

The intimate knowledge of diverse sciences and complex technologies that must be acquired will involve interdisciplinary efforts directed to basic and applied studies of scientific concepts and principles. These studies can produce the accurate data which can be applied immediately to the advancement of mining technologies and ultimately to the development of whole new mining systems. New systems are, inescapably, a "must" if we are to produce a continuing adequate supply of minerals from lower grade and less accessible deposits and, at the same time, minimize mining-related damage to the environment.

The value of the research and development effort can be measured largely in the public benefits it can be expected to yield. These include the assurance of a continuing supply of minerals (on which 80-85% of our industrial economy depends), improved conservation and expansion of domestic minerals resources, and preservation of environmental quality.

MARINE MINERAL MINING

The need to develop the technology of marine mining is born of the accelerating demand for minerals, the projected potential of the marine environment as a supplier of minerals, and the embryonic level of present marine mining technology. A primary purpose of the Department program is to accurately define the resource potential of the marine environment. Initial attention is directed to the continental shelf because of ready accessibility to land-based processing facilities and because of the probability for discovery of heavy, high-unit-value materials, such as gold and platinum.

A major element of the program deals with development of sampling and deposit delineation equipment and of techniques for the characterization of marine mineral deposits. An integral part of this effort is definition of deposit characteristics and of the environmental conditions essential to quantifying the mining problem and establishing mining system requirements.

A second element of the program encompasses the design, development, and testing of equipment and systems that will enable economic recovery of minerals from the ocean environment. Initially, emphasis is being placed on engineering research studies to determine the adaptability of existing dredging systems for marine mining.

MARINE MINING EQUIPMENT

The technology of marine mining is still in a primitive stage, struggling to develop adequate equipment and techniques for exploration. Only now are we beginning to recognize and define the problems to be overcome in developing a domestic marine mining industry. Nevertheless, with Federal encouragement in the form of an adequate research effort, a domestic industry probably can be established within five years.

U.S. population is increasing and so is per capita consumption of minerals. Depletion of known mineral reserves will be accelerated as other nations step up their industrial expansion. The ability of our last frontier, the sea, to help satisfy future mineral needs must be determined now, and such an assessment requires a whole new technology.

Instruments and techniques must be developed to permit accurate identification of all distinguishing features of marine mineral deposits. Once this can be done, production methods can be developed on a systems basis. Only then can the significance of marine minerals be determined.

To augment USGS exploration techniques, the Bureau of Mines is developing both geophysical and direct methods for delineation studies. Development of production-systems technology will involve research and engineering studies in materials handling, in situ fragmentation and beneficiation, mining platform design, mineral processing, waste disposal, and problems of environmental disturbance.

Quantitative data on marine mineral resources are nearly non-existent. Nonetheless, production of metal and non-metal minerals in the U.S. totaled \$7.4 billion in 1965, about \$2,049 per square mile of land area. If this ratio is projected to the continental borderlands within 125 miles of the coast, an eventual level of mineral production of \$3.2 billion can be projected. Such extrapolation is the best guess that can be made until more reliable data becomes available.