ANNIVERSARY RETROSPECTIVE

Deep-sea ore deposits

The discovery of metal-rich hot springs on the ocean floor has spawned a new mineral exploration industry. Also known as black smoker chimneys or seafloor massive sulfide deposits, people are looking to mine these deposits for base and precious metals, including Cu, Zn, Pb, Ag and Au (Fig. 1). Some authors have suggested that this new resource could drastically shift the metal supply markets[1,2] and solve the looming peak copper crisis, when demand will outstrip production from land-based resources. The possibility of deep-sea mining has triggered debate about the sustainable use of our oceans, and whether the environmental impacts of mining active black smokers — populated by unique chemosynthetic ecosystems — are worth the risk.

To date, approximately 165 seafloor massive sulfide deposits containing appreciable quantities of metals have been found[3]; however, there is a serious lack of information about their size, composition and distribution. It is unclear as to whether these seafloor resources can provide the metals we need in the future. Studying deposit densities, Hannington and colleagues[4] calculated a global estimate of the resource potential of seafloor massive sulfide deposits. This study examined deposit densities in 32 control areas of equal size along mid-ocean ridges, arcs and back-arc spreading centres, representing the range of geological settings where seafloor massive sulfide deposits form. From here, the total accumulation of metal in these deposits was calculated based on resource calculations from well-explored deposits.

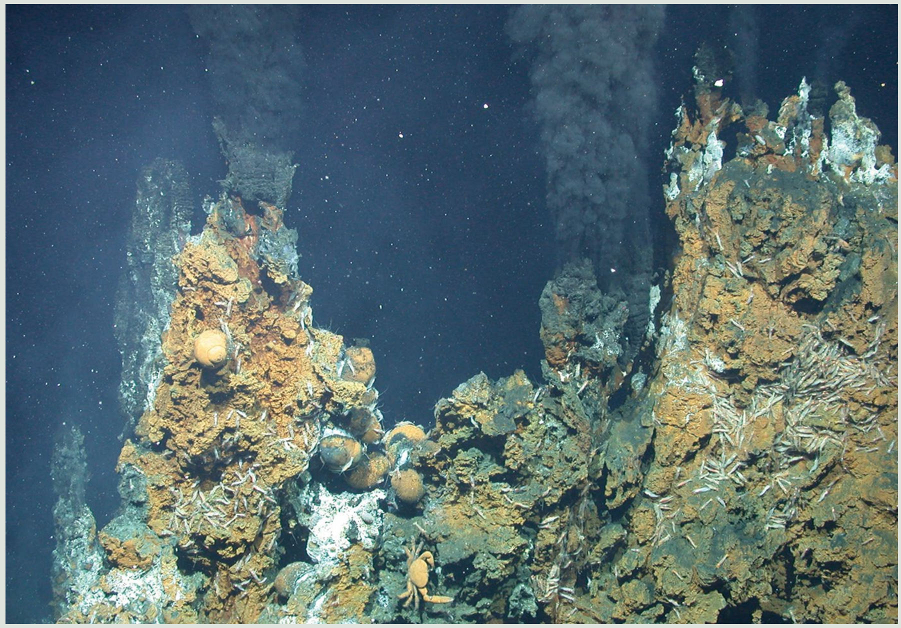

Fig. 1 | Active high-temperature black smoker chimneys associated with the formation of seafloor massive sulfide deposits. The chimneys were discovered at the Niua South Vent Field, NE Lau Basin, using conventional water column survey techniques. Photo from ROV QUEST dive 429, SO-263 TongaRift Cruise, June 2018. Credit: MARUM – Center for Marine and Environmental Sciences, University of Bremen

The authors estimated the total tonnage for seafloor neovolcanic zones to be approximately 600 Mt. This is small compared to both total past production and current reserves of fossil deposits on land (estimated to be about 14,000 Mt), and some meagre individual deposits were only about 70,000 t in size[4]. Although the total metal content is significant, these findings suggest that the predicted resources on the seafloor contained within neovolcanic zones is insufficient to satisfy the growing global demand for these metals. In addition, the predicted amount of metal in these deposits is much less than the total amount of metal delivered to the seafloor by black smoker chimneys. The fate of these metals is unknown, but may be contained within the plumes of black smoke that end up accumulating in distal marine sediments.

The research by Hannington and colleagues inspires an important question: where should we look to discover high-tonnage deposits, or districts of smaller but closely spaced deposits on the seafloor? It is possible that inactive deposits may represent a much larger resource than the active deposits contained within neovolcanic zones of the world's oceans. It is therefore necessary to develop genetic and exploration models for large, inactive deposits on the seafloor that cannot be found using conventional water column survey techniques, to identify the areas of the ocean with the greatest mineral potential. Deep-sea mining may become a reality within the next decade, so a priority must be developing methods to find inactive deposits that pose lower environmental risk. ❐

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