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Woods Hole Sea Grant: Energy and Marine Mineral Resources

China Sea Coastal and Marine Nonfuel Minerals: Investigation and Development
Hoagland, P., J. Yang, J.M. Broadus, and D.K.Y. Chu
In: Marsh, J.B. (ed.), Resources and Environment in Asia's Marine Sector, Taylor & Francis, New York, pp. 219-275, 1992 WHOI-R-92-010

Administrative Discretion in the Management of Outer Continental Shelf Minerals
Hoagland, P.
In: Farrow. R.S. (ed.), Managing the Outer Continental Shelf Lands: Oceans of Controversy. Ocean Policy Studies, 18 pp., 1991 WHOI-R-91-003
Mineral developers face varying kinds of risks and uncertainties associated with the exploration, development, and production of minerals from a marine deposit. These risks can be geologic (e.g., ore grade), environmental (e.g., storm frequency), or legal (e.g., lease suspension). To the miner, these types of risks all have the same result: they raise the private costs of proving- out and working a deposit. Both geologic and environmental risks could be reduced through exploration and meteorological forecasting. This publication is concerned with the special case of legal risks arising from administrative discretion by a resource manager over the rights to work publicly controlled ocean minerals.

Marine Nonfuel Minerals in the U.S. Exclusive Economic Zone: Managing Information as a Resource
Broadus, J.M. and P. Hoagland
Ocean and Shoreline Management, Vol. 13, No. 3 & 4, pp. 275-294, 1990 WHOI-R-90-023

Nonfuel Minerals
Broadus, J.M. and P. Hoagland
In: Farrow, S., J.M. Broadus, T. Grigalunas, P. Hoagland, and J. Opaluch (eds.), Managing the Outer Continental Shelf Lands: Oceans of Controversy, pp. 119-134, 1990 WHOI-R-90-021

Ocean Enterprises: The Ocean and the Economy in the 1990's
Ross, D.A., J. Fenwick, M.A. Champ, and R. Knecht
In: Halsey, S.D. and R.B. Abel (eds.), Coastal Ocean Space Utilization. Proceedings of the International Symposium on Coastal Ocean Space Utilization, Elsevier Press, pp. 369-371, 1990 WHOI-R-90-006
In the late 1980's, less than 1% of the resources consumed annually in the United States came from the ocean. The U.S. Exclusive Economic Zone (EEZ) proclaimed in 1983 gave the United States exclusive jurisdiction over ocean resources out to 200 n. mi. This extensive new zone adds over 3.9 billion acres of resource potential, more than doubling the "territorial size" of the United States. The EEZ offers many opportunities to improve the national economy of the United States. Nevertheless, the potential rewards from the development of ocean resources by the private sector have been greatly inhibited by the risks of candidate projects. Each opportunity or action is laden with different types of risk: technical, economic, environmental and political. Ocean Enterprises is a concept to explore and develop these resources. Among the areas that show the most promise for development are: marine mining of coastal heavy minerals, ocean thermal energy conversion (OTEC), offshore waste treatment plants, mariculture (fish and shellfish) and platforms for air and space operations.

Overview: Marine Mineral Reserves and Resources--1988
Emery, K.O. and J.M. Broadus
Marine Mining, Vol. 8, pp. 109-121, 1989 WHOI-R-89-008
Marine mining has been conducted on local and generally small scales for thousands of years. Large-scale recovery from beaches and piers began only about 40 years ago, and soon afterward powered ships and tools and new exploration methods revealed the presence of economic concentrations of oil and gas, sand and gravel, and some heavy minerals beyond the beach. These materials are in relatively shallow waters of the continental shelf and now are known well enough to be considered reserve ores. Rapid success for them led to immediate expectation of marine mining of many other minerals that have higher value per unit weight, but they occur in deeper waters beyond the shelf where conditions are more difficult and costs are higher. They include phosphorite, ferromanganese nodules and crusts, and (less than a decade ago) polymetallic sulfides. All are still potential resources that cannot yet be considered reserve ores. Increased knowledge of the deep ocean floor and its natural processes is likely to be applied first to expanding the reserves of similar deposits now on land and perhaps later to ocean floor mining. Moreover, ocean floor mining must compete economically with improved methods of recovery from existing low-grade resources on land and from waste piles left from earlier and less efficient methods of mineral recovery.

The Ocean Enterprise Concept
Only available on loan from the National Sea Grant Library
Ross, D.A. and J.E. Dailey
Report to the National Science Foundation on the Ocean Enterprise Workshop, February 20-24, 1989, 198 pp., 1989 WHOI-W-89-003

The Ocean Enterprise Concept
Ross, D.A., M.A. Champ, J.E. Dailey, and C.E. McLain
In: Report to the National Science Foundation on the Ocean Enterprise Workshop, February 20-24, 1989, 13 pp., 1989 WHOI-R-89-018

The Conservation and Disposal of Ocean Hard Minerals: A Comparison of Ocean Mining Codes in the United States
Hoagland, P.

Natural Resources Journal, Vol. 28, pp. 451-508, 1988 WHOI-R-88-024

Seabed Materials
Broadus, J.M.
Science, Vol. 235, pp. 853-860, 1987 WHOI-R-87-004
A large catalog of materials has been proposed as potential seabed resources, and some seabed materials such as hydrocarbons and tin already contribute to the world's economy. Scientific advances have increased our knowledge of other seabed prospects, but realization of their potential will be determined by their relative economic accessibility compared to rival resources on land. Examination of existing stocks of conventional resources, and of the economic process by which new resources are added, suggests that most potential sources of seabed materials will not be exploited in the near future. Strategic behavior in seabed materials development, however, implies that investment in exploration and R&D could proceed on a larger scale and at a more rapid pace than might be expected solely on the basis of apparent commercial potential.

Performance Requirements in Ocean Mineral Development
Hoagland, P.
Marine Policy Reports, Vol. 9, No. 3, pp. 5-10, 1987 WHOI-R-87-001

Seabed Material Commodity and Resource Summaries
Only available on loan from the National Sea Grant Library
Hoagland, P. and J.M. Broadus
Woods Hole Oceanographic Institution Technical Report WHOI-87-43, 235 pp., 1987 WHOI-T-87-002

Asian Pacific Marine Minerals and Industry Structure
Broadus, J.M.
Marine Resource Economics, Vol. 3, No. 1, pp. 63-88, 1986 WHOI-R-86-006

Seabed Mining Patent Activity: Some First Steps Toward an Understanding of Strategic Behavior
Hoagland, P.
Journal of Research Management and Technology, Vol. 14, No. 3, pp. 211-222, 1986 WHOI-R-86-005

Patent Activity in the Seabed Mining Industry
Only available on loan from the National Sea Grant Library
Hoagland, P.
Woods Hole Oceanographic Institution Technical Report No. WHOI-85-20, 71 pp., 1985 WHOI-T-85-001

Rivalry and Coordination in Marine Hard Minerals Regulation
Broadus, J.M. and P. Hoagland
In: Proceedings of Oceans '84 Conference & Exposition, 10-12 September 1984, Washington, D.C., pp. 415-420, 1984 WHOI-R-84-015

Evaluating the Economic Significance of Polymetallic Sulfides Deposits
Broadus, J.M. and R.E. Bowen
15th Annual Offshore Technology Conference in Houston, Texas, May 2-4, 1983, pp. 419-426, 1983 WHOI-R-83-010

Evaluating the Risks of Offshore Oil Development Environmental Impact
Lahey, W.L. and T.M. Leschine
Assessment Review, Vol. 4, No. 3/4, pp. 271-286, 1983 WHOI-R-83-024

Effective Use of the Sea: Overcoming the Law of the Sea Problems
Ross, D.A.
Proceedings of Oceans, 3 pp., 1983 WHOI-R-83-021
Alternative Regimes for Future Mineral Resource Development in Antarctica
Westermeyer, W.E.
Ocean Management, Vol. 8, pp. 197-232, 1983 WHOI-R-83-011

Deep Ocean Mining
Only available on loan from the National Sea Grant Library
Knecht, R.W.
Oceanus, Vol. 25, No. 3, pp. 3-11, 1982 WHOI-R-82-012
Resources of the Deep Sea other than Manganese Nodules
Ross, D.A.
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