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# Economics of Undersea Resources

by Ingo Walter, New York \*

**The open seas have recently become recognized as a major resource on which the world is likely to grow increasingly dependent in the years ahead. With regard to their exploitation questions of efficiency and equity have arisen that are being fought out primarily within the UN Conference on the Law of the Sea the sixth round of which ended last month, once again without any concrete results. Professor Walter explains what is at stake.**

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The oceans provide economic services in five different ways: as highways of trade, as a source of food, as a waste disposal facility, as a source of energy, and as a source of basic materials. The first three of these are the *traditional* uses of the sea. The last two are *new* uses that are now rapidly gaining in importance and triggering some dramatic changes in the rules of the game.

Traditionally, the use of the seas has been free to all, with unrestricted navigation and fishing rights in international waters, and the freedom to pollute essentially taken for granted. Increasingly, though, population and income growth — together with technical change and dwindling alternatives — have raised the prospective economic value of the seas as a resource. Fish can be caught and processed in great numbers at low cost. Petroleum can be recovered at substantial depths and under adverse weather conditions. Growing materials scarcity and new techniques may soon permit economical mining of the ocean floor. All of these economic gains flow from something that nobody owns or controls, that nobody has felt the need to conserve or invest in, and that only those with the capital and the knowhow are in a favourable position to exploit.

Major questions of efficiency and equity have thus arisen — questions that have triggered both an enormous land-grab via creation of national 200-mile exclusive economic zones (EEZs), as well as an international effort to allocate and safeguard what remains unclaimed of the world's oceans. At the same time, the traditional use of the seas for navigation is being threatened, with over 100 international straits like Gibraltar and Malacca less than 24 miles wide. Twelve-mile territorial limits thus present the riparian nations with a prospec-

tive economic asset, while major maritime powers face a serious dilemma — the desire for continued freedom of navigation for commerce and defense versus the desire to obtain the largest possible share of the sea's potential wealth.

## Fisheries

While fishing is not a seabed resource, historically it clearly has been the single most important marine asset. It is also the issue that has brought much of the debate about undersea resources to a head. And given the long-term world food outlook, it is likely to become still more important before very long. Rapid improvements in fishing technology have raised the global catch from 40 to 70 mn tons annually between 1960 and 1976. Increased efficiency has also depleted stocks and led to overfishing, however, and this is the natural outgrowth of what economists call the "free rider principle". And so there has been increased pressure for nationally-managed fishing zones, as established earlier this year by the United States. The species approach is frequently used, with estimates of maximum sustainable yields allocated first to domestic fleets and the residual going to foreign fleets. It is likely to cause significant changes in the structure of the global fishing industry and in patterns of international trade. Yet there remains a great deal of uncertainty regarding sustainable yields and the ultimate results of the 200-mile EEZ on the fishing industry itself and on fish stocks. The wording of the US law adds still more uncertainty by replacing sustainable yield with "optimum yield", defined as that which provides the greatest "overall benefit" to the nation, taking into account relevant economic, social, or ecological factors. That fuzzy wording in the law, plus the fact that administration is largely in the hands of regional fisheries management councils of unknown competence, means that still more uncertainty is introduced.

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The size of the exclusive economic zones of all coastal states put together is staggering, encompassing roughly 24 p.c. of the earth's surface. Nor is it evenly distributed, with 10 countries getting about a third of the total and countries that are landlocked or having short coastlines getting nothing or very little. The paradox is that only by nationalizing large fishing areas can yields be sustained. This is because under existing conditions only national control creates the *property rights* needed to induce investment — abstention from current yields to promote future yields. Without them, nobody invests because nobody can claim exclusive rights to the incremental future output that results, and so overfishing is the inevitable consequence. Under nationalization the state becomes the sole owner, and can manage the resource so as to assure maximum long-term flows of benefits. And so the 200-mile EEZs from an economic point of view make a great deal of sense in terms of resource conservation and obtaining sustained long-term benefits.

This does not mean that national control is optimal. In fact, a much superior economic result could be achieved if an international fisheries agency allocated production on the basis of maximum global sustainable yields to the most efficient national fleets, with the resulting catch being freely traded internationally at market prices. The global resource-management policies that would result from international fishery control could well be far superior to the hodgepodge of national policies that exist under unilateral appropriation. Historically, governments have certainly not managed marine resources falling under national jurisdiction very well. Nevertheless, both the economics of resource management and the biological requirements of fisheries conservation are becoming better understood, so the outlook for national control is by no means entirely bleak — especially as increasing pressure on food resources put successively higher premiums on careful management.

### Petroleum

Undersea petroleum recovery is already highly developed, both economically and technically, with offshore oil currently accounting for roughly 20 p.c. of world production. Estimates are that at least as much potentially recoverable oil may still be offshore as there is on land — mainly off the US and Canadian coasts, and the North Sea, Persian Gulf, East China Sea, Yellow Sea and the Gulf of Alaska. Most of this is fairly close to shore at depths up to 200 meters — around 55–70 p.c. of the total. An estimated 80–95 p.c. of potentially recoverable petroleum lies within 200 miles of shorelines — i.e., within the national exclusive

economic zones. This leaves between 5 p.c. and 20 p.c. potentially outside of national jurisdictions, virtually all of it landward of the continental margin.

The 1958 Geneva Convention had already recognized national control up to 200 meters depth, and the declaration of the 200-mile EEZs and bilaterally negotiated mid-points have taken up the rest. But since the continental margin sometimes extends well beyond 200 miles, this means that significant potential petroleum resources still reside outside of national jurisdictions. Its value is estimated at current OPEC prices to be around \$ 10 bn by 1980 and \$ 30 bn by the year 2000. So even if we agree on the finality of the 200-mile EEZs for non-fishing purposes — sometimes called the biggest land-grab since the colonial carving-up of Africa — there may still be substantial unclaimed undersea petroleum resources waiting to be exploited.

The 1945 Truman Proclamation of national jurisdiction over the continental shelf and the 1958 Geneva Convention have so far provided a stable legal climate for oil firms' investments in close-in exploration and production. Nonetheless, oil companies have not been too enthusiastic recently about paying large sums for leases of uncertain value — around \$ 600 mn went for leases in the Gulf of Mexico and with virtually no success, and environmental pressures are of serious concern elsewhere including the Atlantic Coast of North America and the North Sea. Still, about 17 p.c. of American production now comes from offshore fields, even though only 3 p.c. of the US continental shelf has been opened for exploration. For example, the Gulf of Alaska may harbor reserves up to 50 bn barrels of crude, but weather conditions will raise the costs beyond current OPEC price levels.

So a great deal of petroleum activity is still possible inside national EEZs without tapping unclaimed resources which, in any case, represent a relatively small proportion of the total. But rapid technical progress involving operations at great depths and in violent weather — together with growing petroleum scarcity from conventional close-in and land-based sources — are likely to bring the problem of allocating "free" petroleum reserves to a head before very long.

### Mineral Resources

Perhaps the largest potential economic yield of the seabed — certainly the most speculative — is associated with undersea mining. There are three sources of minerals recovery from the oceans. One is seawater itself, where each cubic kilometer is estimated to contain about 40 mn tons of dissolved solids including 12 elements in concentra-

tions exceeding 1 part per million. Of these, only salt, bromine and magnesium are now economically recoverable in quantity, although others may eventually be recovered as byproducts in projects such as desalinization plants. A second source is metalliferous muds and brines containing iron, manganese, zinc, lead, copper, gold and silver in potentially recoverable quantities. But exploitation is still awaiting new technologies that can withstand corrosive materials at great depths, operating under severely adverse conditions.

Of greatest immediate interest are manganese-oxide nodules, roughly the size of potatoes, that contain large amounts of manganese, iron, nickel, copper and cobalt. Recent estimates assess the *potentially* recoverable metals at several trillion tons — with *readily* recoverable amounts of 2.4 bn tons each of copper and cobalt, 3.6 bn tons of nickel and 96 bn tons of manganese. The existence of these nodules has been known for over a century, but interest has been aroused only in the last 10 years. Their origin still appears to be rather mysterious, and some contend that they are growing faster than they could be mined. There are between 40 and 100 mining sites that have been identified, just one of which by 1980 could satisfy 2 p.c. of the world manganese demand, 7.9 p.c. for cobalt, 1.3 p.c. for nickel and 0.13 p.c. for copper.

#### Threat to Land-based Mining

In whatever form, the real economic value of seabed resources depends entirely on the evolving economics of land-based mining. So-called "reserves" on land themselves depend on prevailing prices, technologies, exploration and development. For example, a doubling of the copper price alone would quadruple the output from existing mines. Assuming that existing reserves increase five-fold and demand continues to grow at an average annual rate of 4 p.c., land-based nickel supplies are estimated to be adequate for 124–171 years and copper for 56–70 years. However, in several important land-based mineral-producing areas the outlook is increasingly bleak, with mounting exploration costs, governments unwilling to invest in research and development, unfavourable fiscal and environmental policies, and unwillingness on the part of some developing countries to allow large-scale foreign mining ventures without themselves having the resources needed to exploit proven deposits.

So seabed nodules containing these metals — plus recycling of metallic wastes, mining of very low grade ones on land, exploitation of so-far undiscovered deposits and inter-materials substitution — will have to come into play relatively soon at the global level.

According to the Bureau of Mines, United States demand for nonferrous metals is expected to outpace world demand, and is projected to grow at an average annual rate of 5.1–7.3 p.c. between now and the year 2000. This also applies to Europe, having minimal land-based resources. The United States currently imports essentially all of its manganese (Gabon), cobalt (Zaire) and nickel (Canada). Although the US remains the world's largest copper producer, it imports substantial amounts from countries like Chile and Peru. These suppliers, together with other major copper producers like Zaire and Zambia, hope to develop a supply cartel on the pattern of OPEC, or at least benefit from commodity agreements being proposed by the developed countries as part of the New International Economic Order. The industrialized market-economy countries' long-term import-dependence for all of the metals contained in seabed nodules — in several cases on rather uncertain sources of supply — therefore argues for strong interest in this new source of basic materials. When fully on-line, seabed mining is estimated to be able to supply all American manganese, cobalt and nickel needs for the foreseeable future, and about 1/3 of its copper requirements. The figures are similar for other industrial economies. So the stakes are rather high.

Even in the short term, prices of metals contained in seabed nodules may already be high enough to make deep-sea mining profitable with existing technologies. Either a vacuum or conveyor-scoop mechanism would operate round-the-clock at a mine site, raising nodules to the surface and transferring them to shuttle vessels for transport to an on-shore leaching facility, where the various metals would be extracted. Capital requirements for a leaching plant are estimated at \$ 300 mn. The mining and shuttle vessels are estimated to cost another \$ 300 mn per unit capable of producing 1 million dry tons per year. So the costs appear to be comparable to those involved in bringing large-scale conventional mines on stream.

Four international consortia are now planning to initiate exploitation of seabed nodules in the early 1980s. Each is made up of firms from various countries that include such industrial giants as Kennecott Copper, United States Steel, Sun Company, Lockheed Missiles and Space Corporation, Rio Tinto Zinc, British Petroleum, Royal Dutch Shell, Mitsubishi Corporation, and Union Minière of Belgium, as well as a number of German, Canadian and Dutch firms. So far, an estimated \$ 300 mn has been spent for research and development by such firms.

For their part, developing countries — the principal world exporters of the metals involved in undersea mining — see it as a threat to their exist-

ing land-based mining sectors, their balances of payments and their terms of trade.

The economics of seabed mining thus already appear potentially attractive. But the political and legal uncertainties surrounding mining rights unaffected by national EEZs remain undiminished. Until this is resolved the enormous capital investments required are not likely to be forthcoming. The nodule sites represent, with the exception of Antarctica, the only mineral resource not currently under national control. At one extreme, countries and companies that have the technology and are now in a position to exploit the resource could engage in a scramble to divide up the ocean floor and themselves appropriate the gains involved. At the other extreme, the seabed could be viewed as "the common heritage of mankind" — to use United Nations terminology — with exploitation carefully controlled and the economic rents divided up among all the world's countries on the basis of some mutually agreed formula. The political uncertainty still attached to the range of possible outcomes is enormous.

The developing countries have demanded an international monopoly to control exploitation and marketing, with prices and production quotas set to protect land-based suppliers. Some LDCs prefer no undersea mining at all. The advanced industrial countries in a position to go ahead with seabed mining want open access to resources, preferably under an authority with restricted powers to license and supervise operations but *not* to control production levels or pricing. The licensed firms would pay royalties to the authority, which could be used in various ways to aid the developing countries.

The US has proposed a compromise "parallel" system whereby mining companies would propose two sites to the authority, one of which would be awarded to the company and the other would be retained by the authority for exploitation by itself or by others. This proposal has been rejected by the developing countries, partly on the grounds that they do not now have (and may never have) the necessary capital or technology to engage in undersea mining, and it would be unrealistic to expect the advanced nations in effect to subsidize

their own competition by helping the LDCs. The US specifically tied the creation of an international deep-sea mining authority to the assurance of continued free passage through straits — thus trading off an uncertain future asset for guaranteed access to sea lanes. Meanwhile, the developed market-economy countries have agreed to consider price stabilization schemes and buffer stocks to help the developing countries, and this may make it easier to incorporate such mechanisms into the terms of agreement for a new authority to oversee the allocation and sale of seabed leases.

### Conclusion

The issue of undersea resources ultimately boils down to property rights — who is really entitled to the marine, energy and mineral resources of the sea? This is being fought out in the international political arena. The primary forum has been the United Nations Conference on the Law of the Sea (UNCLOS), which has met periodically since 1958 but with very little success so far. The Conference is now under pressure from the US Congress, with draft legislation already proposed to unilaterally permit US deep-sea mining operations until an international treaty is concluded. This legislation would authorize government indemnification of mining companies in case any other nation or international agreements in the future interfere with their undersea mining operations.

Such unilateral moves to proceed with undersea resources exploitation recognize that UNCLOS is working under the worst of all possible conditions, with a large number of disparate nations trying to allocate among themselves something that appears to be very much worth having and which only a few of them at present have the ability to go and get. They foresee the possibility that UNCLOS will ultimately fail on deep-sea resources in much the same way that its failure on coastal resources led to the unilateral creation of national EEZs. The consequences of failure at the UN will be far less serious for the advanced countries than for those less fortunate. And in the long run what now appears as a boon to mankind may end up as a major source of international conflict.

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