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Chapter 1

Summary, Issues, and Options

EXCLUSIVE ECONOMIC ZONE: THE NATION'S NEW FRONTIER

Ever since the research vessel H.M.S. *Challenger* hoisted manganese nodules from the deep ocean during its epic voyage in 1873, there has been persistent curiosity about seabed minerals. It was not until after World War II, however, that the black, potato-sized nodules like those recovered by the *Challenger* became more than a scientific oddity. The post-war economic boom fueled an increase in metals prices, and as a result commercial interest focused on the cobalt-, manganese-, nickel-, and copper-rich nodules that litter the seafloor of the Pacific Ocean and elsewhere. World War II also left a legacy of unprecedented technological capability for ocean exploration. Oceanographers took advantage of ocean sensors and shipboard equipment developed for the military to expand scientific ocean research and commercial exploration.

Over the last 30 years, much has been learned about the secrets of the oceans. Several spectacular discoveries have been made. For instance, only two decades ago, most scientists rejected the ideas of continental drift and plate tectonics. Now, largely due to research carried out on the oceanfloor, scientists know that the surface of the Earth is constructed of 'plates' which are in exceedingly slow but constant motion relative to each other. Plates pull apart along "spreading centers' where new crustal material is added to the plates; plates collide along "subduction zones' where old crust is thrust downward. While these plates move at rates of only a few inches per year, crustal material moves as if on a conveyor belt from spreading center to subduction zone. More recently, scientists have discovered that the seafloor spreading centers are zones where mineral deposits of potential use to humanity are being created. These sites of active mineral formation are often habitats for unique biological communities.

Scientists are excited by the new discoveries that have enabled them to better understand the Earth's structure and the processes of mineral formation, among other things. Other experts are more interested in the implications of this new knowledge for potential financial gain. Nonetheless, despite the several decades of scientific research since World War II and some limited commercially oriented exploration, only the sketchiest picture has been formed about the type, quality, and distribution of seabed minerals that someday may be exploitable. A large part of the ocean remains unexplored, and this is almost as true of the coastal waters under the jurisdiction of sovereign states as it is of the deep ocean.

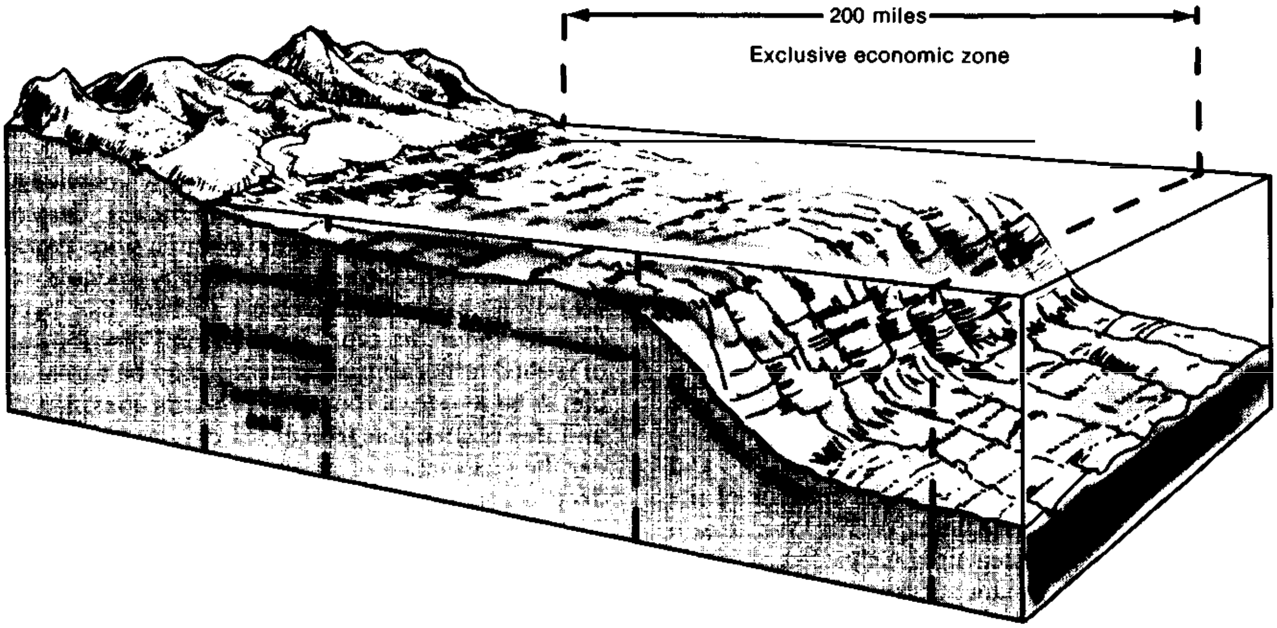
During the past three decades, many coastal nations have established Exclusive Economic Zones (so-called EEZs)–areas extending 200 nautical miles[1] seaward from coastal state baselines wherein nations enjoy sovereign rights over all resources, living and non-living (see figure l-l). The EEZ concept has given new impetus to acquiring knowledge about the oceans and the inventory of mineral deposits within coastal nation jurisdiction. More than 70 coastal countries have now established Exclusive Economic Zones. When the United States established its own EEZ by Presidential proclamation in March 1983, it became the 59th nation to do so. Covering more than 2.3 million square nautical miles (nearly 2 billion acres, equivalent to more than two-thirds of the land area of the entire United States), the U.S. EEZ is the largest under any nation's jurisdiction.[2] Its international legal standing is based on customary international law, which has been codified in the Law of the Sea Convention (see box l-A). Although the United States has thus

[1] A nautical mile is 6,076 feet. All uses of the term "mile" in this assessment refer to a nautical mile.

[2] L. Alexander, "Regional Exclusive Economic Zone Management, in *Exclusive Economic Zone Papers,* Oceans 1984 (Washington, DC: Marine Technology Society, 1984), p. 7. Others have estimated the U.S. EEZ to be much larger—3.9 billion acres—but the larger estimate includes portions of the former Pacific Trust Territories that are no longer considered U.S. possessions (See W.P. Pendley, ' 'America's Exclusive Economic Zone: The Whys and Wherefores, *Exclusive Economic Zone Papers, Oceans 1984* [Washington, DC: Marine Technology Society, 1984], p. 43.)

[3] Law of the Sea Convention Article 55 et seq.

Figure 1-1.—The Ocean Zones, Including the Exclusive Economic Zone (EEZ)



The Exclusive Economic Zone (EEZ) extends 200 nautical miles from the coast. Within the EEZ, the coastal States have jurisdiction over the resources in the 3-mile territorial sea*, and the Federal Government has jurisdiction over the resources in the remaining 197 miles.

● Except for Florida and Texas where State jurisdiction extends seaward 3 marine leagues (approximately 9 miles).

SOURCE: B. McGregor and M. Lockwood, *Mapping and Research in the Exclusive Economic Zone* (Washington, DC: U.S. Geological Survey and the National Oceanic and Atmospheric Administration, 1985), p. 3.

far declined to sign the agreement, the legal status of the U.S. EEZ is not in question. Like the EEZs of most other countries, the U.S. EEZ remains largely unexplored. It is the Nation's ocean frontier.

This assessment addresses the exploration and development of the U.S. territorial sea, continental shelf, and new EEZ, focusing on the mineral resource potential of these areas except for petroleum and sulfur. The known mineral deposits within U.S. waters are described; the capabilities to explore for and develop ocean mineral resources are evaluated; the economics of resource exploitation are estimated; the environmental implications related to seabed mining are studied; the contribution that seabed minerals may make to the Nation's resource base are examined; and the importance of seabed minerals relative to worldwide demand and to land-based sources of supply is assessed.

Unlike the sovereign control that governments have traditionally exercised over their territorial possessions, control over the ocean and the utilization of its resources has been accommodated through intricate rules of international maritime law that have evolved since the 1600s. The Exclusive Economic Zone is an outgrowth of the Law of the Sea Convention—the most recent international effort to develop a more comprehensive law of the sea.

Within its EEZ, the United States claims "sovereign rights for the purpose of exploring, exploiting, conserving and managing natural resources, both living and non-living, of the seabed and subsoil and the superjacent waters. Each of the U.S. coastal States retains jurisdiction over similar resources within the U.S. territorial sea, a 3-nautical-mile band seaward of the coast, that was awarded to the States by Congress in the Submerged Lands Act of 1953.[5] The interests of the coastal States in the 3-mile territorial sea and the responsibilities of the Federal Government in the administration of

[4]Executive Proclamation No. 5030 (1983).
[5]Public Law 83-31; 67 Stat. 29 (1953); 43 U.S.C. 1301-1315.

Box 1-A.—The United Nations Convention on the Law of the Sea

Comprising 320 articles and nine additional annexes, the 1982 Law of the Sea Convention (LOSC) is one of the most complex and comprehensive international agreements ever negotiated. Begun in 1973, the negotiations aimed to formulate international law covering a broad range of uses of the ocean and seabed. Eleven sessions were held between 1973 and the concluding session in 1982. Among the many law of the sea issues for which new rules have been devised or customary international law codified are:

1. innocent passage in the territorial sea,
2. transit of passages and innocent passage in international straits,
3. extension of coastal state jurisdiction on the continental shelf,
4. conservation and management of the living resources of the high seas,
5. the regime of islands,
6. enclosed or semi-enclosed seas,
7. land-locked states,
8. protection and preservation of the marine environment,
9. environment of ice-covered areas,
10. marine scientific research,
11. settlement of disputes,
12. exploitation of mineral resources in areas beyond national jurisdiction, and
13. exclusive economic zone.

The entire set of issues was negotiated as a package, an approach that called for trade-offs and compromise among the 150 or so countries participating in the Convention. As of early 1987, 32 countries had ratified the LOSC. The treaty will take effect one year after 60 countries have ratified it. Some believe that this number will be reached in 1989 and that the treaty therefore will be in force by 1990. However, the United States has not signed the Convention and currently has no plans to accede to it.

The principal objections of the United States to the Convention are the provisions pertaining to exploitation of mineral resources in the international seabed area, which are codified in Part XI. The United States objected to these provisions because, in its view, they would deter future development of deep seabed mineral resources, the decisionmaking process would not give the United States a role that fairly reflected its interests, assured access to qualified seabed miners was not stipulated, and the mandatory transfer of private technology was required.* Most of the remainder of the Convention is acceptable to the United States, and all but a few provisions are considered to be customary international law.

Subsequent to the signing of LOSC, the Preparatory Commission was established to draft detailed regulations for the regime governing the exploitation of deep-sea mineral resources. The United States is eligible to attend the Preparatory Commission as an observer even though it has not signed the Convention. To date, it has not sent any official observers.

An alternative regime, known as the reciprocating states agreement, has been established by the United States and several other countries interested in seabed mining (some of whom are also signatories to LOSC). The principal purpose of the agreement is to ensure that disputes among signatories over possible overlapping claims can be amicably resolved.

*Statement by the President, press release July 9, 1982. See also *Law of the Sea*, hearings before the Subcommittee on Oceanography and the Committee on Merchant Marine and Fisheries, House of Representatives, U.S. Congress, Serial No. 97-29, p. 173.

the EEZ make the management of offshore resources a joint Federal-State problem.[6]

As of July 1987, Congress had yet to enact implementing and conforming legislation to codify the provisions of Executive Proclamation No. 5030, issued in 1983, which established the U.S. Exclusive Economic Zone except for reference in a few specific laws. The legislative task of implementing the EEZ Proclamation is not trivial. Reference to national ocean boundaries is contained in numerous statutes, and the impact on each must be considered carefully when amending laws to implement the new EEZ.

[6]R. Bailey, "Marine Minerals in the Exclusive Economic Zone: Implications for Coastal States and Territories," White Paper, Western Legislative Conference, Pacific States/Territories Ocean Resource Group, Feb. 28, 1987, p. 32.

. the most important aspect of the Reagan Proclamation is its ceremonial declaration that the resources within the EEZ, . . . are declared to be held in trust by the U.S. Government for the American people.

Extension of U.S. control over the resources within the 200-mile EEZ in 1983 actually added—for practical purposes—little additional area to that already under the control of the United States. The U.S. and other coastal countries already had asserted control over fish within a 200-mile zone (under the Magnuson Fishery Conservation and Management Act of 19767 and over other resources located on the continental shelves. This extended control over resources can be traced to the Truman Proclamation of 1945, in which President Harry Truman declared that the United States asserted exclusive control and jurisdiction over the natural resources of the seabed and the subsoil of the continental shelf.[8] Many believe this proclamation was responsible for a flurry of new maritime claims. Following the proclamation, for instance, Chile, Peru, and Ecuador claimed sovereignty and jurisdiction out to 200 miles[9] and considered the 200-mile zone to be wholly under their national control for all ocean uses except innocent passage of ships. Various other claims, but none quite so extensive, were asserted by other countries in the wake of the Truman Proclamation.

The United States implemented the Truman Proclamation by passage of the Outer Continental Shelf Lands Act in 1953. This act authorizes leasing of minerals in the continental shelf beyond the State-controlled territorial sea.[10] The unilateral action of the United States in extending jurisdiction over the petroleum-rich continental shelf led to an international agreement in 1958 (see box 1-B). As a result, all coastal nations acquired the rights to explore and exploit natural resources within the continental shelves adjacent to their coasts.[11]

The area of the U.S. continental shelf is estimated to be approximately 1.6 million square nautical miles. Thus, a substantial proportion of the area of the recently proclaimed EEZ has been under the jurisdiction of the United States since 1945; mineral leasing on the Outer Continental Shelf has been authorized since 1953; and fisheries have been managed within the 200-mile Fishery Conservation and Management Zone since 1976. Hence, only mineral deposits in areas within 200 miles of the coast but beyond the continental shelf edge—the least accessible part of the EEZ—have been added to the resource base of the United States with the establishment of the new EEZ.

President Ronald Reagan's establishment of an Exclusive Economic Zone in 1983 kindled interest in the exploration of the "newly acquired" offshore province. Some likened the creation of the EEZ to the Louisiana Purchase. Others called for an EEZ exploratory venture akin to Lewis and Clark's exploration of the Northwest or John Wesley Powell's geological reconnaissance of the western territories in the 1800s. Perhaps the most important aspect of the Reagan Proclamation is its ceremonial declaration that the resources within the EEZ, whether on the seafloor or in the water column, whether living or non-living, whether hydrocarbons or hard minerals, are declared to be held in trust by the U.S. Government for the American people.

[7]Public Law 94-265 as amended. The Fishery Conservation and Management Zone extends seaward from the 3-mile State-controlled Territorial Sea and is contiguous with the EEZ. The seaward boundaries of Texas, Puerto Rico, and the gulf coast of Florida extend 9 nautical miles; all other States have a 3-mile seaward boundary.

[8]Executive Proclamation No. 2667; 59 Stat. 884 (1945).

[9]L. Alexander, "The Ocean Enclosure Movement: Inventory and Prospect," *San Diego Law Review,* vol. 20, No. 3, 1983, p. 564.

[10]Public Law 83-212, 67 Stat. 462 (1953), 43 U.S.C. 1331-1356; as amended Public Law 95-372, 92 Stat. 629 (1978), 43 U.S.C. 1801-1806.

[11]1958 Convention on the Continental Shelf (UNCLOS I), 15 UST 471; TIAS 5578.

Box 1-B—A Source of Confusion: *Geologic* Continental Shelf; *Jurisdictional* Continental Shelf; Exclusive Economic Zone

International and domestic law has established several ocean zones to accommodate the exploration and development of ocean resources. For instance, "Outer Continental Shelf" is used in the Outer Continental Shelf Lands Act to define the Federal offshore area in which mineral leasing is authorized. The legal entity "Outer Continental Shelf" is easily confused with the "continental shelf," which is a geologic subsea landform with scientific definition. Establishment of the Exclusive Economic Zone (EEZ) contributed more to the confusion. The EEZ overlays both the jursidictional Outer Continental Shelf and the geological continental shelf (figure 1-1). These overlapping zones seldom coincide exactly, and in some instances the geologic continental shelf may extend well beyond the 200-mile EEZ, while in other cases where the shelf is narrow it may extend only a few miles seaward, well short of the line of demarcation for the EEZ.

The Outer Continental Shelf Lands Act of 1953 defines Outer Continental Shelf as "all submerged lands lying seaward and outside of the area of lands beneath navigable waters . . . [three-mile State-controlled territorial sea] . . ., and of which the subsoil and seabed appertain to the United States . . ." A more precise definition of the continental shelf emerged from the international Convention on the Continental Shelf in 1958, which described it as extending from shore to a depth of 200 meters or *beyond* that limit to where the depth of the superjacent water admits of exploitation of the natural resources.

The 1958 international definition of continental shelf, therefore, is somewhat open-ended regarding the seaward extension of the shelf and bases the determination of the final outer boundary on technological capability to explore and exploit. The World Court has limited the extent of the continental shelf, at least in cases of boundary disputes, based on the notions of proximity and natural prolongation. Because the land is the legal source of a state's marine jurisdiction, it must be established that the submerged lands are in fact physical extensions of the state's territory.*

The United Nations Law of the Sea Conference, which concluded in 1982, established yet another international definition for the continental shelf. Article 76 of the Law of the Sea Convention (LOSC) defines it as the "sea-bed and subsoil of the submarine areas that extend beyond its territorial sea throughout the natural prolongation of its land territory to the outer edge of the continental margin . . ." Where the "continental margin" extends beyond the boundary of the 200-mile EEZ, LOSC requires that signatory nations establish a finite outer limit based on formulae for determining where the foot of the continental slope meets the abyssal depths of the ocean. However, regardless of where such an outer point may lie as determined by formulae, the continental shelf can neither extend more than 350 nautical miles from the coast, nor exceed 100 nautical miles beyond the 8,200 foot isobath (point of equal water depth).

Since the United States is not signatory to the recent LOSC, the limitations imposed by Article 76 do not apply. Some legal analysts believe that the 1958 Convention on the Continental Shelf with its open-ended, technology-determined definition of the outer boundary of the shelf would apply unless Congress redefines its boundaries in subsequent EEZ implementing legislation. Under the more liberal 1958 interpretation, the Outer Continental Shelf could perhaps extend several hundred miles beyond the EEZ. According to this legal reasoning, with disagreement among legal analysts on the overlapping effects of the EEZ, the Outer Continental Shelf, the continental shelf within the meaning of the 1958 Convention on the Contintental Shelf, and international ocean space beyond, there is the possibility that a legal "no-man's land" exists offshore where no domestic law governs.

The geological definition of the continental shelf is only slightly more precise than the several legal definitions. The Dolphin *Dictionary of Geological Terms* defines it as the "gently sloping, shallowly submerged marginal zone of the continents extending from the shore to an abrupt increase in bottom inclination; greatest average depth less than 600 feet, slope generally less than 1 to 1,000, local relief less than 60 feet, width ranging from very narrow to more than 200 miles." For scientific purposes, the definition is adequate since geologists can generally agree on where the continental shelf begins and ends. The industry seeking to explore and develop resources of the seabed and government administrators charged with managing the outer continental shelf have more difficulty in deciding the jurisdictional limits of the Outer Continental Shelf.

**North Sea Continental Shelf, 1969, I.C.J. 3.*

MINERAL RESOURCES OF THE EEZ IN PERSPECTIVE

> The economic potential for seabed mining at this time is not favorable when compared to alternative sources of supply for most mineral commodities.

Knowledge about marine geology has steadily accumulated in recent years. Such knowledge has enabled scientists to revise their theories about the formation of some types of mineral deposits and to better predict where new deposits might be found. For instance, many continental features and mineral deposits were formed on or beneath the seabed. By studying the formation of mineral deposits on the oceanfloor, earth scientists are better able to understand geology on land. In the case of the formation of polymetallic sulfide deposits at seafloor spreading centers, mineral deposition can be observed as it occurs.

At the same time, knowledge of mineral deposits on land—gained through years of geological observation and research—provides clues about the nature and possible location of offshore minerals. For example, beach sand deposits containing heavy minerals (e. g., chromite or titanium) or phosphorites that were formed under the ocean before ancient seas receded may help identify the likely location and composition of similar deposits located in nearshore areas. Polymetallic sulfide deposits, now on shore but formed under the sea, have yielded large commercial quantities of copper, zinc, and lead ores. Knowledge about these onshore deposits may lead to better understanding of the evolution of polymetallic sulfide ores formed under the ocean.

Aside from the scientific knowledge that comparative studies of undersea and onshore mineral occurrences can provide, the potential for discovering sizable deposits of minerals on land or in the ocean as a result of seabed exploration could be important in the future. The economic potential of seabed mining at this time is not favorable when compared to alternative sources of supply for most mineral commodities. However, onshore mineral deposits are finite, and, given sufficient economic incentives, even the higher cost seabed mineral deposits may become commercially viable—and perhaps attractive later.

Investment in seabed exploration and ocean mining technology should be considered a long-term venture. Its value cannot be gauged against either current economic conditions or present mineral demand. In the past, even short-term demand projections for mineral and energy resources have widely missed their marks. There is little reason to believe that supply and demand relationships will be any more predictable in the future. Today's overcapacity in many sectors of the minerals industry may give way to increased demand as populations expand and global economic growth resumes. On the other hand, changes in technology can also result in reduced demand for conventional mineral commodities through substitution, recycling, introduction of new materials, and miniaturization. Growth in minerals demand has been linked to world economic growth, and it is likely that the course of minerals consumption will continue to be affected by economic trends in the future.

Until more is understood about the location, extent, and characteristics of offshore minerals within U.S. jurisdiction, including their associated marine environment, the economic future of seabed minerals is mere conjecture. Their market position will be first determined by comparing their production costs with those of their closest domestic and foreign onshore competitors and next with competing foreign offshore producers. Minerals markets, as with most commodities, favor the least cost producers first, thus recognizing an economic pecking order among potential mineral sources. The determinants of minerals costs are dynamic and can change dramatically with the development of cost-saving technologies, discovery of exceptionally rich ore bodies, or erratic jumps in market prices as a result of increased demand or of supply disruptions. However, if environmental impacts could result from the mining or processing of seabed minerals,

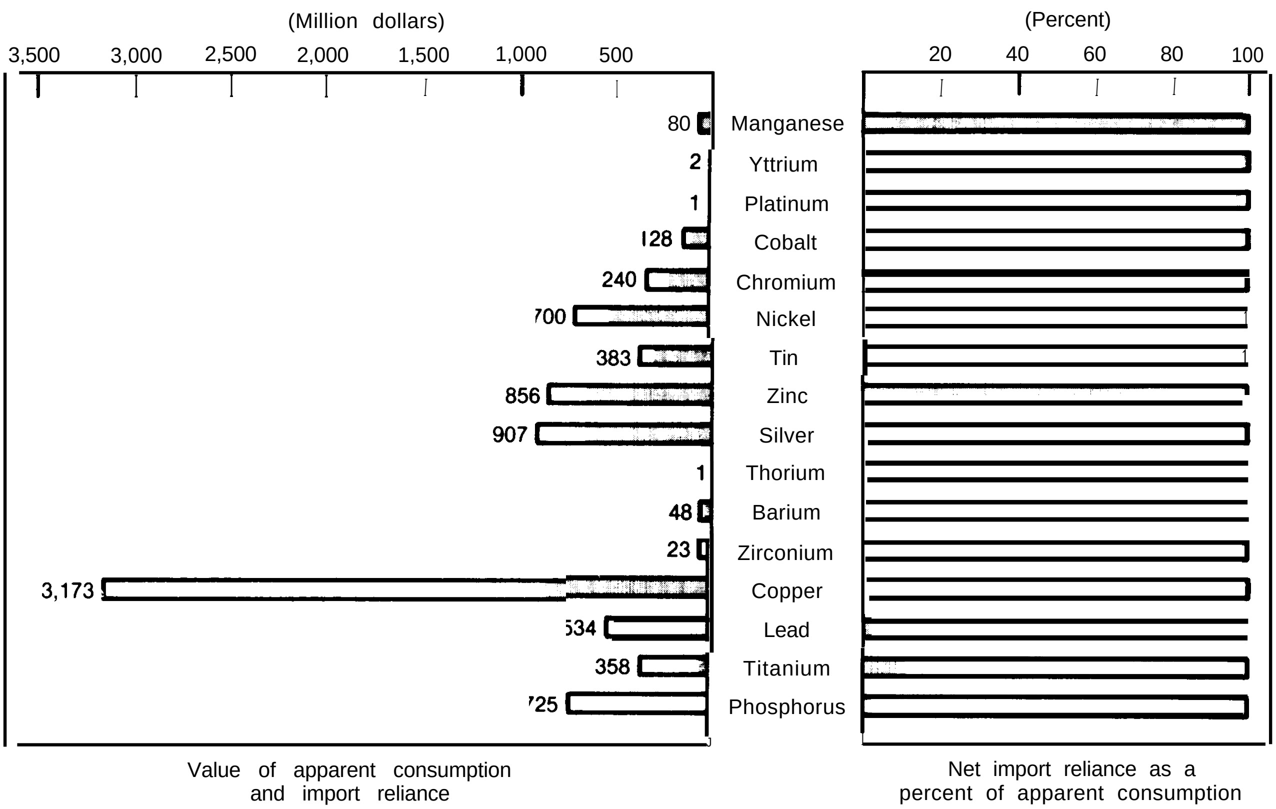
> Even though the occurrence of some minerals within the EEZ might have a dim economic future . . ., an understanding of their location, extent, and availability y could provide an important cushion under emergency conditions.

then the cost of mitigating or avoiding damage to the marine environment must also be considered in determining economic feasibility of development.

The strategic importance of several minerals in the seabed—e.g., cobalt, chromium, manganese, and the platinum group metals—could make future economic considerations secondary to national security. Between 82 and 100 percent of these critical metals are imported (figure 1-2) from countries with unstable political conditions or where other supply disruptions could occur for geopolitical reasons, e.g., the Republic of South Africa, the Soviet Union, Zimbabwe, Zaire, Zambia, China, Turkey, and Yugoslavia. Even though the occurrence of some minerals within the EEZ might have a dim economic future during normal periods, an understanding of their location, extent, and availability could provide an important cushion under emergency conditions. For shorter, less significant disruptions, the National Defense Stockpile could supplant the loss of some of the imported critical minerals on which the United States is dependent.

While the immediate challenge to the United States is to gain a better understanding of the physiography and geology of the seafloor and its envi-

Figure 1-2.—U.S. Mineral Imports



The United States is reliant on imports of a number of critical minerals that are known to occur on the seafloor within the 200-mile U.S. EEZ.

SOURCE: J.M Broadus and P. Hoagland, "Marine Minerals and World Resources," paper presented at the Marine Policy Center, Alumni Symposium, Woods Hole Oceanographic Institution, Woods Hole, MA, Apr 5.7, 1987 (modified).

> At the current stage of preliminary resource assessment in the EEZ, little credence should be given to estimates of the economic value or tonnages of seabed minerals . . . .

ronment and to inventory minerals occurrences within U.S. jurisdiction, the potential value of developing and marketing technology for seabed mining and shipboard processing systems should not be ignored. It is possible—perhaps likely—that the major commercial seabed mining ventures may not be in the U.S. Exclusive Economic Zone, but rather in other countries' waters (small mining operations have already taken place). In this instance, U.S. innovation and engineering know-how applied to developing seabed mining technology could place the United States in a pivotal competitive position to exploit a world market (probably modest in size) for seabed mining equipment. Technological innovation in seabed-mining systems could 'also assist the U. S. industry in maintaining a national capability to deploy such technology in U.S. waters or elsewhere in the world when economic opportunities arise or if emergencies occur.

MINERAL OCCURRENCES IN THE U.S. EEZ

Only a miniscule portion of the U.S. EEZ has been explored for minerals. However, several types of mineral deposits are known to occur in various regions of the U.S. EEZ (figure 1-3). These include:

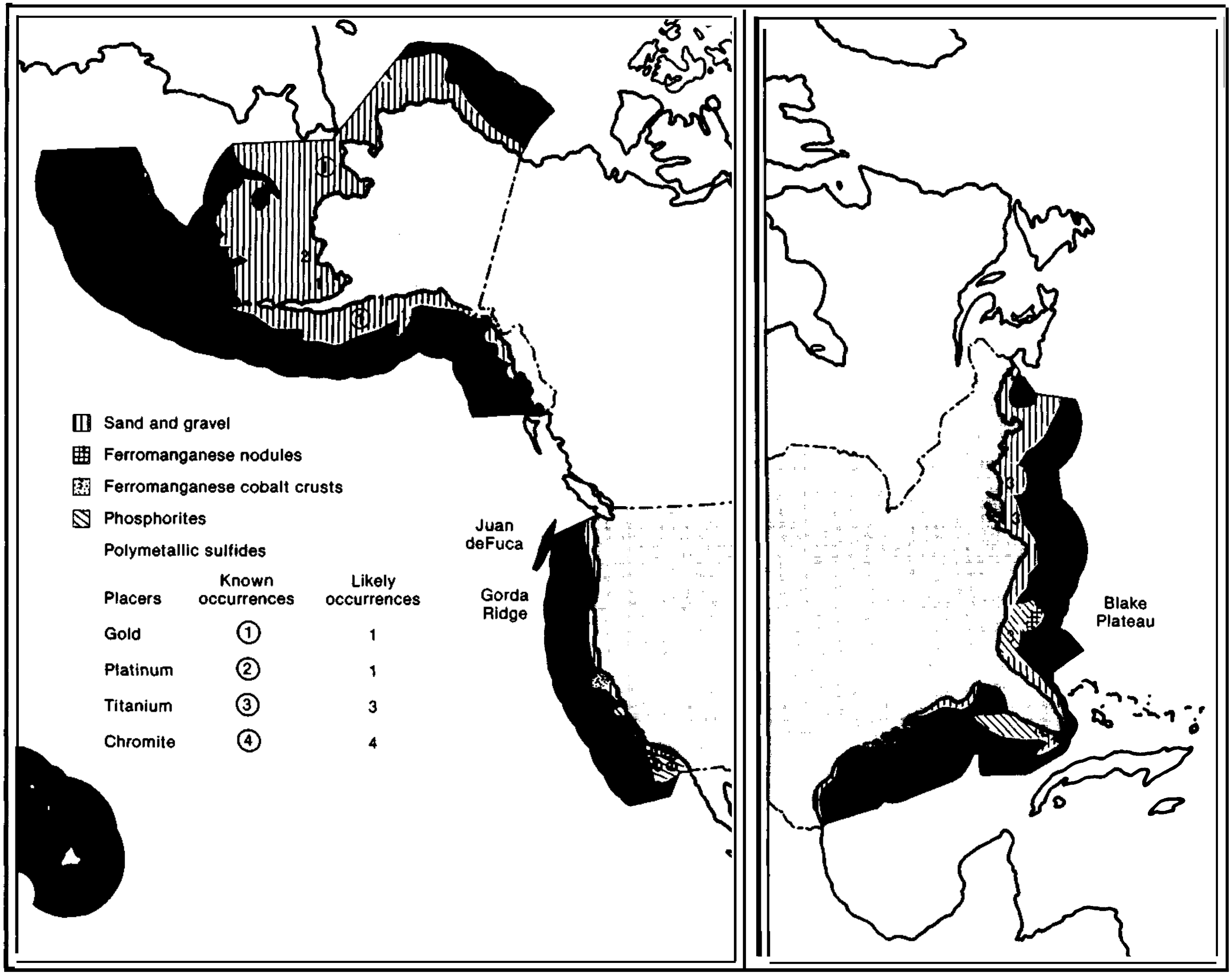
- Placers—accumulations of sand and/or gravel containing gold, platinum, chromite, titanium, and/or other associated minerals.
- Polymetallic *Sulfides*—metal sulfides formed on the seabed from minerals dissolved in superheated water near subsea volcanic areas. They commonly contain copper, lead, zinc, and other minerals.
- *Ferromanganese* Crusts-cobalt-rich manganese crusts formed as pavements on the seafloor on the flanks of seamounts, ridges, and plateaus in the Pacific region. They may also contain lesser amounts of other metals such as copper, nickel, etc.
- *Ferromanganese* Nodules—similar in composition to ferromanganese crusts, but in the form of small potato-like nodules scattered randomly on the surface of the seafloor. Those found within the EEZ in the Atlantic Ocean tend to be lower in cobalt content than deep ocean manganese nodules in the Pacific Ocean.
- *Phosphorite Beds*—seaward extensions of onshore phosphate rock deposits that were laid down in ancient marine environments.

Since so little is known about the volume in place and the mineral content (assay) of most seabed deposits, most deposits are properly termed "occurrences' rather than resources. Not much more can be said about a mineral occurrence other than that a mineral has been identified, perhaps in as little as one surficial grab sample. A few EEZ mineral deposits have been investigated enough to be termed ' 'resources, deposits that occur in a form and an amount that economic extraction is potentially feasible.

At the current stage of preliminary resource assessment in the EEZ, little credence should be given to estimates of the economic value or tonnages of seabed minerals that have been inferred by some observers. Current information should be interpreted cautiously to avoid implying a greater degree of certainty than is justified by the sampling density, sampling design, and analytical techniques used. Misinterpretation of the results (i. e., by inferring that the results of a small number of surficial samples are representative of an extensive, three-dimensional deposit) of preliminary assessments can lead to false expectations.

Close-grid, three-dimensional sampling is needed to adequately delineate and quantify mineral deposits in the seafloor. Sand and gravel, phosphorite beds, and placers vary in depth below the seabed

Figure 1-3.—Potential Hard Mineral Resources in the EEZ of the Continental United States, Alaska, and Hawaii



SOURCES: Strategic Assessment Branch, Ocean Assessments Division, Office of Oceanography and Marine Assessment, National Oceanic and Atmospheric Administration; Office of Technology Assessment; and S.J. Williams, U.S. Geological Survey.

To be competitive, marine minerals probably must either prove to exist in large, high-quality deposits, and/or to be cheaper to mine and process than their onshore counterparts.

Only a miniscule portion of the U.S. EEZ has been explored for minerals.

and must be sampled by taking cores through many feet of sediment and sometimes down to bedrock. Sampling polymetallic sulfides is considerably more difficult than the other EEZ minerals. The thickness of polymetallic sulfide deposits is expected to be much greater, sometimes extending into the basement rocks of the seabed. Polymetallic sulfides are generally found in deeper water, and prohibitively expensive hard-rock coring techniques are required to adequately sample them. Resource assessments of cobalt-manganese crust deposits and manganese nodules are on somewhat firmer footing than placers or polymetallic sulfides. Nodule and crust distribution can be observed and visually mapped, while grab samples and shallow coring devices can assess the thickness of these deposits and obtain samples for chemical analysis.

More is known about sand and gravel than other hard mineral resources in the U.S. EEZ as a result of extensive sampling by the U.S. Army Corps of Engineers. Although onshore sand and gravel resources in most areas of the United States are ample to meet mainland needs for the near future, offshore deposits of high-quality sand may be locally important in the future, especially in New York and Massachusetts. Geologists have identified several offshore areas that have potential for hosting heavy mineral placer deposits, although data are still too sparse for compiling resource assessments. Occurrences of shallow-water mineral placer deposits have been identified in both State waters and the Federal EEZ.

One of the most promising areas for titanium sands and associated minerals in the U.S. EEZ is located between New Jersey and Florida. On the west coast, the best prospects for chromite placers, other associated minerals, and perhaps precious metals are offshore southern Oregon. In Alaska, gold is being investigated off the Seward Peninsula near Nome where some test mining has occurred, and platinum has been recovered onshore near Goodnews Bay on the Bering Sea, providing some evidence that precious metal placers may also lie offshore; in the Gulf of Alaska, lower Cook Inlet may be a promising area to prospect for gold.

Phosphorite beds located onshore in North Carolina and South Carolina extend seaward in the continental shelf. Extensive phosphorite deposits are found near the surface of the seabed in the Blake Plateau of the southeastern Atlantic coast, as well as off southern California.

Cobalt-rich ferromanganese crusts on the seabed adjacent to the Pacific Islands have piqued the interest of an international mining consortium. Data on the manganese crusts are insufficient to determine the resource potential, to identify a potential mining site, or to design a mining system. Ferromanganese nodules are located in the Blake Plateau and have been recovered in experimental quantities while testing deep seabed mining systems that were intended for use in the Pacific Ocean. The Blake Plateau nodules are in shallower water than those in the Pacific and thus may be more easily mined, but they have lower mineral content.

Polymetallic sulfide deposits located in the volcanically active Gorda Ridge in the U.S. EEZ and also located in the Juan de Fuca Ridge, that straddles the U.S.-Canadian EEZs off the Northwestern United States, have attracted considerable scientific curiosity. Although these deposits are known to contain large quantities of copper, lead, zinc, and other metals, uncertainties about the quality, composition, and extent of the deposits makes their resource potential difficult to determine.

MINERALS SUPPLY, DEMAND, AND FUTURE TRENDS

Commodities, materials, and mineral concentrates— the stuff made from minerals-are traded in international markets. There is nothing special or unique about marine minerals that makes them different from those obtained domestically onshore or from foreign sources. They must, nevertheless, compete for price, quality, and supply reliability with other foreign and domestic mineral suppliers. To be competitive, marine minerals probably must either prove to exist in large, high-quality deposits, and/or to be cheaper to mine and process than their onshore counterparts. Major questions remain as to where marine minerals may fit in the future economic pecking order of producers.

The commercial potential of marine minerals from the U.S. EEZ is uncertain because development, when it occurs (or if it occurs in the case of some minerals), is likely to be in the distant future. It is difficult to foresee the future of marine minerals for several reasons:

- Little is known about the extent and grade of the mineral occurrences that have been identified in the EEZ.
- Little actual experience and few pilot operations are available to evaluate seabed mining costs and operational uncertainties.
- Erratic performance of the domestic and global economies adds uncertainty to forecasts of minerals demand.
- Changing technologies can cause unforeseen shifts between demand and supply of minerals and materials.
- Past experience indicates that methods for projecting or forecasting minerals demand are not dependable.

Materials are constantly competing with one another for applications in goods and industrial processes. Total consumption of a mineral commodity is determined by the amount (volume or number) of goods consumed and by the amount of a commodity used in manufacturing each unit. The former is linked to the vitality of the economy and customer preference, while the latter is related to technological trends which also may be related to economic factors. Substitution of new or different materials, conservation through more efficient manufacturing, and recycling of used materials can reduce the demand for virgin materials.

Major changes in domestic and world economies, coupled with technological advancements and changes in consumer attitudes, have significantly altered consumption trends beginning in the late 1970s and continuing through the present. For most of the commodities derived from marine minerals, the amount used relative to the goods produced has decreased for chromium, cobalt, manganese, tin, zinc, lead, and nickel from 1972 to 1982. Only platinum and titanium increased in use intensity. Consumption of goods and consequently the demand for mineral commodities used to produce the goods —with the exception of platinum and titanium—also decreased (but less abruptly than use intensity) during the same period,

Mining capacity increased—particularly in the mineral-rich Third World—in the early 1970s when mineral prices were high, consumption strong, and the economic outlook bright. In the 1980s, demand softened, prices dropped, and the world economy slowed, causing significant excess world mining capacity for most of the minerals that occur in the U.S. EEZ. It is unknown whether technological trends toward miniaturization, substitution, and lower intensity of use of the commodities derived from marine minerals will continue in the future, or whether domestic and world economic growth will rebound to new heights or merely continue sluggishly on the current course. These uncertainties will affect the utilization of existing capacity and determine the need for new mineral development in the future, including minerals from the seabed.

As a result of excess world capacity, the U.S. minerals and mining industry has met with substantial foreign competition. Metals prices remain low, and, until recently, production costs in the United States and Canada have been well above the world average for copper, zinc, lead, and other metals used in large industrial quantities. Competition from low-cost foreign producers, with advantages of lower capital and operating costs and higher grade ores, have resulted in a depressed domestic mining industry, a trend that accelerated in the early 1980s.

Foreign producers, including state-owned or state-controlled companies, are likely to continue to be the measure of competition that must be met by both domestic onshore and offshore producers. Only when seabed mine production is the least cost source with respect to both domestic and foreign onshore producers and even foreign offshore producers will it become commercially viable.

Manganese, chromium, and nickel are alloying elements that are used to impart specific properties to steel and other metals. Their demand is closely tied to the production of steel; they are usually added to molten metal as a ferroalloy or as an intermediate product of iron enriched with the alloying element. There are no domestic reserves (proven economic resources) of manganese or chromium; therefore, the United States must import substantially all of these alloying metals.

A decade ago, concentrated ores were imported for conversion to ferromanganese and ferrochromium by U.S. ferroalloy firms to supply a then-robust domestic steel industry. Since 1981, the United States has imported more finished ferrochromium than it has chromite ore, and a similar pattern has developed with ferromanganese. Foreign producers now supply U.S. markets with about 90 percent of the ferrochromium consumed for the domestic manufacture of chromium steel. Chromite-producing countries are now converting ore to finished ferroalloy and gaining the value added through the manufacturing process before exporting to consumers. There is currently no existing domestic capacity to produce ferromanganese.

U.S. steel production has also declined in favor of cheaper imports. With decreases in both U.S. ferroalloy production and iron and steel production, demand for chromium and manganese ores (manganese is also used to desulfurize steel) for domestic ferroalloys is likely to continue to diminish. The United States is fast approaching total dependence on foreign processing capacity of ferroalloys. Even if EEZ chromite heavy sands off southern Oregon were to prove economically recoverable, there are no ferroalloy furnaces in the Pacific Northwest to process the chromite produced. Any offshore chromite recovered probably would be used for the production of sodium bichromate, the major chemical derivative of chromium.

Titanium metal is used extensively in aerospace applications, and its use in industrial applications is expected to expand in the future. Heavy mineral sands in the EEZ off the Southeastern Atlantic States contain substantial concentrations of ilmenite, a titanium-bearing mineral. Although ilmenite can be converted to titanium metal through an intermediate process (alteration to synthetic rutile), the added expense might make it uneconomical. The most probable use for ilmenite recovered from the Atlantic EEZ would be as titanium pigments, since two major plants currently operate in northern Florida using locally mined onshore minerals; over 30 percent of world's titanium pigment production is in the United States.

About 90 percent of the phosphate rock mined in the United States goes for the production of agricultural fertilizers. Most of the remainder is used to manufacture detergents and cleaners. Phosphate is abundant throughout the world, but only a small proportion is of commercial importance, Offshore phosphorites are similar to those that are mined in the coastal plain onshore. The United States historically has been the leading producer of phosphate rock, but its preeminence is now challenged by cheaper foreign producers.

Precious metals-gold, platinum-group—are in a class of their own. By definition, they are less abundant and more difficult to find and recover than other minerals, hence their enhanced value. Both are used to some extent in manufacturing, the platinum-group metals are used most widely. Demand for the platinum-group is expected to increase in the future as Europe, Australia, and Japan adopt automobile emission controls that use platinum as a catalyst. Gold remains a standard of wealth, and is used for jewelry. Both platinum and gold are subject to the whims of speculators who respond to anticipated economic changes, market trends, world political conditions, and other factors; therefore, prices can change abruptly and unpredictably.

OUTLOOK FOR DEVELOPMENT OF SELECTED OFFSHORE MINERALS

OTA has assessed the potential for near-term development of selected minerals found within U.S. coastal waters. Costs of offshore mining will determine its competitive position with regard to onshore sources of the same minerals in the United States and abroad. For most offshore minerals, the near-term prospects for development do not appear promising. Although only minor new developments in technology will be required to mine offshore placer deposits or phosphorite, costs for offshore mining equipment are likely to be higher than capital costs for onshore operations. Some of the factors that will increase costs include the need for seaworthy mining vessels and possible requirements for motion compensating devices and navigational and positioning equipment.

In addition to greater capital costs, operating costs for offshore mining typically will be higher than for onshore operations. Occasional adverse weather conditions will undoubtedly reduce the number of days per year during which mining is feasible. For most offshore settings, mining rates of 300 days per year are considered optimistic. The necessity of transporting to shore (possibly great distances) either raw or beneficiated ore for final processing is another factor that may increase operating costs relative to costs for onshore operations. On the other hand, siting offshore mining equipment is easier and less expensive than for onshore facilities.

Sufficient data are not available with which to make detailed cost estimates of typical future offshore mining operations. However, first approximations of profitability can provide insights into the competitiveness of offshore relative to onshore mining. OTA has developed mining scenarios for four types of hypothetical marine mineral deposits in areas where concentrations of potentially valuable minerals are known to occur. The deposits evaluated include titanium-rich sands off the Georgia coast, chromite-rich sands off the Oregon coast, phosphorite off the North Carolina and Georgia coasts, and gold off the Alaska coast near Nome.

Titanium

OTA's analysis of offshore titanium sand mining indicates that it is not very promising in the near term. Nevertheless, there has been some commercial interest shown in these deposits. The recovery of ilmenite alone from an offshore placer does not appear economically feasible and will not be feasible unless primary concentrate can be delivered to an onshore processing plant at costs comparable to those incurred in producing the equivalent titanium minerals from an onshore placer deposit. To be competitive, the offshore deposit would have to contain considerable amounts of higher valued heavy minerals like rutile (valued at $350 to $500 per ton) or other more valuable minerals, e, g., zircon, monazite, or precious metals. Such deposits have not yet been identified.

Chromite

Mining and processing chromite-rich sands show results similar to those obtained for titanium. For chromite, revenues of about $125 per ton would be required to realize a 3-year payback on investment. The average price of low-grade, nonrefractory chromite concentrate imported into the United States during the first half of 1986 was $40 per ton, exclusive of import duties, freight, insurance, and other charges. Production of chromite alone, therefore, would not meet revenue requirements. The presence of higher valued minerals, such as gold, could improve the profitability of mining offshore chromite sands if revenues from the sale of coproducts exceeded the costs of their separation.

With excess capacity in the world's ferroalloy industry, it is unlikely that a viable U.S. ferrochromium installation could survive foreign competition. It is possible that the Oregon chromite sands might be used for the manufacture of sodium dichromate, the major industrial chromium chemical. A west coast "green field" plant probably would have to be built for this purpose to offset the transportation costs of shipping to existing east coast chemical plants.

Phosphorite

The economic outlook for offshore phosphorite mining is not especially promising either. In the past, the United States led world phosphate rock production with onshore mining in northern Florida and North Carolina; now the United States is being challenged by Morocco, which has immense high-grade reserves judged to be capable of satisfying world demand far into the future. The prospect that mining of U.S. offshore phosphorites could successfully compete with low-cost Moroccan phosphate rock or other possible low-cost foreign producers is considered remote. However, domestic onshore producers have met considerable opposition because of potential environmental disturbance and land use conflicts. The offshore marine deposits of North Carolina and other Southeastern States might become more competitive with domestic onshore production in the future if environmental and land use problems become insurmountable.

Gold

Offshore gold placer mining near Nome, Alaska, appears more promising. In fact, Inspiration Mines has already undertaken pilot mining and is planning to begin full-scale gold mining with a converted tin dredge from southeast Asia. Some of the data OTA used in estimating capital and operating costs for this project were provided by Inspiration Mines; thus, some of the assumptions used in the gold offshore mining scenario are considered more reliable.

Assuming the price of gold to be $400 per ounce (a conservative assumption in July 1987, but the price of gold is subject to wide swings), the projected pre-tax cash flow on the estimated production of 48,000 ounces of gold per year would be approximately $19 million. This figure indicates that the offshore gold mining project at Nome shows good promise of profitability if the operators are able to maintain production. Note, however, that offshore mining will be possible only about 5 months per year, because ice on Norton Sound prohibits operations during the winter months. The duration of yearly ice cover (as well as the fluctuating price of gold) will have a significant effect on the profitability of this operation.

With the exceptions of sand and gravel and precious metals, the commercial prospects for developing marine minerals within the EEZ appear to be remote for the foreseeable future.

Sand and Gravel

The least valuable marine minerals by volume are sand and gravel. However, these resources may have the most immediate competitive position in relation to onshore supplies. Although onshore sand and gravel resources are immense, coarse sand is sometimes hard to find and land use restrictions increasingly prohibit access to suitable resources. Some limited offshore mining of sand and gravel is taking place. Sand and gravel is a high-volume, low-value commodity where short-haul transportation is important. Around high-growth, high-density areas in the Northeast and on the west coast, marine sand and gravel might soon prove profitable to mine.

Deep-Sea Minerals

OTA did not estimate the potential for near-term exploitation of ferromanganese nodules, cobalt-rich ferromanganese crusts, or polymetallic sulfides. Recovery of ferromanganese nodules (which include copper, nickel, and manganese) from the deep seafloor beyond the U.S. EEZ has been studied by the industry, the National Oceanic and Atmospheric Administration (NOAA), and the Minerals Management Service (MMS). Prototype technology has been designed and tested, but plans to mine nodule resources in the central Pacific Ocean have been on hold pending favorable economic conditions.

Even less is known about the economic potential for recovery of cobalt-rich crusts (within the Hawaiian EEZ) or polymetallic sulfide deposits (within the U.S. EEZ off Oregon and northern California) than about the potential for recovery of nodule or placer deposits. Technology has not yet been developed for mining these deposits nor does sufficient information about the nature of the deposits

> The job of exploring the U.S. EEZ is immense, difficult, and expensive . . . [it] is not an activity that is likely to be undertaken by the private sector in response to market forces.

exist to permit meaningful estimates of future economic potential to be made, More data about the physical characteristics of cobalt crusts and polymetallic sulfides are needed before mining concepts can be refined and mining costs estimated. An international consortium is studying the potential for mining cobalt-rich crusts in the Johnston Island EEZ, but near-term incentives for mining crusts and sulfides do not exist.

It is risky to attempt to rank the future potential for development of marine minerals in the EEZ because of shortfalls in resource data. Nevertheless, an assessment based on what is known of the nature and extent of the mineral occurrences, coupled with insights into mineral commodity markets and trends, suggests the following rank "guestimate" for the probable order of development:

1. sand and gravel
2. precious metal placers,
3. titanium and chromite placers and phosphorite,
4. ferromanganese nodules,
5. cobalt-rich ferromanganese crusts, and
6. polymetallic sulfides.

TECHNOLOGIES FOR EXPLORING THE SEABED

The job of exploring the U.S. EEZ is immense, difficult, and expensive. The job is not an activity that is likely to be undertaken by the private sector in response to market forces. In its initial reconnaissance stages, it is largely a government responsibility. As knowledge narrows the targets of opportunity to those of economic potential, commercial interest may then motivate entrepreneurs to explore in more detail. But without the first efforts by the Federal Government, both the scientific community and industry will be unable or unwilling to launch an effective, broad-scale exploration program.

Technological capabilities for exploring the seabed in detail are currently available and in use. These range from reconnaissance technologies that provide relatively coarse, general information about very large areas to site-specific technologies that provide information about increasingly smaller areas of the seafloor. A common strategy is to use these technologies in the manner of a zoom lens, that is, by focusing on progressively smaller areas with increasing detail.

Among the reconnaissance technologies available are echo-sounding instruments capable of accurately determining the depth of the seafloor and producing computer-drawn bathymetric charts showing the form and topography of the bottom. Side-looking sonar devices produce photo-like images that can reveal interesting features and patterns on the seafloor. These technologies can be combined in one piece of equipment or used simultaneously to survey broad swaths of the seafloor while a vessel is underway, thus providing near-perfect registry between the sonar and bathymetric data. Broad-scale coverage of side-looking sonar imagery for most of the U.S. EEZ soon will be available from the U.S. Geological Survey (USGS). However, high-resolution, multi-beam bathymetric data collected by NOAA will take much longer to acquire. Moreover, the future of NOAA's bathymetric charting program is uncertain, since the Navy considers the data to be of sufficient quality to classify for national security reasons.

Seismic technologies, which are used extensively by the offshore petroleum industry, can detect structural and stratigraphic features below the seabed which can aid geological interpretation. New three-dimensional seismic techniques, although very expensive, can enhance the usefulness of seismic information. Gravimeters can detect differences in the density of rocks, leading to estimates of crustal rock types and thicknesses. Magnetometers provide

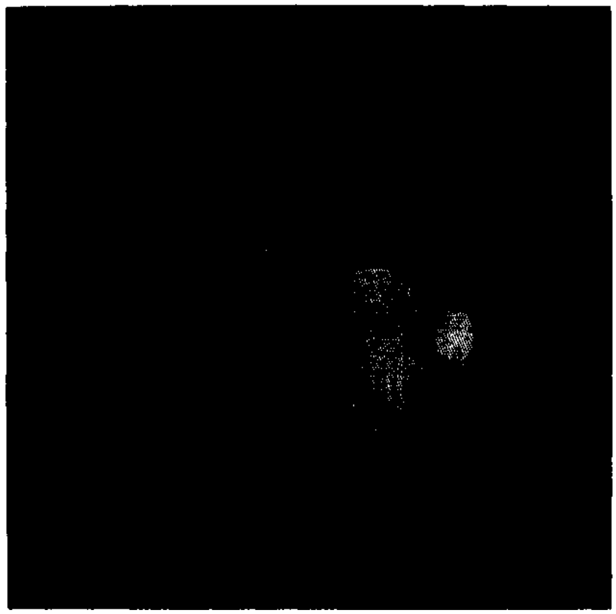
The military value of some EEZ data might require restrictions on access and use of certain information for national security reasons.

information about the magnetic field and may be used offshore to map sediments and rocks containing magnetite and other iron-rich minerals. Both of these technologies are also used for oil and gas exploration. Data can be collected rapidly by moving vessels and stored in retrievable form.

Other technologies may also be used to explore the EEZ. Some, like many electrical techniques, are proven technologies for land-based exploration which have been adapted for ocean use, but have not been widely tested in the marine environment. Induced polarization, for example, has potential for locating titanium placer deposits and for performing rapid, real-time, shipboard analyses of core samples. Nuclear techniques may also prove useful for identifying such minerals as phosphorite, monazite, and zircon that emit radiation.

When the focus of attention narrows to prospective targets of interest on the seafloor, direct visual observation is often useful. Manned submersibles and/or remotely operated undersea vehicles (ROVs), similar to those used for locating the Titanic in 1986, may come into play. Remotely operated cameras capable of observing, transmitting, and recording photographic images have proved valuable exploration tools.

Direct sampling of seabed minerals for assessment presents special problems. In some cases, it is possible (as has been done with the research submersible Alvin to recover limited samples of seabed minerals using manned submersibles or ROVs). A number of devices have been developed to retrieve a sample of unconsolidated sediment, but few are capable of extracting undisturbed samples that reflect the mineral concentrations contained in the



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seabed deposit. Many of the sediment coring devices were designed for scientific use, and few are capable of economically and efficiently recovering the large number of samples that are needed to accurately determine the commercial feasibility of a refine mineral deposit and to delineate a mine site.,

Quantitative sampling of hard-rock deposits, e.g., ferromanganese crusts and polymetallic sulfides, is economically infeasible with existing technology. While large drill ships (e. g., the *Joides Resolution)* used in the Ocean Drilling Project or those used by the offshore petroleum industry, are capable of drilling and extracting cores from hard basaltic rock, their cost is prohibitive for extensive, high-density sampling of the kind needed to assess a mineral deposit. It may prove easier to develop a practical sampling device for thin ferromanganese crusts than for the thicker, less regular, polymetallic sulfides.

TECHNOLOGIES FOR MINING AND PROCESSING MARINE MINERALS

> Existing or modified dredge mining systems could place many potential placer deposits in the range of technical exploitability.

From table-flat, heavy mineral sand placers deposited in shallow water to mounds and chimneys of rock-like polymetallic sulfides at depths of over a mile, marine minerals present a variety of challenges to the design, development, and operation of marine mining systems. Development and capital costs for vessels and marine systems can be high. Profitability of offshore mining ventures will hinge on whether safe and efficient mining systems can be built and operated at reasonable costs. With the exception of conversions of onshore dredge mining equipment for shallow, protected water offshore and work done on deep seabed manganese nodule mining systems, there has been little development effort thus far.

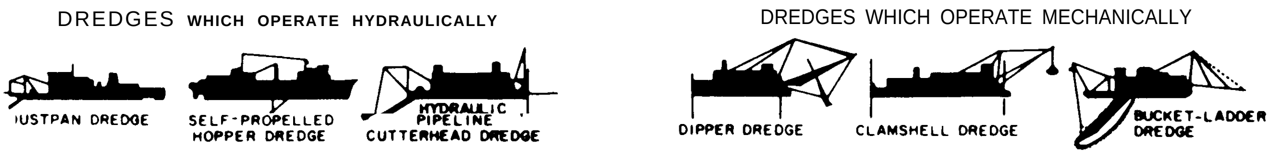
Dredge mining technology is used extensively for harbor and channel dredging in coastal waters and for onshore mining of phosphate rock and heavy mineral sands. It has also been used for mining tin in coastal waters in Asia and is currently being used in pilot mining of gold in State waters near Nome, Alaska.

In deeper waters subject to winds, waves, swells, and currents, specially designed mining dredges must be developed. High endurance dredges for deep waters must be self-powered, seaworthy platforms with motion compensating systems and may be equipped with onboard mineral processing plants and storage capacity. Conceptual designs of such equipment are being readied. The design of even the most sophisticated dredge probably can be achieved without major new technological breakthroughs. Cost will be the most important limiting factor.

The maximum practical operating depth for most dredging systems is about 300 feet from the surface of the water to the bottom of the excavation on the seafloor. Airlift systems can be used on suction dredges to lift unconsolidated material from much greater depths. Existing or modified dredge mining systems could place many potential placer deposits in the range of technical exploitability.

Solution or borehole mining has been tested in north Florida land-based phosphate rock deposits as a means to reduce surface disturbance and environmental impacts. The technique involves sinking a shaft into the phosphorite deposit, jetting water into the borehole, and pumping the resulting slurry to the surface. Although the technique has not yet been tested under marine conditions, some mining engineers speculate that it could have potential for offshore phosphorite mining.

Several preliminary mining systems have been sketched out for recovering ferromanganese crusts as well as for mining polymetallic sulfide deposits, but little if any development work has proceeded in either area. Collection and airlift recovery systems developed for deep seabed manganese nodules may be adaptable to mining both crusts and polymetallic sulfides. Too little is known about the



Dredge Technologies

Dredge technologies are well developed and proven through years of experience. Adaptation of inshore dredge mining systems for offshore use could make the technical exploitability of some heavy mineral placer deposits possible if seabed mining is found to be economically competitive.

Source: Office of Technology Assessment, 1987 nature and extent of the deposits to allow the development of prototype mining systems at this time.

Mineral processing technology has evolved through centuries of experience with onshore minerals, although such techniques have not been widely applied at sea. No major technological breakthroughs are considered to be needed to adapt onshore processing technologies to shipboard use, but considerable uncertainty remains about the costs and efficiency of operating a minerals processing plant at sea.

Shore-based v. at-sea minerals processing will be a trade-off that a seabed mining enterprise must consider. If shipboard processing is installed, it may be cheaper to transport smaller amounts of high-grade processed ore (beneficiated) than to haul large volumes of unprocessed ore containing as much as 85 to over 90 percent waste material to an onshore processing plant. Economic conditions that would influence such a decision could vary for each case.

ENVIRONMENTAL CONSIDERATIONS

Little direct experience exists with commercial offshore mining with which to estimate the potential for environmental harm.

Little direct experience exists with commercial offshore mining with which to estimate the potential for environmental harm. Even channel and harbor dredging operations or recovery of sand for beach nourishment, which have been studied in some detail, are sporadic operations and do not reflect the impacts that could result from long-term placer dredge mining operations that would move considerably more material from a larger area of the seafloor. Less is known about impacts to deep water environments than shallow water environments.

Physical disturbance from dredge mining operations will consist of removing a layer of the seafloor, conveying it to the surface, and reinjecting the unwanted material onto the seabed. The mining operation will generate a transient "plume' of sediment that will affect the surface, the water column, and adjacent areas of the oceanfloor for an uncertain period of time.

Experience with sand and gravel mining in Europe and with the dredging operations of the U.S. Army Corps of Engineers suggests that as long as sensitive areas (e. g., fish spawning and nursery grounds) are avoided, surface and mid-water effects from either shallow or deep water mining should be minimal and transient. Benthic communities assuredly will be destroyed if mined, and some nearby areas may be adversely affected by sediment returning to the seafloor, However, mining equipment can be designed to minimize such damage, and, except where rare animals occur, entire benthic populations are eliminated, or the substrate is permanently altered, the seafloor should recolonize. Recolonization is expected to take place quickly in high-energy, shallow water communities, but very slowly in deep-sea areas. If any at-sea processing of the mined material occurs —with subsequent discharge of chemicals-negative impacts would possibly be more severe.

It is not scientifically or economically feasible to research ecological baseline information on all of the marine environments that may be affected by seabed mining. Furthermore, the consequences of the range of possible mining scenarios are unknown. Anticipating and avoiding high-risk, sensitive areas and mitigating damage through improved equipment design and operating procedures can reduce the impacts from offshore mining. Environmental monitoring during the mining process will provide an additional margin of safety and add to the knowledge of what effects seabed mining might have on the marine environment as well. Concurrent observations in undisturbed control areas similar to those being mined could also provide an understanding of the processes at work.

> Anticipating and avoiding high-risk, sensitive areas and mitigating damage through improved equipment design and operating procedures can reduce the impacts from offshore mining.

What effects might extensive mining in shallow waters have on the coastline? The removal of large quantities of sand and gravel or placers in near-shore areas might alter the coastline and aggravate coastal erosion by altering waves and tides. Experience with sand removal off Grand Isle, Louisiana, for beach replenishment suggests that the mining of even small areas to substantial depths may cause serious damage to the shoreline. This potential problem requires considerably more investigation.

More, too, should be learned about the structure and energetic of deep-sea communities. However, to do so requires expensive submersibles and elaborate sampling equipment because of the difficulty of operating at great depths.

A considerable amount of environmental data already has been collected by a number of Federal agencies as part of their missions. Much of the information remains in the files of each agency, and only a small part finds its way into the public literature. Some of this environmental information could be useful in planning offshore mining operations. The public investment in such environmental information represents hundreds of millions

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COLLECTING AND MANAGING OCEANOGRAPHIC DATA

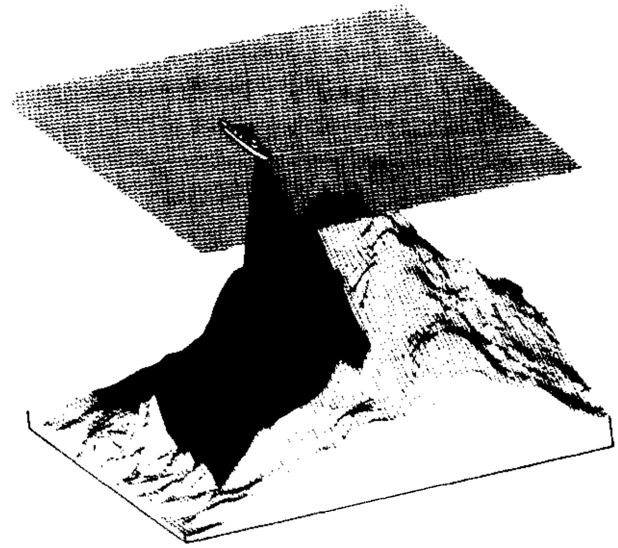
Several Federal agencies share responsibility for exploring various aspects of the U.S. EEZ. In addition, coastal States, oceanographic institutions, academic institutions, and private industry also contribute information and data about the Nation's offshore areas. All of these institutions, except the private firms, are funded primarily with public funds. The overall investment in collecting oceanographic data related to exploring the EEZ is not trivial, nor are the problems of coordinating exploration efforts and archiving the results.

At a time when the Federal Government is struggling to reduce the Federal budget deficit, it is important to ensure that Federal agencies coordinate their complementary and overlapping functions and promote a spirit of cooperation among investigators that will encourage efficiency and responsibility, With regard to EEZ exploratory programs, there have been notable and unprecedented achievements in cooperation and communication between the Department of the Interior (DOI) and NOAA during the last few years. USGS and NOAA have agreed to a division of effort in EEZ exploration and have taken steps to create a joint office to take the lead in integrating information from government and private sources. However, the Minerals Management Service, with responsibility for managing the Outer Continental Shelf mineral resources, and the Bureau of Mines, with responsibility for mining and minerals research and investigations, are not formally linked to the USGS-NOAA cooperative agreement.

About a dozen Federal agencies administer programs related to the exploration and investigation of the EEZ. The oceanographic and resource data produced by the numerous Federal programs and augmented by similar data collected by States, industry, and academic institutions make up an impressive body of information. The data sets are of highly variable quality and were collected in different places over different time periods. Some of these data are available to other researchers and the public through formal and informal exchanges among the institutions; other data, however, are less accessible.

As exploration of the EEZ increases in intensity, data management problems will worsen. Modern instruments, such as multi-beam echo-sounders, satellites, and multi-channel seismic reflection recorders, produce streams of digital data at high rates of speed. To succeed, a national exploration effort in the EEZ must effectively deal with the problems of compiling, archiving, manipulating, and disseminating a range of digital data and graphic information. Historically, Federal agencies have spent proportionately more on collecting the data than on archiving and managing databases compared to their counterparts in the private sector. Industry managers consider data collected in the course of investigations to be capital assets with future value; in general, the Federal agencies seem to consider data more as an inventory of limited long-term value and hence have spent less on data management.

There is no governmentwide policy for archiving and disseminating oceanographic data to secondary users. The National Science Foundation's Ocean Sciences Division has taken steps to ensure that data collected in the course of research it funds are submitted to NOAA's National Environmental Satellite, Data, and Information System. There are two national data centers that act as libraries for oceanographic and geophysical data: 1) National Oceanographic Data Center, and 2) National Geophysical Data Center. Both are managed by NOAA. Data at the centers are acquired from Federal agencies under interagency agreements; some agencies are more responsive and reliable in forwarding data to the centers than are others.



Modern multi-beam echo-sounding systems and computer mapping technologies can produce accurate topographic maps of the deep seabed, Mapping is the first step toward a systematic program for exploring the EEZ.

SOURCE: Naval Research Laboratory

Funds for the centers have never been adequate to provide effective oceanographic data services to secondary users in industry, academia, or State governments. As a result of chronically inadequate funding, the centers are neither able to acquire existing data sets that have intrinsic historical baseline value nor to preserve and store but a relatively small proportion of the new data that are currently being produced. Oceanographic data discarded for lack of storage facilities is a government asset lost forever.

Detailed charts of the seafloor, such as those produced by multi-beam echo-sounding instruments (e.g., Sea Beam), are considered to be invaluable tools for geologists and geophysicists exploring the

EEZ. Unfortunately, they are also considered to be invaluable tools for navigating and positioning potential hostile submarines within the EEZ. As a consequence, the U.S. Navy has taken steps to classify and restrict the public dissemination of high-resolution bathymetric charts produced by NOAA's National Ocean Services in the EEZ.

NOAA's plans for exploring the EEZ include broad-scale, atlas-like coverage of the EEZ with high-resolution bathymetry. The plan is applauded by the academic community, but the Navy, concerned about the national security implications of public release of such data, opposes NOAA's plan unless security can be assured. Negotiations between NOAA and the Navy continue in an attempt to resolve the classification issue. Suggestions by the Navy that bathymetric data may be skewed or altered in a random fashion to reduce its strategic usefulness have been met by protests from the research community that claim its usefulness for research also would be reduced.

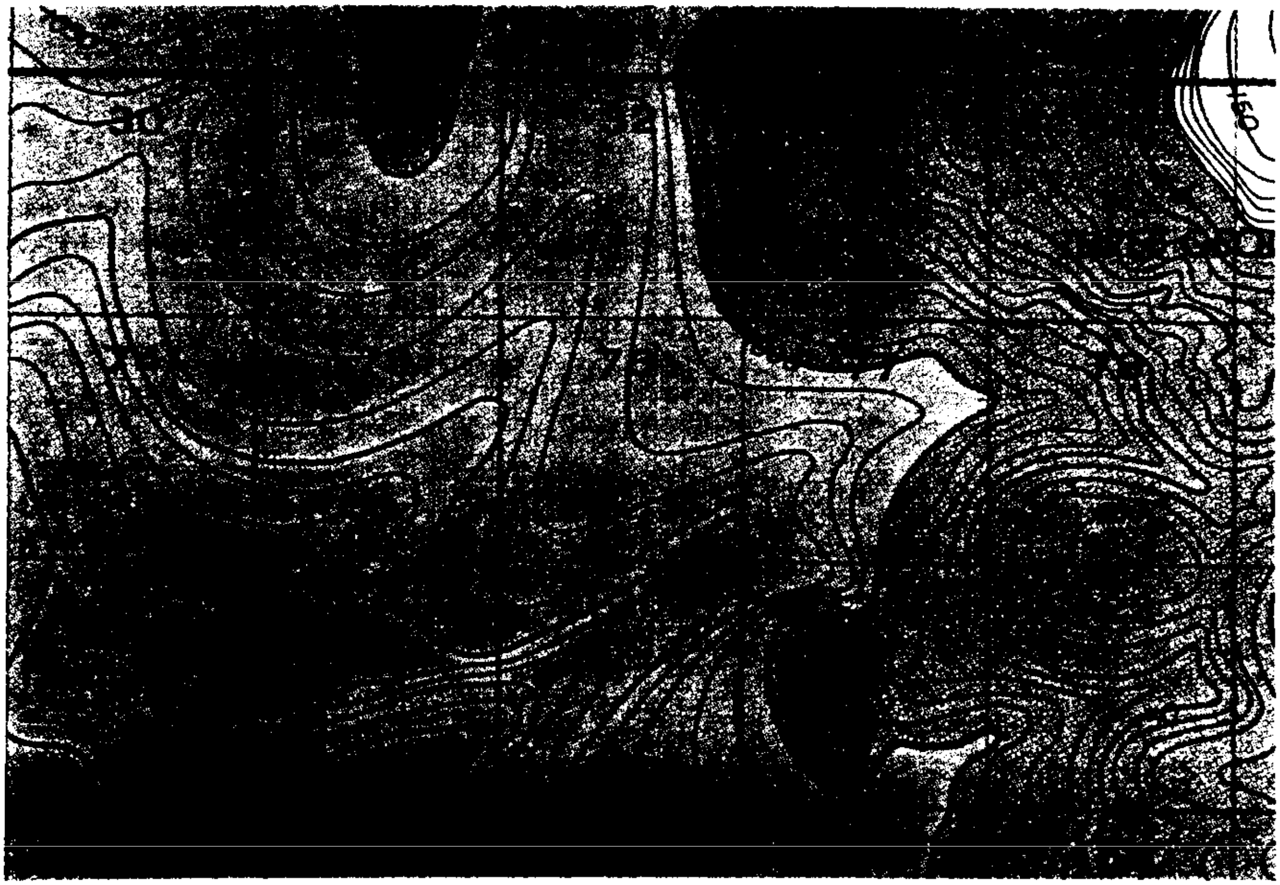
There is little doubt that the Navy's strategic concern over the value of high-resolution bathymetry to potentially hostile forces is well founded. However, critics of the Navy's position cite mitigating factors that they consider to undermine the Navy's security argument, such as the availability of multibeam technology in foreign vessels; the U.S. policy of open access for research in the EEZ, which would allow foreign vessels to gather similar data; and the stringent criteria for classification established by the Navy that could include existing bathymetric charts that have been in the public domain for some time.

The importance of high-resolution bathymetry to efficient exploration of the EEZ is apparent. Both the Navy and the scientific community have failed to effectively communicate their concerns to each other. To ensure that the scientific community has access to precise bathymetry to facilitate the exploration of the EEZ and at the same time to protect the national security, a flexible policy must be agreed to and supported by all parties. Undoubtedly, there will be appreciable financial costs connected to such a policy, but it should be considered a cost of doing the government's business in the modern, high-technology research environment.

Before the marine mining industry will invest substantially in commercial prospecting in the EEZ, it must have assurances that the Federal Government will encourage development and grant access to the private sector to explore and develop seabed minerals. While the Outer Continental Shelf Lands Act authorizes the Secretary of the Interior to lease non-energy minerals as well as oil and gas in the Outer Continental Shelf, little guidance is provided by the legislation for structuring a hard mineral leasing program. There also is disagreement as to whether the Secretary's mineral leasing authority can be extended to areas beyond the limits of the continental shelf in the EEZ. Furthermore, the bidding requirements for hard mineral leases, which require advance payment of money before a mine site is delineated, may not be workable for EEZ hard minerals. New marine mining legislation is needed to ensure the seabed mining industry that it will have a suitable Federal leasing program in place when it is needed.

SUMMARY AND FINDINGS

With a few possible exceptions (e. g., sand and gravel and precious metals), the commercial prospects for developing marine minerals within the Exclusive Economic Zone appear to be remote for the foreseeable future. There is currently no operational domestic seabed mining industry per se, although some international mining consortia have a continuing interest in deep seabed manganese nodules and perhaps cobalt-manganese crusts in the EEZ. One land-based mining company is currently operating a gold mining dredge in Alaskan State waters, and sand is being mined at the entrance to New York Harbor. Commercial interest in some near-shore placer deposits and Blake Plateau manganese nodules has occurred sporadically. Because of the economic uncertainties and financial risks of EEZ mining, it is doubtful that the private sector will undertake substantial exploration in the EEZ until



Advances in mapping technology have provided oceanographers with valuable detailed information about the depths and topography of the seafloor. However, the accuracy and precision of multi-beam and echo-sounding also makes the maps valuable for military navigation and positioning. (Old technology on this page; new technology opposite).

Source: National Geophysical Data Center, NOAA

more is known about marine minerals. Preliminary reconnaissance and exploration by the Federal agencies to determine mining opportunities, as well as assurances from Congress that the Federal Government will provide an appropriate administrative framework and economic climate to conduct business offshore, probably will be needed to interest the private sector in further prospecting and possible development.

The possible strategic importance of some EEZ minerals is additional justification for the United States to maintain momentum in exploring its offshore public domain. We know too little about the mineral resource potential of the EEZ to judge its long-term commercial viability or its strategic value in supplying critical minerals in times of emergency. A time may come, however, when it is judged that it is vital to the Nation that the Federal Government indirectly or directly support the offshore mining industry to maintain a competitive, strategic position in seabed mining relative to European countries, Japan, and other industrial nations.

The vastness of the U.S. EEZ requires that exploration proceed according to well-thought-out plans and priorities. Federal agencies will have to coordinate efforts, share equipment, and collaborate in a collegial atmosphere. Academicians, State personnel, and scientists and engineers from private industry also will be major participants in the Federal EEZ exploration program. To achieve this extraordinary level of collaboration inside and outside the Federal Government, a broad-based coordinating mechanism is likely to be needed to tie the various public, academic, and private sector EEZ activities together.

ISSUES AND OPTIONS

Although EEZ exploration costs could be large in the aggregate, there are several possible low-cost actions that Congress might take along the way to bolster the national effort by focusing the government exploration effort and improving Federal agency performance through better communication, coordination, and planning. The major needs of the fledgling U.S. ocean mining industry might be best met through appropriate legislation aimed at providing a suitable Federal administrative management framework.

Focusing *the National Exploration Effort*

Responsibility for various aspects of EEZ minerals exploration is shared by several Federal agencies: U.S. Geological Survey, National Oceanic and Atmospheric Administration, Minerals Management Service, U.S. Bureau of Mines, U.S. Navy, U.S. Army Corps of Engineers, National Aeronautics and Space Administration, Department of Energy, Environmental Protection Agency, National Science Foundation, and several other contributing agencies. Moreover, the major academic oceanographic institutions—Scripps Institution of Oceanography, Woods Hole Oceanographic Institution, Lamont-Doherty Geological Observatory—play a key role in the pursuit of scientific knowledge about the seafloor and the ocean environment, as do a large number of marine scientists at many universities and colleges throughout the country.

State agency efforts, though modest in comparison to the Federal programs, are focused on the 3-mile territorial sea under the coastal State's con-

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> . . . it is important to ensure that Federal agencies coordinate their complementary and overlapping functions. . . .

trol and provide an important adjunct to the Federal exploration efforts. The offshore mining industry's stake in the outcome of the Federal EEZ exploration program also necessitates that the industry be a major contributor to national EEZ planning.

With the large number of actors involved in collecting EEZ information, it is important that their efforts be focused and coordinated through a national exploration plan-yet no such planning process currently exists. In an effort to coordinate EEZ activities in NOAA and USGS, these two agencies recently established a joint EEZ office (Joint Office for Mapping and Research) to foster communication between them and to establish an EEZ point of contact for the public. The joint EEZ office is a positive step towards coordination, but its activities apply principally to the sponsoring agencies and there is no separate funding for this office.

MMS also has made efforts to improve communications and information transfer with the coastal States regarding anticipated offshore mineral leasing in the EEZ. State-Federal working groups have been organized for cobalt crusts off Hawaii; polymetallic sulfides and placers off Washington, Oregon, and California; phosphorites off North Carolina; heavy mineral sands off Georgia; and placers in the Gulf of Mexico. Such efforts to coordinate Federal EEZ activities are good as far as they go, but they fall short of providing the comprehensive focus needed to integrate the full range of government activities with those of the States, academic institutions, and the seabed mining industry.

Faced with a similar planning and coordination problem in Arctic research, Congress enacted the Arctic Research and Policy Act (Public Law 98-373) in 1984. The Act established an Interagency Arctic Research Policy Committee composed of the 10 key agencies involved in Arctic research, A parallel organization, the Arctic Research Commission, was concurrently established to represent the academic community, State and private interests, and residents of the Arctic and to advise the Federal Government. The Federal Interagency Arctic Research Policy Committee and the Arctic Research Commission are charged with developing 5-year Arctic research plan which includes goals and priorities. Budget requests for funding of Arctic research for each Federal agency under the plan are to be considered by the Office of Management and Budget (OMB) as a single "integrated, coherent, and multi-agency request' (Sec. 110). The Arctic Research and Policy Act does not authorize additional funding for Arctic research. Each Federal agency designates a portion of its proposed budget for "Arctic research" for the purpose of OMB review.

Congress opted for a similar solution to coordinate multi-agency research activities in acid precipitation. Title VII of the Energy Security Act of 1980 (Public Law 96-294) established an Acid Precipitation Task Force, consisting of 12 Federal agencies, 4 National Laboratories, and 4 presidential appointees from the public. The Task Force was assigned responsibility for developing and managing a 10-year research plan. Funds ($5 million) were authorized by the Act to underwrite the cost of developing the plan and to support the Task Force. Research funds requested by the Federal agencies (comprising each agency's acid precipitation research budgets) are combined annually into a National Acid Precipitation Assessment Program budget that is submitted to OMB as a unit.

Both the Arctic Research and Policy Act and Title VII of the Energy Security Act may be considered prototypes for focusing, planning, budgeting, and coordinating Federal exploration and research activities in the EEZ. Neither Act has proved to be expensive, nor has either unduly encroached on the autonomy, jurisdiction, or missions of the individual agencies. Neither Act authorizes or earmarks special funds for its intended purposes (except to offset the cost of plans and administration), but collective budgets are presented to OMB along with plans and programs to justify the expenditure of the requested funds. Both approaches build in participation from the general public and the private sector in developing research plans.

Another approach to interagency planning and coordination is used for marine pollution. The National Ocean Pollution Planning Act of 1978 (Public Law 95-273) designates NOAA as the lead agency for compiling a 5-year plan for Federal ocean pollution research and development (R&D), a plan that is revised every 3 years. The National Marine Pollution Program links the R&D activities of 11 Federal agencies, establishes priorities, and reviews the budgets of the agencies with regard to the goals of the program and screens them for unnecessary duplication. Public participation in Federal planning is fostered through workshops at which marine pollution R&D progress is reviewed and future trends and priorities discussed. Each agency submits its own budget request to OMB, but appropriations are authorized to cover NOAA's expenses for preparing the plan and monitoring progress. In 1986, the Act was amended to provide for an interagency board that will review individual agency budget requests in the context of the current 5-year plan.

Congressional Options

Option 1: Establish an interagency planning and coordinating committee within the executive branch and a public advisory commission similar to those created in the Arctic Research and Policy Act, with Federal agency budgets submitted separately to OMB.

Congressional Action: Enact authorizing legislation.

Option 2: Establish an interagency planning and coordinating task force composed of Federal agency representatives and public members similar to the task force established for acid precipitation R&D by the National Energy Security Act, with a budget request combining all agency budgets in a single EEZ document.

Congressional Action: Enact authorizing legislation.

Option 3: Mandate interagency planning and coordination and assign lead-agency responsibility to a single agency as Congress did in the National Ocean Pollution Research and Development and Monitoring Act of 1978.

Congressional Action: Enact authorizing legislation.

Option 4: Allow ad hoc cooperation and coordination to continue at the discretion of Federal agency administrators.

Congressional Action: No action required.

Advantages and Disadvantages

Congress has attempted in various ways to improve the planning and coordination of government functions among Federal agencies with related missions. Informal agency coordination has largely failed in the past, although the track record of interagency coordination groups has had mixed results. To be effective, interagency coordinating mechanisms must have means to coordinate both the programs and budgets of the agencies. The success of *ad hoc* agency coordination depends primarily on comity and cooperation among government managers. Therefore, personnel changes, which happen frequently at high levels of the Federal Government, can alter an otherwise amiable relationship among the agencies and destroy what may have been an effective coordination effort.

Efforts by Congress to improve agency accountability, planning, coordination, and budgeting through legislation have also met with mixed results. Some laws require elaborate plans that must be updated periodically and transmitted concurrently to Congress and the President. Other statutes require that annual reports be similarly compiled and transmitted. Such information can be useful to Congress in carrying out its oversight responsibility for agency performance and may be useful to the President in his capacity as "chief executive officer' of the Federal Government.

The extent to which congressional committees and the President effectively use these agency plans, programs, and reports required by law varies considerably. In some cases, agency plans and programs receive little or no attention from Congress; in other cases, such as the MMS 5-year leasing program required under the Outer Continental Shelf Lands Act, the planning document often becomes the focus of public debate.

Although Federal agencies often have closely related functions, their budgets are generally formulated with little or no mutual consultation. Furthermore, budget examiners at OMB who are responsible for the review of individual agencies seldom collaborate with other OMB examiners who are responsible for other agencies with similar programs (e. g., NOAA's budget is reviewed by a different OMB budget examiner than is DOI). A similar situation exists within Congress among the appropriations subcommittees that are responsible for individual agency appropriations. To remedy this problem, Congress has in several cases mandated that "cross-cutting" budget analyses be prepared for related multiple-agency activities so that the entire range of funds directed toward a specific effort can be easily seen. Cross-cutting budget analyses are required in the Arctic Research and Policy Act, Title VII of the Energy Security Act, and the National Ocean Pollution Research and Development and Monitoring Act of 1978.

OMB exercises nearly omnipotent control over the funding levels recommended in the President's budget that is submitted to Congress each year. Program budgets that are presented to Congress are arrived at through a byzantine negotiation process that involves OMB, Cabinet departments, agencies within the departments, programs within agencies, and finally, if appealed, the President. The budget process is internal, and neither the public nor Congress is privy to the negotiations.

Congress has attempted to open the executive branch budget process to more public scrutiny by directing the agencies by statute to submit recommended program budgets directly to Congress as part of the interagency planning and coordination process without prior review by OMB; the National Ocean Pollution Research and Development and Monitoring Act uses this mechanism. Although the approach appears reasonable in theory, it seldom—if ever—works in reality. OMB continues to maintain its authority over all budget recommendations transmitted to Congress from within the executive branch.

Unified budget submissions to OMB accompanied by cross-cutting budget analyses and program plans that justify the funding levels, such as provided in both the Arctic Research and Policy Act and Title VII of the Energy Security Act, seem to work reasonably well for developing rational interagency budgets within the normal budget process. As currently implemented under the Energy Security Act, unified budget submissions from several agencies in a single document covering acid precipitation have the advantage of earmarking funds specifically for research in each agency as if it were a line item in the budget; on the other hand, the Arctic Research and Policy Act merely requires that Arctic R&D be "designated" in the normal agency budget submissions to OMB. The budget procedures under the Energy Security Act focus more directly on the multi-agency budget related to acid precipitation rather than on the single budget of each agency. The National Ocean Pollution Research and Development and Monitoring Act provides little advantage over the normal agency budgeting process.

Providing for Future Seabed Mining

The Outer Continental Shelf Lands Act (OCSLA) authorizes the Secretary of the Interior to lease minerals in the Outer Continental Shelf. Although the main thrust of OCSLA is directed toward oil and gas, provisions are also included for leasing sulfur (Sec. 8[i] and [j]), and other minerals (Sec. 8[k]). Sulfur has been mined in the Gulf of Mexico since 1960 using borehole solution mining techniques. Because of the similarities between sulfur mining and oil and gas extraction, DOI applies to sulfur the same general regulations that govern petroleum operations.[13] When OCSLA was enacted in 1953, little **was** known about hard minerals in the continental shelf. Scientists were aware of their existence, but technology was then not generally available for either exploring or mining the seabed for hard mineral deposits.

DOI claims jurisdiction under OCSLA to all offshore areas seaward of the territorial sea over which the United States asserts jurisdiction and control. Since the United States is not a party to the Law of the Sea Convention, the only applicable treaty recognized by DOI as affecting offshore jurisdiction is the 1958 Convention on the Continental Shelf.[14] The 1958 Convention authorizes **coastal**

[12] Public Law 83-212; 67 Stat. 462, **Aug.** 7, **1953; 43 U.** S.C. 1331-**1356; as amended by Public Law 93-627; 88 Stat. 2126, Jan. 3, 1975; and 95-372; 92 Stat. 629, Sept.** 18, **1978.**

1330 *Code of Federal Regulations,* ch. **II, part** 250.

I+ Convention on the Continental **Shelf,** *in force* **June** 10, 1964, 15 **UST 471, TIAS No. 5578, 499 U.** N.T. **S. 311.**

> Before the marine mining industry will invest substantially in commercial prospecting in the EEZ, it must have assurances that the Federal Government will encourage development and grant access to the private sector to explore and develop seabed minerals.

State control over the seabed to a depth of 200 meters or beyond "where the depth of the superjacent water admits of the exploitation of the natural resources. DOI concludes that the concept of 'exploitability y" in the 1958 Convention further supports the department's opinion that the legal continental shelf includes the breadth of the 200-mile Exclusive Economic Zone, regardless of the physical attributes of the submarine area.

DOI's Minerals Management Service most recently attempted to lease hard minerals in March 1983, when plans were announced to prepare an environmental impact statement for a proposed lease sale of polymetallic sulfide minerals associated with the Gorda Ridge geological complex.[15] Authority for the proposed lease sale was based on Section 8(k) of OCSLA.[16] The site of the mineral deposits of the Gorda Ridge is a tectonic spreading center and, therefore, is not part of the geological continental shelf. DOI based its authority to lease the area on the definition of the "legal' continental shelf implied in Section 2(a) of OCSLA.[17] The Gorda Ridge lease sale is yet to be held, but, in March 1987, MMS published proposed rules for prelease prospecting for non-energy marine minerals.[18] The prelease prospecting rules are the first of a three-tier regulatory program proposed by MMS; future rules would cover leasing and post-leasing operations.

Environmental groups and industry representatives have questioned DOI's leasing authority under OCSLA, claiming that DOI is misinterpreting the 1958 Convention by delineating the breadth of the continental shelf to include the 200-mile EEZ by using the "exploitability" definition in OCSLA. These groups have asserted that no U.S. agency has statutory authority to grant leases or licenses to recover hard minerals from the seafloor beyond the Outer Continental Shelf, except for NOAA which has authority to license commercial manganese nodule mining only. There is no disagreement that DOI has authority to lease hard minerals in the Outer Continental Shelf. The controversy extends only to how far that authority extends seaward beyond the geological continental shelf,

Notwithstanding the legal question of whether DOI has legislative authority to lease in the 200-mile EEZ beyond the geographical limits of the continental shelf, questions remain about the adequacy of the Outer Continental Shelf Lands Act for administering an EEZ hard minerals leasing program.

Several shortcomings limit OCSLA's suitability for managing hard minerals in either the Outer Continental Shelf or the EEZ:

- DOI is given little congressional guidance for planning, environmental guidelines, intergovernmental coordination, and other administrative details needed for structuring a hard mineral leasing regime under Section 8(k) of OCSLA.
- Section 8(k) of the Act is discretionary with the Secretary of the Interior; thus, there are no assurances to the industry that a stable, predictable leasing program will be continued by subsequent administrations,
- Bonus bid competitive leasing requirements (money paid to the government before exploration or development begins) set forth in Section 7(k) of OCSLA are not well suited for stimulating exploration and development of seabed hard minerals by the private sector.
- The Outer Continental Shelf Lands Act does not apply to the territories; therefore, the Minerals Management Service may not have authority to lease in a large area of the EEZ adjacent to the U.S. Territories.[19]

[15] "Scoping Notice to Prepare an Environmental Impact Statement, *Federal Register*, vol. 48, Mar. 28, 1983, p. 12840,

[16] Sec. 8(k): "The Secretary is authorized to grant to the qualified persons offering the highest bonuses on a basis of competitive bidding leases of any mineral other than oil, gas, and sulfur in any area of the Outer Continental Shelf not then under lease for such mineral upon such royalty, rental, and other terms and conditions as the Secretary may prescribe at the time of offering the area for lease.

[17] 'Frank K. Richardson, ' 'Opinion of the Solicitor, ' U.S. Department of the Interior, May 30, 1985.

[18] *Federal Register*, vol. 52, Mar. 26, 1987, p. 9753.

[19] The narrow definition of the term "State as used in the Sub-

(continued on next page)

An ad hoc working group consisting of representatives of the marine minerals industry, environmental groups, coastal States, and academicians was formed in 1986 to develop a conceptual framework for managing marine minerals in the EEZ. After several meetings, the members reached a consensus that the Outer Continental Shelf Lands Act was unsuitable for administering a seabed hard minerals exploration and development program, and that new "stand-alone' legislation is needed to replace the oil- and gas-oriented OCSLA.[20] The working group recommended that the authorizing legislation should:

1. use the Deep Seabed Hard Minerals Resources Act (Public Law 96-283) mining provisions and its regime for public participation and multiple-use conflict resolution as a model for new EEZ seabed mining legislation;
2. provide for a comprehensive and systematic research plan including bathymetric charting, mineral reconnaissance, and environmental baseline studies;
3. require wide public dissemination of data but protect confidential information;
4. provide incentives for private industry to collect and contribute to the resource information base;
5. apply legislation to all areas within the U.S. EEZ and the territories consistent with U.S. authority and obligations; and
6. provide for effective Federal/State/local consultation.

Legislation was introduced in both the 99th and 100th Congresses to establish a regime for exploring and developing hard minerals in the EEZ.[21] H.R. 1260, The National Seabed Hard Minerals Act of 1987, includes many of the suggestions by the ad hoc working group.

According to DOI, MMS's proposed rules for prelease prospecting of marine minerals is a first step toward providing access for private industry to obtain geologic and geophysical information about the EEZ (box 1-C). With the likelihood that development of EEZ minerals will not take place any time soon, the promulgation of acceptable prelease prospecting rules under OCSLA maybe sufficient to allow preliminary prospecting by the industry while Congress formulates and enacts EEZ seabed mining legislation that overcomes the deficiencies of OCSLA.

Congressional Options

Option 1: Enact "stand-alone' legislation for exploring and developing minerals in the U.S. EEZ patterned after the Deep Seabed Hard Minerals Resources Act.

Congressional Action: Enact new legislation.

Option 2: Amend the Outer Continental Shelf Lands Act by adding a new title to apply exclusively to marine hard minerals in the EEZ.

Congressional Action: Amend the Outer Continental Shelf Lands Act.

Option 3: Amend the Outer Continental Shelf Lands Act to extend its application to U.S. territories and possessions. Section 8(k) could either be amended to provide guidelines for marine hard mineral leasing or be allowed to remain in its present form. The Outer Continental Shelf also might be redefined so as to be identical to the Exclusive Economic Zone.

Congressional Action: Amend the Outer Continental Shelf Lands Act.

Option 4: Permit the Minerals Management Service to continue to develop a regulatory system based on its authority under the Outer Continental Shelf Lands Act, but amend Section 8(k) to provide more specific guidance for administration, planning, and coordination.

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merged Lands Act and incorporated into the Outer Continental Shelf Land Act (Sec. 6[e]) limits the applicability of OCSLA to the waters off "any State of the Union. This definition contrasts with other laws that specify Congress' intent to extend their effect to the territories as well.

[20] Clifton Curt is, President, Oceanic Society, Memorandum, Apr. 1, 1986, to Ann Dore McLaughlin, Under Secretary of the Interior.

[21] H. R. 1260, National Seabed Hard Minerals Act, 100th Cong., 1st sess., Feb. 25, 1987; H.R. 5464, 99th Cong., Sponsor: Lowry et al. Another bill would impose a temporary moratorium on seabed mining in the Gorda Ridge, H. R. 787, Ocean Mineral Resources Development Act, 100th Cong., 1st sess., Jan. 28, 1987, Sponsor: Bosco.

Box 1-C.—Prelease Prospecting for Marine Mining Minerals in the EEZ: Minerals Management Service Proposed Rules

The Minerals Management Service (MMS) published in the *Federal Register*, Mar. 26, 1987, pp. 9758-9766, proposed rules for marine minerals prospecting in the EEZ. Prospecting for all minerals except oil, gas, and sulfur would be covered by the proposed rules. Covered activities include operations such as those normally carried out by mineral explorations and university researchers. The Department of the Interior believes that promulgation of prospecting regulations is an important step in ensuring the industry access to the U.S. Exclusive Economic Zone for the purpose of mineral exploration. The effect of the proposed regulations is far reaching, and would cover "operations such as those normally carried out by mineral explorationists and university researchers."

The following provisions are proposed by MMS:

- *Term of Permit*— Two years, with extension for good cause.
- *Prospecting Plan*—An application for a permit must be accompanied by a description of the proposed geological and geophysical activities, including anticipated environmental impacts and appropriate mitigation measures. Drill holes deeper than 300 feet require additional information.
- *Reporting*—Quarterly reports required with final report to include charts, summary of mineral occurrences, and identification of environmental hazards.
- *Environmental*—A list of exploration technologies considered environmentally safe are included. The use of explosives, trenching, dredging, and excessive drilling requires special approval.
- *States*—Governors of adjacent States are notified upon application by prospectors, and the States may comment on the application. If an environmental impact statement is required, States may review and [redacted]
- [redacted] procedures and restrictions.

No special property rights or preferences to a mineral lease are given to a permittee as a consequence of being granted a prospecting permit. The Minerals Management Service has announced intentions to promulgate leasing and postleasing rules to follow the prospecting regulations.

Congressional Action: Amend the Outer Continental Shelf Lands Act.

Option 5: Allow the Minerals Management Service to continue to develop a regulatory system for preleasing, leasing, and postlease management of Outer Continental Shelf hard minerals under the existing provisions of Section 8(k).

Congressional Action: No action required.

Advantages and Disadvantages

Whether new EEZ mining legislation is incorporated as a separate title to the Outer Continental Shelf Lands Act or is enacted as a "stand-alone" law would make little difference so far as the effect of the statute is concerned. However, stand-alone legislation might relieve the concerns of oil and gas interests that fear opening the Outer Continental Shelf Lands Act up to amendment of Section 8(k) or adding a new EEZ seabed mining title might make the Act vulnerable to amendments affecting the offshore oil and gas resource leasing program.

Should Congress decide not to enact separate EEZ seabed mining legislation through a stand-alone law, or a separate title in the Outer Continental Shelf Lands Act, or amendments to Section 8(k) of OCSLA, the Minerals Management Service could continue to promulgate seabed mining legislation under the current authority of Section 8(k) of OCSLA. However, leasing authority under Section 8(k) pertains only to the continental shelf adjacent to "States of the Union, " and, therefore, the Minerals Management Service probably lacks authority to lease seabed minerals in the EEZ off Johnston Island and adjacent to the other Pacific trust territories and possessions.

U.S. innovation and engineering know-how applied to developing seabed mining technology could place the United States in a pivotal competitive position to exploit a world market. . . for seabed mining equipment.

Congress also has the option of merely broadening the geographical coverage of the Outer Continental Shelf Lands Act to include the U.S. territories and possessions. Such action, if it applied to the Act in general, would also open these areas to potential oil and gas leasing in the future, although the EEZs of most of the territories and possessions are not known to have oil and gas potential. If Congress chose to redefine the Outer Continental Shelf and make it identical to the EEZ, the status of the oil and gas leasing program might be clarified in some areas of legal uncertainty beyond the continental shelf but within the 200-nautical mile zone.

Improving the Use of the Nation's EEZ Data and Information

Oceanographic data collected in the course of exploring the EEZ are a national asset. Because of the immense size of the U.S. EEZ, exploration activities are likely to continue for decades. Information and data may take many forms, may differ in quality, may come from many geographical areas, and may be collected by many agencies and entities. It is important that such data be evaluated, archived, processed, and made available to a wide range of potential users in the future.

As the pace of EEZ exploration increases, the existing Federal oceanographic data systems—which are currently taxed near their capacity based on available funding and resources—probably will be unable to adequately manage the load. Even today, in some cases, data must be discarded for lack of storage and handling facilities, and user services are limited. In other cases, Federal agencies sometimes do not submit data acquired at public expense to the National Oceanographic Data Center or the National Geophysical Data Center in a timely and systematic manner.

Limitations on the national data centers are primarily institutional, budgetary, and service-connected. Funding for data archiving and dissemination generally has been considered a lower priority by the Federal agencies than data collection. The historical usefulness of oceanographic, environmental, and resource information is often overlooked by Federal managers with mission-oriented responsibilities.

Consistent policies for transmittal of EEZ-related information to the national data centers are lacking in many Federal agencies. However, inventories of data collected by the academic community under the auspices of the National Science Foundation's Division of Ocean Sciences are required to be transmitted to the national data centers in a timely manner as a condition of its research grants. The Ocean Science Division's ocean data policy is an excellent example that other Federal agencies might emulate.

But even with more effective policies to ensure transmittal of EEZ information to the national data centers, little improvement in efficiency can be expected unless resources—both equipment and personnel-- are upgraded and expanded commensurate with the expected increase in the workload. The mere "storage' of data does not fulfill the national need; such information must be retrievable and made available to a wide range of potential users, including Federal agencies, State agencies, academia, industry, and the general public.

Improved data services will require additional funds to raise the level of capability and performance of the existing national data centers. Eventually, regional data centers may be required to adequately service the public needs; but for the time being the major Federal effort aimed at improving data services probably should be directed at upgrading the performance of the existing centers.

Congressional Options

Option 1: Direct each Federal agency to establish an EEZ data policy that will ensure the timely and systematic transmittal of oceanographic data to either the National Oceanographic Data Center or the National Geophysical Data Center, whichever is appropriate.

Congressional Action:

a. Amend authorizing legislation for each appropriate program and/or Federal agency.
b. Direct action through the annual appropriations process.
c. Enact general legislation that would apply to all Federal agencies collecting EEZ data and information.

Option 2: Provide additional funds and directives to the National Oceanographic Data Center and the National Geophysical Data Center to upgrade EEZ data services according to a plan, to be developed by the National Oceanic and Atmospheric Administration, for meeting the future needs of archiving and disseminating EEZ data and information.

Congressional Action: Issue directive through the annual appropriations process.

Option 3: Continue at the current level of funding and continue to permit the Federal agencies to transmit EEZ-related information to the National Oceanographic Data Center and the National Geophysical Data Center at each agency's discretion.

Congressional Action: No action required.

Advantages and Disadvantages

Incentives for the agencies and the academic community to place more emphasis on data services could take several forms. Since improvements in data services are tied to adequate funding, the most expedient approach for Congress would be to direct appropriate agency actions through the annual appropriations process. This option, however, would only be effective for one budget cycle and would have to be repeated annually if an effective long-term data services program were to continue.

Amendments to individual agency authorizing legislation, or alternative "umbrella" legislation applicable to all agencies collecting EEZ data and information, would establish continuing programs to improve data services. Long-term plans for meeting the expanding EEZ data needs of the future should provide guidelines for improving overall government data services.

Providing for the Use of Classified Data

National security may require that public dissemination and use of certain EEZ-related data continue to be restricted. This restriction may result in some hardship and perhaps additional expense to the scientific community as well as the marine minerals industry, but it need not totally lock up that information. There are responsible ways in which classified data can be made available to those needing to use such data for further EEZ exploration.

Federal personnel, contractors, and academicians in many technical and engineering fields have access to and routinely use classified information on a daily basis. While maintaining security installations is sometimes unwieldy and expensive, it may be possible to achieve a compromise between the national need for security and the national need for timely and efficient exploration of the EEZ by establishing secure data centers to manage classified EEZ data.

Other aspects of EEZ data classification may prove to be more troublesome. The ocean science community may be restricted from publishing some EEZ data or information that would, if unclassified, be freely available in the scientific literature. There are also inconsistencies in U.S. policy regarding scientific access of foreign investigators to the U.S. EEZ and the Navy's access to foreign EEZs to gather hydrographic information that seem at odds with current EEZ data classification policies. Diplomatic questions may arise from these inconsistencies that could result in access restriction for U.S. scientists working in the EEZs of other countries.

Congressional Options

Option 1: Establish regional classified data centers at major oceanographic institutions or at colleges and universities, with access assured for certified scientists and with guidelines established for the use and publication of data sets and bathymetric information.

Congressional Action: Direct the Department of Defense in collaboration with the National Oceanic and Atmospheric Adminis-

tration to establish regional classified centers under contract with academic institutions for the operation and administration of the centers, or consider Federal operation of such centers.

Option 2: Review the current EEZ data classification policies and assess their possible effects on academic research and their possible international impacts on access to other countries' EEZs by U.S. scientists.

Congressional Action: Hold oversight hearing on Navy's classification policies and procedures.

Option 3: Continue to allow the National Oceanic and Atmospheric Administration and the Navy to seek a solution to the EEZ data classification problem.

Congressional Action: No legislative action required.

Advantages and Disadvantages

The cost of establishing and operating regional classified data centers either at academic institutions or at Federal centers is likely to be significant. There also may be policies at some of the academic institutions that prohibit the location of classified data centers at their facilities.

Congress may choose to learn more about the details of the need for classification of EEZ data and the impact that classification restrictions might have on scientific activities and commercial exploration before it takes further action. Classified hearings may be needed to fully evaluate the security implications of EEZ data.

Without either legislative or oversight activities by Congress, the uncertainties regarding the future availability of classified data may continue for some time until mutual agreement is reached between the Navy and the National Oceanic and Atmospheric Administration.

Assisting the States in Preparing for Future Seabed Mining

The first major U.S. efforts to commercially exploit marine minerals are likely to occur in State waters. Most coastal States do not currently have statutes suitable for administering a marine minerals exploration and development program. Many States do not separate onshore from offshore development, providing only a single administrative process for all mineral resources. Four of the States —California, Oregon, Texas, and Washington— separate the leasing of oil and gas from other minerals, but most do not.

Oregon has completed surveys of its coastal waters, and Florida, Louisiana, Maine, Maryland, New Hampshire, North Carolina, and Virginia are among the States where offshore surveys are continuing. These survey programs are often cooperative efforts between the States, the U.S. Geological Survey, and the Minerals Management Service. State-Federal task forces formed through the initiatives of the Department of the Interior are assisting the coastal States in coordinating their efforts with marine minerals exploration currently taking place in the EEZ. State-Federal task forces have been formed in Hawaii (cobalt-manganese crusts), Oregon and California (polymetallic sulfides in the Gorda Ridge), North Carolina (phosphorites), Georgia (heavy mineral sands), and the Gulf States (sand, gravel, and heavy minerals off Alabama, Louisiana, Mississippi, and Texas),

The Federal Government could provide valuable technical assistance to the States in preparing for possible exploration and development of marine minerals in nearshore State waters. The Federal-State task forces are currently coordinating the States' and DOI's activities in the EEZ, but further assistance may be needed in formulating State legislation for leasing, permitting, or licensing marine minerals activities in the States' territorial seas.

Such legislative initiatives must originate with the individual States, but the Federal Government could provide assistance through existing programs such as those authorized by the Coastal Zone Management Act. Private organizations, such as the Coastal States Organization or the National Governors Association, could also serve as a catalyst and guide to States for developing legislative concepts or model seabed mining legislation.

Congressional Options

Option 1: Direct the National Oceanic and Atmospheric Administration's Office of Ocean and Coastal Resource Management to provide technical assistance and financial support to coastal States' coastal zone management programs to formulate State marine minerals management legislation through the Coastal Zone Management Act, Section 309 grants program.

Congressional Action: Issue directive through the annual appropriations process,

Option 2: Direct the Minerals Management Service to provide technical assistance to the States to aid in formulating marine minerals legislation that could provide an interface between marine minerals activities in the EEZ adjacent to the States' territorial seas.

Congressional Action: Issue directive through the annual appropriations process.

Option 3: Provide technical assistance and funds to the coastal States to aid in formulating marine minerals legislation through seabed miring legislation enacted as a "stand-alone' statute, amendments to Section 8(k) of the Outer Continental Shelf Lands Act, or through a new title in the Outer Continental Shelf Lands Act.

Congressional Action: Enact stand-alone legislation or amend the Outer Continental Shelf Lands Act.

Option 4: Rely on the individual initiative of the coastal States to undertake a legislative effort to formulate marine minerals legislation.

Congressional Action: No action required.

Advantages and Disadvantages

Directives to agencies through the annual appropriations process are often followed to the minimal extent possible and only apply to the expenditure of funds during the specific fiscal year. Authorizing legislation is probably needed to ensure a continuing, long-term effort.