# “Following the Research”: Extractivist Histories of Marine Science in Deep Seabed Mining

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**SLIDE**

It will come as no surprise to folks in this room that so-called “renewable” energy infrastructure is material intensive. The World Bank[1] has projected 3 billion tons of new metals need to be mined to produce the energy systems needed to stay within 2º C of global warming.

Much of the highest grade and most easily accessed metal ores on land have already been mined with often detrimental effects to surrounding ecosystems and communities. The geographic distribution of remaining ore bodies is also cause for growing geopolitical concern among industrialized states of the global north who import a significant proportion of many critical minerals. For these states, mineral supply chain security depends on the stability of geopolitical relations—an increasingly uncertain prospect.

Recalling economic geologist Eugene Cameron[2], this situation arguably poses a wicked “mineral problem” for future supply and demand scenarios. It of course varies by mineral, and demand projections assume, perhaps problematically, a status quo continuation of the current global economic order. But accepting the conclusions of these models for the time being, they raise important questions about the geographies of future mineral supply chains.

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One possible solution lies in exploiting the mineral-rich geologic deposits of the deep ocean floor. Scientists on the 1870s HMS Challenger expedition discovered small dark brown ferro-manganese concretions strewn across the Atlantic seafloor. Subsequent expeditions[3] in the 19th and early 20th century found them in greater or lesser abundance throughout the world ocean, and geochemical analyses revealed they contained high concentrations of manganese, copper, nickel, and cobalt, among other minerals.

These odd seafloor rocks were largely ignored until John Mero’s 1965 publication of “Mineral Resources of the Sea” drew attention to polymetallic nodules as a possible mineral resource to be exploited. By the early 1970s, various mining companies and states from the global north had formed consortia to jointly develop technological and economic capacity for deep seabed mining (DSM) while concern grew among countries in the global south about the possibility for a “race to the bottom” to extract mineral resources from seabed under international waters. This conflict led to the third UN Conference on the Law of the Sea (from ‘1973-’82), which concluded with the proclamation that mineral resources in areas beyond national jurisdiction—or The Area—would be governed as the “Common heritage of mankind”, to be used only for peaceful purposes benefiting humanity as a whole.

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[1] World Bank (2022). "Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition” https://pubdocs.worldbank.org/en/961711588875536384/Minerals-for-Climate-Action-The-Mineral-Intensity-of-the-Clean-Energy-Transition.pdf

[2] Cameron, E. N. (1986). *At the crossroads: the mineral problems of the United States*. Wiley-Interscience.

[3] Wüst, G. (1964). The major deep-sea expeditions and research vessels 1873-1960: a contribution to the history of oceanography. *Progress in Oceanography*, *2*, 1-52.

Commercial DSM has yet to occur, and much about the deep ocean remains unknown[4], but a handful of studies on DSM's potential ecological impacts have indicated it is likely to cause long-term impacts to the seabed ecosystem.

In 1994, UNCLOS established the International Seabed Authority (ISA) as the international body responsible for governing DSM-related activities. ISA is also required under UNCLOS to protect the deep ocean ecosystem from "serious harm" caused by mining, which ISA's Mining Code defines as "significant adverse change" to the deep ocean environment. What such change would look like in practice is the subject of much ongoing debate among marine biologists and other DSM stakeholders and serves as an interesting entry point into broader debates about ontological politics in the deep ocean and other spaces mediated by technoscientific representation.

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Common in discourse from both sides of the DSM debate is that "more research is needed" to accurately assess environmental impacts that mining may cause. Environmental groups call for a moratorium on DSM activities until there is enough research to mitigate serious harm[5], while mining companies say such a moratorium would be counterproductive because they are the ones doing—or at least funding—the necessary research to improve our understanding of the deep-sea environment. DEME-GSR, one ISA-licensed mining contractor, has said they will only proceed toward commercial operations if research shows that harm may be effectively managed.[6]

But in such a space constructed as lacking techno-scientific knowledge claims adequate for decision making, what kind of research is conducted? What questions do researchers ask? And whose knowledge counts within the ISA's governance framework? Traditional and indigenous knowledge of island and coastal communities has been largely ignored in ISA policy[7] despite many of these communities' proximity to seabed mining sites and familiarity with ocean dynamics arguably relevant to assessing the impacts of DSM. Reflecting on the ontological politics of contesting DSM, political ecologist John Childs[8] (117) states that "Both the qualitative uniqueness and relative invisibility of the deep sea—its seabed, water column, and associated biology—continue to limit the possibilities of apprehending it scientifically." Such limitations pose a challenge for bureaucracies like the ISA whose structure of discrete subcommittees and regulations prefer the discreteness of techno-scientific knowledge to what Philip Steinberg and Kimberley Peters[9] call "wet ontologies" of fluid, oceanic space. Thus, while Childs' interlocutors in the Duke of York Islands understand the sea as a "relational congregation of different actors in which nature is not separated from human politics," the

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[4] Amon, D. J., Gollner, S., Morato, T., Smith, C. R., Chen, C., Christiansen, S., ... & Pickens, C. (2022). Assessment of scientific gaps related to the effective environmental management of deep-seabed mining. Marine Policy, 138, 105006.

[5] IUCN (2021, Sept. 22). "069 - Protection of deep-ocean ecosystems and biodiversity through a moratorium on seabed mining". https://www.iucncongress2020.org/motion/069

[6] DEME-GSR (2021, April 26). "Deep-Seabed Mining Robot Patania II Successfully Reconnected—Mission Continues". https://www.deme-group.com/news/deep-seabed-mining-robot-patania-ii-successfully-reconnected-mission-continues

[7] Reichelt-Brushett, A., Hewitt, J., Kaiser, S., Kim, R. E., & Wood, R. (2022). Deep seabed mining and communities: A transdisciplinary approach to ecological risk assessment in the South Pacific. *Integrated Environmental Assessment and Management*, *18*(3), 664-673.

[8] Childs, J. (2020). Performing 'blue degrowth': critiquing seabed mining in Papua New Guinea through creative practice. *Sustainability science*, *15*(1), 117-129.

[9] Steinberg, P., & Peters, K. (2015). Wet ontologies, fluid spaces: Giving depth to volume through oceanic thinking. *Environment and Planning D: Society and Space*, *33*(2), 247-264.

ISA's primary mission as a governing body assumes just such a separation: the common heritage is something to be managed *on behalf of* [hu]mankind.

Returning to the calls by mainstream environmentalists for "more research" to assess DSM's potential impacts, I wanted to trace the history of marine science in the context of DSM to understand its connections to present-day seabed governance and the role that technoscience plays in addressing uncertainty surrounding DSM's impacts on the benthic environment. What kind of science is produced from the problem frame of DSM? And if this science precedes the establishment of the governing body responsible for managing DSM's impacts, to what extent do policies based on "science" simply reflect mining company interests? It is these questions I will attempt to answer in the rest of this paper.

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Earlier this year, by sheer coincidence, I discovered a key piece of DSM history at my own land-locked university in Wisconsin.

The Sea Grant College program was established in the U.S. in 1966 to provide funding for scientific research, training, and extension for managing marine environments under a "multiple-use" framework. That is, co-management of extractive industries with recreation, fisheries, and marine conservation. Universities from the Great Lakes states were also included in the Sea Grant Act because the Great Lakes were, in Wisconsin Governor Warren Knowles's words, "America's fourth coast". The St. Lawrence Seaway opened in 1959 and connected the Great Lakes industrial economy to the rest of the world.

One of the earliest Wisconsin Sea Grant projects was a program on marine and underwater minerals which, starting in 1968, funded research to map mineral resources in Lake Michigan and Lake Superior. In the first year, University of Wisconsin faculty Dr. J. Robert Moore (Professor of Geology) and Dr. Robert P. Meyer (Professor of Geophysics) discovered a large deposit of manganese nodules in the lake bottom sediments of Green Bay, Wisconsin.

As Moore reflected in 1988[10], this discovery boosted support for the underwater minerals program and attracted attention from the mining industry who had become aware of similar mineral discoveries under the international high seas. Thereafter, the foundation was laid for the first Underwater Minerals Conference (or UMC) in 1970.

The first UMC sought to bring university scientists—primarily engineers and geologists—in conversation with Milwaukee's heavy equipment industry to facilitate new partnerships for technology transfer and research funding and enable the extraction of underwater minerals in the Great Lakes and the global seafloor. Few partnerships between local industry and scientists developed out of the first conference, but representatives from Mobil oil and the Inlet Oil Corporation took interest in the seabed mineral industry and began several years-long partnerships with Wisconsin scientists to map new mineral deposits and develop extraction technologies for use in the deep ocean. By the 1980s, UMC's annual meetings had international reach and the conference founders reorganized as the International Marine Minerals Society (IMMS)[11], the only such

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[10] Moore, J.R. (1988). "The Underwater Mining Institute: Two Decades of Partnership" https://www.underwatermineralsconference.org/Moore_UMI_Two_Decades.pdf

[11] Siapno, William D. "Organization of the International Marine Minerals Society." *Marine Mining* 6 (1987): 245–52.

international professional organization for marine minerals. This past October (2022), UMC held its 50th annual meeting in St. Petersburg, Florida[12].

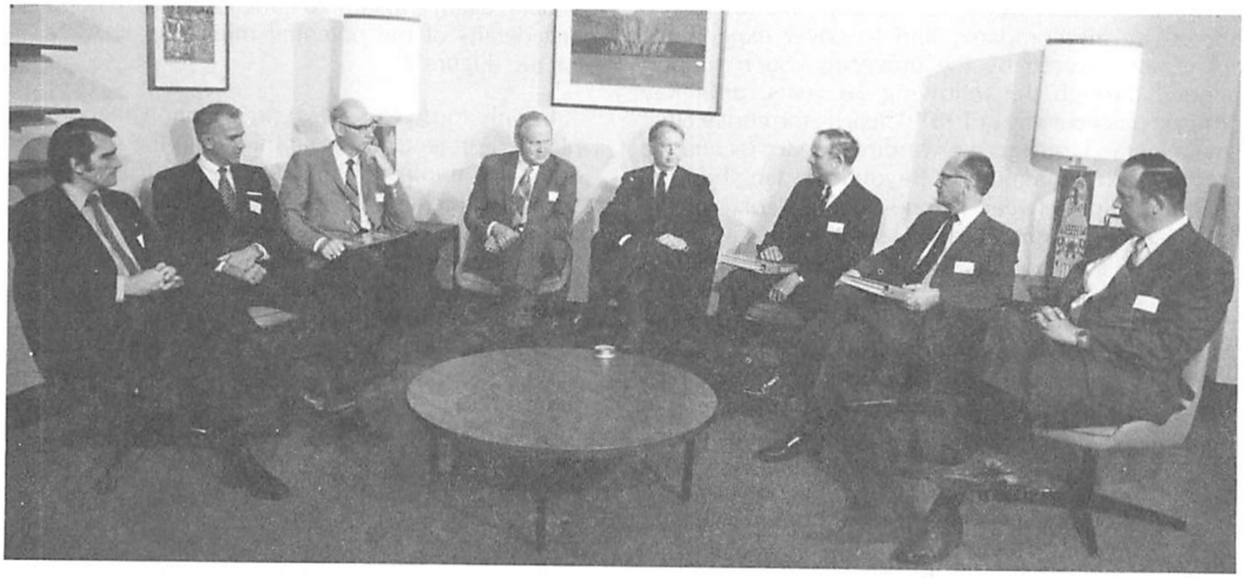

*Figure 1 - Industry representatives and university scientists (including J.R. Moore, fourth from right) meet during first Underwater Minerals Conference, 1970 (Moore, 1988)*

Given this background, I was interested in how the traces of UMC's history might be found in the DSM sector today. Specifically, how did UMC meetings over the years shape what kinds of research is relevant to DSM? How did UMC shape the conditions of possibility for knowledge production in deep ocean? And how does this knowledge manifest in specific mineral governance policies at the ISA?

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In tracing the history of the U.S. Office of Naval Research and its influence on "basic" oceanographic research, Naomi Oreskes[13] argues that the "context of motivation" matters in what knowledge is produced. The first observation of seafloor hydrothermal vents in 1977, long predicted by plate tectonic theory but not yet confirmed, was a major discovery for "basic science". It was also made possible by Department of Defense funding meant to improve submarine surveillance technology during the Cold War. Oreskes argues that the discovery occurred because oceanographers and engineers internalized the values of their Navy patrons; their interests were "bred in a context in which certain lines of inquiry were funded over others".

DSM, and the extractive industries more broadly, are a similarly motivating context in which the lines of inquiry available for researchers to pursue are constrained by the funding sources available. Deep ocean science is a particularly expensive endeavor, with costs as high as $40,000 per day[14]. In the context of extractive industries, industry-academic partnerships are more likely to address research

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[12] UMC 2022. "Half a Century on: Learning from the Past to Inform the Future. https://www.underwaterminerals.org/

[13] Oreskes, N. (2003). A context of motivation: US Navy oceanographic research and the discovery of sea-floor hydrothermal vents. *Social Studies of Science*, *33*(5), 697-742.

[14] Valdés, L. (2017). Global ocean science report: the current status of ocean science around the world. https://unesdoc.unesco.org/ark:/48223/pf0000250428

questions that provide a return on investment for the industry partner than less profitable, but potentially more interesting or more socially valuable, research problems.

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But how did this operate in the UMC in particular? Based on an analysis of UMC abstracts from the conference's 50-year history, as well as other UMC and Sea Grant archival documents, I've identified four themes that illustrate how UMC shaped the ways science is deployed within DSM governance:

1. Industry-academic funding partnerships that were developed at UMC **narrowed the scope of research** to the specific problem of DSM

2. Annual meetings **sustained academic interest and industry momentum** despite ongoing regulatory and economic barriers inhibiting commercial development

3. UMC's founding of the academic journal *Marine Mining* (now *Marine Georesources and Geotechnology*) in 1978 **offered a platform for academic conversation** outside UMC meetings and helped **construct DSM as evidence-based practice**

4. UMC's founding in 1970 established it as a **recognized, international expert community** for marine mineral research throughout UNCLOS III and ISA's formation and thus well-positioned to provide technical-policy guidance

Given my limited time, I will just explore themes one and four today.

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First, DSM as a problem frame narrowed the scope of relevant research and constrained the kinds of questions that could be asked by scientists in the UMC community.

One early project funded by the Sea Grant Geo-environmental and Mineral Resources Program sought to improve sediment coring technology to better sample rocky nodule-rich clay in Lake Michigan[15]. Previous sediment core sampler developed for soft lake-bottom sediments were made of plastic and reportedly broke or became deformed after several uses during Moore and Meyer's Green Bay manganese nodule survey. Moore partnered with the University of Wisconsin Engineering Department to increase the sampler's width and depth capacity, thus improving its utility for sampling nodule-rich clays and assessing an area's resource potential. Professor Meyer similarly developed a specialized acoustic bottom profiler with greater resolution to allow analysts to resolve individual nodules from the muddy background sediment. Bottom profilers and sediment core samplers were both standard technologies at the time but Moore and Meyer's adaptation of these tools to solve DSM-specific problems produced knowledge that reflects this motivation (FIGURE 2).

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[15] Moore, J. Robert, R. P. Meyer, and C. L. Morgan. *Investigation of the Sediments and Potential Manganese Nodule Resources of Green Bay, Wisconsin*. WISCU-T-73-001. University of Wisconsin, 1973. https://drive.google.com/file/d/1njQ2WaXDteRvUiKyho86oQ45Soj6n2OO/view?usp=sharing

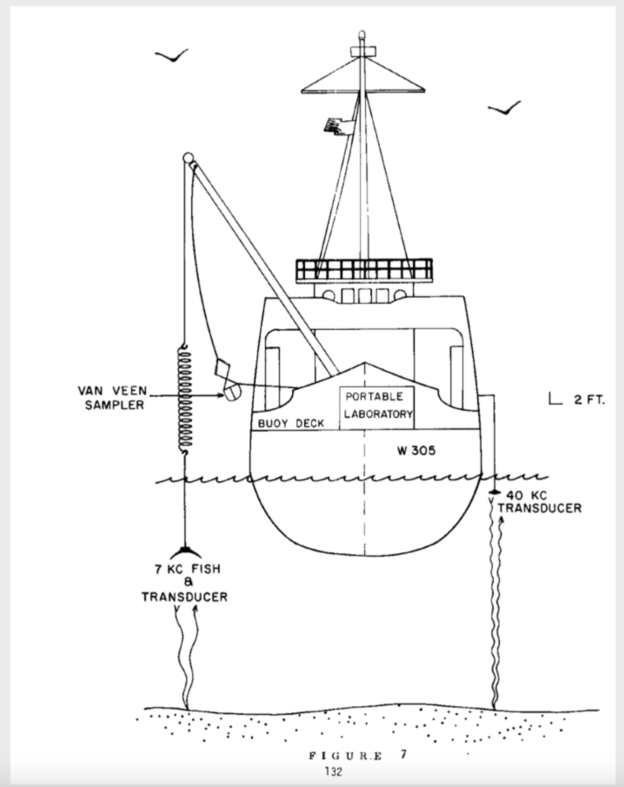

*Figure 2 - Diagram of research vessel used by Moore and Meyer to map Green Bay manganese nodule deposits. (source: Moore et al., 1973)*

One of the most common sediment core samplers used in benthic ecological research is the box corer (BC). The BC is lowered to the seafloor where the sampler is pressed deep into the sediment and closed from the bottom. It is then raised back up to the surface, preserving the sediment “slab” in its original stratigraphic order (FIGURE 3). Marine scientists analyzing BC samples can gather a large amount of information about the deep ocean environment from a single sample including sediment depositional history, biodiversity and abundance of microbes and benthic fauna, and the position of nodules relative to their sedimentary context. However, BC sampling is slow and costly, and DSM companies have primarily used the more efficient free-fall grab (FFG) for sampling nodules and making resource estimates[16].

Modeling methodologies for resource abundance was a frequent area of research presented at UMC conferences. Charles L. Morgan, doctoral student of J.R. Moore at University of Wisconsin-Madison and president of the IMMS from 1991-1994, worked with other scientists on such a model[17] of the Clarion-Clipperton Zone (CCZ) for the ISA. Using FFG (and a small number of BC) samples of nodule abundance and geochemical content from across the CCZ, Morgan and collaborators interpolated nodule abundance to produce a resource map of the entire area (FIGURE 2). In this way, the FFG and interpolation model enabled them to ontologically “fill” the seafloor with mineral resources without sensing the nodules directly (or more directly via remote sensing techniques).

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[16] Parianos, J., Lipton, I., & Nimmo, M. (2021). Aspects of estimation and reporting of mineral resources of seabed polymetallic nodules: A contemporaneous case study. *Minerals*, *11*(2), 200.

[17] ISA (2010). Technical Study 6: A Geological Model of Polymetallic Nodule Deposits in the Clarion-Clipperton Fracture Zone. https://www.isa.org.jm/documents/geological-model-polymetallic-nodule-deposits-clarion-clipperton-fracture-zone

*Figure 1 - Box core sample with nodules sitting on top of sediment slab. Source: Parianos, Lipton, & Nimmo (2021).*

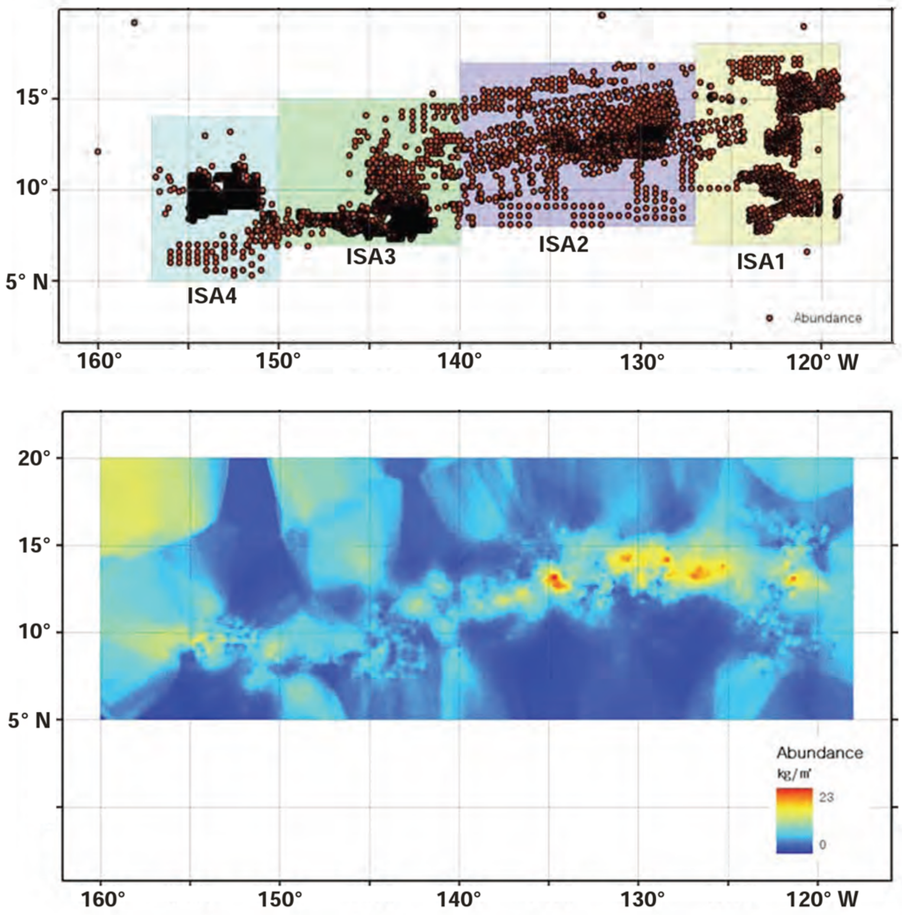

*Figure 2 - Nodule sampling station points (upper) and nodule abundance estimated with GSLIB Kriging model (lower)(Source: ISA, 2010)*

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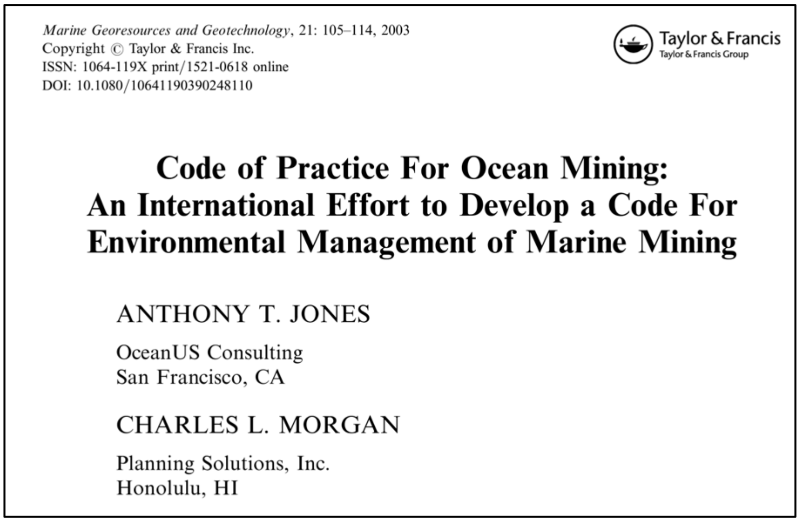
Second, UMC preceded UNCLOS by several years and the ISA by nearly 25 years, and thus served as an already established body of international experts on marine minerals. There is frequent collaboration between UMC and ISA experts on policy decisions and ISA delegates regularly speak at UMC meetings.

One notable example of crossover between the two bodies is in the Code of Practice for Environmental Management[18] (FIGURE 3). This is distinct from the ISA's legally binding Mining Code or explorations guidelines in that it is a voluntary instrument designed to guide the industry as a whole. The idea for the Code of Practice was introduced at UMC in 2000 by Julian Malnic[19], the CEO of DSM company Nautilus Minerals. In his paper he emphasized the growing power of "so-called Civil Society" trying to stop mining operations they perceived as harmful and that it is in the interest of companies in the burgeoning DSM sector to take a proactive approach toward managing their public image by publicizing adoption of such a code.



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**Code of Practice For Ocean Mining:**
**An International Effort to Develop a Code For**
**Environmental Management of Marine Mining**

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*Figure 3 - IMMS Code of Environmental Management, co-authored by IMMS president Charles L. Morgan.*

The Code from which Malnic draws inspiration originated in the Australian minerals industry[20] and was developed in response to a series of negative PR events for the industry including BHP Billiton's OK Tedi mine disaster in Papua New Guinea. He argues that the Australian industry's experience with the Code demonstrates the high economic returns possible from consciously managing public perception and he suggests that the forces of civil society are such that it is irresponsible as a company *not* to prioritize management of public opinion and ensure the public that one's company

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[18] Jones, A. T., & Morgan, C. L. (2003). Code of practice for ocean mining: An international effort to develop a code for environmental management of marine mining. *Marine georesources & geotechnology*, *21*(2), 105-114.

[19] Malnic, Julian. (2000). "A Self-Regulatory Model For The Management Of The Environment And Public Issues In Marine Mining." International Marine Minerals Society. https://drive.google.com/file/d/1Fs5VQlYoFDrovA2J8BjNF4vaiPhWsSH-/view?usp=sharing

[20] Satchwell, I. (1997). Australian Minerals Industry Code for Environmental Management. *Australian Journal of Environmental Management*, *4*(1), 6-7.

takes seriously values around sustainability and responsible practice. Reflecting on the high stakes involved in managing public opinion about the still-novel marine minerals sector, Malnic states that:

> *"It is essential that a suitable cultural environment be created for the rational valuation of the benefits and penalties that marine mining presents. To this end, the Code for Environmental Management can offer a skeptical world a clear signal that our hearts and minds are in the right place as we set about making this assessment."*

Following Malnic's 2000 UMC presentation, the IMMS adapted the Code for the marine minerals industry and subsequently presented it to the 16th session of the ISA in 2010. The Code is now available on the ISA website in the six different official UN languages. However, it's not clear the degree to which the (voluntary) Environmental Management Code has shaped the ISA's more legally binding Mining Code and Exploration or Exploitation Guidelines. Malnic's sentiment that the former is meant as a "clear signal that [their] hearts and minds are in the right place" is noteworthy, especially considering the Australian Industry's poor track record in the years after adopting their own voluntary code. For example, Stuart Kirsch[21] shows just how little corporate practice changed at the Ok Tedi Mine despite BHP's "heart and mind [being] in the right place".

Malnic's Nautilus Minerals was eventually granted the world's first commercial DSM license for the Solwara I project in PNG's Exclusive Economic Zone. However, despite adopting the voluntary IMMS Environmental Management Code, Nautilus Minerals later for bankruptcy after years of protest and grassroots resistance efforts (or, in Malnic's words, struggles against the forces of "so-called civil society"). This case illustrates that voluntary corporate social responsibility efforts like the IMMS Code are largely performative and ineffective for obtaining a "social license to operate"[22] in oceanic spaces with strong prior cultural knowledge claims. However, it's unclear to what extent this applies to areas of the seabed like the CCZ that are geographically much further from island and coastal communities. Here, which knowledge claims are granted epistemic authority arguably depends on how they articulate with the relevant governing body—which, in the case of the CCZ, is the ISA—and to which publics the governing body is held accountable. What power might industry virtue signaling offer in this governance context? And what role does industry techno-science play in constructing the ground—both geophysical and ontological—on which governance decisions are debated? These are questions I plan to investigate as this research develops.

## SLIDE - CONCLUSION

Western knowledge of the deep seafloor is mediated by techno-scientific tools. The ways that we view the deep ocean is therefore constructed to a large degree by the context in which these tools were developed and that motivated their production. In the case of DSM technologies for mapping the seabed, these were developed to measure mineral resource abundance and distribution and thus construct ocean space as a container for (more or less) mineral resources. Non-mineral objects in this space—e.g. living things—are simultaneously constructed as being already at-risk from future mining.

The case I discussed here of the Underwater Minerals Conference is one site in which to interrogate questions around deep seabed mining and calls for "more research" before mining can begin. As my research is still developing it's unclear to what extent the UMC has shaped broader governance approaches to DSM, but it serves as a useful case study of the ways in which techno-scientific

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[21] Kirsch, S. (2014). Mining capitalism. In *Mining Capitalism*. University of California Press.

[22] Filer, C., & Gabriel, J. (2018). How could Nautilus Minerals get a social licence to operate the world's first deep sea mine?. *Marine Policy*, *95*, 394-400.

knowledge production in one context plays an ontological role in the politics of mineral resource management more broadly.