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Mid-Pacific Research Laboratory

Annual Report
for the period
1 October 1980--30 September 1981

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Patrick L. Colin
John T. Harrison III
February 1982

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University of Hawaii
Office of Research Administration
Honolulu, Hawaii 96822

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ANNUAL REPORT FOR FISCAL YEAR 1981

Introduction

The past fiscal year has seen the completion of field work for some major research projects begun in FY 1980 and the extension of Mid-Pacific Research Laboratory scientific investigations to previously unstudied environments. To cap the scientific activities of the past year, during the summer of 1981 MPRL organized and carried out the Enewetak Submersible Project, which allowed 14 scientists to work at Enewetak using the research submersible Makali'i of the University of Hawaii. The funding obtained for the submersible project also allowed many of these scientists to conduct additional studies using more conventional techniques which otherwise would not have been possible. Research at MPRL during FY 1981 has confirmed suspected errors in a number of assumptions made previously regarding marine environments at Enewetak; thus, certain operational concepts of the atoll ecosystem must be modified.

The year also saw success of MPRL in its "stand-alone" mode of operation and continued good relations with the Enewetak community. It is increasingly evident that the people of Enewetak consider the presence of MPRL the major indicator of radiological safety at Enewetak, as well as evidence of continued good intentions of the United States government. The condition of the laboratory and its ability to meet the needs of visiting researchers was substantially enhanced in preparation for the submersible project.

RESEARCH PROGRAM

Overview

MPRL is tasked by DOE to evaluate biological and physical-chemical processes in the poorly-known sediment bottom communities of the Enewetak lagoon. Dynamic interactions between these communities and their immediate sediment environment are important, because the sediments are the repository for the majority of residual radionuclides from the weapons testing program. Understanding pathways and rates of remobilization and/or burial of these materials is crucial if we are to fairly assess the effects of the program on the environment and on the repatriated island inhabitants.

Due to the intrinsically cryptic lifestyle of sedimentary infauna, studies of their ecology rely heavily on indirect evidence of their activity. The research designed and implemented by MPRL scientists over the past two fiscal years has focused on features of the environment which reflect biological influence as opposed to direct studies of the constituent organisms. This is appropriate, because sedimentary components and processes rather than the individual animals are the critical features of the Enewetak research. It is noteworthy that results garnered from work at Enewetak both elucidate and capitalize on the most unique feature of that ecosystem: its radionuclide inventory. Thus, greater understanding of the ecology of sedimentary infaunal communities is a serendipitious benefit of the evaluation of radionuclide distribution within the sediment column. Our results have the satisfying characteristic of confirming the significance of biological influences upon the physical-chemical elements within the system while posing new questions about the structure and function of atoll ecosystems in general.

RESEARCH PROGRAM

Radionuclide Distribution and Mobilization

In association with Dr. Gary McMurtry of the University of Hawaii, several 7.5 cm diameter sediment cores were taken in the vicinity of the Scaevola ground zero on the lagoon side of Runit Island. The longest core penetrated 2.7 m, and SCUBA divers carefully noted the immediate environment of each core. All cores were taken from heavily bioturbated open sediment areas typical of Callianassid shrimp communities which represent the dominant bottom type found in the Enewetak lagoon below 10 m depth. The cores are by far the deepest quantitative sampling of Enewetak sediments to date, and the presence of significant, often greatly elevated radionuclide concentrations is of utmost significance in assessing radionuclide distribution in the Enewetak marine environment. The locations of these cores are depicted in Figure 1, with bathymetric information and Plutonium 239,240 distributions from the 1973 "Enewetak Radiological Survey" superimposed. Figures 2 and 3 are histograms of overall gamma activity with depth for three cores as determined by NaI counter. These cores have undergone discriminate gamma counting with Co^{60}, Cs^{137} and Bi^{207} being the major gamma-emitting radionuclides present, but plots are not available at present. The sediment depths indicated in Figures 2 and 3 are actual core lengths; in practice, due to core compression, actual penetration of the core barrel averages 30-35% more (a 2.0 m core equals 2.7 m penetration). Alpha track film analysis of 2 cores (5d-2 and 5b-3) reveals the presence of alpha-emitters, almost certainly Pu, throughout the length of the cores (to 1.1 m core length). Alpha emission peak levels differ from those of gamma emission. Peak alpha activity levels were not found in surface

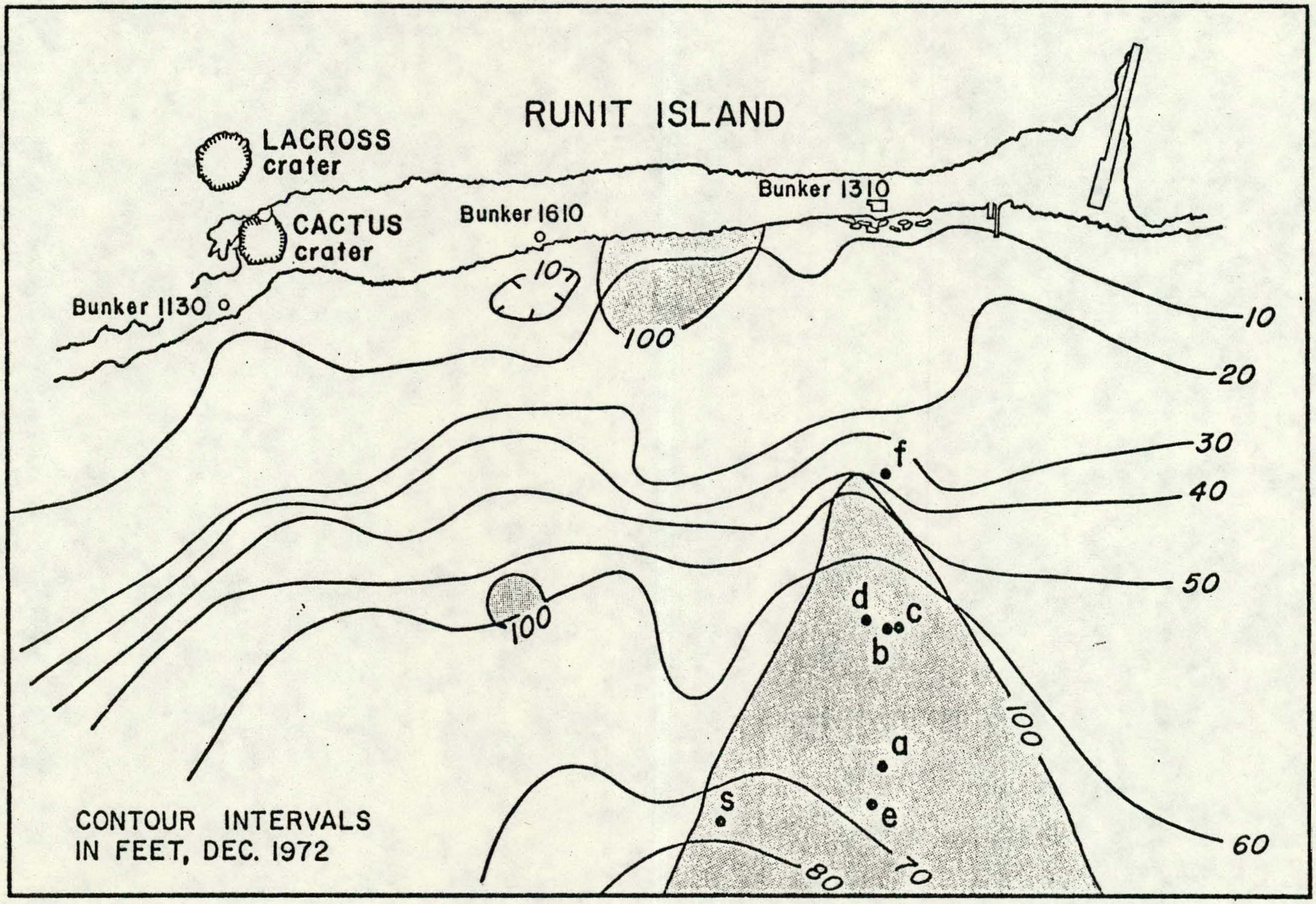


Figure 1. Locations of sediment cores taken on the lagoon side of Runit Isl., Enewetak. Bathymetric lines and Pu 239/240 distribution from Noshkin et al. (1973) Enewetak Radiological Survey, NVOO 140.

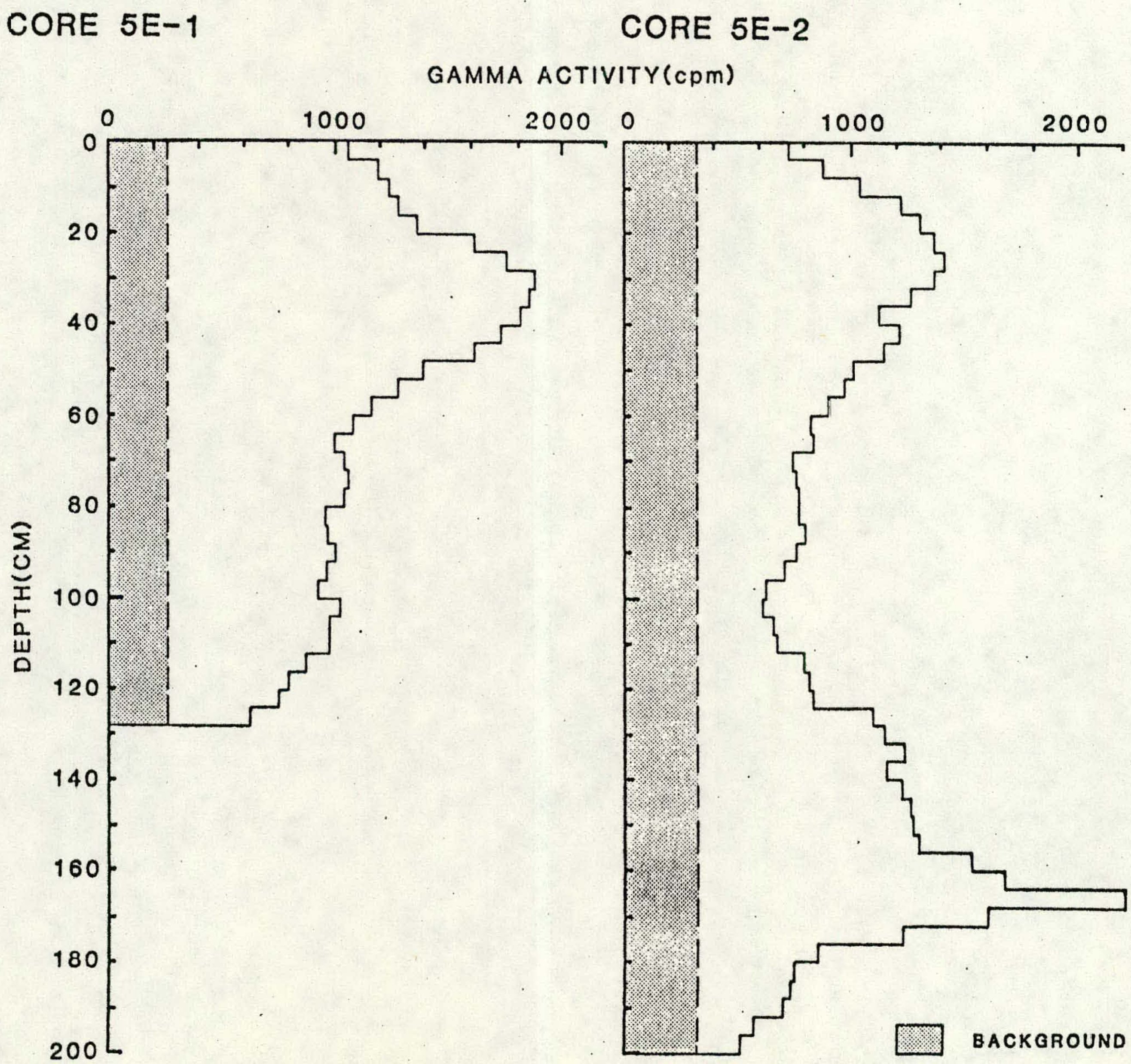


Figure 2. Overall gamma activity of sediment cores from the lagoon side of Runit Island, Enewetak as determined with NaI detectors. Core length is represented as "depth", but does not reflect actual penetration depth of the core barrel.

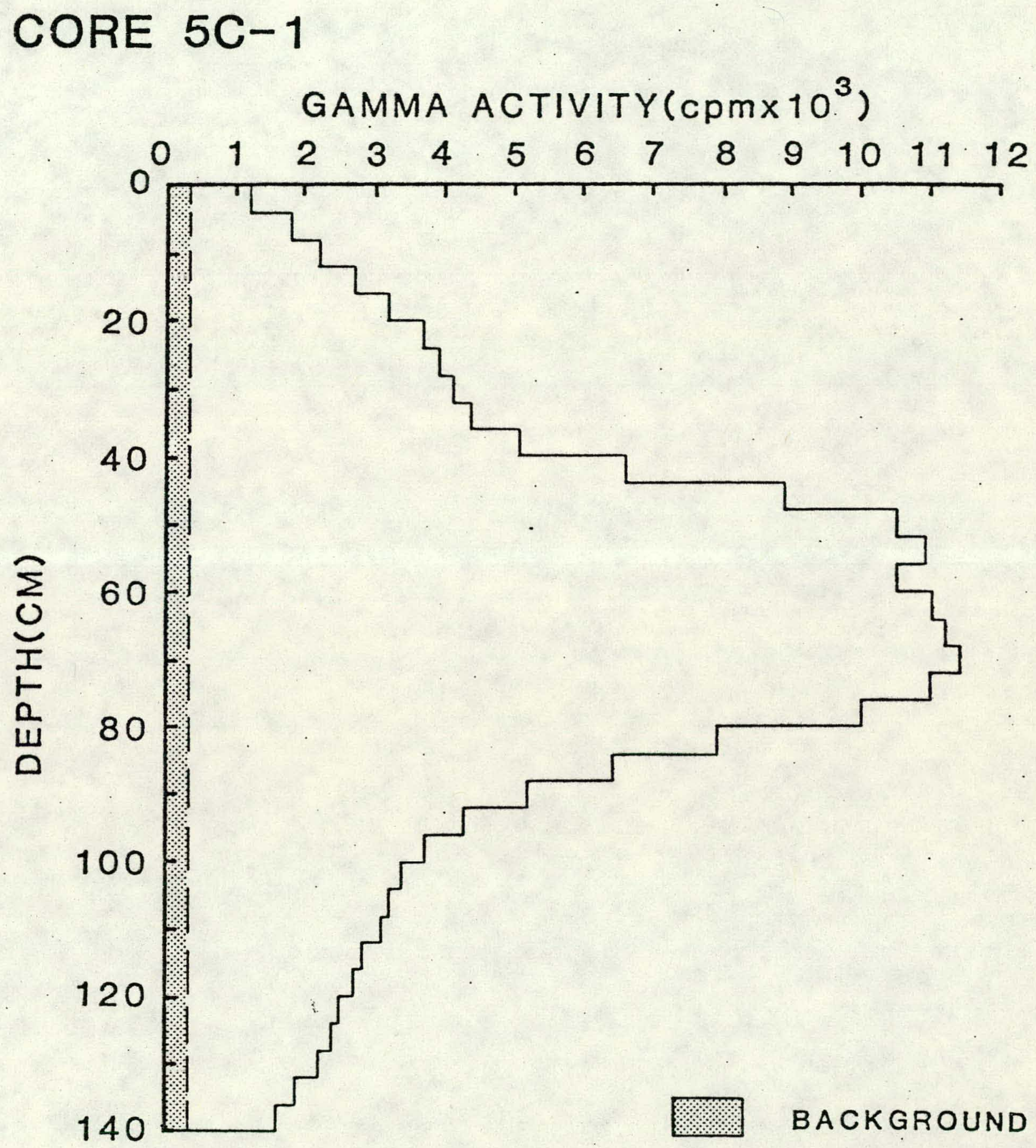


Figure 3. Overall gamma activity of a sediment core from the lagoon side of Runit Island, Enewetak as determined with a NaI detector. Core length is represented as "depth" above, but does not reflect actual penetration depth of the core barrel.

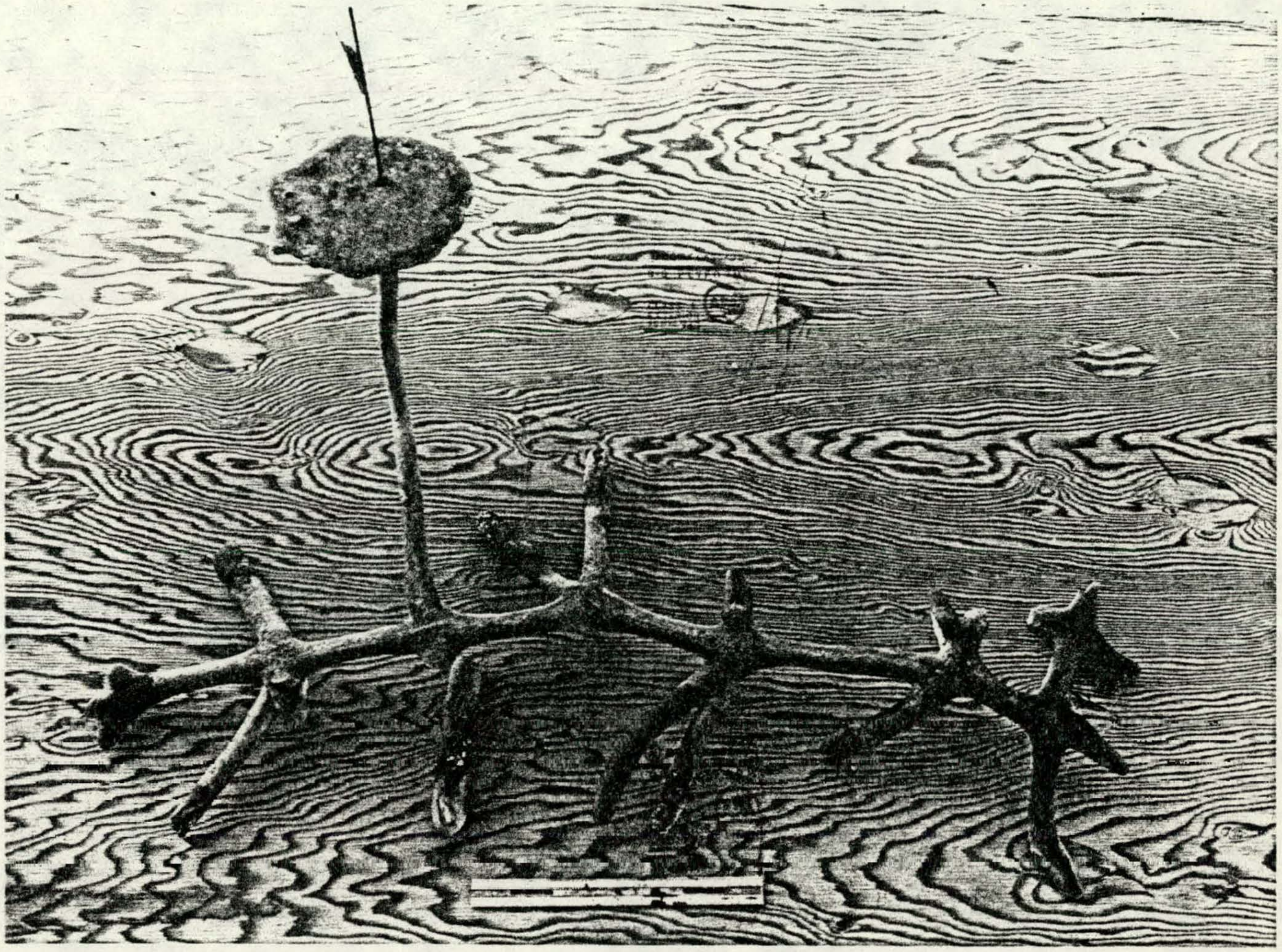


Figure 4. Polyester resin cast of the burrow structure created by Callianassa spp. Cast was collected in 20 meters of water on the lagoon side of Enewetak Island.

sediments; layers 20-110 cm deep showed alpha-track densities 3 to 10 times that of surface sediments.

Existence of activity peaks below surface sediments is consistent with physical models of sediment accumulation rates measured previously (see FY 1980 annual report). However, purely physical-chemical principles cannot account for the disparity of peak depths of gamma activity within cores from nearby areas (areas C and E, figure 1; peak depths as noted in figures 2 and 3). In addition, depth divergence of alpha from gamma peaks is highly suggestive of post-depositional sediment modification. Accordingly, investigations into the complex burrow structure of callianassids in the Enewetak lagoon were stepped up. Working in combination with Dr. Thomas Suchanek of the West Indies Laboratory, St. Croix, polyester resin casts were made of limited sections of burrow systems. Numerous difficulties are encountered in attempting such castings, but the sections obtained give some insight into the extremely complex nature of the systems. One casting, illustrated in Figure 4, shows the large diameter, multi-branched nature of one species' burrow. This casting was limited by the amount of time the resin could penetrate the burrow system before hardening and represents only a small portion of the system. A second casting consisted of two small conical openings that merged and went downward in a single tunnel nearly vertically to a depth exceeding 1.5 m. The casting continued deeper into the sediment but could not be further uncovered with our air lift dredges. The complex nature of these burrow systems has been evident since initial air lift excavation of burrow systems in FY 1980, but until now castings illustrating this complexity have not been obtained.

Burrows such as that illustrated in Fig. 4 are lined with a fine, mud-like material. Samples of burrow linings were subjected to grain size analysis.

The burrow lining material is generally less than 100 microns in diameter with close to one third of the material smaller than 63 microns. This is considerably finer than the surrounding sediment, implying active selection and maintenance of material in the burrow lining.

Additional time-lapse motion picture photography of callianassid burrowing was completed in the past year. The films made in FY 1981 cover about 250 hours of activity, both day and night, in "typical" open sand areas and in Halimeda dominated "meadows". These new films have confirmed the results from the previous year as to the timing of sand/water pumping and sediment production rates at the "volcanos".

The amount of water expelled at the "volcanos" by callianassid pumping was not previous quantified. During FY 1981, a special collector designed to trap both water and suspended particulates was used in a series of experiments on the lagoon side of Runit Island. Due to the intermittent nature of callianassid pumping, extensive sampling was necessary to insure inclusion of a sufficient quantity of active mounds. In addition to the "coarse" sediment produced by the pumping activities, as much as 2.05 l of water and 25 mg sediment per liter were expelled from volcanos in 24 hours. This water contains about 5 times the normal load of suspended particulates found in water immediately overlying the sediment surface and is an order of magnitude above the average for Enewetak lagoon waters. The effluent water and particulates have been cycled deep into the sediments via the callianassid burrow systems and thus have contacted levels of peak concentration of radionuclides. The samples from Runit are presently undergoing radiological analyses.

Considering the entire Enewetak lagoon, it appears that on the order of 10^3 kg of fine sedimentary material is put into suspension by Callianassid activities every day. Since the particulates constitute the major portion of radionuclides in any given water sample, and considering the extremely fine nature of the particulates suspended by Callianassids, this may represent a very significant transport (or loss) of radionuclides in the environment.

Twenty samples of sediment expelled from callianassid mounds, collected using Suchanek buckets, are virtually identical in their size fraction. The callianassid mound sediments are depleted in both larger (above 1 mm) and smaller (below about 75 microns) grain sizes compared to samples taken at some distance from active mounds. Such a thing as a true "unprocessed" sediment sample does not exist at Enewetak since the turn-over rate, particularly for surface sediments, is such that samples should be described in terms of how recently the sediment has been processed. Once returned to the surface various factors act to introduce additional fine and coarse sediment to the surface layers before their next trip into the callianassid processing system.

The amount of sediment expelled by individual "active" callianassid mounds varied between 24 and 2010 gm per day with a mean value of 648 gm per day. Considering a conservative estimate that there is one active callianassid mound per 2 m^2 in the lagoon and that the deep lagoon is 85% covered with sediment bottoms, this is roughly 300-400 gm of sediment expelled per m^2 daily. Considering the entire lagoon, it is estimated that about 2.5 x 10^8 kg of sediment are expelled by callianassids daily based on the distribution and passage rates for mounds.

A second method of estimating sediment overturn, the "addition-subtraction level square", agrees reasonably well with these results. In this case, a 4 m^2 frame of aluminum angle is deployed on a randomly selected area of sediment bottom. A long piece of angle aluminum is used to level the bottom within the frame by making successive passes over the area using the frame as a horizontal, plane surface. Once the area is planed level within the square, the mounds and depressions produced on following days are easily seen and their volumes measured. Thus the total amount of sediment brought up and that disappearing can be measured. Successive experiments indicate that, by volume, about 0.5 l/m^2 of sediment are brought to the surface daily by bioturbational activities. Assuming an overall density of about 1.5 for combined sediment and pore water, roughly 750 gm of sediment are brought to the surface per m^2 per day. This is larger than the estimated 300-400 gm/m^2 determined by expulsion rates of individual callianassid mounds but represents the bioturbational activities of all organisms, not just those of the large mounds. The small bioturbational phenomena greatly outnumber the larger (about 10-20 to 1) but are slightly less extensive in volume or weight. Hence, the figures derived from each method are in relatively close agreement.

Sediment Community Metabolism

Introduction

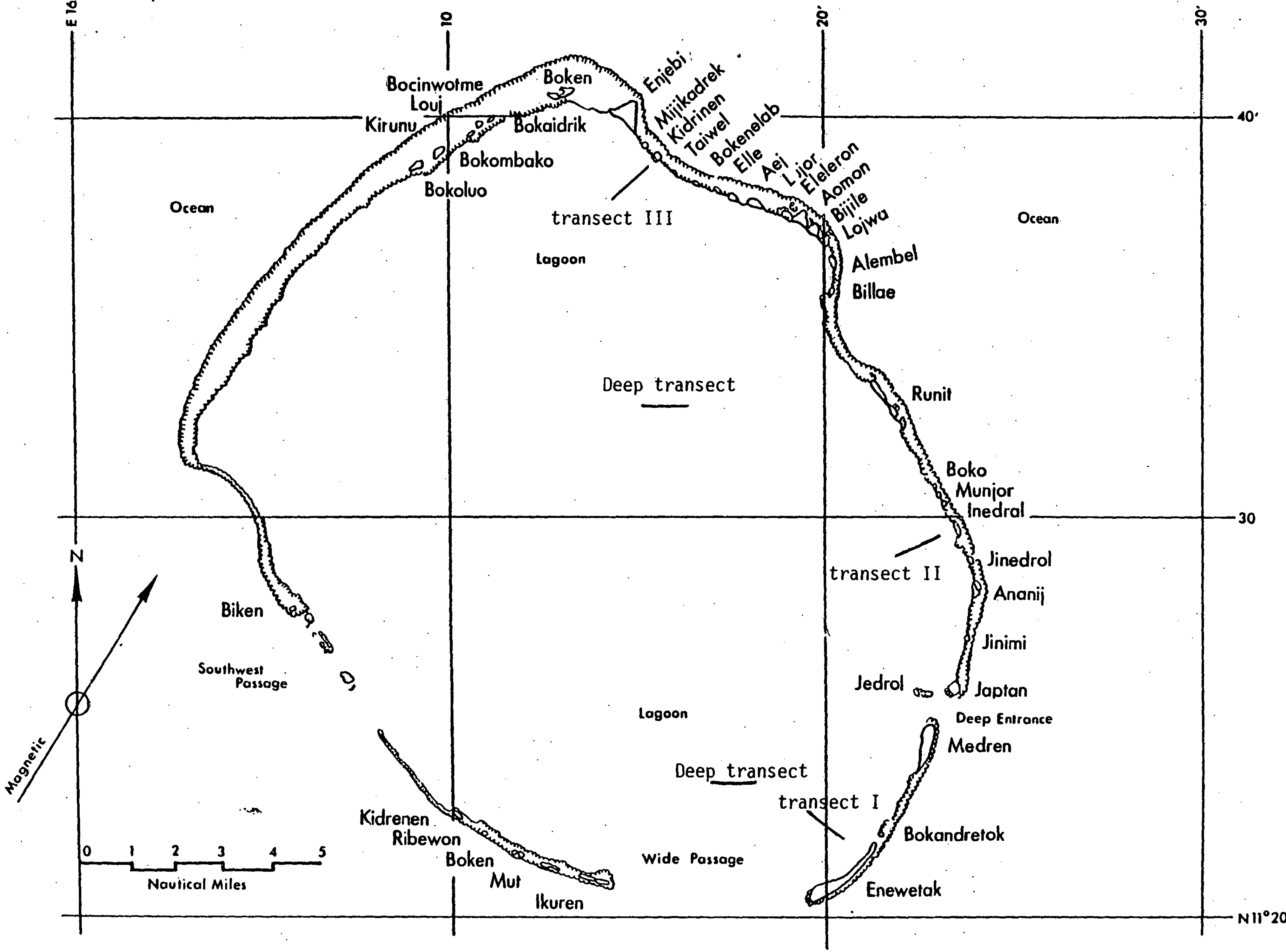
Quantification of bioturbational phenomena bears out preliminary qualitative assessments of sediment reworking suggested by continuing community metabolic studies. The high variability in production, respiration, and nutrient dynamics described in the FY80 Annual Report was attributed to either sediment reworking or to insufficiency of sample size. Accordingly, a comprehensive series of dome incubations was performed over the course of FY81, both to evaluate the relationship between flux variability and sample size, and to further our understanding of sediment community ecology. A total of 75 incubations, each for a minimum of 24 hours, was performed at eleven different locations throughout the Enewetak lagoon. Study sites (Fig. 5) were chosen to evaluate potential spatial variability within the lagoon, with an ultimate goal of establishing whole-ecosystem estimates of community dynamics. Based on results of preliminary studies (see Annual Report, FY80), studies concentrated on two depth zones, 4 and 20 meters, respectively. The former depth is characteristically open sand communities, often with extensive grazing mollusc populations, whereas the latter is a zone of extensive callianassid bioturbation. Concurrent research was performed at each station to establish particle size distribution and near-surface sediment macro-infaunal populations.

Results

Although detailed analyses of results are ongoing, preliminary data reductions have yielded substantial additions to our understanding of sediment community biology at Enewetak. Table I presents mean daily oxygen fluxes for both shallow and deep stations at all lagoon transects. Comparison of net

Figure 5. Sediment metabolic study stations, Enewetak Lagoon.

ENEWETAK ATOLL



values indicates that slight flux differences, both between locations and between depths, are not significant considering inherent variability. Furthermore, net oxygen fluxes are very close to zero, suggesting an overall dynamic balance between production and respiration. There are, however, distinct differences between metabolic elements of the three transects, as shown by production and respiration data in Table II. The mid-lagoon station, transect II (Fig. 5), clearly supports a higher autotrophic as well as heterotrophic biomass at its shallow station than does the other transects. However, differences between deep stations are not similarly significant, despite mean tendencies. There are also no significant differences in dissolved inorganic nutrient fluxes between either transects or stations (Table III). Furthermore, the daily range of dissolved inorganic nitrogen and phosphorus levels is between 2 and 3 orders of magnitude below similar values measured in lagoon sediments of Kaneohe Bay, Oahu, Hawaii. Finally, inherent variability in both oxygen and dissolved inorganic nutrient fluxes is characteristically high (Tables I, II, III) as previously noted. Persistence of high variability despite greatly enlarged sample size provides compelling evidence that the source of variability lies in the environment rather than in the analytic method.

Conclusions

Zero, or near zero net fluxes of oxygen and dissolved inorganic nutrients confirm the distinction between atoll and high-island lagoon sediment ecosystems. In the former, low nutrient or organic input are reflected in communities which are neither sources nor sinks for nutrients and oxygen. Instead, these communities are limited by available energy resources, and they cycle nutrients tightly within themselves. In contrast to high-island

Transect	Depth (m)	Mean O_2 Flux	Standard Deviation
I	7	0.43	0.36
I	20	0.02	0.22
II	8	0.35	0.24
II	17	-0.11	0.23
III	7	0.13	0.34
III	17	-0.09	0.15

Table I. Daily oxygen flux at sediment surface, Enewetak lagoon. Units = mmoles m^{-2} hr^{-1}. Negative sign denotes uptake. n = 8

Transect	Depth (m)	Production			Respiration		
		mean	S.D.	n	mean	S.D.	n
I	7	4.42	1.36	12	0.71	0.37	12
I	20	2.26	0.66	9	0.54	0.34	8
II	8	7.66	2.76	8	1.03	0.24	8
II	17	3.44	1.39	8	0.91	0.29	8
III	7	3.22	0.87	10	0.55	0.23	6
III	17	2.37	0.68	10	0.48	0.09	8

Table II. Hourly gross production, respiration at sediment surface, Enewetak lagoon. Units = mmoles oxygen m^{-2}.

Transect	Depth (m)	PO_4 mean	PO_4 S.D.	n	$NO_2 + NO_3$ mean	$NO_2 + NO_3$ S.D.	n	NH_4 mean	NH_4 S.D.	n
I	7	1.92	8.51	8	0.02	2.59	8	1.27	17.03	8
I	20	-1.41	6.90	8	-0.53	1.30	8	15.60	14.69	8
II	8	1.10	20.82	8	1.30	4.39	8	5.90	11.77	8
II	17	0.79	3.52	8	-0.94	2.67	8	10.42	14.96	8
III	7	75.05	207.03	8	2.68	5.23	8	15.76	25.52	8
III	17	-5.69	9.89	8	0.76	5.65	8	-3.28	17.41	8

Table III. Daily fluxes of dissolved inorganic nutrients from Enewetak lagoon sediments. Units = umoles m^{-2} hr^{-1}. Negative sign denotes uptake.

	Gross Production	Respiration	Net Flux O_2	Net Flux PO_4	Net Flux $NO_2 + NO_3$	Net Flux NH_4
Mean	7.88	2.27	-0.57	-0.29	0.47	3.05
S.D.	3.05	0.63	0.28	0.84	1.64	5.01
n	9	9	12	12	12	12

Table IV. Oxygen and dissolved inorganic nutrient data from *Halimeda* communities, Enewetak lagoon. Depth = 20m.

Units: oxygen = mmoles m^{-2} hr^{-1}. nutrients = umoles m^{-2} hr^{-1}.

lagoon systems, such as Kaneohe Bay, Oahu, Hawaii, atoll lagoon sediments do not represent potential amplification mechanisms for plankton community enrichment. Thus, lower planktonic productivity is reflected in substantially greater lagoon water clarity. Although the net fluxes of oxygen and nutrients from the sediments are very low, the variability is proportionately equal to that of previously studied lagoon systems. As noted earlier, such high variability is characteristic of highly bioturbated sediment systems. Thus, these results agree with previous descriptions of sediment processes at Enewetak. The juxtaposition via sediment reworking of sediment column radionuclides with metabolically active sediment surface communities reveals the potential for heretofore unevaluated biological incorporation of radioactivity at the level of systemic primary productivity.

Additional Metabolic Studies

In addition to work described in the previous section, a series of dome incubations was performed within a *Halimeda*-dominated community at a depth of 20 meters. These communities have been identified as potentially significant contributors to benthic production within the Enewetak lagoon. Accordingly, research was initiated to quantify their metabolic characteristics.

Table IV presents the results of 12 24-hour incubations. In marked contrast to open sediment communities at similar depth and location, the *Halimeda* beds show a significant daily oxygen decrement. Although this is conceptually contradictory to the principle of algal-dominated productive ecosystems, examination of net production and respiration data reveals a substantial elevation of both production and respiration over open sand communities. Thus, the net daily oxygen loss from the community reflects the substantial heterotrophic community which more than balances the autotrophic influence of the *Halimeda*. The high activity of this community is indicated again by the variability, not only of oxygen data, but of nutrient fluxes as well.

One final series of dome emplacements was performed in conjunction with the Enewetak Submersible Project, and results of that series will be discussed in the next section.

Enewetak Submersible Project

During the Enewetak Submersible Project fifty-two dives were made in the deep lagoon and outer reef slopes to a maximum depth of 360 m with the research submersible Makali'i. The dives were about evenly divided between the lagoon and outer reef areas. Participating were scientists from 9 different institutions, including the Defense Nuclear Agency and the Lawrence Livermore National Laboratory. Support for the project was provided by the National Oceanic and Atmospheric Administration, the Defense Nuclear Agency and the U.S. Dept. of Energy.

Submersible activities in the deep lagoon included dome emplacements at depths below SCUBA diving, examination of the large nuclear craters, *in situ* examination of deep lagoon benthic communities, collection of water and particulate samples for radiological analysis, and submersible/SCUBA diver collections for LLNL marine programs. The lagoon dives were limited in depth to the maximum depths of the lagoon (about 65 m), and every effort was made to use the submersible for work impossible with conventional SCUBA diving techniques.

Outer reef submersible dives were used to examine the geologic structure of the outer reef face, its biological communities, and selected aspects of reef growth at extreme depths. Most dives included observational transects to depths of 300-360 m, often leading to detailed work subsequently at 100-200 m depths. Outer face biota were collected with the mechanical arm of the submersible, and over 2000 photographs and over 100 hours of video tape recordings were made. The transcripts from the audio recording system in the sub exceed 250 pages.

It is planned that the results of this project will be presented at a symposium in conjunction with a major national scientific meeting sometime in 1982. A number of important results, however, were apparent at the conclusion of the project and are summarized here.

The bottoms of the large nuclear craters were previously considered lifeless, the finely pulverized coral debris restricting life in their vicinity. This has been found not to be the case. Crater sediments, even at 55 m depth, support large surface populations of irregular sea urchins and very dense populations of buried callianassids. The presence of these dense populations of callianassids reinforces the long standing but disputed viewpoint of MPRL that bioturbation is all pervasive in the Enewetak marine environment and of the utmost importance in the system remobilizing radionuclides to the water column. This finding of the Enewetak Submersible Project emphasizes the need for reevaluation of all data regarding distribution of radionuclides in the sediment and water column.

The submersible was used to conduct four series of sediment metabolic studies at previously inaccessible lagoon depths. The high proportion (80-90%) of the lagoon sediments below depths accessible by SCUBA conveys particular significance to the findings of these incubations in the context of understanding the atoll ecosystem as a whole. Eleven separate incubations were performed, and results of these incubations are summarized in Table V.

As with other sediment communities (Tables I, II, III) daily net fluxes of oxygen and nutrients are near zero. In addition, high variability of dissolved inorganic nutrient fluxes is indicative of extensive bioturbation at these depths. Thus, overall metabolic characteristics of shallow sediment

	Gross Production	Respiration	Net Flux O_2	PO_4	$NO_2 + NO_3$	NH_4
Mean	1.59	0.37	0.06	-1.58	-1.89	-3.00
SD	0.61	0.08	0.08	2.23	1.88	2.27
n	5	4	9	8	8	8

Table V. Oxygen and dissolved inorganic nutrient dta[a] from deep lagoon sediment communities.
Mean depth = 55 m.

Units: oxygen = mmoles m^{-2} hr^{-1}; nutrients = umoles m^{-2} hr^{-1}

communities appears to prevail throughout the lagoon. The major difference between shallow and deep sediment communities lies in rates of production and respiration. Progressive decreases in both production and respiration with increasing depth supports the hypothesis of energy limitation as the determinant of community size.

Dives in other areas of the deep lagoon confirmed the previously hypothesized activity of callianassids and allowed close examination of communities earlier identified by the benthic photography survey of MPRL. The dives confirmed the existence of the Cycloseris coral dominated community on some soft bottoms.

Dives made on the outer reef on both the windward and leeward sides provided the first look ever at this environment. Discoveries included the penetration of large scleractinian coral colonies to depths of over 90 m with significant coral communities occurring in the 60-90 m depth range. Apparent differences in density and diversity of community components between the leeward and windward faces of the atoll were also seen. The presence of macroalgae to almost 145 m depth was unexpected as was the persistence of algal films in good health to depths below 150 m. The abundance of Halimeda, the major constituent of outer reef sediments, was carefully examined at depths of 60-120 m with sizable colonies of the algal genus occurring to unprecedented depths.

The geomorphology of the outer reef face offered some surprises, but was not dramatically different from that encountered in other reef areas of the world at similar depths. The occurrence of distinct "chutes" for sediment transport into deep water was verified, these features appearing as highly polished grooves several meters across on steep limestone faces at 300 m depth.

The slopes of the face below 60 m were somewhat steeper than originally anticipated, seldom being less than 60° and often approaching the vertical. In several cases no distinct interface where the slope of the bottom decreases markedly was found, although such must exist somewhere below the maximum working depth of the sub of 360 m. Significant quantities of sediment were determined to be migrating down the slope; particularly in the area of the wide channel, where an extensive Halimeda sandfall was encountered at 200-300 m depth.

The field photography for the lagoon benthic survey was completed during the FY81. Approximately 2300 photographs of the lagoon bottom were made at 190 stations on a 2 km grid throughout the deep lagoon and cover 55,000 m^2. Preliminary analysis of the photographs using point count techniques for each photograph was completed. This constitutes about 230,000 individual data points throughout the deep lagoon. A very accurate appreciation of the communities occurring in the deep lagoon, their percent coverage, and distribution relative to environmental parameters, is now readily accessible. This overall portrait of deep lagoon communities combined with detailed information obtained with the submersible Makali'i will facilitate modeling of the sediment dynamics of the entire lagoon. The intense bioturbation of the deep lagoon, implied for the entire area from the partial coverage of the lagoon in FY 1980 photography, was confirmed. Detailed analysis of bioturbation site distribution from photographs is presently proceeding, but initial data indicate that processes in the deep (below 30 m) lagoon are identical to those observed in shallower water (10-30 m) by SCUBA diving. This fact will allow the extrapolation of sediment overturn data, vertical fractionation of the sediment column, and sediment/water pumping data to the entire lagoon.

Previously undetected biological communities were encountered at a number of stations in the northern lagoon. Extremely high densities of corals of the genus Cycloceris occur on unattached open sandy substrata. The corals cover large areas (100's of square meters) at densities of 50-100 corals/m^2. They are adapted to life on a soft substratum, possessing the ability to remain above the sediment and to right themselves if turned over, and they occur at depths of 50-60 m. This community was subsequently examined in situ using the Makali'i and additional typical elements (sponges, algae) identified.

Additional Research Activities

MPRL served as sponsor and coordinator for the visit of Dr. Frank Ratty of San Diego State University to Kwajalein and Wake Islands, to collect grasshoppers for examination of chromosomal abnormalities. In his previous work at Enewetak Dr. Ratty had found a high correlation between background radiation levels on islands and chromosomal abnormalities in dividing cells in grasshopper testes. However, lack of a "control" population from an atoll other than Enewetak required that comparative areas be visited. On his trip, Dr. Ratty sampled at Majuro, Kwajalein, Wake and Ponape. Results indicate that no chromosomal abnormalities exist among non-Enewetak populations and that the situation observed at Enewetak is almost certainly due to background radiation levels. Intentions are to extend this work to Bikini in the near future.

MPRL continued its support of research by Dr. Klaus Wyrtki of the Hawaii Institute of Geophysics through the maintenance of the tide gauge. In addition, recording and transmittal of magnetometric recordings to William Sager of the Hawaii Institute of Geophysics provided background readings against which flux variations measured on a University of Hawaii sponsored oceanographic cruise in the Marshall Islands could be compared.

MPRL personnel also performed routine sampling and transmittal of filters and water bottles for the SEAREX Asian Dust Study. This program, headed by Dr. Robert Duce of the University of Rhode Island, has provided extensive data on worldwide circulation of atmospheric contaminants. Monitoring will continue through FY1982.

Personnel

In the past year 10 persons have been employed by MPRL. During this period two research assistants terminated their employment to return to their graduate studies and were replaced. Personnel with dates of employment are as follows:

Helfrich, Philip, Director, full year (non-salaried)

Colin, Patrick L., Senior Scientist, full year

Harrison, John T., III, Research Scientist, full year

Richmond, Robert, Research Assistant, full year (half time)

Frey, Vicki S., Research Assistant, 1 Oct 1980-30 June 1981 (half time)

Boucher, Lisa, Research Assistant, 15 May 1981-present (half time)

Johnson, Scott, Research Assistant, 15 June 1981-present (half time)

Bell, Lori J., Research Assistant, Enewetak Submersible Project,
15 June-30 September 1981 (half time)

Zmarzley, Deborah, Research Assistant, 1 Oct-15 Nov. 1981 (half-time)

Behag, Ted L., Facilities Maintenance, Holmes and Narver, Inc. via MPRL.

Community Service

MPRL continued to be a valuable asset to the entire Enewetak community, assisting with a wide assortment of medical, mechanical, communications, and safety considerations. Space does not allow all this assistance to be recapitulated, but the major events need to be recorded.

MPRL communications link was the sole means of alert for the approach of Typhoon Freda on 12 March 1981 for the entire Enewetak community. When first aware of the serious nature of this storm and its approach to Enewetak on the morning of 12 March, MPRL personnel risked their lives to make a very hazardous trip to Medren to warn the entire school group and teachers that they must return to Enewetak immediately to avoid having to stay at Medren during the storm. The group had gone to Medren early in the morning on an LCM boat in spite of increasing winds and deteriorating weather. Miraculously, everyone was able to return to Enewetak safely, but conditions deteriorated to the extent that the same trip would have been impossible one hour later.

In June 1981 two dri-Enewetak fishermen failed to return triggering a search by MPRL boats for them in the following two days and subsequently an Air-Sea Rescue search coordinated at Enewetak by MPRL. The men were not found, however, until 30 days later when they were sighted and rescued by a Japan-bound freighter 600 miles west of Enewetak.

MPRL provided medical assistance in numerous cases during FY 1981. Several were of such a serious nature that without assistance and supplies provided by MPRL the patients would possibly have died.

Scientific Visitors - FY 1981

The following scientists participated in the Enewetak Submersible Project on the dates indicated:

Couch, Robert, Defense Nuclear Agency, 7/7/81 - 7/21/81;

Devaney, Dennis R., Bishop Museum, Honolulu, 7/7/81 - 7/21/81;

Highsmith, Raymond C., Univ. of Washington, 9/1/81 - 9/29/81;

Hillis-Colinvaux, Llewellya, Ohio State University, 9/1/81 - 9/29/81;

Land, Lynton S., Univ. of Texas, Austin, 9/15/81 - 9/18/81;

McMurtry, Gary S., Univ. of Hawaii, 7/21/81 - 8/3/81;

Randall, John E., Bishop Museum, Honolulu, 7/7/81 - 7/21/81;

Ristvet, Byron R., Defense Nuclear Agency, Albuquerque, 7/7/81 - 7/21/81;
9/15/81 - 9/18/81;

Suchanek, Thomas H., West Indies Laboratory, St. Croix, 8/18/81 - 9/1/81;

Self, Dan T., Univ. of Texas, Austin, 9/1/81 - 9/29/8;

Thresher, Ann, University of Sydney, 8/3/81 - 9/1/81;

Thresher, Ron, University of Sydney, 8/3/81 - 9/1/81;

Wellington, Gerald, Univ. of California, Santa Barbara, 9/1/81 - 9/29/81.

Other Visitors

Foremost among groups visiting Enewetak in FY 1981 was the party of Gen. Harry Griffiths on 7 Jan 1981. As the new Director of the Defense Nuclear Agency, Gen. Griffiths was making an inspection tour of Enewetak to personally view the results of the cleanup efforts. MPRL personnel coordinated logistics on Enewetak, provided boat and land transportation to the party, and briefed the group on MPRL research and activities.

MPRL also provided support for various USDOE programs at Enewetak. In January 1981 logistic support was provided for the Brookhaven National Laboratory whole body counting team while at Enewetak. Support was provided to Lawrence Livermore National Laboratory programs with continued maintenance of the Engebi garden site through MPRL, as well as transportation, lodging, and logistic support for emergency repair of the Engebi automated weather station.

In June 1981 MPRL provided accommodations and support for a Holmes and Narver Inc. crew sent to Enewetak to destroy substandard aircraft fuel remaining in tanks on the island.

Facilities

The facilities of MPRL continued to improve through the summer of 1981. Damage from tropical storm Freda was completely repaired by June, and additions to equipment increased MPRL's ability to work at Enewetak.

The 25 foot twin inboard-outboard boat, the "Yok Yok" was launched and put into service in January 1981. This boat served its purposes well, acting as a fast, all weather platform for trips to the northern lagoon carrying large amounts of equipment. It also served as the prime towing vessel for the 27,000 lb. LRT platform and Makali'i submersible during the summer. Three additional 21 ft Boston Whaler outboard boats were also in service. New outboard engines were purchased for two of these boats, one 140 hp and two 70 hp.

One new housing trailer, previously used for storage, was put into service making three such trailers available at the laboratory site. Modifications were made to the MPRL dormitory to accommodate extra people, raising the number of persons that can be comfortably accommodated at the lab to 20, a number which was actually accommodated during the submersible project.

The major disaster which befell MPRL facilities during FY 1981 was typhoon/tropical storm Freda in March 1981. This storm swept away the middle one third of the MPRL dock, toppled one radio tower at the laboratory, and brought waves over the island at the laboratory which resulted in 2 inches of standing salt water inside the laboratory and deposited a thick layer of coral rubble over the entire grounds of the laboratory. Three weeks were spent by MPRL personnel repairing the dock using timbers and telephone poles brought from other islands. A loading platform was installed on the dock for the first time during this repair and has proven to be a valuable asset in increasing safety during the potentially hazardous loading and unloading of boats.

Additional capital equipment purchases included additions to the MPRL minicomputer purchased the previous year to include floppy disk storage and print out capability. These additions allow the computer system to be used as a word processor and speeded transcription of the audio tapes during the Enewetak Submersible Project. A 15 mm lens for a Nikonos camera was also purchased, allowing distortion-free photos to be taken underwater under the poor visibility conditions often encountered during the sediment bottom work.

After the typhoon of March 1981, the two generators located at the Building 4 complex supporting the TTPI/H&N grove and house maintenance project became inoperative due to water damage. The shops and living units of this complex were connected to the MPRL power system via a buried power cable and transformers at either end of the line and electric service provided at no charge to the TTPI project. This arrangement has persisted throughout the Fiscal Year.

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