Greening the blue? Corporate strategies for legitimizing deep sea mining

1. Introduction

The awarding of the world's first deep-sea mining (DSM) lease to Nautilus Minerals in 2011 has ushered in plans to extract copper and gold from seabed deposits in offshore Papua New Guinea (PNG) at a site named Solwara 1[1]. DSM's proponents have situated the emerging industry as a more sustainable alternative to terrestrial mining and a necessary, new 'frontier' for resource extraction (New Scientist 2016). At the same time, DSM's critics have viewed it as 'experimental', 'uncertain' and seek to highlight an invisible terrain of struggle that has the potential to be ecologically catastrophic (Rosenbaum and Grey 2016). In this context, this paper asks how do powerful human actors - especially the corporation - shape, negotiate and respond to critique of the activity? What is different and important about the strategies used to legitimise an *underwater* form of resource extraction that, unlike terrestrial mining, encounters a remote, sometimes volatile seabed, yet is promised to have a reduced spatio-temporal and ecological footprint?

Drawing upon primary data collected at the Solwara 1 DSM project in PNG[2], this paper argues that the specific materialities of the deep-sea provoke and enable particular forms of 'corporate social technology' (Rogers 2012) that shape the corporate response to controversy. In particular, the paper exposes and analyses the ways in which the geophysical properties of the deep-ocean are mobilised by Nautilus Minerals in PNG in order to counter narrate DSM as a more 'sustainable' alternative to conventional forms of terrestrial mining. In other words, it considers how the unique characteristics of a deep-seabed mine site (a geologically active and dynamic place situated in a watery, lightless environment nearly a mile beneath the sea's surface) shifts the sense(s) of the socio-political terrain at stake.

DSM can be situated as more than just a site of empirical novelty; it also invites a conceptual reconsideration of the ways in which the geographies and practices of resource extraction interact with the terms of the 'social'. In the nascent DSM sector, such technologies and strategies of corporate counterinsurgency might be folded into a politics of corporate social responsibility (CSR), yet they demand an interdisciplinary engagement across the social and natural sciences. Thus, I employ a political ecology framework that draws upon insights from political geography and anthropology as well as from oceanography and geoscience. This framework highlights the ways in which resource spatio-temporalities come to matter for the types of CSR practices and narratives that emerge in the context of deep-ocean space and time. In other words, the materially and

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[1] Solwara 1, which means 'salt water' or 'sea' in Tok Pisin (a widely spoken language in PNG), is the site of world's first deep-sea mining license to extract metals and minerals. It should be noted however, that since its issue, the Japan Oil, Gas and Metals Corporation (JOGMEC) - a Japanese government Independent Administrative Institution - successfully extracted an ore deposit 1600m deep (the same depth as Solwara 1) off the coast of Okinawa in 2017. It is said to contain an 'amount of zinc equivalent to Japan's annual consumption' (Japan Times 2017).

[2] Details of the methodology appear in section 2.

geophysically specific agency and properties of the deep-sea 'minescape' (Ey and Sherval 2016) enable and constrain certain types of corporate legitimation to take place.

The analytical focus is thus placed upon the corporation as the key human actor for shaping the politics of DSM in PNG. This is because, despite a degree of support from the PNG state, full responsibility for legitimising DSM to external stakeholders globally and for engaging meaningfully with communities at the local level has fallen upon the firm. In this regard, it is a story with at least some parallels in the land-based mining sector (Benson and Kirsch 2010). Nautilus Minerals has approached this challenge through an array of corporate social technologies enacted in both discursive and material ways. What emerges in the subsequent analysis is that unique oceanic and benthic materialities shape these technologies in ways that are distinct from terrestrial landscapes. It should be pointed out that for all the engagement with the corporation, other human actors remain important, including the state and grassroots activism from below[3]. Nevertheless, as will be shown, it is the corporation (and not the state) that has designed and designated the political terms of engagement. It has also produced the technologies of calculation and visualisation upon which the resultant politics of DSM has coalesced. That it has done so by mobilising the unique properties of the deep ocean should serve as a preview for future empirical instances of DSM globally.

The paper proceeds in section 2 by situating the political geography of deep-sea copper and gold extraction in Papua New Guinea, focusing on its relevant material dimensions and detailing the research methods employed. Section 3 sets up the conceptual framing of the argument. It builds upon corporate anthropology – which has sought to expose the legitimising discursive and material practices and technologies employed by a corporation to counter critique – by questioning the role of nature's agency in shaping corporate strategy. In order to do so in the context of DSM, it draws upon critical approaches to the ocean that have positioned its properties as political *actors* (and not factors) in their own right. Section 4 presents a critical analysis of the ways in which Nautilus Minerals manufactures consent for DSM and responds to critique from local and global activism. It does this in three key ways, all of which draw upon deep-sea spatio-temporal materialities. First, Nautilus shifts its responsibility away from the 'social' realm, instead placing it on a deep-sea environment that is constructed as violent, dynamic and unruly. Secondly, the DSM corporation emphasises both the relatively short life-span and areal footprint of its mining operations. Finally, Nautilus emphasises the 'placelessness' and remoteness of the deep-ocean by claiming that its operations 'have no human impact' despite the presence of proximate small island communities. Section 5 concludes by considering the implications for understanding extractive firms as increasingly cognisant of the legitimating work that a codified 'nature' can do in responding to critique from below.

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[3] At the local level, the most prominent form of resistance is materialised through The Alliance of Solwara Warriors. This geographically dispersed activist group is based in New Ireland province but has members from the nearby Duke of York Islands. Emerging recently, they are the most organised indigenous group standing against seabed mining in PNG and they regularly conduct information campaigns across the region. More globally, their message can be connected to the 'Deep Sea Mining Campaign' in Australia, the leading global network specially dedicated to coordinating the critical response to DSM.

2. Deep Sea Mining: situating a global activity in Papua New Guinea

Deep-sea mining is not a singular activity but rather should be understood as a range of practices taking place in different geographies and legislative regimes, with varied mineralogy and with different associated value chains[4]. Collectively DSM encompasses the exploration, extraction, transportation and processing of minerals retrieved from the ocean floor and thus opens up physical and human geographies that extend beyond the seabed itself. The regulatory framework for DSM can be (crudely) split into two regimes. First, DSM activity that occurs within the exclusive economic zone (EEZ) of a nation state (a 200 nautical mile area that surrounds it), falls under the jurisdiction of national legal regimes. This is the case for Solwara 1. Secondly, DSM activity that occurs on the seabed outside of a coastal state's EEZ is codified as being in 'The Area' and is regulated by the International Seabed Authority (ISA), an intergovernmental body established by the United Nations Law of the Sea Convention (UNCLOS) in 1994.

DSM is typically focused on three main deposit types: polymetallic nodules, seafloor massive sulphides (SMS) and cobalt rich crusts. These all occur globally but occur more frequently according to certain geological features and conditions (Petersen et al. 2016). This paper's focus - Solwara 1 -- is a seafloor massive sulphide (SMS) deposit which is found 1600m below the Bismark Sea, 30km from the nearest point on land in New Ireland Province (see Figure 1). 42% of SMS deposits lie within the EEZs of coastal states (Petersen et al. 2016) and occur near volcanic, hydrothermal vents on the seafloor and form as ore rich in copper and gold precipitates through the interaction of hot magma and cold seawater. Sites such as Solwara 1 are associated with the 'ring of fire', a seismically and volcanically active area of the Pacific Ocean. Thus, Solwara 1's material characteristics can be defined around a combination of their remoteness, their volatility and their spatio-temporal extent. It is precisely these properties, and the ways in which they are 'made to do work' for the corporation, around which section 4's analysis is focused.

The materiality of Solwara 1 presents particular challenges for the corporation, not least in the way that it seeks to attend to its 'corporate social responsibility' (CSR) commitments in face of such extreme remoteness and geologic agency. Indeed, a key paradox emerges. On the one hand, the contractor – Nautilus Minerals – proclaims that, by virtue of being 'at sea', mining operations will have very limited social impacts and that 'no people need to be relocated' (Nautilus 2018a). Yet, on the other hand, Nautilus simultaneously has tried to highlight and enact different forms of community engagement, all of which are founded on a need for 'a social licence to operate'. If CSR in the extractive industries rests on the identification of 'mine-affected areas' (Filer and Gabriel 2018: 395) and 'affected communities', then how can be it be enacted in the context of DSM which is seen to be geographically and politically relevant only 'at sea'?

In an earlier study, Filer and Gabriel (2018) have begun to address this question by critically analysing the ways in which a deep-sea mining 'community' has to be 'created' by the corporation, a solution that is only ever unstable and partial. Yet there are significant aspects missing from this account, not the least of which relate to the political possibilities afforded by the geophysical

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[4] This is not a full review. A much fuller summary of DSM's varied characteristics can be found at Petersen et al. 2016

properties of the deep-ocean itself[5]. Taking these materialist considerations seriously opens up new challenges to the firm because, rendered this way, deep-sea resources can be said to be 'intra-active' in their becoming (Barad 2003). In this sense, the words used by Nautilus and other extractive firms to describe and frame nature's material agency are not 'things' in their own right. Instead, they contend with the (deep-sea) environment's tendency to 'act-out', expressed, for example, through its dynamic volcanism and the uncertainties that support hitherto unknown lifeforms. In doing so, corporate discourse does not exist independently of the 'material-discursive practices' through which they 'are constituted' (Barad 203: 818). It emerges as a kind of performance in which its agency resides in its power to 'reconfigure the world' (*ibid.*).

Of course, the contentious politics that is emerging around deep-sea mining does not only play out along the corporate-community interface. For one thing, corporate activity at Solwara 1 has been enabled by the state, through PNG's government. Under the country's seventh Prime Minister, Peter O'Neil, it eventually agreed a 15% stake in the project in 2014[6]. Although this reminds us of the state's crucial 'gatekeeper' role for legitimising DSM projects found within a given country's EEZ in the future, in this case the government has latterly sought to distance itself from involvement in the project. Owing to the financial and ecological uncertainty surrounding the project, O'Neil himself has recently been quoted as describing Solwara 1 as 'a deal that should not have happened' (Post Courier 2019). Yet, according to the former country manager for Nautilus's CSR division in a research interview, the state's contemporary lack of enthusiasm for the project only continues a desire to 'take a hands-off approach. Basically, they [the government] asked us [the company] to deal with the social aspects of deep sea mining'.

For PNG, this continues a national history in which the corporation, as well as the state, has been a central human actor in the politics of land-based resource extraction more generally. Indeed, it is a history that features countless examples of mining related conflict and ecological disaster shaped by state and corporate involvement. Perhaps most notorious are the examples of Ok Tedi and its mining pollution which negatively affected over 50,000 people (Kirsch 2014) and the Panguna copper mine in Bougainville which catalysed a decade of violent conflict in which the PNG state turned on its own people, creating thousands of casualties and an ongoing threat of violence (Kent and Barnett 2012; Allen 2013). Other instances of mining conflict exist in PNG (for example, at Freeport and Porgera) which have highlighted the relationship between indigenous communities, the corporation and the state in rendering the mine as a social and political place (Golub 2014). Against this background, it is both perhaps surprising that the state would sanction deep sea mining in its waters and that it has been so slow to help define what a 'land owner' looks like in an industry with such different geographic realties from its terrestrial equivalent. Whatever the case, it has been the corporation, and not the state, that has been foremost in dictating the political and social geographies of the DSM debate in PNG.

In order to examine the specific corporate technologies used to legitimise DSM practices, this paper draws upon a range of primary and secondary data generated and collected between 2016 and

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[5] Additionally, Filer and Gabriel's account is not based on primary ethnographic data as is the case in this paper.

[6] The original government investment deal was agreed at 30% under the government of Sir Michael Somare in 2011.

2018. Part of a broader mixed-method research project[7], it analyses 26 interviews conducted with key informants from Nautilus Minerals and their suppliers. These took place at Nautilus Minerals' corporate headquarters in Brisbane, their country office in Kavieng, Papua New Guinea, and with the underwater vehicle manufacturers SMD, based at Wallsend, UK. All interviewees' names are removed in order to protect privacy, although contextual information is given to help situate quotations as detailed in signed consent forms generated during the course of the research. Key environmental baseline studies and corporate reports were also analysed, whilst participant observation was conducted at corporate headquarters in Brisbane and at the country office in Kavieng, New Ireland in Papua New Guinea. The quotations used in this paper's analysis were selected through a critical discourse analysis approach that is 'distinctive in its view of the relationship between language and society' (Wodak 2017: 173). By using this approach, 'issues of dominance…power and control as manifested in language' (Wodak 1995: 204) were analysed. In particular, it allowed for a rich interrogation of the ways in which the materiality of deep-sea environments enables particular forms of corporate legitimation to surface.

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[7] The full project, which examines the geopolitics of Deep-sea Mining in Papua New Guinea, has worked with a wide range of research participants from proximate island communities. This broader work employed participatory methodologies including participatory art and drama as well as other more conventional ethnographic methods such as interviews, focus groups and problem ranking. As mentioned in the main text, this paper draws upon the critical discourse analysis of texts derived from interviews and corporate reports.

Figure 1: Location of the Solwara 1 deposit (source: Nautilus Minerals 2018)
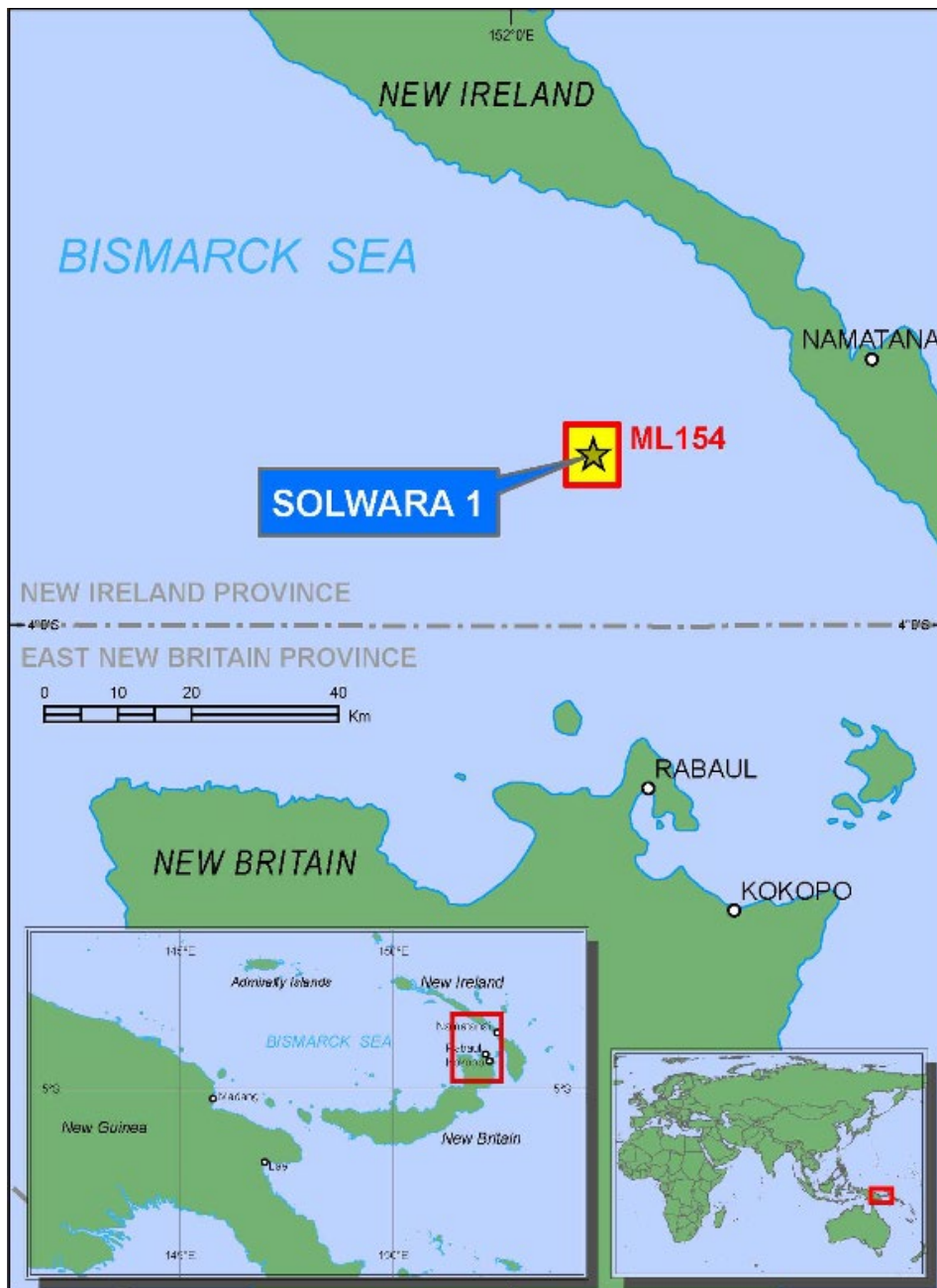
3. Corporate social responsibility and materiality: mobilising the ocean in resource politics

In the age of the Anthropocene, the politics of resource extraction is shaped by the interface between the geologic and human 'making' of resources. On the one hand, human actions rupture the earth both literally and metaphorically as they script metals and minerals found in ever more challenging and extreme locations as being essential to human development and security. Yet on the other hand, for all that human intervention discursively provokes resources into 'becoming' political objects, the spatial and material dimensions of newly encountered resources also prefigure particular political possibilities. However, despite the fact that the human, non-human and geologic

all combine to produce resource politics and define the new 'frontiers' of extraction, analyses of corporate responsibility have been slow to consider space and materiality as important to the kind of contentious politics which emerges when the imperatives of companies and their critics collide. This section highlights the potential of political geography, political ecology and resource anthropology to address this gap and to understand corporate social responsibility of the DSM industry as reflecting spatio-material, as well as socio-cultural, factors.

The materiality of resource politics

The making of a 'natural resource' is now increasingly well understood as both a discursive and material series of processes (Bakker and Bridge 2006; Li 2014; Valdivia 2015). It follows that the political possibilities that resources afford are assembled by different kinds of 'arrangements of substances, technologies, discourses, and the practices deployed by different kinds of actors' (Richardson and Weszkalnys 2014: 16). With specific reference to mining politics and conflict, these actors are now being increasingly recognised beyond simply the human realm. For example, spiritual beings are now more widely understood as being political agents in mining conflicts everywhere from Peru (Li 2015) to Colombia (Escobar 2017), with empirical examples largely focusing upon the many varied forms of 'cosmopolitics' found in Latin America (de la Cadena 2010). Relatedly, 'things' now matter to academic thinking about resource politics, so that everything from pollution, diseases and mapping practices to geological processes and formations (Bridge 2009; Fairhead 2016; Li 2015; Strandsbjerg 2012; Valdivia 2008; Yusoff 2013) are all implicated in the contention that is thrown (dug) up by extractive activity.

Furthermore, the making of a 'new' resource, such as those targeted on the deep-seabed, is intimately bound up with a politics of time. Whether this is through an engagement with the deep-geologic temporalities of mineral formation, the lifespan of mining activity at any given site, or future speculation over new hydrocarbon prospecting (Weszkalnys 2015), temporal dimensions cannot be ignored in fostering political contention between corporations and their critics. A recognition that the politics of a 'new' resource is inherently a dynamic one also opens up an acknowledgement that the spatial dimensions of extractive activity are aesthetically realised beyond linear horizontal or vertical penetrations into or across the earth. Instead, following Stuart Elden's assertion that geopolitics is about more than competing claims to flatly conceived territory, the politics of mining should be thought of as operating in a voluminous space (Elden 2013; Bridge 2013) which is 'embedded in a world of things, bodies, networks or socio-economic relations' (Bridge and Bakker 2006: 18). Adding the temporal as a fourth dimension to this 3D rendering of space is an apposite conceptual starting point for understanding the emergent politics of DSM, with its unique combination of resource tempo-materialities (Childs 2018, Le-Meur et al 2018).

Mobilising the ocean as a political actor

There has been an accelerating interest in the ocean as an object of social scientific enquiry (Gilroy 1993; Steinberg 2001; Blum 2010; Deloughrey 2017). Yet this has followed a plethora of work emanating from marine science, where oceans as a social place have 'remained outside of history' (Hannigan 2016: 3). Whilst this statement should be questioned given notably rich postcolonial histories of oceanic political economy (Baucom 2005, Gilroy 1993, Hau'ofa 2008, Desai 2013), it is true to say that in most cases the material dimensions of the ocean have tended to slide away from conceptual view (Steinberg 2013). Rather than seeing the ocean as a static or inert factor in politics,

a burgeoning range of scholarship from political ecologists, sociologists, geographers and social theorists is urging us to mobilise seas and oceans as a vibrant, fluid and 'stubbornly material' political *actor* in its own right (Steinberg and Peters 2015: 248, Lehman 2013). Taken together, there has been a rise of 'critical ocean studies' that have positioned seas and their 'multispecies engagements' as both agents of politics and invitations to think through the world differently as part of a 'wet' or 'oceanic' ontology (Steinberg and Peters 2015; Deloughrey 2017).

Rendering the ocean in this way has also opened up the need think about geopolitics, not just as a 'volume', but as a *depth*. As Elizabeth Deloughrey asserts, there has been a conceptual 'shift from a long-term concern with mobility *across* transoceanic surfaces to theorizing oceanic *submersion*, thus rendering vast oceanic space into ontological place (Deloughrey 2017: 32, emphasis added). Thinking through depth means being attentive to both the geophysical and material properties of the deep ocean (its varied temperatures and pressures, sediment plumes from hydrothermal vents and so on) and its social construction shaped by particular epistemologies, mapping practices and territorial designs (Hannigan 2016: 4). These political technologies of knowing the deep ocean might find their expression in particular constellations of capitalist accumulation (and are usually inspired by terrestrial practices), for example the designation of exclusive economic zones. However, they are also conditioned and constrained by the 'socio-natural cycles and forces at sea', including the mobility of, for example, migratory fish such as tuna (Campling and Colas 2017: 8).

Materialising corporate responsibility and its technologies

There is now widespread recognition that in response to decades of burgeoning critique and mistrust of its social, environmental and economic impacts, the extractive industries have had to react in more sophisticated and focused ways than perhaps any other industrial sector (Kirsch 2014; Yakovleva et al. 2017). The corporate response to such opposition has taken many forms but is here parsed as distinct types of 'corporate social technologies' that aim to 'direct and plan efforts to shape social and cultural life' (Rogers 2012: 294). These technologies are particular iterations and practices of CSR, and mark a break from conceptually narrow and uncritical work in the business and management studies literature which has sought to mollify contention and protect corporate value chains. Most recently, CSR practices have been read as examples of 'corporate counterinsurgency', which, for Brock and Dunlap, can take either 'soft' and 'indirect' forms (e.g. biodiversity offsetting) or 'direct repressive techniques to supress resistance and criminalise and isolate activists' (Brock and Dunlap: 2018: 36). Yet, there remains an underdeveloped need to factor in materiality to discussions around CSR.

Where this has happened, it has been anthropology, rather than geography, that has been at the forefront of work that has begun to address this provocation (Manning 2010; Rogers 2012). Seen as essential for understanding CSR in the era of the Anthropocene, this framing critically positions the 'social terrain' being fought over as being about the 'biophysical properties of place' (Dougherty and Olsen 2013) as well as the 'corporate political strategies' articulated by different human interests (Levy and Egan 2003). Where political geography has reflected upon CSR and materiality, it has done so predominantly in the context of terrestrial resource extraction. Brent Kaup has consistently highlighted, for example, the ways in which multinational extractive firms (as well as anti-mining coalitions) are constrained and enabled by the specific materialities of both natural gas and mining in Bolivia (Kaup 2008, 2014). From another angle, it has been argued that ignoring socio-material

contexts in favour of a generic focus on corporate 'performance standards' does little to alleviate social and environmental insecurities (Gilberthorpe and Banks 2012). The question remains, however, as to how the spatio-temporal properties and characteristics of *non-terrestrial* extractive spaces (such as the seabed and deep-sea) are mobilised as legitimising techniques? As Filer and Gabriel contend in Papua New Guinea, 'it is clearly difficult for Nautilus [the focus of this paper] or any other mining company to obtain and maintain a social licence for a deep-sea mine…because of the physical separation of the mineral deposit form anything which might be construed as a "local community"' (Filer and Gabriel 2018: 399). By emphasising a materialist political ecology, I will now critically analyse how Nautilus Minerals strives to overcome that challenge and to legitimise its practices.

4. Legitimizing DSM through 'nature'

Because the Solwara 1 site is scheduled to be the world's first commercial deep sea mine, empirical evidence concerning the social and environmental impacts is characterised by uncertainty. This ambiguity has opened up a range of political possibilities both for Nautilus Minerals, the DSM contractor, and its critics as they seek to secure and shape the social terrain over which DSM's future in PNG is fought. The concept of 'social terrain' is key for understanding the ways in which CSR is performed (Dougherty and Olsen 2014: 426) because it highlights the importance of materiality for shaping social meaning and manufacturing consent. In this section, I outline three main 'types' of materiality which Nautilus mobilises in order to legitimise its practices and defend itself against critique: a) the deep-sea's dynamism, b) the deep-sea's spatial and temporal configuration and c) the deep-sea's remoteness.

a) The dynamic deep-sea: violent and powerful

It is typical for mining corporations operating in terrestrial settings to discursively minimise the potential social and environmental impacts of extraction. Partly because of the visible altering of terrestrial landscapes that result from such mining activity, corporate strategies of legitimation often rest on mitigation and/or remedial strategies. These include efforts towards mine reclamation or, more recently, offsetting practices that aim to render affected environments as suffering 'no net loss' to biodiversity. Such linguistic sleights of hand are necessary from a corporate perspective because a mine site's physical geography and impacts are undeniable, visible and conceptually legible to proximate communities. On the other hand, because of its depth, remoteness and its relative 'invisibility', those who have access to mapping technologies (i.e. the corporation, the state) assume that geographies of the deep-sea are resistant to the human senses of those who do not. In understanding the deep-sea environment as an 'imagined' geography, it allows its characteristics and dynamics to be narrated and reified by those in power. For Nautilus Minerals this is both a source of political expediency (allowing a particular version and description of the underwater mine-site to be 'scripted' in time and space) and a challenge of scientific communication. As the former CEO of Nautilus put it:

'Misinformation is a big thing. The deep-sea is a completely different environment to what most people envisage. It is quite rugged in some places…there's volcanoes. We've got a volcano 3km from us that's been erupting for more than 30 years. It's a quite dynamic environment, quite different from what people portray it as.'

The presence of an active volcano so close to the proposed mine site at Solwara 1, notwithstanding volcanism's association with SMS deposit formation, might be expected to be a source of concern for a junior mining company that is actively seeking global investment and seeking to minimise risk[8]. However, as a reaction to both popular media and critique, which often describe the deep-sea environment as 'pristine' (e.g. Hughes et.al 2015, Fitch 2017, Pauley 2015), it actually highlights the instability, violence and dynamism of the seabed and its surroundings. For the former head of CSR at Nautilus, the challenge is clear:

'it's about trying to communicate how messy the seafloor environment can be, especially when you have a seafloor volcano right next to you'

Rather than presenting the seabed and water column as something that can be 'managed' and 'controlled' by the corporation, it is instead depicted as being lively and disordered. This unruly condition, particularly through the presence of volcanism, takes on at least three modes of materiality, which are then exploited by the DSM corporation in order to legitimise its practices and counter critique. These relate to the volcano's power, its noise and its persistence. In the first instance the power of the nearest volcano, called 'North Su' is highlighted and compared to the potential impact of deep-sea mining activity. The lead designer for the underwater mining equipment being used at Solwara 1, makes the comparison:

'if you look at black smokers you've got to think hold on a minute, a plume from mining is a bit like smoking an ultra light cigarette next to a smoking volcano.'

Here, the impacts of human-induced mining activity is rendered inconsequential against the power and potential violence of the volcano. By comparing an 'invisible' earth process to an everyday (and, thus, recognisable) human act of consumption, DSM is trivialised. By removing the impact of DSM in this way, it recalls a tactic employed by mining companies who seek to foster 'misleading comparisons of natural and industrial systems' (Kirsch 2014: 128). Yet, it also renders it, like a cigarette that is 'light' (and thus stripped of its consequences for biological health), as something ephemeral and inconsequential. This iterated, fleeting nature of DSM activity is further stressed by the designer:

And that whole chain of islands is volcanic – it's dumping things into the sea all the time. So it's all about comparing it to background'

In other words, not only is the deep-sea mining environment dynamic, it is persistent. The violence and the effects that are wrought by volcanic activity represent a kind of 'natural' *status quo* unaffected by the short-term actions of DSM. Problematic sediment plumes, seen as an undesirable impact of DSM by its critics, are thus produced 'not by mining activity but is most likely to be eruptions from North Su with lesser contributions from South Su and Solwara 1' (Nautilus 2014). For a senior figure at Nautilus, describing this terrain becomes a key part of the corporate communication strategy:

'so you say [to the communities] here's the plume that the volcano makes, and that's natural and it occurs all the time and it's kind of ongoing. And it's been there well before us and it will be there well after us.'

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[8] This is especially the case given that AngloAmerican, a leading global mining company, withdrew support from the Solwara 1 project. After initially reducing their share stake from 8 to 4%, they have now completely withdrawn citing the size of the risks involved. Nautilus Minerals continue to face major problems in attracting the necessary flows of global investment.

In making the physical geography of the seabed an everyday process, it limits the ability for human action on the seabed to disrupt the power and rhythms of volcanic activity both in terms of its temporal and physical insignificance. Such argumentation is used to directly address the critique that unique, chemosynthetic organisms are at risk of extinction. As leading oceanographers have asserted, 'loss of biodiversity will be unavoidable because mining directly destroys habitat and indirectly degrades large volumes of the water column and areas of the seabed due to the generation of sediment plumes' (Van Dover et al. 2017: 464). The language of 'extinction' and 'unavoidability' is evocative and useful to critiques from both academia and activism because it suggests that a precautionary approach that delays DSM activity is not just a suggestion but a necessity. However, even this is subverted by a member of the technology design team when placed into relation to the violent materiality of a volcanic eruption:

'They say it's teeming with life around these hot vents where the SMS deposits are. Well yeah, because it's warm there. But, er, it's also teeming with death when there's an eruption – an extinction event'

Conceptualising the seabed as a place of both life *and* death is important because it helps to establish the biogeography of the deep-ocean as *resilient* and cyclical. Using scientific research that has shown how life actually returns to hydrothermal vents even after an 'apocalyptic' underwater eruption (Qiu 2017), the argument proceeds that if underwater life can endure the magnitude of a volcanic eruption, then it can comfortably endure the disruption caused by DSM. These arguments are all based on the establishment of 'baselines' that represent environmental facts against which DSM activity is then measured. Notwithstanding the uncertainty that surrounds current deep-sea science's state of knowledge, such baselines serve to 'fix' temporal as well as spatial impacts. In the context of a dynamic deep-sea environment, the question thus becomes not just a case of what nature should look like, but *when*? What ecological 'moment' is chosen has significant bearings on attitudes to human mining activity against which it is judged. Huge volcanic eruptions, for example, though not *always* happening, can be presented as 'baseline' in order to render the consequences of DSM insignificant.

A related argument is made concerning the impacts of noise upon marine fauna. Nautilus has made concerted efforts to record acoustic data from underwater volcanic activity at North Su, developing its own submarine monitoring data as well as that held by the nearby Rabaul Volcanic Observatory. For example, presenting data from its 2016 Annual General Meeting, Nautilus highlighted a background noise of between 110 and 120 decibels over a three-month period and peaks of up to 170 decibels during a 'volcanic event' (Nautilus 2016: 12). This noise from the volcanic system is then used in comparison with that made by underwater mining equipment (despite the profound differences in its frequency) in order to suggest that the deep-sea environment is an *always* noisy place, and that its associated fauna are used to such noise levels.

Taken together, the corporation argues through scientific data that the noise and physical disturbances wrought by the 'natural' agency of the deep-sea far exceed those created by DSM and that any such impacts are mitigated by the highly resilient nature of ecosystems accustomed to geophysical upheaval. Nature's everyday actions thus provide a kind of 'natural licence to operate' for the company, simultaneously allowing it to bypass its social commitments and countering concern over its potential impact. Through comparison, the corporation mobilises the particularly dynamic and ecologically complex nature of SMS deposits (as opposed to other types of DSM and

terrestrial mining) in order to present its environment as resilient, even *renewable,* in order to speak to the sustainability narrative provoked by critics and (increasingly) investors alike. Indeed an argument from Nautilus former environmental manager stated that for most deep-sea environments, 'you can't rehabilitate [them]. Once you've taken that habitat away it's gone. The only exception to that is the seafloor massive sulphides which have the potential to recover from mining which is fantastic'. In short, the dynamic aspects of the seabed around hydrothermal vents are highlighted not as an example of its complexity so much as a reminder of its on-going power to mitigate (even dominate) any human-induced challenges that might be encountered.

b) Minimising the spatial and temporal extent of deep-sea mining

The second major way in which material dimensions are made central to a counter-narrative against critique is through the highlighting of the spatial and temporal registers of the Solwara 1 site. Specifically, Nautilus emphasises both the relatively short life-span and areal footprint of its mining operations. It does this, in particular, through positive comparison with terrestrial mining projects that presents DSM as a more *sustainable* alternative for resource extraction. Moreover, it is the spatial and temporal registers of SMS deposits that allows such claims to be made. A first example of this relates to the perceived connection between the (small) size of the SMS deposit and its ecological footprint. For the former CEO of Nautilus, it is the minimal size of the deposit which protects the company from claims of wide-scale ecological extinction:

'Some of the claims are so outlandish! Like we're going to wipe out entire species! For crying out loud, we're mining an area 0.1sq km. If that has the effect of wiping out entire species and eliminating them from the gene pool, I'll eat my hat! We have strategies in place, regardless, to make sure that that isn't the case'

One issue relates to the obvious counterpoint that only 10% of deep-sea habitats have been explored (Ramirez-Llodra et al. 2010) and that 'two new hydrothermal vent species are being described every month in the 25-year period following their discovery' (Miller et al 2018). Another is that, even when moving beyond both the increasing evidence pointing to the 'area' metaphor and discussing it in terms of a 'footprint', the mining area is dismissed as negligible in comparison to terrestrial copper mines. As the erstwhile environmental manager for Nautilus asserted in a face-to-face interview:

'seafloor massive sulphides have usually very small footprints associated with those. So Nautilus's footprint is about 11 hectares and for a 3 million tonne per annum resource that's a *very* small footprint.'

Official documentation made publicly available by Nautilus also points to the same limited spatial footprint. For example, its commissioned 'Environmental and Social Benchmarking Analysis' (ESBA) uses visual comparisons between the Solwara 1 project and three terrestrial copper mines (one of which has not be completed yet) and JFK Airport in New York (see figure 2). By using GIS, the implication is clear: Solwara 1 will have a minimal impact compared to conventional mining projects. The image is powerful because it renders visible the invisible, making comparison with above ground objects (terrestrial mines, airports etc.) that are legible to investors. It can be read, in similar ways to land (Li 2014), as part of a technological 'assemblage' of practices that recasts the seabed as a 'resource'. It also continues to discuss the impacts of deep-sea mining in terms of area, rather than
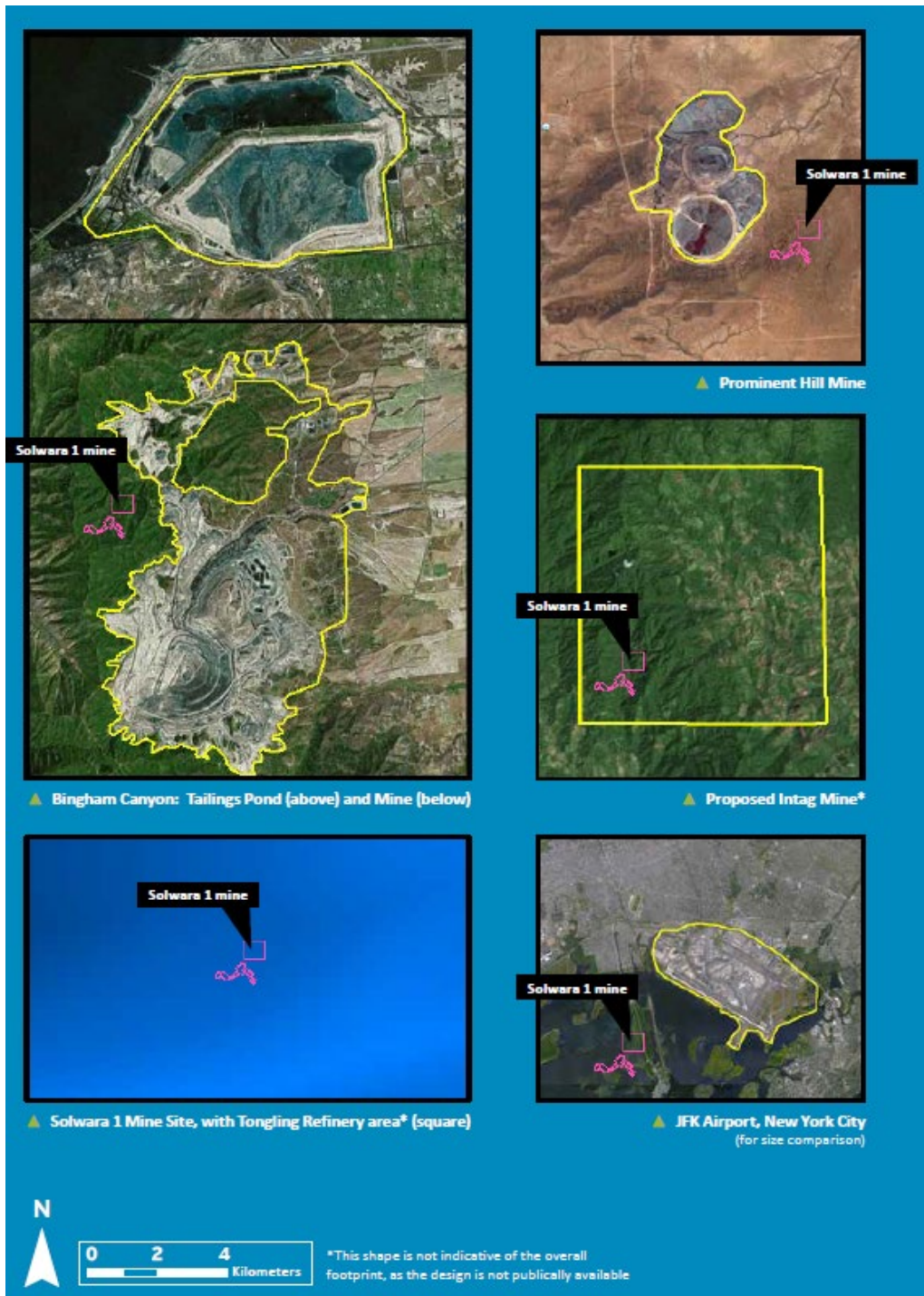
volume, neatly sidestepping engagement with the three dimensional implications of sediment plume formation, noise pollution and changes in the environment to both light and temperature.

However, the straight comparison between mines on a spatial basis alone is disingenuous because the life spans of each is significantly different, as is the way in which terrestrial mining and DSM operate over time. One major critique of the benchmarking analysis, contended by a major global network of activists – The Deep Sea Mining Campaign – is that:

Because DSM is proposed as a rolling series of small scale, short-lived mines, the ESBA framework should have accounted for the cumulative effects over time of the several mines (Rosenbaum and Grey 2016: 10).

The debate that emerges here contributes to a further dimension of what Stuart Kirsch calls the 'politics of time' (Kirsch 2014). Kirsch's concept centres on the relationship that corporations and their critics both have with action that either speeds up or slows down time for political advantage. On the one hand, he argues, critical alliances must seek to accelerate levels of organisation and information gathering and sharing in order to 'focus attention earlier in the production cycle' (Kirsch 2014: 13). From the contrary perspective, the mining corporation seeks to promote 'doubt and uncertainty, in order to delay action against them, including regulation and potential delegitimization' (Kirsch 2014: 226). At a simple level, the slowing of political time might be expected to explain Nautilus's engagement with its critics. Indeed, being a 'first-mover' in the DSM industry means that it would appear to be in the corporate interest to withhold or delay the release of information on potentially adverse environmental impacts.

Figure 2: GIS maps of relative sizes of mine sites

Bingham Canyon: Tailings Pond (above) and Mine (below)
Prominent Hill Mine
Proposed Intag Mine*
Solwara 1 Mine Site, with Tongling Refinery area* (square)
JFK Airport, New York City (for size comparison)

N

0 2 4 Kilometers

*This shape is not indicative of the overall footprint, as the design is not publically available

(Source Batker and Schmidt 2015)

However, Nautilus are (especially for their size) conspicuously active about providing a range of environmental and social impact reports. Notwithstanding the contestable nature of the context of their data, their relative transparency lies at odds with existing theories of the terrestrial mining firm which is thought to want to hide the 'slow violence' of its environmental actions and impacts (Nixon 2011). Instead, Nautilus Minerals actively 'speeds up' time by drawing upon the unique materiality of the SMS deposit. In their Environmental Impact Statement, Nautilus invokes so-called 'natural

mitigation' in order to assert that 'the active venting field will remain, chimney structures will reform and the underlying hydrothermal energy basis will still exist' after mining activity has concluded (Gwyther and Wright 2008: 26). The rapid rate of formation of the hydrothermal vents is also highlighted in the same report - (60cm of new chimney growth was recorded 'in just two days from the top of a drill hole') - in order to suggest relative sustainability vis a vis terrestrial mining (Gwyther and Wright 2008: 20). Relatedly, the limited life span of the SMS sites highlighted above (3 years as opposed to the decades long duration of terrestrial mines) actually *enables* the corporation to *speed up* the 'politics of time' and present DSM as having a shorter as well as smaller environmental footprint. Corporate 'tenure' of the seabed, like 'land', signals both 'possession…and its limited duration' and becomes a key 'institutionalizing mechanism' in the politics of DSM (Li 2014: 276). It emerges as an example of how firms can manufacture consent through careful manipulation of resource temporalities as well as their spatialities.

However, the placing of the Solwara 1 DSM project as a mine site characterised by both its spatial and temporal extent fails to account for the much more extensive spatialities and temporalities involved. Rather than focusing uniquely on the extraction phase, a mining project should be conceptualised as taking place over much longer time scales and through more extensive spatial dimensions including its afterlife. Minerals are physically 'made' in geologic time, decades of exploration work are involved in order to prove a DSM site's commercial viability whilst investment is concerned with future facing financial returns. Thought about in this way, a deep sea mine 'timescape' is an example of 'the conflictual interpenetration of industrial and natural temporalities as an interactive and mutually constitutive whole' (Adam 1998: 56 in Le Meur et al 2018: 6). The natural temporalities here are, in addition to 'the exploration period and the time for acquiring, processing and making use of necessary data[…]part of the scientific landscape' (Le Meur et al 2018: 6) and a key mechanism for Nautilus to shift political responsibility away from itself and 'onto nature'. As Kirsch summarises in the terrestrial mining context, 'naturalizing environmental impacts [and] seeing like a mining company entails viewing time like a geologist' (Kirsch 2014: 139).

Similar to this 'politics of time', communicating the spatial dimensions of Solwara 1's extent in a way that references industrial (and terrestrial) systems is a key part of Nautilus's counter-narrative. The challenge of reaching a shared understanding has been actively considered from the start of the project. As their former CSR manager highlighted:

'To talk about size with a scientist is easy…"well it's this big", they can automatically picture how big that is. But talk to a local community about that and it's a totally different discussion…so then we talked about "well its x number of football fields" but they didn't play football and that didn't resonate…so we compared it to things that they did value, like fish…You have to keep going until you get it right'

Even when the target audience is changed from critical local communities to potential investors this invocation of the relativity of physical extent endures: it is only the industrial point of reference which is changed. So, in Nautilus's social and environmental benchmarking analysis, the Solwara 1 mine is described as 'the same area as a typical Walmart parking lot' (Batker and Schmidt 2015: 98). By 'overgrounding' the point of comparison with an everyday site of consumption legible to the investment community, Nautilus is able to belittle its spatial footprint. This is a common tactic of extractive companies' discursive strategies and is echoed, for example, by the memorable quotation of another mining company's executive who claimed that his company's ecological footprint was the 'equivalent of me pissing into the Arafura Sea' (Bryce 1996: 69). Communicating a mine's extent

becomes an exercise in using natural systems to dwarf industrial infrastructures and thus manufacture consent for DSM activity.

c) The 'remote' deep sea: towards a 'closed' and 'sustainable' system?

Finally, Nautilus emphasises the 'placelessness' and remoteness of the deep-ocean by claiming that its operations 'have no human impact'. The nearest communities to the project, in fact, lie 30km to the east of the Solwara 1 deposit on the west coast of New Ireland Province, whilst a series of atolls - the Duke of York Islands with a population of around 20,000 people - lie around 35km to the South East on the same latitude as Rabaul to the west. Although these communities feel impacted by the proposed activity owing to a relational ontology that positions 'beings', 'spirits' and 'nature' as co-shapers of *graun* (the world) and not as separate domains[9], Nautilus still highlights the remoteness of DSM activity from the human realm. However, in doing so, the corporation is confronted with a paradox of simultaneously needing to satisfy the imperatives of being accountable to society whilst denying that its activity is particularly social at all. As Filer and Gabriel (2018) ask, 'how could Nautilus Minerals get a social licence to operate the world's first deep sea mine?' This irony is not lost on those who directed Nautilus's CSR strategy at the project's outset:

'the social impact of deep-sea mining is much different to terrestrial mining. You don't have land owners *per se*[...]In the deep-sea world it's much more nebulous. It's much more difficult to define who your affected communities are and how they're going to be affected'.

The corporate strategy has thus far centred around the assertion that Nautilus has developed a unique 'closed system', one in which any impacts are limited to the oceanic depths. The strategic deployment of scientific data and jargon helps to establish a sense that the upper 'zones' of the ocean are unaffected by DSM activity. According to the company's one-time CEO,

'From the environmental studies we've done, we know the current directions, we know what happens with the water column - that it doesn't mix. One of the big things that we're doing is making sure that we're maintaining the integrity of the water column so that we aren't mixing it. Basically we're doing our activity around 1500m and it's only up to around 30m around it is all that's impacted'

Superficially it seems as though the fluidity of water is denied its agency as Nautilus seeks to circumvent its material properties through the development of technological solutions. Specifically, once the ore is disaggregated at the seafloor it is then pumped up to a 'production support vessel' (PSV) on the surface of the water as a seawater slurry in a 'riser pipe'. When on board the PSV, the ore is dewatered before being pumped back down to the seafloor environment. As official communication from Nautilus states, the 'discharge of the return water at the seafloor from where it came eliminates mixing of the water column, and minimizes the environmental impact of the operation' (Nautilus 2018). A simple reading suggests that this is a kind of techno-fix in which an industrialised, 'closed' system does the work of traversing different 'layers' of the water column. Yet such an industrial aesthetic reminds us that the deep sea is a volume, not an area. The extraction of ore might take place at the seabed through a process of cutting and disaggregation, but it is then pumped *upwards* through the water column as a slurry, *downwards* as dewatered seawater, and then removed *across* the sea to a terrestrial processing centre. In the deep-sea, a materially and

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[9] This point is more fully developed in future research that considers the role of ontology in the making of DSM politics.

spatially attuned geopolitics becomes necessary in a dynamic environment 'where magma meets water, solid meets liquid and where levels of pressure and sound dramatically vary' (Childs 2018: 17).

Moreover, it is actually the materiality of water that does the work of legitimising DSM's limited impacts. This is particularly the case for defending against the charge that seafloor mining will increase the risk of sediment plumes and affect ecologies located higher up the water column. As the CEO continued, by again comparing materiality of the DSM environment to their industrialised system:

'That thing [the North Su Volcano] has been erupting, quite massively erupting at times, and there's never been any of the eruption ejection come close to the surface because it's physically impossible! The way that the water column is structured, the volcanic material as it's being ejected out, eventually it becomes neutrally buoyant, it becomes neutralised by all the seawater. It becomes the same temperature and Ph and then it starts drifting sideways. It takes about 600 or 700m on average for the volcanic ash to get to that point and then it goes sideways and just settles out. It's the same principle with our mining machines. Any plume that they make only goes up about 50 or 100 metres or so and then it can't go any higher because it becomes neutrally buoyant.'

The scientific concept of 'neutral buoyancy' is here deployed as a means to discursively lessen the anticipated impacts of plume formation through anthropogenic means. Occurring at the point of mutually equal density, it is the materiality of the both the water and plume itself that allows a natural mitigation of DSM's impacts. This relieves the corporation of its responsibility to manage these impacts, instead leaving such a task to the rhythms of the oceanic depths which are always on-going. It is also another instance of the power of volcanism exceeding that of mining activity (with sediment plumes caused by an eruption reaching over 10 times the height of those created by DSM). What emerges for Nautilus is a kind of, 'ecological subsidy' to the firm (Bridge 2009). In other words, the specific properties and characteristics of the deep-sea environment actually help to facilitate 'modern social and economic life' (*ibid.*). Not only are hydrothermal vents capable of producing higher quality ores than at a terrestrial mine (Solwara 1 is around a 7% grade compared to nearer 1% on land) but their surrounding environment replaces the need for active, human mitigation efforts too. For Nautilus, the use of this 'subsidy' is a key strategy for offsetting its corporate social responsibility obligations.

However, the deferral of responsibility to 'nature', returns to their paradoxical CSR position of how to gain a 'social licence to operate', if the social is denied through the discursive construction of DSM as remote? The identification of an affected community is 'solved' by attempts to establish a new concept, a so-called 'coastal area of benefit' (CAB) - see figure 3. As Nautilus's country manager for PNG explains:

'We don't have the traditional concept of land ownership. For this project, the advice we got from the government was that we don't have a land ownership structure where people are regarded as land owners. Whereas with a land mine, that's the concept you'd have. But we can't just say to the communities nearest to the project, "I'm sorry we can't deal with you". So we came up with the concept of coastal area of benefit.'

However, implemented as part of Nautilus's CSR efforts, the designation of the CAB is based on a crude, 'artificial' line being drawn. As the country director continues, 'Solwara 1 is 30km away from

the nearest land mass which is the west coast [of New Ireland Province]. From there, we've come up three wards and down three wards giving us 7 wards in total.'

Figure 3: The Coastal Area of Benefit for Solwara 1 (source: author)

The spatial designation of the wards considered 'inside' the CAB has caused consternation amongst neighbouring communities considered 'outside' the area. Partly, this is because they are denied access to its material benefits - 20% of the royalties collected by the national government[10]. Yet, more pointedly, several wards that are geographically closer to the Solwara 1 site (to the east of the yellow shaded area in figure 3) are considered outside the CAB. At the same time, some of those considered within are recognised 'as people who will not jointly (and exclusively) experience the negative impacts of the project' (Filer and Gabriel 2018: 399). It is perhaps no coincidence that the communities outside the CAB wards are more populous than those inside it. Nautilus is thus able to exploit the spatial remoteness of DSM in order to minimise the financial burden of its CSR obligations. Yet, the temporality of the SMS deposit allows it to render its lessened commitment even smaller as the benefits only accrue to the affected communities for the duration of the mine's lifespan. As has been already noted, for a deposit whose 'life' is at least ten times shorter than that of a terrestrial mine, this enables a hugely reduced CSR commitment. The CAB becomes 'a matter of time as much as a question of space' (Filer and Gabriel 2018: 399).

Conclusion

Recently, there have been welcome calls from academia to recognise the importance of the agency of remote, violent and dynamic environments in matters of resource politics. However, as this

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[10] The 20% royalty rate has been noted as being a 'mirror image of the landowning community whose members are already entitled to 20% of the royalties collected from a terrestrial mining project under the terms of the Mining Act' (Filer and Gabriel 2018: 398).

paper's analysis shows in the context of DSM, companies are, with a nuanced sense on the political, already thinking about and acting upon 'the geologic violence and agency of volcanism, shifting states of mineral matter and the challenges of darkness and pressure that they face' in deep-sea environments (Childs 2018). In doing so, responsibility for the ecological impacts of DSM is shifted away from the corporation and onto the category of 'nature' itself.

This article has illustrated how scientific knowledge of the deep-sea and the things which deep-sea environments 'do' – its agency and violence (expressed through underwater volcanic eruptions, extreme pressure and the temporal dimensions of geology) – comes together to mollify resistance to DSM practices. The novel extractive 'minescape' of deep sea mining and, in particular, the mining of SMS deposits, provides one example of the value of including analyses of materiality into geographical critiques of CSR. A number of studies of 'corporate responsibility' in the DSM sector have emerged in the grey literature (e.g. Rosenbaum and Grey 2016; Vanreusel 2016) but they approach the issue through an invocation of the familiar political actors (usually identified as 'stakeholders') centred on the human realm (corporations, communities, activist groups and so on). Incorporating materiality into analyses of the DSM firm widens the cast of political actors and leads to a better understanding of the politics of corporate social responsibility. Doing so moves beyond the useful starting points offered by Filer and Gabriel's (2018) study of Nautilus that centre upon the discursive framing of deep-sea 'community' and, instead, engages meaningfully with the 'stuff' of deep-sea mining and its political implications.

Political geography and cognate disciplines are particularly well placed to make sense of the ways in which the political is about more than the human, especially when analysing resource extraction. Indeed, such research has enlivened resource geographies such that its politics is populated by post-human characters (e.g. Theriault 2017) and inhuman materialisms alike (e.g. Clark 2011). It has not yet, however, fully turned its analytical attentions to a corporate anthropology of CSR and taking material factors as partly constitutive of its politics seems productive. Yet, for all the progress that political geography has made in understanding the political importance of material dimensions in its work, the question remains as to whether it still lags behind the corporate sector in its understanding.

The funding landscape for ocean-based research, including for deep-sea mining, is changing. For example as recently noted in the US context, 'ocean scientists have gradually turned away from the federal government and towards the private sector' (Rogers 2015). The implications are twofold. First, it suggests that academic critique of the extractive industries is likely to be responsive to rather than generative of, environmental data and thus its ability to recognise the 'new' political actors brought into view by research. If, as has been suggested, a 'politics of time' is important to the way in which corporations respond their critics, then critical social science must react quicker to the emergence of dynamic, material dimensions from new resource frontiers. Secondly, rather than firms being seen as ignorant of, or at least indifferent to, the political consequences of their work, they might actually be amongst the most attuned to a broadened and more nuanced view of politics.

In recent times, more progressive work across the social sciences (e.g. Kirsch 2014, Li 2015, Brock and Dunlap 2018) has begun to open up these questions, especially with regard to how agency is distributed between different actors. Some have questioned, for example, whether the allocation of agency to objects and things 'necessarily limits recognition of power differences', and 'limits

attention to the role corporations play in mining conflicts' (Kirsch 2016: 435). For the present study, and for thinking about the politics of DSM in general, agency is only ever distributed partially. On the one hand, material considerations (such as the dynamics and properties of hydrothermal vents, volcanoes, deep water) do have an agency of their own and they do both enable and constrain certain political possibilities. Yet, on the other, there is still a (still understudied) agency of the extractive firm, in particular around its ability to manipulate those same material dimensions.

Corporations like Nautilus Minerals that work at the new frontiers of resource extraction have an intentionality that the material realm does not. Objects like hydrothermal vents are not only dynamic, they are unruly and do not conform to managed or planned behaviours in the same way that firms do. The firm, in this context, is both explorer and extractor and is thus in a position to manufacture consent through its understanding of the materiality of the deep-sea environment. In doing so, it is able to position itself as sustainable by allowing nature itself to mitigate its obligations towards social responsibility. By virtue of being 'at sea' it thus can cast itself as a solution to global *'need'* for DSM in order to supply 'necessary' raw materials for (future) green energy infrastructures in a way that is less environmentally damaging than terrestrial mining alternatives. It thus creates an oxymoronic narrative of 'sustainable deep-sea mining' and a promise of 'a better future' by bringing together the 'use of green economic logic, novel spectacles and narratives' (Brock and Dunlap 2018: 45) with a blue economic one.

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