

# Web Supplement 18.2.1

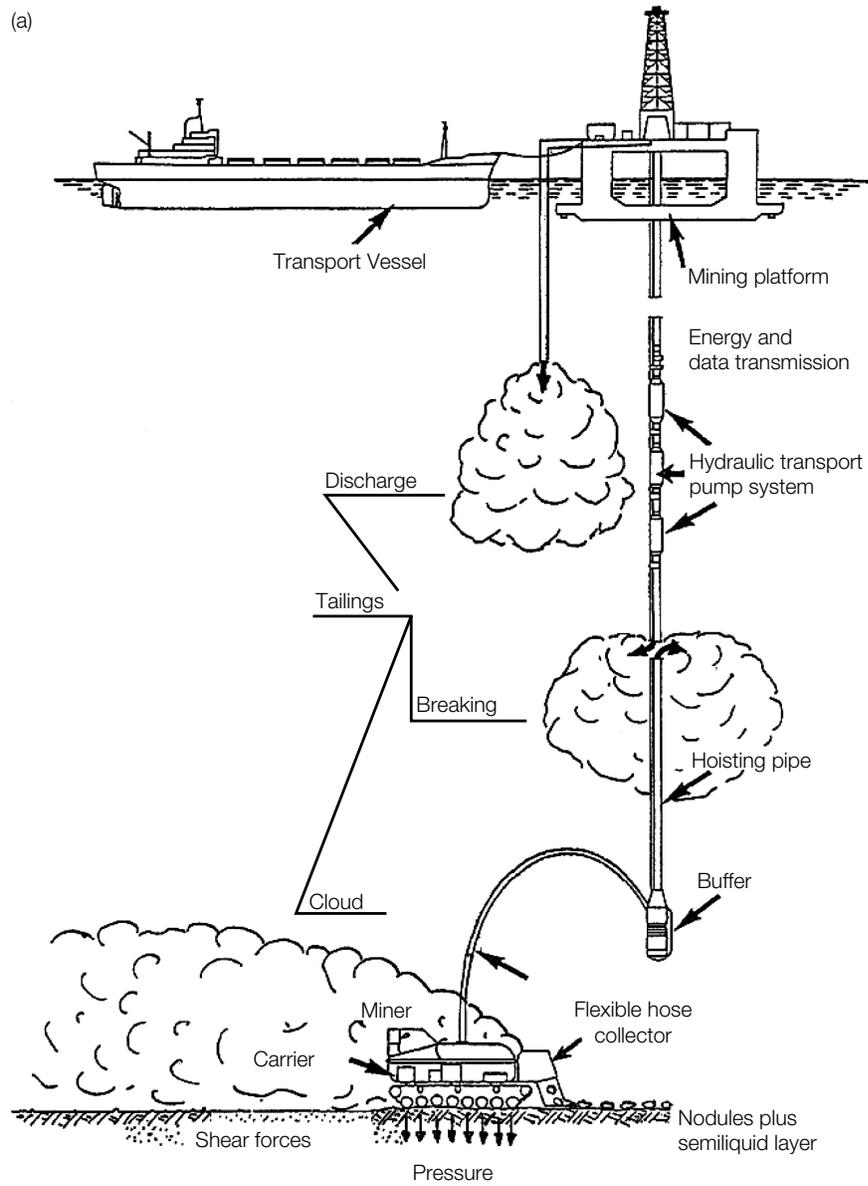
## ***Mining Manganese Nodules***

The known deposits of nodules are estimated to contain on the order of  $10^9$  metric tonnes of metals. Of greatest economic interest are nickel, copper, and cobalt. The possibility of exploiting this resource has been hampered by the legal question as to who owns the deep-sea floor. The international community has attempted to resolve this problem in 2000 by formulating a joint agreement under the Law of the Sea Treaty, which involved creation of an International Seabed Authority. As of this writing, the United States has not become a party to this treaty.

Several technological problems must also be solved to enable profitable mining. First, the sites where metal-rich nodules are most abundant must be determined. As illustrated in Figure 18.8, the equatorial Pacific Ocean appears, in general, to contain the densest collections of economically attractive nodules. The “oxic diagenesis” mechanism of formation is thought to be responsible for their relatively elevated copper, nickel, and cobalt contents. Nodules in Pacific Ocean lying beneath areas of low biological productivity (10 to 40°N and 20 to 50°S) are characterized by lower Ni and Cu and higher Fe and Co contents. In comparison, nodules lying beneath the equatorial zone, where productivity is higher, are characterized by Mn, Ni, and Cu enrichments as these metals are transported to the sediment by sinking detrital POM.

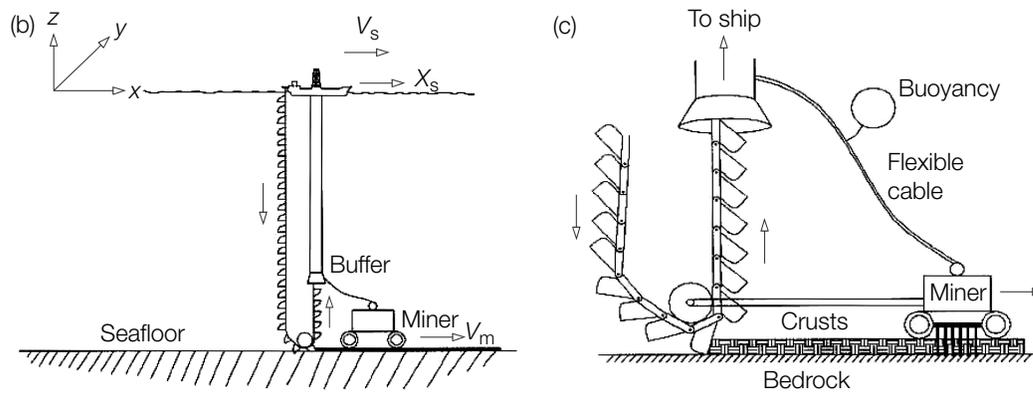
Second, a cost-efficient way must be found to remove the nodules from the seabed. One proposed technique is illustrated in Figure W18.1. Third, a cost-effective method for separating and purifying the metals must be developed. Finally, the environmental consequences of disturbing the seabed must be evaluated.

Some test mining was conducted in the 1970s, and several environmental impact studies were conducted during the 1970s through 1990s. Because of the high cost of recovery and refining relative to the market prices of the minable metals, interest in proceeding further has waned in the United States, but such mining continues to be pursued by India, China, and Japan. In addition to nodules, efforts are now underway to mine Co-rich polymetallic sulfide crusts (Chapter 19.4.6).



**FIGURE W18.1**

*(Continued)*



**FIGURE W18.1**

Manganese nodule mining concepts: (a) hydraulic transport, (b) continuous line bucket system, and (c) combined continuous line bucket and hydraulic systems. *Source:* Oebius, H. U., J. B. Hermann, S. Rolinskib, and J. A. Jankowski (2001). Parameterization and evaluation of marine environmental impacts produced by deep-sea manganese nodule mining. *Deep-Sea Research II* 48, 3453–3467; and Chung, J. S. (1994). Deep-ocean cobalt-rich crust mining system concepts, Proceedings of the MTS-94 Conference, Marine Tech. Soc., Baltimore, MD, pp. 98–104.

