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The Dawning of Deep Sea Mining of Metallic Sulfides: The Geologic Perspective

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ABSTRACT

Hot springs ("black smokers") on the deep ocean floor are accumulating economic concentrations of copper, zinc, lead and silver sulfides, together with gold. Mining of these deposits is on the verge of becoming a reality, driven by the ever increasing need for raw resources, especially copper. Two entrepreneurial companies have exploration licenses covering vast areas of the seabed in the western Pacific targeting seafloor massive sulfide deposits. A third company is being established. Technological and financial challenges for recovery of seafloor sulfide deposits are not insurmountable and mining these may be less environmentally deleterious than mining on land.

KEY WORDS: Marine; mining; metals; sulfides; copper; gold; environment

INTRODUCTION

Oceans and seas cover 71 % of Earth, equivalent in surface area to the sum of twice that of Mars plus twice that of our Moon. More than three-quarters of this vast territory is deep ocean basins. The surface area of the Pacific Ocean alone is twice that of all the continents. Both the shallow continental margins and the deep ocean basins harbor mineral resources, many of whose economic potential and especially those in the deep basins, we are only beginning to appreciate. The main potential metallic mineral resources are manganese nodules, manganese crusts and polymetallic seafloor massive sulfides. The latter deposits of iron, copper, zinc, lead, silver and gold are the subject of this paper.

Although seafloor massive sulfides have been known for four decades, that they might be commercially exploited is a relatively recent idea. The author first expressed this possibility in 1984 (Dotto, 1984; see also Scott, 1985, 1992, 2001) but concluded that the deposits held more value then as natural laboratories in order to learn better how analogous deposits being mined on land may have formed as an exploration aid to finding more. All of this changed over the last decade as entrepreneurial companies saw the possibility of economic exploitation of massive sulfides on the seabed.

This paper reviews the formation of seafloor massive sulfides and draws comparisons with similar deposits that are mined on land but that formed in ancient oceans. It traces the emergence of sulfide marine mining companies and their current activities. Environmental issues for marine mining of sulfides are also considered.

WHY MINE THE OCEANS?

Ocean mining is not a new venture. Throughout much of the 19th century and even earlier, there has been placer mining of gold, diamonds, tin and other heavy minerals (chromium, titanium, thorium, zirconium, rare earths) and aggregates (sand, gravel) from beaches and from contiguous shallow waters. Present-day recovery of gem quality diamonds from the seabed off the Atlantic coast of Namibia represents a potential half trillion-dollar industry utilizing advanced marine technologies.

Although it is not mining in the traditional sense, the oil industry moved offshore in the middle of the 20th century. Critics of the day questioned the need for recovering this oil when there was plenty on land and industry lacked the technology. As pointed out by the author (Scott, 2001), the same objections were leveled at ocean sulfide miners. Today, however, about one third of the world's petroleum production comes from this source and is growing as technology allows for increasingly deeper installations. Wells are producing from 1500 m water depth offshore Brazil. In the Perdidi Fold Belt of the Gulf of Mexico, exploration is taking place at 2700 m water depth (World Oil, November, 2005, p. 75-82) and a lease at 3379 m water depth was issued in 2000 (U.S. Mineral Management Service; http://www.mms.gov). Six wells have been completed in >7,000 feet (2,134 m) water depth in the Gulf (Tubb, 2006). Chevron's Jack Well in the Gulf of Mexico in 2,123 m water depth is 250 km offshore. In Orphan Basin off Canada's east coast, oil exploration leases extend to 4000 m (B. Taylor, Jacques Witford Environmental, personal communication, 2000). If the oil industry could do it, so can the mining industry especially when they have the decades of experience of offshore oil to call upon.

The impetus for developing seafloor mines is being driven by increasing the demand for base and precious metals, especially copper,