The new gold rush: seafloor hydrothermal research and marine mining

Maurice Tivey
Department of Geology and Geophysics, Woods Hole Oceanographic Institution, Woods Hole, MA, USA 02543

Once the sole purview of research scientists, deep-sea hydrothermal vent systems are now attracting considerable interest from commercial mining companies. Hydrothermal vent systems precipitate metal-rich seafloor massive sulfide (SMS) deposits in the form of chimneys many meters tall, collapsed edifices, and mounds tens to hundreds of meters across with a stockwork zone that penetrates several tens of meters beneath the seafloor. These deposits are rich in copper, zinc, gold and silver and are typically found in a midocean ridge spreading environment as well as in back-arc spreading systems and associated with active seamount volcanism. Commercial and political interest in SMS deposits in the deep sea has been encouraged by several factors. The offshore oil and gas industry has pushed into deeper waters (> 3000 m depth) over the past decade and technologies for accessing and exploiting SMS deposits have emerged. Furthermore, the infrastructure costs of mine development and ore extraction are likely to be much less than conventional terrestrial projects. Similarly, geophysical and geological exploration of the deep sea has become more efficient with the use of Remotely-Operated vehicles (ROVs) and autonomous underwater vehicle (AUV) mapping technology. Perhaps the most important factor, however, has been the dramatic rise in the price of metals such as copper, zinc, gold, and silver over the past few years. In the past decade, several start-up companies were formed to specialize in the exploration and possible development of SMS deposits, seeking min-

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ing claims with countries such as Papua New Guinea, Tonga, and New Zealand. While the economic news of recent times has seen a decline in metal prices and perhaps a cooling of activity on the commercial side, the political side of the equation is continuing. The deep sea resources of the ocean floor beyond the national jurisdictions of the EEZs and continental shelves is under the purview of the International Seabed Authority (ISA), a body created by the treaty of the United Nations Convention on the Law of the Sea (UNCLOS) in 1982. ISA recently announced plans to divide the global mid-ocean ridge into segments for exploratory licenses, similar to areas already claimed by national interests for polymetallic nodule mining in the central Pacific. In 2007, the ISA published its first "Draft regulations on prospecting and exploration for polymetallic sulphides in the Area", which includes block sizes (10 km × 10 km, not to exceed 100 contiguous blocks) and annual fees. It is unknown what the effects of nationalizing or privatizing these areas might have on continued free access to the High Seas and the Area for marine scientific research, however, it may offer opportunities too. Woods Hole Oceanographic Institution (WHOI) has a long-standing interest in the study of hydrothermal vents on the mid-ocean ridge, with research towards an understanding the geological, chemical and biological processes that create the Earth's crust and sustain life adapted to the extreme environment of the deep sea. Recently, WHOI scientists collaborated with a commercial mining company to characterize and quantify the mineral resource of hydrothermal vent fields in the Bismarck Sea of Papua New Guinea. WHOI's approach to fast, high-resolution, multi-parameter mapping and precision measurements along with sampling and analysis contribute to a framework for discovery and exploration in the new frontier of deep sea mining.

