Deep Seabed Mining

Report To Congress

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
December 1987

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary
National Oceanic and Atmospheric Administration
Washington, D.C. 20230

DEC 30 1987

Honorable George H. Bush
President of the Senate
Washington, D.C. 20510

Dear Mr. President:

I am pleased to submit the Deep Seabed Mining Report of the National Oceanic and Atmospheric Administration to the Congress in compliance with Section 309 of the Deep Seabed Hard Mineral Resources Act (P.L. 96-283).

Sincerely,

J. Curtis Mack, II

Enclosure

THE DEPUTY ADMINISTRATOR

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary
National Oceanic and Atmospheric Administration
Washington, D.C. 20230

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Honorable Jim Wright
Speaker of the House of Representatives
Washington, D.C. 20515

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Deep Seabed Mining

Report To Congress

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Ocean Minerals and Energy Division
1825 Connecticut Avenue, N.W.
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December 1987

U.S. DEPARTMENT OF COMMERCE
C. William Verity, Secretary

National Oceanic and Atmospheric Administration
J. Curtis Mack, II, Assistant Secretary

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EXECUTIVE SUMMARY

The National Oceanic and Atmospheric Administration (NOAA) activities related to the implementation of the Deep Seabed Hard Mineral Resources Act (Pub. L. 96-283, the Act) in fiscal years 1986 and 1987 are described in this fourth report to the Congress. The effort has included the revision of two of the four exploration licenses issued by NOAA in 1984 and the development and issuance of proposed regulations for future commercial recovery operations under a NOAA permit. Research in support of future regulatory decisions was conducted. International negotiations authorized by the Act were also conducted.

Activities conducted by the licensees during the second and third years of their licenses involved primarily the exchange of exploration data with other consortia as a result of the private agreements resolving site conflicts. The evaluation, analysis, and integration of these data into the licensees' existing data bases continued.

NOAA also has been proceeding with the development of proposed commercial recovery regulations. Proposed and supplemental proposed regulations were issued in 1986 and 1987, respectively. Final regulations are expected to be issued in 1988.

Research is continuing into the environmental and mineral resources aspects of deep seabed mining. These efforts have begun to focus primarily on potential benthic impacts from such operations.

Consultations among the United States, Belgium, Canada, the Federal Republic of Germany, Italy, the Netherlands, the United Kingdom, and the USSR produced an arrangement for identifying any remaining deep seabed mine site overlaps, and for allowing them to be resolved between the affected parties. All remaining site overlaps were resolved in 1987. Agreements have been signed among the above governments to implement the settlements reached. NOAA is continuing to consult with other mining nations to establish a network for exchange of information on environmental research efforts and regulatory measures to protect the environment.

CHAPTER I

INTRODUCTION

Purpose and Scope

This fourth biennial report to the Congress, submitted pursuant to Section 309 of the Deep Seabed Hard Mineral Resources Act, describes deep seabed mining activities conducted by the National Oceanic and Atmospheric Administration during fiscal years 1986 and 1987.

This chapter contains an overview of the nature of the resource and the status of industrial activities. The domestic aspects of implementing the Act, including activities under the exploration licenses, are addressed in Chapter II, while international aspects are summarized in Chapter III.

Activities included in this report relate to: activities under four exploration licenses, including the revision of two of the licenses; research in support of future regulatory decisions; the development and issuance of proposed regulations for future commercial recovery operations under NOAA permits; and international negotiations under the Act.

Activities reportable under the Act but not yet having occurred include: permit issuance and denial, environmental damage from mining activities, and civil and criminal proceedings.

The Resource

Manganese nodules are small, irregular, potato-shaped concretions of manganese and iron minerals that are found on the bottom of many of the world's oceans and lakes. They were first discovered during the 1873-76 oceanographic voyage of the HMS CHALLENGER but remained scientific curiosities until their value as potential mineral resources was realized in

the late 1950's. Although 79 elements have been identified in Pacific Ocean nodules, only four are of strategic and economic importance: manganese, copper, nickel, and cobalt. In spite of the worldwide occurrence of nodules, their population density on the seafloor and the concentrations of the value metals are highly variable. Main commercial interest therefore focused on an area in the east-central Pacific Ocean (Figure 1) that contains a higher concentration of high-grade nodules than other surveyed areas. The nodules in this area have a high average percentage of the value metals, especially nickel (approximately 1.3 percent nickel, 1.1 percent copper, 0.2 percent cobalt, 25 percent manganese). This 13 million km^2 area--commonly known as the Clarion-Clipperton Fracture Zone--was the subject of NOAA's 5-Year Deep Ocean Mining Environmental Study (DOMES) and so is also referred to as the DOMES area. The DOMES study formed the basis for many of the scientific findings in NOAA's Deep Seabed Mining Final Programmatic Environmental Impact Statement (September 1981). The DOMES area has been estimated to contain from 3.6 to 13.5 billion metric tons (dry weight) of nodules--an apparently enormous resource for the future.

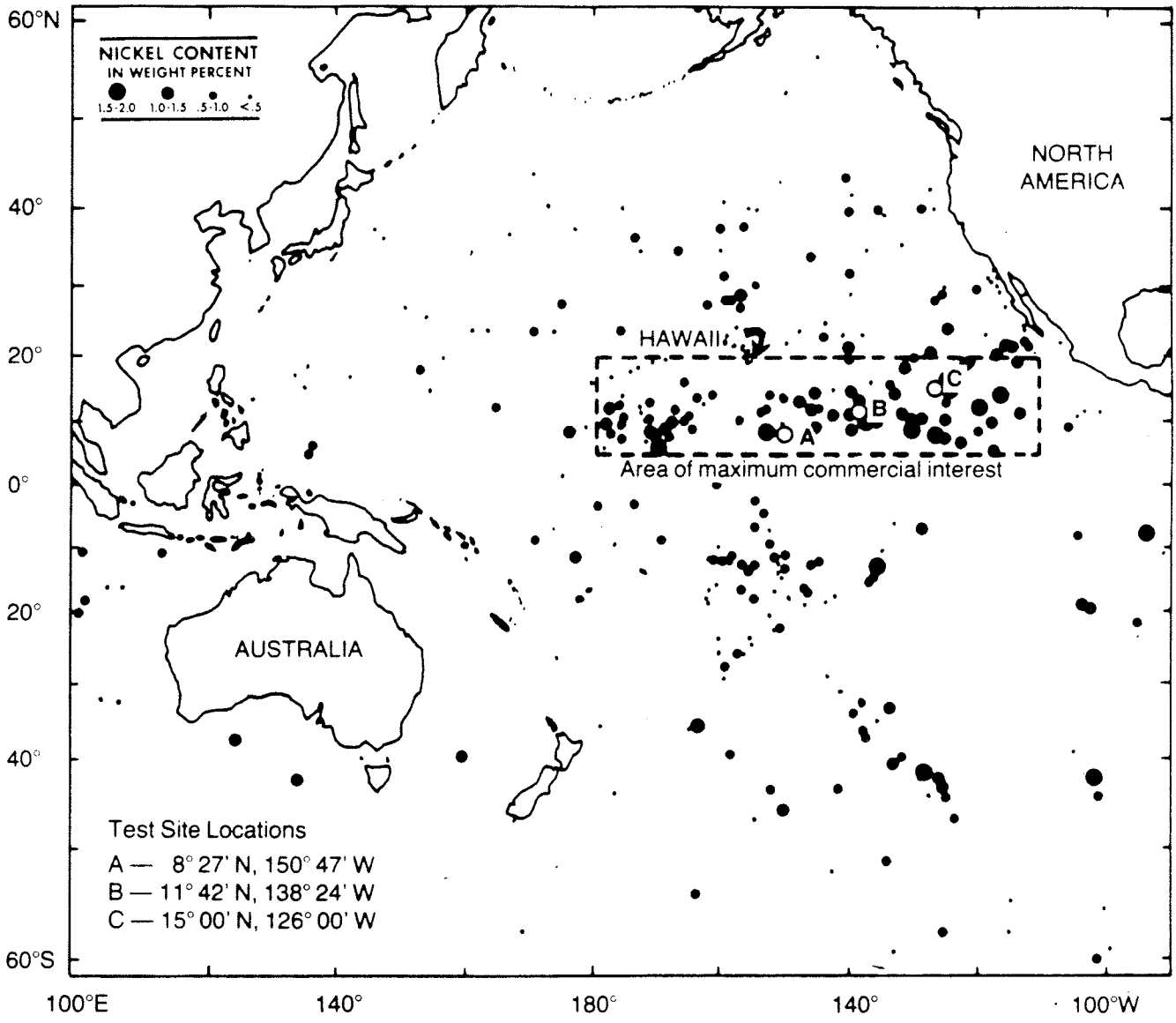

Figure 1 --Area of manganese nodule maximum commercial interest and high nickel concentration in nodules with DOMES test site locations (Horn, Horn, and DeLach, 1972).

The National Interest

The United States is dependent on foreign sources for two of the strategic metals found in manganese nodules: cobalt and manganese. Cobalt, which we import primarily from Zaire and Zambia, is used for the high-temperature alloys necessary in the aerospace industry. Manganese, imported primarily from Australia, Brazil, and South Africa (which has been projected as our major source in 10 to 20 years), is required in the steel industry. Nickel, used mainly in stainless steel and other high temperature steel alloys, is supplied by Australia and Canada. Copper, in which the U.S. is nearly self-sufficient, is used mainly in electrical equipment.

Dependence on foreign sources of metals can lead to uncertainties in supply ranging from cost instability to supply disruption. In addition to the possibility of political instability, foreign producers may retain more of their domestic output as they acquire their own capability to manufacture finished products. Also, as the sources of supply become more restricted, the ability of the mines to meet world demand can become a factor in determining both supply and price.

The establishment of a domestic deep seabed manganese nodule mining industry would provide the United States with: (a) a stable supply of strategic metals important to the economy at competitive prices, (b) a reduced annual balance of payments deficit, (c) increased investment in a basic industry, (d) regional employment benefits, and (e) continued leadership in new ocean technologies.

The presently depressed level of world metal markets has dimmed prospects for commercial mining in the near term. Nevertheless, nodule

mining appears to be competitive with new sources of these metals and so must remain an option for United States industry in the decades ahead.

Mining Consortia

The domestic deep seabed mining industry presently includes four multinational private sector consortia with U.S. members (Table 1) which were issued exploration licenses by NOAA in 1984. The United Kingdom and the Federal Republic of Germany each have also issued licenses, for additional areas under their own respective domestic seabed mining legislation, to one of these multinational consortia. There are also two national private sector consortia presently developing their own deep seabed mining capabilities: the French consortium GEMENOD, and the Japanese consortium, Deep Ocean Resource Development Company (DORDCO). The Federal Republic of Germany also issued one license to the wholly-German consortium AMR. In addition to these seven consortia, each of which has been involved in the complete spectrum of nodule mining research and development activities, exploration has been conducted by India, the USSR and the Republic of Korea.

Overview of Industrial Activity

Exploration activities by U.S. entities prior to the issuance of a license were allowable for those who had been engaged in exploration prior to enactment of the Act.

Table 1. Deep seabed mining consortia involving United States firms and parent companies, including dates of consortia formation, as set forth in applications filed with NOAA in February 1982, and subsequently amended, showing NOAA license identification.

Nation	USA-1 Ocean Minerals Company (OMCO) (11/77)	USA-2 Ocean Management Inc. (OMI) (5/75)	USA-3 Ocean Mining Associates (OMA) (10/74)	USA-4 Kennecott Consortium (KCON) (1/74)
United States	Cyprus Minerals Co. (Cyprus Mining Co.) 50% Lockheed Missiles & Space Co., Inc. (Lockheed Corp.) 37.528% Lockheed Systems, Co., Inc. (Lockheed Corp.) 12.472%	Schlumberger Technology Corp. 24.94%	Essex Minerals Co. (U.S. Steel) 25% Sun Ocean Ventures Inc. (Sun Co.) 25%	Kennecott Corp. (a U.S. corporation owned by Sohio/BP) 40%
Belgium			Union Seas, Inc. a U.S. corporation (Union Miniere) 25%	
Canada		INCO, Ltd. 25.02%		Noranda Exploration, Inc., a U.S. corporation 12% (Noranda Mines Ltd.)
Italy			Samim Ocean Inc., U.S. corporation (ENI/Italy) 25%	
Japan		Deep Ocean Mining Co., Ltd. (DOMCO-19 Japanese Companies) 25.02%		Mitsubishi Corp. 12%
United Kingdom				R.T.Z. Deep Sea Mining Enterprises, Ltd. (Rio Tinto-Zinc) 12% Consolidated Gold Fields, PLC 12% BP Petroleum Dev., Ltd. 12% (British Petroleum)
West Germany		AMR 25.02% (Preussag A.G., Salzgitter A.G., Metallgesellschaft A.G.)		

All of the NOAA-licensed consortia had already conducted extensive seafloor studies, as well as at-sea technology testing, as long ago as the early 1960's, so all license activities are designed to augment what they already know. License activities presently consist primarily of the analysis of exploration data received from other consortia as a result of the resolution of overlapping claims.

Although further mining system tests may be authorized under the license, no additional tests are presently planned by the licensees.

A discussion of specific activities conducted by each licensee over the last two years is presented in Chapter II.

Technology Presently Contemplated for Mining

The first generation mining technologies under consideration by the United States consortia are all hydraulic type systems. Hydraulic systems - using either submerged centrifugal pumps or air lift systems - will recover nodules in a seawater slurry and pump them through a pipeline from a seafloor collector to a mining ship on the ocean surface. The hydraulic collector likely will sweep the bottom in nearly adjacent swaths; each swath may be up to 20 meters (65 feet) wide. One consortium's collector will be self-propelled. The other collectors probably will be towed across the seafloor by the mine ship. Both types of systems have been tested by the consortia and monitored by NOAA.

In addition to the nodules, bottom water, sediment, and some macerated benthos will be drawn into the collector. Most of this extraneous material will be ejected at the seafloor; however, some of this material will be transported up the pipeline and, after separation from the nodules, discharged at the sea surface. The two activities, ejection near the seafloor

and sea surface discharge, are the twin perturbations toward which NOAA has addressed most of its environmental effects research. Direct collector contact, while having an environmental impact, will affect a relatively small area and is unavoidable if nodules are to be mined.

CHAPTER II

DOMESTIC ASPECTS OF IMPLEMENTING THE DEEP SEABED HARD MINERAL RESOURCES ACT

Exploration License Activities

In 1984, NOAA issued exploration licenses to four mining consortia:

USA-1 -- to Ocean Minerals Company (OMCO)

USA-2 -- to Ocean Management, Inc. (OMI)

USA-3 -- to Ocean Mining Associates (OMA)

USA-4 -- to Kennecott Consortium (KCON)

These actions followed the resolution of originally overlapping site applications by the above consortia and the French and Japanese consortia. Part of their overlap settlement agreement led to the exchange of extensive exploration data pertaining to relinquished areas. All four consortia are now authorized to conduct exploration activities in their respective areas for the 10 year duration of the license (Figure 2).

The terms, conditions and restrictions (TCRs) issued with each license require the licensee to pursue exploration activities in accordance with its approved exploration plan. In order to show that it is following its exploration plan and achieving the major objective of exploration, the ability to apply for a commercial recovery permit by the end of the 10 year license period, each licensee must submit an annual report to NOAA within 90 days of each anniversary date of the license. Annual reports have been received each year from OMCO, OMA, OMI and KCON.

The information included in the annual reports indicates that in spite of the continued depressed mineral markets and a general reduction

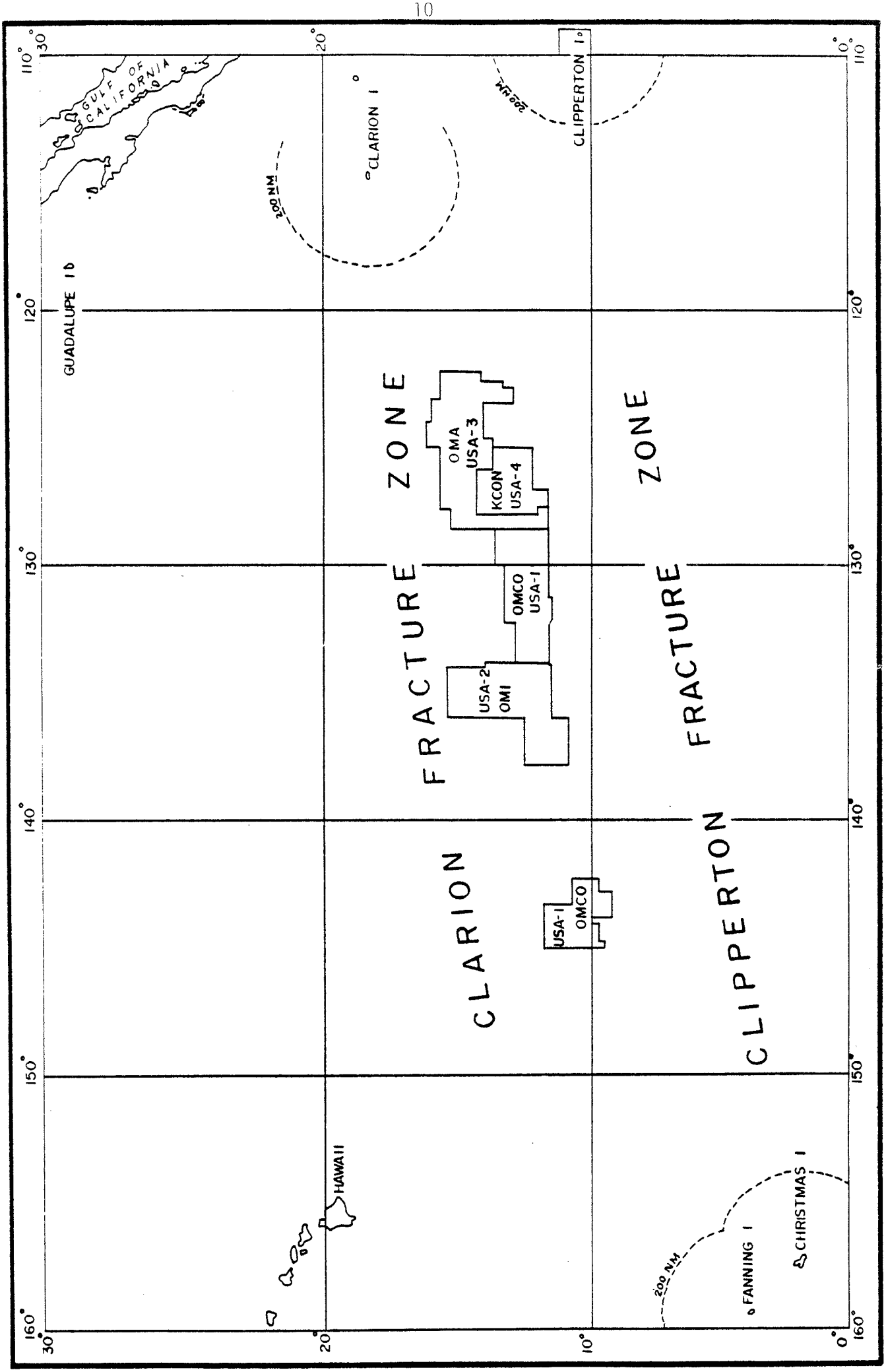

Figure 2. Location of NOAA Licensees' exploration sites, as of September 30, 1987, showing NOAA license identification.

in all staff levels, the NOAA licensees have been diligent in each license year in pursuing the activities authorized under NOAA licenses and the accompanying TCRs. Activities and expenditures were explained in a manner which demonstrates to NOAA the evolving ability of each licensee to apply for a commercial recovery permit by the end of the 10-year license period.

All licensees were involved in the process of negotiating settlements to mine site overlaps involving the USSR (see Chapter III). Actual overlaps existed with respect to licenses USA-1, -2 and -3. The consortia holding those licenses were heavily involved in technical evaluations, discussions and negotiations, as outlined below. As a result of the successful settlements, holders of USA-1, -2 and -3 have applied to NOAA to amend their licenses to reflect the resultant boundary changes.

° USA-1 -- Ocean Minerals Company (OMCO)

During its two reporting periods between August 29, 1985 and August 31, 1987, OMCO's license efforts consisted primarily of the following activities: 1) completing the exchange and clarification of exploration data received from other consortia as a result of the conflict settlement agreements; 2) computer processing and analysis of the exploration data; 3) developing an improved data management and computer processing capability for efficient processing and display of OMCO and other data; 4) attending and participating in governmental, academic, and industry sponsored technical meetings on marine mineral resources, ocean mining technology, and environmental issues; and 5) concluding negotiations with the USSR on settlement of overlapping mine site claims.

The exploration data received by OMCO for its license area includes several thousand ore grade and abundance analyses, hundreds of ore pulp samples, thousands of miles of ship's tracklines and acoustic data records, hundreds of miles of seafloor photographic and video coverage, plus various other data pertaining to hardware, techniques, and methods used during exploration. Additional effort was required on the part of OMCO in requesting data identified as missing from these data sets and resolving questions regarding the data received. For example, OMCO had to request additional information about the equipment and methods used to gather data and samples and the absence or significance of annotations in the data records and shipboard logs. A report was prepared to summarize the various types of data received and to document the equipment and methods used in collecting it.

OMCO's efforts at analyzing these data were focused on the development of an improved computer processing system for managing and processing the data and the evaluation and integration of the data into OMCO's existing data base. For example, ore chemistry analyses were compared with the results of OMCO analyses. Estimates of true nodule abundance were made from weighed abundance values received from other consortia using test tank data obtained with the OMCO sampler. These estimates show how sampled seafloor abundance varies with both the true abundance and the size of the nodules sampled. From the ore chemistry analyses and the calculated abundance values OMCO is able to estimate mineral reserves in their license area.

Weather and environmental data stored on magnetic tape were transferred to OMCO's newer PC-based system.

A successful series of negotiations was held with the USSR to negotiate a settlement of overlapping mine claims. OMCO performed significant data processing and analysis during its claim boundary overlap evaluations and negotiations. Data for the portion of the OMCO area relinquished to the USSR was forwarded to them.

A set of versatile statistical and plotting programs were developed for use on OMCO's microcomputer. These programs will be used for searching, retrieving, merging and displaying bathymetric, ore grade, abundance and other parameters in plots of various scales.

OMCO's navigational data base was upgraded by evaluating the acoustic and ship trackline data received from the other consortia and merging these new data with existing data sets. A complete set of ship's trackline data for OMCO and other consortia cruises was then generated. Trackline charts of the license area will be used for identification of areas needing future analysis.

All abundance and ore grade data received in data exchanges were sorted by 1/2 degree grid blocks.

OMCO camera run photographs of the seafloor were examined for megafauna identity and abundance in cooperation with a benthic biologist under contract to NOAA. Seafloor photographs received by OMCO from AFERNOD were inventoried by OMCO and a preliminary assessment was made by the biologist of their value for describing epibenthic communities in the license area. Position data for tow camera and Epaulard vehicle photographs were modified to a standard format and entered into OMCO computer files.

Additions were made to the OMCO program documentation volumes. These additions include a summary of all OMCO data, samples, and equipment storage and an inventory log of engineering data stored offsite.

OMCO continued to follow technological developments in oceanographic survey equipment through attending and participating in technical conferences and reviewing the technical literature.

Changes were made in the partnership members comprising Ocean Minerals Company. Through internal reorganization Cyprus Minerals Company replaced AMOCO Ocean Minerals Company (U.S.), and two Netherlands partners (Billiton and Royal Boskalis) withdrew (See Table 1).

° USA-2 -- Ocean Management, Inc. (OMI)

During its two reporting periods within the dates from August 30, 1985 through August 29, 1987, OMI's license activities were focused primarily on the reviewing and processing of exploration data received from other consortia as a result of the conflict resolution agreements. Negotiations were also held with the USSR to settle the conflict resulting from overlapping claim areas. OMI also updated its High Speed Exploration System and continued to review the scientific literature pertaining to deepsea exploration and mining operations.

Because of the data received during conflict resolution, OMI revised its planning and submitted to NOAA an application for amendment of its exploration plan. After a review of the proposed revision and the opportunity for public review and comment, NOAA approved the changes as a license revision. The revision resulted in two principal changes in the exploration plan. A two-stage approach was adopted where "prime areas", identified with available data, are selected and intensively explored.

Subsequent exploration of non-prime areas would then be conducted to establish a resource base adequate for a commercial minesite. The detailed evaluation of those aspects of the non-prime areas which are not essential to OMI's determination of the feasibility of commercial mining and site selection will be postponed until the permit phase. The amount of at-sea exploration is reduced from 310 days to a maximum of 180 days. No additional at-sea testing of new survey systems is planned. No change is proposed in the objective of filing for a commercial recovery permit within the ten-year license period.

The exploration data received by OMI from other consortia as a result of conflict resolution include: dredge samples; data from grab samples; box cores, free-fall cores, and piston cores; ship protocols; data on magnetic tape and computer printouts; and photographs and videotape coverage of the seafloor.

OMI's data analysis efforts were focused on converting the exchange data to OMI standards in order to prepare a proper feed base for computer processing. OMI data and exchange data were compiled for each square degree within OMI's license area. With the complete integration of the exchange data within the OMI data base, information is now available for a total of 2,536 qualitatively comparable sampling stations within the license area. This information consists of sample identification, geographical coordinates, metal contents (manganese, iron, copper, cobalt, nickel), and nodule abundance. Additional data from the published literature will also eventually be added to the station data. An assessment was made to determine the potential economic value of the license area and to identify areas for future exploration.

OMI continues to collect and review both patent and scientific domestic and foreign literature on ocean mining, on marine exploration and research equipment, and on scientific cruises of various universities. All pertinent information about OMI's license area is being incorporated into its data base.

A comprehensive bibliography relating to literature on manganese nodules is being compiled and stored as a computerized data bank. This literature data base is being established mainly for the purpose of future planning of specific environmental research in the license area.

Exploration and prospecting equipment developed by one of the partners of OMI is being reviewed for possible use in manganese nodule exploration. One applicable instrument is an electrohydraulic grab with an underwater television camera which can be used for both visual observation and sampling of the seafloor. Another is a combination of instruments called the Ocean Floor Observation System. This system includes a TV and photocamera. It also includes instrumentation to obtain water samples and to measure and transmit data on water temperature, pressure, and distance to the seafloor.

OMI's High Speed Exploration System (HSES), which had been developed and successfully tested during an early stage of OMI exploration, is being refurbished for applications beyond the scope of its original use. OMI is working to improve the reliability of the system, to replace outdated or malfunctioning components, to reduce its size and weight for use on various types of ships, and to streamline the data processing involved in the operation of the system. OMI plans to deploy the HSES in 1988 during a scientific cruise with the West German research vessel "SONNE".

Considerable effort was expended in seeking to confirm the existence of any overlap between OMI's licensed site and sites for which other parties may be seeking exploration rights under the 1982 United Nations Law of the Sea Convention. Numerous discussions and consultations were held with representatives of various governments to seek a means for identifying any overlap between the unpublished areas claimed by third parties and OMI's area.

A conflict was identified when it was learned that overlaps existed between the OMI site and the area for which the USSR was seeking rights under the Law of the Sea Convention. Lengthy negotiations involving OMI, the USSR, NOAA, the Department of State, all U.S. licensees, and the governments of Canada, Belgium, Italy, the Netherlands, the Federal Republic of Germany, and the United Kingdom resulted in a successful resolution of the conflict. During the negotiations, OMI was required to perform extensive analyses of its exploration data in assessing the size and value of the areas in conflict. Some data were provided to the USSR during negotiations. OMI is presently negotiating with the USSR for a more complete mutual exchange of data.

° USA-3 -- Ocean Mining Associates (OMA)

During its two reporting periods from September 1, 1985 until August 31, 1987, OMA's license efforts consisted primarily of the following activities: 1) continuing analysis of data and samples collected in prior years by Deepsea Ventures, Inc. (OMA's service contractor) or obtained from the public domain or as a result of conflict resolution; 2) identification of an interim preservational/impact reference area to be designated by OMA in consultation with NOAA; 3) settlement of area conflicts between OMA and

the USSR; 4) related activities involving permitting and the communication and public notice of OMA rights to give notice to potentially conflicting claimants; and 5) monitoring of mineral markets and associated economic, technical, legal and political developments.

There were no significant changes in the approved exploration plan and no at-sea activities were conducted in the license area. OMA navigational devices do however remain deployed in the area.

OMA continued to collate and analyze the data collected by Deepsea Ventures, Inc. or obtained from other consortia as a result of conflict resolution. These data include nodule abundance and ore grade determinations from free-fall grab samples; bathymetric data; video and still photos of the seafloor; sub-bottom profile records; weather observations; data from box cores; megafauna collection records; miscellaneous data on nodule size, distribution, and mineralogy; and sediment characteristics. The results of the analyses were added to the OMA data base to produce detailed assessments of license area topography, nodule abundance and assay and tropical storm/hurricane frequencies. These assessments were then used to delineate potential mining blocks (mineable areas within which a mining vessel can operate without having to adjust pipe length to accommodate topographic changes) to evaluate strategies for settlement negotiations with the USSR, and to identify the interim preservational/impact reference area proposed by OMA.

OMA developed computer generated geostatistical models for nodule abundance and assay for the four metals of primary interest (manganese, cobalt, nickel, and copper). Additional computer statistical techniques were then used to calculate in-situ tonnages and relative metal values

within various mining block sizes. OMA can now confidently derive candidate first and second generation mining blocks which can be confirmed in the future with a minimum of at-sea exploration.

Specifications are being developed for the next generation exploration systems which will be needed later in the license phase to collect the data necessary for selecting optimal mining strategies within each mining block. These data include maximum slopes, obstacle occurrences, and minimum runs and turning radiuses for the collector. OMA is also staying current on exploration and navigation systems development.

New conceptual designs were developed for systems for exploring for other types of deep seabed minerals. One design was for a survey system which can continuously measure hard mineral crust thickness together with associated microtopography. Another design was for a corer which can collect a large undisturbed sample of hard minerals along with associated substrate.

A statistical analysis of tropical storm and hurricane tracks was performed to show the probability of frequency, location, and month by month occurrences of these storms in OMA's license area. These statistical data are now being used to design a commercial mining plan that will enable mining operations to be efficiently shifted between sub-areas during periods when storms are predicted, identified and tracked.

The continuing analysis of their resource and environmental data enabled OMA to identify an area which they feel is sufficiently characteristic of a nodule mining environment to be designated as an interim preservational/ impact reference area. This area of approximately 6,520 square kilometers lies entirely within OMA's license area. OMA's extensive data in this

area -- including SEA BEAM bathymetry; still photographs of the seafloor; dredge, boomerang grab, and box core samples; and nodule assays -- reportedly show it to be characteristic of the mining environment within their site and the contiguous license areas. OMA plans to consult with NOAA on this subject and to familiarize NOAA with the data available in the area.

OMA, in cooperation with the U.S. Department of Commerce and State, engaged in extensive discussions with representatives of the government of the USSR concerning the settlement of mine site overlaps which arose between OMA and the USSR. A settlement was reached and set forth in certain agreements dated August 14, 1987 that included associated understandings between and/or among the governments of the United States, the USSR, Italy, Belgium, Canada, the United Kingdom, the Federal Republic of Germany, and the Netherlands.

Although NOAA published the geographical coordinates of the license areas in the Federal Register in 1984, OMA has continued to assert its rights and widely publish its own coordinates in appropriate fora and media in order to identify and resolve any further potential conflicts with those rights.

Work continued on the OMA multi-volume internal report (Consolidation/ Documentation of OMA License Area Legal Documents).

OMA also gathered additional data needed to update and refine its Venture Analysis to reflect current and projected cost and market factors. OMA actively monitored the following fields which it considers important to the furtherance of its program: 1) metals supply/demand and market prices; 2) competitor costing; 3) marine biology and environmental

research; 4) marine and process engineering; 5) naval architecture; 6) mineral assessment geostatistics; 7) marine hard minerals technology; 8) deepsea and EEZ seabed exploration; 9) weather statistics; 10) alternative energy availability and cost; 11) technology "classification" and export control issues; and 12) legislative, regulatory and diplomatic developments.

OMA personnel continued to present professional papers and make presentations and other formal commentary related to marine hard mineral mining. Appropriate conferences and symposia were also attended.

° USA-4 -- Kennecott Consortium (KCON)

KCON received its exploration license on October 29, 1984, therefore its annual report to NOAA is not due until January. KCON's activities described here are based on its second annual report received in January 1987 as well as information supplied with a subsequent request to modify its exploration plan. In its license application, KCON stated that its specific objective during exploration was to determine if sufficient area exists having the characteristics that would permit at least 20 years of mining at a rate that would yield 40,000 mt per year of nickel. Its proposed activities involve remote sensing for the purposes of detecting bathymetric features and estimating the variability of obstacles and of nodule abundance.

The majority of KCON's effort since issuance of the license has been spent in assembling and evaluating the volumes of data received from other consortia during conflict resolution. For example, data on bathymetry and on nodule grade and abundance, as well as detailed information from seafloor photos and videotapes, have all been assembled into a common data base computer file. All obstacle and microtopography data have been tabulated.

Following the establishment of the data base, KCON's main objectives became to: 1) use the bathymetric data to produce maps of the seafloor and use these maps as guides in a production plan and in an engineering design review; 2) make summaries of the obstacles as needed for the engineering design review; 3) complete the engineering review of both obstacles and topography and determine what effect the new data would have on design and production; and 4) revise the production schedule/mine plan.

The maps of the seafloor were used specifically to: 1) define areas that are too rough to mine and therefore must be deleted from the mineral inventory; and 2) locate the boundaries of areas that can be mined without making a change in the length of the lift pipe.

Maps showing the size and location of obstacles are important because of the effect obstacles can have on mining operations. Obstacles can stress or damage the collector and result in increased repair time and lower production. An engineering design review was conducted utilizing all the data in the data base. The review concluded that the seafloor topography was generally not as severe as KCON had originally anticipated. The new data also indicated that other mine site factors such as average nodule abundance and frequency of obstacles remain as anticipated.

KCON updated an economic study that it had originally conducted in 1979. The original mine planning/production schedule was revised using the recently acquired and analyzed data.

Because of the acquisition and evaluation of the new exploration data and the results of KCON's previous exploration and development work, KCON feels that there is no longer any need to collect the bathymetric/

topographic data it originally thought necessary. On September 4, 1987 KCON applied to NOAA for a modification in its exploration plan to reflect the effects of the data acquisition and analysis, and to change the schedule of expenditures. No change is proposed in KCON's objective of being prepared to file for a commercial recovery permit by the end of their ten-year license period. NOAA has determined that this request constitutes an application for revision of the license and has commenced public review procedures.

Development of Proposed Commercial Recovery Regulations

Following the exploration activities under an exploration license, the second phase in the development of a deep seabed mine site will involve the issuance of a commercial recovery permit. Although commercial mining is not expected to be achieved in the near term, NOAA recognizes that the Act allows commercial recovery after January 1, 1988, and recognizes the need for the consortia to be able to proceed with their efforts toward developing a commercial recovery capability. In light of the decisions that industry will need to make with respect to the future commitment of significant new levels of resources to further technology development, NOAA has been proceeding with the development of commercial recovery regulations. U.S. companies will thus be in a better position to assess and plan for the complete legal framework under which they would operate.

Proposed regulations were published for public comment in July 1986. After review of the public comments, NOAA considered modifications of portions of the regulations. Because several of the proposed modifications were sufficiently different than the original proposals and of sufficient

public interest, additional opportunity for public comment was provided. Supplemental proposed regulations were issued in September 1987; final regulations are expected to be issued in 1988.

Environmental Impact Studies

As a result of NOAA's monitoring of industry at-sea mining tests during the Deep Ocean Mining Environmental Study (DOMES), NOAA's Programmatic Environmental Impact Statement (PEIS, September 1981) was able to determine that most of the original environmental impact concerns have a very low probability of causing a significant adverse environmental impact. Other concerns, however, either appear to be certain to cause a negative impact, although of unknown significance, or were unresolved at the time. In addition, because the tests were only pilot-scale and of short duration, NOAA also emphasized that it was essential for the PEIS findings to be validated through additional research and during monitoring of industry mining system endurance tests. Although no further at-sea systems tests have occurred since the publication of the PEIS and none of the consortia presently plans to conduct further test mining under its license, NOAA continues to sponsor research directed at important remaining environmental issues that have not been adequately resolved and that can be examined prior to testing.

The action of the nodule collector as it moves along the seafloor will cause environmental impacts through destruction of the benthos in its path and through the creation of a plume of fine-grained sediment. This plume may bury the smaller benthic animals and dilute their food supply at distances away from the mine site. Research aimed at obtaining a better understanding of the significance of these impacts is continuing to be the highest priority for NOAA's deep seabed mining research program.

The following discussion summarizes environmental research funded by NOAA in FY 1986 and 1987, all of which has focused on the benthic impacts issue.

° Analysis continued on samples acquired in 1983 when NOAA began a research effort directed at examining benthic recolonization at DOMES Site C, where Ocean Mining Associates conducted test mining in 1978 (monitored by NOAA during the DOMES project). Scientists from Scripps Institution of Oceanography, in cooperation with Deepsea Ventures, Inc., surveyed the site in 1983 and obtained box cores in an area directly adjacent to the test mining tracts and from an area some distance away thought to be unaffected by the mining plume. These two sets of samples were analyzed for both macrofauna and meiofauna to determine if there is any significant faunal difference between them. As reported earlier, results subsequently showed no significant differences between samples expected to have been affected by the plume and those samples thought not to be impacted. Although there are several explanations for this result, one possibility is that the mining test did not cause sufficient changes in the benthic community of the test area to be detected at the scale of the sampling program 5 years later.

Additional taxonomic analysis was recently completed on these same samples for an order of macrofaunal crustaceans (tanaidea) that was not analyzed initially. This study provides data on the identities and abundances of these benthic organisms and also provides a comparative analysis of their community structure with the same macrofauna from DOMES Site A. The new data suggest that the manganese nodule province may not be

faunally homogeneous over its entire extent. If true, this could influence the nature of monitoring of future mining operations.

° A workshop was held at Scripps Institution of Oceanography in 1986 to define a strategy for continuing the controlled impact experiment, recommended by the National Research Council in 1982 as top priority for understanding benthic impacts.

Specific research projects recommended at the workshop that are presently being conducted within the study include seven elements:

1) Engineering design studies to determine possible mechanical systems for emplacing sediment of varying thickness on the seafloor;

2) Examining the feasibility of using gold adsorption and activation as a technique to label deepsea sediments. This technique would provide a means of tracing and quantifying the sediments redeposited on the seafloor during the experiment to simulate the effects of the benthic plume. An earlier study used hydrodynamically equivalent glass microbeads as tracers to quantify the amount of redeposited sediment;

3) Developing statistical techniques and models that incorporate what is known about deepsea biological communities for purposes of designing a sampling strategy that will be needed to detect a given level of change in the fauna resulting from the experiment. A workshop was held in 1987 to discuss the numerical indices currently in use to describe biological community structure and the use of the indices in evaluating the effects of disturbance on deepsea communities;

4) An experiment was conducted in 1987 in the Santa Catalina Basin to determine the amount of sediment cover that will result in complete mortality of the benthic community exposed to resedimentation.

In the experiment, a remote underwater manipulator was used to place four box cores on the seafloor, treat them with known amounts of sediment, and later recover them for examination for acute mortality effects. A final report for this experiment is in preparation;

5) Preparation of a document reviewing the literature and the present status of deep-sea biology. The purpose of this paper is to familiarize the non-specialist with the unique properties of the deep sea, the adaptations of the organisms living there, and the reasons for the concern about the effects of disturbances on these communities;

6) Taxonomic analysis of box core samples collected during DOMES cruises. One project is examining polychaete worms; another is examining the crustaceans. These data will add to our knowledge of benthic fauna identities and abundances in the Clarion-Clipperton Fracture Zone and thus to our ability to detect impacts; and,

7) A data base and annotated bibliography for the biology and general oceanography of the Clarion-Clipperton Fracture Zone is being developed for NOAA. This computer accessible data base contains citations for published literature on the deep-sea biology and the physical, chemical and geological oceanography of the eastern tropical Pacific Ocean. This data base will provide a better understanding of the environment and overall ecology of this area where commercial mining will likely occur.

° NOAA is funding a study to analyze for megafauna presence and abundance the seafloor photographs and video films taken by Ocean Minerals Company in their license area. These films were originally taken by the consortium to define areas of high nodule abundance. A similar study of the video films taken by OMA was recently completed for NOAA.

° A recently completed study has shed some light on an apparent paradox involving the settling of fine particles in the water column. Most of the deep seabed mining environmental impact concerns are associated with the sediment plumes discussed above. Most of the concerns deal with the presence of the fine particles in the plumes and their fate and effects. Monitoring of the 1978 mining tests showed that the particles in the surface plume settled faster than had been predicted. On the other hand, more recent laboratory studies suggested slower settling particles. Slower settling would mean that plumes would spread out more and have the potential to impact larger areas.

It is now known that the process of settling of fine particles in the open ocean is speeded by their interaction with large particles of rapidly settling organic matter called marine snow. NOAA's benthic plume model was modified to take this factor into account, along with new information on concentration dependent settling velocities and the structure of velocity and turbulence in the benthic boundary layer.

The resultant model, now a numerical model, shows that the previous estimates of the character of the benthic plume (as described in NOAA's 1981 Programmatic EIS) are reasonable.

Mineral Resource Studies

Mineral resource studies during 1986 and 1987 were as follows.

° NOAA assisted Washington State University (WSU) in establishing a permanent archive for its collection of manganese nodules, photographs, maps, analytical data, and reports accumulated during years of laboratory and at-sea research on manganese nodules. While the collection contains thousands of nodules from more than 250 surveyed sites in the Pacific,

Atlantic, and Indian Oceans, most of the nodules were collected in the North Pacific Ocean during DOMES when a WSU geologist was a Principal Investigator for NOAA. The goal of this project was to organize, label and index the nodule collection for efficient use for future research by scientists and display for the public.

° A comprehensive data base and bibliography on marine mineral deposits is being developed by NOAA's National Geophysical Data Center (NGDC). This on-going effort is meant to provide up-to-date data on the formation, world-wide occurrence, grade and abundance of manganese nodules, phosphorites, polymetallic sulfides, and marine placers.

° A study is being conducted which will provide NOAA with information and economic analytical tools for determining whether a permittee has intent to selectively mine (high-grade) and prematurely abandon a commercial recovery area. This information will enable NOAA to develop terms, conditions, and restrictions to incorporate into a commercial recovery permit that will ensure the prevention of waste and the future opportunity for the recovery of the unrecovered balance of the resource.

Continuing Activities

NOAA anticipates that in the future licensees will be submitting other applications for revisions to their licenses. Subsequent revisions may be similar to the initial ones (to the OMCO, OMI and KCON licenses) and will involve adjustments to exploration plans made on the basis of exchanged information and improved technology. In addition, NOAA will continue to receive reports annually on the progress licensees have made toward completing their ability to apply for commercial recovery permits by the end of their license terms. These submissions will be reviewed by NOAA

for adherence to regulatory requirements and consistency with exploration plans. During the license period, it is also expected that licensees will consult on permit application requirements which NOAA will refine as more information becomes available from the licensees and NOAA-funded research programs. Although it is highly unlikely, mining equipment tests could be conducted during the latter period of the licenses. This would require substantial NOAA preparation (e.g., supplemental site-specific environmental impact statements) and oversight in order to monitor technology performance and environmental effects.

The other main thrust of NOAA's seabed mining program, which can be conducted independently of industry's schedules, will be the conduct of generic research pursuant to Section 109(a) of the Act. This research will establish a foundation for future regulatory decisions by providing: 1) an improved understanding of the deep sea environment, 2) a better assessment of potential environmental effects from mining, and 3) foundation for a cost-effective environmental monitoring program for industry implementation. This program will complement NOAA's DOMES by concentrating on the impact on the benthic environment where relatively little effort had been directed in the past and where an impact will occur. NOAA's research will continue to focus on the potential severity of this impact to the deep sea environment.

CHAPTER III

INTERNATIONAL ASPECTS OF IMPLEMENTING THE DEEP SEABED HARD MINERAL RESOURCES ACT

In 1984 negotiations were concluded that produced an agreement among the United States, Belgium, the Federal Republic of Germany (FRG), France, Italy, Japan, the Netherlands and the United Kingdom (UK) to avoid deep seabed mine site conflicts and to maintain consultations on seabed mining matters of mutual interest. Pursuant to Section 118 of the Act, upon the recommendation of the Secretary of State, NOAA subsequently designated the FRG, France, Italy, Japan and the UK--those parties to the agreement with domestic seabed mining laws--as reciprocating states.

In 1986 consultations among the United States, Belgium, Canada, the FRG, Italy, the Netherlands, the UK and the USSR produced an arrangement for identifying any remaining deep seabed mine site overlaps, and for allowing them to be resolved between the affected operating entities. U.S. licensees therefore participated actively in the process. In the summer of 1987 technical settlements were reached in all instances, thus resolving all remaining site overlaps. In August agreements then were signed among the above governments to implement these settlements. The affected U.S. licensees have applied to NOAA to amend their mine sites accordingly.

During fiscal years 1986 and 1987, NOAA also continued to provide environmental information from its research efforts to other seabed mining nations. In addition, NOAA participated in joint meetings and otherwise

consulted with persons in those countries on research efforts which are relevant to seabed mining. In this vein, NOAA also continued its role as the chair of the marine mining panel of the United States-Japan Cooperative Program in Natural Resources.