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TITLE: Report of the workshop Evaluating the nature of midwater mining plumes and their potential effects on midwater ecosystems

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ABSTRACT:

The International Seabed Authority (ISA) is developing regulations to control the future exploitation of deep-sea mineral resources including sulphide deposits near hydrothermal vents, polymetallic nodules on the abyssal seafloor, and cobalt crusts on seamounts. Under the UN Convention on the Law of the Sea the ISA is required to adopt are taking measures to ensure the effective protection of the marine environment from harmful effects arising from mining-related activities. Contractors are required to generate environmental baselines and assess the potential environmental consequences of deep seafloor mining. Understandably, nearly all environmental research has focused on the seafloor where the most direct mining effects will occur. However, sediment plumes and other impacts (e.g., noise) from seafloor mining are likely to be extensive in the water column. Sediment plumes created on the seafloor will affect the benthic boundary layer which extends 10s to 100s of meters above the seafloor. Separation or dewatering of ore from sediment and seawater aboard ships will require discharge of a dewatering plume at some depth in the water column. It is important to consider the potential impacts of mining on the ocean?s midwaters (depths from ~200 m to the seafloor) because they provide vital ecosystem services and harbor substantial biodiversity. The better known epipelagic or sunlit surface ocean provisions the rest of the water column through primary production and export flux (This was not the focus at this workshop as the subject was considered too large and surface discharges are unlikely). It is also home to a diverse community of organisms including commercially important fishes such as tunas, billfish, and cephalopods that contribute to the economies of many countries. The mesopelagic or twilight zone (200-1000 m) is dimly lit and home to very diverse and abundant communities of organisms. Mesopelagic plankton and small nekton form the forage base for many deep-diving marine mammals and commercially harvested epipelagic species. Furthermore, detritus from the epipelagic zone falls through the mesopelagic where it is either recycled, providing the vital process of nutrient regeneration, or sinks to greater depths sequestering carbon from short-term atmospheric cycles. The waters below the mesopelagic down to the seafloor (both the bathypelagic and abyssopelagic) are very poorly characterized but are likely large reservoirs of novel biodiversity and link the surface and benthic ecosystems. Great strides have been made in understanding the biodiversity and ecosystem function of the ocean?s midwaters, but large regions, including those containing many exploration license areas and the greater depths where mining plumes will occur, remain very poorly studied. It is clear that pelagic communities are distinct from those on the seafloor and in the benthic boundary layer. They are often sampled with different instrumentation. The fauna have relatively large biogeographic ranges and they are more apt to mix freely across stakeholder boundaries, reference areas and other spatial management zones. Pelagic organisms live in a three-dimensional habitat and their food webs and populations are vertically connected by daily or lifetime migrations and the sinking flux of detritus from the epipelagic. The fauna do not normally encounter hard surfaces, making them fragile, and difficult to capture and maintain for sensitivity or toxicity studies. Despite some existing general knowledge, ecological baselines for midwater communities and ecosystems that likely will be impacted by mining have not been documented. There is an urgent need to conduct more research and evaluate the midwater biota (microbes to fishes) in regions where mining is likely to occur. Deep-sea mining activities may affect midwater organisms in a number of ways, but it is still unclear at what scale perturbations may occur. The sediment plumes both from collectors on the seafloor and from midwater discharge will have a host of negative consequences. They may cause respiratory distress from clogged gills or respiratory surfaces. Suspension feeders, such as copepods, polychaetes, salps, and appendicularians, that filter small particles from the water and form an important basal group of the food web, may suffer from dilution of their food by inorganic sediments and/or clogging of their fragile mucous filter nets. Small particles may settle on gelatinous plankton causing buoyancy issues. Metals, including toxic elements that will enter the food web, will be released from pore waters and crushed ore materials. Sediment plumes will also absorb light and change backscatter properties, reducing visual communication and bioluminescent signaling that are very

important for prey capture and reproduction in midwater animals. Noise from mining activities may alter the behaviors of marine mammals and other animals. Small particles have high surface area to volume ratios, high pelagic persistence and dispersal and as a result greater potential to result in pelagic impacts. All of these potential effects will result in mortality, migration (both horizontal and vertical), decreased fitness, and shifts in community composition. Depending on the scale and duration of these effects, there could be reduction in provisioning to commercial fish species, delivery of toxic metals to pelagic food webs and hence human seafood supply, and alterations to carbon transport and nutrient regeneration services. After four days of presentations and discussions, the workshop participants came to several conclusions and synthesized recommendations. 1. Assuming no discharge in the epipelagic zone, it is essential to minimize mining effects in the mesopelagic zone because of links to our human seafood supply as well as other ecosystem services provided by the mesopelagic fauna. This minimization could be accomplished by delivering dewatering discharge well below the mesopelagic/bathypelagic transition (below ~1000 m depth). 2. Research should be promoted by the ISA and other bodies to study the bathypelagic and abyssopelagic zones (from ~1000 m depths to just above the seafloor). It is likely that both collector plumes and dewatering plumes will be created in the bathypelagic, yet this zone is extremely understudied and contains major unknowns for evaluating mining impacts. 3. Management objectives, regulations and management actions need to prevent the creation of a persistent regional scale ?haze? (enhanced suspended particle concentrations) in pelagic midwaters. Such a haze would very likely cause chronic harm to deep midwater ecosystem biodiversity, structure and function. 4. Effort is needed to craft suitable standards, thresholds, and indicators of harmful environmental effects that are appropriate to pelagic ecosystems. In particular, suspension feeders are very important ecologically and are likely to be very sensitive to sediment plumes. They are a high priority for study. 5. Particularly noisy mining activities such as ore grinding at seamounts and hydrothermal vents is of concern to deep diving marine mammals and other species. One way to minimize sound impacts would be to minimize activities in the sound-fixing-and-ranging (SOFAR) channel (typically at depths of ~1000 m) which transmits sounds over very long distances. 6. A Lagrangian (drifting) perspective is needed in monitoring and management because the pelagic ecosystem is not a fixed habitat and mining effects are likely to cross spatial management boundaries. For example, potential broad-scale impacts to pelagic ecosystems should be considered in the deliberations over preservation reference zones, the choice of stations for environmental baseline and monitoring studies and other area-based management and conservation measures. 7. Much more modeling and empirical study of realistic mining sediment plumes is needed. Plume models will help evaluate the spatial and temporal extent of pelagic (as well as benthic) ecosystem effects and help to assess risks from different technologies and mining scenarios. Plume modeling should include realistic mining scenarios (including duration) and assess the spatial-temporal scales over which particle concentrations exceed baseline levels and interfere with light transmission to elucidate potential stresses on communities and ecosystem services. Models should include both near and far field-phases, incorporating realistic near field parameters of plume generation, flocculation, particle sinking, and other processes. It is important to note that some inputs to these models such as physical oceanographic parameters are lacking and should be acquired in the near-term. Plume models need to be complemented by studies to understand effects on biological components by certain particle sizes and concentrations.

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