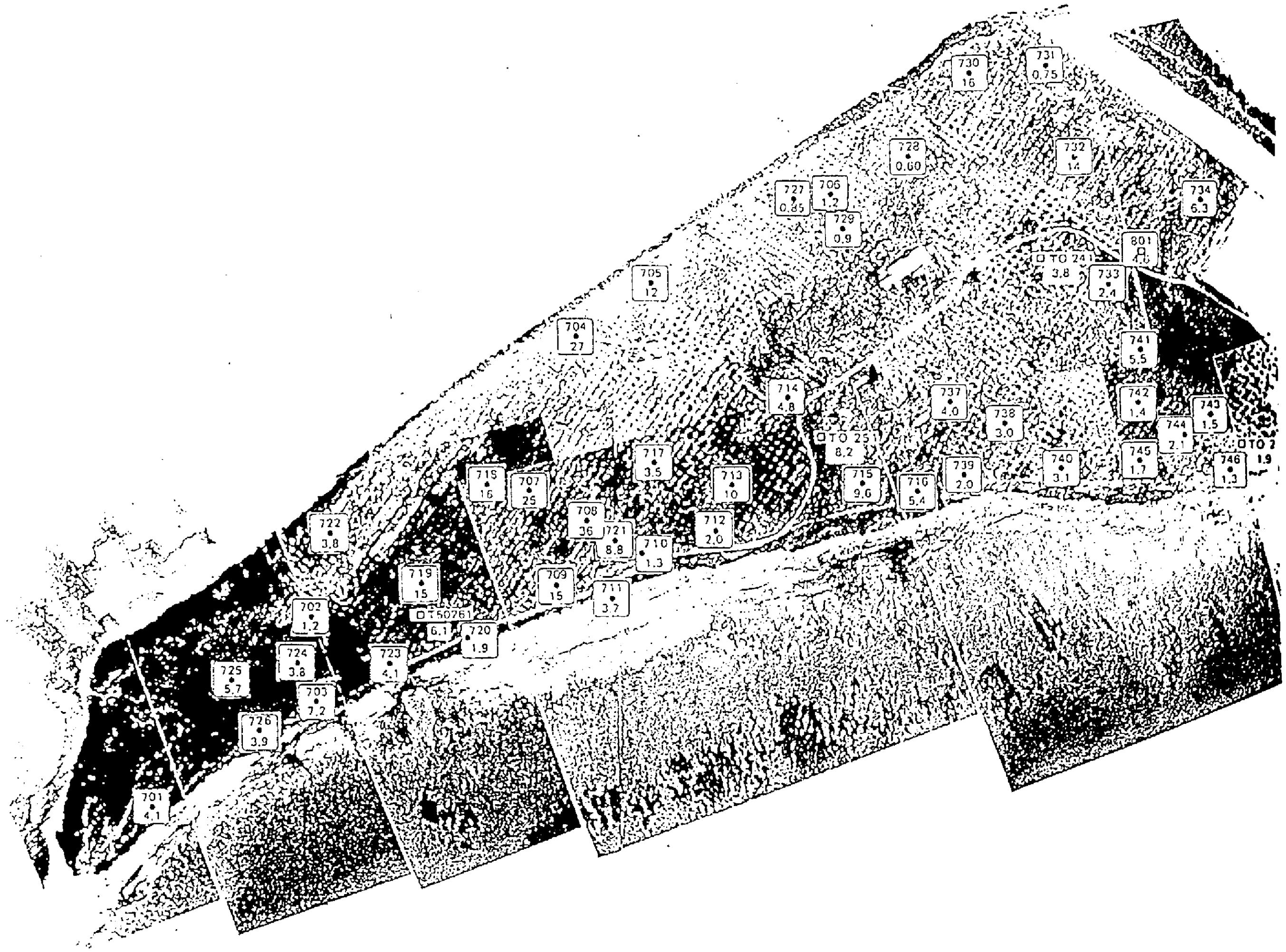


744 0.05
801 0.10
741 0.06
742 0.03
745 0.01
733 0.11
TO 24 0.071
732 0.21
731 0.01
740 0.08
738 0.04
730 0.22
737 0.04
739 0.02
716 0.12
728 0.01
TO 25 0.19
715 0.14
729 0.01
706
727 0.01
714 0.10
713 0.14
712 0.02
705
717 0.09
710 0.01
721 0.19
711 0.13
708 0.95
704
709 0.28
707 0.56
718 0.33
720 < 0.0043
TF50261
719 0.26
723 0.03
722 0.09
702 0.02
724 0.07
703
726 0.11
725 0.13
701 0.09


735 0.41
736 0.01
751 0.16
752 0.26
750 0.06
753
754 0.07
800 0.25
755 0.06
757 0.01
749 0.03
756 0.16
747 0.24
748 0.02
802
762 0.02
758 0.35
763 0.01
TO 301 0.31
770 0.04
759 0.02
784 0.02
760 0.07
761 0.05
765 0.10

land, $^{60}$Co

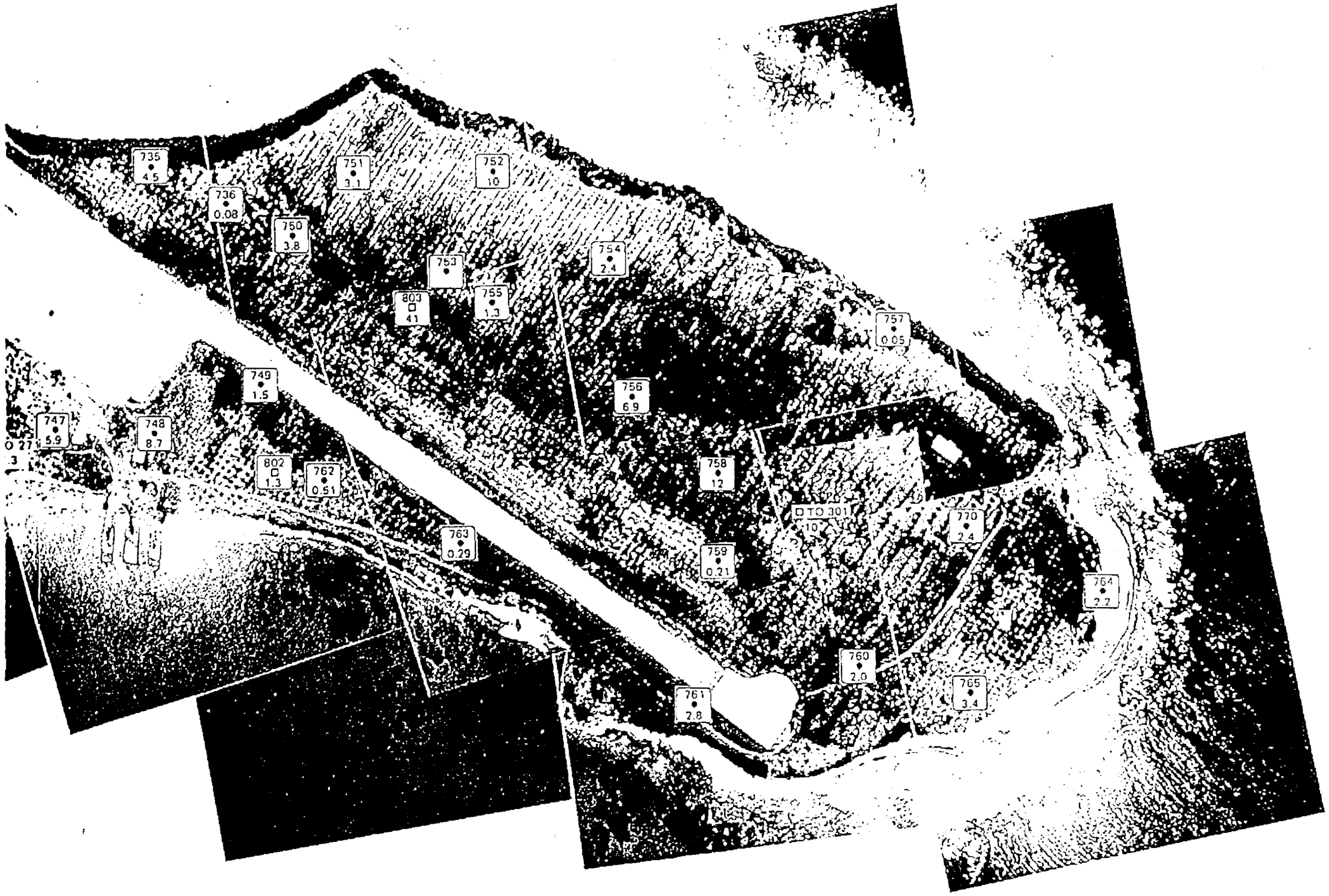
C-9




Eneu Islan

C-1

5010173

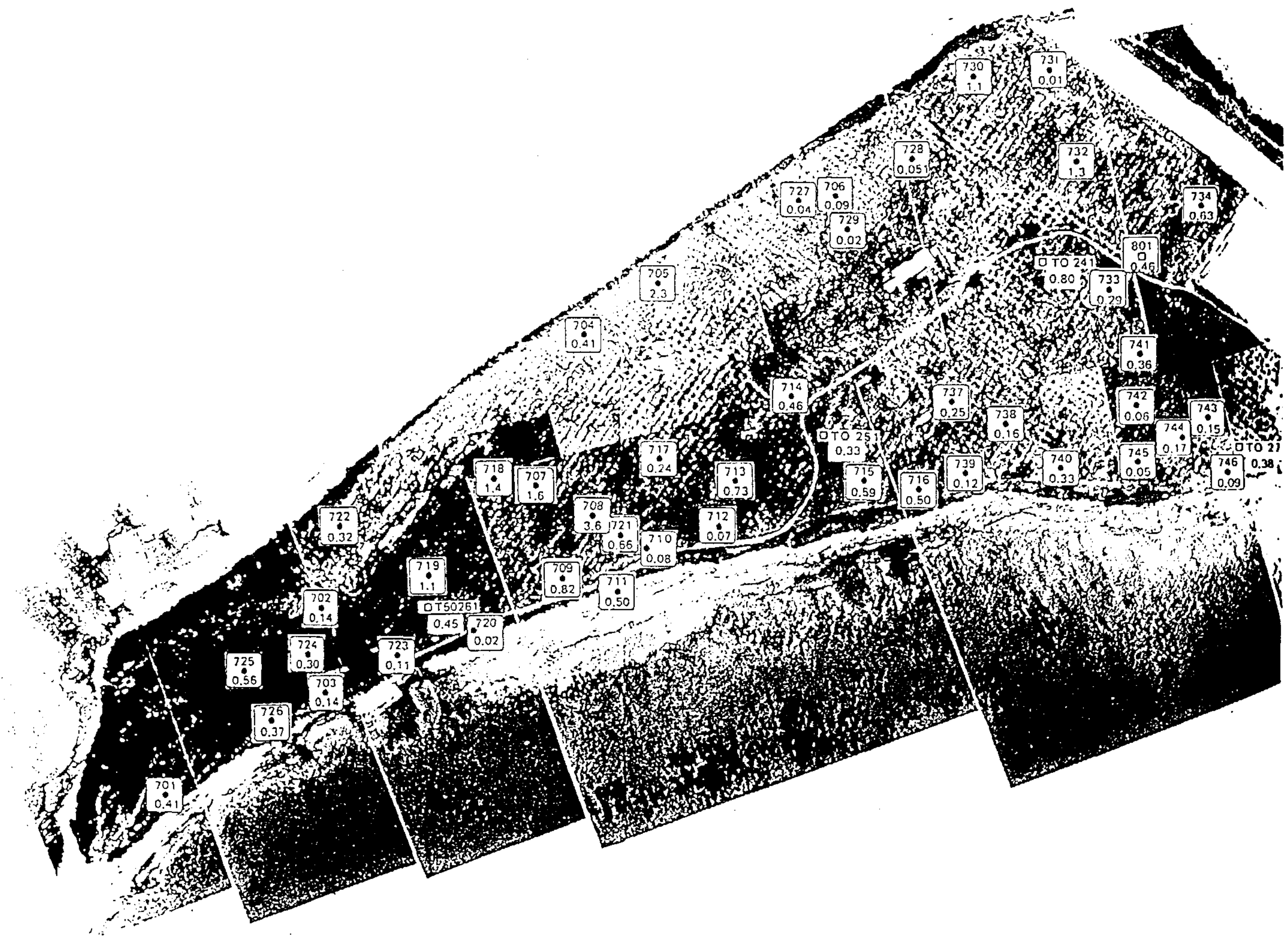



and, $^{137}Cs$

C-11

730 4.4
731 0.39
728 0.29
732 8.8
727 0.57
706
729 0.36
TO 24 3.8
801 5.8
733 4.3
705
704
741 4.9
714 8.5
737 3.0
742 1.0
738 4.4
TO 25 8.7
744 3.9
717 5.4
713 5.1
715 5.1
716 5.1
739 2.1
740 6.6
745 2.2
718 11
707 29
708 28
721 9.5
712 2.2
710 0.74
722 6.4
719 15
709 12
711 2.0
702 2.8
TS0261 5.1
720 1.0
724 4.8
723 5.7
725 3.3
703
726 2.2
701 3.7

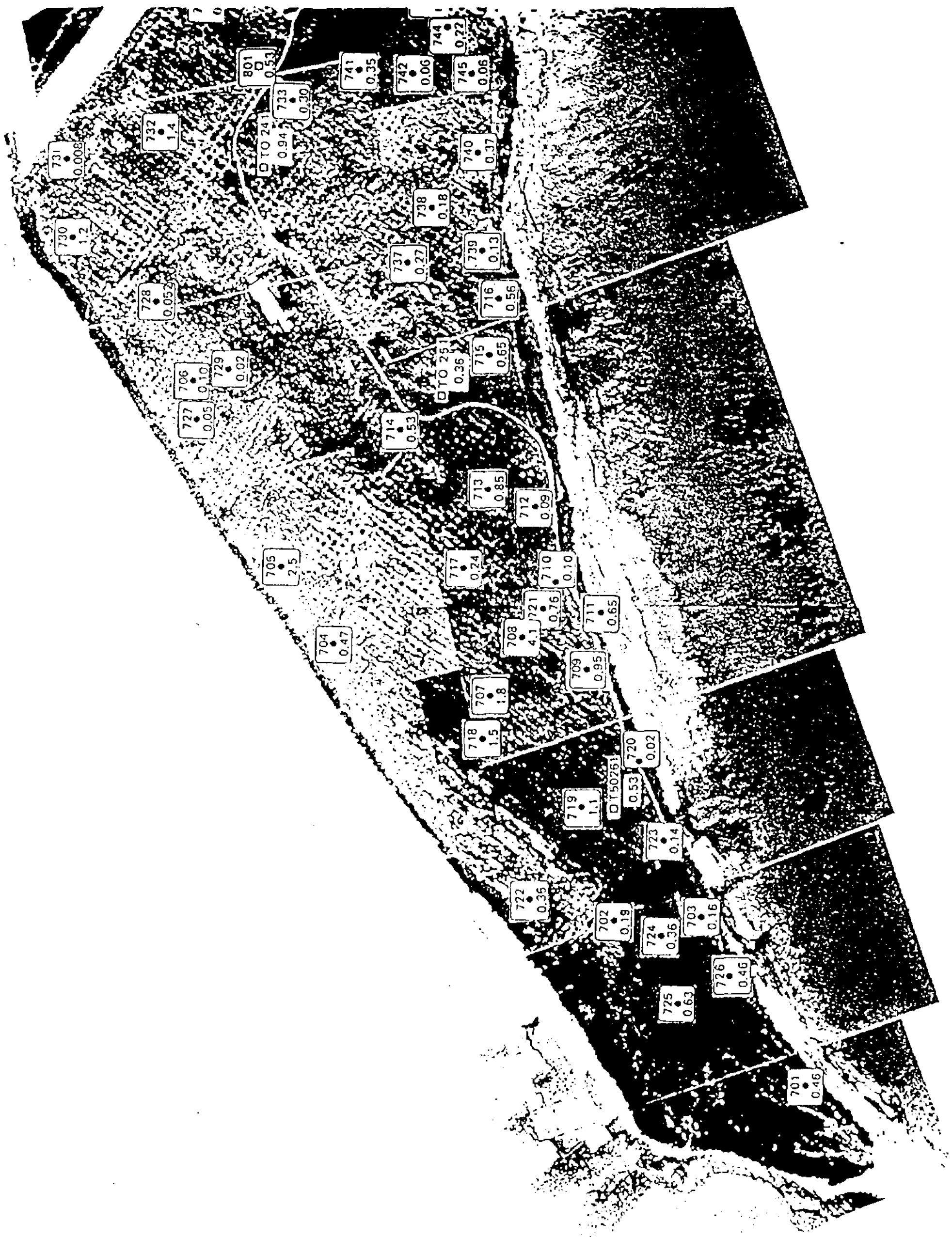

En



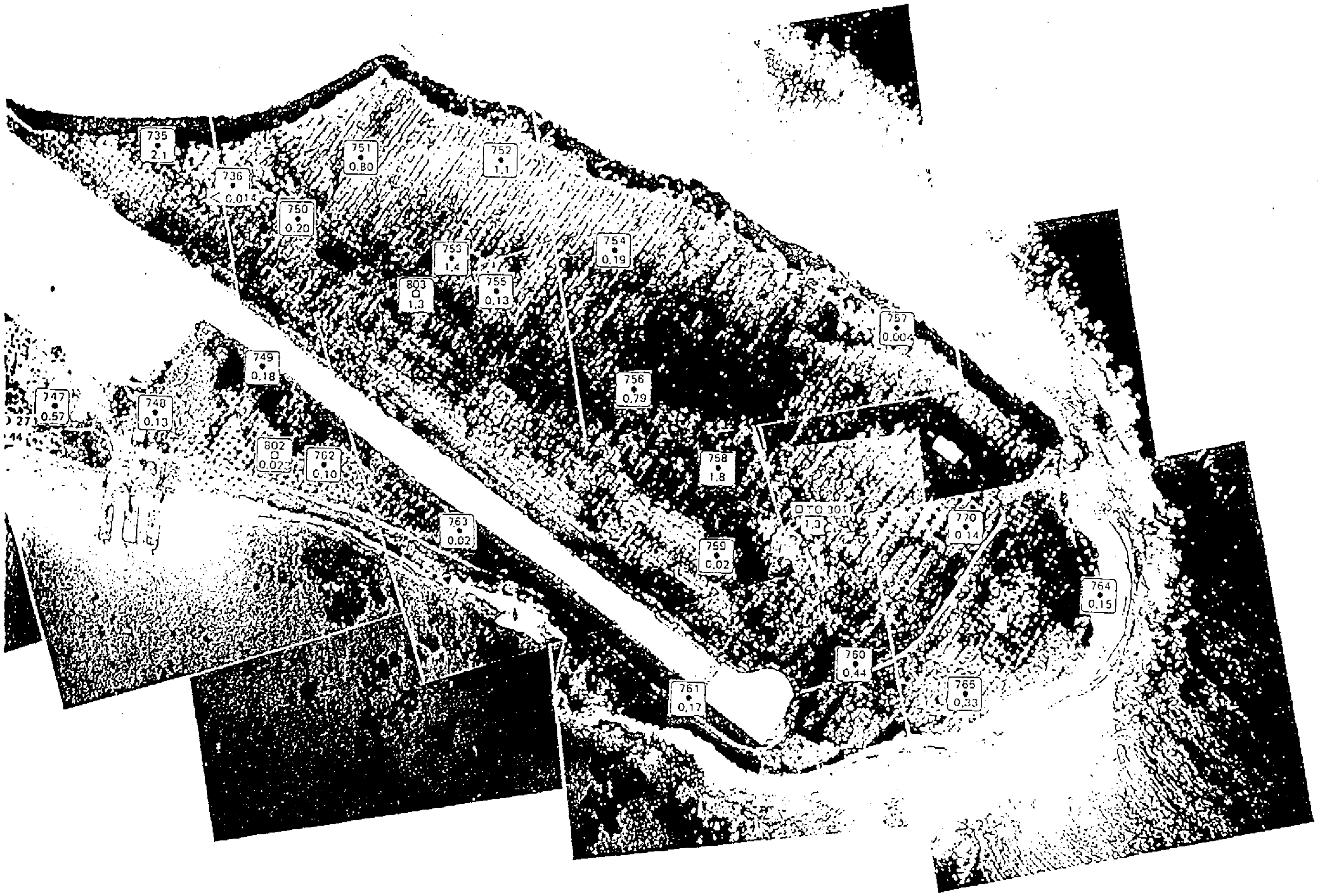
730 1.1
731 0.01
728 0.051
732 1.3
727 0.04
706 0.09
729 0.02
734 0.63
801 0.46
TO 241 0.80
733 0.29
705 2.3
704 0.41
741 0.36
714 0.46
737 0.25
738 0.16
742 0.06
743 0.15
744 0.17
TO 251 0.33
717 0.24
713 0.73
715 0.59
716 0.50
739 0.12
740 0.33
745 0.05
746 0.09
TO 27 0.38
718 1.4
707 1.6
708 3.6
721 0.66
710 0.08
712 0.07
722 0.32
719 1.1
709 0.82
711 0.50
702 0.14
T50261 0.45
720 0.02
724 0.30
723 0.11
725 0.56
703 0.14
726 0.37
701 0.41


Eneu Islan

C-

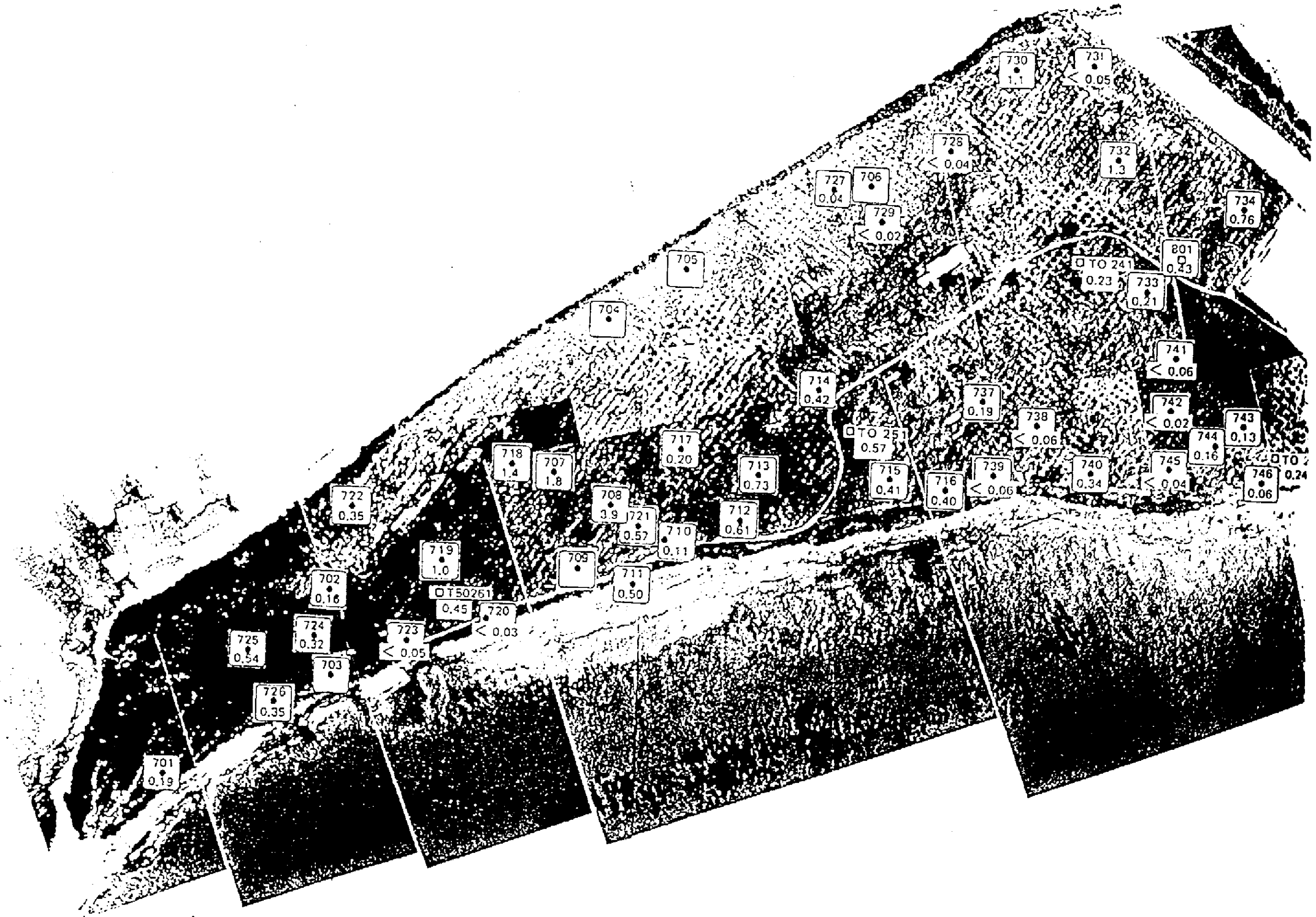

801 0.53
741 0.35
742 0.06
744 0.22
745 0.06
733 0.30
D TO 241 0.94
732 1.4
731 0.008
740 0.37
738 0.18
730 1.2
737 0.22
739 0.13
716 0.95
728 0.052
715 0.65
D TO 251 0.36
729 0.02
706 0.10
727 0.05
714 0.53
713 0.85
712 0.09
705 2.5
711 0.24
710 0.10
721 0.76
717 0.65
704 0.47
708 4.1
709 0.95
707 1.8
718 1.5
720 0.02
719 1.1
723 0.14
722 0.35
702 0.18
724 0.36
703 0.16
726 0.46
725 0.63
701 0.46

5010179


735
2.1
736
< 0.014
751
0.80
752
1.1
750
0.20
753
1.4
754
0.19
803
1.3
755
0.13
757
0.004
749
0.18
756
0.79
747
0.57
748
0.13
802
0.023
762
0.10
758
1.8
TO 301
1.3
770
0.14
763
0.02
759
0.02
764
0.15
760
0.44
765
0.33
761
0.17

...nd, $^{240}Pu$

-13


730 1.1
731 < 0.05
728 < 0.04
732 1.3
727 0.04
706
729 < 0.02
734 0.76
801 0.43
TO 241 0.23
733 0.21
705
704
741 < 0.06
714 0.42
737 0.19
742 < 0.02
743 0.13
738 < 0.06
TO 251 0.57
717 0.20
744 0.16
TO 2 0.24
718 1.4
707 1.8
713 0.73
715 0.41
716 0.40
739 < 0.06
740 0.34
745 < 0.04
746 0.06
722 0.35
708 3.9
721 0.57
712 0.81
710 0.11
719 1.0
709
711 0.50
702 0.16
T50261 0.45
720 < 0.03
725 0.54
724 0.32
723 < 0.05
703
726 0.35
701 0.19

Eneu Isla

C-


735 1.7
736 < 0.02
751 0.66
752 1.2
750 0.19
753 1.3
754 0.13
803 1.1
755 0.14
757 < 0.04
749 0.11
756 0.71
748 < 0.07
802 < 0.04
762 < 0.05
758 1.5
763 < 0.05
759 < 0.05
TO 301 1.0
770 0.11
764 0.19
760 0.30
761 0.21
765 0.30

5010182

UCRL-51879, Part 4

# EVALUATION OF THE RADIOLOGICAL QUALITY OF THE WATER ON BIKINI AND ENEU ISLANDS IN 1975: DOSE ASSESSMENT BASED ON INITIAL SAMPLING


V. E. Noshkin, W. L. Robison,
K. M. Wong, and R. J. Eagle


January 21, 1977


Prepared for U.S. Energy Research & Development Administration under contract No. W-7405-Eng-48



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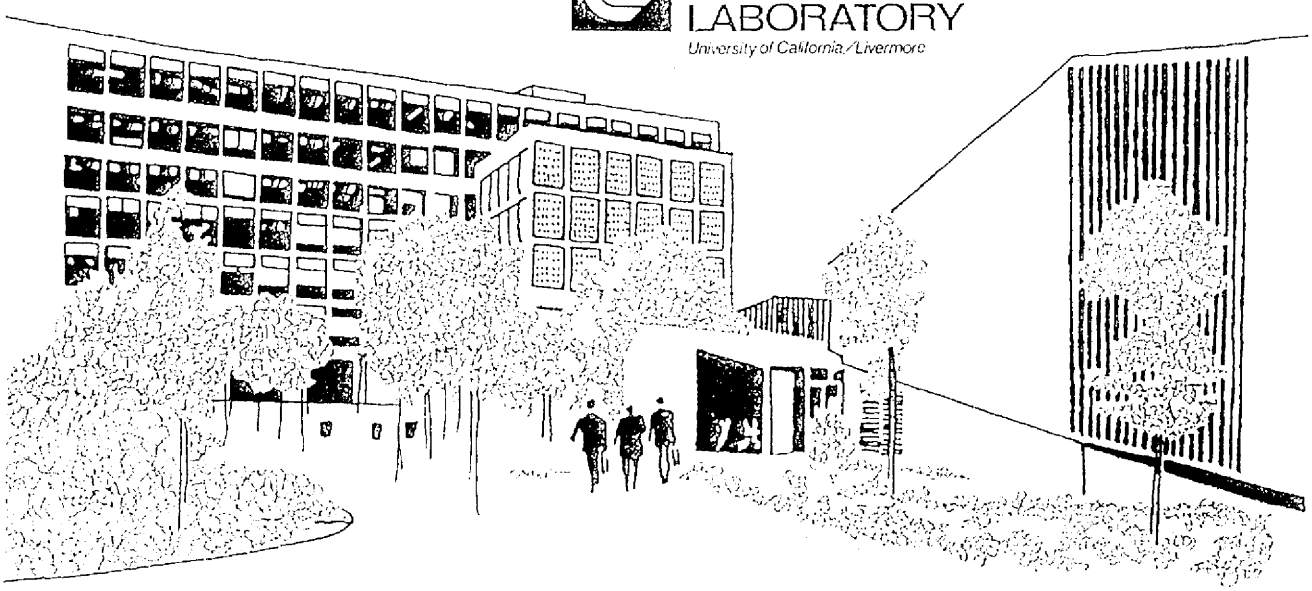

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Available from
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