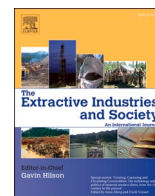


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Review article

Geographies of deep sea mining: A critical review

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ABSTRACT

Commercial deep sea mining (DSM) stands at a threshold as both national and global legal regimes seek to move beyond exploration of the seabed towards its exploitation. As an emerging political issue that takes place in complex geographies that are not always accounted for by science, deep-sea mining demands critical attention. It is against this background that this paper aims to highlight work that foregrounds these different geographies and actors that together shape the politics of DSM. As it emerges as a political reality in the Anthropocene, it asks what geographies are implicated and why do they matter? It highlights scholarship that has explored both the human and more-than-human dimensions and relations of DSM and argues for a broad range of thinking that is appropriate to the complex deep-sea environments being targeted for extraction.

1. Introduction

Commercial deep sea mining (DSM) stands at a threshold as both national and global legal regimes seek to move beyond exploration of the seabed towards its exploitation. Operating at the intersection of a geologically dynamic and fluid environment, DSM is characterised by large degrees of political risk and uncertainty¹ – in terms of its potential environmental impacts, resource potential and its social consequences and relations. Uniquely for mineral extraction and its politics, DSM is taking place deep at sea and is thus enacted in novel geographies that are rendered materially and emotionally in different ways by various human actors unable to physically encounter the socio-political terrain at stake. Furthermore, the places in which DSM activity happens and the ways in which these come to be represented matter politically. Yet, despite the huge range of possibilities which such uncertainty brings into being, contemporary debates surrounding the political constitution and consequences of DSM centre variously on the familiar trope of resource ‘security’ and questions of ‘sovereignty’. Indeed, the seabed has become a new frontier for an emergent ‘blue economy’, imagined as both a key engine for economic growth and as a sustainable alternative to terrestrial mining. By metaphorically highlighting the ‘blue’, the imperatives of global capital script the deep-ocean environment as a more sustainable alternative to the landed locations of erstwhile mineral extraction, adding another layer to an already long list of imagined geographies that have cast it as variously dangerous, elusive, exotic and resource-rich

(Rozwadowski 2005).

As an emerging political issue that takes place in complex geographies that are not always accounted for by science, deep-sea mining demands critical attention. It is against this background that in this paper, I aim to highlight work that foregrounds these different geographies and actors that together shape the politics of DSM. With a growing number of exceptions (e.g. Carver et al., 2020; Childs 2019; J. 2020a, J. 2020b; C. Filer and Gabriel 2018; Filer et al., 2021; Le Meur et al. 2021; P.Y. 2018; Reid 2020; Sammler 2016; Sparenberg 2019; Zalik 2018,), most academic scholarship on DSM can be found in the natural and physical sciences (especially in oceanography, deep sea ecology and chemistry). This work (which is often the best funded) is hugely important and is providing novel scientific accounts of unique and understudied deep sea environments. Yet here the aim is to build upon these studies by bringing them into conversation with critical thought more concerned with the deep-sea as a political question and which highlights the interconnectedness and relations of deep-sea space and time. For example, the seabed’s ‘production’ as a ‘resource’ occurs through a whole assemblage of discursive, material and technological actors and actions, yet it is its unique spatial and temporal properties – in particular, its geologic liveliness and hostility towards human experience – that open up a very specific series of challenges to the imperatives of capital accumulation. In short, as DSM emerges as a political reality in the Anthropocene, what geographies are implicated and why do they matter?

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¹ 4. Discussion

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To answer these questions, a transdisciplinary approach is needed, one which not only spans multiple academic approaches including environmental humanities, physical and social sciences but also includes activism at different scales. Because understanding deep-sea mining is as much about how it is geographically imagined as how it is physically constituted, in this article I draw upon literature and examples from across the social and physical sciences, the arts and humanities. At times it builds upon this author's previous work on the political geography of DSM but, in the main, new insights are offered from academia, corporations and activism which together serve to illustrate that deep sea geographies are new, varied and complex. I arrange the article according to the following heuristic. In section two, I consider deep sea mining's relationship with and shaping by *human* actors. This means highlighting both state and non-state actors, supranational through sub-national institutions and communities. I show the ways that these actors work to script the deep-sea in a range of discourses and practices; from the growth driven narrative of the 'blue economy' to the international debates around 'the common heritage of mankind'. I illustrate the social terrain fought over by corporate and activist actors as they strive to make the case for how the deep-sea should be encountered. Section three examines the relationship between DSM and its more-than-human actors. These relate variously to the materiality of the deep ocean, non-human deep-sea life, deep-sea technology and to spiritual beings. They are often mediated by human actors but also often have an agency of their own, capable of constituting the political shape of DSM in their own terms. At times, these kinds of geographic relation offer up disruptive ways of thinking about deep-sea space whilst at others, extractive capital finds new ways of fixing it. Section four concludes by questioning how DSM's geopolitics could be better thought about in the anthropocene. As an industry that is not yet commercially operational, it demands thinking that is appropriate to the complex deep-sea environments being targeted for extraction. DSM is profoundly different from terrestrial mining just as the 'seabed' is politically different to 'land'. In an age in which terrestrial mining (and other human) actions are likely to leave a permanent record in emergent geologic strata (Zalasiewicz et al.: 2008), there is an urgent need to stress both the *where* and the *when* of DSM's political geography.

2. The human actors of deep sea mining

This section analyses writing that has focused on a wide cast of human political actors that together help to shape the governance and legislative agenda for DSM. These include key roles for the supranational bodies, the state, the corporation, and activism. Bringing these four groups together points to the historically and geographically situated ways that DSM is constituted politically. Similar models have been deployed elsewhere in critical takes on resource extraction including Ballard and Banks', (2003) discussion of the corporation, state, and community relations within terrestrial mining. To this well-known triptych, Filer and Le Meur (2017) add another category of 'society' which is inclusive of political actors like multilateral agencies and this was built upon with reference to DSM itself (Filer and Gabriel C. 2018). For this review, it is highlighted how these interest groups variously highlight different narratives for the industry, sometimes even concurrently. For example, sometimes it is promoted as an engine for growth, part of a 'blue economy' narrative, at other times as key to the geopolitical securing of 'strategic' metals and minerals (Klinger 2018). Cautioning against this, some actors highlight DSM and its effects as uncertain, leading to the invocation of the precautionary principle whilst others go further still by offering resistance to DSM through activism. These narratives together produce the discursive regime produced by the human actors described below.

2.1. The supranational

The seabed - the extractive target for DSM - is regulated in different

ways globally. Whilst it remains the case that a significant percentage of the earth's seabed can be found under the jurisdiction of the nation state (see the following section), it remains the case that nearly half (48%) of it is still regulated through supranational oversight (Jouffray et al., 2020). It is the International Seabed Authority (ISA), set up under the United Nations Convention on the Law of the Sea (UNCLOS) a subsidiary of the United Nations, which manages the exploitation of the seabed in international waters, the so-called 'Area'. Until now, they have only issued exploration licences (of which there are currently 31) but a mining code is currently being drawn up which is expected to pave the way for extraction to begin (ISA 2021). Under existing legislation, the Area is considered to be the 'common heritage of mankind' (CHM), a designation that is aimed at ensuring that any benefits (and costs) derived from the seabed are equitably shared across all states.

However, it is easy to be critical of the ISA and its interpretation of CHM, and there exist several coruscating arguments that critique its implementation. For example, Anna Zalik makes three excellent and related points in arguing forcefully that firstly 'the push for an ISA deep seabed exploitation regime[...]is the product of a neomercantilistic drive on the part of state and affiliated fractions of capital to claim potentially valuable resources perceived as globally scarce' (Zalik 2018: 344). Secondly, she argues that much of the drive towards an exploitation regime has taken place 'in the absence of substantive ecological and fiscal regulation' whilst thirdly pointing out that 'pre-existing investors claims are protected, guards private knowledge and militates against transparent science and technology' (Zalik 2018: 345). These points coalesce to highlight how it is the imperatives of global capital which are guiding the ways in which CHM is being understood and enacted. This chimes with the related notion that the blue economy is ultimately about the pursuit of economic growth and the different 'initiatives and investments' under its banner are organized towards that aim (Winder and Le Heron 2017: 14). We could also question whether the nomenclature of 'mankind' could be challenged from both feminist and/or decolonial perspectives and ask whether it is inclusive of all of humanity. And that is before we consider the 'common heritage' of other, more-than-human political constituents of DSM detailed in Section 4 of this paper - such as the deep-sea fauna and spirits - who are excluded from the framing of CHM.

The separation of the human realm from a nature characterised as inert has been a longstanding ontological impulse of global capitalism, just as relevant when conceiving of oceanic political economy (Campling and Colas 2014) as of its landed examples. As Benjaminsen and Bryceson put it whilst discussing the similarities between green and blue 'grabbing' in Tanzania, 'contradictions between the rights and interests of people to land, sea and natural resources vis-à-vis foreign investors and state agencies vying to capture control over land and natural resources, are all strikingly similar' (Benjaminsen and Bryceson 2012: 350). Applied to the deep-seabed, these perspectives echo work focused on the 'resource frontier', memorably described by Anna Tsing as an 'edge of space and time' in which nature 'appears inert: ready to be dismembered and packaged for export' (Tsing 2003: 5100). They also point us to an analytical and political tension found in deep-ocean space between 'commoning' and 'grabbing', a relation that has been argued to be at the heart of understanding the contemporary production of new oceanic frontiers like those surrounding DSM (Fache et al., 2021).

It is clear that there are numerous actors, ontologies and epistemologies to be negotiated if supranational regulation of the seabed is to be enacted in a socially and environmental just manner (Moses and Brigham 2021). In this way, Moore and Squires emphasise 'the value of integrating stakeholders across environmental domains, rather than jurisdictions *per se*' whilst cautioning that 'we must pay serious attention to how the precautionary principle can be institutionalized in domains where, as in the deep sea, uncertainty is pervasive' (Moore and Squires 2016: 106). Similarly, the possibilities of 'adaptive management' for DSM are discussed by Jaekel who notes that adjusting environmental standards on a continuing basis is incommensurate with the ISA's

currently rigid yet poorly defined regulatory framework, noting the need for greater flexibility in the face of procedural shortcomings (Jaekel 2016). In other words, the United Nations' faith in the 'Blue Economy [to] break the mould of the "brown" development model where the oceans are perceived as available for free resource extraction and waste dumping' (United Nations 2013: 3) comes with a major caveat. Such transformation is a geopolitical concern where the frictions of capital will likely play out unevenly in distinct contrast to the promises of CHM.

2.2. The state

The seabed's potential as a resource frontier has already been cartographically extended to an extent not previously seen.² UNCLOS, itself catalysed by the 1945 Truman Proclamation, served to extend seawards the territory of the states by 200 nautical miles by establishing Exclusive Economic Zones all over the globe. More recently still, under article 76 of UNCLOS, countries are able to claim sovereign rights over the seabed up to 350 nautical miles from the coastal baseline given the right geophysical conditions (see Fig. 1 below).

Such moves have been described as 'the most significant, yet largely unremarked, twentieth century remapping of the globe' (Deloughrey 2017:32). Highlighting this profound rewriting of the earth, Fig. 2 shows a comparison between A) the landmass under national jurisdiction versus B) a combined landmass and seabed under national jurisdiction (Jouffray et al., 2020). Notwithstanding their Atlantic centring and biases and their 2-dimensional flatness, maps like these now illuminate the fact that, for the first time, a majority of the seabed is under state control. Moreover, 'in many cases, the territorial basis of a state is made of more seabed than land', a notion that is particularly acute for small island states (*ibid.*). The state's territorial sense of itself has consequently enlarged to varying degrees but can increasingly be understood as 'terraqueous' (Campling and Colas L. 2018; Deloughrey 2017; Foley and Mather 2019).

For the terraqueous state, this has opened up the possibility of promoting the 'blue economy'. Characterised by a wide range of discourses, political technologies and practices globally (Silver et al., 2015), the blue growth narrative seeks to script and secure the ocean as a space of capital accumulation through a posited commitment to a sustainability agenda. This 'globalizing presence of blue economy imaginaries and the rapidly forming arrangements around biology and economy' has begun to attract the attention of critical social scientists (Winder and Le Heron 2017: 21; Childs and Hicks 2019). This builds on the recent focus within social theory and critical geography upon 'sea' or 'wet' ontologies (Deloughrey 2017; George and Wiebe 2020; Peters and Steinberg 2019; Steinberg and Peters 2015) that have helped to resituate our understanding of geopolitics in the Anthropocene, bringing into view 'new', more-than-human actors in oceanic geographies.

The blue economy envisages a simultaneous ability to promote economic growth *and* encourage more sustainable practices. For some who riff on Harvey's notion of spatial fix, this twin promise is manifested in the form of a 'blue fix' in which the ocean is 'reframed and regulated' as key to capital's ongoing geographic expansion (Brent et al., 2018: 3). This fix encompasses both a tendency to 'sink money into physical objects' (e.g. ports, ships, deep-sea mining equipment) and a metaphorical 'addiction' to resource extraction (*ibid.*). In these cases, oceanic space is reimagined to provide clear access to a socially necessary bounty of resources without the attendant social impacts that are associated with

² This 'extension' of the state into oceanic space can be thought about not only in cartographical terms but also in a figurative sense. For example, small island states are able to recalibrate their territorial 'extent' by including the ocean in their geopolitical imagination, whilst for other states the inclusion of the ocean enables a projection of power more aligned to classical views of international relations and geopolitics.

land-based extractive practices. Indeed, it has been shown how some advocates for deep-sea mining argue precisely this: that it can provide metals and minerals for human society by, for example, operating in an environment rhetorically emptied of biological life (Childs 2019). Such thinking recalls Mumford's (2010 [1934]) proposal that it is the 'mineshaft - flush with resources but devoid of life - that is modernity's most haunting venue' (in Clark 2017: 219). In deep-ocean space, although the aesthetic of extraction is often shifted 90° from the vertical penetration of the mineshaft to the horizontal cutting of the seabed, the same imaginary is produced.

Deep sea mining is, in one sense not hugely different from other marine industries both 'old' and 'new' being inculcated into the discourse of the blue economy. It is, from a certain perspective, another example of resources being imagined as part of the territorial inventory of a political body (most often the state), in which they are 'trapped' into a mythical container ready for extraction (Agnew 1994; Bridge 2013). All that has changed is that the seabed and its mineral deposits are now brought into an extended version of that same box. In this reading, although 'blueness' offers an imagined break from the consequences and impacts of human intervention, it nonetheless is tied back to the familiar workings of human development narratives. Thus, as Silver et al. (2015) have noted, the blue economy becomes about discourses of 'natural capital' and 'good business' into which small island states and small-scale fisherfolk (to name just two examples) can reimagine more prosperous and just economic futures. In short, the blue economy attempts to 'recast control of and access to blue resources, with major impacts on small-scale users, while large-scale, capital-intensive uses [like DSM] continue' (Barbesgaard 2018: 145).

2.3. The corporation

The corporation has emerged as a key actor for DSM politics not only in terms of the way in which it influences the ISA but also in which it shapes the discursive terrain over which DSM is understood publicly. A key narrative is that as a 'blue' form of extraction, DSM is cleaner than its landed alternatives, a point reinforced through the assertion that it is *necessary* to supply the green energy infrastructures of the future. As the general manager of leading deep-sea mining firm Global Sea Mineral Resources (GSR) has put it:

'These minerals are simply lying on the seabed. We do not have to dig up the ground. Nowadays large areas of rainforest have to disappear on land because mining companies look for the ores deep in the earth. In the case of deep-sea mining no major infrastructure works are required. For example, no tunnels have to be dug and even fishing is not compromised because we work so far from the coast and at such great depth. We therefore think that per kilogram of metal extracted the impact on the environment can be smaller.' (Van Nijen 2018)

This 'emptying out' of the ocean's vitality and agency is a key part of the strategies used by deep-sea mining's proponents to legitimise its activities. Recent work that offered a corporate anthropology of deep-sea mining corporations showed how one particular firm - Nautilus Minerals³ - characterised the deep ocean as 'placeless', 'remote' and with 'no human impact despite the presence of proximate small island communities' (Childs 2019). Doing so, and presenting the deep-ocean as 'barren' serves to 'counter narrate DSM as a more 'sustainable' alternative to conventional forms of terrestrial mining' (*ibid.*).

Another characteristic of the DSM firm is to present itself as marginal to the processes of extraction itself. Given DSM's development as a

³ Nautilus Minerals were the world's first corporation to be awarded a commercial licence to extract minerals from the deep sea-bed at a site called Solwara 1. Operating in the Bismarck Sea, 30km off the coast of Papua New Guinea, they have been beset by funding difficulties. At the time of writing, they are undergoing a corporate restructuring and appear unable to begin commercialised extractive activity.

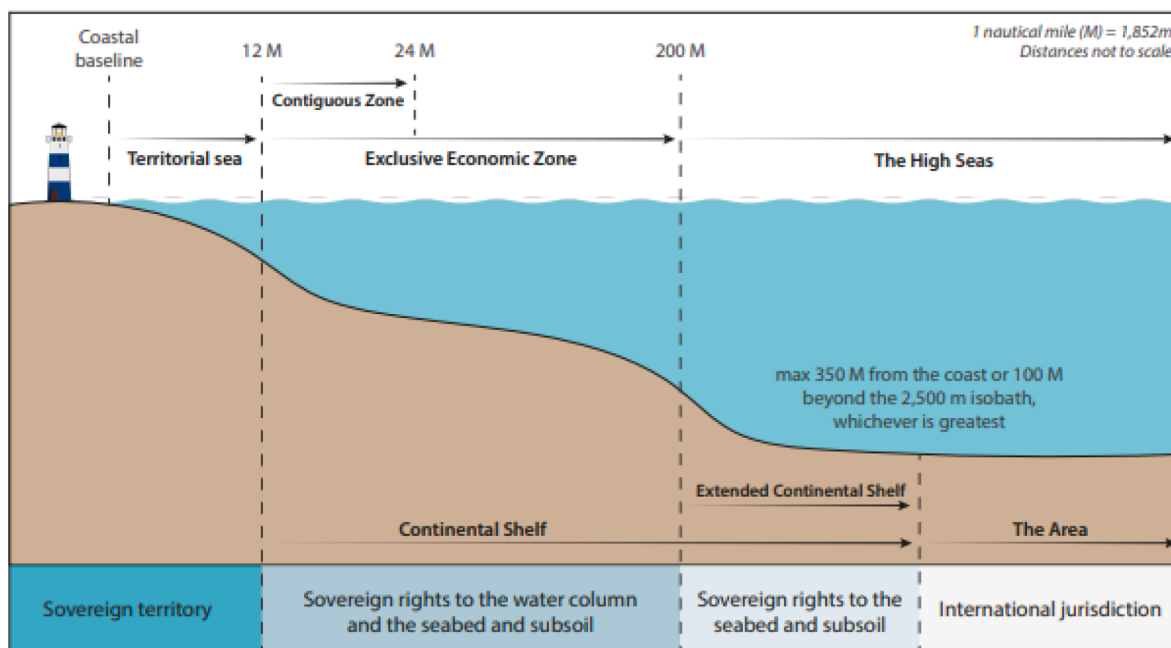


Fig. 1. The legal regime for seabed jurisdiction. Reproduced from Jouffray et al. 2020.

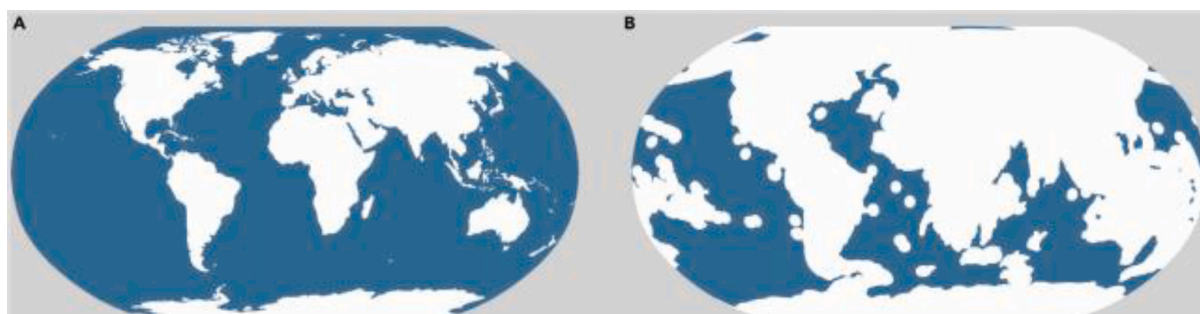


Fig. 2. Landmass under national jurisdiction, with or without the seabed included. Reproduced from Jouffray et al. 2020.

technologically driven industry, such claims may well be misleading for the emergent sector. DSM corporations like Nautilus Minerals have described themselves as ‘technology solution providers’ rather than mining companies *per se*. It is noticeable too, that for the UN Sustainable Development Goal 14 which are entitled ‘Life Below Water’, the vast majority of targets of targets and their indicators relate to fishing rather than to deep-sea mining (United Nations 2019). In other words, as the economic imaginary of ocean based development moves deeper underwater, so too does the prospect of human labour creation start to diminish. By the time the seabed is reached, the notion of ‘no human impact’ is repeated and is instead replaced by the rhetorical promise of genuinely sustainable extractive methods. This narrative is one of four identified by Hallgren and Hansson when they assert that the blue economy discourse ‘means...less displacement of indigenous people in close proximity to mining-sites’ (Hallgren and Hansson 2021: 5261).

Critics have been quick to point out the fallacy of seeing DSM as separate to human impact and to highlight the multifarious ways in which communities (especially those living along the Pacific ‘Ring of Fire’) are intimately related to the extractive deep-sea sites being targeted. At the forefront of this work are social anthropologists. For example, Filer and Gabriel have proffered an excellent analytic for understanding the role of the DSM firm in Papua New Guinea (PNG) originally through an early intervention which concisely asked ‘How could Nautilus Minerals get a social licence to operate the world’s first deep sea mine?’ (C. Filer and Gabriel 2018). Their later collaborative

work draws upon actor network theory in order to understand the reasons behind the subsequent ‘failure’ of that project (Filer et al., 2021). They note with precision that the policy network in which the DSM project found itself is both far from finished but rather an ever circulating and moving constellation of political actors that far exceed a simple case of human profiteering and resistance to it. Instead they caution that the ‘DSM network exemplifies the kind of network whose junctions seem to be pulling it in all sorts of different directions, thus casting a cloud of uncertainty over the movement of the “blue economy of appearances” with which it is associated...[and that] the next act in the play could just be a network with a different shape’ (Filer et al., 2021: 122). In another island space – French Polynesia – Pierre-Yves Le Meur and colleagues have highlighted the ways in which different corporate and state actors have come together in a ‘virtual’ resource frontier that is characterised by moral and ontological uncertainty which are themselves made dynamic by the shifting sands of both geographical space and time (Le Meur et al. 2018).

2.4. Activism

In their recent paper that delineates the deep-sea mining actor-network in Papua New Guinea, Filer et al. point to the presence of a ‘swelling chorus of opposition [to the Solwara 1 DSM project] from an international advocacy network’ (Filer et al., 2021: 99). Though their argument proceeds in a much more sophisticated way beyond a simple

description of that network, it is important to note that an activist community that is opposed to DSM is both growing and becoming more international in scope. Although the network is by no means coherent, and is made up of different actors at different geographic scales, certain points of convergence emerge in their activism. A key point of contention for most of these groups is to take issue with the promises made by the blue economy narrative, in particular its futurist tendencies to ignore 'the violence of colonial histories on the world's oceans...in favour of a future ocean economy that is about sustainable development' (Childs and Hicks 2019: 330).

For communities in PNG, especially those closest to the *Solwara 1* DSM site in New Ireland Province and the Duke of York Islands, the key network has been the Alliance of Solwara Warriors. Its leader and main spokesperson Jonathan Mesulam has campaigned for several years both locally (through rallies held across PNG) and internationally (through regular interview citations in the international press). These kind of interventions are no less significant in shaping the politics of knowledge surrounding DSM than corporate or state led narratives as they shape the 'social terrain' over which DSM debates are fought (Dougherty and Olsen, 2014). Described elsewhere as 'the most organised indigenous group against seabed mining' (J. Childs 2020b: 126), the Alliance has become an 'example of the new virtual networks which have emerged to 'enrol participants who might not participate in more conventional forms of NGO politics'' (Kirsch 2014: 199). Of course, we should also note the ways in which 'local' groups like these often form strategic alliances across scale, and can serve to connect and circulate ideas between local associations, NGOs and customary authorities. One excellent example of these could be seen at the recent COP26 People's Summit for Climate Justice session where a 'Pacific Talanoa' was held to argue that 'deep sea mining is no answer to the climate crisis'⁴ (Stopdeepseamining 2021).

New geographies and tactics for DSM activism are emerging as the industry edges closer to commercialisation. For example, creative practice has been increasingly deployed as a means of apprehending and resisting deep-sea extractivism in a variety of contexts. Art collectives like the Thyssen Borzemia Foundation have highlighted through international exhibitions and online videos the relations between DSM and human geography (see, for example, Mendes 2021). As is described in one exhibition, the aim is to 'deconstruct the idea of a marine-based blue economy and policy commonly supported by governments' (TBF 2018). The *Deep Sea Mining Campaign*, an international association of NGOs concerned with the impacts of DSM, regularly post creative videos and animations in order to help make their arguments (Deep Sea Mining Campaign 2021) whilst . Most recently, the first ever 'action at sea' was carried out by Greenpeace on its *Rainbow Warrior* ship as it confronted a *DeepGreen* corporate boat whilst San Diego's port has seen protest aimed at vessels designed to transport DSM equipment (Greenpeace 2021). It seems clear now, that just as the extractive industries move their attention to new geographies, so too are activist communities responding dynamically and creatively. This turn towards novel approaches to DSM activism echoes broader work that has highlighted the relationship between geography and the creative arts (see for, example, Hawkins, 2019). It opens up a new politics of visualisation that may prove to be an important battleground for the securing or destabilising of deep ocean space in the geopolitical imagination.

3. The non-human actors of deep-sea mining

That the blue economy discourse has conceived of the ocean as

⁴ This *talanoa* (a term used across the Pacific and means a kind of dialogue that is inclusive and open) brought together leading activists, policy makers and scholars from several Pacific states including Fiji, Papua New Guinea, Cook Islands, Tonga, Vanuatu with a global audience inclusive of academics and activist organisations based in Australia, USA and Europe.

bounded, fixed and as qualitatively *different* to land should come as little surprise. The ocean has historically been literally 'written off' as an 'other' space, functioning as little more than a place of traversal between land masses (the places that really matter politically) and as hollowed out of its meaning (Schmitt 2015 [1942]). As Peters and Steinberg (2019: 3) have put it recently, 'the ocean continues to be conceptualised as a closed-off space, a vast basin of salt water that, as a distinct geophysical entity, neither spills nor leaks into the starkly differentiated 'landed' spaces to which it is set in strong opposition.' Counter to this prevailing understanding, academia has seen a new minority of scholars developing a 'critical ocean studies' in which 'concepts of fluidity, flow, routes, and mobility have been emphasized' (Deloughrey 2019: 22). Common to this sort of work is an appreciation that the ocean is a vibrant and agentive volume (and not a flat surface) which is formed in relation to more-than-human actors and invites new epistemological and ontological orderings.⁵ These include those who have foregrounded oceanic materialities (Steinberg and Peters 2015; Peters and Steinberg 2019) as well as its colonial histories and violence (Deloughrey 2017) in order to better situate oceanic politics in the Anthropocene. Yet, even though this work does a great deal to 'think with' the ocean for understanding a planet of fluid political connections, most of it focuses on its watery aspects leaving the seabed somewhat under-theorised.⁶ The following sections briefly review some of the work and arguments that apply this critical ocean thinking to DSM and who think through its non-human actors.

3.1. The materiality of the deep ocean

The seabed has very specific materialities that mark it as distinct from land. Although it is described as an 'underwater' form of extraction, the seabed is not really 'under' the water at all so much as immersed 'in' it. For example, the black smoker chimneys, which are the mineral rich formations targeted by much of the DSM activity today, are formed by magma-heated seawater rising from beneath the seabed and meeting cold seawater above it. Thus, the seabed acts as a kind of porous threshold through which water flows. Such semantics matter. The mining industry often couches these geologic features in terms that deny their vibrancy and uniqueness. As Scales puts it in her widely publicised book on the deep sea, 'the mining industry commonly refers to hydrothermal vent deposits as "seafloor massive sulphides"...and seamount deposits as 'cobalt-rich ferromanganese crusts'. I will call them what they are: hydrothermal vents and seamounts' (Scales 2021: 233). The language of science is nothing if not political.

Critics have been quick to point out the extraordinary range of potential impacts ushered in by commercial DSM activity in a variety of contexts. These might include, for example, 'direct removal and destruction of seafloor habitat and organisms; alteration of the substrate and its geochemistry; modification of sedimentation rates and food webs; changes in substrate availability, heterogeneity and flow regimes; suspended sediment plumes; released toxins; and contamination associated with noise, light or chemical leakage during the extraction and removal processes' (Levin et al., 2016: 256). Such a plethora of effects are not spatially confined to the seabed understood as a fixed 'edge' or 'bottom' of the ocean. Rather, they point to a level of diversity that has real significance for shaping and complicating politico-legal regimes as

⁵ It should of course be noted that this sort of work which blurs the ontological boundaries of land and sea is not 'new' to many communities in the Pacific who often, and with different nuances, understand the sea in relational terms with profound implications for the production of selfhood, identity and space.

⁶ Peters and Steinberg's (2019) recent updating of their earlier 'wet ontologies' thesis extends water's agency beyond its liquidity and emphasises the potential of its different material states (ice, mist etc.) for rendering political ways of imagining the world.

they are scripted globally. How, precisely, is the law to deal with a deep seabed that refuses to 'stay put'? As others have put it, the specific physical characteristics of deep-sea mineral deposits in all their diversity 'affect the significance of DSM's impacts' in constituting what 'serious harm' looks like, for whom and for where responsibility lies (Levin et al., 2016). Critical social science has also been quick to pick up on the false promises of understanding oceanic edges as having fixed properties. Rather, work like Braverman and Johnson's edited collection brings together scholarship that highlights how 'the inscription of boundaries and binaries onto the sea' produces a confrontational politics into which whole communities are either written 'in' or 'out' (Johnson and Braverman 2020: 15). As argued elsewhere, 'Law is a form of practice that is productive of an edge' (Jeffrey, 2019: 1, cited in Carver et al., 2020) which, when applied to the seabed, becomes 'apparent in the very designation of the continental shelf as a juridical place' (Carver et al., 2020).

This link between the legal consequences of environmental damage and materiality has been seen elsewhere in deep oceanic resource politics such as the notorious Deepwater Horizon oil spill. There it was shown how the 'probability of an offshore drilling accident increases with the depth of industrial activity, and a single isolated incident may require decades to centuries for recovery because of the slow growth and longevity of the deep-sea fauna' (Cordes and Levin 2018: 719). For DSM, the links are more complex but no less pronounced. In each of four main deep sea mineral deposits types, Levin et al. (2016) identify very specific 'special features [of deep-sea environments] that affect the significance of predicted impacts.' These material specificities matter not only because they shape the ways in which the seabed is legally *defined* and thus *regulated* but also because they are likely to change the political response to DSM activity.

More crucially, the imaginative work performed by these bio- and geo-physical realities will serve to shape the political response to the disruption of the seabed. For example, extracting a polymetallic nodule from the abyssal zone may leave effects that will 'likely persist for millennia because the formation of new nodules, and the habitats and heterogeneity they provide, is estimated to take millions of years' (Levin et al., 2016: 250). These timescales which likely exceed both the imaginative and physical potential of humanity raise vastly different political questions and reactions than those thrown up by the extraction of seafloor massive sulphides from minerals deposited by 'black smoker' chimneys which can form at recorded speeds of up to 30 cm per day (Tivey 1998). Moreover, black smokers form around either 'active' or 'inactive' hydrothermal vents with a consequence that the associated fauna is either very quick to grow with high rates of resilience (in the case of active vents) or endemic with slow recovery rates (inactive vents) where mining disturbance could even cause the 'extinction of taxa' (Levin et al., 2016: 252). These examples point to the ways that violence can be either 'slow' (Adam 2005; Nixon 2011) or fast, a tension that is made political by the speed at which they are made knowable to advocates and opponents of DSM. It is, in other words, an example of the 'politics of time' to which Kirsch (2014) refers to in his critique of corporate-led mining in Papua New Guinea. The seabed's temporalities will have a great deal of influence in shaping debates to come.

3.2. The politics of deep-sea life

The commercial spotlight is shining on the deep-seabed for everything from pharmaceutical development to cosmetics (Synnes et al. 2007). Bioprospectors are attracted by the unique organisms associated with the seabed. As a recent paper points out, the genetic code of this kind of life 'has evolved to thrive under extreme conditions of pressure, temperature, salinity, or darkness' (Jouffray et al., 2020: 45). It is not difficult to see how, in the not too distant future, the seabed will have to be understood relative to a politics of organic as well as inorganic matter. Yet for all that much of the recent debate between those broadly for and against deep sea mining imagine the deep ocean as a political

space of life/non-life in an absolute sense, it misses important nuance. Geo-politically speaking, the seabed also becomes an example of a space of life/death in which the crucial distinction is between that which sustains life and that which is left to die (Povinelli 2016).

For deep-sea mining, leading ecological risk assessments (Washburn et al., 2019) highlight a wide ranging series of potential impacts to deep sea ecosystems, not least through habit removal and the impacts of plumes generated by mining (*ibid.*). This has led authors from across disciplines to conclude that, as elsewhere, DSM with no net loss of biodiversity is 'an impossible aim' (Niner et al., 2018). Certain species, like the scaly-foot snail have been classified as 'endangered' as a direct consequence of deep-sea mining (Sigwart et al., 2019) whilst Scales simply points to the 'unavoidable loss of biodiversity' that renders 'sustainable' DSM an impossibility (Scales 2021: 261).

There are specific concerns that the sound generated by DSM will have negative impact on deep-sea ecologies. This should point us towards the notion that sound and its affordances also have political implications in the anthropocene (Kanngieser 2015). For the seabed, with its sounds of seamounts (the proposed DSM site *Solwara 1* in PNG is situated only 3 kms from an underwater volcano called North Su), the humanly imperceptible communications of deep-sea fauna and the infrasound of sonar, these are multifarious. Sound can offer a 'way of building the different ecologies necessary for political attenuations to forms of life and matter, which are not of the human' (Kanngieser 2015: 82) but how these sounds are represented or made audible to human audiences change the political stakes. For example, it has been shown how the deep-sea corporation in PNG employs the 'background' noise and persistence of nearby volcano as a way to counter the argument that sound caused by its underwater mining equipment can disrupt the communication patterns of deep-sea fauna (Childs 2019).

Relatedly, and looking at the same site, Nason considers how the same company has 'recruited' an obscure deep-water snail in order to recast its proposed site of extraction, not as a mine site but as an 'experiment in making development sustainable' (Nason 2018). Drawing upon environmental anthropology, he notes how certain members of indigenous communities close to the DSM site – so called "'shark callers'" – can not only catch but also *become* sharks, just as the corporation uses the language of biodiversity conservation to offset critique and the impacts of extraction (*ibid.*). Highlighted here is the politics of knowledge, and specifically the ways in which power is implicated in shaping deep-sea environments that are characterised by uncertainty. This point is picked up elsewhere, where it is argued that a relative lack of public knowledge of the deep-sea paves the way for shaping attitudes towards the environmental and social risk of mining it (Kaikkonen and van Putten 2021). Indeed, whilst it is concluded by widely cited papers that 'decision makers must remain cognizant of the immense knowledge gaps that persist in understanding environmental consequences of deep-sea mining activities' (Washburn et al., 2019), the bigger point relates to how those knowledge gaps are exploited by those in power.

3.3. Deep-sea technology

For many proponents of the DSM industry, deep-sea technology's key contribution is premised on its ability to make the seabed visible. A political consequence of apprehending the seabed though image, is that the human actions relating to such extraterritorial spaces become detached from the earth, their effects rendered remote and meaningless to the 'meaningful' politics that happens on land. With reference to outer-space, Elizabeth Deloughrey (2014: 260) points out that 'because extra-territorial spaces cannot be fully inhabited, we rely on their visual, technological representations by satellite and other vessels' in order to make sense of them politically. These same modalities can be witnessed through the particular techno-sensory practices used to 'unearth' or 'reveal' the seabed. For example, a recent special section of *The Economist* entitled 'Blue-sea thinking' charted a variety of technologies designed to counteract a 'subsurface ocean that is inhospitable to

humans and their machines' and 'make it even simpler to drill or mine' (Economist 2018: 2–3). Although deep saltwater's properties include its ability to absorb visible light, the blue economy is seen by its apologists as a means of moving beyond invisible environmental externalities associated with the economic exploitation of the ocean. Through a whole series of political, discursive and material 'technologies', DSM's proponents 'light up' the deep ocean in order to make it investible and legible to global capital.

For the deep sea mining industry itself, one of the ways in which it seeks to counter critique and legitimise extractive practices is to visually 'empty out' the deep sea, presenting the seabed and its vibrancy as devoid of life. As Fig. 3 shows, DSM operations hinge on the transportation of rocky matter from a seabed presented as inert and through a water column lacking in vibrancy. Such practices have been shown to be at the heart of a corporate imaginary which promotes itself as better than landed alternatives due its supposed remoteness and separateness from human concern (Childs 2019).

Source: Nautilus Minerals (2019)

Deep-sea environments remain resistant to being mapped - around 5% of the deep-seabed has been mapped to an equivalent level of detail to that of the Moon and Mars (Cordes and Levin 2018). Sensing and knowing the seabed in this way has different qualitative effects depending on those who are encountering it. Indeed, *who* or *what* you are has profound impacts on the ways in which a geoimaginary of the seabed is made. On the one hand, the seabed might be imagined by investors as an edge of a kind of 'hyperobject' (Morton 2013) whose 'vastness, in all three dimensions, impedes meaningful scientific

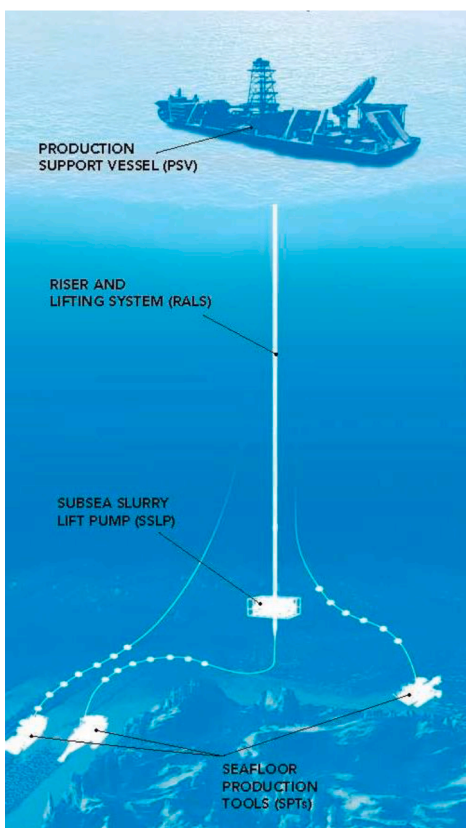


Fig. 3. A corporate picture of DSM's method of extraction.

knowledge based on direct, personal experience' (Rozwadowski 2010: 521). Yet on the other, as the history of oceanography has shown and for scientists of all traditions, the seabed is fundamentally about discovery, illumination and even identity formation.⁷ So whilst the seabed might lack the forms of illumination common to other extra-territorial spaces like the moon, it can shape the political outlooks of those people who do encounter it.

The kinds of identify formation that coalesce around this 'other worldliness' are also echoed by those engaged in the operation of remote operating vehicles (ROVs) at the seabed. As anthropologist Stefan Helmreich (2009) has pointed out, scientists who use ROVs often 'feel a direct body to body connection with these objects' despite the challenges of locating them precisely though GPS. Building on these ideas, Lehman (2018) argues that it is the deep ocean's materiality which shapes communication in such a way that the 'remote sensing' is transformed into a kind of 'intimate sensing' (Helmreich 2009). For global investors and policy makers of DSM, such forms of visualising the seabed are enabled through remote sensing in which the 'remote' is understood in two ways. First, it is remote on account of the physical distance between the human observer and the robotic 'sensor'. But it is also remote because of the psychological inability to understand the kinds of pressures, sights and sounds produced by the deep seabed. This remoteness is partly what enables the familiar 'will to master nature' narrative and is the assumption upon which grand claims of progress and necessity can be made. This kind of remoteness stands in contradiction to those who operate and manipulate ROV's and their data on the seabed.

For some, the shift towards new ways of knowing the deep ocean and the seabed, made possible by advances in underwater robotics, ironically might bring with it great emancipatory potential for decoupling some of the problematic relations fostered by modernity. In the first instance, as more and more of the work of 'knowing' the seabed is done by robots and artificial intelligence, it can begin to undo some of the mastery narrative long promoted by the 'marine scientist'. As Lehman (2018: 76) puts it, 'the figure of the enterprising solo scientist in command of technology and nature, and to the notion of an ocean gridded, measured [and] falsely transparent' is under threat. Instead 'increasingly independent technologies' point to the 'always-partial nature of ocean knowledge' (*ibid.*). A second possibility also emerges, namely that such 'new sensing practices might proliferate relations that de-centre not just the (white, male) scientist but the human itself as the omniscient witness and draw attention to different dimensions of the ocean's [and seabed's] materiality' (*ibid.*).

In short, the qualitative aspects of sensory engagement with the deep ocean changes the political stakes. Diverse forms of sensory engagement are set to change the way that humanity encounters, understands and, even, regulates the deep sea. If it used to be the case that oceanography's diverse practitioners (from marine biologists to geologists) were united not so much by a 'shared set of intellectual questions so much as a common definition of themselves as scientists who go to sea' (Rozwadowski 2005: 218), that is not universally the case anymore. With the advent of new satellite and other technologies, the seabed is at the centre of a 'massive shift away from ship-based sensing, which entailed labour at sea to collect relatively limited data, to the use of robotic and remote sensors, which garner exponentially more data than ever before' (Lehman 2018: 58). The technologies deployed and developed to secure the seabed for capital accumulation open up new human and more-than-human geographic relations.

⁷ This is not to mention the fact that for many communities around the world, the deep ocean is a fundamental part of the fabric of their identities. This idea is detailed in the following section.

3.4. The spiritual deep sea

A recent special section in *Political Geography* concerning the crucial questions for understanding contemporary political ecologies of the state urges scholarship 'to consider natures not just in terms of the materiality of what we can see and touch, but also to highlight those natures that are otherwise experienced' (Harris 2017: 92). This provocation has obvious relevance not only for the political geography of resource extraction in general but also for DSM in particular, given that, from certain perspectives, the extreme location of the deep seabed eludes human senses. For all that recent studies in geography and anthropology have populated their work with 'new', non-human, even spiritual actors (De la Cadena 2010; Escobar 2016; Li 2015), they have done so in relation to *landed*, terrestrial mining projects and not to those in relation to the sea. Moreover, whilst the oceanic turn moves beyond a terrestrial bias in political geography, it has yet to consider the politico-ontological implications wrought by new forms of resource extraction such as those focused on the seabed.

There are dozens of examples of the world's ocean and seas being inhabited by gods, spirits and mythological creatures, found in everywhere from Celtic and Icelandic mythologies to the cosmological orderings of Maori and Japanese cultures (Scales 2021: 32). Yet only a few studies have detailed the specific ethnographies of DSM that highlight spirits as important political actors in their own right. Patrick Nason (2018) has made the links between indigenous belief of communities in New Ireland Province, PNG and the politics of proposed DSM in the region. Relatedly, as I have argued previously, for those positioned closest to the proposed DSM site in PNG, the concept of *graun* is foundational to their resistance of DSM (J. Childs 2020b). More specifically *graun* is understood as a 'relational concept of the earth in which 'being well' (*gutpela sindaun*), to be achieved through the coming together of nature, beings and spirits' (*ibid.*).

Notions like these echo Szerszynski's (2016: 293) notion of a geo-spiritual formation that is defined as 'a particular gathering of the Earth that achieves some kind of coherence between what are normally considered as three quite separate domains: the dynamics and metabolics of matter, energy, and form on a far from-equilibrium planet; the ordering of political and social relations between interdependent living beings; and the action of nonhuman spiritual agencies, whether materialized in physical entities and processes or otherwise.' The example from PNG also points to the political importance of understanding and recognising the seabed as a collection of 'living worlds' (Nirmal and Rocheleau 2019) in ways that move beyond legally recognised means of measuring impact such as Environmental and Social Impact Assessments. As political tensions over the seabed's ontology surface globally everywhere from New Zealand⁸ to the Cook Islands (Roche and Bice 2013), confronting this dimension will be ever more important. This is especially the case as a great deal of the seafloor massive sulphide deposits are found in the Pacific ring of fire, where belief systems as well as the environmental impacts of DSM are likely to attract the greatest controversy.

What emerges then is a particular type of politico-ontological problem for the governance of the seabed. How do particular political regimes negotiate differences in understanding human-seabed relations? Clearly there needs to be a thought given to the decolonisation of the blue growth imaginary which seems to display many commonalities with 'green' growth-based narratives widely critiqued elsewhere (Cavanagh and Benjaminsen 2017; Demaria et al., 2019). These imaginaries, even with notional space given to an increased cast of actors, usually play out in a 'prefigured universe' and deny the 'profound effect' that 'supernatural or metaphysical forces' have on the political geography of

resources and their 'making' (Theriault 2017). Thus, the examples given above with reference to DSM's spiritual dimensions not only serve to advance the recent extension of political geography's remit to include matters of 'post-human politics and political ecology' (Benjaminsen et al., 2017: 1). They also attend to the call in the subfield to 'make a firmer commitment to ontological multiplicity' as a means of better understanding the scripting and exclusionary practices of rendering new resource frontiers (Theriault 2017). Foregrounding indigenous ontologies of the deep ocean that far outdate western modernity's relatively novel gaze are more than representational matters, they are also matters of sovereignty understood in frames that move beyond inter-state relations (Bambridge et al., 2021). By drawing upon foundational indigenous thought (some published - e.g. Hau'ofa, E. 1994, 2000; Teaiwa 2014 - but much not), the approaches to DSM governance can work to avoid many of the burdens and horrors that have been experienced by communities from terrestrial extractive projects.

Such approaches need to go further still, to work with the problem of multiple ontologies and to find ways of allowing each its own agency in shaping seabed governance. Scholarly work has begun to address this need in related themes, notably water, where the notion of 'ontological conjuncture' has been mobilised in order to promote a 'networked dialogue amongst multiple water ontologies and which points to forms of water governance that begin to embrace such a dialogue' (Yates et al., 2017). This means, in the first instance being critical of claims towards the seabed's 'sustainability' and 'community awareness' (especially when compared to terrestrial mining), and the practices of 'corporate responsibility'. But it also means that they can't be completely dismissed either. Simply setting up different ontologies in opposition to one another is a mistake, not just because it can further entrench a series of injustices for marginalised voices. It also reifies ontological categories that can, in turn justify the modalities of capitalism and/or overly romanticise 'indigenous communities' affected by resource extraction. Facing up to and moving beyond these challenges is key to understanding the political geography of the seabed.

4. Conclusion

There is something qualitatively *different* about the seabed (from both land and the sea more generally) that demands attention, especially through its relation with modernity. Thinking about its 'place' in this way, especially vis-à-vis DSM, can provoke different sorts of imagined geographies in relation to 'land' (and not separate to it) and destabilise the ordering work done by the blue economy discourse. As has been shown, DSM has already witnessed the use of different kinds of technologies that are used to visualise, monitor and codify the seabed and which produce or resist a 'scopic regime of modernity' (Jay 1988: 4). In order to understand DSM appropriately, there must be engagement with a cast of political actors - both human and non-human - that work across and beyond those implicated by a land-capital relation. There must even be an emphasis on the role of spirituality in relation to the seabed's physical geography and the interface between human and non-human life that together produces a kind of 'geo-spiritual formation' (Szerszynski 2017).

By focusing specifically on the *geographies* of deep sea mining, this paper has first sought to highlight how the imperatives of capital expansion seek to fix the seabed in time and space. It does this by scripting the seabed as a visible (and thus legitimate) site of the blue economy which offers the twin promises of sustainability and economic growth. This is made possible by an emphasis on the seabed's material specificities especially compared to land. Secondly however, the paper has argued that in order to think about the seabed in ways that don't reproduce the kinds of environmental violence and injustice seen throughout the history of terrestrial mining, attention needs to be paid to different approaches and actors which together disrupt the blue economy imaginary. This approach understands the seabed as better attuned to the political questions raised in the context of the anthropocene and

⁸ Proposed Iron Sands mining in Taranaki has prompted fears over impacts upon customary practices from Maori Groups (Kiwis Against Seabed Mining 2014)

echoes an 'oceanic turn' that has embraced the sea's vibrant and dynamic 'geopolitical, biopolitical, environmental and ontological dimensions' (Deloughrey 2017: 34).

Understanding the political uncertainty and struggle wrought by the extreme location of deep-sea mine sites is, it is argued, best approached by stressing both its ontological multiplicity and its material dynamism and instability. 'Placing' DSM onto a seabed as is currently prescribed by corporate, state and regulatory orderings will only serve to continue the 'business-as-usual' case. By moving beyond the ontological dualism presented by the blue economy discourse, a reimagined seabed pays more attention to the problem of how to politically engage with 'a world in which many world's fit' (Escobar 2016: 13).

It also opens up the political potential of possibilism as an alternative to environmental determinist critiques which are sometimes levelled at studies foregrounding the constraining effects of the physical environment.⁹ Applied here, it maintains that on the one hand the physical geographies of the seabed (its pressures, growth rates for mineral deposits and the chemosynthetic dependencies of associated deep-sea fauna) do shape and limit the kinds of politics that surfaces. Yet, on the other, it does not foreclose the rich diversity of options open to society's future governance of the seabed. This is a point worth remembering given that, unlike terrestrial mining, DSM as an extractive activity has yet to fully take shape. Despite the successful testing of extraction having taken place both by private-run companies (in PNG) and by state-run corporations (in Japan), DSM has yet to be proven commercially viable. Yet, at the same time the International Seabed Authority is currently considering a draft code for the exploitation of deep-sea minerals.

At the heart of the tensions raised at these geopolitical moments lies the importance of how the seabed is imagined. Despite the increasing levels of research funding dedicated to seabed exploration and scientific understanding, a prevailing air of uncertainty remains. This is positioned against the 'certainty' of the legacies of colonialism for those that have lived through and endured them, or the centuries-old belief systems by users of the same seas which include a broadened range of political actors. All of which highlights the need to allow conceptual and policy space for alternative and multiple geoinflections of the seabed to be seen as legitimate. These might be influenced by creative practice, through activism or through critical scholarship but they must all share a common suspicion of the 'fixing' of the seabed into a singular imaginary.

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⁹ For a full account of the politics of possibilism in the Anthropocene, see Dalby 2016

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