The Deepest Paradox: Seafloor Mining and Its Future

by

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ABSTRACT

Metals mined from the seafloor could support tomorrow's technological and clean energy innovations. Though the mineralogical and geochemical significance of seafloor deposits, which lie thousands of meters below the water's surface in geological formations such as polymetallic nodules, ferromanganese crusts, and seafloor massive sulfides is well-established, the biological and ecological profiles of these sites are still actively developing. As a result, the two scientific disciplines – geochemistry and biology – have advanced at different rates.

Regions of the seafloor including the Clarion-Clipperton Fracture Zone, the Prime Crust Zone, and inactive or waning hydrothermal vent systems have attracted attention for their unique concentration of metals used in electronics and strong magnets. With commercial mining activities set to commence in 2019 by Canadian company Nautilus Minerals, it is time to assess the paradoxical nature of seafloor mining: to mine the seafloor to support sustainable and efficient technological development on the land above.

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Fatima Husain

Thousands of meters below the ocean surface lie rich, metallic treasures, carefully distributed along the seafloor by a delicate combination of ocean chemistry, physics, and biology. And for these treasures, the wars of the deep are about to begin.

The battlegrounds are only partially understood: humankind will venture to remote, unexplored territory that can described no more precisely than as "the bottom of the sea." Other planets of the solar system, including Venus and Mars, are better mapped than Earth's own seafloor. Describing ocean environments that are so physically out-of-reach calls for the use of advanced geophysical tools, developed only in the second-half of the twentieth century and attached to the bottoms of research ships that travel in jagged lines across the oceans. But many more lines are needed to cover all of Earth's waters, which comprise over seventy percent of the planet's surface. As a result, much of the seafloor remains essentially invisible and unimaginable. Accurate and detailed maps of the Earth's depths, used and created by prospectors and scientists alike, are perhaps as rare as the desired treasures themselves.

A few areas, comprising only a small fraction of our vast ocean floor, have been deemed particularly valuable. They contain both common and rare earth metals – commodities which could fuel technological advancements on the continents above. For example, deposits off the coast of Papua New Guinea contain high grades of copper, which is used in electrical wiring. Deposits in the Clarion-Clipperton Zone (CCZ), an area of the seafloor located between the west coast of Central America and Hawai'i, contain manganese, which is used to create steel. Deposits west of the CCZ, in an area called the Prime Crust Zone (PCZ), contain metals like dysprosium, which is found in computer hard disk drives. Currently, these metals are all mined from land-based deposits – but that's set to change: seafloor mining will begin in late 2019.

While the technological and computing revolutions of the late twentieth century were supported by metals mined across Earth's continents, the innovations of tomorrow may be supported by metals mined at depth. The circumstances are changing. Mines aren't renewable resources. As the amount of metal remaining in mines on land dwindles, it is becoming harder, potentially more dangerous, and less economically feasible to extract them. Once the metals are taken, they're essentially gone forever. At the same time, recycling efforts have fallen flat while the demand for rare earth metals – the group of seventeen elements organized at the bottom of the periodic table – has skyrocketed.

The Critical Materials Institute (CMI), run by The Ames Laboratory for the U.S. Department of Energy, keeps close watch on the availability of metals deemed essential for technological development. Without these materials, entire industries would come to a standstill. CMI focuses specifically on seven elements, five of which are rare earth metals. Alex King, the director of CMI, stresses just how ubiquitous these rare earth metals are in day-to-day technologies. "Almost of every device you can think of contains some kind of rare earth metal," King says. He points to common technologies that rely on rare earth metals to function: fluorescent lighting, LCD screens, loudspeakers. "We don't use very much [per product], but they're absolutely essential. Some people describe them as the vitamins of the mineral world," he says.

Vitamins are common, and, despite their name, rare earth metals are, too. The metals are abundant in the Earth's crust but are too dispersed to economically mine on land. "One of the big problems is that the usage of rare earths does not closely match the production of rare earths," King says. "If you want to get a lot of rare earths ... then you have to mine an awful lot." But that's not the case on the seafloor, where the deposits are enriched in rare earth metals and many other metals used in manufacturing.

In the shadow of ever-present electronics, another industry is quietly growing hungry for metals: clean energy. Dysprosium isn't used solely in hard disk drives; it's also a critical element in offshore wind turbines. At the Block Island Wind Farm, the first commercial offshore wind farm in the United States, the futuristic turbines do not have traditional gearboxes – components which smooth the transitions between slowly rotating turbine blades and quickly rotating electrical generators. Instead, the gearboxes are replaced with strong, permanent magnets made with rare earth metals.

"Virtually any electrical turbine generator will work better if it has rare earth magnets in it," King says. Facing the risk of rare earth metal shortages, though, some land-based wind turbine manufacturers still use the gearbox technology, even though such turbines more prone to failure.

"You have to live with what's available … sometimes [shortages] force you into less good technologies," King says.

But clean, efficient energy is the ultimate goal. So, in order to support an industry otherwise championed for its sustainability and limited environmental impacts, some argue that seafloor mining, which isn't sustainable and may irreversibly damage seafloor environments, must take place. A paradox. Nevertheless, most scientists and miners alike agree that seafloor mining is inevitable. It's no longer a question of *if* the seafloor will be mined – it's a battle over how and when.

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Seafloor mining has taken many years to get started. In 1967, Arvid Pardo, a Maltese diplomat, delivered a speech to the United Nations General Assembly Meeting on the management and governance of the ocean's mineable resources. At the time, Pardo spoke of manganese nodules – fist-sized bulbs rich in mainly four metals: manganese, nickel, copper, and cobalt. The nodules can blanket sea floors, creating odd round, rugged environments. The nodules Pardo spoke of had been discovered nearly a century earlier, and it was suspected at the time that they were renewable, fast-growing commodities, as if a nodule could be grown and harvested over and over, like cabbages. Pardo also spoke briefly of potential "aquanauts" permanently living on submarine mountain ranges by the year 1975, suggesting that, at the time, there was considerable optimism about a potential oceanic manifest destiny.

Besides embodying the spirit of exploration prevalent in the 60s, Pardo laid the foundation for a resolution stating that the seabed and ocean floor were "a common heritage of mankind" and "should be used and exploited for peaceful purposes and for the exclusive benefit of mankind as a whole." This concept today comprises the heart of the United Nations Convention on the Law of the Sea, which defines how countries may use and explore the waters beyond each country's national waters. The Convention led to the establishment of the International Seabed Authority in 1994, the intergovernmental organization that currently regulates all mining within international jurisdiction. And now, as miners race to the seafloor, the International Seabed Authority must responsibly regulate an industry that doesn't yet exist.

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The Earth was a very different planet when the deposits to be mined at the seafloor began to form. Geological research on the manganese nodules, and on compositionally similar formations known as ferromanganese crusts, has revealed that they grow on the order of millimeters over millions of years. Some nodules in the Pacific Ocean are estimated to be two to three million years old; some crusts are over 145 million years old – nearly three times as old as the Himalayan mountain range. Further ocean exploration has revealed the existence of yet another formation set to be mined: seafloor massive sulfide deposits. These deposits are millions of years younger – they range from hundreds to thousands of years old. On human timescales, the formations are not quite as renewable as Pardo believed.

And the genesis of each formation is unique. Millions of years ago, a prehistoric shark lost a tooth in its quest for prey. That tooth slowly sank down to the seafloor, traversing thousands of meters of water in the process. Along the way, the tooth encountered waters with changing composition: the sunlit waters at the top of the oceans aren't the same as the chemically-rich, oxygenated waters at the bottom. When the tooth finally nestled onto the sandy seafloor, a curious set of chemical reactions commenced, wrapping the tooth all around with thin coats of metal previously dissolved in the ocean water. This process repeated over and over for millions of years, growing thicker and thicker layers of metal and rock around the tooth. The end result? A bulbous, uneven rock enriched in iron and manganese. But it doesn't always take a tooth: This process has been repeated many times with all sorts of debris, including fragments of broken nodules themselves, shells, or even other rocks present on the seafloor. As a result, entire fields of nodules cover some parts of the seafloor. Some of them visibly stick out from the seafloor below, much like round, gray pebbles strewn across a white sandy beach. Because the specific dissolved metals in the water vary across the oceans and at different depths, not all nodules are created equally, meaning that some may be more valuable than others.

James Hein, a research geologist for the United States Geological Survey, began studying manganese nodules in the 1970s. His work was part of the Deep Ocean Mining Environment Study, conducted by the National Oceanic and Atmospheric Administration. This agency aimed to monitor the environmental impacts of small-scale pilot mining activities. Hein studied the particular characteristics of the soft seafloor that surrounded the nodules. "I originally had no interest in mineral deposits – I thought it'd be rather boring," Hein says. "It turns out that it is *not* boring at all."

Hein points to the CCZ in the Pacific Ocean as a future hotbed for mining activities. The greatest concentration of nodules is found 3000 meters to 6000 meters below the surface in this zone. Here, a single square meter of seafloor could contain nearly 15 kilograms of nodules. Unlike some other parts of the seafloor, nodules at the CCZ are lifted up from the seafloor by marine organisms that live in the sands below, so that they essentially stick out from the ground. As a result, collecting the nodules for mining is, at least conceptually, simple. Hein names two viable methods: either raking them up or vacuuming them up. The nodules, he says, are strong enough that they don't typically break apart during each process.

The CCZ nodules are also special because of the metals contained within them. A 2016 study, on which Hein was a co-author, places estimates on just how much metal is contained in the CCZ nodules. The study's "conservative calculation" suggests there are 6000 million tonnes of manganese, 270 million tonnes of nickel, and 44 million tonnes of cobalt – quantities for each metal that overtake the known amounts in land-based reserves. But the study is also quick to point out that not all of the nodules in the CCZ can be mined, due to physical constraints and environmental protections.

Hein hopes that when the nodules are mined, as many metals as possible are collected from them. Manganese nodules are sometimes referred to by a different name: polymetallic nodules. As that name suggests, the nodules contain a significant mix of multiple metals – besides just manganese, cobalt, or nickel. The hardest part of nodule mining isn't collecting the nodules themselves: it's extracting the metals from the nodules once they're above ground. This mirrors the issue with mining rare earth metals on land: the deposits are accessible but getting all the metals out of them is an economic hassle – so it's easier to pick a metal or two out and ignore the others. But because of their unique method of formation, the nodules are enriched in a whole suite of metals that other companies might want to extract. "I hope that [companies] will pass whatever's leftover down to somebody else to extract," Hein says. "Because I'd hate to see those metals wasted."

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Though the metals on the seafloor have caught our eyes only over the past few decades, they caught the attention of marine life far earlier. Some of the marine organisms, such as corals or sponges that live on ferromanganese crusts, are thousands of years old – much older than any land animal alive today. The same environments that allow metals to settle onto the seafloor are attractive to deep-sea life. A seafloor that is relatively undisturbed provides a stable, long-term home.

Diva Amon, a deep-sea biologist and current Marie Skłodowska-Curie Research Fellow at the Natural History Museum in London, studies the impacts mining could have on these deep-sea and seafloor-dwelling organisms. Growing up on Trinidad and Tobago, Amon was surrounded by the ocean and made it her goal to understand all that happens within it.

Fields rich in nodules contain an array of small but diverse lifeforms – many of which couldn't tolerate the disturbances that mining would cause. Nodule-rich environments are so stable that many of the organisms that live there aren't capable of moving on their own – they're sessile. If a machine comes to mine the rocks they live on, they can't move out of the way. And these organisms don't just constitute a small fraction of life at depth: Amon says fifty percent of the species of megafauna, animals that can be seen without magnification, live directly on the nodules. "If the nodules were to be removed, there would be quite a huge component of the biodiversity lost," Amon says.

To illustrate what's at stake, Amon describes marine life in the CCZ. "[The CCZ contains] many of the same animal groups as in shallow waters, but everything is just *weirder* down there," Amon says with a laugh. The environment, though rich with life, appears sparse and looks wholly alien. For example, a coral resembles an all-white pussy willow branch – without the fuzz. A white, semi-transparent cnidarian with eight-foot-long tentacles attaches itself to a sponge and catches any fish that swims its way. A brittle sea star sits passively atop a nodule, laying down its wiggly thin arms on rocks and soft sand. The deep-sea habitat is quite different from other ocean environments: it receives no light and little food – so the organisms that live down there are evolutionary survivors, equipped with the biology necessary to thrive in the abyss.

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The International Seabed Authority has currently entered into seventeen contracts with mining companies from various countries, including China, the United Kingdom and Germany, for nodule exploration in the CCZ. But both the zone and its neighbor, the PCZ, also contain ferromanganese crusts – pavements of metals that accumulated onto flat surfaces in the oceans over millions of years. The same study that conservatively estimated the amounts of metals contained within the CCZ nodules estimates that the crusts of the central Pacific Ocean contain "four times more cobalt, three and a half times more yttrium, and nine times more tellurium than the entire land-based reserves of these metals."

Crust accumulation is one of the slowest geologic processes on Earth and is facilitated in the Pacific Ocean by the cold, chemically-rich waters that wash over flat-topped seamounts and underwater plateaus. Though this process can occur nearly anywhere in the oceans, it is interrupted when the seafloor is disturbed by falling debris from surface waters or by animals perturbing the seafloor. The CCZ and PCZ didn't have enough interruptions to stop millions of years of growth, making the zones prime targets for mining.

"[Crusts are] enriched in practically every element in the periodic table, so they're of great interest," Hein says. As the name suggests, ferromanganese crusts contain significant amounts of iron, but they also contain rare earth metals that are used in traditional, existing clean energy technologies. In 2011, a single two-megawatt land-based wind turbine required some 800 pounds of neodymium along with other rare earth metals – even with gearboxes intact.

But collecting the crusts themselves is a formidable feat. "They're attached to rock," says Hein. As a result, miners must figure out how to extract ten to twenty centimeters of pavement-like crust – without collecting any of the undesirable rock beneath. So, crusts, which contain the greatest diversity of metals, won't be mined until the technology catches up. But that hasn't deterred mining companies from applying for contracts through the International Seabed Authority. Presently, there are four contracts to explore ferromanganese crusts in the Pacific Ocean and one in the Atlantic.

But again, there are biological concerns. Christopher Kelley, program biologist for the Hawaii Undersea Research Laboratory, has long studied life on the crusts. Through deep-sea exploration missions, Kelley has seen the vast ecological communities that live at those depths. Because of his research efforts, Kelley has had two species, a coral and a sea star, named after him. "It's kind of a chubby little sea star," Kelley says, "so that's kind of fitting I'm afraid because I'm a little bit chubby these days, too."

As Kelley marvels at the life present on these minable formations, he is well-aware of the disturbances that would come by exploiting them. "Crust mining is going to be far more destructive when it takes place," Kelley says. Life on crusts is prolific compared to life in the nodule environment. Forests of corals and sponges grow atop crusts. And as with forests on land, they support a lot of animal life – including brittle stars, crabs, and barnacles. These forests aren't small or short, either – over thousands of years, the corals and sponges have had the chance to grow immensely. Kelley and his colleagues marvel and joke about the sizes, affectionately nicknaming certain large sponges "Jabba the Hut sponges" because "they were just so massive."

Kelley encountered similarly large sponges during research cruises in other parts of the Pacific. During an exploration aboard the R/V OKEANOS Explorer, Kelley encountered a sponge at 2117 meters depth "whose length, height and width exceeded the dimensions of the largest specimens reported in the literature." At over three-and-a-half meters high, two meters across, and one-and-a-half meters thick, the sponge looks like haphazardly-layered foamy insulation.

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There are no plans to begin commercial nodule or crust mining in the foreseeable future. But there are plans – beginning in 2019 off the coast of Papua New Guinea – to mine another kind of deposit: seafloor massive sulfides. These deposits were the last of the formations to be discovered, and the first set to be commercially mined. They form along active mid-ocean ridges and seamounts, where metal-rich jets of water violently escape from Earth's interior through the seafloor. The hot, dissolved chemicals in the water solidify and fall around the vents as they come in contact with near-freezing seafloor bottom waters, and form what look like little seafloor volcanoes or termite-like mounds. Over time, these chimneys build up, creating actively changing seafloor landscapes. But that activity is subject to change without notice: tectonic movements can render hydrothermal vents inactive almost instantly. And once the sites are inactive, they stop growing.

Solwara-1, the site set to be mined by Canadian company Nautilus Minerals in 2019, has waning hydrothermal activity. "It's not the vent sites themselves that will be mined," Hein contends. "It's really dead systems or nearly dead systems that will be mined." But is that true? Not all scientists are convinced that miners will continue to mine only dead or dying systems. And that's important because the same chemical processes that create massive vents and deposits also support a rich diversity of life, worrying marine biologists like Verena Tunnicliffe. Tunnicliffe, a professor at the University of Victoria in Ontario, Canada, has studied hydrothermal vent systems for over three decades and advocates for labeling active vent systems as off-limits for mining activities. Tunnicliffe leads a project in her lab titled "Hot Vents Undermined." She's working to compile the scientific literature and data that supports the case against active vent mining, which hasn't been explicitly disallowed by the International Seabed Authority or local governments.

"If you're going to go mining, you don't want to get a few little chimneys," Tunnicliffe says. "You go to the long-term stable sites." And these sites are more likely to be active, hosting ecosystems comprised of marine organisms entirely new to science.

"When you go to new places, guess what? Everybody's new. I just said to my class yesterday, 'You want to come discover new species? Come to my lab and start sorting the samples,'" Tunnicliffe says. Through her extensive research, Tunnicliffe has discovered an estimated eighty to one hundred new species of marine organisms at vent systems worldwide.

Tunnicliffe's fears about mining at active sites draw from principles of conservation and biodiversity. "Long time and stability are two of the predictors of high biodiversity," Tunnicliffe says. That high biodiversity varies depending on the location of the system. At the Mid-Atlantic Ridge, for example, thousands of shrimp swarm vent systems, while in the Pacific, it's thousands of tubeworms.

If an active vent system is mined, the geological consequences are straightforward: the towering mounds of minerals and metals will be replaced over time. But the ecological consequences are much harder to predict, causing scientists like Tunnicliffe to take pause at the prospect. Inactive vent systems, which could be richly-concentrated in metals and minerals, are likely ubiquitous – they're just much harder to locate. To find active systems, scientists look for the heat signatures of the hot plumes rising from the seafloor. Inactive vent sites no longer produce those plumes, so scientists look for areas spread out around active vent systems in the hope that they'll locate inactive ones. It's essentially informed guesswork, and guesswork is rarely a good business strategy.

But Nautilus Minerals doesn't necessarily see it that way. John Parianos, the chief geologist for the company, says that Nautilus Minerals plans to stay away from active vents. "We're just not going to go there because the water is really hot and will damage our equipment. There's ash – acidic, sulfurous ash blowing around," Parianos says. "There's just not that much metal in them, anyways." He clarifies that what miners are most interested in is concentrated metal ore in the rocks beneath the chimneys themselves. The chimneys contain only two percent of the ore they want to mine – while the other ninety-eight percent are in subterranean mineral deposits.

Parianos acknowledges the biological diversity at active vents and noted that Nautilus Minerals set up a preservation zone near the Solwara-1 site, "where the animals, for all intents and purposes, are identical" to those at Solwara-1 itself. "Even if we wiped out every animal at Solwara-1, which wouldn't happen, we think they would repopulate from [the preservation zone]. It's almost like a backup plan."

In February 2018, Nautilus Minerals announced successful field tests of their mining equipment. The machinery is inspired by existing equipment used to mine land-based deposits – an advantage miners have on these types of deposits compared to crusts and nodules, which have no equivalents on land. Their Solwara-1 site contains particularly impressive concentrations of copper. According to Hein, the deposits are fourteen times more concentrated in copper than the copper deposits mined on land. Though this concentrated copper might seem appealing and convenient, the potential amount of copper overall is surprisingly small, given the size of the site. "It's about one square kilometer," Hein says. "It's a really tiny little thing. There's enough ore for about two and a half years of mining." Nautilus Minerals plans to mine the site for the copper, but also gold, silver, and zinc before moving on to other mine sites.

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Seafloor mining necessitates technological ingenuity. Equipment must track along a non-uniform seafloor, operate well at depth with only artificial light to guide the machinery, and it must be able to transport the mined material up to the surface for processing.

Though the specific technologies used in land and sea mining are proprietary, Nautilus Minerals shares some details about their technology and mining process on their website. First, construction-like cutting and grinding vehicles are slowly dropped to the seafloor. A long tube, a riser pipe, extends from the vehicles below to the surface, which is used to transport mined sediment up to a ship that collects all the mined materials. Once the operations are over, the equipment on the seafloor is transported to its next site and the process is repeated. It's likely that variations of the process will be used in mining operations that span nodules, crusts, and sulfide deposits.

“The ore will be collected [at the seafloor], it will be crushed, and then it will be brought up a riser pipe to the ship,” Hein says. Aside from crushing and killing the animals that live on the deposits being mined, another aspect of the mining process that concerns scientists is the generation of toxic sediment plumes. The plumes are a direct result of crushing and squeezing water out of the rocks and minerals that contain metals, as well as kicking up sediments on the seafloor that were deposited over millions of years. The plumes essentially create a toxic blanket which smothers the organisms who cannot move out of the way as the blanket falls onto the ocean floor.

The risks of plumes vary with each type of deposit. Crusts, which sit on hard rocks, aren’t likely to produce massive plumes. But Hein believes nodule mining poses a greater risk because the nodules sit directly on sediment that could be easily kicked up during the collection process. But even still, Hein believes the talk of toxic plumes is exaggerated.

“It looks like the sediment plumes are not going nearly as far,” he says. “The research is showing that they are more confined than had originally been imagined.” The danger the plumes pose is a function of the size of particles within them, the depth of the water, and the currents they encounter. Recent research suggests that plumes with larger particles may be better environmentally because the particles would sink to the seafloor rather than finely clog and cover organisms. The logic is similar to that of giving small toys to a child. A child could choke on a toy that fits in his or her mouth, whereas that same child is unlikely to choke on a life-sized doll.

Geophysical models of how plumes are created and dispersed are used to assess mining impacts. They draw from both observations taken from exploratory mining expeditions and theoretical data in disturbance studies. Hein seems to trust the models: “I’ve seen a couple that look pretty good. I think they’re close to being right.”

But Parianos says the models could be even better. He believes that much of the speculation about plumes is drawn from models that largely overestimate plume travel deep in the sea. And Parianos isn’t far off from the scientific adage – models lie. What’s needed, in this case, is an actual study that monitors a physical plume in a deep-sea environment.

Malcolm Clark, a principal scientist and biologist at the National Institute of Water and Atmospheric Research in New Zealand, aims to perform that research in the upcoming year – specifically to assess the impacts of potential seafloor mining. In the beginning of May 2018, Clark went to sea to perform a disturbance study – a type of study in which an environment is deliberately perturbed and then closely monitored afterwards. In Clark's case, he examined the ecological communities and how they were affected by disturbances such as the plumes that could be generated by mining.

Disturbance studies for seafloor mining aren't new. In 1989, a team of West German researchers intentionally disturbed the seafloor near a potentially lucrative mining site to study how life would adapt. Even now, the site contains fresh-looking tracks – even though they were made nearly three decades earlier. Further contemporary studies of the site show that the ecological communities in the area bounced back, but not exactly in the proportions they were in before the disturbances.

Clark wants to take the science a step further. Before disturbing the environment, Clark and his colleagues collected marine organisms for study in a lab environment with the intention to perform experiments on the organisms to quantify just how much sediment, delivered by a plume, the organisms could tolerate before dying. He describes this part of his work as measuring "the biological response over time of sedimentation."

"[Plumes] might be less important than the media has portrayed. We simply don't know and that's why it's one of the key areas of uncertainty when looking at the potential effects of mining," Clark says. "The work I'm trying to do here in New Zealand is to try and put some objective information into that area of uncertainty, so that we've got a better idea of whether [Hein] is right or wrong" about the plumes.

This puts the marine biological community at a disadvantage. The miners are ready to go to work, but biologists are just beginning to thoroughly explore the ecology of the deep oceans.

When deep sea biologists such as Kelley, Amon, or Tunnicliffe go on an expedition, they discover new things about the ocean each time. “Every time you explore the deep sea, especially below three kilometers depth, you have a fifty percent chance of finding a new animal,” Amon says. “And that’s just because it been so poorly explored everywhere.”

While the CCZ is well understood for its rich resources, knowledge of its biology falls short. “We don’t even know [with certainty which] species live there. And there’s a good chance many of those species are new to science,” Amon says. “If we can’t answer that most basic question, we then can’t answer things like, ‘How do they reproduce? How do they eat? Where are their populations?’ There’s this spiral into just unknown information.”

Kelley agrees, and hopes his biology research will inform miners and the public alike that mining will impact species that we know little about. “It’s not just bare and dead environments … there are some incredible communities down there.” And some researchers like Tunnicliffe worry that mining will irreversibly impact marine life that isn’t found any place else on Earth. “I could probably pretty safely say that if mining goes ahead at certain sites, I do believe we’ll lose species.”

Hein agrees that there’s risk of biodiversity loss, but that it is still possible to mine the seafloor safely: “Responsible mining of the seafloor is, of course, doing everything in the most environmentally sound way that’s possible … [Seafloor mining] is probably one of the most regulated non-industries that exists since there’s never been any [commercial] deep ocean mining.”

Hein envisions ideal mining operations that are completely transparent to the public and scientists. And he points to Nautilus Minerals as a paragon. The company has their environmental impact statements on their website, invites scientists onto their exploratory cruises, and issues detailed press releases. That transparency not only informs the public of what’s going on at the seafloor, but also keeps the company itself in check. “We still know that getting acceptance by the broader community is really important and we also know that we’ve got a chance to do it right,” Parianos says.

No miner can touch the Earth's surface without having some impact. "It's not possible anytime you build a road, a school, or a power plant," Hein says. "I mean, the biggest destroyer of ecosystems on [land] is farming … what the [mining] companies need to be make sure of is they're not going to destroy ecosystems."

However, little is known about how these underwater ecosystems even function. "We've got a large number of very rare species which are going to be affected. But does that have an impact on the ecological function of the deep sea?" Clark says. It will be difficult to forestall faster computers, smarter cellphones, and increasingly energy-efficient technologies before a full understanding is achieved.

Given that, Kelley acknowledges that ocean mining will have to occur to sustain demand for metals on land, yet he's still hopeful about improving public perception: "One of the things that those of us working in this area are trying to do is to create awareness of the fact that there's some amazing animals and amazing communities that are living a mile or two miles below the surface – some things that they'll never come in contact with but still deserve some measure of protection and some measure of attention because they're co-inhabiting the planet … A lot of these corals take thousands of years to grow … It takes about thirty seconds to destroy [them]."

To go from a petroleum-based world to a green-technology world, as Hein puts it, requires the mining of tremendous amounts of new rare earth metals. "You talk to the general public and they think all solar [energy] is free, wind [energy] is free. But it's not free," Hein says. "It's not free by any means because all of the technologies are requiring such abundant amounts of rare metals that haven't been part of our societies in the past. So, if we want to go from a petroleum world to a green technology world, this is one of the issues that we have to deal with."

"This isn't just a science discussion," Tunnicliffe says. "It's not just a minerals mining discussion. It's a societal discussion. Is this something we want as a society in 2018? … Do we really know what we're doing at the bottom of the sea?"

SOURCES AND FURTHER READING

INTERVIEWS

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