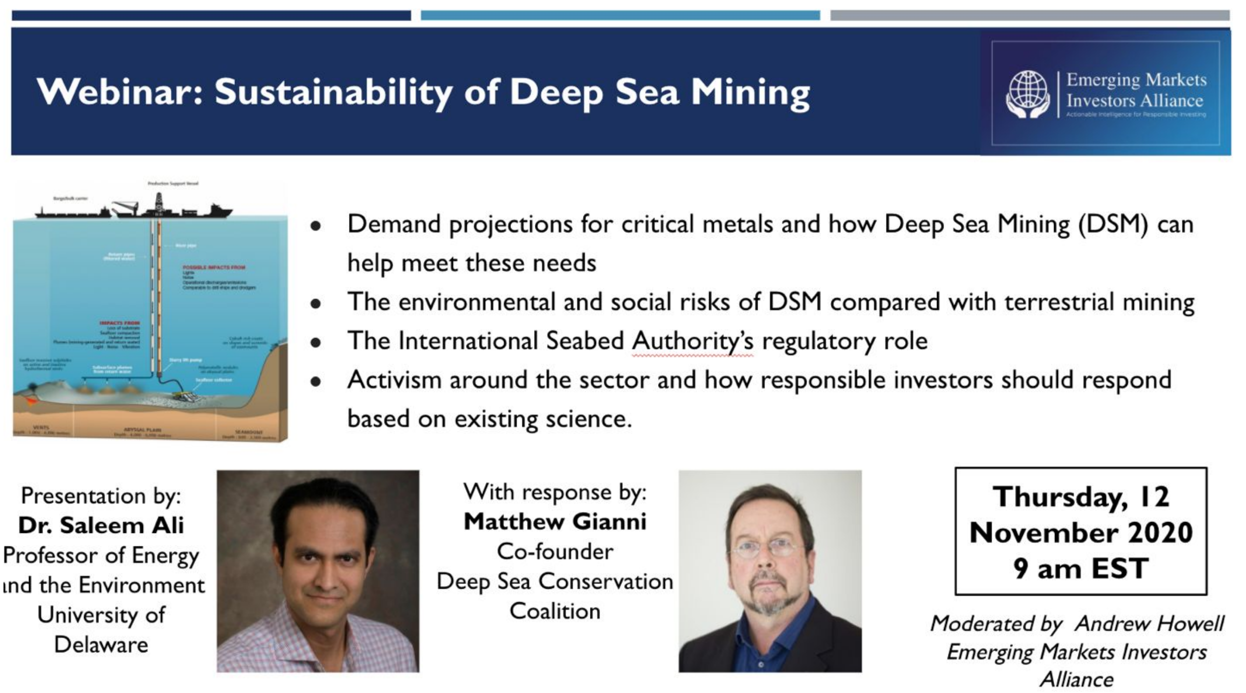
Emerging Markets Investors Alliance
Actionable Intelligence for Responsible Investing

Detailed Webinar Summary

**Sustainability of Deep Sea Mining**

Alliance Extractive Industries Program, 12 November 2020

***With Dr. Saleem Ali (University of Delaware), Matthew Gianni (Deep Sea Conservation Coalition) and Andrew Howell (Emerging Markets Investors Alliance)***




*Discussed research: [Deep sea mining: the potential convergence of science, industry and sustainable development?]() and DSCC [Factsheets]() on Deep Sea Mining.*

**Dr. Saleem Ali** is a Professor of Energy and Environment at the University of Delaware and serves on the UN International Resource Panel. He serves in a scientific advisory role for DeepGreen Metals inc as part of a technical research partnership with the Sustainable Minerals Institute at the University of Queensland where he previously was Chair in Sustainable Resource Development and Director of the Center for Social Responsibility in Mining.

**Matthew Gianni** is co-founder of the Deep Sea Conservation Coalition (DSCC) and an advocate for marine conservation. He has been involved in international fisheries and marine conservation campaigns, policy, law and treaty negotiations for almost 30 years and has worked to promote ocean conservation and improve international oceans governance at the General Assembly and summits of the United Nations, the UN FAO, regional fisheries management organizations and the International Seabed Authority.

See Dr. Ali's presentation here.

****

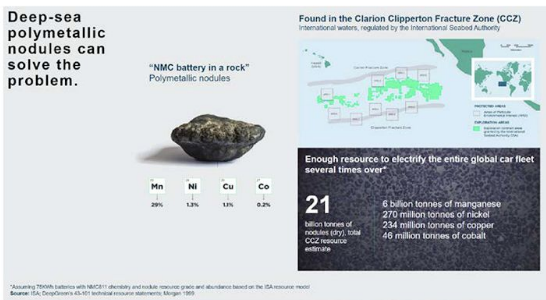
***Andrew Howell***
Thank you all for joining the Emerging Markets Investors Alliance monthly webinar on the extractive industries. This discussion is part of a series of topics related to the mineral transition in mining. We had a webinar on lithium mining in northern Chile, and we've talked about resource governance in the Congo and what that means for cobalt supply. This webinar brings us outside the terrestrial sphere to the deep seabed – a topic which certainly is new to me and which is somewhat controversial, as it turns out, so this is a good opportunity to have a look at this from a couple of perspectives. We have professor Saleem Ali of University of Delaware who has very kindly agreed to share his expertise, as well as Matt Gianni of the Deep Sea Conservation Coalition, which is opposed to deep sea mining, who can provide a response to Saleem's presentation and an alternate view. Without further ado I'll pass it on to Saleem.

***Saleem Ali***
Thank you, Andrew. The role of investors in an activity such as Deep Sea Mining – making sure these kinds of ventures are done responsibly – is exceedingly important, and we're seeing that investors can have a really positive impact in this regard. As was mentioned, I have a science advisory role for Deepgreen Metals. This is a scientific research role; all deep sea mining activity is being explored under a public-private partnership model, and so inevitably one has to engage with industry. One of the reasons why I was willing to engage with this company, in terms of doing peer reviewed publications, was because I saw that they actually had a lot of science engagement. On the board of the company you have the former Chief Ocean Scientist for Conservation International and the co-founder of the Ocean Health Index: when I observed that there were scientists who had worked on the oceans for much of their careers in executive positions, I felt within my comfort zone. This is, by the way, noticeably different from terrestrial mining companies, where you rarely have scientists on the governing board.

Three years ago, I was the lead author on a paper published in Nature, a notable scientific journal, where groups of geoscientists and environmental planners like myself looked at the issue of mineral supply and governance at the international level. We were especially concerned about how the targets for the Paris Climate Agreement were going to be met; if we were going to invest in renewable energy infrastructure or the transition to green mobility. We were concerned that there was no international governance mechanism around minerals or *terrestrial* mining; there *is* a governance mechanism for oceanic minerals, the International Seabed Authority, which isn't perfect but it does exist. I'll share some of the key observations from the paper.

One of the key takeaways was that ore grades are declining – this means that you have to create far more waste in order to get the resource that you want. There is a distinction between a resource and a reserve in geology: a resource is what is extractable from a geological perspective, and a reserve is what is *economically* extractable. All oceanic minerals are currently resources. In this slide, the concentration of metals in these particular nodules is very high, with manganese, nickel, copper, cobalt, and on the right you can see a table from a recent peer reviewed publication from Jim Hein at the US Geological Survey comparing the total nodule resource in the Clarion-Clipperton Zone – this is the region, between Mexico and Hawaii, which is most likely to have extraction proceed.

# Ore gradation of nodules



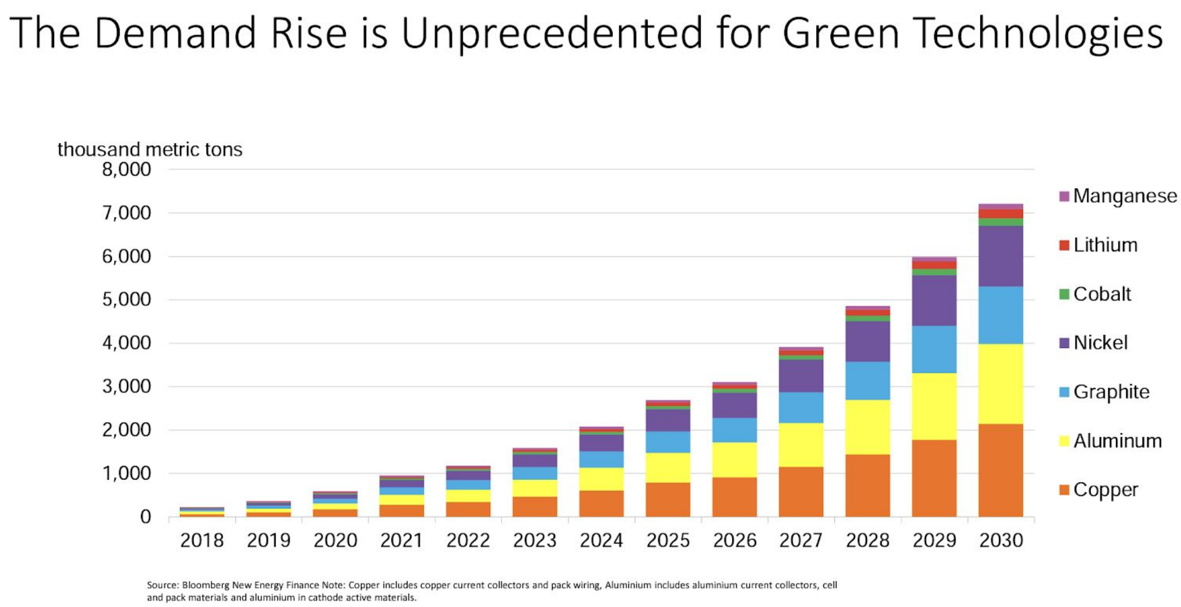

| Element | Total CCZ nodule resource[a] (× $10^6$ tons) | Global terrestrial reserve base[b] (× $10^6$ tons) | Global terrestrial resource[c] (× $10^6$ tons) | Example metal uses |
|---|---|---|---|---|
| Manganese | 5,992 | 5,200 | ND | Steel, batteries |
| Nickel | 274 | 150 | ND | Stainless steel, superalloys, wind turbines, batteries |
| Copper | 226 | 1,000 | 5,600 | Electrical, electronic, most high-tech products |
| Titanium | 67 | 900 | 1,200 | Aerospace, superalloys |
| Cobalt | 44 | 13 | ND | Batteries, superalloys, electromagnets |
| TREE | 15.1 | 128 | ND | Turbines, high-tech smartphones etc. |
| Molybdenum | 12 | 19 | 25.4 | Steel for strength and hardness |
| Vanadium | 9.4 | 38 | ~63 | Steel alloys, jet engines |
| Zirconium | 6.5 | 77 | ND | Nuclear industry |
| Thallium | 4.2 | 0.0007 | 0.65 | Photoresistors, infrared optics |
| Lithium | 2.8 | 11 | 62 | Batteries, aircraft |
| Yttrium | 2.0 | 0.6 | ND | Red phosphor for televisions |
| Arsenic | 1.4 | 1.6 | ND | Semiconductors |
| Tungsten | 1.3 | 6.3 | ND | High-strength steel, superalloys, electrodes |
| Tellurium | 0.08 | 0.05 | ND | Solar cells, superalloys |

CCZ, Clarion–Clipperton Zone; ND, no data; TREE, total rare earth elements. [a]Calculated on the basis of an estimated 21.1 billion metric tons of CCZ nodules in place on the seafloor and the mean chemical composition detailed in TABLE 1. [b]Reserve base is the measured plus indicated resource that includes resources that are currently economic (reserves), marginally economic and some that are currently subeconomic[129]. [c]Terrestrial resource is a concentration of a naturally occurring material in or on the Earth's crust that is in such a form and amount that economic extraction is currently or potentially feasible[130].

Hein, J. R., Koschinsky, A., & Kuhn, T. (2020). Deep-ocean polymetallic nodules as a resource for critical materials. *Nature Reviews Earth & Environment*, *1*(3), 158–169. https://doi.org/10.1038/s43017-020-0027-0

The global terrestrial reserve base in some cases, for example for manganese, is comparable, and the resource base in many cases hasn't even been ascertained because there hasn't been the same degree of engagement and in many cases it's becoming very difficult to actually do geological exploration in terrestrial sites because of competing land uses. What's really interesting here is cobalt. Cobalt is particularly high in terms of the resource base compared to the reserve base and cobalt is going to be particularly important with regard to batteries for electric cars.

The other thing which we observed in this paper was that the delay between discovery and development of new terrestrial mineral extraction projects was getting longer. The average time was 15 to 20 from the point of exploration to the point of the start date. So there is a huge time lag between terrestrial mining start and extraction. Why was this happening? Another paper we've published in the National Academy of Sciences examines a framework where social conflict was the main determinant of project risk in mining, so there is immense community conflict, particularly indigenous conflicts with mining companies. Another interesting dynamic is that the private sector markets for exploration in terrestrial mining are dominated by gold. Gold is largely a luxury metal – small amounts are used in electronics, but 70 to 80 percent is used in jewellery. So the incentives on the market side to invest in exploration are profit driven, so you end up with a deficit in terms of the exploration companies you might see at the prospective development Association Canada meeting in Toronto every year – which is the big festival of exploration. It can vary a lot, but one third of the market is gold. Environmental planners like myself are trying to move towards a circular economy; there's no doubt that natural systems are circular and we should aspire towards circularity in human systems. We looked at recycling in this paper, too, with some of the data coming from Steve North Theatre University of Technology at Sydney in Australia. We looked at the potential for recycling meeting the demand for copper. The modelling clearly shows that recycling – even for copper, for which we have actually a very large metal stock – is not going to be enough to meet the demand for infrastructure. For some of these new exotic metals, there's absolutely no way that recycling is going to be able to meet that demand in the short term because of the technologies that are going to be developed, such as batteries. Eventually, the batteries will be very good to recycle but you have to build a stock *to* recycle – that is the challenge.




This is demand projections data from Bloomberg – there are lots of different scenarios for metal demand projections. There is no doubt that the demand is increasing in remarkable terms because of new technology; here you can see up to 2030, where projections are particularly high for graphite and for cobalt.

***Andrew Howell***
Question on your chart; does this depict net demand? Does it account for recycling and demand that may disappear due to the transition and other factors?

***Saleem Ali***
This is the projected demand if we are going to try and meet some of the Paris Climate Agreement targets with regard to the renewable energy transition and the battery transition. It doesn't provide information on supply, so it isn't *net* demand. This next slide, which is just for copper, shows peak supply and peak demand, and the dotted line shows that recycling will eventually be able to meet demand after a certain period, 50 or 60 years from now. We've done some work in China, where they have very large recycling stores for some metals – they may be able to meet demand much sooner. Then, they will have recycling products – or what we call urban mining – available as a supply source, mostly for their own domestic needs or particular infrastructure.

So you have decreasing ore grades, and you have deeper mines with greater emissions and waste production. Tailings is, of course, a global concern. You have energy and water consumption increasing as the ore grades decline, and increasing competition for land use which is leading to immense conflict, sometimes violent. Many of our friends in the NGO community have done admirable work in this regard, trying to champion the environmental defenders. The highest number of assassinations of Global Witnesses were related to extractive industry defenders of environmental ecosystems, who were killed by proponents of industry, especially in South America. There is a very serious violent conflict problem with regard to extraction on land, which leads me, in part, to my interest in the opportunities in the ocean.

So, what are the opportunities? I've already mentioned building the stock for recycling and creating a circular economy. Resource efficiency is something else we should aim for – this is one of our main goals at the International Resource Panel. There are limits to this – I just completed a report with professor Edgar Hurt in Norway which asks how much you can get out of resource efficiency to mitigate climate change. There are some prospects, but there are limits as well.

Oceanic metals come in as part of the solution – I'm approaching this from a systems perspective, not as a proponent of one industry or another. This is a tellurium reserve – the world's largest resource – tellurium is one of the metals used in solar panels. Cadmium telluride is an important part of some of the new generation of solar panels. A British Geological Survey a few years ago found this huge seamount near the Canary Islands which has an enormous tellurium deposit. From a biodiversity perspective, this is a concern. A lot of these mines are located in highly sensitive terrestrial ecosystems, and there is a qualitative value difference between different terrestrial ecosystems – there is a qualitative difference between the biodiversity of Ohio and the biodiversity of the Amazon rainforest. The per unit biodiversity in some terrestrial ecosystems is enormous. Oceans are home to a very unique biodiversity: very particular niches, very special places and certain kinds of organisms that you don't find anywhere else. We want to conserve them as best we can, but we cannot neglect these ecosystems either. In the deep ocean you do not have, for example, plants. So one entire genre of biodiversity is not present in the deep ocean, *but* you have phenomenal microbes.

One thing worth thinking about in this context is the precautionary principle. This is used to argue against any activity in the deep sea. The precautionary principle dates back to the 1992 Rio Declaration, where it was laid forward as a framework for environmental planning. We need to be clear: well intentioned as it is, it is not a science based principle. In fact, it can often impede science. For example, if we followed the precautionary principle to the letter during the pandemic, we would actually not be doing a lot of clinical trials for vaccines. So the precautionary principle is a risk based decision making tool, but it should not be masqueraded as science per se. It's very important normatively for people to make their decisions – we are not scientific automatons and we should make decisions based on other principles. But let's not conflate it with something inherently scientific, although it is often presented this way. The International Union for Conservation of Nature prepared a very detailed primer, a lot of which comes back to some kind of balancing act around the degree of risk and the degree of benefits and ensuring such benefits fully reach fruition.

This is where deep sea mining becomes important, because the opportunity is to use these metals for mitigation of climate change emissions and a transition to a green technology. So, you have to consider the precautionary principle in that context. It's often used to argue for moratoria, which is what a lot of our friends in the conservation community are currently doing. Moratoria work in certain contexts, where there isn't an immediate trade off situation. For example, the Antarctic treaty has a moratorium on extractive industries which I totally support – right now, there is no viable proposition for mining in Antarctica for a variety of reasons. In more imminent situations, the moratoria argument has been rejected most recently in the Convention on Biological Diversity regarding gene drive technology. In 2018, there was a resolution on the floor of the CBD to have a moratorium on gene drive. My friends in the NGO community, well-intentioned as they are, can often blur the scientific consensus. For example, 107 Nobel Prize winners signed a letter in 2016 affirming that GMOs, in certain conditions, are absolutely safe and the science is absolutely clear. Despite this, we still have the precautionary principle driving activism around particular genetic technologies. We have to be careful, of course, you have to follow the protocols. For example, we don't want Crispr Gene Editing to be used in stem lines for cells where you could suddenly extrapolate to use in humans. But what was proposed was to use it for eradicating malaria in mosquitoes. The benefits of eradicating malaria are considerably greater than the perceived risk.

Biodiversity concerns are absolutely valid, but we have to think through them from a systems perspective. With hydrothermal vents, for example, we have to be very careful. This is where you have those marvellous organisms you see in documentaries; phenomenal chemosynthetic systems that produced energy without sunlight, largely due to volcanic activity. These will probably be the lowest priority for extraction because of these biodiversity concerns. There are some interesting restoration properties of those ecosystems, but still, I think this is where most caution is in order. The concern with seamounts, where you have these crusts and other very interesting geological features, is that there could be interaction with fishing. That's also going to be of lower priority; right now, the real action is around these polymetallic nodules because they are in this area where the relative level of biodiversity is more manageable and there is more homogeneity. According to the International Seabed Authority's approach, you must have reference zones – conservation areas which are of as equal quality as the area where extraction is happening, so that you can still preserve the species diversity. This requires a lot of careful research through the process of licencing. This is a unique feature of this deep sea mining system: in terrestrial mining, a company is never asked to set aside a reference zone. Overall, the approach is one which is still following the precautionary principle but considering it in context with the benefits in the systems approach.

The other concern, of course. is with environmental justice. There have been lots of terrestrial mining conflicts related to equity. One of the interesting features of deep sea mining is that there are small island developing states who are involved in some of the activity; this as a way for them to achieve an alternative development trajectory. We know what has happened recently in Australia with Rio Tinto and the desecration of the aboriginal heritage sites – these are real concerns for a lot of terrestrial mining projects. On the oceanic side, there aren't any communities to displace; the same concerns aren't at play. In fact, you could potentially achieve a net positive impact for some of the states involved.

This is the cobalt profile – most of the cobalt is in the Congo. You might ask, *what would happen to the Congo if more cobalt is found under the sea?* Under the ISA, there are mechanisms to ensure that affected countries receive some measure of compensation. Going back to my first slide about mineral governance and why I became interested in this issue, it's a very unique effort at the international level to have governance of mineral resources, which, again, we do not have for terrestrial mining.

The system that's being proposed for tailings nodules is going to have far less waste generation than before. We've just submitted a paper to the Journal of Industrial Ecology, which looks at a waste comparison of terrestrial and oceanic minerals. This paper should also highlight some benefits with regards to the tailings question and waste generation. This is the ISA regulatory process itself – I've highlighted here that Nauru and Kiribati, two small island states, were involved as partners. This is an opportunity to benefit from their interaction with the international community, whereas they have very few other steady revenue-generating options beyond tourism, which is vulnerable. So the Cook Islands, Jamaica, Kiribati, Nauru, Tongo – these are the countries who are engaged. There are some who are not – Fiji is not interested – but that's fine because Fiji has as many other options.


The ultimate trajectory is moving towards a circular economy, perhaps in 40 or 50 years. The industry themselves is saying this – they don't want to be stuck in the current model forever, and they're thinking about becoming a metal service provider rather than a mining company down the road. Samantha Smith, who has worked with the industry but is now an independent consultant in Toronto, prepared this slide which looks at the ways in which the seafloor minerals can contribute to the SDGs for the 2030 agenda. From my perspective, this is a very interesting opportunity for NGOs to engage. We put together a paper called SMED Model – which stands for Smart Mineral Enterprise Development – that details the role of NGOs in environmental and social risk certification. This is where investors come in; with the stock exchange capital infusion. You need to have better communication between technology developers, where the demand is coming from. These are the green tech firms, and those where the supply will come from – recyclers, mining entrepreneurs – all of this should be connected from a systems viewpoint. NGOs play a very important role in this; IRMA, of which I'm a big fan, has NGOs embedded in their governance system. Kudos to the NGOs for their vigilance, but they need to do it in a pragmatic way such that there is an opening for scientific progress.

***Andrew Howell***
Thank you, Professor Ali – very fascinating presentation that raised a lot of interesting issues. Let's move on to Matt Gianni, so he can share his views on the topic with us.

***Matthew Gianni***
Thank you, Andrew, and thank you, Saleem for your presentation. I've been involved in international oceans governance advocacy, policy, and law for about 30 years. I'm the co-author of a number of papers on deep seabed mining, deep sea fisheries, oceans governance, and have been active at the science-policy interface of this issue for the better part of the last decade.

The concerns that stem from the NGO side of the discussion are several fold. Number one: scientists are warning that biodiversity loss will be unavoidable if deep seabed mining is permitted to occur. Most of this loss of biodiversity is likely to be permanent on human time scales, and the notion that offsets can compensate for biodiversity loss in the deep sea is scientifically meaningless – this is the conclusion of an article published in *Nature Geoscience* in June 2017 titled "Biodiversity loss from deep sea mining". I'm a co-author on this paper alongside a number of very knowledgeable deep sea biologists and scientists.

On the question of recovery, another paper that came out in special issue of *Marine Biodiversity* from three scientists who have studied the Clarion-Clipperton Zone, where DeepGreen has three of its exploration contracts, concludes that due to the slow growth rate of the nodules, at only 10 millimetres per million years, and overall low sedimentation rates, short term recovery of species impacted in this area is unlikely. The authors state, and I quote "the nodules in the nodule-dependent fauna may take millions of years to recover, and even the partial recovery of the sediment-dwelling fauna" the animals living in the sediment"may take hundreds to thousands of years". Clearly, the impacts are going to be pretty significant. I might add that the ecosystems in this area are recognised to be quite heterogeneous; it's not a single mass of nodules and species spread uniformly across the area between Hawaii and Mexico - the area of greatest commercial interest to the seabed mining industry. So, there are additional concerns about impacts in the water column from the wastewater, the mining fines and the sediment that will be discharged from the collector ships; a recent publication in the Proceedings of the National Academy of Sciences highlights those concerns. Something like 50,000 cubic metres of waste water per day would be dumped over the sides of the ships and these could potentially introduce toxins into the marine food web at depths of 1,000 metres or so, and potentially impact commercial fish species such as tuna as well as migratory species such as whales, dolphins, and sea turtles. This could impact species that drive what is called the biological carbon pump – the process within the oceans whereby carbon is drawn by biological activity from the surface layers of the sea down into the deep abyssal plain and effectively is sequestered by the deep ocean.

Further concern surrounds the actual size of these mining operations. Each company gets a mining licence area from the International Seabed Authority of 75,000 square kilometres. To meet the production targets that have been established, they would need to strip mine about 10,000 square kilometres of that 75,000 square kilometres over the course of a 30 year licencing period. Modelling on plume flows – sediment flows that would be generated by the mining activities themselves on the seabed – indicates that an additional 20,000to 50,000 square kilometres of the licence area would be covered by sediments in the water column on or near the ocean bottom generated by the mining operations on the seafloor which would affect the species that filter feed the nutrients from the water column *beyond* the actual mining sites with concentrations in the water anywhere from 10 to 100 times the concentrations of natural rates of sedimentation. So, you might be asking, *all this for what?* Based on the information from the mining companies doing the exploration through contracts with the International Seabed Authority, just to double annual production of nickel based on the amount currently produced through terrestrial mining, sixty deep seabed mining operations would need to be running per year. For copper, that figure is over 600 deep seabed mining operations per year, and for cobalt it's somewhere between twenty-two and twenty-five per year.

The CEO of DeepGreen Metals, Gerard Baron, has been quoted often about how much metal he thinks the world will need to transition to a green economy. I'm quoting a press release from DeepGreen in March, where he stated: "The green transition is going to require hundreds of millions of tonnes of nickel, copper, and cobalt". Based on the calculations I was referring to earlier, even to produce 100 million tonnes of copper and nickel would require strip mining approximately one million square kilometres of nodules, and over 4 million square kilometres to produce 100 million tonnes of cobalt. And again, the plume flows would extend well beyond the actual mining sites – it's for this reason that quite a few organisations have called for a moratorium on deep seabed mining until we have a much better understanding of these deep sea ecosystems and how they might be impacted by mining, and whether it can be managed. Amongst those calling for a moratorium are the Deep Sea Conservation Coalition with its 80 members including Greenpeace International, WWF International and Conservation International. The European Parliament has come out calling for a moratorium. Others include the Prime Ministers of Fiji, Vanuatu, Papua New Guinea; the Pacific Council of Churches; Amnesty International; the Special Envoy for the Oceans of the UN Secretary General; the high seas and distant water fishing industry associations in Europe; and increasingly public figures such as David Attenborough and Jane Fonda, amongst others. So, it's not just us advocating for a pause.

There's also the issue of developing country impacts. The International Seabed Authority secretariat recently contracted a study that indicates that developing countries with terrestrial mining interests might be quite significantly adversely impacted by deep-sea mining for the same metals they produce, including countries like Zambia, Republic of Congo, Eritrea, Chile, Laos, Mongolia Peru, Madagascar, Zimbabwe, Gabon, Mauritania, Namibia, and Papua New Guinea. The whole question of environmental and social governance standards is relevant here as well, and they are increasingly linked to global political commitments, as we've seen for example with the Paris Agreement on Climate Change. Note that at the recent UN Biodiversity Summit in September of this year, a leaders' pledge to reverse biodiversity loss by 2030 was signed by over 79 heads of state, the president of the European Commission, the World Bank, and the GEF, amongst others. The Sustainable Development Goals are also increasingly a factor in informing environmental and social governance standards and policies. Note Sustainable Development Goal 14 ("Life Below Water"), Target 14.2, which commits states by 2020 to "sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts including by strengthening their resilience and taking action for their restoration". All the science is pointing to the fact that deep seabed mining is likely to be entirely contrary to this target: it will cause significant adverse impacts to marine ecosystems, it will degrade the resilience of deep water ecosystems, particularly in relation to the impacts of climate change which are now being felt in the deep sea as well as in shallow water areas, and cause damage to these ecosystems from which they may never recover. Clearly, this is not something that is consistent with the Sustainable Development Goals.

A number of financial institutions are starting to take note of this issue. ABN Amro, Royal Bank of Scotland, and Lloyds Banking Group have all adopted policies against funding in deep seabed mining; UBS recently organised a briefing on deep seabed mining with 40 other banks, which myself and a couple other colleagues participated in; the World Economic Forum has come out warning of potential reputational risks to downstream users of the metals produced from mining in the deep sea.

Coming back to DeepGreen, the company issued a report in April this year which concluded that in order to build a billion electric vehicles by 2050, we're going to either have to mine 156,000 square kilometres of terrestrial areas, or 508,000 square kilometres of seabed to get the cobalt and the nickel needed. However, the report seriously underestimated the size of the area of the ocean that would be impacted. As I mentioned earlier, scientists estimate quite large areas would be impacted by plume flows, and whole ocean habitats in the water column would be impacted by the wastewater flows beyond the 508,000 km2 of seabed directly mined.

More importantly, the report offers a false choice. It's important for us as a society to recognise that we don't need to choose between destroying 156 thousand square kilometres of terrestrial ecosystems or 1 to 2 million square kilometres of deep sea ecosystems. Tesla has announced on Battery Day that their Model 3 car will be using a lithium iron phosphate battery – no nickel, no cobalt. China is experimenting with hydrogen cell vehicles, and the state owned company SAIC Motor, based in Shanghai, aims to roll out at least ten models and produce 10,000 hydrogen vehicles by 2025. IBM Research has discovered a new battery chemistry that is free from *any* heavy metals, like nickel and cobalt, and it is working with Mercedes-Benz, amongst others, to develop this technology into a viable commercial battery. So, there *are* alternatives to mining in the ocean *or* on land – we can use substitute materials and metals in the construction of electric batteries for vehicles and other energy storage technologies. Coming back to the car issue, do we really need a billion cars by 2050, or will our societies organize around smarter, less wasteful methods of transportation over the next 30 years?

To conclude, if deep seabed mining does go forward it will be hugely controversial. Even if a majority of the government members of the International Seabed Authority do not want deep seabed mining to go forward, the ISA has some fundamental structural problems that may result in it licencing deep seabed mining even if the majority of the countries there would vote against it. There are some serious issues that need to be resolved with the ISA as a structural body. Ultimately, the urgent transition to a green economy is going to come down to choices that society makes on the materials to provide the technology – choices as consumers, as companies, as investors, and ultimately, the choices that our governments make to incentivise the transition to green economies in a way that uses the metals, the materials, and the technologies, that have the least environmental impact. Rather than having to make a choice between going into the deep sea or destroying terrestrial ecosystems to mine cobalt, nickel and other metals, maybe we don't have to do either.

***Saleem Ali***
I don't want this to be thought of as a pro-mining versus anti-mining situation. In response to what Matt has said, I would just say that overall I have to look at this from the point of view of thermodynamics. If you think about hydrogen and hydrogen fuel cells, they need platinum; if you think about the lithium phosphate options, the energy density tradeoffs are going to be there. We all want to move towards a circular economy, and decisions will have to be made. We may well find ourselves in a situation where

new technologies are developed and the choice is made by society to go the hydrogen route – so we may not need as many batteries that require oceanic minerals. However, we are currently not in this situation. There is very vast infrastructure set up to try and explore these prospects, and there are lots of checks and balances along the way, which I think the NGO community should engage with further. It may well be that a particular project does not pass all those checks and balances to commence – that's how we should go about looking at this situation. With regard to some of the papers Matt has cited and the consensus in the ocean science community, my concern is that we parochialize this issue. Those scientists who are writing some of these papers are indeed phenomenal ocean scientists, but any such analysis has to be located in comparison. I wish there was an option where we didn't have to disturb any ecosystem, but we just need to consider it in that light, and that's what we're trying to do – look at the situation comparatively. It may well be that some of the results of this comparative  analysis conclude that oceanic mining is not a good idea in certain situations, but let's have that analysis proceed. I'm not here to champion a particular sector, I'm just here to look at it from a systems perspective at the planetary level.

***Andrew Howell***
A question from the chat relates to the fact that a lot less is known about the oceanic floor and the ramifications of mining it than is known about terrestrial mining.

***Dr Saleem Ali***
I don't think that is accurate. Oceanic exploration has been going on for several decades, there have been numerous amounts of sampling. My concern is with the NGO community, whom I have immense admiration for. They're going down the same route as the GMO activism, the anti-nuclear activism. Consider anti-nuclear activism in the 60s, where an emotional investment in activism that was, yes, backed by some scientists, led to a situation where the safest kind of nuclear technology to be developed that could've potentially solved some climate change was priced out.

***Andrew Howell***
Matt, you might respond to that as well as a question over whether there are some conditions under which you would reconsider your opposition to Deep Sea Mining?

***Matthew Gianni***
We're calling for a moratorium, not a ban, although some of the organisations that are part of the coalition are calling for a ban on seabed mining. We've identified a set of conditions. For example, we need to know much more about the areas that are targeted for mining. The reality is that very little of the Clarion-Clipperton Zone has been studied – something like half of the specimens from the Clarion-Clipperton Zone are species that have never been discovered before, they are so called 'singletons'. They don't know whether that's because the sampling has been so limited in that area, or because these really are rare species, or species that only exist in one place; we need to know a lot more before we can make informed decisions about whether the mining can go forward in the deep ocean and under what conditions. The head of the JPI Oceans MiningImpact2 Project, which is the largest project of its kind looking at the potential impacts of deep seabed mining in that area -- the Clarion Clipperton Zone -- has said we may need at least another ten to twenty years before we can have enough information to determine what the environmental impacts and ecosystem impacts of mining in this area will be.

A second condition for us is reform of the International Seabed Authority (ISA). This is a body where, if the Legal and Technical Commission of the ISA – a group of thirty people that are nominated and elected by the thirty-six member countries of the Council of the ISA – recommends handing out a commercial mining licence, it's virtually impossible for governments to prevent that from happening, even if the member governments were opposed. The voting structure of the ISA needs a supermajority of governments to reject a recommendation of the LTC, and even there, as few as three countries on the Council of the ISA can block the council from blocking a recommendation to give a company a licence.

Third, there's this thing called the two year rule, which DeepGreen is threatening to trigger. This rule basically means that, if there aren't any regulations in place and a company wants to mine, it can get the country that sponsors the company at the ISA – like Nauru, which sponsors DeepGreen and has been contemplating this – to trigger this rule. That means that the ISA either has to complete and adopt the rules in two years, or the company can become licenced anyway, even if the regulations aren't complete. It's a way to short circuit or circumvent the process before regulations can be developed that are sufficient to ensure that any sort of mining activity does not damage the environment.

***Andrew Howell***
I would like to give Saleem a chance to respond to that point on the ISA. Saleem, are you comfortable with this regulatory regime, or do you believe institutional reform is needed before proceeding full speed ahead?

***Saleem Ali***
I think many of the criticisms from the NGOs on reform of the ISA are valid, and they should be engaged – I'm all for constructive engagement and reform. Keep in mind, however, we do not have an equivalent entity for terrestrial mining. There's no global governance mechanism for terrestrial mining; it's often a race to the bottom. The countries which have the least regulations are where the mining companies often prefer to go – so you have to keep that in perspective. Despite many resolutions at the UN environment assembly and calls for some international governance mechanism for terrestrial mining, we don't have one: it's all voluntary certification systems, some which are very good, like IRMA. So this is a challenge. Ultimately, I'm in favour of engaging in reform of ISA where appropriate.

***Andrew Howell***
Unfortunately, we've run out of time, although there's clearly a lot more to say on this topic. Thanks Saleem and Matt, and thank you everyone for attending.

Emerging Markets Investors Alliance
Actionable Intelligence for Responsible Investing