Benthic Geopolitics off the Bangka and Belitung Islands, Indonesia: Go Offshore, Go Deeper

Figure 1: Offshore tin mining operations (Photo by author)

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Abstract

Bangka and Belitung islands, Indonesia, have been geopolitically framed as *kepulauan timah—the islands of tin* by Indonesian central and provincial authorities, the International Tin Association (ITA), and the Organization for Economic Collaboration and Development (OECD). This geopolitical category comes about as over 30% of the global tin supply originates from this place. Tin, *Stannum* (Sn 50) on the periodic table is crucial for global automobile, electronic device, weaponry, and kitchen utensil manufacturers. Since over 90% of the tin ores from these islands are extracted through offshore tin mining operations, the notion of tin islands has flattened the seafloor into none other than a mineral extractive frontier. When this capitalist assumption is not questioned and contested, one may fail to imagine the seabed off these islands beyond the global capitalist imagination. Bringing together critical ocean studies, island studies, science and technology studies (STS), and queer ecology studies within new materialist geopolitics, this study aims to contest such a capitalist narrative of the seafloor. It does so by examining and re-interpreting the seafloor sensing and extracting in seabed uses as "benthic phenomena". In this study, benthic phenomena are broadly defined as any emergent measuring agencies (e.g., human bodies, animals, technologies, events, and ideas) interacting with, relating to, and/or associated with the depth of the sea (benthic) that continuously reconfigures multiple realities of the seafloor. This interpretation is informed by intensive ethnographic fieldwork on offshore tin extractions and other seabed uses (e.g., undersea cable installation and coral reef restorations) off the Bangka and Belitung islands. The significant and original contribution to knowledge is that this thesis expands the concept of the "benthic" in marine science (i.e., benthic ecology) to social science through conceptualizing benthic phenomena. Across three main empirical chapters, this thesis argues that ITA, OECD, and central and provincial authorities shape and are shaped by seafloor sensing, tin diving, and sediment plumes in offshore tin industries. This indicates how the intersection between benthic phenomena and geopolitics—*benthic geopolitics*—across spatial and temporal scales manifests in the spatial conflict of the seafloor. Ultimately, this study adds critical knowledge to the growing area of geography that has paid attention to the oceanic space and, more recently, the seafloor. This critical knowledge is crucial and urgent because such insight brings to the surface human-seafloor relation, exploitation, and dangerous labor, which otherwise is covert by the depth of the sea and the dominant geopolitics of the seafloor.

Zussamenfassung

Die indonesischen Inseln Bangka und Belitung werden von den indonesischen Zentral- und Provinzbehörden, der Internationalen Zinnvereinigung (ITA) und der Organisation für wirtschaftliche Zusammenarbeit und Entwicklung (OECD) geopolitisch als kepulauan timah - Zinninseln - eingestuft. Diese geopolitische Kategorie kommt zustande, da über 30 % des weltweiten Zinnangebots von diesem Ort stammt. Zinn, das im Periodensystem als Stannum (Sn 50) bezeichnet wird, ist für die Hersteller von Autos, elektronischen Geräten, Waffen und Küchenutensilien weltweit von entscheidender Bedeutung. Da über 90 % der Zinnerze auf diesen Inseln im Offshore-Zinnbergbau gewonnen werden, hat die Vorstellung von Zinninseln den Meeresboden zu nichts anderem als einem mineralischen Abbaugebiet gemacht. Wenn diese kapitalistische Annahme nicht hinterfragt und angefochten wird, kann man sich den Meeresboden vor diesen Inseln nicht jenseits der globalen kapitalistischen Vorstellung vorstellen. Diese Studie, die kritische Meeresforschung, Inselstudien, Wissenschafts- und Technologiestudien (STS) und Studien zur Queer-Ökologie im Rahmen einer neuen materialistischen Geopolitik zusammenführt, zielt darauf ab, eine solche kapitalistische Erzählung des Meeresbodens zu hinterfragen. Dies geschieht durch die Untersuchung und Neuinterpretation des Meeresbodens, der als „benthische Phänomene“ wahrgenommen und ausgewertet wird. In dieser Studie werden benthische Phänomene im weitesten Sinne als alle auftauchenden Messinstanzen (z. B. menschliche Körper, Tiere, Technologien, Ereignisse und Ideen) definiert, die mit der Tiefe des Meeres (benthisch) interagieren, in Beziehung zu ihr stehen und mit ihr verbunden sind und die fortlaufend verschiedene Realitäten des Meeresbodens neu konfigurieren. Diese Interpretation stützt sich auf intensive ethnografische Feldforschung zum Offshore-Zinnabbau und zu anderen Nutzungen des Meeresbodens (z. B. Verlegung von Unterseekabeln und Wiederherstellung von Korallenriffen) vor den Inseln Bangka und Belitung. Der bedeutende und originelle Beitrag zum Wissen besteht darin, dass diese Arbeit das Konzept des „Benthos“ in der Meereswissenschaft (d.h. der benthischen Ökologie) durch die Konzeptualisierung benthischer Phänomene auf die Sozialwissenschaft ausweitet. In drei empirischen Hauptkapiteln wird in dieser Arbeit dargelegt, dass das ITA, die OECD sowie die Zentral- und Provinzbehörden die Meeresbodenerfassung, das Zinntauchen und die Sedimentfahnen der Offshore-Zinnindustrie beeinflussen und von ihnen beeinflusst werden. Dies zeigt, wie sich die Überschneidung zwischen benthischen Phänomenen und Geopolitik - benthische Geopolitik - über räumliche und zeitliche Skalen hinweg im räumlichen Konflikt des Meeresbodens manifestiert. Letztendlich fügt diese Studie dem wachsenden Bereich der Geographie, der sich mit dem ozeanischen Raum und in jüngerer Zeit mit dem Meeresboden befasst, wichtiges Wissen hinzu. Dieses kritische Wissen ist wichtig und dringlich, weil es die Beziehung zwischen Mensch und Meeresboden, die Ausbeutung und die gefährliche Arbeit an die Oberfläche bringt, die sonst durch die Tiefe des Meeres und die dominante Geopolitik des Meeresbodens verdeckt wird.

Ringkasan

Kepulauan Bangka dan Belitung, Indonesia, secara geopolitik telah dibingkai sebagai kepulauan timah oleh pemerintah pusat dan provinsi, intervensi timah global seperti International Tin Association (ITA) dan Organization for Economic Collaboration and Development (OECD). Kategori geopolitik ini muncul karena lebih dari 30% pasokan timah dunia berasal dari kepulauan ini. Timah, Stannum (Sn 50) dalam tabel periodik merupakan mineral penting bagi produsen mobil, perangkat elektronik, persenjataan, dan peralatan dapur global. Karena lebih dari 90% bijih timah dari kepulauan ini diekstraksi melalui operasi penambangan timah lepas pantai, gagasan tentang kepulauan timah ini telah menyederhanakan makna dasar laut menjadi sekedar ruang ekstraktif mineral. Untuk itu, apabila asumsi kapitalis ini tidak dipertanyakan dan diberdepatkan, kegagalan dalam membayangkan dasar laut di luar imajinasi kapitalis global akan terus terjadi. Dengan mengintegrasikan studi sosial kelautan, studi kepulauan, studi sains dan teknologi, dan studi ekologi *queer* pada pendekatan geopolitik materialis, penelitian ini bertujuan untuk menentang asumsi kapitalis tentang dasar laut tersebut. Untuk mencapai tujuan ini, penelitian ini menafsirkan ulang proses pengindraan dan ekstraksi dasar laut sebagai "fenomena bentik" (*benthic phenomena*). Dalam penelitian ini, fenomena bentik didefinisikan secara luas sebagai setiap agensi pengukuran (seperti, tubuh manusia, hewan, teknologi, peristiwa, dan gagasan), yang berinteraksi, berhubungan, dan terkait dengan kedalaman laut yang secara terus menerus memberikan berbagai makna (realita) dasar laut. Interpretasi ini didasarkan pada penelitian lapangan etnografi intensif tentang ekstraksi timah lepas pantai dan penggunaan dasar laut lainnya (misalnya: pemasangan kabel bawah laut dan restorasi terumbu karang) di lepas pantai pulau Bangka dan Belitung. Kontribusi signifikan dan orisinil terhadap pengetahuan adalah tesis ini memperluas penggunaan konsep "bentik" dari ilmu kelautan (yaitu: ekologi bentik) ke arah ilmu sosial melalui konseptualisasi fenomena bentik. Dalam tiga bab empiris utama, tesis ini berargumen bahwa ITA dan OECD membentuk dan dibentuk oleh proses penginderaan dasar laut, penyelaman timah, dan pembuangan debu laut dalam ekstraksi timah lepas pantai. Temuan empiris ini menunjukkan bagaimana persinggungan antara fenomena bentik dan geopolitik: "*benthic geopolitics*" bermanifestasi dalam konflik spasial di dasar laut. Pada akhirnya, penelitian ini menambah pengetahuan kritis pada bidang geografi yang mulai berfokus pada laut, terutama dasar laut. Pengetahuan kritis ini penting dikarenakan hasil penelitian ini dapat menampakan hubungan manusia dan dasar laut, eksploitasi, dan praktek kerja yang berbahaya pada dasar laut, yang umumnya tertutupi oleh kedalaman lautan dan geopolitik dominan dasar laut.

Publications and presentations

Material from Chapter 5 appears in the peer-reviewed article Saputra, M.A. and Sammler, K.G., 2024. Volumetric, embodied and geologic geopolitics of the seabed: offshore tin mining in Indonesia. *Territory, Politics, Governance*, pp.1-19.

Chapter 5 has also been disseminated in the Helmholtz Institute for Functional Marine Biodiversity (HIFMB) podcast, the International MARE: People and the Sea conference, Amsterdam, the Netherlands (where it won the Douglas Clyde Kongshøj Wilson prize award for best paper), and the Science and Technology Societies (STS) conference, Aachen, Germany.

Material from Chapter 6 is part of a peer-reviewed article currently being prepared for the *Nature & Space Journal.*

To reach public audiences, I have worked with Indonesian artists to create a film about the seafloor sound and our ecological relations to seabed mining. Saputra, M.A, Gardika, G., Alvi, M. (2024). Obscura: the sound of Anthropocene in the Unaesthetic world. https://drive.google.com/file/d/1HBTnhsd5CuQakEaWXEoQY2kWa-5O4jim/view?usp=share_link

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Acknowledgment

I declare that I wrote this dissertation myself (as a non-native English speaker) without the assistance of a professional English editor. While my kind interlocutors during fieldwork in 2022 provided empirical information about the seabed tin mining operations, I am the sole person responsible for interpreting empirical evidence in this study. However, the word 'I' here does not necessarily mean that I, as a singular actor. Indeed, I have the privilege to write, synthesize, analyze, and abstract empirical findings from this research project, "*Benthic Geopolitics*". But this PhD, indeed, takes a village to complete. In other words, this dissertation is not an individual work but the work of a community, and hopefully, in return, helps in many ways the community who are entangled with this work. For that reason, I acknowledge many humans and non-humans (e.g., tin ores, minerals, aquatic plants, and marine animals) located from seas to below the sea that have inspired my writing for the knowledge production within this dissertation. Given the many actors involved in proffering their specific contributions to this dissertation, I cannot mention all of their names.

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Beyond my incredible supervisors and external advisor, I want to thank you, my significant other, Lina Nur Laila—Lila. Thank you for your sacrifice, love, trust, patience, and care, and for being my fire that lids my spirit and keeps me going with this PhD work daily. I would argue if geopolitics is about war and conflict, we both, darling, have gone through and conquered the war together, away from our parents and facing difficulty with new cultures, racism, and the loss of our beloved ones. While your existence and appearance are often invisible throughout the PhD process, you are one of the main actors that make this dissertation possible. I owe you so much, my love, and I hope to repay your kindness in a different way after this PhD phase. Additionally, the PhD writing is also situated in a specific place. Therefore, I want to thank you for a set of generous research institutes where my doctoral research is located. I want to thank the Helmholtz Institute for Functional Marine Biodiversity (HIFMB) and Alfred Wegener Institute (AWI) for providing me with financial, emotional, and physical support for this project.

This generosity of personal and professional assistance facilitates my research and helps me focus on finalizing my PhD dissertation. That being said, these research institutes are not merely physical infrastructure, but some humans build positive and caring research environments. This means that many kind and caring colleagues make the working environment supportive and safe for me within this institution. For that reason, I also want to thank you to Solomon Sebuliba. My PhD comrade and friend who helps me within and beyond academic life. Thank you for our critical discussion and reflection on our PhD work. Thank you for your first visit to our tiny flat and for helping my family and me install all the lights at my flat. You are an excellent and caring colleague. I also want to thank you, Dr. Ole Mullër (my PhD buddy), Dr. Rebecca Borges, Dr. Paula Satizabal, Dr. Amelia Hine, Late Dr. Satya Savitzky, Dr. Geraint Rhys Whittaker, Jonas Healy, Dr. Indrawan Prabaharyaka, Dr. Irina Rafliana, Dr. Kristin Tietje, Soli Levi, and Vani Sreekanta. You show me how being intelligent can also come hand in hand with being kind and caring. Thank you for always being willing to read my work and provide feedback on my papers and chapters. I hope that, reciprocally, I also help you back to your work and life in different ways.

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Glossary list

No	Terms and abbreviation	Elaboration and definition
1.	Seafloor, seabed, and ocean floor (exchangeably used)	Seafloor, seabed, and ocean floor is geologically known as the top-earth surface beneath the sea. Despite that, there is no consensus on what this oceanic space means.
2.	Tin	Tin also known as Sn (Stannum) on periodic table is a metal with atomic number 50. This number means that tin has 50 protons (a subatomic particle with a positive electrical charge). Tin is anti-corrosive metal used for electronic device, weaponry, automobile, and food industries.
3.	Benthic ecology	Benthic ecology is a branch of marine science, investigating the material relationship between seabed-dwelling organisms, known as benthos (e.g., plants, animals, and microbes)
4.	Benthic phenomena	Benthic phenomena are any emergent measuring agencies (e.g., bodies, technologies, seawater, marine animals, ideas, and events) interacting with, relating to, and associated with the seafloor, which reconfigure multiple realities of the seafloor. As benthic phenomena move on the seafloor, below and above it (on the water column), and beyond, these phenomena indicate the seafloor is a volumetric and embodied space.
5.	Geo	Geo is the material or physical space where certain geopolitical interventions interact with geo-physicality of the space. In this study, geo is the seabed, seafloor, or ocean floor.
6.	Geopolitics (geo-politics)	Geopolitics is broadly defined as the relationship between politics and space. Geopolitics is often developed and used to create and access the territory of certain space. In this way, geopolitics indicates who geopolitically constructs and accesses the territory of the space and whose bodies and space are affected or resist the geopolitical construct. For example, miners, provincial authority, central authority, and even media coverage, geopolitically constructs the seafloor as tin mining sites to enable the territory production of the offshore tin mining operations.
7.	PERDA (2020)	Peraturan Daerah (PERDA) 2020 is the provincial regulation used to govern land and marine activities. The provincial authority, given the

		decentralizing authority since 2000, can develop and impose their own provincial regulation.
8.	MSP	Marine spatial planning (MSP). Within PERDA (2020), the provincial authority also provides the Marine Spatial Planning, locally known as RZWP3K. RZWP3K stands for *rencana zonasi wilayah dan pulau-paulau kecil*. This MSP is utilized to allocate marine uses and island uses of the Bangka and Belitung islands.
9.	ITA	The International Tin Association (ITA) is the international organization that governs the international tin industry worldwide and the international tin commodity.
10.	UNCLOS	The United Convention on the Law of the Sea is international treaty used as a guidance to regulate ocean spaces, resources and uses within and beyond national jurisdiction.
11.	OECD	The Organization Economic for Collaboration and Development (OECD) is the intergovernmental institution provides sustainable mining guidelines such as conflict-free mineral framework, PPE (personal protective equipment), social and environmental impact assessment guideline for all mineral mining including tin mining.
12.	RMI	Responsible Mineral Initiatives (RMI) is an international electronic coalition. This non-profit organization aims to improve mineral supply chain sustainability through assessing the mining practices in the field.
13.	ISA	The International Seabed Authority (ISA) is an international organization established and appointed by the UNCLOS members to govern the Area (the seabed) beyond national jurisdiction.
14.	CSD	Cutter suction dredger (CSD) is a mining technology literally used to cut, suction, and dredge the seafloor. This mining device is installed in the ship to recover tin ores from 15-25 meters below the sea.
15.	BWD	BWD (Bucket Wheel Dredger) is also like CSD in digging the seafloor. However, what sets apart BWD from CSD is the size of BWD (bigger than the size of the CSD) and how BWD is extracting

		seafloor sediments through buckets moved by conveyor belts instead of suction pipes. Moreover, BWD can operate deeper (up to 60 meters) than the sea depth access of the CSD.
16.	SIOPL	*Sistem Informasi Operasi Pertambangan Laut* (SIOPL) is the digital twin technology. This device provides a 3-dimensional seabed simulation and position map on CSD and BWD.
17.	KKPRL	*Ketentuan Kesesuaian Penggunaan Ruang Laut* (KKPRL) is literally translated as Marine Space Use and Suitability Requirement. This governmental guideline is an integrated and centralized marine spatial planning first introduced in early 2021. With this integrated MSP, the government aims to monitor whether the use of the sea and the seafloor (e.g., undersea pipelines, undersea cables, and offshore tin mining operations) operate within their obligated corridors and routes.
18.	CCTV	Close-circuit telecommunication camera (CCTV) is used to monitor the flow of sediment and tin ores on CSD and BWD.
19.	TI Selam	*Tambang Inkonvensional Selam* (TI Selam) is tin recovery using rudimentary diving equipment such as air compressors, wooden rafts, goggles, wetsuits, breathing pipes, and suction pipes. This mining technique enables tin divers to recover tin ores from the depth up to 25 meters below the sea.
20.	GIS	Geographical information system (GIS) is a mapping software to map an area. In offshore tin mining operation, this software is used to map the location of the seabed tin mining sites.
21	PTSP	PTSP referred to *Pelayanan Terpadu Satu Pintu* is the governmental integrated society service. This website helps people in Bangka to apply for citizen identity card, driving license, and mining license.

Prologue

I begin to open up the narrative of this thesis with my positionality. That is because considering my positionality matters in sensitive offshore tin mining issues. While positionality can mean many things, such as the position between researchers and participants (Rose, 1997), insider's position (Wilson et al., 2022), and insider-outsider position (Yip, 2024), the multiplicity of positionality here indicates that positionality is a "spatial" term (Ahmed, 2006b). This is because the location (standpoint) of a researcher and participants indicates how different spaces where their bodies inhabit direct and shape their views on their observed topic. As Ahmed (2006b) argues: "[S]pace acquires direction through how bodies inhabit it, just as bodies acquire direction in this inhabitance…[In this way] Position, implies location [a fixed point] vis- a-vis other locations and incorporates a sense of perspective on other places" (12). Therefore, my location vis-à-vis my interlocutors' location shapes how I interpret the empirical evidence of this study. This has to do with our bodies being shaped by the product of Indonesian history, language, ideology, culture, and ongoing colonial and geopolitical relations. In this way, scholars outside Indonesia may have different interpretations of this study's empirical data as their place of origin also bellies different languages, cultures, histories, ideologies, and politics within which their interpretation might be situated (Khandoker, 2024). Hence, considering my positionality, I hope to avoid being "tokenistic" in this study.

By tokenistic here, I mean that the reason why I am conducting this study is not just because I am an Indonesian, Indonesian-speaking, Javanese, and brown scholar. Instead, rethinking positionality, for me, should show a deeper reflection of my personal location. For that reason, I commence my positionality reflection on how the representation of my place of origin has affected me and my community intimately and how such intimate experience on the impact of spatial representation is also felt by Indigenous communities in my field site. To put it in another way, what happens when someone, often becoming an object rather than a subject in dominant geopolitics of extractive industries, narrates the story of his/their place? I, therefore, contemplate how the dominant narrative of my hometown vis-à-vis the Bangka and Belitung islands becomes, as Said (1977) argues, "an erection that is hard to demolish and rebuild" (62). Thus, I aspire to bring to the surface the experience of those (e.g., animals, plants, Indigenous, sea, and land) affected by the mainstream and static representation of Indonesian spaces. While such a geopolitical representation of land and sea can be an abstract and invisible[1] thing (Dodds et al., 2022), this hegemonic spatial representation is, indeed, not far from and, in fact, is embedded in my hometown, Bojonegoro, East Java, Indonesia.

Since 1898, this small town in East Java Province has garnered much traction from global capitalist attention and imagination, given the oil and gas reserves this place contains (Nugroho, 2022). This means the oil and gas exploration project in Bojonegoro has been going on for over 120 years. The oil and gas data explorations have further changed the everyday reality of Bojonegoro and its biodiversity. This argument echoes the work of Bobbette (2023) how geological data on mineral wealth is often followed by social violence and exploitation. For example, as now current estimation indicates about 25% of Indonesian oil reserves (over 200,000 barrels per oil per day) are situated in this town (PEMKAB, 2020), capitalist companies and the state government have named Bojonegoro as *Kota Minyak* (the oil city). Indeed, the notion of the oil city here reproduces the ever-living imagination about Bojonegoro, flattening other discourses of environmental violence[2]. In this case, the ambition to realize the oil city here has driven local and central government to issue mining permits and land access for trans-national mining companies such as Exxon Mobiles (the US oil and gas mining company), Shell (the UK oil and gas mining company), and Pertamina (the state-owned oil and gas mining company) (Kasali, 2018). To realize this notion of the oil city, these actors, unfortunately, have to cut down natural forest trees to build the oil extraction sites everywhere in Bojonegoro. Resistance and assistance of local communities collide and create Bojonegoro as a contested space for those favoring and against the oil and gas project (Subadi, 2023).

Furthermore, as I am writing this positionality reflection, my memory[3] took me back to my conversation with my father in his car as we went to his bank office in Cepu, Central Java. On the highway, while my father drove the car, I saw trees removed to open up oil and gas extractive sites. Seeing such deforestation events, I curiously asked my father, "[W]hy do we allow these

[1] Invisible here is not because one can read it. Instead, the geopolitical construct of space becomes invisible as people take for granted certain dominant ideas and representations O'Lear S (2018) *Environmental geopolitics.* Rowman & Littlefield..

[2] Environmental violence means that the exploitation and extraction of natural environment is normalized and naturalized as the one who inhabits this physical site is the Indigenous community. Meaning the racial category is used to decide that the natural extraction and exploitation is justified. Erman E (2017a) Aktor, akses dan politik lingkungan di pertambangan timah Bangka. *Masyarakat Indonesia* 36(2): 71-101.

[3] What I could recall from this memory is this conversation took place when I was still in my primary school (2005-2009). That is because within this period, my father still became a bank customer in Cepu.

foreign companies to cut down our forests?" my father simply replied, "[B]ecause we are too stupid, we do not know how to extract our oil and gas reserves for our economy". Indeed, the sophisticated technologies (e.g., digital twins, sensors, and big data) and the well-educated mining actors (e.g., geologists and geo-engineers) in the oil and gas projects, as Sammler (2020b) argues, are often construed as the apogee of scientific and technological progress. This also means those who cannot mine these land oil and gas resources are considered uneducated and, to say rather harshly, "stupid or even backward". This argumentation echoes the work of Lehman and Johnson (2022) of how Western science and technologies are tethered to racist logics and imperialist projects (see Chapter 2 on what imperialism means). Therefore, the discourses of technological progress and economic development indeed emerge simultaneously with the oil and gas exploration and exploitation project in Bojonegoro to underpin the notion of the oil city. But I believe my father did not think about such a deeply embedded geopolitical narrative attached to our bodies. Instead, from his positionality, as my father worked as a rice trader, he might have thought that oil and gas extraction was a pragmatic way to alleviate poverty by providing job opportunities and income to local people. Despite that, unsatisfied with his answer regarding "our stupidity", I asked again: "(B)ut are you sure that we are going to get all the economic benefits from these foreign companies by sacrificing our trees, rivers, and lands?" Needless to say, he stopped to answer my question. This conversation ended in his car, yet the oil and gas project has continued through time. Fast forward 20 years later, the oil and gas extraction project has now been well-established in Bojonegoro.

Indeed, physical infrastructures such as roads, schools, and hospitals have been built with the corporate social responsibility (CSR) fund from the oil and gas extraction projects (Sholikin, 2019). However, as the existence of oil industries in the city means more deforestation to create mining sites, ecological problems have become inevitable (Hidayati, 2024). For example, in the rainy season, the Indigenous community in Bojonegoro often suffers from massive flood disasters (Yulianti et al., 2024). That is because the forests as natural buffers to absorb and reduce erosion have long disappeared (Ansar et al., 2024). Meanwhile, during the dry season, people in Bojonegoro experience extreme heat. In 2017, the temperature reached its peak of 40 ^{o}C, given that global climate change was amplified by the deforestation and carbon emissions caused by the oil and gas mining project (Tirtosastro and Musholaeni, 2017). For that reason, the overpromised discourses of the oil city have created an illusion of economic development, given that the biodiversity loss and the climate disaster are counted. Apart from the environmental problems, social issues emerge from the extractive industries. That is because the Indigenous community in Bojonegoro sold their lands for Exxon mobiles and Shells (Nugroho, 2020). Indeed, this land transaction also gives them temporary financial benefits for their needs (e.g., children's education and health) (Nugroho, 2021). However, as the revenues from land trading are dissipating, they have lost their main source of income and livelihood as farmers. In this way, their economies are plummeting, resulting in family conflicts. As such, facing economic adversity, women divorced their husbands to work as sex workers to meet their basic needs. Divorcees in prostitution are also prone to HIV (Human Immunodeficiency Virus) and unwanted pregnancy (Zahida, 2019). At this point, one learned how the geopolitical category of my land, the oil city, permeates through and affects across scales, from the scale of the oil and gas extractions to the scale of ecological ruination and even the intimate scale of family and bodily (sexual) relationships (see Chapter 1 on the discussion of scales).

This story of my land resonates well with the story of those Indigenous on the Bangka and Belitung Islands in Indonesia. That is because, similar to my town, with the current global capitalist interest in tin ores, these islands are described, portrayed, and represented by governmental and business actors as *Kepulauan Timah*: "the islands of tin". This means that the notion of tin islands here has also reduced the reality of these islands into anything but tin mining sites. In other words, the story of humans, animals, and plants on and off these islands and their struggles to survive amid the expansion of the seabed tin mining operations are often excluded from this dominant notion. While the dominant narratives of tin islands here are used as a self-evident picture of what the Bangka and Belitung islands are, the source of the tin ores is, in reality, mainly from the seafloor (BPSPKBB, 2024). For instance, the International Tin Association (ITA), an intergovernmental organization, has reported that over 90% of tin ores on the Bangka and Belitung islands are produced from offshore tin extractions, both artisanal and industrial scale of the seabed tin mining operations (ITA, 2021b). This means that even though the geopolitical category is the islands of tin, the seafloor is where such a notion manifests and shapes benthic habitats. In this way, this assertion of the tin islands indeed shapes the way the seafloor off the Bangka and Belitung islands is used, governed, and exploited.

Such concern about the tin island notion here has already long been expressed by the WALHI, Wahana Lingkungan Hidup, a non-profit environmental organization in Indonesia. As the WALHI representative explains: “[W]ho says that the Bangka and Belitung islands are the islands of tin? We, as Indigenous, of course, know about tin ores, but we do not exploit them. Our grand-grand-parents do not say that the Bangka and Belitung islands are the islands of tin. Who initiates this notion of our lands and seas, and to what ends?” (WALHI, 2022: Interview on 5th June 2022). This statement signifies that the fixed identity marker, the islands of tins, has been used to silence any discussion that challenges its misleading meaning. This is because, as the Bangka and Belitung islands are framed as tin islands, this notion assumes these islands are inherently tin mining sites. This means one may not imagine otherwise. However, indeed, contesting such a notion is burdensome. This has to do with the fact that the media, state government, popular culture, and mining actors give a texture, a shape, an identity, and even a history to this narrative. For example, an online national magazine, Kompas, describes the tin wealth and the history of tin extraction as a way of depicting the Bangka and Belitung islands as the islands of tin (Danur, 2023). In popular culture, the Indonesian soap opera actress Sandra Dewi has become a successful Indonesian icon, owning her own private jet and supercar as her husband Harvey Moeis is a tin businessman on the Bangka and Belitung islands (Natalia, 2024). With such constructed imaginations, the media and popular culture unintentionally or perhaps intentionally campaign the notion of the tin islands to the public mind on the Bangka and Belitung islands and Indonesia.

Meanwhile, this notion of the tin islands does not end in media coverage and popular culture. Instead, the provincial government also tells a relatively similar narrative to the social media above through their website, *Pelayanan Terpadu Satu Pintu* (PTSP) (PTSP, 2024), mentioning the tin of the Bangka and Belitung islands has contributed to the global tin supply. Beyond this digital space, the idea of the tin islands here has also manifested in physical infrastructure for public learning. For instance, Pangkalpinang, the capital city of the Bangka and Belitung Islands, has the Timah Museum (tin museum). At this museum, domestic and international tourists can learn how the islands of tin are naturally pre-given. As my research diary explains:

> “[T]in Museum is rich in the history of tin on Bangka and Belitung islands. This Dutch building legacy provides visual simulacra and their textual description of tin artifacts, tin as ancient currency, and tin as barter media in the Bronze Age (3300-1200 BC). Meanwhile, another section of the museum talks about the shifting authority of tin mining in the Bangka and Belitung from Proto Sriwijaya Kingdom in the 7 century, Java Kingdom in the 8 century, Sumatera Kingdom in the 12-18 AD (Anno Domini), to the shared authority of tin mining area (Kawasan Kongsi Penambangan Timah) on these islands. To give an immersive experience about past and ongoing offshore tin mining operations, the visitors also can touch sands, rocks, and tin ores, see mining technology diorama and movies, and the development of tin geology and tin explorations, equipped with audio sounds explaining the story of these mineral samples and explorations” (Research Diary, 2022: April 2022).

Of course, the positionality of the museum funders and designers here also defines what representations of the Bangka and Belitung islands are or are not told to public audiences. In this case, as the Museum Tin was established from the interest of the tin mining company, the textual, visual, and material representation of the Tin Museum aims to embed the notion of the tin islands. This means that this museum also instills the islands of tin to its public audiences. Thus, this fixed representation of the Bangka and Belitung islands here is, what Foucault (1980) called, “le savoir des gens” (the popular knowledge) (2). In this way, the notion of the tin islands from media coverage, popular culture, governmental websites, and the museum creates a fixed and confined geographical template of the Bangka and Belitung islands as a sole tin extractive landscape. This confinement bars the mind of public society from straying somewhere else beyond the global capitalist tin imagination. But, indeed, as most tin ores originate from the bottom of the sea off these islands through offshore tin extractions, the confined spatial imagination constructs an imaginary fence that surrounds, separates, and isolates the seafloor of these islands from the rest of the world.

Figure 2: An example of rocks containing tin ores (known as granite) (personal documentation, 2022)

Such a dominant geopolitical imagination also permeates into the minds of political leaders and their current provincial regulatory interventions on enabling and constraining offshore tin mining operations. For instance, the current provincial regulatory intervention (PERDA, 2020) allows offshore tin mining operations to operate in the Indigenous sea territory, *Perairan Tuing*, of the Bangka and Belitung islands (Wijaya and Ismi, 2021). With the challenge of deviating from this hegemonic geopolitical framing, I shared the feeling of helplessness about how this global capitalist imagination has informed the structural system to sustain and normalize mineral exploitations. The helplessness here also comes from the fact that as much as I care for the land and the sea, I am also entangled with the exploitation of the seafloor through the flow of the tin ores in my electronic devices, cars, and even most likely, in my computer, I am using to write this study. In this way, as an Indigenous Javanese person, my heart also goes with those whose stories of violence and injustice are affected and erased by this representation of our places. Additionally, while the Bangka and Belitung Islands have the seabed and sea, and Bojonegoro does not, the Indigenous people here share the same struggles on environmental justice issues (e.g., land displacement and pollution). Beyond that, the relationship between these two places also exists because the oil and gas extraction in Bojonegoro affects the sea of the Bangka and Belitung islands, and vice versa, the offshore tin mining operations of Bangka and Belitung islands also affect the land of Bojonegoro through carbon emission these extractive industries create (Kusmita et al., 2022; Nugroho, 2022).

Meanwhile, reflecting my positionality as a spatial term is challenging to me. That is because whilst I was born and lived in Bojonegoro, I am now experiencing, as Ahmed (2006b) asserts, an "in-between or out-of-place" experience. This situation also comes into being, given my current geographical location, as I am studying and working in a European country, Germany. In this way, as an Indonesian Javanese diaspora, I recognize that I am a hybrid of European Western liberal and Javanese thinking. This means while, indeed, I am Indonesian and still hold fast to certain Javanese cultural values, I am also exposed to and adopt modes of European liberal thinking and doing. Of course, in the fieldwork, my research activities benefit from such hybridity as my current institution provides research funding and a position to conduct this study. For example, in the field, given my research position and institution, coupled with my Javanese race, trilingual language proficiency skills (e.g., Bahasa, Javanese, and English), and assumed gender, this social class facilitated my research activities. Many of my interlocutors showed their conviviality during my fieldwork on and off the Islands. This means that other researchers, given their social class, gender, and languages, may find conducting this study arduous and inaccessible.

While the social class seems invisible, the strata of me (the researcher) and my research participants, indeed, play a vital role in enabling access to the empirical evidence of this research. That is because the governance of the seabed uses off the Bangka and Belitung islands is mostly centralized in Java Island. In this way, my identity as a Javanese person enables me to connect with high directors of the seabed experts and governmental employees, as most of them also come from Java Island. For that reason, with research position and funding, I acknowledge that my work is part and parcel of ongoing hierarchical colonial and geopolitical relations. Despite that, considering this positionality and reflexivity, I reorientate myself to hopefully challenge and contest the accepted knowledge of the seabed off the Bangka and Belitung islands. Therefore, I acknowledge that the knowledge produced from this study is far from neutral. Instead, the knowledge here is *political* and, to some extent, as Scott (2009) described, *controversial* given my positionality. That is because I use my position as a researcher to re-capture multiple realities of the seabed off the Bangka and Belitung islands that deviate from the singular constructed reality of this oceanic space: tin extraction sites. In what follows, I share and reflect on my research notes from my experience of seafloor embodiment and encounters through my ethnographic fieldwork. This showcases how a wide range of human-seafloor relations coproduce various meaning-making of the seafloor through multiple modes of knowing the seafloor. Such a reflection may complicate, disturb, and challenge the fixed narrative that reduces the seafloor into none other than the extractive frontier.

~~Benthic~~ notes[4]

While the Prologue above explains my positionality in the thesis, this part of the monograph reflects the relationship between the seafloor and me in this study. In the fieldwork, my first seafloor encounter started with my ethnography sometime in 2022. This ethnography is unique because it often required me to go onshore before heading offshore. In other words, the coastal area was the in-between space where the story of the seafloor uses began. This reflection also brought me back to one of the sea harbors that became the gateway to offshore mining sites. On the sea harbor, skippers had waited for us (mining crews and me) with their wooden boats, called *pompong*. This boat especially carries miners from the harbor to the mining sites. Except, on that day, the skippers would also take me on board. Along the boat's voyage to the mining ship, I could witness how chaotic and living the sea was. Diverse mining ships moved from side to side, digging and suctioning seafloor sediments. The noisy sound of boats, mining ships' engines, and crashing sea waves echo everywhere. These are often un-documented offshore sceneries. Fascinated by the unfamiliar offshore environment, the seawater splashed on my face, awakening me from the fascination and reminding me that this boat operated on a fluid surface. This water splash was the byproduct of the friction between the boat's body and the sea wave as the boat propelled forward against the sea surface.

Indeed, the sea waves made the boat's journey bumpy and nausea-inducing space. The skippers, even, had to make the U-shape movement to avoid the boat's direct encounter with the wave. Upon safely splitting through the wave, the boat was approaching the mining ship. From onshore, the ship that looked small and, to some extent, invisible, slowly and steadily, appeared like a giant construction. The size of the ship was more or less equal to the size of the German *Kindergarten* building in Oldenburg. Whilst everyone was grateful and made a relief to eventually see their mining ship, the difficulty did not end yet. Another challenge to access the ship emerged as the skippers were about to anchor the boat near the ship. The continuously moving boat meant everyone had to be cautious with their personal safety when hopping off from the boat to the ship. That is because the boat's and ship's surfaces were slippery and could make someone fall in between the ship and boat, squeezed and injured by the continuous oceanic movement.

[4] My fieldnotes here are intentionally paraphrased to make the flow of the narrative easily understood for readers.

Despite unceasing sea waves and the unstable boat, the miners and I successfully entered the mining ship without injury. Hopping onboard, we started to walk to the meeting point. The meeting point is a site where everyone is gathered and coordinated by the head of the mining ship. After hearing the instruction of the mining ship head regarding the main task of that day (e.g., exploiting tin sites and fixing broken engine gears), we went to our berth (sleeping rooms). Walking from the meeting point to the berth, I saw the corroded steel of the ships. Perhaps this is because the ship was already old, and it might also be due to the corrosive salt water that eroded the layers of steel-made mining ships. In the berth, miners and I put our bags. Shortly after placing our bags, each of the miners rushed to their specific space. Some went to the mining navigation room, and others went to the tin washing plant and mining engine control sites. With my role as a sole researcher, the head of the mining ship asked me to join him and his mining crews to stay in the mining navigation room. Indeed, the division of the ship's space represents specific expertise and social hierarchy in operating offshore tin mining operations. The mining navigation room indicates the highest strata of the profession in offshore tin mining operations with their lack of direct sea water and sediment interaction and their right to order everyone outside the room. Despite that, such strata did not mean the level of importance as the success of the offshore tin mining operations depended on the well-coordinated mining team. Furthermore, in spite of the hierarchical mining specialty they have, these miners are connected to the seafloor through their ways of extracting tin ores, separating tin ores from seafloor sediments, fixing inoperable mining engines, and literally depending on this space for their livings.

Meanwhile, moving beyond the material site and the everyday routine of the mining ships, outside every morning and night, I observed humans operating their tin extraction operations near the mining ship using floating wooden rafts. These miners are traditionally known as tin divers. Indeed, considering their profession name, this mode of tin extraction is a hybrid of diving and mining. This means they dive to the seafloor and, at the same time, extract seafloor sediments using their suction devices. For that reason, unlike those on mining ships, to extract tin ore tin divers corporeally descend to the bottom of the ocean using their rudimentary diving equipment (e.g., wet suits, air compressors, swimming fins, and breathing devices). Once they arrived at the target seafloor environment, they pulled their suction pipes to give a sign to their mining crews on wooden floating rafts. The sign indicates they successfully managed to enter the seafloor hole. Knowing that they have reached the seafloor, the mining crew turns the suction engines on to vacuum seafloor sediments, sands, and other materials (e.g., corals and shellfish). After a while, mining crews on the wooden floating rafts reciprocally gave a sign to divers by bending one to four times divers' breathing pipes. The higher bending number means a higher amount of tin was collected. After about four to five hours under the sea, tin divers emerge. They rest while looking at their suctioned minerals. Their crews pack tin ores in their sacks. When they are happy with their extracted minerals, they stop diving into the seafloor and start putting their sacks of tin ores on their wooden boats and return to shore. Otherwise, if they need to collect more ores, they continue their diving activities. While tin divers and miners on the mining ships have different mining techniques, their bodies are linked to the seafloor through their interests in the seafloor's material: tin ores.

As my ways of knowing the seafloor here are often mediated by my ethnography on the mining ship, the boat, and the wooden raft, the tin diving above made me curious to know what it feels like to be under the sea. To cure this curiosity, I further challenged myself to experience the seafloor intimately. By intimate here, I mean to experience the seafloor with my own skin. That is why I registered and joined the scuba diving training with PADI (professional association of diving instructors). Of course, I acknowledge that scuba diving and tin diving are not comparable, as scuba diving has modern diving equipment (e.g., diving computers, regulators, and buoyancy compensators), strict health and safety guidelines, and is for recreational purposes. However, both modes of diving enable one to experience the seafloor in the deep. Scuba diving reorientated my way of knowing the seafloor from above the sea surface toward below the surface (subaqueous). In this way, I can see the seafloor from another standpoint. However, unlike walking on the stable surface of the terrestrial land, encountering the seafloor requires scuba diving training. This dive training consisted of learning the techniques, the health and safety theory and test, taking a practical test in an indoor swimming pool, and, finally, under the sea. Upon practicing the basic scuba diving technique and safety in the closed water session, my scuba diving trainer set the plan for the open water training. With the boat, we went to the scuba diving site. The skipper parked the boat using an anchor. Meanwhile, we prepared and wore the scuba diving devices. In this diving training, my favorite diving entry was back roll water entry, as this technique required me to trust myself and let go of my fear of entering the water. To perform this technique, I had to sit, turn my back on the sea, and flip myself. This means my head touched the sea water first before my swimming fin.

Once everyone (my scuba diving trainer, my diving buddy, and I) entered the seawater, we began inflating and, later, deflating our buoyancy compensators. This air deflation allowed our bodies to swim down into the sea to reach the meeting point. Arriving at the meeting point at a depth of five meters below the sea, the difference between my body's fluid pressure and the undersea pressure caused pain in my ears. I pinched my nose and blew the air through my nose gently. This technique allowed me to balance the different space pressures between my body and under the sea to remove the ear pain. After the first equalization was successful, we descended deeper to see coral reefs and fish. At the depth of 18 meters below the sea, my body also felt the seawater temperature drop suddenly. The sea environment was getting colder as we dove deeper. This sensation was anxiety-inducing to me. That is because breathing with devices, wet bodies, and being occupied by seawater was against my normal habits on the dry land. This unfamiliar feeling alerted me to escape from this volumetric space. For that reason, I tried to distract myself by observing my surroundings: coral reefs, anemones, sponges, and coral fishes.

Whilst the undersea environment was mind-blowing, and everyone enjoyed the tropical reef scenery, my anxiety outgrew this wonder. I started being unable to breathe the air through the regulator properly. To make it worse, the water kept flowing into my mouth and nose and occupied my eyes. I was suffocating and afraid of drowning. Out of my survival instinct, I swam to the surface, disobeying my diving buddies and diving instructions. Despite this dreadful under-the-sea experience, this scuba diving humbled me as a human being. This is because even though humans have their scuba diving technology and science to avoid scuba diving risks (e.g., drowning and breathing difficulty), the fluid sea always tends to be out of human control. This means one starts to realize the limits of technology and science that attempt to condition the livable undersea environment for humans. On top of that, the diving experience allowed me to reflect on my unprecedented inextricable relations to the seafloor. Primarily, this has to do with the fluid water that permeated through my body and vice versa, how my bodily liquid (e.g., sweat and tears), coming from my subconscious fear, seeped through the sea. Such reflection confounds the opposing binary between bodies (my body) and space (seafloor) as the moving seawater moved outside and inside my body.

While modes of knowing the seafloor through the quotidian event of mining ships, tin diving and scuba diving are, by nature, dissimilar, these human and seafloor interactions have a shared commonality. These activities capture how human technologies and seafloor knowledge production mediate interactions and relations with the seafloor. Of course, such human and seafloor relations here defamiliarize one from the imagination on the habitat and the inhabitance of the seafloor as the seafloor is not a mere material site devoid of humans. Instead, the reality of the seafloor is constantly shaped through such human and undersea interfaces. In other words, these ways of knowing also shape what the seafloor means. However, indeed, the questions remain. What happens when human and seafloor interactions become part of the very seafloor's meaning formulation? What should one call these phenomena? Holding on to these questions, Chapter 1 examines and interprets such phenomena to open up more possibilities of the seafloor meaning-making to re-envision the seafloor beyond the hegemonic capitalist representation of the seafloor earlier mentioned in the Prologue.

Chapter 1 Introduction: Benthic consciousness matters

1.1 Introducing research background

On 15th July 2022, during an interview, the lead-tin exploration geologist from one of the mining companies turned on his laptop and showed me his GIS (geographical information system) map. He explained to me why the seabed site is crucial for his mining company, despite a spatial conflict between his offshore tin mining operations and an undersea cable installation company in the target mining environment. As he asserted:

> "[A]round here to there [pointing on his GIS map], there exists 2000 metric tons of tin ores beneath the seabed. They are worth exploiting. This high amount of tin ores can keep our business running; we can pay the tax and contribute to building the national economy and infrastructure. Therefore, as we owned the concession area of the seabed, the existence of the undersea cables has disabled our access to the seabed. Now, we are disputing the ownership of the seabed site" (Geologist: Interview on 15 July 2022).

In another interview, the director of a mining ship, leading over 25 other mining ships, also expressed the same argumentation about the relationship between exploiting the seabed tin deposit (i.e., the estimated, calculated, accessible amount of tin ores beneath the seafloor) and infrastructure development. As he mentioned:

> "[E]veryone from non-governmental organizations (NGOs) to local communities have become against [are opposing] offshore tin mining operations [blocking our access to the seabed tin deposit]. Do they forget that roads, hospitals, and schools on the Bangka and Belting Islands exist by the practice of tin recovery?" (Mining corporation employees II, 2022: Interview on 23 May 2022).

Indeed, as the price of tin on the international tin market in June 2024 is about USD 33 per kg (Business Insider, 2024), the 2000 metric tons mentioned by the geologist are worth about USD 66 million. But this is just one of the many seabed sites. On their website, the provincial government estimates that two million metric tons of tin deposits exist on and off the Bangka and Belitung Islands (PTSP, 2024). Roughly 80% of the tin deposits are situated on the seafloor (Dahnur and Alexander, 2023), while the rest are on the islands. Hence, the capitalist sentiments of the geologist and head of the mining ship concerning the value of the seabed tin deposit for economic development are confirmed, provided that marine biodiversity[5] (e.g., coral reefs, shellfish, and fish) and the Indigenous fishers are excluded on the seabed (see what capitalism means in Chapter 2).

Capitalist dynamics promote the seafloor as a solution to national economic problems by demonstrating how commodifiable seafloor minerals can contribute to Indonesia's national revenues. However, indeed, tin profits often deviate from this ideal capitalist imagination. For instance, on 17 April 2024, a corruption case in the management of offshore tin production within the mining business involving 271 trillion Indonesian Rupiahs (USD 17 billion) and Harvey Moeis (Sandra Dewi's husband as mentioned in the Prologue) came to light (Tiawarmank, 2024). The corruption scandal revealed that significant portions of the profits from offshore tin production were siphoned off by corrupt officials and business leaders rather than being used to support national economic development as promised. Despite these issues, the capitalist notion still manifests in how current regulatory interventions (PERDA, 2020) ease the granting of mining permits (Ahmad et al., 2022). The rise of legal mining license ownership here, indeed, doubled the number of seabed tin mining operations from 1000 units in 2017 to 2000 units of seabed tin recovery in 2022 (Ranto et al., 2023). This expansion highlights the ongoing tension between capitalist interests in the seafloor and how the seabed is used and governed. In response to this issue, social science scholarship has shed more light on the conflict between fishers and offshore tin miners (Rosyida et al., 2018; Nugraha and Purwanto, 2020; Ranto et al., 2023), the colonial history, actors, and access of offshore tin industries (Erman, 2017a; Ibrahim et al., 2018; Muhammad, 2020; Irzon, 2021), countering illegal tin mining (Rahayu et al., 2024), and the recentralizing authority effects on offshore tin recovery management (Fahira et al., 2024). These scholarly works provide a multifaceted view of the complex issues linked to seabed tin mining beyond just the economic implications.

[5] Indeed, the term biodiversity alone is contested by social and natural science scholars as the way biodiversity is conceptualized, measured, and used depending on the interest of marine actors (e.g., policymakers and scientists) (see: Sebuliba, 2024).

Whilst the social science work above reveals that historical, social, and regulatory factors contribute to the broader challenges facing the offshore tin industry, this literature does not critically investigate how geoscience [6](i.e., the geology of tin), together with legal, digital twin technology, and politics underpins a capitalist narrative of the seabed by producing and enacting tin deposit data, tin distribution map, and tin-centric development discourses (building on Barad (2011), Chapter 4 explains what discourses are). This means little attention is given to how the dominant capitalist construction of the seabed off the Bangka and Belitung islands has flattened this oceanic space as, Sammler (2020b) argues, an essential frontier for international, national, and provincial mineral interests (see what frontier means in Chapter 2). When this accepted knowledge of the seabed is not questioned, checked, and contested, it may make us (i.e., Indonesian people) fail to imagine the seafloor off these islands beyond global capitalist imaginations. Hence, the notion continues to recreate the reality of the seabed as nothing more than tin extraction sites, influencing provincial, national, and even international regulatory interventions to focus on commercial tin values. Addressing the intersections of the different factors may provide a comprehensive understanding of how these various issues shape, support, and perpetuate the capitalist exploitation of the seafloor. Despite that, of course, this understanding may also mean affecting offshore tin industries and even global tin supply and demand as it may reveal how seabed mining exploit the seafloor through their scientific-technological apparatus (see Chapter 4 for more explanation on what an apparatus means).

Bringing together critical ocean studies (Sammler, 2020b; Peters and Steinberg, 2019), island studies (Hau'Ofa, 2008), science and technology studies (STS) (Barad, 2007; Helmreich, 2011b; Starosielski, 2015; Lehman, 2018; Lehman, 2020b), and queer ecology studies (Ahmed, 2006b; Mortimer-Sandilands and Erickson, 2010; Hird, 2016; Hayward, 2016; Neimanis, 2018; Farrales et al., 2021) together with what are called 'new materialist geopolitics' (Elden, 2013; Childs, 2018; Peters et al., 2018; Barry and Gambino, 2020; Squire, 2021; Sammler and House-Peters, 2023), this study aims to contest the uncontested capitalist assumptions of the seabed above. It does so by examining and re-interpreting seafloor sensing and extracting within empirical chapters of this study (see Chapter 4, Chapter 5, and Chapter 6)

[6] The geo-science here refers to modern and enslaved Chinese geological knowledge of tin. This geological knowledge production has become a guideline to sample, identify, and detect the existence of the tin ores beneath the seafloor. Source: Geologist (2022) Interview about offshore tin mining operations..

and beyond (Chapter 2) as “benthic phenomena”. However, indeed, the questions remain. What do benthic phenomena mean in this study? Why does understanding benthic phenomena matter in contesting the dominant capitalist knowledge of the seafloor? To answer these questions above, one should revisit and reflect on what phenomena mean.

Phenomena, according to Barad (2007), are “[t]he objects and measuring agencies emerge from rather than precede” (128). In this way, the object is literally emergent with measuring agencies. Of course, as I described further in Chapter 5, the term agency, “the capacity to act”, according to Knappett and Malafouris (2008), has become the sole property of humans, especially given that such formulation of *agency* solely considers human consciousness and intention. However, as Knappet and Malafouris, Yusoff (2013) and Nowak and Roynesdal (2022), among others, argue non-humans (e.g., rocks, animals, viruses, and plants) have agency as these non-humans inspire, enable, constrain, or imbricate human agencies. Thus, understanding such human and non-agencies, one should also understand that measuring agencies is not one thing. That is because an object can also become a measuring agency. This argument underpins the work of Childs (2018) on how the seafloor has always been imagined as a passive and static object while, in practice, such an object continues assisting and resisting the culture of seafloor mineral mining operations (Barry and Gambino, 2020). In the offshore tin mining operations, for example, while, indeed, the nexus of the tin geologist, mining technologies, and geo-scientific perspectives are measuring agencies for observing and finding the seafloor tin deposit, the seafloor tin deposit can also become a measuring agency to decide whether the seafloor is worth or not worth extracting (Chapter 4). This means tin ores can be both an object and measuring agency for offshore tin extractions.

These phenomena also exist beyond the context of offshore tin mining operations. In the coral reef restoration project, even though coral conservationists deployed the substrate for brown coral reefs (*Arcopora sp.*) on the seafloor and measured the growth of the coral reefs, this marine animal can also become a measuring agency as to whether sediment plumes affect the coral reef growth (see Chapter 6). This means that the object and measuring agencies are dialectically exchanging their roles. Concurrently, beyond the scientific and technological scales of seafloor use, such phenomena also exist on global, national, and provincial scales. The International Tin Association (ITA), the Organization for Economic Collaboration and Development (OECD), and the provincial and central regulation of offshore tin recovery rely on their tin mining standards (e.g., owning concession areas, possessing mining permits, and using personal protective equipment) to determine whether the practice and the production of tin ores extracted from the seafloor are aligning with their mining requirements. In this way, the governance actors using mining standards to control offshore tin mining operations become the measuring agency of offshore tin production. At the same time, tin ores also become measuring agencies for whether allowing offshore tin mining operations can sustain global tin supply and demand and national revenues through tax payments.

The emergent object and measuring agencies above remind us that the seafloor is not devoid of human interventions and is not merely a mineral space. That is because the diverse phenomena above showcase that our relations to the seafloor off the Bangka and Belitung islands are mediated by the flows of tin ores from the seafloor to islands and even to our daily infrastructure (e.g., cars, mobile phones, and computers). As these phenomena interact with, are related to, and/or associated with the seafloor, above it, and beyond, this interplay between measuring agencies and the seafloor occupies the depth of the sea, and simultaneously, the depth of the sea also occupies this ongoing human and seafloor interaction. Whilst the depth of the sea is often measured numerically through technological and scientific instruments (Sammler, 2020c), reflecting on the depth of the sea here also complicates our understanding of how *deep* the ocean is. This is partly because one cannot know obviously when and where the sea[7] begins and ends (Sammler, 2016b; Pauwelussen, 2017; Lehman, 2020a) since the sea evaporates, condenses, and precipitates as part of the hydrological cycle (Steinberg and Peters, 2015; Sebuliba, 2024) and even exists within humans' blood, tears, and bodies (Neimanis, 2012; Levi and Peters, 2024).

Considering how the depth of the sea can mean deeper than its mere numeral representation, in Ancient Greek, the sea depth is referred to *βένθος* (benthic) (Dauvin et al., 2008; Liddel, 2022; Serge et al., 2024). **That is why I interpret such phenomena as "benthic phenomena". Benthic phenomena can be broadly defined as "any emergent measuring agencies (e.g., human bodies, animals, technologies, events, and ideas), interacting with, relating to, and/or associated with the depth of the sea (benthic) that continuously reconfigure multiple realities of the seafloor".** Therefore, benthic phenomena feature material

[7] Lehman (2020) argues that "the ocean's [sea's] capacity to move, change, and create effects on a planetary scale appears vital to its very nature. Moreover, this planetary notion of the ocean fundamentally underlies the environmental politics of the present" (2).

categories (e.g., animals, plants, sands, seawater, minerals, and humans) and immaterial categories (e.g., human ideas, actions, technologies, and events) that redefine what the seafloor means (see Chapter 2). As the interaction with the seafloor can exist within and without this oceanic space, benthic phenomena cannot be confined to one site. Rather, benthic phenomena permeate through spatial, temporal, and material boundaries (e.g., land, sea, and air space). This insight into benthic phenomena here is crucial to challenge and contest dominant views that flatten the reality of the seafloor into an extractive mineral landscape. This is because benthic phenomena also indicate that the seafloor is not a flat space with a static meaning. Instead, the seafloor is a volumetric, embodied, continuously evolving space given benthic phenomena.

Demonstrating the benthic phenomena above, I contend that this thesis provides an ecological understanding of the seabed crucial for rematerializing geo[8] in geopolitics (hereafter geo-politics or geopolitics) (Sammler, 2020c; Jackman et al., 2020; Squire, 2021; Dodds et al., 2022; Satizábal and Melo Zurita, 2021; Elden, 2021; Bobbette and Donovan, 2021; Bobbette, 2023). Ecological understanding here means human and seafloor relations are mediated through particular benthic phenomena. This ecological understanding is reflective of and expands how queer ecology scholars (see: Plummer, 2002; Ahmed, 2006a; Mortimer-Sandilands and Erickson, 2010; Barad, 2011; Hayward, 2016; Neimanis, 2018; Hazard, 2024; Nurmi, 2020) conceptualize the term '*ecology*' as the non-hierarchical divide between nature and culture, bio and geo, political and material. As Nurmi (2020) argues:

"[I] use "ecology" to mean only interrelations and influences between individuals and larger systems, whether cockroaches, smallpox, or sailors- turned-writers. Ecology is the consideration of relations over entities, form over content…. Ecology is collapse and absorption, exchange, and resistance (Nurmi, 2020: 32).

This means ecology is not just how marine science (i.e., benthic ecology) defines and confines benthic phenomena as the material relationship between benthos/seabed-dwelling organisms (e.g., animals and plants) and their surroundings (Pelletier, 2016; Reynolds, 2006; Dauvin et al., 2008). Instead, benthic phenomena in this study display the entanglement between

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[8] Geo in geopolitics, according to Peters et al. (2018), means territory beyond earth ground. Instead, territory also takes place in other elements (e.g., water, fire, and air).

animals, plants, sands, minerals, seawater, human actions, events, technologies, ideas, and politics with the seabed and how such interaction gets entangled with broader scales of geopolitics. Hence, this ecological understanding of the seabed enables us to understand that this space is not exterior to our bodies as the air we breathe in and out, among others, is also connected to and shaped by the seafloor uses. Therefore, this insight encourages public scrutiny to pay attention to and care for the seafloor within and beyond the Bangka and Belitung islands.

To underpin the main argument in this study, this opening chapter is divided into five sections. The first section (1.2) concerns the specific scope and context of this study, to set up the boundaries of the research and to situate this research within previous research in the geo-politics of seabed mining. Considering the previous critical work on the geo-politics of seabed mining and my positionality in this research, the subsequent section develops and provides research questions (1.3) for this study. Additionally, as answering research questions and achieving the general research objective in this monograph demands empirical evidence, the fourth section (1.4) introduces the justification for why the seabed off the Bangka and Belitung islands becomes the field site of this study. Expanding the work on the geo-politics of the seabed mining literature, the subsequent section (1.5) introduces benthic geopolitics to indicate the intersection between benthic phenomena and geopolitics. Furthermore, I highlight my significant and original contribution to knowledge in this monograph (1.6). Ultimately, the last section (1.7) provides the structure of the dissertation to explain the main arguments of each chapter in this monograph, which become the bedrock of the main argument of this monograph.

1.2 Introducing the scope and context of this study

While Erman (2017a), Ibrahim et al. (2018), Rosyida et al. (2018), Sulista et al. (2019), Ranto et al. (2023), and Fahira et al. (2024), among other critical social scholars, do not challenge the capitalist construction of the seabed off the Bangka and Belitung Islands, human geographers have long questioned, contested, and challenged this capitalist narrative of the seabed in multiple geographies to contribute to what is called the 'new materialist' analysis of geopolitics (Childs, 2018; Carver et al., 2020; Sammler, 2020b). Indeed, geopolitics has long traditionally been interpreted as the power relationship between countries/states[9] to create, expand, and defend the

[9] According to German political geographer Friedrich Ratzel (1844-1904) through his concept organic states, states are like organism as states are consist of the government, the territory of their area, and an

territory of countries (states) using their legal, technological, and scientific representations (e.g., legal maps and discourses) (Wegge and Keil, 2018; Klinke, 2021). Speaking of power, the power concept in the classical interpretation of geopolitics echoes the notion of institutional power (van Tatenhove et al., 2013) and discourses as persuasive power (O'Lear, 2018). That is because state actors can create legal institutions (e.g., ministry, military, and police officers) to enforce state regulatory interventions such as legal maps of land and space and the regulations on how to use this space.

Institutional power here is, by nature, coercive as the state interventions force others to meet the state representatives' interventions. This means non-compliant behavior might lead these actors to get fined and even end up in prison. Meanwhile, state discourses are persuasive as political leaders' spoken and written texts are used to campaign to what end space should be used. In other words, the discourse does not coercively force other actors to follow their persuasions. For example, as mentioned in the Prologue, the state government promoted the idea of the tin islands to construct the seafloor of the Bangka and Belitung islands as the state territory of tin mineral extractions. So, why is this territory created by and crucial for the state actors? The answer to this inquiry is too many ends, depending on the interest of the state political leaders and actors in spaces (e.g., sea, land, underground, seafloor, airspace, and outer space) for transportation, oil and mineral extractions, security, research development, and tax accumulation (Peters et al., 2018; Dodds et al., 2022).

With the focus on state power relationships, this geopolitical interpretation fixates the geopolitical analysis merely on the state's interest and power relationship on a global scale. This means that such interpretation flattens or disregards diverse actors in relation to the very materiality of space (e.g., land, ocean, and seafloor) (Tuathail and Dalby, 1998; Peters et al., 2018). For that reason, the new materialist interpretation of geopolitics redirects our attention to how geopolitics manifests in and requires the material space (geo) such as land, sea, seabed, air space, and outer space (See Chapter 2 on what geo means) (Peters et al., 2018; Squire and Dodds, 2019; Jackman et al., 2020; Dodds et al., 2022; Bobbette, 2023; Sammler, 2024). These spaces bear their

ability to govern those within their territories. See Dugin A (1997) Foundations of geopolitics. *ratnikjournal*. But indeed, as the states are often represented by the political leader (e.g., kings, prime ministers, and presidents), the representation of the state here has become how certain states are depicted including their policies and regulations. See Tuathail GÓ and Dalby S (1998) *Rethinking geopolitics.* Routledge London.

material qualities (materiality), such as maps, humans, animals, plants, technologies, volume (depth and distance), depth, minerals, seawater, air, water, fire, and politics. In other words, geopolitical actors are not just state leaders and political leaders but also humans and non-humans (animals and non-animals) (Tuathail, 1999; Elden, 2013; Elden, 2021; Squire, 2021; Barry and Gambino, 2020; Sammler, 2020c). On top of that, what makes the material world of the geo here is geopolitical, I argue, is when the material and immaterial quality of the space is used to justify, enable, defend, and produce state and non-state territories. Therefore, Child (2018), Carver et al., (2020), and Sammler (2020), among others, capture how certain actors construct the reality of the seabed through the use of technology, time, space, and minerals to enable territory-making of the seafloor and how the process of the seafloor territory-making here affects those within and without the oceanic space.

While such scholarship on the geo-politics of seabed mining above has contributed to, as what Peters (2020) argues, "the ways of knowing and understanding the world that drive it [the seabed mining] (1)", such work does not question the ontology of the seabed. According to Conde et al. (2022), "[e]ven before practical developments or adaptations [e.g., regulatory institutions, laws, and methods for stakeholder incorporation and risk assessment] are made, fundamental decisions must be enacted about what precisely this place [the seabed] is vis-à-vis established political-economic and regulatory norms" (329). This means that the ontology of the seafloor (the hybridity of oceanic and land space) is not separated from the epistemology of the seafloor—the way of knowing the seafloor. In this way, as the way of knowing the seafloor can be possible through undersea technologies and science, the political and technological construction of the seabed itself is, obviously, never neutral. That is because only a certain group of actors who have the authority, technology, and science can define the seafloor based on their interests and expertise (Sipiorski, 2020). Thus, the particular knowledge of the seafloor is linked to centralized, powerful institutions and their epistemic communities.

Furthermore, despite the fact that these human geographers above have critically pushed back the geo-politics that recreates the seabed as none other than the capitalist extraction sites, their work has not yet reinterpreted multiple spatial, temporal, material, and technological dimensions of the seafloor as benthic phenomena. Indeed, to be clear, I do not argue that seeing the seabed through benthic phenomena here is more profound than these current works. Instead, what I attempt to articulate is the opposite. These previous studies on the geo-politics of seabed mining have encouraged me to analyze these multiple seabed relations as benthic phenomena. This intervention is crucial because benthic phenomena allow us to examine how diverse measuring factors reconfigure diverse realities (meaning-making) of the seafloor and how benthic phenomena remind us of our inextricable relations to the seafloor.

Concurrently, seeing human and seabed relations as benthic phenomena above comes from my deeper personal reflection on my positionality in land and seabed material extractions (see Prologue). Living in Bojonegoro, framed as the oil city, has made me realize how my intimate experience and relation with this land, air, humans, water, animals, and plants have also been flattened and occluded by the dominant capitalist imagination of this space. In other words, the existence of me and my community has been outshined by the purpose of extracting oil and gas projects. For that reason, the story of extreme heat and flood disasters we (i.e., my Indigenous community and me) encounter in everyday life due to the ongoing opening of mining sites has been out of the radar from the global capitalist industries and their regulatory interventions. Indeed, this problem is similar to what those Indigenous people experience on the Bangka and Belitung Islands. Their existence has also been shrouded by the narrative of economic development from seabed mining. More importantly, being told that our land and sea are tin and oil sites incessantly, we forget what our relations to our land and seabed are and what these spaces mean for us. This confusion aligns well with the argument of Hau'Ofa (1994) on how capitalist framing of land makes the Indigenous suffer from helplessness and desperation because it makes them fail to imagine otherwise.

In aiming to conceive the seabed beyond the capitalist framing, I obtain power from my previous training in marine science. What I mean by power here is as what Foucault (1980) described as the "insurrection of knowledge":

"[W]e are concerned, rather, with the insurrection of knowledges that are opposed primarily not to the contents, methods, and concepts of a science, but to the effects of the centralizing powers which are linked to the institution and functioning of organized scientific discourse within a society" (Foucault, 1980: 84).

This means there exists a thin line between knowledge and power because certain knowledge can become power when enacted and is linked to centralizing powerful institutions.

For instance, in seabed mining, since the geo-science perspectives provide the practical and technical knowledge to calculate, estimate, and access the minerals on and beneath the seabed, the geo-scientific ways of knowing the seabed are, thus, linked to the centralizing power of mining companies, domestic tin buyers, and international tin buyers. Therefore, despite the fact that such a geological perspective of the seabed discriminates against benthic phenomena, its knowledge production has been used to justify offshore tin mining operations.

Meanwhile, marine science has seen the seabed from a marine ecological perspective. As Pelletier (2016) argues, "[B]enthic ecology…focuses on organisms living in or on the bottom of a water body and the interactions among these organisms living and with their surrounding environment [e.g., sea and seabed]" (1). For instance, my work on the reproduction strategy of *Harpodon nehereus* (Bombay duck fish) in Gresik, East Java, (Saputra et al., 2016) has showcased how this benthic species swims back and forth from the seafloor to the sea surface. In other words, as marine science captures these benthic phenomena, the seabed is not just a site of minerals but also a home for marine life. However, the problem is that the scope of benthic phenomena studied through benthic ecology excludes human actions, ideas, events, and politics that reconstruct multiple realities of the seafloor. While this argumentation seems that I am against marine science, what I am trying to do here is the reverse. I do not argue that this knowledge does not matter. In fact, I acknowledge that the knowledge produced by benthic ecology matters. For instance, in the case of the *Harpodon nehereus* above, the migratory movement of this benthic species from the seabed to the sea and, vice versa, contributes to the nutrient cycle in the ocean through their preying and defecating process. This nutrient production is crucial for the photosynthesis of microalgae and aquatic plants to absorb CO^2 (carbon dioxide) and produce O^2 (oxygen). Thus, the benthic ecology here enables us to understand that this benthic habitat matters for human survival and life through its contribution to the carbon and oxygen cycle of the earth. To put it simply, the air we breathe in and out every day relies on the benthic habitat health (see Chapter 2). Also, this demonstrates how the seafloor is not a flat, bounded space but a dynamic volumetric space.

However, why do these benthic phenomena matter in seabed tin mining operations? To put it another way, what are these benthic phenomena trying to tell us about the capitalist narrative of the seabed? Given benthic phenomena indicate our inextricable relation to the seabed, one can use this inescapable relation to expand benthic phenomena to analyze the interaction of plants, sands, seawater, minerals, and humans with human ideas, human actions, human technologies within and beyond the seabed. Therefore, I interpret how one sees and senses the seafloor through their bodies, seafloor minerals, seabed-dwelling organisms (e.g., marine plants and animals), undersea infrastructures, and/or beyond as benthic phenomena. In offshore tin industries, seeing the seabed through benthic phenomena, one can fathom the entanglement between the seafloor, aquatic animals, aquatic plants, minerals, offshore tin mining, humans, and their political interventions. This provides a radical view of capturing multiple realities of the seafloor. Therefore, the new materialist interpretation of geopolitics should consider the geo (seafloor) and benthic phenomena as benthic phenomena complicate a straightforward definition of the seafloor (see Chapter 2).

1.3 Introducing research questions

When the seabed is understood as the physical terrain (geo) for geopolitical interventions of offshore tin mining operations, such geopolitical interventions inevitably interact with diverse benthic phenomena emerging from the seabed uses. By geopolitical interventions here, I refer to global dominant geopolitics of intergovernmental organizations such as ITA and OECD that regulate offshore tin mining operations. Meanwhile, indeed, as further explained in Chapter 2, benthic phenomena do not exist merely because of seabed mining. Instead, benthic phenomena also emerge from other modes of knowing the seafloor (e.g., benthic ecology, undersea cables, and undersea winery). In the context of seabed mining, specifically, the convergence between benthic phenomena and geopolitical interventions is often overlooked in current social science literature. Of course, Sammler and House-Peters (2023), (Childs, 2018), and Squire (2021), among others, have shown how technological, material, spatial, and temporal dimension matters for the geopolitics of the seafloor. However, they do not focus on and conceptualize how benthic phenomena exist at the depth of the sea and reconfigure multiple realities of the seafloor. Therefore, this study is the extension of their work to capture the complexity of what seafloor means through benthic phenomena and how such a meaning making matters for enabling and constraining the access to the seafloor.

Beyond current human geography work, this analysis on the interplay between benthic phenomena and geopolitics is even rarer in offshore tin mining operation literature as current social science studies have not investigated offshore tin extractions from the new materialist geopolitical context and have not conceptualized benthic phenomena. In this way, this lacuna creates a lack of understanding of how benthic phenomena assist and resist the creation of seafloor territory for offshore tin industries, as well as other marine uses (e.g., fishing and coral reef restorations). Therefore, understanding the entanglement between geopolitics and benthic phenomena in offshore tin mining operations is vital because it remediates the capitalist narrative of the seabed. This has to do with the fact capitalist dynamics have flattened or reduced the seabed to a tin site. Meanwhile, benthic phenomena become a reminder of the complex configuration and interactions between sands, minerals, animals, plants, humans, technology, events, politics, and the seabed. Therefore, considering benthic phenomena, I ponder on research questions:

1. How do the geopolitical interventions (e.g., provincial regulatory intervention, OECD, and ITA) of the seabed tin mining operations count and discount benthic phenomena?
2. How do benthic phenomena get entangled with the multi-scalar geopolitics of the seabed tin extractions?
3. How does the multi-scalar geopolitics of the offshore tin extractions manifest in benthic phenomena?
4. How do benthic phenomena redefine the meaning-making and territory of the seabed?

While the research questions create the context of this study, the set of research questions leaves me with the challenge of justifying the seabed off Bangka and Belitung Islands as the primary case study site in this study. For that reason, to strengthen the rationale of this case study site, the following section gives the reader an in-depth reason why the seabed off these islands is a significant site to conduct empirical investigations on the interaction between benthic phenomena and geopolitics.

1.4 Introducing the case study area: why is the seafloor off the Bangka and Belitung islands?

1.4.1 The pragmatic and politics rationale

The challenge of conducting this study is also about selecting the case study area. That is because benthic phenomena exist in diverse practices, spaces, times, and even in our bodies (see Chapter 2 for more information about benthic phenomena). As such, benthic phenomena permeate through multiple spatial and temporal boundaries. In this way, I could conduct this study in multiple sites. However, of course, the financial, temporal, and physical constraints of conducting multi-case study sites are often the case. For instance, my 6-month fieldwork in Indonesia already cost over 7,000 euros[10], and it required me to travel back and forth from the field site and the capital city of Jakarta, Indonesia, as well as visiting multiple villages and districts of the Bangka and Belitung Islands (e.g., Pangkalpinag, Belinyu, Bakik, Tempilang and Penganak) (see Appendix 5 for my research budget estimation). Nonetheless, my interest was to provide deep knowledge of the benthic phenomena through the practice of sensing and extracting the seabed, which may contradict the capitalist narrative of the seabed. This means that the main point is not merely about collecting data as much as possible but, more importantly, *how* the data can answer my research questions in this thesis and provide deeper knowledge about the seabed. Therefore, in making this study performable under temporal and spatial limits, I chose the seabed off the Bangka and Belitung Islands, a significant seabed tin mining site, as my case study area.

The reason why the Bangka and Belitung Islands are significant tin mining sites primarily has to do with the fact that these islands are situated in the Southeast Asian tin belt (see Figure 3). Indeed, even though the distribution of granite[11] in this region is called the tin belt, its mineral deposit composition is not just tin (Sn) but also other mineral deposits such as cu (copper) and au (gold) deposits (Ng et al., 2017). However, given that 50% of the granite is tin ores (Schwartz et al., 1995), this flowing mineral deposit is named the tin belt. In the Southeast Asian region, Schwartz et al. (1995) specifically explains how the tin belt runs across diverse provincial and national boundaries. As they describe, "[t]he Southeast Asian Tin Belt is a north-south elongate zone 2800 km long and 400 km wide, extending from Burma (Myanmar) and Thailand to Peninsular Malaysia and the Indonesian Tin Islands (1)". The Indonesian Tin Islands here primarily refer to multiple islands in Indonesia, including Karimun Island and Kundur Island, part of Bangkinan in the North and South Sumatera, and the Bangka and Belitung Islands (Widodo and Syari'udin, 2024). Given the high molecular density of the tin deposit (7.28 microgram per cubic meter), heavier than sands and mud (Taylor, 2014), the alluvial tin deposit, or the stream of tin deposit, follows the gravity rule. That is to say, as the Bangka and Belitung Islands are

[10] This AWI's funding is, of course, unusual because other PhD students in different institutions can get less funding (for instance, one may only receive 250 euros per year for their research and in total, 750 euros for their three-year PhD research). For that reason, as I mentioned in Prologue, I have the benefit and privilege to conduct this study given such high research financial support.

[11] Granite is the igneous rock. That is to say before mining breaks down the ingenious rocks into sediments, tin, copper, gold, and other minerals, these geologic materials are interlocking in the solidified rocks. Ng SW-P, Whitehouse MJ, Roselee MH, et al. (2017) Late triassic granites from Bangka, Indonesia: A continuation of the main range granite province of the South-East Asian tin belt. *Journal of Asian Earth Sciences* 138: 548-561.

geographically situated below the elevation of other Indonesian Tin Islands, the intrusive formation of tin deposits streams down and accumulates on and off these islands through the gravitational pull from high to low surface. Thus, the land and the seabed [12]of these islands are the world's richest tin deposit sites, attracting tin mining corporations to explore and extract this commercial seabed mineral.

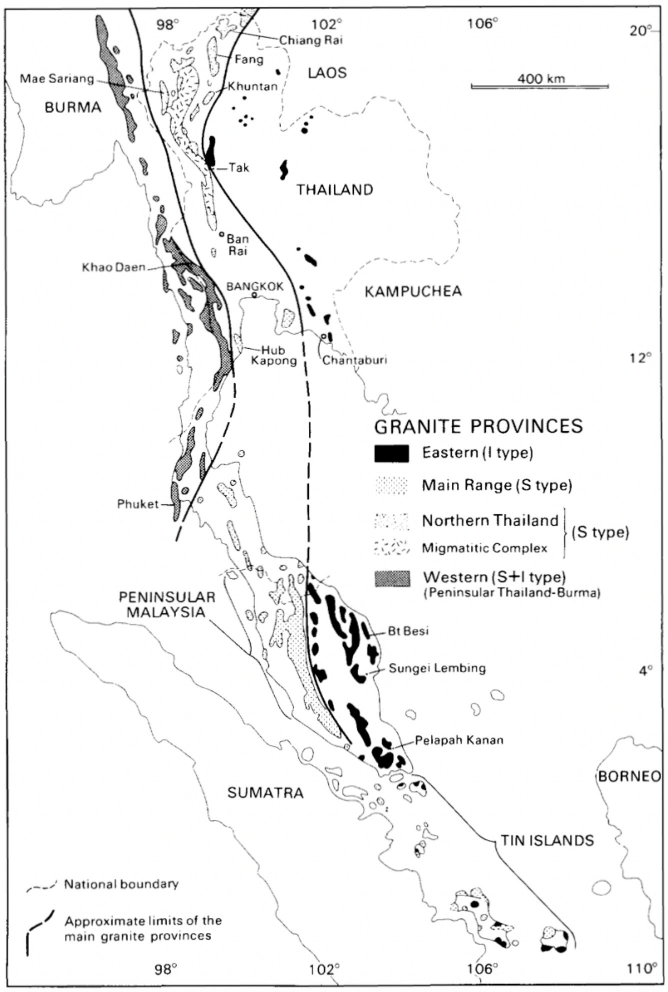

Figure 3. The distribution of granite provinces within the Southeast Asian Tin Belt (Cobbing et al., 1986).

[12] During the fieldwork, there exists debate whether the rich tin deposit is situated in either the land or the seabed. From the account of marine ecologist, the tin deposit is mostly situated on land because the alluvial tin ores are formed by the freezing magma of the volcanic mountain eruption on land. Marine Ecologist 1 (2022) Discussion about seabed tin mining operations on Bangka and Belitung Islands. Meanwhile, according to the head of mining, the tin deposit is situated beneath the seabed as the tin flows from high earth surface to the low surface. Head of mining ship H (2022) Discussing the concept and practice of mining tin ores. In: Saputra MA (ed). Bucket Wheel Dredger (BWD).

The process and practice of tin recovery indicate inextricable human and seabed relations off the Bangka and Belitung islands. Hence, this case study area can provide empirical evidence of benthic phenomena at work. Beyond the geographical reasoning, I conducted fieldwork in this area as I considered the accessibility of interlocutors concerning the practice of tin recovery. In this way, as previously I worked for the international non-profit electronic coalition Responsible Mineral Initiatives (RMI) in 2017 for offshore tin recovery, and I have built my tin mining stakeholder connections (e.g., academics, mining corporation representatives, and governmental employees) within and beyond these islands. This working experience also gave me background knowledge of the spatial conflict between fishing communities and seabed tin miners off these islands, given the marine activities that operate in the same sites. However, in my previous project, I interpreted this conflict between marine users as a mere dispute that ends in the material sites given the competition over sea space and resources (e.g., fish and tin ores). This means I did not investigate the relationship between geopolitical interventions and this spatial conflict off the Bangka and Belitung Islands. Despite that, the network of actors from this work played a crucial role in facilitating my fieldwork to gather data by connecting me with other tin mining stakeholders and providing me with updated regulatory interventions in the seabed utilizations (see Chapter 3 for the research methodology hereafter called benthic methodology).

The selection of the seafloor off Bangka and Belitung islands is also because the seafloor in this place is as crucial as other benthic habitats, despite their different geographies (e.g., the Area beyond National Jurisdiction (ABNJ) and in the territorial sea). In the specific context of the Bangka and Belitung islands, for instance, Sari et al. (2022) and Al-Risqia et al. (2021), working separately, have demonstrated how sediment plumes caused by offshore tin mining operations smother coral reefs and mangroves off and on these islands. This means that the carbon cycle of the earth is disturbed because both mangroves and coral reefs play a crucial ecological role in reducing carbon emissions through the way mangrove leaves and the way zooxanthella on the coral reefs also use the carbon for their energy (Syari and Nugraha, 2022). The mangrove and coral reefs are, indeed, important for carbon sequestration as these coastal marine habitats in a shallow coastal environment contribute to carbon dioxide (greenhouse) emission sink (burial) (Watanabe and Kuwae, 2015). As Yang et al. (2024) reported in their review article: "[M]angrove forests cover only 0.1 % of the global land area but contribute 5 % to global carbon sequestration. Seagrass beds cover only 0.1 % of the oceans but account for approximately 18 % of marine carbon sequestration. Coral reefs also have major potential as carbon sinks, with carbon being stored as calcium carbonate" (2). Therefore, one should understand how benthic habitats in this site are governed, managed, and used. Attending to benthic phenomena, as this thesis illustrates, is one way to do this critically.

Moreover, with the current carbon emission problem, the Intergovernmental Panel on Climate Change (hereafter IPCC) has suggested many countries reduce their greenhouse emission (carbon dioxide). As IPCC (2018) mentioned: "[T]here are clear benefits to keeping warming to 1.5^{o}C rather than 2^{o}C or higher. Every bit of warming matters. And it shows that limiting warming to 1.5^{o}C can go hand in hand with achieving other global goals such as the Sustainable Development Agenda. Every year matters, and every choice matters" (VI). In this way, as coral reefs, seagrass, and tidal mud flats offer crucial roles in carbon sinks, these benthic habitats contribute to sequestering atmospheric carbon emissions. As Kuwae and Hori (2019) argues: "[T]he suppression of CO2 emissions to the atmosphere by blue carbon storage is a process that reduces atmospheric CO2 concentrations and mitigates climate change indirectly. The role of both blue carbon storage and CO2 gas uptake should therefore be considered when SCEs (shallow coastal ecosystems] are targeted for climate change mitigation" (VII). This means that the benthic ecosystem and the seabed are crucial for carbon burial. Hence, whilst the physical site of the offshore tin mining operations is situated in the Indonesian territorial sea, the effects of seabed mining can span beyond the Indonesian national jurisdiction. For that reason, although the case study of this thesis may seem discrete, the benthic habitat health here also defines our survival and existence on our planet, and, thereby, it is worth investigating how *this* site is regulated by provincial, national, and international actors.

1.4.2 The unexpected entanglement of seafloor via the 'spice element'

Beyond considering the role of benthic habitats in the earth's environment, one should understand that our connection with the seafloor of the Bangka and Belitung islands especially emerges as the flow of tin ores permeates into our everyday lives. Even ITA (2024b) mentioned such entanglement: "[T]in is called the 'spice element' because a little of it is present everywhere in ways that are essential to our quality of life" (1). The importance of tin ores can be clearly seen through how tin ores, with their non-corrosive metal properties, have improved the preservation of processed food (Erman, 2017a). As Storli (2014) described in their book Tin and Global

Capitalism: A History of the Devil's Metal, 1850-2000: "[T]he importance of tin is most powerfully represented by the tin can—an invention that created a revolution in food preservation and helped feed both the armies of the great powers and the masses of the new urban society"(1). Seeing this crucial role of tin materials in society and armies, Abraham (2015) even describes tin ores as "the element of power" (48). The element of power here might also be seen on how tin ores are fundamental for enabling current state wars. This geopolitical entanglement[13] between state wars and tin ores exists as 75% of solders[14] concentrations are tin ores (State et al., 2024). In this way, as solders are key materials for military war, security, and defense technology manufacturers (e.g., air jets, weapons-equipped drones, and warships) (Solder, 2022), the state wars and tin materials are also inextricably linked to one another. Beyond the state wars, according to the US Department of Energy, tin ores are considered critical minerals (important non-fuel material) for US energy security (USDE, 2020) as raw tin materials are also used as semiconductors to transmit electricity currents in American households. Therefore, the production and consumption of tin ores are entangled with wider scales of geopolitics as tin ores underpin both warfare and welfare (Storli, 2014).

[13] If, according to Tsing (2015), entanglement is "*varied trajectories gain a hold on each other, but indeterminacy matters*" (62), the geopolitical entanglement between tin ores and state wars means that this mineral and state wars have inextricable relations, but the relations are often invisible. Tsing AL (2015) *The Mushroom at the End of the World.* Princeton University Press.

[14] The invisible here, especially during my research, the weaponry industries do not mention directly tin ores as their fundamental materials on their website. Instead, they mention solders. However, in practice, without tin supplies, solders production may not even exist. See: Martin L (2024) *Weapon system*. Available at: https://www.lockheedmartin.com/en-us/capabilities/weapon-systems.html.

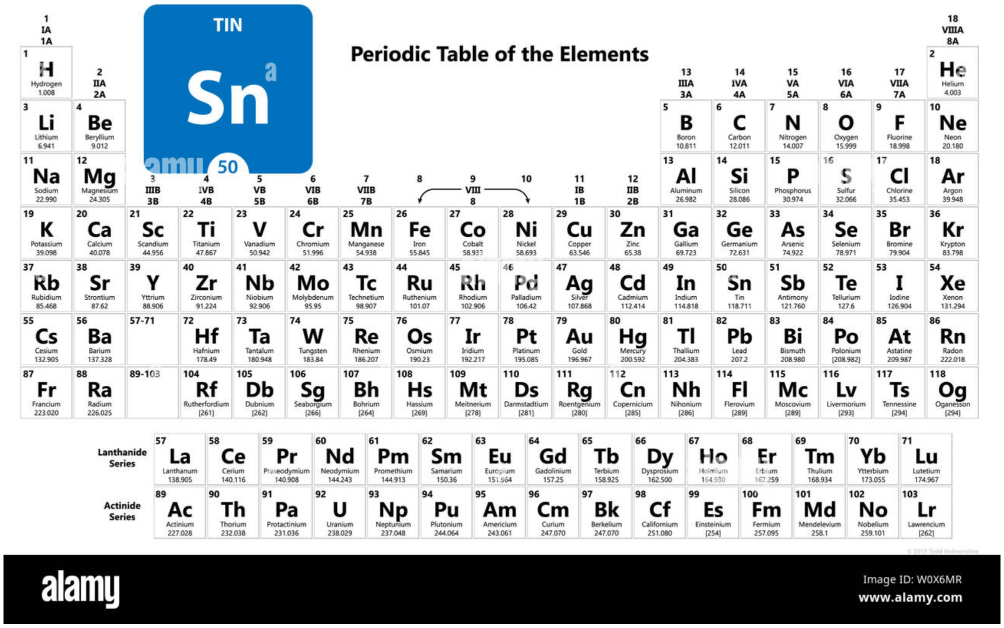

Figure 4: Tin (Stannum Sn in Latin) on the periodic table (Alamy, 2024) (the picture's license was purchased by AWI for me, see Appendix 9).

So, how is the relationship between the tin ores and multi-scalar geopolitics also linked to the geopolitics of the seabed off the Bangka and Belitung islands in Indonesia? The key to answering this question is the origin and global flow of tin ores. In the Indonesian context, even though the Indonesian government aims to ban raw tin export to encourage the use of tin ores for domestic high-end manufacturers (e.g., electronic devices and automobiles) (Mining, 2024), this ambition has not been achieved as these high-end industries are not well-established yet these days (Septianda, 2023). In other words, Indonesia does not use its tin ores for its domestic industries (Dalimunthe and Aldila, 2023). Instead, most of the tin ores are exported to industrial countries (ITA, 2021b). For instance, since 2022, Indonesia has become the world's largest raw tin exporter by supplying 36% of global tin demand, equal to USD 2.84 billion (see Figure 5) (OEC, 2022). The global demand of tin ores is mainly rising as tin is integral for solar panels, 5G (fifth generation) technologies, lithium-ion batteries, and electronic devices (Joué et al., 2023). In China, according to Blanco-Encomienda et al. (2024), raw tin materials are used to produce 96% of the world's famous electronic device products such as Vivo, Oppo, Honor, Apple, Samsung, Meizu, and Lenovo. Therefore, given that Indonesia contributes to the largest tin supply to the international tin market, this also means that its tin ores also contribute to the manufacturing of technological infrastructure.

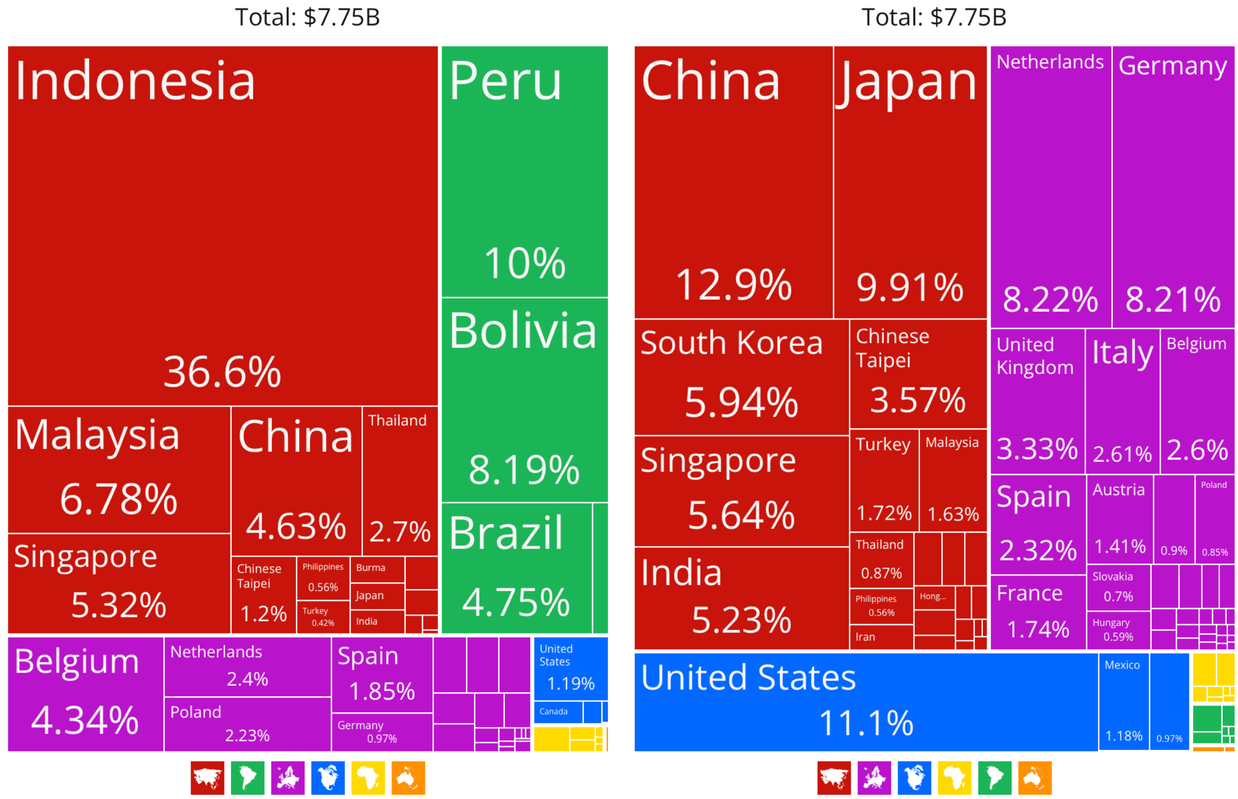

Figure 5. The graph of raw tin exporters (left side) and tin importers (right side) (OEC, 2022).

While Indonesia has become the world's largest tin producer, remarkably scanty attention is given to the material site of where the tin is mostly extracted from. For instance indeed, as mentioned earlier, Indonesia supplies over 30% of the world's global tin demand (OEC, 2022). However, one should also understand that about 90% of this national tin production here comes from the Bangka and Belitung Islands (Frinaldi, 2024). Even though these islands become the material site where the tin ores are accumulated and refined into tin ingots (Nugraha and Purwanto, 2020), in practice, offshore tin mining operations contribute to over 90% of this tin production and refinery process (ITA, 2021a). In other words, most of the Indonesian tin ores exported to the global tin market are from the seabed off these islands. Hence, the flow of tin ores from production to consumption sites (high-end industries) above also explicates our complex relations and interactions with the seabed off the Bangka and Belitung islands through infrastructure one uses (e.g., cars, computers, and mobile phones). Understanding how the seabed is inextricably linked to the practice of tin recovery and the global tin market, one can understand how the seabed off these islands is geopolitically entangled with the world outside of the Bangka and Belitung islands

(ITA, 2024a). To keep the global tin supply and demand, global geopolitical interventions (e.g., OECD and ITA) are required to govern the flow of tin ores through their mining standard requirements (e.g., mining permits, concession areas, and environmental impact assessment/EIA) (see Chapter 6). While this section has briefly mentioned the series of geopolitical interventions on offshore tin industries of the Bangka and Belitung islands, the next section will explain what and how these intergovernmental organizations govern offshore tin mining operations

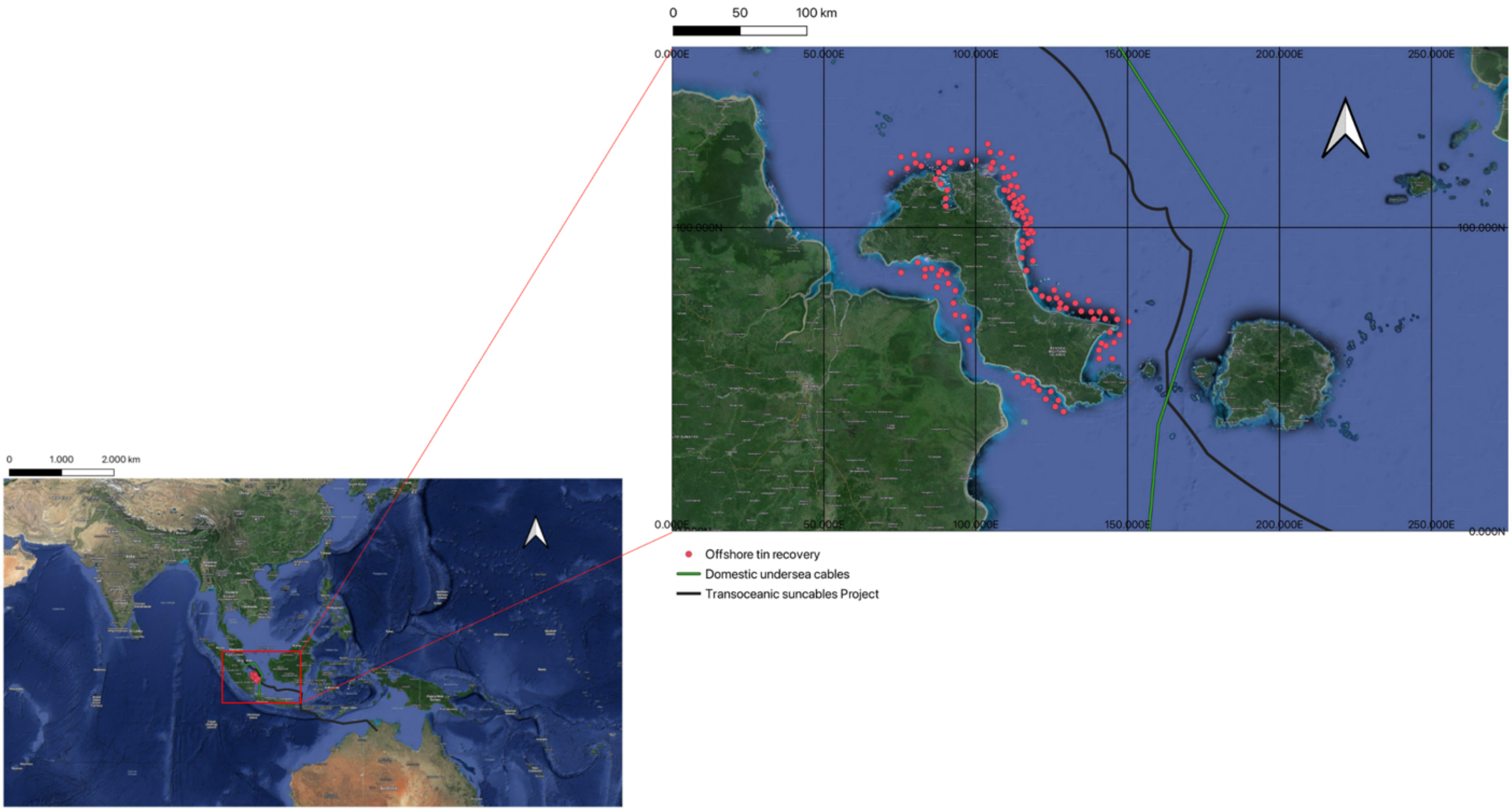

Figure 6: A map of the Bangka and Belitung Islands in Indonesia geopolitically tangled with seabed mining and undersea cables made through quantum geographical information system (QGIS) software (made by the author)

1.4.3 The seabed off the Bangka and Belitung islands as an arena of geopolitics

The geopolitical entanglement described above has showcased how the seabed off Bangka and Belitung Islands has become a significant geopolitical field for many actors within and beyond Indonesia to maintain the global tin supply and demand. But what has also been missing from the previous studies is the long *history* of when and what drives global geopolitical interventions to emerge. Indeed, the land and the seabed of the Bangka and Belitung islands became an already contested space between Johor Sultanate, Sriwijaya Kingdom, Majapahit Kingdom, and Palembang Sultanate to secure their tin wealth (Swastiwi et al., 2017). However, the industrialization of seabed tin mining operations can happen, especially given the transfer of tin geology and mining technologies that has existed since Dutch and British East Indies tin extraction and trade control (Irzon, 2021). Additionally, understanding the global market of tin commodities, the Dutch and British East Indies created the global tin value chain connecting the seabed tin miners to weaponry and utensil industries in Europe (Muhammad, 2020; Erman, 2017a). The interest in tin ores reflects on the first historical encounter of Sir Thomas Stamford Bingley Raffles, the Secretary of the British East Indies Company, with tin ores of the Bangka and Belitung islands in 1812. Sampling the tin ores with his hand, Sir Raffles said to his general Lord Minto: “[M]arked my word, the Bangka and Belitung Islands will be the world’s richest tin producer. Every site of these islands will contain valuable tin ores” (17). While, indeed, this prediction of Sir Raffles has manifested in the present through how 30% of the global tin supply comes from these islands, the history of tin extraction and trade control on and off these islands tends to focus on the colonial and imperial powers controlling these islands and their tin productions (Chapter 2 elaborates what colonial and imperial power mean).

This narrative of tin history, however, often removes the experience of those living on these islands (Muhammad, 2020). In other words, when the history of colonial occupation on the islands also takes into those colonized human bodies, this endeavor, as Dixon (2019) argued, showcases the untold story of the territory-making of the colonized land and bodies. For instance, to accumulate tin ores from the seabed, the British East Indies brought enslaved Chinese people from the China mainland to the Bangka and Belitung Islands (Sya et al., 2019). That is because enslaved Chinese people understand the geology of tin, including but not limited to the capability of identifying high-quality tin ores versus less-quality tin ores through the color of tin ores (black versus white tin ores) and identifying the presence of the bedrock (also known as *Kong*) (see Chapter 4 and Chapter 5). Bringing enslaved Chinese people to the Bangka and Belitung islands improved the production of tin ores. As the archival work of Swastiwi et al. (2017) showcased: "[T]he tin geology knowledge and technology of Chinese people increased the production of tin ores by 20,000 pikul per year (1 pikul is equal to 62,5 kg)"(66). This tin knowledge is still applied to current offshore tin mining operations off these islands today to collect the seabed tin ores (see Chapter 4).

Given their tin expertise, enslaved Chinese people were tasked by the British East Indies to identify seabed sediments collected by the enslaved Malay (Sya et al., 2019). Indeed, the enslaved Malay physically dug the seafloor to collect sediments for enslaved Chinese people (Dunia Tambang, 2020), and as such, the Malay workers had a higher risk of getting buried in seabed pits, a hole in the seabed produced by the process of the tin recovery (Geologist, 2022: Interview on 15th July 2022). The different roles and physical risks of the tin miners here indicate that there exist social strata between enslaved Chinese people and Malay people. This social hierarchy represents, what Marston (2020) described as, the vertical arrangement of human bodies in the tin mining operations. In other words, the bodies of enslaved Chinese people were considered by the British East Indies government to matter more than the bodies of enslaved Malay people, mainly given their knowledge of tin geology. However, despite the social hierarchy between enslaved Chinese and Malay, both of these tin workers were socially less crucial than the tin ores they collected and the bodies of the British East Indies. This work on the social hierarchy of miners and colonial bodies aligns well with the work of Dixon (2019), arguing that the vertical arrangement of enslaved and colonial bodies often normalizes and naturalizes social violence in mineral mining operations. In seabed tin mining operations, such vertical and material arrangements extend to colonial (British East Indies), enslaved (colonized), and ore bodies. That is because enslaved Malay and Chinese bodies were hierarchically lower than British East Indies colonial bodies and tin ores bodies. This means colonial bodies consider the commercial value of tin ore bodies matter more than the safety of the enslaved bodies.

While the British East Indies obtained profit from the seabed tin extraction through their enslaved Chinese and Malay, in 1816, the London Treaty in 1816 forced the British East Indies government to trade back the Bangka and Belitung Islands to the Dutch East Indies government (Ibrahim et al., 2018). That is to say the Dutch East Indies became the main authority of the Bangka and Belitung Islands. However, despite the change of the central colonial authority on these islands, the Dutch East Indies continued the slavery system along with their social hierarchy. As Sya et al. (2019) noted in their historical analysis of the tin recovery: "[D]uring colonial tin extraction and trade control], Dutch East Indies government categorized Chinese people as second-class citizens after Dutch and European. Meanwhile, Malay people were considered as third-class citizens" (154). In other words, the social hierarchy between colonial, enslaved, and ore bodies was maintained by the Dutch East Indies to accumulate tin wealth from the seabed. Meanwhile, upon the Indonesian independence in 1945, the central authority of offshore tin mining operations shifted from the Dutch East Indies to the central Indonesian government (Swastiwi et al., 2017). In this way, the Indonesian government has inherited several Dutch East Indies mining companies, such as Banka Tin Winning Bedrijf (BTW) and Naamloze Vennotschap Billiton Maatschappij (NVBM) since 1952 (Erman, 2017a).

Despite having excessive colonial wealth and a tin company legacy, unfortunately, Indonesian authority inherited not only the physical infrastructure of the Dutch tin mining company but also its vertical and material arrangement of bodies. For instance, in the process of governing current tin diving (locally known as TI selam), the central and provincial authority has, in fact, continued creating the hierarchy dichotomy between the central authority, provincial authority, tin divers, and tin ore bodies. As WALHI (2022) described: "[W]hile tin divers contributed to national tin production, the central and provincial government do not record tin diving accidents. We noted that over 100 tin diving accidents took place. Their bodies were often unfound as they were trapped and buried by the collapsing walls of the seabed tin mining sites" (Interview on 5 June 2022). This means that the vertical and material arrangement of authority, tin divers, and tin ore bodies is continued through time (see Chapter 5). WALHI alone is the Indonesian non-profit environmental government that works on conserving the marine and land environment of the Bangka and Belitung islands. This organization also advocates a total moratorium for offshore tin mining operations, including tin diving operations, given their ecological impacts and their tin diving-associated accident risks.

Even though tin diving is arguably the riskiest form of seabed tin extractions, especially given that it requires tin divers to physically dive and suction tin ores from the seabed pit, tin diving is still prevalent off the Bangka and Belitung islands. For instance, over 2,000 floating wooden rafts of tin diving operations exist off the Bangka and Belitung islands in Indonesia (Prianto and

Husnah, 2017). That is because this practice of tin recovery operates with rudimentary mining equipment such as air compressors, breathing pipes, suction pipes, wet suits, goggles, and wooden floating rafts. As these devices are affordable (Rp. 50 to 200 million) (Mayu and Kurniawan, 2019), in comparison with the large-scale seabed tin mining operations[15] (over Rp. 20 billion) (Mining corporation representative, 2022: Interview on 24th April 2022), a group of tin miners can afford to purchase the traditional tin diving technologies. With the diving devices, the tin divers can access the sea depth from 10 to 25 meters (Putri et al., 2023). Beyond tin diving devices, other groups of tin miners and state and non-state mining companies invest in mining technologies such as cutter suction dredgers (CSD), bucket wheel dredgers (BWD), and tin tower dredging devices to access deeper into the sea and reduce mining accident risks (Nugraha and Purwanto, 2020). The difference between these tin mining technologies also lies in the tin extractive capacity. For instance, while BWD can produce up to 30 metric tons of tin ores per day (Ripanda, 2019), the CSD can produce up to 20 metric tons of tin ores per day (Mining engineer, 2024b) (see Table 1 below for an example of CSD-based tin production). Indeed, this tin production also depends on the richness of tin deposits, tin mining sites, and the age of the mining engines (i.e., since when the mining engines have been operated by tin miners).

Table 1: CSD mining ship production per day

Date: 27 December 2023		
CSD ships	Production per metric ton	
	S/D kampel	Sn/day/ton
CSD A	955	36.407
CSD B	223	7.863
CSD C	645	21.523
CSD D	369	12.423
Total	2192	78230

[15] The large-scale seabed tin mining operations here refer to CSD (Cutter Suction Dredger) mining ships. During the interview with mining corporation representative (2022), he mentioned that one CSD ship is worth Rp 21 billion.

Note: *Kampel* (30-60 kg). *Kampel* is a unit used in seabed tin mining to measure how many sacs of tin ores are produced a day. Thus, *kampel* means a sack of tin ores. Tin production also depends on the sea weather and the supply of fossil fuels and fresh water to the mining ships (Mining navigator 4, 2022: , interview on 30 June 2022).

Using the CSD, BWD, and tower dredging devices, tin miners can dredge, cut, and suction the seabed from their boats and ships. The mining technologies also enable them to recover tin ores from the sea depth between 10 to 60 meters (Ripanda, 2019). Among these mining technologies, the BWD exported from IHC (Dutch Maritime and Dredging Technologies), the Netherlands, can extract the tin ores at the deepest level (up to 60 meters below the sea) (Tresiera, 2019). This means that by utilizing this Dutch dredging technology, mining companies can secure seabed access as they can access the sea depth other miners cannot. Additionally, while fossil fuels power the seabed tin mining operations, the ongoing process of these seabed tin recoveries exists largely given the geopolitical interventions of offshore extractive industries. The geopolitical interventions here refer to the state and non-state organizations, governing offshore tin mining operations off the Bangka and Belitung islands through, among others, global tin market interventions. For instance, in the present moment, whilst Dutch and British governments and non-state mineral actors cannot directly control seabed tin mining operations, the Netherlands and the United Kingdom formed the ITA (International Tin Association) in 1950 and the OECD (the Organization for Economic Co-operations) in 1961 to indirectly control offshore tin mining operations from a far distance through their international tin market interventions and enforcing ‘good’ mining standards (e.g., the use of personal protection equipment and conflict-free mineral framework) to offshore tin mining operations (Readhead et al., 2023). Therefore, ITA and OECD are also known as inter-governmental institutions governing offshore tin industries off the Bangka and Belitung islands to ensure the sustainability of global tin supply and demand (see the governance framework of OECD in Figure 7 below).

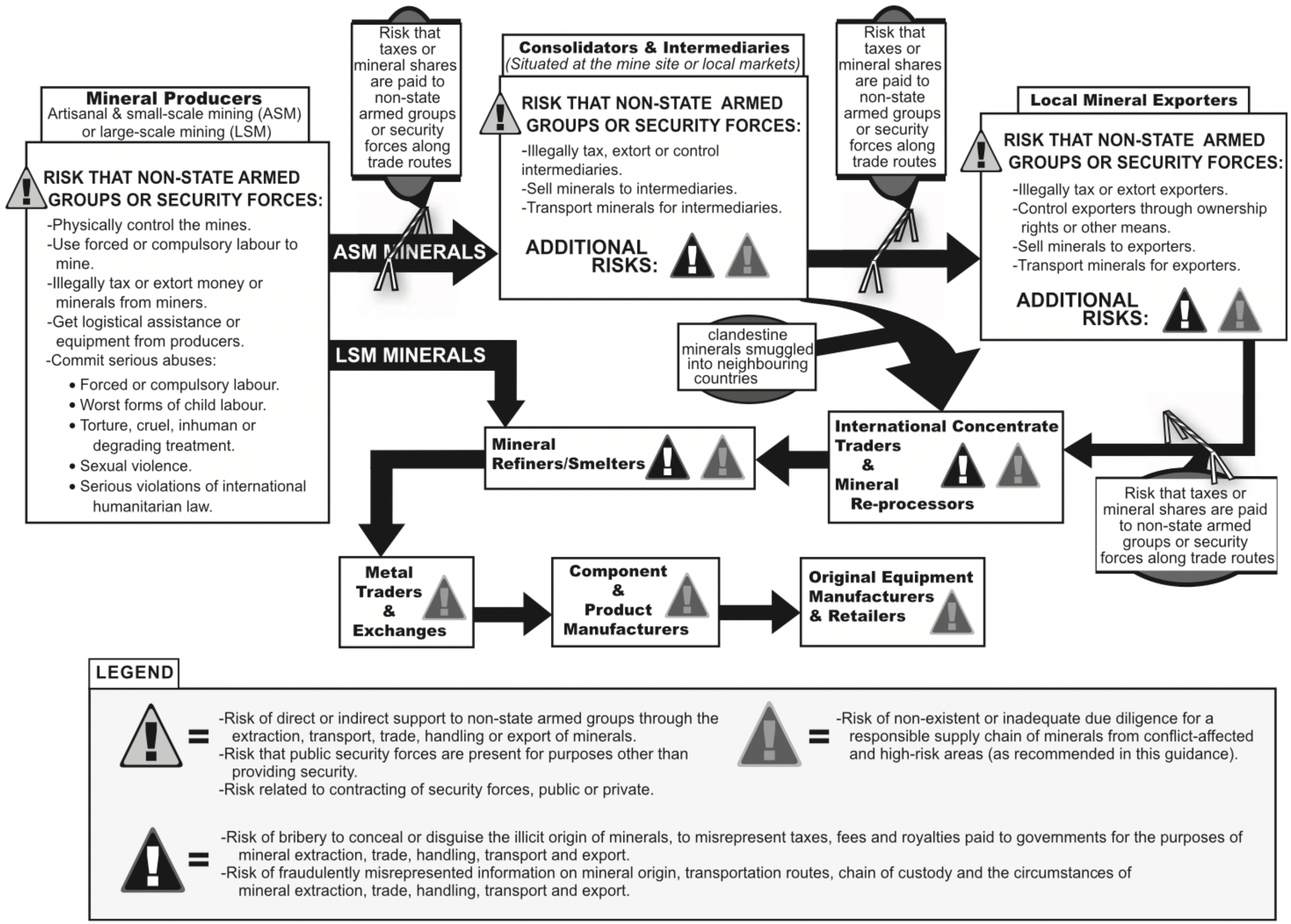

Figure 7: the risks in tin's supply chain from conflict affected and high-risk areas (OECD, 2016)

Of course, multiple international and intergovernmental institutions also govern the seabed tin mining operations beyond the OECD and ITA. For instance, given the rising awareness of European and American electronic consumers demand more information on responsible mineral sourcing, electronic device companies developed an electronic device coalition known as Responsible Mineral Initiatives (RMI) in 2008 to create the tin transparency and traceability framework through mapping and identifying local and international tin collectors (Leeuwerik and Saputra, 2017). The governance regimes of this geopolitical intervention, as mentioned earlier, often interact with central and provincial governmental interventions (PERDA, 2020). The central and provincial government govern the seabed mining operations by requiring every tin mining company, group, and individual, to possess mining permits, own concession areas, submit environmental impact assessment (EIA) reports, and pay corporate social responsibility (CSR) funds. This effort ideally aims to balance the socio-economic and environmental impacts of seabed tin mining operations (e.g., conflict between miners and other marine users and benthic habitat health damages) with their social contribution to the local and marine habitat restoration.

Despite the seemingly positive governance ambitions from international, national, and provincial scales, such interventions take a top-down geopolitical approach and have mainly maintained the appearance of responsible seabed tin mining operations only from a distance. Such governance initiatives, as Barry (2010) argues, are transparent only as a political device, creating a regime of visibility in the assumption that complying with governance regimes means that seabed tin mining operations and their impacts *are* governable and mitigable. This regime here also creates a regime of invisibility because the process of governing mining only amplifies the economic benefit of tin mining operations to the public. For example, offshore tin mining operations obviously contribute to the local and national economy through tax and CSR (corporate social responsibility) payments for hospitals, roads, and school construction (Ranto et al., 2023). With the good record on governance regimes compliance, the central and provincial governments have even deemed seabed tin mining operations to represent blue growth initiatives ambition (Ciptono and Cahyacipta, 2021) as extracting seabed tin ores optimizes the income and revenue generation from ocean uses. The blue growth is one of the United Nations' sustainable development goals based on ocean use (Sakellariadou et al., 2022). However, the geopolitical interventions and discourse here often disregard the practical difficulty of habitat restorations in the previously mined seabed, the dangerous labour practice in tin diving, and sediment plumes caused by seabed tin mining (see Chapters 4, Chapter 5, and Chapter 6).

While specific geopolitical interventions govern seabed tin mining operations, understanding how they act to spatially manage, control, and govern the material site of the seabed off the Bangka and Belitung islands is also crucial. That is because one then does not assume that the seabed off these islands is, as Childs (2018) argues, a passive, ready-to-exploit, and empty oceanic space. Instead, beyond the seabed tin mining, domestic and international transoceanic cable companies also consider the seabed space crucial undersea network routes for their marine infrastructures (CNN, 2021; Sun Cable, 2022). For instance, the transoceanic cable project, so-called the sun cable project, plans to connect Darwin, Australia, to Singapore by crisscrossing diverse Islands in Indonesia, including off the Bangka and Belitung Islands. The existence of the transoceanic cables can amplify existing conflict between domestic seabed tin mining operations and other marine uses as there will exist the spatial conflict between offshore tin mining operations, domestic, and transoceanic cables. For that reason, the central and provincial authorities off the Bangka and Belitung islands have designed and imposed centralized and provincial marine spatial planning (MSP) mapping policies to govern the existence of the current marine uses by creating imaginary borders to allocate the seabed space for those marine users (PERDA, 2020; KKPRL, 2021). In other words, even though the seabed off the Bangka and Belitung Islands is situated within the territorial sea, the seabed off these islands is crucial for the current geopolitics that requires space and mineral resources. Therefore, with the multi-scalar geopolitical entanglement of the seabed off the Bangka and Belitung Islands, this field is crucial for offering empirical evidence to address the research questions of this study. Whilst this section already explains why and how the seafloor of the Bangka and Belitung islands have become a significant geopolitical site for offshore tin industries and other marine users, such explanation does not show the intersection between benthic phenomena and geopolitical interventions off these islands. For that reason, the following section elaborates the interface between benthic phenomena and geopolitical interventions off the Bangka and Belitung islands: in short, benthic geopolitics. This conceptualization of benthic geopolitics, further, expands current new materialist geopolitical interventions to take into account benthic phenomena emerging from multiple seafloor uses.

1.5 Introducing benthic geopolitics

As already noted, new materialist geopolitics has shifted geopolitical analysis from state-centric geopolitics to geo-politics to emphasize the importance of physical space (the material world) for power politics (Peters et al., 2018; Lehman, 2020b; Sammler, 2020b; Squire, 2021). While the geo can, indeed, mean many things (see Chapter 2), geo is territory beyond terra (earth ground) (Peters et al., 2018) where the intersection between geopolitics and the geo-physicality of space shape particular state and non-state territory making (Elden, 2013; Sammler, 2016b). In this way, geopolitics is always material—having a texture and a shape, and can be felt physically and intimately (Bobbette, 2023). In the seabed tin mining operations, given provincial, national, and international interventions of offshore tin recovery, the seabed off Bangka and Belitung islands become the physical site of these geopolitical interventions. Hence, this space has become a significant territory for the global tin supply and demand industries. Meanwhile, this oceanic space here is not a mere physical space (geo) devoid of humans, animals, plants, events, and politics. Instead, as mentioned in the earlier section, benthic phenomena emerge from and are constituted by marine activities. This assertion echoes the work of Dittmer and Klinke (2014), arguing that: "[M]acro-scale of geopolitics is composed of trans-local relations between bodies and materials…It is the interaction of these elements that produce the forces that shape global politics, often with outcomes that differ from the prediction of the macro-scaled theories"(1). For that reason, the current new materialist geopolitical analysis of the seafloor demands counting benthic phenomena to understand how benthic phenomena interact with, facilitate, and hamper certain geopolitics and in turn, shape multiple realities of the seafloor. The convergence between benthic phenomena and geo-politics here is what I call "benthic geopolitics".

Benthic geopolitics indicates that geo in geopolitics depends on the elemental and geological (Peters et al., 2018; Bobbette, 2023), technological, scientific, and biological agencies of space: in short, benthic phenomena. Primarily, existing benthic phenomena shape the geopolitics of the seabed and vice versa; the geopolitics of the seabed also shapes benthic phenomena. While benthic geopolitics is, indeed, the extension of the previous work, undersea geopolitics (Squire, 2021), given Squire also focuses on the undersea environment. Benthic geopolitics has its distinctive characteristics from under-sea geopolitics. Benthic geopolitics indicates how diverse emergent measuring agencies interacting with, relating to, and associated with the seafloor reconfigure multiple realities of the seafloor and, in turn, shape the seafloor into contested space. Thus, through benthic geopolitics, one can understand how benthic phenomena recreate what the seafloor means across multiple scales of seafloor uses and how spatial conflict of seafloor access emerges due to diverse seafloor meaning-makings. This insight is crucial as it addresses the taken-for-grantedness of the seafloor's meaning-making (see: Conde et al., 2022).

Furthermore, understanding benthic geopolitics matters in the context of seabed tin mining operations because one can further understand that geopolitical interventions of seabed tin recovery cannot be confined to a specific site. However, in practice, these efforts often intersect with provincial regulations such as marine spatial planning (MSP) policies in the Bangka and Belitung Islands. While both provincial (PERDA, 2020) and global regulations (OECD, 2022) may require offshore tin mining operations to hold concession areas, specific mining durations are governed exclusively by provincial MSP interventions (see section 5.3 and Chapter 5 for more information about provincial MSP policies and regulations). Given that MSP also defines the use of the seabed off Bangka and Belitung islands, global geopolitical interventions can be hindered, facilitated, negotiated, or compromised by the enactment of local regulations. Furthermore, the hierarchical geopolitical approach often lacks specific environmental impact assessment (EIA) and mining technology recommendations for offshore tin recovery.

The hierarchical geopolitical approach here refers to how mining requirement standards (e.g., personal protective equipment (PPE), environmental impact assessment, and mining permit ownership) are often designed by experts beyond the Bangka and Belitung islands. Thus, there exists a hierarchy of authority on who develops mining requirements and who should comply, and whether the mining requirements, indeed, fit in with the material practice of the seabed tin recovery. In other words, the enactment of such mining requirements indicates, as Sammler and House-Peters (2023) argued, seeing the seafloor from above (God's eyes view) as the actors do not necessarily need to visit and experience directly and intimately the material site of the seabed tin recovery. Despite the top-down geopolitical vision and intervention, this global geopolitical intervention indirectly shapes and influences the geo-physicality (the physical characteristics) of the seabed off Bangka and Belitung Islands (Readhead et al., 2023). This is because, with the lack of defined environmental and technological assessment guidelines, this tin recovery continues changing the geo-physicality of the seabed of these islands without defined limits.

Concurrently, this hierarchical approach also interacts with multiple political seafloor interests. The interests range from large-scale seabed tin mining operations, non-governmental environmental organizations, artisanal tin diving, coral reef restoration, and undersea cable installation off the Bangka and Belitung Islands. For example, Chapter 5, Chapter 6, and Chapter 7 demonstrate that tin deposit exploration and exploitation can emerge given that the ITA and OECD connect international tin buyers with offshore tin producers. Therefore, geopolitical interventions of seabed tin recovery interact and get entangled with benthic phenomena off the Bangka and Belitung islands.

This insight expands our understanding of the geopolitical dimensions of seabed mining. For instance, Childs (2020) argues that the geo-politics of seabed mining exists across four main dimensions —material, technological, spatial, and temporal dimensions — yet this study expands on this by revealing that the geo-politics of offshore seabed tin mining spans *bodily, material, technological, digital, spatial, temporal, provincial, national and global scales* as benthic phenomena exist across scales of the seafloor uses. These geopolitical scales parallel on what Marston (2000) argues that scales in geography are interconnected rather than disconnected. In offshore tin mining operations, the flow of tin commodities from production to consumption indicates that the scales of geopolitical interventions in offshore tin mining operations are relational. Such relations can exist given benthic phenomena above mediate particular geopolitical interventions to the material site of the offshore tin extractions. Indeed, this connected scales of geopolitics also reflects on the work of Massaro and Williams (2013), arguing that: "…[G]eopolitics…connects seemingly disparate people, places, events, and issues to show the connections across various operations of power and productions of inequality and exploitation"(567). Therefore, benthic phenomena emerging from technological, bodily, volumetric, spatial, temporal, and material dimensions of seafloor tin mining operations make visible such trans-local relations of material and bodies with the global scales of the geopolitical interventions for offshore tin mining operations.

Additionally, the multi-scalar geopolitics also results the spatial conflicts of the seafloor. That is because each actor constructs the reality of the seabed to mirror their political seafloor interests. For instance, in measuring, calculating, and estimating the seabed tin deposit, tin geologists have focused on producing tin deposit maps (see Chapter 4 for an example of the tin deposit maps). Through this process of seabed sensing, tin geologists, hence, contribute to constructing the seabed as a mere tin extraction site. However, since this construction of the seabed fits in with the interest of domestic and international tin buyers, the way tin geologists portray the seabed here underpins the global capitalist imagination of the seabed off these Islands. That is because the tin geologists provide, what Monteiro (2022) call "*the geo-data"* (1). Specifically, in offshore tin production, the geo-data of the seabed tin deposit refers to the map of tin mining sites, the depth of the seabed tin ores, the quality of the tin ores, and the quantity of the tin ores (see Chapter 4). This geological information is geopolitically crucial[16] for the tin mining companies as they can predict whether their capital investment in the specific target seabed mine is economically profitable to them, allowing them to supply the global tin demands.

The delicate relation between geopolitics and prediction echoes the work of Dodds (2007), arguing that: "[geopolitics is] an ability to see the world and make a confident prediction about its future composition, usually for the benefit of one particular country as opposed to others" (51). Providing such a sense of certainty, the tin geo-data also helps estimate whether extracting the seabed can help mining companies pay for concession area taxes and their international tin corporation memberships. For instance, Indonesian tin mining corporations should pay their ITA corporation membership[17] annually to get connected with their international tin importers (ITA, 2020). In this way, the tin geodata also plays an integral role to keep the global geopolitical intervention running through how using such tin deposit information enables mining company generate annual revenues for this international tin market intervention. Therefore, the importance of the tin geo-data here also aligns well with the work of Ramírez-Monsalve and van Tatenhove (2020), arguing that the availability of data is "a form of relational power*"* (1) as the seabed tin data allows us to understand the sectors' interest at sea. Indeed, in seabed tin mining, the collected visual and material data of seabed tin ores can enable us to understand how tin buyers and tin industries have interests in the seabed off these islands.

Even though the tin-centric seabed data is beneficial for keeping the global tin intervention and the tin industry running, the geological assumption inhered in the geo-data has, of course, disregarded other human, non-human, and seabed relations. In this way, when the experience of benthic species, fishers, and non-environmental organizations on and off the Bangka and Belitung

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[16] The act of measuring seabed to produce geodata here is called geometry. According to Virilio P (2001) *Virilio live.* Sage., even geometry recreates a particular space as political or geopolitical space. A political space is a geopolitical space. 'Political' means nothing. A political space applies to a piece of land, whether small (a city) or large (the nation-state). It is geopolitical in the 'political geography' sense, but also in the 'geometry' sense (55).
[17] On the International Tin Association (ITA) website, they, unfortunately, do not detail how much their annual tin membership fee is. Thus, I contacted the ITA CEO. I did not obtain the data even after contacting her especially, perhaps, given that the membership fee information is only for established tin corporations.

Islands is included in this geological assumption, these benthic phenomena may contest the narrowing capitalist assumption of the seabed. That is because the seabed then becomes not just mere tin extraction sites. But, instead, the seabed is a benthic habitat (see Chapter 2 for benthic habitat's definition), Indigenous fishers' livelihood, and the marine protection area (MPA). As Aliansi Pecinta Terumbu Karang (local coral reef alliance) representative argues: "[T]he seabed is a living environment where coral reefs grow and where our Indigenous people rely on their lives" (Aliansi Pecinta Terumbu Karang, 2022: Interview on 17 May 2022). The multiple ways of seeing the seabed here indicate how certain knowledge of the seabed can contradict, defend, contest, and the dominant knowledge of the seabed.

Despite that, as geological knowledge of the seabed informs the decision-making process of the seabed uses, and the temporal and spatial regulations of the seafloor uses, the reality of the seabed is then reduced in the chosen interest of tin mining actors. The effects of such contested seabed space can also affect the global geopolitical intervention as the spatial conflict between offshore tin mining operations and other marine users stemming from the different ways of seeing, feeling, and using the seabed may hinder or facilitate the global tin supply and demand. For instance, as certain seafloor sites off the Bangka and Belitung islands are considered sacred spiritual places for the Indigenous, Indigenous communities closed the access to the sea harbor of offshore tin mining operations (WALHI, 2017). Such resistance may, of course, hamper tin production and global tin supply while at the same time maintaining benthic habitat health (e.g., coral reefs and coral fish populations) off the Bangka and Belitung islands.

1.6 My significant and original contribution to knowledge

M*y original* and *significant contribution* to *knowledge* is multi-fold in this study. Empirically, I provide an ethnographic account of the everyday life of miners and artisanal tin divers on mining ships and wooden float rafts. While, indeed, the everyday experience of tin miners seems mundane knowledge and, as such, is rarely documented, their existence, in actuality, matters in geopolitics. That is because they become, what Peters et al. (2018) argued, "the material foundation of power politics". This means that without the quotidian event of seabed tin mining here, the global geopolitical interventions of tin ores can also be affected because they require tin ores from offshore tin mining operations to continue operating. Beyond the notion of power, the everyday practice of miners and tin divers has indicated how the global geopolitics of tin industries also intimately affect the bodies of tin miners and divers by how global tin capitalist imagination (un)intentionally removes the everyday struggle and challenging condition of miners. This argumentation reflects on how their websites do not record, for instance, the mining accident in tin diving (OECD, 2022; RMI, 2023; ITA, 2024a). This means that global geopolitics can indeed condition dangerous labor practices of miners as these regulatory interventions also mediate the tin supply chain from tin producers and collectors to international tin buyers (see Chapter 5). Indeed, such an understanding of the intersection between geopolitics and human bodies here speaks to, adds, and expands critical insight into the current work of feminist geopolitics (Dixon, 2019; Hyndman, 2019; Laketa, 2021; Satizábal and Melo Zurita, 2021; Squire, 2021; Jackman and Squire, 2021). In this way, this study, in fact, extends the work of current feminist geopolitics to touch upon the everyday practice of the tin divers and tin miners (see Chapter 5).

Furthermore, conducting my ethnography on mining ships allowed me to demonstrate that diverse seabed relations exist through the process and practice of sensing seabed activity, tin diving, and sediment plume production (see Chapter 4, Chapter 5, and Chapter 6). In other words, this study captures how the nexus of tin experts, sensing devices, and mining technology constructs the seabed, how tin divers risk their lives to collect tin ores, and how sediment plumes are literally emergent with the process of offshore tin mining operations and their regulatory interventions (Chapter 6). With this insight, this study contributes to making visible the technological and political mechanism of constructing the seafloor as seabed tin sites and its effect on sustaining benthic habitat damages and dangerous labor practices of the seabed. This knowledge is crucial because the story of such everyday seabed tin extraction is often not accessible for critical academic research, given that conducting this ethnographic research requires researchers to be on mining ships and floating wood rafts (Chapter 3 details the challenges of this ethnography). This evidence, hence, can be used as feedback on current global geopolitical interventions of offshore tin mining operations. In this way, I contribute to expanding the work of Barry (2010) on criticizing regimes of transparency in offshore industries. Specifically, in this study, I showcase how the tin mining requirement standards make the responsible appearance of the tin business by making visible and invisible the material, practices, and human bodies in seabed tin mining operations (see Chapter 4, Chapter 5, and Chapter 6).

In addition, by understanding seabed sensing and extraction as benthic phenomena, I theoretically contribute to expanding the conceptual application of the benthic beyond the scope of marine science to the relationships between benthic phenomena and geopolitics across digital, temporal, material, spatial, and bodily scales (expanding Childs's seabed work) (See:Childs, 2018; Childs, 2020). In this way, this insight enables us to fathom how the benthic habitat damage, seabed conflict, and violence not only exist due to seabed tin mining but also due to the multi-scalar geopolitical interventions. This means that a radical change for offshore tin mining operations requires not only site-specific interventions but also radically contests the capitalist narrative of the seabed prescribed, enacted, and maintained by multi-scalar geopolitics of mineral mining recovery. While this study contributes to showcasing the relationship between offshore tin mining operations and multi-scalar geopolitics, methodologically, I also translate and operate benthic phenomena into an applicable methodology by thinking with benthic phenomena (see Chapter 3). Briefly, thinking with benthic phenomena means understanding that the researcher who conducts the study of benthic geopolitics is also part of benthic phenomena as they also interact with and relate to the seafloor through the seafloor uses they observe. This methodological approach can be used in other emerging and long-standing seabed uses such as undersea cables, underwater cemeteries, and wine aging (Laskow, 2022; Pomranz, 2021; Noor, 2024) for developing critical knowledge in human geographies, science, technology, and studies (STS), and sociology.

With this methodological approach of this study, I encourage social scholar communities to investigate benthic geopolitics beyond the seabed off the Bangka and Belitung Islands. This research agenda is crucial to democratize the knowledge production of the seabed. That is because democratizing the seabed knowledge here means that the seabed is, thus, not just politically constructed by certain disciplines such as law and geo-science but also by other forms of seabed relations through their multiple seabed uses. Additionally, democratizing the seabed knowledge production may enable us to imagine the seabed beyond the global capitalist mineral imaginations (Hine and Edwards, 2023; Sammler, 2020b). That is because multiple ways of knowing the seafloor also shapes multiple realities of the seafloor. Thus, the main imaginary of the seafloor informing this oceanic space's geopolitical intervention is not just from a legal and geological perspective. But also, formulating seafloor's spatial interventions can count other ways of relating and making meaning of the seabed (Hawkins, 2020; Childs, 2020; Sammler, 2020b).

Concurrently, this study contributes to current human geography, political geography, science, and technology studies (STS) in the current project of rematerializing geo in geopolitics (Peters et al., 2018; Squire and Dodds, 2019; Jackman et al., 2020; Lehman, 2020b; Sammler and

Lynch, 2021; Sammler and House-Peters, 2023). In this way, as rematerializing the seabed as geo in geopolitics means re-problematizing the accepted knowledge ('the status quo') of the seabed, this study also contributes to adding critical knowledge of the seabed to a growing area of critical geography that has shifted toward oceanic space (Sammler and Peters, 2023). This study indirectly makes us familiar with benthic geographies and defamiliarizes us from the dominant capitalist construction of the seabed (see the debate on the term benthic phenomena and seabed in Chapter 2). Indeed, this argumentation here also echoes the work of Haraway (2013) on defamiliarizing the familiar and familiarizing the unfamiliar. However, benthic geography here should not be misunderstood as the geography of benthic habitats, the domain of marine science perspective. Instead, if Peters (2016) argued that geography is earth-writing or to be more precise, as Peters et al. (2018) argued geography is “a loose spatial sensibility”, benthic geography here is about being spatially sensible toward our inextricable relations to the seabed. Therefore, if the seabed is not exterior to our bodies, one should care about the ongoing seabed uses because what happens to the seabed also affects our bodies. On top of that, as this study is situated within undersea work, such work on benthic geopolitics creates a different and more appropriate vocabulary for exploring diverse undersea infrastructure through not only expanding the use of *benthic* beyond marine science but also showing how benthic can provide deeper to the depth of the sea than a mere numerical representation of the sea depth.

1.7 Structure of the thesis

To convey my significant and original contribution above, I divide the following monograph into seven chapters. Following this introductory chapter is a literature review, a methodological chapter, three chapters of interpretation-based empirical investigations, and a conclusion chapter. Each of these chapters has its own role in the monograph. In Chapter 2, I elaborate on benthic phenomena by bringing together islands studies, critical ocean studies, and queer ecology studies, and science and technology studies (STS) within the new materialist geopolitical analysis of the seafloor. I further contextualize the concept of this study within current new materialist geopolitical scholarship to provide an ecological understanding of the seabed. However, in Chapter 2, I do not explain the translation and operation of benthic phenomena in methodology. For that reason, Chapter 3 explains how I translate benthic phenomena into the research methodology.

Obtaining empirical information from the deployment of benthic methodology, Chapter 4, Chapter 5, and Chapter 6 provide a deep interpretation of the empirics. In Chapter 4, I problematize the everyday seabed sensing activity in offshore tin mining operations. The main argument of this chapter is the act of sensing in offshore tin mining operations is crucial because the seafloor simulation and seafloor tin deposit map become the bedrock of geopolitical interventions. Chapter 4 also argues that the configuration of sensing devices, mining technology, and human senses in offshore tin mining operations have fixated senses in the mining ship to focus on tin ore recovery while occluding existing benthic habitat damages caused by offshore tin mining operations. That is because sensing here does not portray the damaged benthic habitats under the sea. Instead, it only displays the flow of seabed sediments, tin ores, and digital seabed sensing technology. Thus, such apparatus creates the paradox of sensing: sensing, sense-ability, and insensitivity. Upon conducting ethnography on offshore tin mining operations, I saw diverse tin divers. Given that the bodily experience of tin divers has only been nominalized, their dangerous labor practice is often excluded from the regulatory intervention of offshore tin mining operations. For that reason, Chapter 5 focuses on introducing the empirical findings on the bodily experience of tin divers. Chapter 5 argues that the nexus between bodies, volumetric space, and geologic materiality in tin diving becomes a tactical point to assist and resist certain geopolitical interventions of tin production.

As the practice of seafloor sensing and extraction in Chapter 4 and Chapter 5 produces sediment plumes, Chapter 6 further explores how sediment plumes *queer* the governance of offshore tin mining operations. This means this chapter shifts our views from tin-centric interventions toward sediment plumes. This chapter also explains how plumes are not just physical properties of the seafloor but also possess political dimensions. The political dimensions here are because miners and coral reef restorations insert diverse constructions of plumes, creating the notion of whether benthic habitats are worth protecting or exploiting, given the existence of plumes. Ultimately, reflecting on these empirically interpreted chapters in Chapter 7, I conclude how Chapter 4, Chapter 5, and Chapter 6 enable me to address research questions and, thus, achieve the general research objective of this study. Beyond that, I also provide the main reason why this study matters, especially given that this study becomes part of a broader research agenda to reveal benthic geopolitics beyond the Bangka and Belitung islands, Indonesia.

Chapter 2 Literature Review: When Benthic Phenomena Meets Geopolitics

2.1 Introduction

While the previous chapter briefly described the scope and context of this study, this chapter contextualizes the intersection between benthic phenomena and geopolitics: what I call "benthic geopolitics" within the current project of rematerializing the 'geo' in geopolitics (geo-politics). This chapter explains further how benthic phenomena provide an ecological understanding of the seabed (i.e., how ecology is enrolled in seabed geopolitical understandings). Indeed, recent new materialist interpretations of the 'geo' have contributed to providing bodily, spatial, temporal, technological, volumetric, and geologic contributions to understanding the workings of geopolitics (Peters et al., 2018; Sammler, 2020b; Sammler, 2020c; Squire, 2021; Jackman and Squire, 2021; Sammler and House-Peters, 2023). However, current political geographers have rarely proffered ecological understandings in this framework. This ecological understanding is vital to add because it helps us to remedy the global capitalist lens that recreates the seabed as anything but a place of resource extraction, "the new frontier" (Havice and Zalik, 2018: 1). Regarding the concept of frontier, building on the work of Steinberg (2018), Ruiz (2024) argues that: "[F]rontiers are spaces of opening and of closure at the same time, in this sense, new spaces and resources are integrated in both state sovereignty and global networks of production and consumption…" (4). Therefore, contesting such a notion of the new extractive frontier here is crucial, especially when one considers environmental conservation matters. This ambition aligns well with Sammler's (2016) argument: "[R]emedying the land biases [fixed and static logics] that exist in the literature is of utmost importance as capitalist development sets its sights on the most remote and inhospitable places [e.g., seabed and ocean] on Earth and beyond" (16). This chapter contributes to expanding the current project of rematerializing geopolitics through how multiple realities of the seafloor, including inextricable relations between humans and the seabed, are created through benthic phenomena. However, this scholarly work intentionally excludes discussing the extensive onto-epistemological debates within and between classic geopolitics (state power-centric analysis) (Wu, 2018), critical geopolitics (state-knowledge and power deconstructive analysis) (Dodds, Woon, & Xu, 2022), and feminist geopolitics (the everyday and bodily experience analysis) (Dixon, 2016; Massaro & Williams, 2013; Sharp, 2022) which is beyond the remit of this study.

The literature exclusion is made here, given that current geopolitical scholarships, regardless of those geopolitical camps (e.g., classic, critical, and feminist geopolitics), have shifted their interventions on the importance of '*geo'* by bringing together new materialism (material-turn) in their geopolitical analysis. Although material-turn can mean many things in geopolitics, the critical material analysis of geopolitics has focused on examining the *materiality* or 'thingy-ness' of *geo*-politics by considering the very physical properties that shape and are shaped by the politics of place. Material analysis also pays attention to the spatial, temporal, technological, human, and non-human dimensions of spaces, affected by and interacting with specific material geopolitics (Sammler, 2020; Sammler & House-Peters, 2023; Squire, 2021; Steinberg & Peters, 2015).

Furthermore, as the materiality of geo means a thread that weaves together 'material' (the physical properties of matters) and '*meaning*' (certain social construct of matters) (Haraway, 2020; Law, 2019), Peters et al. (2018) argue that rematerializing geopolitics does not necessarily mean removing the immaterial of the material qualities: "[O]f course, geopolitics is more than material. Attending to animals [for instance] also shines a light on qualities and behaviors. On individuals and groups, on single species and ecosystems, on bodies and affects, on discourses, and how things come together and come apart over and again, and with what effects" (205). For that reason, rematerializing geopolitics does not intend to create a materially determinist geopolitics (Flint, 2021). Such an approach argues that physical space – material properties – define geopolitics (Dodds, 2007). Instead, approaches to rematerializing geopolitics offer an understanding of the active, social, dynamic interaction, tension, and coproduction between geopolitical and geophysical space in the process of particular territory production (Sammler, 2020b; Elden, 2013).

To expand such excessive work on geo-politics, this chapter brings together literature on islands, critical ocean studies, queer ecology studies, and science and technology studies to reinterpret the materiality (e.g., material, bodies, spatial, temporal, and technological) of the seabed as benthic phenomena to showcase the ecological understanding of the seafloor. In other words, this chapter creates a radical intervention by providing the ecological understanding of the seabed as geo in geopolitics. But, indeed, the question emerges. How is the ecological understanding of the seabed here still material? Or how does this still contribute to the new materialist geopolitics? The key to answering this inquiry is to reflect on benthic phenomena. That is because benthic phenomena consist of material (e.g., plants, humans, animals, technologies, and human actions) and meaning (e.g., human ideas, politics, events, and representations), which interact and reconfigure the multiple realities of the seafloor from the deep. The difference is that benthic phenomena indicate how such materialities become measuring agencies that continuously reconfigure the multiple realities of the seafloor. This ecological understanding of the seabed in geopolitics here is crucial because this interpretation enables us to capture our relations to the seabed. Thus, one can care about how certain geopolitical interventions shape the seabed and human relations.

This chapter is divided into several sections, underpinning the main argument for offering an ecological understanding of seabed as geo in geopolitics. The first section (2.2) explains the state of the art in *geo*-politics*,* including agreements, disagreements, and the development of a rematerializing of *geo*-politics. Since studies of *geo-politics* have moved offshore and deeper, reaching the seabed, section (2.3) revisits, discusses, and problematizes the taken-for-granted definition of the seabed prescribed by the UNCLOS (the United Convention on the Law of the Sea) and the Law of the Seabed, a book written by geoscientists Braathen and Brekke (2020). I intentionally use the Law of the Seabed book here as this geo-science book offers the geo-scientific definition of the seabed and guidelines of the seabed extraction minerals used by seabed users[18] as a supplement to the UNCLOS. In this way, as the dominant geopolitical construct of the seabed has mostly adopted the legal and geological tradition, the section (2.4) following this introduces how benthic ecologists view the seabed and how such benthic ecosystem knowledge ruptures the dominant geopolitical construct of the seabed prescribed by the UNCLOS and the Law of the Seabed. However, even though benthic ecosystem knowledge decenters the dominant geopolitical construct of the seabed, benthic ecologists do not expand their analysis beyond benthos and habitat relationships. To address such a constraint of benthic ecology, the next section (2.5) summons islands studies, critical ocean studies, queer ecology studies, and science and technology studies within this new materialist geopolitics approach to inform my interpretation of benthic phenomena.

In the final section (2.6), I argue that the benthic phenomena here are conceptually significant in that one can understand the ecological understanding of the seabed in geo-politics. For example, reflecting on how the benthic ecosystem not only shares organic and inorganic

[18] The Law of the Seabed book, for instance, offers a lithography (the vertical map) of the seafloor to identify the properties of each seafloor's layers (e.g., muds, sands, and rocks). The seafloor users such as undersea cables, seabed mining, and offshore oil and gas use such lithography to determine whether these offshore industries can use the seafloor for their marine activities.

materials ('the origin of life') with us but also contributes to the healthy air we breathe in and out on an everyday basis, we start to understand that the seabed is not external to us. Instead, our bodies are intimately linked to the seabed. Such ecological understanding of the seabed not only showcases our intimate relation to the seabed but also provides us with, arguably, an ethical political positionality to care for the seabed. If the seabed is not exterior to our bodies, what happens to the seabed happens to our bodies, and our views may become orientated to scrutinize the practice of the seabed uses. Beyond ethical political positionality, considering benthic phenomena also offers a pragmatic and practical lens for studying the seabed uses and their geopolitical entanglement. That is because since the UNCLOS and the Law of the Seabed become the main top-down and hierarchical geopolitical orders and guidelines for governing, managing, and using the seabed, various scales of the seabed use, including off Bangka and Belitung Islands and beyond practically adopt the dominant geopolitical construct of the seabed within their policies and actual practices. In this way, benthic phenomena can allow us to examine how policies and practices of the seabed adopt the dominant geopolitical definition of the seabed and observe how benthic phenomena contest and challenge such geopolitical logic in practice. Finally, with such conceptual understanding, benthic phenomena allow us to reimagine what the seabed means beyond the capitalist definition of the seabed.

2.2 The state of the art: geo in geopolitics (*geo-politics*)

Ever since Rudolf Kjellen, a Swedish Political Scientist and Geographer, coined the concept geopolitics (*geopolitik*) in 1916, inspired by the work of German Political Geographer Friedrich Ratzel (1844-1904) on "organic states" (Dugin, 1997, 23; Dodds, 2007), political geographers have increasingly researched, developed, and debated geopolitical concepts and approaches within foreign policy and academic arenas. This classic geopolitical approach focuses on state power relations (see Dodds 2019). Yet there are other modes of thinking geopolitically – what is called a critical geopolitics alert to the complex workings of geopolitics that might be driven by space, time, representation, and *materiality* (Tuathail, 1999; Wegge and Keil, 2018; Dodds et al., 2022). Indeed, more recently, for instance, given the latest geopolitical scholarship focusing on rematerializing *geo*-politics, current political geographers have offered the rationale on how and why thinking alongside *geo* matters in geopolitics. For example, building on 'agential realism[19]’ (Barad, 2007), Squire (2014) argues that the new materialist geopolitical approach helps to decenter representation-centric geopolitical analysis (e.g., language and geopolitical maps) toward examining the very physical, material practices and embodied experience in certain physical territory. The shift from representational to material geopolitics here also creates a significant shift from examining state discourses and narratives-centric geopolitics to rethinking the world and earth in geopolitics. This statement aligns well with the assertion of Elden (2013): “[G]eopolitics has tended to become conflated with global politics or political geography writ large. But could we turn this [geo] back to thinking about land, earth, world rather than simply the global or international*?*” (49). Elden’s provocation here has moved many geopolitical analyses beyond the traditional geopolitics that put state power as the main player in geopolitics, following previous critical geographers (Tuathail and Dalby, 1998). Instead, political geographers have now examined the power, politics, and territory production of geo inspired by the materiality of the physical sites.

However, this movement does not mean removing the geopolitical role of the state in certain geopolitical production. Rather, this critical material analysis helps to showcase and deconstruct certain state-centric geopolitical constructs and territory production of the geo. For instance, following the work of Elden here, Sammler (2016) argues that thinking about geo allows us to—“investigate entanglements of the geopolitical and geophysical in constructing and practicing (re)interpretations of territory and sovereignty, power and space” (10). If Sammler's work examines the intersection between geopolitical and geophysical materiality to push back on certain dominant political construction of space, Dodds et al. (2022) reflect on the current climate crisis to argue: “[U]nder climate change, the physical geographies of the earth are changing then it is ever more plausible to suggest that geopolitics needs to be taken literally because the “geo” in geopolitics is warming, thawing, melting, burning and so on” (80). As such, *geo*-politics can open up wide possibilities for problematizing geo in geopolitics as this materialist analysis also focuses on power and territory relations to environmental issues. Therefore, contextualizing the seabed as

[19] "[A]gential realism is an epistemo- logical, ontological, and ethical framework that makes explicit the integral nature of these concerns. This framework provides a posthumanist performative account of technoscientific and other naturalcultural practices.11 By “posthumanist” I mean to signal the crucial recognition that nonhumans play an important role in naturalcultural practices, including everyday social practices, scientific practices, and practices that do not include humans" (p.32). Barad K (2007) Meeting the universe halfway. *Meeting the universe halfway.* Duke University Press.

geo in geopolitics means understanding the multiplicity of what the seafloor means and how it contributes to shaping the seafloor as a contested territory.

2.2.1 Geo-politics, power, *and processes of imperialism, colonialism, and capitalism*

The work on rematerializing geopolitics further continues beyond environmental geopolitics. For instance, Peters et al. (2018) argue that thinking about geo in geopolitics offers a crucial understanding of how geo has become the material foundation of power politics. The material foundation here can mean how geo provides a space for good transportation and other modes of wealth accumulation that strengthens the position of particular actors by securing and claiming geo as their part of the territory (Squire, 2021). Since the geo as the material foundation of power politics here can be interpreted, too, for instance, as to how mineral and geological processes fuel the power politics (Yusoff, 2013), Bobbette (2023), a political geologist, argues that "the geos of politics were actual material: grounded geological processes" (1). The geological process here also includes how humans can become geological agents as they can move minerals and oil from one place to another and create environmental impacts within and beyond the site of particular material extractions (e.g., sands and minerals) (Jamieson, 2021). Such recognition of humans as geological agents in the geological epoch here is notably known as the "*Anthropocene*" (Yusoff, 2013). However, the Anthropocene tends to homogenize all human beings as equal geological agents to move minerals and oil from the earth (Yusoff, 2018; Lehman, 2020a). Rejecting such political homogenization that often erases the historical context of geopolitics and its impacts on the environment, Dixon (2019), a feminist scholar, argues that the historical context of imperialism, colonialism, and capitalism should be taken into account in geopolitical analysis to create a careful differentiation between which powerful human bodies that force and exploit other human bodies in material wealth accumulation and which humans are exploited and become the victim of mineral extractions. She then conceptualizes the bodies with the power to force as '*geologic-becoming*' and the exploited bodies in extractivism as '*becoming-geologic*' to remedy the homogenization between imperial, colonial, and capitalist settlers and the colonized natives.

While, indeed, imperialism, colonialism, and capitalism are intertwined in the tradition of geopolitics, they are, by definition, different. Understanding the relation and difference between this taken-for-granted tripartite is crucial to fathom how geopolitics relates to and enables imperialism, colonialism, and capitalism. Even though imperialism, colonialism, and capitalism can mean many things, political geography scholars have indicated how tripartite demands physical spaces to operate. For example, Liboiron (2021) argues that "[C]olonialism is a set of specific, structured, interlocking, and overlapping relations that allow these events [stealing lands] to occur, make sense, and even seem right to some" (16). This means the main objective of colonialism is to steal the Indigenous's land through a structure that normalizes this action. Meanwhile, as colonialism is a structured and interlocking process of conceding the practice of stealing lands, imperialism indicates the unequal power of humans to access space and resources. As Derek et al. (2009) argue:

"[I]mperialism is an unequal human and territory relationship, usually in the form of superiority and practices of dominance, and involving the extension of authority and control of one STATE or people over another…Both [imperialism and colonialism] are intrinsically geographical and traumatic processes of expropriation, in which people, wealth, resources, and decision-making power are relocated from distant lands" (Derek et al., 2009: 373).

As such, power difference also means that colonial power defines how material wealth from certain physical spaces should be moved from colonies to colonial and imperial regions, Moore (2010) reflecting on such phenomena of the goods movement defines what capitalism is. As she argues:

"[Capitalism is the process and practice that maintains] the products of the countryside (especially but not only in the peripheries) flowed into the cities…In essence, the land was progressively mined until its relative exhaustion fettered profitability, whereupon capital was forced to seek out fresh lands" (Moore, 2010: 413-414).

In this way, rematerializing geo in geopolitics provides insight into policy, security, economy, environmental, and even colonialism, imperialism, and capitalism issues, often inherently linked to certain geopolitical interventions. Therefore, when framing the seafloor as geo in geopolitics, one should also critically assess how the dominant definition and knowledge of the seafloor is, in actuality, linked to centralized institutional power and epistemic communities (e.g., geologists and lawyers. This may indicate the colonialist, imperialist, and capitalist interests of the seafloor. Therefore, the seafloor should not be seen as a neutral probe but politically a human-made space.

2.2.2 Geo-politics and terrain

While geopolitics shapes and is shaped by the physical (material) space and those bound to the space (Weizman, 2004), there is still a conundrum on what geo means within human and political geography. For example, Owens (1999) argues that: "[G]eo is the physical setting of human activity, whether political, economic, or strategic" (59). Adding to this interpretation, according to Weizman (2004), not only is geo "[a]n arena of conflict but also strategy and weapon" (1). Reflecting on the work of Weizman on how geo can be an arena of strategy and weapon in state-territory conflict, Elden (2013) rethinks the depth and volume of the geo that allows him to explain the relationship between depth and power in certain physical, material, territories. Following his argument here, Elden conceptualizes geo as terrain. As he argues: "[T]errain (geo) combines geophysical issues alongside strategic ones and helps in attempts to develop a broader understanding of territory" (1). Following Elden's work on the geo as terrain – of terrain as the very materiality of territory – Jackman, Squire, Bruun, and Thornton (2020) further revisit the concept of geo as "*terrain"* to suggest geographers acknowledge the "messy, muddy, multiple, and lively terrain [geo]…that [has] remained too neat and too tidy" (10). While reconsidering the messy and muddy geo could potentially enable us to think alongside the complexity of geo and the limit of the territory production, these scholarships mainly focus on the geo as "earthly" *or* "grounded". In response to the conceptual limitation of geo here, Peters et al. (2018) argue that: "[T]erritory is indeed beyond terra or geo as earth ground as territory is air, water, ice, land, and earth with its height and depth rather than just surface" (10). The expansion of geo beyond terra here has enabled future investigation into multiple territories of physical spaces (e.g., state and non-state territories) and the difference materiality makes to geopolitical articulations

Given the provocation and work of Peters et al. (2018) on 'Territory beyond Terra', current scholars have further explained how the location, material form, and texture of physical spaces shape the process and practice of certain physical territory production. For example, building on the work of Elden on geopolitical ordering, power, and the depth of territory, Squire and Dodds (2019) introduce subterranean geopolitics to—"[e]nrich areas of inquiries such as territory as volume, geopolitical assemblage, and elemental geographies"(9). While this geopolitical work on considering the subterranean gives depth to the analysis of geopolitics, the work has again mostly focused on terrestrial land depth – i.e., the deep earth. For that reason, expanding from terrestrial land to oceanic spaces by building on the work of Steinberg and Peters (2015) on wet and fluid ontologies, Sammler (2016) argues that "flat geometrics that prevail on land do not correspond to the geometrics and geophysics of ocean depths. Moreover, static boundaries inscribed on ocean surfaces do not represent the dynamism of changing sea levels" (13). Meanwhile, according to Peters (2020), such consideration of oceanic depths is crucial where many geopolitical interventions of ocean use tend to be "*surficial*" (surface-centric governance). The critical analysis of oceanic materiality here has enabled us to understand that geo is moving, volatile, and fluid rather than static and fixed–complicating the geopolitical production of the physical territory.

While the work on depth and volume has emerged and gained scholarly attention in *mattering* the 'geo' in geopolitics, Barry and Gambino (2020) argue that "the subaquatic should be conceived of not just as a volume but as a site of situated encounters and inter-material relations and interferences between distinct assemblages that take diverse spatial forms—territorial, networked, and rhizomic" (20). This work of Barry and Gambino arguably adds the different interpretations of depths and also how material relations on the oceanic depth matter for assisting and resisting certain geopolitical projects. Meanwhile, even though such work on oceanic materiality has often destabilized the flat discourses of geopolitics from land to ocean, Klinke (2021) argues that this claim about flatness is due to "an incomplete reading of geopolitical tradition as [according to him] the German political geographer Fredrich Ratzel (1844-1904) has theorized the power and politics of geology and the underground, indicating that geopolitics has already become interested in the 3-dimensionality of the struggle for space" (Klinke, 2021). While he disagrees with the notion of flat geopolitical discourses, he also acknowledges that flat and volumetric geopolitics mainly depend on technological and material ways and means of knowing the geo. For that reason, the word new in new materialist geopolitics itself does not mean something new or previously not existing as geographer has long traditions to consider the materiality of the geo (terrain) in geopolitics (Elden, 2021). Instead, new here means re-return to analyzing geopolitics as material analysis of the geopolitical production of certain state and non-state territories. As Peters (2021) argues, "[T]errain,...I argue, could be part of a continued return of the material in cultural geography and to a re-return for political debates of territory" (198). In this light, reinterpreting the materiality of the seabed, such as the volume, seawater, technology, depth, events, ideas, and politics of the seabed as benthic phenomena indicate active interaction and relation on the seabed that assist and resist the territory production of the seabed uses. **Therefore, such benthic phenomena also interact with geopolitics, recreating the seabed as a contested seabed space: in short, "benthic geopolitics".**

2.2.3 Geopolitics, bodies, and technology

With the understanding of how the epistemological approach of geo defines and shapes what geo means, current political and human geographers have currently, and even previously, examined the technological and material ways of knowing the geo to destabilize the entrenched dominant geopolitical construction of geo (Lehman, 2020b). For instance, Pérez and Zurita (2020) study the subaquatic environment to reveal how the definition of the geo is intertwined with the dominant gender construction of the physical spaces and who can (or has been allowed to) access the material world(s) we inhabit. The dominant gender construct here has to do with the hard-to-access physical space that 'men' can access. Agreeing with Perez and Zurita's work on the relation between gender and space, Squire (2021) has showcased how the masculine gender construct (men taming the ocean) has normalized the death of aquanauts due to extreme temperature and pressures in the sea laboratory project during the Cold War. Meanwhile, since certain spaces are not accessible to human bodies, Monteiro (2022) argues that technology enables us to sense and create certain knowledge of certain inaccessible spaces given the depth and distance of the geo. Such work has shined light on how the technological and material ways of knowing also shape the way we ascribe certain meanings to the geo (Hawkins, 2020). Adding technological and bodily ways and means of knowing the geo, Childs (2018), working on deep-sea mining geopolitics, suggests that understanding the geopolitical project of seafloor demands thinking with temporal, spatial, material and technological dimension of the seafloor extractions ("extraction in four dimensions") (1). Continuing the work of Childs on the technological dimension of seafloor extraction, Sammler and House-Peters (2023) reflect on the geopolitical role of the mining technology to argue, "[T]he digital recreations of the target environment [seafloor] are abstracted and compressed into a digitally mediated mine site, it becomes an always-already extractive landscape reducing its capacity to be known as anything else than as mine" (9). While such scholarly geopolitical endeavors have moved to examine the seafloor, the scholarly work on the seafloor has mainly reproduced material, spatial, temporal, technological, elemental, and geological geopolitics of geo.

Meanwhile, the ecological understanding of seabed in geopolitics has been remarkably understudied, even though each of such geopolitical practices shapes the benthic habitats. In this way, benthic phenomena also remain underexamined. Therefore, exploring the intersection between benthic phenomena and geopolitics allows us to reexamine what the seafloor means and who geopolitically constructs the seafloor. In this way, even though this study focuses on the seafloor off Bangka and Belitung islands, the very definition of the seafloor here is also not separated from the dominant knowledge of the seafloor. Hence, the next section revisits the global geopolitical construct of the seafloor prescribed by the United Nations on Convention on the Law of the Sea (UNCLOS).

2.3 The global geopolitical construct of the seabed under UNCLOS

The previous section outlined a rematerialized view on the 'geo' in geo-politics. Within this there is now some limited work on the seabed (Sammler 2016; Childs 2020), but this remains scant compared to other 'geo' political analyses (of earthly matter). Given the focus of this thesis on expanding a materialist geopolitical analysis of the seabed, it is pertinent to first revisit and problematize how the dominant geopolitical orders construct what the seabed means in the first instance. Understanding such a dominant geopolitical construct of the seabed is crucial because it provides certain political assumptions on what the seabed is, how the seabed can be divided and allocated for many actors, and what rules apply and cease to apply (see Conde et al. 2022). Since the UNCLOS (the United Nations on the Law of the Sea) governs the ocean within and beyond national jurisdiction, this international treaty also provides regulations on how to govern the seabed. However, indeed, the UNCLOS does not define clearly what seabed means. But through analyzing this treaty, one can understand how this international treaty has governed the seabed through binary logic, separating the sea and the seabed (and also land and sea). And more importantly, of course, the seafloor does not pre-exist the UNCLOS. Instead, the UNCLOS creates "the seafloor, seabed, and ocean floor" through its mapping metrics and dividing up ocean space for properties. Therefore, in reality, the seafloor is constructed through such benthic phenomena.

2.3.1 The International treaty defining the seabed through its separation logic

Despite no consensus on what the seafloor means, the binary and fixed logic is embedded within how the seafloor is governed. As the international treaty the UNCLOS (1982) articles 77 and 78 mentions, there is a dividing logic regarding the seabed: "[T]he coastal states exercise over the continental shelf sovereignty rights [seabed beyond national jurisdiction] for the purpose of exploring it and exploiting its continental natural resources" (1). Nonetheless, the rights of the coastal state over the continental shelf do not affect the legal status of the superjacent waters" (2). Such an essentialist view is geopolitically strategic because the seafloor can then be allocated into different bounded categories, such as state property and common property for capitalist economic activities. This statement aligns well with the work of Farrales et al. (2021), arguing that "[E]nvironmental regulation functions through discrete timelines with linear notions of progress, and how space is reproduced in neatly bounded categories such as property, place, and scale" (176). Such a division of seabed space has become a way of governing the seabed as the geopolitical construct of the seabed here is agreed upon and constructed politically by the United Nations members.

For the global capitalist[20], the binary logic above can allow them to exploit the seabed as a separate domain (Lehman et al., 2021). That is because the binary between ocean and seafloor above, as prescribed in legal documents, assumes that activities on the seabed do not affect the ocean column, ocean surface, and beyond, and vice versa, what happens on the ocean does not affect the seabed. It keeps each domain 'discrete' and 'fixed' when, in reality, the seafloor and sea are anything but fluid and relational spaces (Peters, 2020). In other words, the binary logic confines the seabed from the rest of the world through its notion of stability and fixity. According to Houfa (1999), this notion can result in apathy toward fatalism in a confined space and place. This has to do with the fact that the separation creates the boundary and distance between the sea and the seabed. Given that the distance reproduces the logic of seeing from afar, this means that the exploitation of the seabed and its impacts stay on the seabed. This recreates the everyday apathetic notion of "it does not happen in my backyard."

Indeed, the same arguments have held true about the sea as the sea is out of sight and mind (Peters, 2017). Given such binary logic, the exploitation of the seabed is naturalized and normalized by such binary static and fixed logic of seeing the seabed (Childs, 2018; Carver et al.,

[20] As mentioned earlier, in conversation with Moore (2010), capitalism and capitalists are not one singular thing. While capitalism is the process that justifies the exploitation of one space as a site of production for the sake of the consumption site and capital accumulation. Capitalists are actors that sustain, maintain, conduct, and benefit from capitalisms.

2020). Contradicting such dominant geopolitical construction of seabed and sea binary, Sammler (2016) argues that:

"[O]cean movements are better represented as relational flows from the viewpoint of a small volume of water moving through a larger fluid background. This is in stark contrast to the perspective of space as a container that the modeler [governmental employees and legal experts] can view from the outside and where motions are imagined at fixed positions in spaces" (Sammler, 2016: 23).

In this way, the dominant geopolitical construction of the sea and the seabed in the international treaty here has represented the dominant politics of the seabed as static, fixed, and dividable rather than the fluid and dynamic movement of oceanic materials (Steinberg & Peters, 2015).

While oceanic space is moving space given the moving liquid seawater, destabilizing the fixed and static geopolitical construction of the seabed (Steinberg & Peters, 2015), the geopolitical construction of fixed and static spatial binaries is also underpinned by the geological scientific knowledge of the seabed. That is because this 'hard' science defines the seabed as a passive-and-ready exploit object (Childs, 2019) rather than a fluid and dynamic space. Such a passive and static view of the seabed can be seen through how Braathen and Brekke (2020), geoscientists, have defined what the seabed is on the law of the seabed (a geo-science book): "[T]he top-surface of the earth in seas and oceans, also known as the seafloor or ocean floor. This surface has a topography that is directly related to the nature of its subsurface geology. Both the topography and the subsurface are important factors in the use of the seabed by humankind" (Braathen & Brekke, 2020, p. 21). The top-earth surface of the earth beneath the sea here has arguably inheres the idea that material properties of the seabed stay on the seabed or beneath the sea. Thus, the geological knowledge of the seabed reproduces the fixity and stability of the seabed.

While the binary, static, and fixed logic of the seabed contradicts the very nature of the seabed, such political assumptions provide practical applicability for marine policies and seabed uses. For example, adopting the vision of the fixed and static seabed, legal and governmental experts can divide and allocate the seabed space for various marine uses through MSP (as briefly mentioned in Chapter 1 and further elaborated in Chapter 5). Meanwhile, beyond this practical policy formulation, the binary, static, and fixed logic of the seabed directs our views only on the geophysical properties of the seabed, removing fluid, volatile, and voluminous oceanic space *above* the seabed (Steinberg and Peters, 2015). Indeed, such visual direction means the capitalist industries can focus on what and why the geophysical properties of the seabed matter for their capital extractions. However, understanding the economic importance of the seabed here, indeed, demands technical practices to identify and assess the content of the seabed. For that reason, Braathen and Brekke (2020) invent lithography to not only map and identify the geological layers of the seabed, such as bedrock, sand, and sediment, but also to assess the composition and texture of the seabed. Such geophysical information about the seabed defines whether the seabed is or is not worthy of mineral extractive operations (Rice, Tyner, Munro-Stasiuk, Kimroy, & Sirik, 2016). Beyond mining, the information on the seabed texture also matters for other offshore industries. For instance, Giussani et al. (2020) demonstrate that the soft and solid textures of the seabed define whether undersea cables require heavy or light armor. Heavy and light armor here refers to the material (metal) layers encapsulating fiber cable optics to reduce friction and damage to the seafloor. Indeed, judging by its name, heavy armor means that the material layer of the undersea cables is thicker than that of the light armor. Therefore, the binary, static, and fixed logic of the seabed has allowed legal, governmental, and private actors to decontextualize the seabed as anything but a target for mining the environment (Sammler and House-Peters, 2023). This statement aligns well with Braverman's (2022) argument that the decontextualization of the ocean and seabed is beneficial for capitalist industries as they can stratify the order of importance based on the composition of seabed properties.

The dominant geopolitical construct of the seabed does not apply only to the spatial separation between the ocean and seabed but also to those within this space. Such essentialist political assumptions also define the dichotomy between living and non-living natural resources. For example, the law of the sea, UNCLOS (1982), article 77, mentions that:

"[T]he natural resources consist of the mineral and other non-living resources of the seabed and subsoil together with living organisms belonging to sedentary species, that is to say, organisms which, at harvestable stage, either are immobile on or under the seabed or are unable to move except in constant physical contact with the seabed or the subsoil" (UNCLOS, 1982: Article 77).

Such a description of "immobile" natural resources homogenizes every mineral and living organism as fixated objects that do not interact with each other. For that reason, the geopolitical construct of immobility inheres the idea that natural resources on the seabed are "*inert and passive targets for extraction*" (Childs, 2018, p. 19). Meanwhile, the notion of immobility is crucial for maintaining the appearance of geopolitical regulatory intervention in governing the seabed. That is because since immobile animals and minerals are relatively easier to control than moving ones, the notion of immobile life here recreates the assumed mastery and control of the law to regulate the ocean. This argument aligns well with the statement of Reid (2023): "The overarching legal framework is the United Nations Convention on the Law of the Sea, an international agreement still caught in the undertow of Western imaginaries of mastery and, therefore, inadequate to the task of enabling ways of living well with the ocean" (108). Therefore, the geopolitical construct of the seabed as fixed and static space and resources is crucial for delineating not only seabed territories but also enabling space and resource extractions.

While the seabed geopolitically prescribed by the UNCLOS has enabled the capitalist industries to use and extract seabed space and mineral resources by recreating the imaginary of the fixed and static seabed, few political geographers deconstruct such a dominant geopolitical definition and knowledge of the seabed prescribed by the legal and geological experts. While the meaning of the seabed is taken for granted, policy-makers and practitioners need the definition of the seabed to enable the way they govern and use the seabed. This argument aligns well with the argument of Conde et al. (2022) on questioning the ontology of the seabed:

"[E]ven before practical developments or adaptations [e.g., regulatory institutions, laws, and methods for stakeholder incorporation and risk assessment] are made fundamental decisions must be enacted about what precisely this place [seabed] is vis-à-vis established political-economic and regulatory norms, for the seabed has some qualities of land (it is a seabed with some degree of fixity), but it is also at sea (that wet, volatile, moving space), beyond habitable land, as well as beneath the ocean's surface" (Conde et al., 2022: 329).

Although questioning how the UNCLOS constructs the definition of the seabed is crucial in order to unpack certain political assumptions about the seabed, such ontological questions here arguably do not go far enough in deconstructing the geopolitical construction of the seabed. That is because the inquiries questioning the seabed focus on the taken-for-grantedness of the seabed by discussing what the seafloor means. This work is crucial as the term seafloor does not get adequate attention, although it has been used widely in policy interventions and practices. Meanwhile, the international treaty's construction of the seabed omits biological dimensions such as benthos (seabed-dwelling organisms), marine animals, zooplankton, phytoplankton, and deep-sea corals that co-constitute the seabed. Such a form of erasure on the seabed feature here echoes the work of Henry Jones (2022) in Braverman (2022), arguing that: "From Grotius to the UNCLOS, international law assisted in the process of striating the seas, making them featureless and amenable for capital" (6). For that reason, the most important thing is to contest, unsettle, and deconstruct the dominant geopolitical construct of the seabed. To do that, understanding what the seabed means also requires another view beyond the frame of the UNCLOS. Therefore, the next section aims to understand the seabed from the perspective of benthic ecologists. The view from benthic ecologists here further informs the conceptualization of benthic phenomena vital in this study. That is because examining the seabed as geo-politics demands a count of benthic phenomena, given that benthic phenomena can assist or resist certain geopolitical interventions of the seafloor through the diverse realities of the seafloor they create.

2.3.2 Shifting the tide from the seafloor to benthic habitats

While the dominant geopolitical construct of the seabed has engrained the static, fixed, and essentialist political assumption of the seabed, marine scientists do not see the seabed as a mere solid and soft top-earth layer under the sea. Instead, they see the seabed as a benthic habitat and ecosystem (Harris and Baker, 2012). The terms "benthic habitat" and "ecosystems" are obviously debatable within benthic ecology in itself. However, benthic habitats are often broadly defined as the relation between benthic animals (seabed-dwelling organisms) and their surroundings (e.g., the sea and the seabed), while benthic ecosystem indicates how benthic habitats also matter for other habitats beyond their specific spatial and temporal location (Dauvin et al., 2010). Given the complexity of what benthic habitat and ecosystem mean, understanding the word benthic is crucial as this term indicates certain invisible geographical concepts. For example, benthic (adjective) itself originally comes from the Ancient Greek, *βένθος*, which refers to the depth of the sea (Liddel, 2022). While the definition of what constitutes "benthic" is indeed dynamic rather than static, given that marine scientists have increasingly researched and developed knowledge about benthic habitats and ecosystems, benthic ecologists take the meaning of "*depth*" in benthic seriously to locate and identify *seabed-specific* marine habitats. Perhaps due to this specificity, NOAA (2021), America's Coastal and Ocean Agency, defines benthic as "anything associated with or occurring on the bottom of a body of water. The animals and plants that live on or in the bottom are known as the benthos" (1). Such understanding of benthic animals and plants and their association and interaction with the seabed exists today thanks to the academic contribution of Danish scientist Carl Georg Petersen, a so-called pioneer in benthic ecology (Rosenberg, 2001).

Debunking the myth of the ocean floor as a lifeless place, Petersen has contributed to our current knowledge of benthic communities. Benthic communities here refer to a group of benthos (e.g., benthic animals and plants) living on the seabed. Continuing Petersen's legacy on the knowledge of benthic communities, his Scandinavian zoologist assistants, Molander (1928) and Thorson (1957), opened the global ecological perspectives on benthic communities in the world ocean by identifying benthic communities beyond Danish marine water (Gage, 1972). Molander and Thorson's work, seminars, books, and publications further inspired many marine scientists in the world to research benthic communities in Scandinavian countries. Since marine scientists have become interested in benthic ecology, the work of benthic communities developed by Petersen and his colleagues here further traveled beyond Scandinavian countries. This benthic ecology research shines light on the importance of the benthic ecosystem for ocean and planetary health. Among many marine scientists, in 1955, Howard L. Sanders, an evolutionary biologist, developed a model using benthos as ecological indicators to assess the long-term biological and environmental consequences of oil spills that are still used today (NAS, 2024).

The growing field of benthic ecology has not only given insight into rich and unfamiliar benthic biodiversity. Such benthic knowledge has also challenged certain geopolitical constructs of the seabed that were informed by the international treaty and the law of the seabed (a geological book). For example, while the UNCLOS has separated living and non-living natural resources of the seabed through its notion of what is deemed "immobile" as outlined in Article 77 (and discussed in the prior section), the hydrothermal vent of the seabed defies such essentialist, fixed, and static view of the seabed. This has to do with the fact that such material substances produced by the hydrothermal vents here not only dynamically move within the sea column, disrupting the notion of static and fixed seabed, but also complicating the essentialist political assumptions made between living and non-living resources. That is because organic and inorganic compounds produced by the hydrothermal vents are also found in human amino acids and genes, which scientists believe as 'the origin of life'. As Purvis et al. (2024), benthic scientists explains:

"[T]he mixing zone between bicarbonate and CO_2-enriched seawater…and the hydrogen-rich fluids from hydrothermal vents is one compelling potential environment of the origin of life. Organic compounds in modern AHV [alkaline hydrothermal vent] fluids of the Lost City hydrothermal vent [for instance] are dominated by C_9-C_{14} aliphatic hydrocarbons, C_6-C_{16} aromatic compounds and C_8-C_{18} carboxylic acids, a fraction of which may have produced abiotically" (Purvis at al., 2024: 2).

While living and non-living resources geopolitically constructed by the UNCLOS also indicate the dichotomy between geology and biology, the hydrothermal vent deviates from this binary logic. That is because the hydrothermal vent has both the quality of fixed and solid rock-like features and some quality of decomposable, volatile, and moving organic compounds (e.g., aliphatic hydrocarbon and carboxylic acids). Since the mixing zone between organic and inorganic compounds is the building block of human amino acids, these organic and inorganic materials showcase how the seabed also exists within our bodies. However, beyond this cellular relation, these organic and inorganic materials matter for the benthic ecosystem and the planetary environment in which we are living. For instance, Tunnicliffe et al. (2024), biologists, have showcased how organic and inorganic materials are vital for the production of phytoplankton. That is because phytoplankton use the organic and inorganic materials produced as their nutrients for biomass growth. Therefore, since phytoplankton produces 70% of the oxygen we breathe in terrestrial land (Sekerci & Petrovskii, 2015), the hydrothermal vent ecosystem determines human quality of life and survival.

2.4 The benthic habitats challenge the binary logic

The deviation from the binary and flat logic of the seafloor also exists, given the relationship between benthic animals and their surrounding (the seafloor, the area above and below the seafloor). For instance, using deep-sea camera monitoring devices, deep-sea biologists from Alfred Wegener Institute (AWI), Germany, Purser and Boetius (2023) have showcased how marine nodules matter for the survival of deep-sea (Casper) octopus populations as these potatoeslike rocks become the octopus's spawning and sheltering ground. The relationship between deep-sea octopuses and marine nodules here has indicated how marine nodules are not mere rocks or non-living natural resources on the bottom of the sea but also a habitat for these benthic organisms. Meanwhile, since the benthic habitat is crucial for developing environmental impact assessment for deep sea mining, Purser continues his work on revealing unique benthic life forms in the deep. As Buehler (2021) documented in Purser's work:

"At one site under the Flichner ice shelf – ice floating in the Weddell Sea – one of Purser's teammates noticed something. Circular nests kept showing up on camera. They belonged to Jonah's icefish (*Neopagetopsis ioanah*). These fish are only found in the Southern Ocean and Antarctic waters. Traits they adapted to survive the extreme cold included the development of clear blood full of antifreeze compounds" (Buehler, 2021: 1).

In this way, the existence of icefish here indicates that separating the geological aspect of the seafloor from its biological aspect is impossible. This, of course, challenges the binary logic of the seafloor inserted by the dominant geopolitical construct of the seafloor. Additionally, as the ice fish can also swim above the seafloor and dig the seafloor, the ice fish also becomes a reminder that the seafloor has its volume and depth.

While the benthic ecologists above create the knowledge of the benthic habitat that contests the flat and binary geopolitical construct of the seabed, this approach has limitations in that their attention is fixed on the material relationship between benthos and their habitats. That is because their interpretation of benthic habitats is mostly influenced by marine scientists' ideology on "ecology". According to Nurmi (2020), the shared ideological and philosophical concern of ecology in marine science, including benthic ecology, is that "*nature*" should be devoid of humans. With this ideology, of course, the interpretation of the habitat and the inhabitance of the seafloor are mere marine animals and plants. In other words, benthic ecologists do not interpret the reality of the seafloor and its inhabitants beyond the scope of benthos and habitat relationships. With such understanding, Nurmi argues that "[S]uch human nature [benthic ecologists] prevents us from telling the story of "nature" in a way that generates action" (4). Perhaps this is because of the belief that benthic habitats are purely marine animals and plants and their surroundings. However, disregarding human and seafloor interactions in itself in an attempt to create the ideology of pure nature (the seafloor) also neglects humans (benthic scientists) are inseparable from the process of observing the benthic habitats, including the existence of the icefish and hydrothermal above.

Even when considering the international treaty (the Law of the Sea) above, human and seafloor interactions already exist directly and indirectly. Beyond the scientific and legal intervention on the seafloor, human and seafloor interventions have manifested in the long-established and emerging seafloor uses. For instance, while the UNCLOS has provided geopolitical stability in accessing oceanic space, including the seafloor, human interventions have long existed beyond such geopolitical interventions. The transatlantic telegraph cable was laid in the 1850s, and since then, transoceanic cables have proliferated, spanning much of the globe yet largely invisible (Starosielski, 2015). The seabed's invisibility is crucial for the undersea infrastructure, given that it sets up conditions under which the infrastructure is hidden and safe from public disturbances (Barry, 2013; Childs, 2019; Barry and Gambino, 2020).

Beyond these established infrastructures, emerging seabed uses have also sprung up worldwide. In Florida, Neptune Memorial Reef company has created undersea cemeteries, allowing one's ashes to be formed into substrates for coral reef growth, purporting ecosystem restoration (Nmreef, 2022). Furthermore, the discovery of wine from the Titanic shipwreck has catalyzed the undersea wine aging industry in France, America, and Italy, where the cold, dark properties of the deep are put to use as a surrogate cellar (Puckette, 2020; Pomranz, 2021; Kassam, 2021; Thompson, 2021). As a new mining frontier, Japan has already begun extracting marine nodules from over 2000 meters below the sea, preceding proposed deep-sea mining projects in Papua New Guinea (Carver et al., 2020) Tonga, Cook Islands, Nauru, and Kiribati and, more broadly, across the Pacific Basin (Sammler, 2016a). In this way, while the long-established and emerging utilization of the seabed here indicates the habitat and inhabitants of the seafloor are not devoid of human interventions and activities, the current marine science (i.e., benthic ecology) does not necessarily expand the reality of the seafloor beyond marine animals, plants, and their habitats.

2.5 Toward benthic phenomena

While the series of phenomena indicate the seafloor's habitat and inhabitance contest both the seafloor's geopolitical construct and the ideology of pure nature often showed in marine ecology, why do such constructs and ideas matter? How do they change and redefine our understanding of and relation to the seafloor? Indeed, speaking of phenomena, as mentioned earlier in Chapter 1, Barad (2007) asserts that phenomenon is "[t]he objects and measuring agencies emerge from rather than precede" (128). Such an understanding of what phenomena mean here is crucial. That is because one begins to understand that the ice fish, the hydrothermal vent's product as the origin of life, the relationship between marine nodules and deep-sea octopus, the international treaty, and the existing and emerging use of the seafloor bring up to the surface as the product of the objects and measuring agencies. This means without the interaction between the object and measuring agencies, diverse understanding concerning the seafloor cannot emerge. For example, our understanding of the nest of the ice fish cannot emerge without the effort of Pulser in documenting the benthic species through his underwater (deep-sea) camera. In this way, Pulser and his underwater camera are the measuring agencies while the ice fish nest is the object. Altogether, the icy fish, Pulser, and his underwater camera are the phenomena. **Therefore, these phenomena allow us to remediate embedded divisions between humans, benthic habitats, and the seafloor.**

As the agency is not only the province of human consciousness and intention to act (Yusoff, 2013; Nowak and Roynesdal, 2022), the object within the phenomena can also become a measuring agency. For example, as mentioned previously, the building block of amino acid produced by the hydrothermal vent can be a measuring agency that challenges and contests the dominant geopolitical construct of the seafloor prescribed by the international treaty. That is because the UNCLOS separates the geological and biological aspects of the seafloor. The organic compound produced by the hydrothermal vent indicates that the seafloor is a mixture of geology and biology. Additionally, the movement of the ice fish from the seafloor to the sea column also challenges the notion of the immobile object used by the international treaty to describe the natural resources as passive and read-to-exploit objects. For that reason, understanding such phenomena is crucial to challenge the dominant binary logic separating the seafloor from the rest of the world and from humans. Also, as phenomena occupy the depth of the sea (benthic) and vice versa, the depth of the sea occupies them. For that reason, I interpret these phenomena as "benthic phenomena". Therefore, benthic phenomena are broadly defined as any emergent measuring agencies (e.g., human bodies, animals, technologies, events, and ideas), interacting with, relating to, and/or associated with the depth of the sea (benthic) that continuously reconfigures multiple realities of the seafloor. In this way, benthic phenomena feature animals, plants, sands, seawater, minerals, humans, human ideas, actions, technologies, and events on the seafloor and the depth of the sea.

Of course, the insight concerning benthic phenomena expands how benthic ecologists capture benthic habitats by not only focusing on the material relationship between benthos and their seafloor and aqueous surroundings but also capturing our relation with the seafloor through such benthic phenomena. Indeed, since such relations are mediated by oceanic water, benthic phenomena, as mentioned in this study, remind us of the depth and the volumetric space of the seafloor. The volumetric space here also means that the seafloor is filled with the relations between humans, animals, plants, technologies, ideas, and politics. Thus, the seafloor is not as static, flat, and binary as prescribed by the dominant geopolitical construct of the seafloor.

The conceptual development of benthic phenomena here expands and underpins the previous work on islands, critical ocean studies, queer ecologies, and science and technology (STS) scholarship that have used certain oceanic phenomena to tell different stories of humans and ocean relations and even utilized oceanic phenomena to inform their perspectives to see social and political problems differently. Such oceanic phenomena-informed perspectives in social science communities have resulted in multiple oceanic concepts including but not limited to 'sea as a theory machine' (Helmreich, 2011), 'more-than-wet ontologies' (Peters & Steinberg, 2019), 'bodies of water' (Neimanis, 2017), 'our sea of islands' (Hau'Ofa, 1999), 'the impression of cup corals' (2010), 'rainbow's ecology' (Cohen, 2013), 'the wired world' (Starosielski, 2015), and 'oceanic matter and meaning' (Sammler, 2020). This work has contributed in offering a further and different lens to research diverse social phenomena from colonialism, imperialism, and capitalism. This means social science communities here have expanded the use of the ocean beyond the onto-epistemological constraint of the ocean within marine science. For example, Hau'Ofa (2008) observed and thought about the birth of islands from the sea to rupture island and sea binary, put to use to maintain and structure the confinement of Pacific Islands:

"[N]amely Europeans introduced the view of "islands in a far sea". Later on, continental men—Europeans and Americans—drew imaginary lines across the sea, making the colonial boundaries that confined ocean peoples to tiny spaces for the first time. These boundaries today define the island states and territories of the Pacific. If this very narrow, deterministic perspective [separating ocean and islands] is not questioned and checked, it could contribute importantly to an eventual consignment of groups of human beings to a perpetual state of wardship wherein they and their surrounding lands and seas would be at the mercy of the manipulators of the global economy and "world order" of one kind and another" (Hau'Ofa, 2008: 32).

The work of Houfa here has contributed to current work on island studies and inspired many activists to reflect on how oceanic phenomena provide theories for seeing human problems differently. For example, DeLoughrey (2017) turned to:

"[K]amau Brathaite's theory of "tidalectics" [inspired by the tidal wave, recurring waves that create shallow water given the moon and earth gravitational pool]", a methodological tool that foregrounds how a dynamic model of geography can elucidate island history and cultural production, providing the framework for exploring the complex and shifting entanglement between sea and land, diaspora and indigeneity, and routes and roots" (Deloughrey, 2007: 17).

While island studies have utilized oceanic phenomena to formulate the theory of sea and island relations as a resistance to colonial binary perspectives, political and human geographers have also developed oceanic phenomena-based perspectives. For instance, Peters and Steinberg (2019) *think with* the ocean in excess to indicate how the ocean teaches us about "being in the world", implying that ocean space reminds us that we are connected to the ocean and other spaces. As they argue: "[W]e have suggested that thinking from a perspective informed by the ocean's material and phenomenological distinctiveness can facilitate the reimagining and re-enlivening of a world and our being-in-the-world" (2). Their argument on a perspective informed by the ocean's material and phenomenological distinctiveness also indicates the fusion between ontology and epistemology—onto-epistemological approach (Barad, 2007; Sammler, 2020b). That is because the ocean does not become an object where interventions are deployed. Instead, the ocean also actively informs the interventions created by human actors.

Concurrently, the reflection on oceanic phenomena contests the nature and culture binary. That is because the human culture of thinking about the ocean shapes the oceanic environment, and vice versa, the oceanic environment also shapes the human culture. For example, if the ocean is divided and allocated by the UNCLOS for certain marine uses, this culture of human intervention can affect and change the use of the ocean and affect the ocean environment to some extent. While contesting a nature and culture binary seems a trivial issue, in actuality, such logic has structured and maintained certain racial, religious, sexual, and gender minority violence and discrimination. For instance, Hayward (2010) argued how the essentialism of “natural” and “unnatural” has become the justification for the discrimination and violence in non-heterosexual and non-conforming gender communities. For that reason, queer ecologies scholars such as Mortimer-Sandilands, Erickson, and Cohen (2010), among others, have reconceptualized the concept of *ecologies* to emphasize nature and culture relations and reject nature and culture dichotomy. In fact, Mortimer-Sandilands & Erickson (2010) argue ecology is by definition ‘queer’ because ecology deviates from essentialism, separating nature and culture and other binary (geo/bio) divides. Meanwhile, parallel with island and critical oceanic material studies above, queer ecologies have also reflected on oceanic phenomena to contest and disrupt certain essentialist political assumptions on human reproduction and the environment. For instance, queer ecologies scholars have informed their work through the non-heterosexual reproduction of marine animals such as cup corals, starfish, grouper fish and other marine animals to challenge the essential separation between natural and unnatural sexual reproduction, criminalizing non-confirming sexual and gender identities (Chisholm, 2010; Hayward, 2010, Garvey, 2012; Hayward, 2008a, 2008b; Mortimer-Sandilands & Erickson, 2010; Wilson, 2002; Wissenburg, 2012). Additionally, queer ecologies scholars have used oceanic phenomena as a form of resistance toward essentialism that enables environmental issues. The expansion of the queer ecologies work beyond sexual violence problems toward environmental issues is possible due to the work of Hunt and Holmes (2015) redefining what queer means:

“[W]hile queer is often used as an identity or umbrella term for non-normative sexual and gender identities [Lesbian, Gay, Bisexual, Trans, and Queer or LGBTQ+], it emerged as a critique of the essentialist constructs and identity politics. As a verb, queer is a deconstructive practice focused on challenging normative knowledge, identities, behaviors, and spaces, thereby unsettling power relations and taken-for-granted assumptions. Queerness is then less about a way of being and more about doing and offers the potential for radical critique” (Hunt and Holmes, 2015: 56).

Given the reconceptualization of queer as a deconstructive practice to unsettle power relations and taken-for-granted assumptions, diverse scholars have contributed to queering certain dominant essentialist political views of nature, catalyzing environmental issues. This argument also echoes the work of thinking with the bodies of water beyond the embodiment (Neimanis, 2017). As Neimanis (2017) argue:

"[G]iven the various interconnected and anthropogenically exacerbated water crises that our planet currently faces – from drought and freshwater shortage to wild weather, floods, and chronic contamination – this meaningful mattering of our bodies is also an urgent question of worldly survival. I reimagine embodiment from the perspective of our bodies' wet constitution as inseparable from these pressing ecological questions. [That is because], we are bodies of water. As such, we are not, on the one hand, embodied (with all of the cultural and metaphysical investments of this concept) while, on the other hand, primarily comprising water (with all of the attendant biological, chemical, and ecological implications" (Neimanis, 2021: 1).

The work of Neimanis above not only expands the concept of embodiment as introduced by feminist scholars (Dixon, 2016; Sharp, 2022) but also indicates how the sea physically connects our bodies through the hydrological cycle of the sea from evaporation, precipitation, and rain. Here Neimanis *queers* the notion of distance inherent between the ocean and humans. Instead, through such hydrological relation, Neimanis wants to show how any contamination and pollution of the ocean also affects human bodies. Additionally, since ocean environmental issues keep emerging given the certain dominant political construct of ecological assessment, Neimanis (2021) further reflects on the queer temporality of the deep-sea, arguing: "[T]he undersea chemical dumps help us fathom how the slow and the spectacular are always queerly tangled, and how any unidirectionality of damage is more uncertain that a seemingly straight temporality of slowness would suggest" (1). Neimanis work here shows how ocean temporalities can go beyond the assumed human capability of controlling and mitigating ocean ecological issues, which tends to underestimate the impacts of waste dumping in the deep ocean. Beyond the watery and temporality dimension of the ocean, the work of queer ecology scholars reflects on other textures and forms of the ocean to decenter certain dominant constructs of "nature." For instance, given that the embedded notion of 'green' in nature has directed environmental conservation activism exclusively to care about the terrestrial land environment, occluding other nature, Cohen (2013) developed “the ecology's rainbow” to direct our attention within and beyond the notion of green nature:

“Why not violet-black (the deep sea)? the problem with “green” is not only that it has been oversold as a lumping term, thereby foreshortening one's sense of other spectrum/spectral possibilities. Ecology as green also perpetuates the implication of binary nature-culture separation (simplistic for both sides of the human-nonhuman divide) and understates the potential for self-intoxicated fetishization of greenery as such, especially when channeled into out-of-control feats of bioengineering” (Cohen, 2013: 1).

Such work critically rejects the dominant political assumption of nature that structures and maintains environmental violence in the ocean, as the ocean does not fit the social construct of green nature.

With a shared way of onto-epistemological approach in islands, critical ocean studies, queer ecologies, and science and technology scholarship, an approach focused on benthic phenomena expands this previous work from understanding our relation to the ocean toward our relations to the seafloor. Thus, this chapter and this thesis have moved the social ocean studies farther and deeper offshore. Of course, practically, benthic phenomena have disorientated us from what the UNCLOS has told us about the seabed. However, disorientation matters in creating a new direction of seeing and sensing the seabed. This statement aligns well with the work of Ahmed (2006b), queer scholar, arguing that:

“[W]hen we are orientated, we might not even notice that we are orientated: we might not even think “to think” about this point (5). That is why “moments of disorientation are vital…the point is not whether we experience disorientation (for we will, and we do), but how such experiences can impact on the orientation of bodies and spaces, which is after all about how the things are “directed” and how they are shaped by the lines they follow. The point is what we do with such moments of disorientation, as well as what such moments can do–whether they can offer us hope of new directions and whether new directions are reason enough for hope” (Ahmed, 2006b: 158).

In this way, although benthic phenomena are disorientating, especially given that benthic phenomena defy such essentialist, static, and fixed political assumption of the seabed, such disorientation enables us to *reorientate* our ways of seeing the seabed beyond the dominant geopolitical construct of the seabed. In other words, one can see the seabed as what this marine space is rather than what the UNCLOS and other forms of geopolitical construct tell us. Therefore, benthic phenomena can enable us to understand how certain geopolitical orientations direct us into believing binary static and fixed political assumptions of the seabed, but crucially can upend these constructions to better grasp how such logics shape the way the seabed is utilized and exploited. Primarily, in this study, benthic phenomena can contest how the seafloor off the Bangka and Belitung islands have been merely imagined as the tin extractive sites, flattening another form of seafloor and human relations.

2.6 Conclusion

2.6.1 Benthic reflection

Bringing together islands, queer ecologies, critical ocean studies, and science and technologies studies within new materialist geopolitics, this chapter conceptualizes benthic phenomena to provide an ecological understanding of the seabed in *geo*-politics. The examination and conceptualization of the benthic phenomena here are vital in expanding the new materialist geopolitical inventions, forming part of my original and significant contribution to knowledge in this study as such endeavor expands the interpretation of bodily, volumetric, elemental, temporal, spatial, and technological geopolitics of the seabed toward the ecological understanding of the seabed, one that is nonetheless material. While such an ecological understanding of the seabed allows us to contest, challenge, and unsettle the entrenched geopolitical construct of the seabed prescribed by the UNCLOS, the question of how to operationalize the benthic phenomena in research and activism still remains unresolved in this chapter. For instance, how can one apply such benthic phenomena in political geography and policy intervention concerning the utilization of the seabed? In what way do benthic phenomena enable political resistance toward extractive seabed activities? Or in what way does it help us dispel the dominant geopolitical construct of the seabed that systemically and structurally maintains and sustains the seabed exploitation and affects those residing on the seabed and beyond? Perhaps one of the most important questions is why benthic phenomena here make us care about the seabed and why caring about the seabed matters in the first place. The series of questions here requires a critical reflection on why one should care for the seabed.

Since critical reflection is, indeed, never an individual activity, as argued by Barad (2007), given that reflection often requires something and someone to reflect on. This means one should rethink various benthic phenomena permeating through our everyday lives. For example, we must reflect on why it matters to understand that the organic and inorganic materials of the seabed are the origin of our lives or that we share our genes with the seabed. Why should we care about knowing that the oxygen we breathe daily depends on healthy benthic ecosystems? Or what is the point of understanding that the benthic ecosystem absorbs the carbon emissions we produce? What do all these various benthic phenomena mean to us (humans)? Indeed, the questions here challenge us to think deeply about our relation to the seabed. And perhaps, some of us might not have the answer as this reflection can create a forever disorientation. However, one thing is for sure, from this reflection, we find the seabed in ourselves, from the carbon and hydrogen chain forming amino acids and genes in our bodies, the air we breathe in and out, the temperature we feel, and beyond. *We are the seabed*. Such a relation is crucial because we may realize that the seabed is intimate and internal to our bodies, interacting with ourselves and sustaining our lives. That is why as we are not exterior to the seabed and the seabed is not external to us, such onto-epistemology of the seabed provides the ethical-political positionality to care about the ongoing, long-standing, and emerging seabed utilizations. That is because what happens to the seabed can also happen to our bodies. This intimate relation hopefully creates global resistance toward seabed exploitation and extraction. After all, if geopolitics is about conflict and war (Dodds, 2007; Elden, 2013), reflecting on benthic phenomena could help us question what war and conflict are worth fighting for humankind. Perhaps the worthy war and conflict we can fight for is to resist the dominant geopolitical construct of space and place that sustains and structures certain social and environmental violence often invisible from our eyes, including seabed exploitation.

While such reflection matters and offers ethical political positionality to care for the seabed, the most important thing is how reflecting on benthic phenomena creates tangible action in research and activism. Indeed, both research and activism here should ideally be queer, as the practice of research and activism often require information and knowledge to create political action. Given such concern on how to operate and translate benthic phenomena in practice, I argue that investigating benthic phenomena provides some tangible steps to understand how certain geopolitical construct of the seabed structures and maintain seabed exploitation. For example, since benthic phenomena remind us of how the UNCLOS has orientated our views on seeing what the seabed is through their binary, static, and fixed logic, this understanding enables us to assume that diverse scales of governance follow this geopolitical orientation (direction). That is because the international treaty has become the top-down hierarchical geopolitical order for its coastal state members and the ocean in general. This means the geopolitical construct of the seabed the treaty prescribed can also be used as a way of governing, managing, and using the seabed. For that reason, one can then trace in what way, where, when, and how policy interventions and practice have applied the binary, static, and fixed logic of the seabed prescribed by the UNCLOS and the Law of the Seabed in managing, governing, and using the seabed. This means one can investigate how such binary, static, and fixed logic propagates ecological violence and in what way certain benthic phenomena can assist and resist seabed exploitation. Therefore, investigating benthic phenomena allows one to understand how certain material practices and policy interventions of the seabed, such as deep-sea mining, undersea cables, submarine pipelines, and beyond, have been adopting such static, fixed, and binary logic in their practices and how certain benthic phenomena can enable us to contest and deconstruct this logic through how the seafloor use create interaction and relation with the seafloor.

2.6.1 Benthic manifestation in the Indonesian context

Perhaps, in Indonesia, the geopolitical construct of the seabed above prescribed by the UNCLOS manifests in the designation and enforcement of current central, provincial, and trans-regional marine spatial plans such as KKPRL (*Ketentuan dan Kesesuaian Penggunaan Ruang Laut—The requirement and suitability of Marine Space Use*) and RZWP3K (*Rencana Zonasi Wilayah dan Pulau Pulau Kecil—Regional and Small Islands Zonation*), RZ AW (Rencana Zonasi Antar Wilayah—Transregional Zonation Plan). That is because these marine spatial planning policies and mapping operate with the same logic by rendering the sea as dividable, fixed, and static space. For instance, the KKPRL plays a central role in defining, separating, and allocating ocean space in Indonesia into different zonations such as "marine tourism, sea harbor, fisheries sea harbor, offshore oil and gas, mining, fisheries, aquaculture, industry, airport, energy management, dumping area, fishing household, and public facilities" (KKPRL, 2021, p. 15 Article 8, author translation). Despite the zonation, in practice, these marine uses interact with each other and with the seabed. In this way, such separation does not work as benthic phenomena continue seeping through or oozing the zonation the marine spatial planning creates.

The difference between provincial, trans-regional, and central marine spatial planning lies in the types of authority, the scale of their spatial intervention, and the jurisdiction of the authority. For example, RZWP3K on the Bangka and Belitung Islands in Indonesia governs the coastal marine environment of islands from 0-12 miles (PERDA, 2020). This distance means that the provincial governor of the Bangka and Belitung Islands can exercise their jurisdiction or the right to control and manage their coastal marine environment from the coastal line of their island to 12 miles offshore. With this spatial jurisdiction, the provincial government defines where, how, and who can access their coastal marine environment. Meanwhile, given that Indonesia has over 17,000 islands, the provincial jurisdiction here often overlaps with another provincial jurisdiction. For example, Sumatra and the Bangka and Belitung Islands are connected by the Bangka strait. In this way, as the jurisdiction of the Bangka Strait is governed based on RZWP3K, the spatial conflict between the two provinces can exist because the Bangka Strait belongs to two overlapping provincial authorities.

To reduce the spatial conflict here, the Indonesian President has implemented RZ AW (Perpres, 2022) to govern the strait, sea, and bay in the Java Sea. That primarily is because the sea distance between one island and another is still within 12 miles. While RZ AW enables the central government to govern the maritime borders of the neighboring provincial islands, the large ocean area and a number of islands have complicated the central government of Indonesia in governing, monitoring, and ensuring the utilization of the sea. For that reason, the Indonesian central government, including the Ministry of Fisheries and Marine Affairs, the Ministry of Living Environmental, and The Ministry of Maritime and Coordination, have designated the KKPRL to assess whether the utilization of the sea matches the zonation plan. Since KKPRL is the Indonesian constitution, KKPRL is integral in not only ensuring the practice of ocean uses within provincial and trans-national but also beyond the sea beyond 12 miles from the coastal line, including the sea beyond national jurisdiction. Thus, the designation of KKPRL follows the UNCLOS (KKPRL, 2021).

While the provincial, trans-regional, and national marine spatial planning in Indonesia does not mention the seafloor, these zonation plans also contribute to the utilization of the seafloor. That is because they are in charge of designing, dividing, and allocating marine spaces for seafloor use using their marine spatial planning policies and maps. For example, KKPRL governs the practice of offshore oil and gas and mining. Meanwhile, KKPRL also provides routes and corridors for undersea cables and undersea pipelines. The utilization of the marine spatial planning policies and maps here has reproduced the geopolitical construct of the seabed as the government using such legal instruments also renders the seabed as static, fixed, and dividable spaces. In this way, since benthic phenomena can only be understood through empirical examinations of the relation between seabed uses and marine zonation relation in reproducing the geopolitical construct of the seabed, this monograph uses the case study area of Indonesia, primarily the Bangka and Belitung Island in Indonesia as a site of where benthic phenomena exist and how it interacts with certain geopolitical interventions of the seafloor. Therefore, the next chapters of this thesis show how benthic phenomena come to life in this study. Chapter 3 provides how benthic phenomena are translated into methodology, so-called benthic methodology.

Benthic methodology is informed through thinking with benthic phenomena in collecting empirical information for this study. Primarily, as this chapter reminds us that *we are the seabed*, through reflecting on benthic phenomena, this also means I am also part and parcel of benthic phenomena as my ethnography indicates that I am also interacting with and relating to the seabed through observing my interlocutors' activities, experience, and perspectives on the seafloor. In this way, I am also translating and operating benthic phenomena into this study methodology. This provides a crucial way of how to conduct research in geopolitical studies. For example, I analyze both hierarchical geopolitical approaches through policy analysis on PERDA (2020), OECD mining guidelines, and ITA interventions on offshore tin mining operations and interviews with directors of offshore mining operations, governmental employees, academics, and non-profit organizations. I also conduct interviews, focus group discussions, participant observation on the mining ships and floating rafts, and even dive into the seabed. This means while I explore how the hierarchical interventions about the seabed uses are mediated by their reports, ethnography allows me to capture the bodily presence of mining actors interacting with the seabed with their technologies (e.g., CSD, BWD, and rudimentary equipment) and my corporeal presence on the seabed using scuba diving. Therefore, such a methodology indicates benthic phenomena as I have to move from the material site of the sea and the seafloor to the site where certain interventions are thought, written, and deployed to intervene in the use of the ocean floor.

Benthic phenomena also manifest in Chapter 4. That is because the apparatus used to sense and extract the seafloor indicates the inextricable relation between observers (e.g., mining crews and mining navigators), observing instrument (e.g., digital twin technology and cutter suction dredgers), and the observed object (the seafloor) (see what the apparatus of offshore tin mining operations is in Chapter 4). This also means that when I was observing such apparatus in offshore tin mining operations, I became part of the apparatus where my relation with the seafloor was also mediated by how mining navigators interpret, identify, estimate, and extract the seabed tin ores. Therefore, such interactions through the apparatus of offshore tin mining operations also indicate benthic phenomena as human bodies, tin ores bodies, and sensing devices become measuring agencies, which redefine what seafloor means. Additionally, Chapter 4 also argues that the apparatus of the offshore tin mining operation does not end in the physical site of the offshore tin mining operations. Instead, the data about tin production also transcends beyond the material sites of the tin recovery to the office of mining companies. The data is crucial to lobby and negotiate the expansion of mining concession areas and mining investment within and beyond the Bangka and Belitung islands because the tin production information indicates whether offshore tin extractions contribute to revenue generation for international and national tin buyers and tax payment for the provincial and central authority. Hence, the apparatus of offshore tin mining operations connects actors within and beyond the Bangka and Belitung islands and, more importantly, is crucial for shaping the seabed as a site of offshore tin extractions.

While our understanding of benthic phenomena is mediated by the apparatus in offshore tin mining operations in Chapter 4, Chapter 5 provides a different point of view on the benthic phenomena through tin diving operations. Indeed, in Chapter 5, I argue that tin diving operations are benthic phenomena. That is because tin diving operations consist of tin divers (humans) and rudimentary diving technology, as well as the volumetric space of the seabed. This means that such bodily experience of tin divers also interacts with and redefines what the seafloor means through how these divers suction the seafloor and, to some extent, become part of the seafloor. Meanwhile, given that large-scale seabed mining operations in Chapter 4 and artisanal offshore mining operations (i.e., tin diving operations) in Chapter 5 produce sediments plumes, Chapter 6 focuses on how plumes complicate the geopolitical governance of offshore tin mining operations. That is because as OECD and MSP create an intervention by recommending and forcing offshore tin mining operations to follow their mining standards (e.g., environmental impact assessment (EIA), personal protective equipment (PPE), and mining permits, this intervention assumes that tin extractions are governable and manageable. In other words, the geopolitical interventions recreate the straight and fixed line of time and space to make the responsible appearance of offshore tin extractions.

While complying with existing governance regimes above recreates an assumed control capacity of seafloor tin mining operations, especially to exist in specific seafloor sites and times, the spatial and temporal movement of plumes defies such static assumption of the offshore tin mining operations. That is because plumes can move beyond the spatial and temporal remit of offshore tin mining operations. The way plumes can permeate into multiple spatial and temporal boundaries here indicates that plumes are benthic phenomena. This is also not to mention, for instance, in Chapter 6, plumes can become measuring agencies that redefine the reality of the seafloor. Primarily, the movement of plumes on and above the seafloor, the seawater column, and beyond indicates the seafloor is dynamic, fluid, and volumetric. In Chapter 6, I argue that current geopolitical interventions should count existing plumes as much as they count the commercial value of tin ores produced by offshore tin mining operations, especially if the geopolitical actors are serious about the governance of the offshore tin recovery. Ultimately, each chapter of this study ultimately enables us to understand the intersection between benthic phenomena and geopolitics, which I previously referred to as benthic geopolitics. This means one can understand how the seafloor becomes contested territory through multiple realities of the seafloor that benthic phenomena create. Concurrently, one can also capture that benthic phenomena off the Bangka and Belitung islands are literally emergent with multi-scalar geopolitics of offshore tin extractions. Thus, one may understand that certain spatial conflict of the seafloor off these islands exists given the multiple geopolitics of the seafloor.

Chapter 3 Benthic methodology: Thinking with benthic phenomena

3.1 Introduction

The previous chapter explains what benthic phenomena mean to this project. It addresses the binary logic between humans and the seabed prescribed by the international treaty. This understanding aligns well with what Sandilands (2016) and Sammler (2024) argue about the inextricable relationship between "geo and bio". However, how might thinking with benthic phenomena be operationalized to remedy shortcomings in existing work? How might it be explored in the methodological approach of this study? In science and technology studies (STS), using the ocean as a theory in research is not uncommon. For example, Helmreich (2011) posits:

> "[T]oday technical, scientific descriptions of water's form prevail. For example, processes of globalization—which may also be called "oceanization"—are often described as "currents," "flows," and "circulations." Examining sea-set ethnography, maritime anthropologies, and contemporary social theory, I propose that seawater has operated as a "theory machine" for generating insights about human cultural organization" (Helmreich, 2011b: 132).

While Helmreich's statement above argues that the sea can be a theory machine, oceanic phenomena like benthic phenomena, in particular, are rarely used as methodological approach in the new materialist geopolitics. Therefore, in this chapter, I contend that benthic phenomena can offer a methodology for studying the geopolitics of the seabed through thinking with benthic phenomena. This means I (as a researcher) acknowledge that I am part of the benthic phenomena. That is because my relationship with the seafloor is mediated by the interlocutors I talked with and observed during my ethnography fieldwork. Indeed, according to Hammersley (2018), while there is no consensus on what ethnography means, given the diverse ontology and epistemology of this term, ethnography should be treated as a research strategy. As a research strategy, ethnography requires the researcher to be in naturally occurring settings and use different qualitative methods such as in-depth interviews, semi-structured interviews, participant observations, and collaboration (Clifford et al., 2016). However, the idea of being in a naturally occurring setting is also contested as ethnographers, especially during the COVID-19 pandemic, depend on social media communication to collect data from their interlocutors (Forberg and Schilt, 2023). In remote and inaccessible areas such as sea and seafloor, digital technologies also provide a way of collecting such data and conducting ethnography (Squire, 2017). Thus, I argue that ethnography is a research strategy that enables researchers to combine different methods in a physical setting and a digital setting to better understand the experience and perspective of participants on certain topics, such as the use of the seafloor and its spatial conflict. Therefore, ethnography enabled me to interact with the seafloor and its users, and such interaction represents benthic phenomena.

Concurrently, as benthic phenomena continue moving from different time and space (e.g., land, sea, and air), thinking with benthic phenomena in methodology demanded me to interview and engage with elite actors [21](e.g., state government, non-profit organizations, and business actors) in their offices and via online meeting. In addition to that, I had to interview and engage with actors interacting with the seabed daily, such as tin divers, large-scale seabed tin miners, and undersea cable engineers offshore. Such methodology also requires me to be “bodily present”, as borrowed from Pérez and Zurita (2020), to experience the benthic environment intimately myself through scuba diving [22](Squire, 2017; Straughan, 2022; Patarin-Jossec, 2024). Therefore, my significant and original contribution to knowledge, specifically in this chapter, is I translate and operate benthic phenomena into a methodological approach. This contribution is crucial as it renews our ways of exploring certain geopolitics of spaces such as ocean and seafloor. Furthermore, the reason for using qualitative methods here is because, as mentioned in Chapter 1 and Chapter 2, this study is contextualized within new materialist geopolitics. Therefore, as the new materialist geopolitical approach focuses on the material quality (e.g., both material and immaterial categories) of the seafloor, the qualitative methods here are meant to capture the materiality of the seafloor in the seafloor use off the Bangka and Belitung Islands in Indonesia (see Figure 8 below).

[21] According to Jackman and Squire (2021), elite actors here mean that those decision-makers that govern the material space through their top-down interventions given their position and knowledge. Thus, they do not necessarily, in this case, experience the material sites of the seafloor uses.

[22] I acknowledge that while using scuba diving as a method helped me to obtain my intimate experience on the seafloor as material evidence for this work, I concur with the contention of Straughan (2022) on how such recreational diving can also affects coral reefs through, among others, boat’s anchoring and oil discharge.

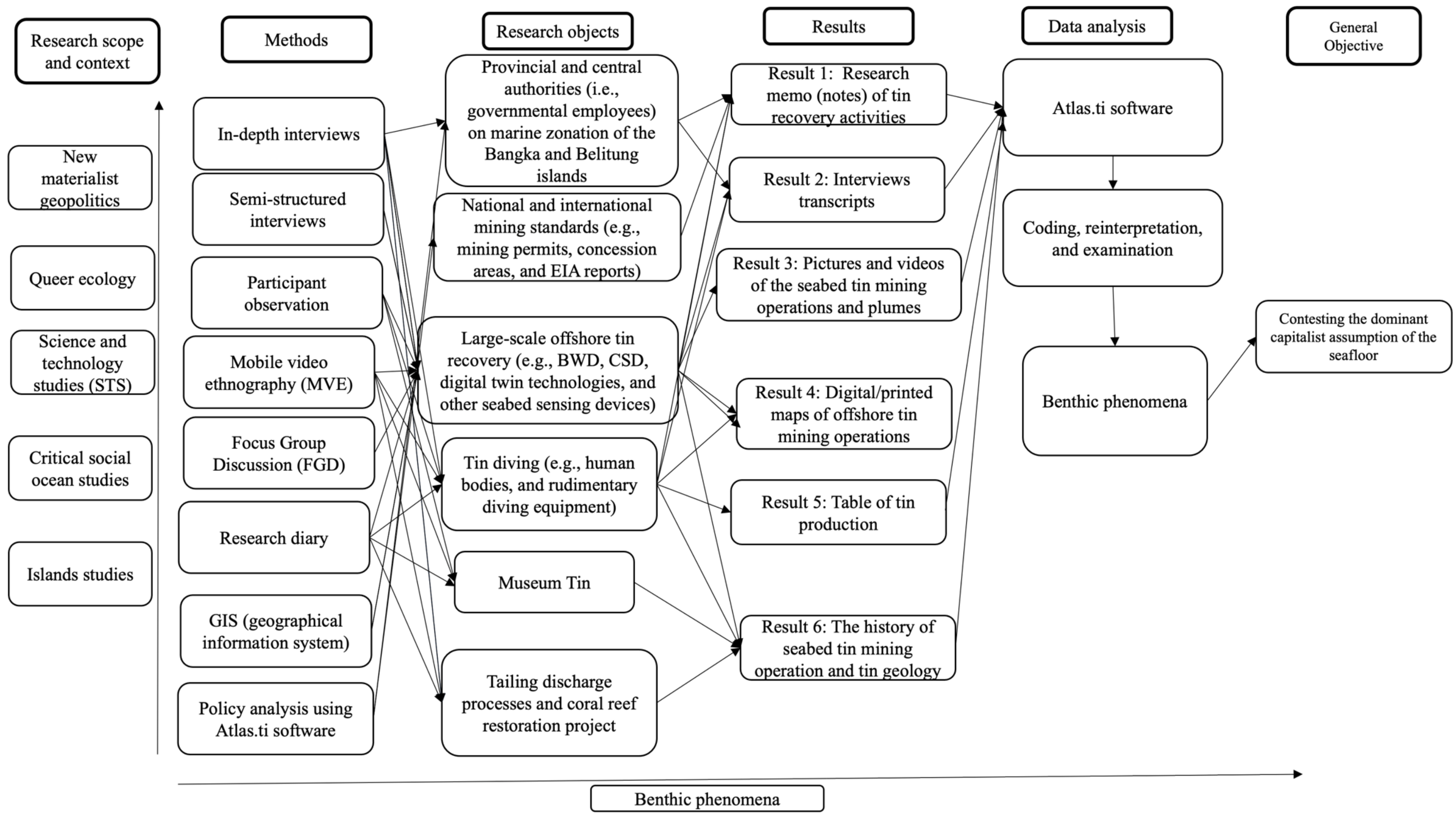

Figure 8: Research design, methods, and data

So, why and how do the data collected through a set of qualitative methods here reveal the benthic geo-politics of the seafloor? This is because the new materialist interpretation of geopolitics has shifted toward geo in geopolitics (*geo-politics*). In this regard, as the seafloor off Bangka and Belitung islands has become a significant site for offshore tin mining operations, marine zonation interventions, and international regulatory interventions such as OECD and ITA, the myriad of qualitative methods here have allowed me to collect a myriad of material evidence for this study. Indeed, this consists of representations (e.g., language, marine maps, and seafloor maps), and reflections on animals, plants, minerals (e.g., tin ores and sands), rocks, technologies, human bodies, time, space, volume, sea waves, and sediments of the seafloor off these islands. These empirics also represent the materiality of the seafloor. Even though I mention *representation*, it comes from material elements and material practices of knowing. For example, Chapter 4 explains how I observed how seafloor sensing involving humans, digital twin technology, and mining technology (i.e., the material elements of sensing) transformed the seafloor into a digital space simulation. This means the material ways of knowing the seafloor representation here indicate the intersection between the representation and the material elements of the seafloor. For that reason, this material way of knowing addresses the issue of representationalism. As Barad (2007):

"[R]epresentationalism is the belief in the ontological distinction between representation and that which they purport to represent; in particular, that which is represented is held to be independent of all practices of representing" (Barad, 2007: 46).

Meanwhile, through thinking with benthic phenomena, there is no ontological distinction, as stated by Barad (2007). This is because this mode of thinking demands me to reflect on how the interaction between my body, miners' bodies, mining technologies, and the seafloor representation are intertwined. However, indeed, such a material way of knowing is then dematerialized in this methodology. This dematerialization explicates the materiality of the seafloor, a thread that weaves together the material (because it has physical properties) and meaning (e.g., language and maps) of this oceanic space (see Chapter 2). This materiality of the seabed becomes a material foundation of power in geopolitics (Peters et al., 2018) to construct the territory of the seafloor. But why does then creating the territory of the seafloor matter for the geopolitics of the seabed uses? While

Weizman (2002) argues that geopolitical actors can use the materiality of space (e.g., height and depth) to control actors within and without the space, an undersea cable expert explains why the territory of the seafloor matters during the interview:

> Me: “[W]hy does securing the seafloor’s access matter?
> The undersea cable expert: “[T]hat is because we can monetize the seafloor. Like infrastructure on land, we need the physical site, which, in this case, is the seafloor. If we secure the seafloor, we can use for our undersea cable infrastructure. We can use for the marine park where you can obtain money from the shipping sectors if they cross your seafloor site. We can also prohibit other people legally to enter our site” (Undersea cable expert, 2022: Interview on 8 August 2022).

With the importance of making the seafloor one’s territory, diverse actors need to have the reason why they need specific sites on the seafloor by considering the materiality of the seafloor. For example, according to one undersea cable expert:

> “[T]he seafloor’s substrates such as mud, rocks, and coral reefs also define the armor of the undersea cable. For example, if the seafloor is muddy, we just need to use light armor. Meanwhile, if it is a rocky seafloor, we use heavy armor. In the deep water below 1000 meters, this means less marine uses (e.g., shipping and fishing). Therefore, one can use light armor” (Undersea cable expert: Interview on August 8th 2022).

The substrate type of the seafloor and the depth, which represents the materiality of the seafloor, here not only defines the undersea cables but also defines whether the undersea cables can access the seafloor and, in turn, constrain other marine actors to access this physical site of the seafloor. Moreover, what makes the materiality of the seafloor geopolitical is the interaction and relationship between the seabed user (undersea cable engineers), their seafloor interests (politics), and also the technology used to produce the seafloor as their undersea infrastructure territory. Additionally, as the materiality of the seafloor creates interactions, relations, and associations with the seafloor and reconfigures multiple realities of the seafloor, such materiality also represents a benthic phenomenon. Therefore, thinking with benthic phenomena in methodology here enables me to collect information concerning the materiality of the seafloor crucial for particular geopolitical interventions, and simultaneously, such materiality can also be re-interpreted as benthic phenomena. That is because such materiality of the seafloor become measuring agencies that reconfigure multiple realities of the seafloor.

This qualitative information is further analyzed and interpreted using Atlas.Ti software to find main themes and how such a network of themes reveals diverse interactions and relations to the seafloor that reconfigure the realities of the seafloor. This means that by thinking with benthic phenomena in the methodology, one can capture the materiality of the seafloor crucial for particular geopolitical interventions and can also be interpreted as benthic phenomena. Indeed, the main point is to gain insight into how benthic phenomena are used to negotiate, lobby, challenge, and contest the territory production of the seafloor for certain marine uses. This is important because benthic phenomena not only define whether offshore tin mining operations have access to the seafloor but also demonstrate whether certain geopolitical interventions are or are not feasible. For example, while WALHI uses the sediment plumes for constraining the expansion of the offshore tin mining operations, the offshore tin recovery deploys plumes to justify the existence of offshore tin mining operations (see Chapter 2). The intersection between plumes, humans, technologies, events, and politics here is a benthic phenomenon. Thus, providing how such benthic phenomena also count and discount within and interact with their geopolitical interventions, such as OECD, ITA, and MSP, enables me to address research questions and further achieve the research objective (see Table 2).

Table 2. A set of qualitative methods, interpretation, and contribution to answering research questions

No.	Methods	Source of data	Data (empirical evidence)	Qualitative Interpretation (Atlas.Ti)	Research questions (Q)
1.	In-depth interviews	Interlocutors (e.g., governmental employees, mining corporation representatives, seabed tin miners, undersea cable representatives, and marine ecologists)	1. Transcripts and recorded voices. 2. Pictures of the interlocutors. 3. Spatial conflict of the seabed uses off Bangka and Belitung islands. 4. Environmental concern on benthic habitats. 5. Economic benefits from offshore tin recovery 7. information on how to access the seafloor legally and technically.	Benthic phenomena and geopolitical interventions	Q 1, Q2, Q3, and Q4
2.	Semi-structure interviews	Interlocutors (e.g., tin divers and large-scale tin miners)	1. Transcripts and recorded voices 2. Pictures	Benthic phenomena and geopolitical interventions	Q 1, Q2, Q3, and Q4
3.	Participant observation	1. Tin Museum (*Museum Timah*) 2. The large-scale seabed tin mining operations 3. Tin diving operations	1. Research notes 2. Pictures 3. Videos	Benthic phenomena and geopolitical interventions	Q 1, Q2, Q3, and Q4
4.	Research diary excerpt	Participant observation, in-depth interviews, and semi-structure interviews	1. Research notes 2. Sketch of the seabed tin recovery	Benthic phenomena and geopolitical interventions	Q 1, Q2, Q3, and Q4

6.	Mobile video ethnography (MVE)	1. Tin diving operations 2. Large-scale seabed tin mining operations 3. Tin Museum	1. Pictures on the seabed tin recovery, offshore tin mining technologies, miners, and the seafloor 2. videos on Pictures on the seabed tin recovery, offshore tin mining technologies, miners, and the seafloor 3. The history of tin mining operations	Benthic phenomena and geopolitical interventions	Q 1, Q2, Q3, and Q4
7.	Marine zonation policy analysis	1. Peraturan Daerah/Provincial regulation (PERDA, 2020) 2. Ketentuan Kesesuaian Penggunaan Ruang Laut (KKPRL, 2021) 3. KKPRL conference	1. Memos 2. The network of thematic codes 3. Main themes	Benthic phenomena and geopolitical interventions	Q 1, Q2, Q3, and Q4
8.	Offshore tin mining policy analysis	1. International Tin Association (ITA) websites, reports, and policies 2. OECD (Organization for Economic Collaboration Development) mining guidelines	1. Memos 2. The network of codes 3. Main themes	Benthic phenomena and geopolitical interventions	Q 1, Q2, Q3, and Q4

		3. PERDA (2020) 4. Environmental Ministry policies on Environmental Impact Assessment (EIA)			
9.	Diving as a method	Joining Padi Scuba Diving training	Pictures and videos about benthic habitats	Benthic phenomena and geopolitical interventions	Q 1, Q2, Q3, and Q4
10.	QGIS	Seafloor mining site from geologist at one of tin mining companies	The map on the mining sites	Benthic phenomena and geopolitical interventions	Q 1, Q2, Q3, and Q4[23]

[23] Each empirical evidence is stored in Alfred Wegener Institute (AWI) Nextcloud. AWI follows the EU General Data Protection Regulation (GDPR) article 6 (1) a, 6 (1) (b), and article 6 (1) (f) to protect the security of data whenever AWI obtains the data on their websites. See: https://www.awi.de/en/privacy-protection.html

While this opening section briefly provides how the set of qualitative methods enabled me to obtain empirical information through thinking with benthic phenomena, the next section of this chapter (3.2) provides a detailed explanation of why thinking about benthic phenomena offers a way of researching the geopolitics of the seafloor. Of course, even though thinking with benthic phenomena offers a way of collecting empirics concerning the materiality of the seafloor, these benefits also come with challenges in enacting this method in practice. For that reason, section (3.3) explains the challenges of thinking with benthic phenomena as a methodological approach to this study. Subsequently, given that there are many marine actors interested in the seafloor off the Bangka and Belitung islands, I also explain how I developed the seabed collaboration inspired by Tsing (2011) on the forest collaboration in section (3.4). The seafloor collaboration enables me to create a list of seabed users, conduct interviews and participant observations, and gather additional data from these interlocutors. As conducting research with offshore tin recovery means performing the study with a sensitive research topic, the following section (3.5) also explains my ethical considerations in performing this research. Finally, in section (3.6), I explain how I use several qualitative methods such as in-depth interviews, semi-structured interviews, focus group discussion, MVE, research diary excerpt, policy analysis, and scuba diving as a method. Obtaining these materials, in sections (3.7 and 3.8) I describe how I interpret the data through Atlas.TI and how I visualize my field sites through QGIS (quantum geographical information system). Ultimately, the last section (3.9) reflects on thinking with benthic phenomena in methodology to obtain the data concerning the materiality of the seafloor and the limitation of such methods informed by the new materialist geopolitical approach.

3.2. Intersection between top-down and bottom-up geopolitical approach

The active and continuous interaction between top-down and bottom-up methodological approaches to studying the geopolitics of the seabed above can capture a different geopolitical understanding of how the seabed becomes an arena of conflict and violence, given specific geopolitical interventions. By geopolitical interventions, I mean the global, national, and provincial scales of the seafloor regulatory interventions such as OECD, ITA, KKPRL, and provincial regulation that governs the use of the seafloor off the Bangka and Belitung islands (see Chapter 1). That is because the geopolitical orientation and position define how policymakers, researchers, and miners see the seabed. For example, top-down geopolitical interventions focus on how and why particular governmental regulatory interventions do not work. During my fieldwork, this way of intervening and governing the seabed relies on state discourses and narratives discussing centralized and decentralized marine space regulations such as KKPRL (*Ketentuan and Kesesuaian Penggunaan Ruang Laut*) and RZWP3K (*Rencana Wilayah Zonasi Pulau-Pulai Kecil*). The conflict usually exists due to the agreement and disagreement between the state-governmental, non-profit organizations, and business actors on the regulatory intervention governing the seabed. Meanwhile, in practice, the conflict manifests corporeally. For example, during my observations, the large-scale seabed tin mining operations compete with the undersea cables and artisanal tin mining activities to use and extract the seabed off the Bangka and Belitung Islands. In this way, the convergence of benthic phenomena and geopolitics requires us to orient our geopolitical analysis on the interaction between top-down and bottom-up geopolitical approaches and, thereby, provide a new way of locating where the geopolitics of the seabed exists.

Of course, through benthic phenomena, one may also understand that the geopolitics of the seabed is not confined to a specific space, such as a distant international treaty or regulatory intervention meeting. Instead, integrating benthic phenomena in geopolitics enables us to track diverse scales of geopolitics. That is because geopolitical interventions and practices do not end on the table of elite actors discussing the seabed but transcend multiple spatial and temporal boundaries. For example, the decisions of marine spatial planning (MSP) initiatives can permeate through multiple scales of the seabed uses, and at the same time, the seabed uses also further shape the enactment of this spatial planning. Thus, thinking 'like' benthic phenomena, I argue that we can analyze diverse scales of geopolitics from the international, national, bodily, material, and other scales of geopolitics, primarily because we focus on how each geopolitical articulation emerges, interacts with, and connects with each other. As mentioned earlier, the materiality of the seabed becomes geopolitical when marine actors use it to justify access to the seafloor for specific means/uses. For instance, the distribution of tin ores is used by tin divers and tin miners to access marine protected areas (even though current marine spatial planning (MSP) already allocates specific ocean space for marine protected areas, tin divers disobey such spatial regulatory interventions by continue extracting in marine protected areas). (see Chapter 5). Therefore, thinking with benthic phenomena allows me to engage with both the top-down geopolitical intervention and the geopolitics of the seabed on an everyday basis, where conflict and violence can be felt intimately.

3.3 The challenges of thinking with benthic phenomena

Even though the reflection on the convergence of benthic and geopolitics enables us to decenter current essentialist ways of knowing geopolitics (e.g., top-down vs. bottom-up methodological approach) in current geopolitical scholarship, such a benthic geopolitical methodological approach faces challenges of how to collect the information especially given the time, budget, and energy limit we have as a researcher, as well as ethical, practical and safety issues (this is also further discussed in ethical consideration section 3.5). The challenges here also emerge due to multiple boundaries of gathering information for the geopolitics of the seabed. For example, since each seabed use, such as offshore tin mining operations and undersea cables, has different policies and regulations to disclose information regarding its practices, its work often follows certain regimes for disclosing and concealing information. Therefore, they create administrative boundaries to select whether I, as a researcher, can interview and perform participant observation on their actual practices.

By administrative boundaries here, I refer to the certain requirements of these capitalist offshore industries for researchers who want to know their activities on the seabed. Mostly, this has to do with their activities on the seabed containing sensitive and discrete information. For example, since their activities also engage with the Indigenous people's land and sea, their practice of using the seabed often contains information related to how they engage with or ignore the protest of the Indigenous peoples over their marine uses or seabed uses. To avoid that, they often require a research proposal summary and cover letter to grant research access at their offices and mining ships. For example, among ten researcher applicants who wished to join seabed mining ships, I was among three successful research applicants who could physically join the mining ships to conduct research activities (see the mining company's approval in Appendix 7). While two applicants were admitted for their research, given their geology and mining disciplines, I was the only human geographer on the mining ships. This, of course, indicates the challenging research situation for social researchers who want to perform ethnography in mining ships and other seabed uses. Meanwhile, in my case, I could get this special access because previously, in 2017, I already worked on my research on offshore tin mining operations (see section 1.4.1). This means mining actors in this company have recognized me. Additionally, through my research proposal summary, one of the main research objectives is to understand miners' mining experience and perspective on the seafloor and their specific mining technologies to access the seafloor. Of course, as joining onboard with mining ships is risky by nature, given that offshore tin mining operations exist at sea, the mining company gave me a health and safety assessment to ensure my physical health and my capability of swimming at sea. The mining company is also equipped with its life jacket, boots, and helmets (i.e., personal protective equipment standard) (this health and safety assessment is also elaborated in ethical consideration section 3.5).

The challenge of the benthic methodological approach to investigating the geopolitics of the seabed does not end with the administrative boundaries of the business actors on offshore tin mining operations. Instead, such a boundary also exists with the state-governmental actors. That is because although the top-down geopolitical approach, such as marine spatial planning (MSP) map policies, environmental regulations, and environmental impact assessment regulations are publicly accessible, interviewing state representatives such as the Ministry of Fisheries and Marine Affairs (MMF) and the Ministry of Environmental Protection (MEP) requires to understand their spatial and temporal boundaries paired with their administrative boundaries. By the spatial and temporal boundary here, I refer to the time and place of the state-governmental actors that do not remain static and fixed. This means that given their roles in assessing the compliance of the business industries on the use of the seabed in Indonesia, they tend to have various meetings, both incidental and well-scheduled. For that reason, meeting and interviewing the representatives of the Indonesian Ministry tasked with governing the utilization of the seabed space in Indonesia, I had to acknowledge their dynamic and ever-changing schedule. their dynamic and ever-changing schedule. In other words, although I had planned ahead of time to meet at their office and at their time availability, a sudden change and cancellations oftentimes took place. This can hinder the process of collecting information from them concerning certain regulations and issues related to the use of the seabed in Indonesia. This is not to mention, for instance, that I also had to send the administrative requirements such as an interview email invitation, my research proposal, and cover letter, and plan the meeting with their secretary. This was also to meet the ethical requirements of the University of Oldenburg (see Appendix 6).

Although above I have mentioned the administrative boundary of interviewing and performing participant observation on offshore extractive industries through fulfilling administrative requirements, joining on the mining ship and artisanal seabed tin mining also requires the awareness of the technical boundary such as personal protective equipment (PPE) and occupational health and safety introduction as well as the regulation of and insurance requirement of Alfred Wegener Institute (AWI) and the University of Oldenburg. This technical boundary was something that I almost did not consider because I thought joining the mining ship meant that I could be on board once I received approval from the head of human resource development at the seabed mining company. Thanks to my Indrawan Prabaharyaka (an Indonesian researcher at the University of Humboldt, Germany), I was reminded of the technical boundary for my offshore ethnography.

Considering such technical boundaries, before conducting my ethnography on commercial mining ships, I joined their health and safety induction. Induction here means to familiarize myself with the health and safety in offshore tin operations, such as wearing a helmet, life jacket, and pair of boots, as well as performing medical checks (e.g., oxygen level, blood pressure, and weight measurement). This information was required by the mining company before I could join their mining crews on board. Additionally, the seabed mining company has a diverse hierarchical structure from central mining company, provincial mining company, and district mining company. Each of them has its regime of permission to get involved in the seabed tin mining off the Bangka and Belitung Islands. During my fieldwork, despite the fact that I had permission from the head of Human Resource Development (HRD) from the central mining company, this did not mean I could directly join the offshore tin mining operations. Instead, I had to send a research proposal and cover letter to the provincial and district scale of the seabed mining company. Instead, I had to send a research proposal and cover letter to the provincial and district scale of the seabed mining company. After they had received my research proposal and cover letter, they began to provide research plans for me, including the dormitory in each district where the seabed tin mining is situated, the introduction of PPE, occupational health and safety in seabed tin mining operations, the duration and the number of the seabed tin mining operations in which I could participate, and the sea harbor and boat that took me to the seabed tin mining sites. The health and safety assessment here, while not being completely similar, is reflective of the AWI's health and safety assessment. This is primarily because AWI also encourages medical checkups to ensure the health and safety of its staff (see AWI's health and safety requirement here).

Such a technical boundary also exists for observing artisanal seabed tin mining operations. That is because, unlike large-scale seabed tin mining, artisanal seabed tin mining operations require a different way of approaching them. For example, since there is a head of artisanal seabed tin mining operations, before conducting interviews and participant observation, I have to contact the head of the artisanal seabed tin mining operations. However, this would also not be easy if I had no connections to the Bangka and Belitung Islands in Indonesia. I am fortunate that previously, I have established a local connection with fishing and tin diving communities. The fishers there enabled me to reach the head of artisanal seabed tin mining operations for conducting participant observations and an in-depth interview with tin divers. While this technical boundary here seems trivial, without having an awareness of how we can access the space and place of seabed uses, gathering information about the utilization of the seabed space both from a top-down and bottom-up geopolitical approach is not feasible. That is why analyzing the convergence of benthic and geopolitics requires strategies, planning, and patience, as we have to be able to collect information through both top-down and bottom-up geopolitical approaches to understanding the interaction of the geopolitical intervention on regulations and policies and the practices of seabed uses.

With the understanding of administrative, spatial, temporal, and technical boundaries, I argue that investigating the convergence of benthic phenomena and geopolitics in various seabed uses is physically and emotionally demanding (Squire, 2021). That is because whilst the methodological application of benthic phenomena indicates I had to go beyond the separation between top-down and bottom-up geopolitical investigation, the enactment of the methodology here required thorough planning to organize research activities. The research planning enabled me to engage with state-governmental and the head of mining companies to understand how their geopolitical interventions, such as MSP policies and offshore tin industry policies, are deployed to govern, manage, and control the seafloor. Concurrently, I can also understand how diverse seabed users interact with the hierarchical geopolitical approach. Therefore, the following section provides the strategies and planning for materializing the integration of the benthic phenomena on the methodology (the ways of knowing) of the geopolitics of the seabed. This methodological approach offers a new way of conducting the geopolitics of the seabed beyond current methodological approaches (e.g., geopolitical discourse analysis versus ethnographic geopolitical analysis) (Jackman and Squire, 2021). What I attempt to argue here is not claiming that geopolitical discourse analysis is better than ethnographic-geopolitical analysis or vice versa, the ethnographic-geopolitical analysis is better than geopolitical discourse analysis. Instead, I argue that geopolitical discourses and ethnographic analysis are entangled with one another. This echoes the work of Law (2019) concerning material semiotics, arguing that:

"[M]aterial semiotics is a set of tools and sensibilities for exploring how practices in the social worlds are woven out of the threads to form weaves that are simultaneously semiotic (because they are relational, and/or they carry meanings) and material (because they are about the physical stuff caught up and shape those relations" (Law, 2019: 9).

Considering Law's argument above, I argue that the geopolitics of the seafloor is an interwoven thread between material and meaning. In other words, geopolitical discourse analysis and ethnographic geopolitical analysis are inseparable. For instance, as mentioned in Prologue, media coverage, governmental websites, and popular culture create the dominant discourse on the islands of tin, flattening the reality of the seafloor as none other than an extractive frontier realized in practice. Indeed, concurrently, the ethnographic study reveals the material practice of tin recovery, such as tin diving operations and CSD tin mining operations. As such, within this ethnography, not only did I obtain information related to the practice of the seabed tin recovery, but also how seabed tin miners materialized the dominant discourse of an extractive frontier. In this way, the geopolitical discourse analysis and ethnographic geopolitical analysis interact with each other. This intersection between discourse and ethnographic analysis was possible through thinking with benthic phenomena in methodology, as mentioned above. Thus, benthic phenomena enable us to integrate and examine the interaction between top-down geopolitical intervention through geopolitical discourse analysis and everyday geopolitics of the seafloor through ethnographic study.

3.4 Seabed collaboration

The seabed collaboration here is inspired by the forest of collaboration by Tsing (2011). The forest of collaboration enables her to trace the network of the global forest protection initiatives in Kalimantan, Indonesia; later, she describes the global as a connection. In my view, the method of forest collaboration here allows us to understand that even though geopolitics often refers to the global scales of geopolitics, geopolitics consists of trans-local relationships between bodies and materials (Peters et al., 2018). In other words, geopolitics also encompasses multi-scalar geopolitics, especially when the way of analyzing geopolitics is to think about the land, sea, and seabed (Squire and Dodds, 2019). For instance, as mentioned earlier in Chapter 1, geopolitical interventions (e.g., OECD and ITA) in seabed tin mining involving diverse international governance regimes come to exist given that geologists and enslaved Chinese people could identify and locate the seabed tin ores through the knowledge of the bedrock (Chapter 5 will elaborate the concept of bedrock). The knowledge of the tin ore location further attracts diverse actors of seabed tin mining from tin diving, large-scale seabed tin mining, domestic tin collectors, and international tin buyers. The tin value chain here further shapes the geopolitical governance of the seabed tin mining regimes and how the tin ores off Bangka and Belitung Islands end up in another part of the world through the connection and network of actors here. Therefore, the network of the actors in such geopolitical governance here means that one can rematerialize geopolitics beyond the global scale of the geopolitics (Elden, 2013). As the forest collaboration offers a way of tracing the seabed actors, I developed the seabed collaboration for this fieldwork.

The seabed collaboration plays a key role in addressing the feeling of being 'overwhelmed' given engaging with the top-down and bottom-up methodological approach as mentioned above. That is because seabed collaboration enables me to create strategies and planning to identify and engage with actors in the use of the seabed in Indonesia. For example, using the seabed collaboration table, I can collect information and map the key actors on the seabed uses in Indonesia, primarily off Bangka and Belitung islands, *before* I went to the case study area of this benthic geopolitics project. This table also provides crucial information, including the names of the interlocutors, their organizations, and companies. Such information also includes their expertise on the seabed, the justification of why I have to engage with them, their office location, and contact information. Additionally, I also added the specific date and time when I could meet and interview them, whether they want to get involved in this research, and to what end. The latter here means that I could assess whether I could also contribute to their specific projects and whether involving them in my research could distract me from the research objective of this thesis. With the involvement of the interlocutors in the seabed collaboration, I had the contact point that allowed me to follow up questions and ask for certain additional information such as seabed policy and regulation documents, seabed maps, environmental impact assessment reports, and regulations. At the same time, some interlocutors became my research connection and often informed me of the current status of seabed uses, such as seabed tin mining operations and marine spatial planning policies.

Even though the name of such research strategies and planning is 'seabed collaboration', echoing Tsing (2011), the collaboration is far from the romanticization of the word collaboration. '*Romanticization*' here refers to the notion that collaboration often relates to mutual agreement and understanding how I can obtain information from the actors using the seabed. That is because the seabed collaboration here means that there exists friction, relation, and disagreement. In fact, as geopolitics creates the material space as an arena of conflict (Weizman, 2004), the seabed collaboration here also explicates the geopolitics itself. This is because seabed collaboration also means that potential conflicts between me (the researcher) and my interlocutors could exist, especially as specific collaborations could create a hindrance to my main research project's progress. For example, one interlocutor, an undersea cable expert, wanted to be my collaborator, provided that I could make him my co-author in my referred article. Of course, I did not intend to say here that the whole focus of this collaboration is my thesis. Instead, what I wanted to argue is that I faced difficulty in how such seafloor collaboration could be reciprocal and caring instead of me only trying to extract information from them. Or else, my interlocutors tried to exploit me, especially given that a power relation of research between me (researcher) and my interlocutor existed in the collaboration.

While I, as a researcher, mostly had power in analyzing and writing research findings, this collaboration attempt with the undersea cable expert indicates my power is lower than my collaborator. This is because I relied on his information to understand the use of the seafloor (i.e., undersea cables) while they did not need me. Therefore, according to him, the type of collaboration reciprocally that may benefit me, and he is through peer-reviewed article collaboration. However, I explained to him that writing a referred article would not be possible for me as I had to conduct my ethnography on and off the Bangka and Belitung islands. As such, I had to cancel the seafloor collaboration with him. This means I did not use his information in this research. My experience in power difference here was also reflective of the work of Begueria and Beneito-Montagut (2024) concerning how interlocutors could also gain more power to exploit researchers during certain ethnography work. That is why I tried to find other participants with whom I could (hopefully) contribute reciprocally to their ongoing project. For instance, one governmental research group allowed me to interview and observe their undersea cable work, and in return, I could moderate their research seminars. In this way, this seafloor collaboration mutually benefits me and my collaborator.

Beyond the article writing collaboration, the power relation between me (researcher) and my interlocutors also manifests in our expectation in the seabed collaboration. That is because my position as a researcher also means that I require access to their space (e.g., offices, online meetings, boats, and ships) to collect information about the practice and process of seabed uses in Indonesia and for my own ends: to get a degree. This means while I did not have to provide something in return, as part of my ethical practice, I desire to have a responsibility and desire to do this in seafloor collaboration, such as time and energy to help my interlocutors' project. As such, seabed collaboration, in this case, also aims to create caring and reciprocal collaboration between me (the researcher) and my collaborator. By caring and reciprocal collaboration, I mean I attempted to create a mutual caring and reciprocal relationship that benefited me and my interlocutors. Despite the endeavor of embedding care and reciprocity in seafloor collaboration, the exploitation issue can exist. As Toombs et al. (2017) argues: "[J]ust as there are plenty of ways that a caring relationship can benefit participants and researchers alike, there are also numerous ways that these relationships can be manipulated so that researchers end up exploiting participants or participants end up exploiting researchers" (2). In my case, due to the power difference between me and my collaborator, I could fall into a trap on the exploitative issue in the seafloor collaboration. For example, since grouper fish species live near the hydrothermal vent in Indonesia, I was interested in investigating the experience of fishers capturing the fish species on this ocean floor. Also, I expected that the information from such research could also give knowledge on the relationship between the grouper fish, hydrothermal vent, and fishers. Accessing this information required me to collaborate with the grouper fish non-profit organization, *Yayasan Konservasi Indonesia* (YKI). Surprisingly, they wanted me to be their unpaid intern and collect receipts from fishers. Not only could such a collaboration potentially exploit me as a researcher, but the project would also have diverted me from my main focus on completing this study. Therefore, I discontinued my attempt to collaborate with this non-profit organization.

This cancellation left me with confusion and forced me to find other organizations. Of course, I also contemplated that I could also access their marine activities through, for instance, their website. Therefore, accessing their physical spaces (e.g., boats and offices) was also not necessary. However, as I also aimed to capture the embodied knowledge of the seafloor and human relations, such collaboration may show how fishers encountered the seafloor on a daily basis. This means that I was lucky that I could obtain financial support to potentially establish seafloor collaboration and access their marine activities. However, I also recognized that other researchers may have less funds to create seafloor collaboration as such a collaboration requires a researcher to move from one field site to another. For instance, while my field site is off the Bangka and Belitung islands, such regulatory interventions from marine actors like YKI come from Jakarta. Of course, one can have a call or an online meeting. However, this still also requires financial support to conduct such an online meeting. As Cheek (2008) has long pointed out how funded qualitative research also shapes the choice of what the researcher can or cannot do. Furthermore, I also recognized that conducting the seafloor collaboration enabling me to access their physical spaces (e.g., offices and boats) was also partly because I was able to do that. Indeed, this also means that the ethnography research privileges able bodies over disabled bodies. As Durban (2022) posits ableism (the discrimination of disabled mind-bodies) is inherent to the embodied knowledge production that requires the researcher to do fieldwork. Thus, seafloor collaboration was also not only for those having limited funding in qualitative research but also for those who are disabled. This issue, indeed, creates a social injustice within who can or cannot collect and interpret information. For that reason, as mentioned in the Prologue, I fully acknowledged how I am privileged by colonial and geopolitical power relations through financial and intellectual support from my institutions. However, while I obtained funding and was an able person, creating seafloor collaboration was not always expected as I had planned. That is because seafloor collaboration could work, not only depending on me as a researcher but also on my interlocutors.

This issue emerges from my other endeavor to expand my seafloor collaboration. For example, during my fieldwork, after canceling my seafloor collaboration with YKIN, I further collaborated with the deep-sea exploration scientists, the so-called Srikandi Bahari from BRIN. Srikandi Bahari is a research group that focuses on the role of female and male scientists on deep-sea exploration in Indonesia. In this group as my approach also focuses on feminist and queer theory, they recruited me to collaborate with this research group. My intention to create seafloor collaboration with Srikandi Bahari was partly because they also had an interest in the deep seafloor and also, they wanted to learn from me on how to use queer and feminist theory. Although the name of this project indicates feminist work, I felt that their research activities were operated in a hierarchy. That is because even though I, as a young researcher, contributed to writing and editing a research proposal for research funding for the deep-sea exploration project in the Java Sea, I also spent my nights joining the meetings, performing writing and editing during the presentation of this project, I and other women below this research group lead felt invisible because there was no recognition on my research contribution. Additionally, such collaboration was not right for me despite I could potentially got access to deep sea research in Indonesia. This has to do with the fact that enacting caring and reciprocity means that I should also care for myself. Meanwhile, besides being overworked and unpaid in this research group, they also required me to conduct many research activities (e.g., interviews and participant observation) in a deep-sea laboratory in Java Islands and beyond. This means collaborating with them may spend my time contributing to their research and publication while distracting my own timeline to research offshore industries off the Bangka and Belitung islands. For that reason, I decided to cease my seafloor collaboration with them.

With many canceled collaborations, the experiment of making seabed collaboration in this research was not as romantic as the word collaboration can sometimes be conceived as disappointment and confusion as to why the research plan, meeting, and interview schedule did not always work as expected or as planned on the table of the seabed collaboration always exist (see Appendix 1). This is also not to mention, for instance, I also had to work with collaborators that had different agendas from this research, like exploiting the seafloor through mining. This argumentation fits in with the work of Tsing (2011) on what collaboration means:

"[T]his is not the most common connotation of collaboration; this collaboration with a difference: collaboration with friction at its heart. Usually, scholars, think of collaborators as like-minded colleagues who each contribute to a commonly conceived product. They are trained to be just alike before they begin to work together, so their collaboration is in itself culturally uneventful. Of course, there is another meaning of collaboration that opens the term in a different direction: collaborators work with the enemy in wartime. Their collaborations do not produce a communal good" (Tsing, 2011: 246).

The seafloor collaboration, in this way, extends the work of Tsing (2011) toward the understanding that friction not only existed between seafloor actors and me but also between my expectations and the reality in the fieldwork. Meanwhile, whilst diverse actors in the seafloor uses to indicate the difference and the friction within the seafloor collaboration, such difference and friction indicate multiple emergent measuring agencies these actors are using to construct meaning to the seafloor. Therefore, the seafloor collaboration helped me to analyze diverse measuring agencies and objects marine actors used to govern the seafloor. In other words, this allowed me to understand benthic phenomena.

While seabed collaboration is not a fail-proof research strategy to collect information about key actors in the seabed uses in Indonesia, it still helped me to engage with the key actors of the seabed uses in Indonesia. In my view, without going through the process and practice of contacting, listing, agreeing, and disagreeing with the mechanism of the seabed collaboration, I do not think I could have collected information from the key actors to understand the geopolitics of the seabed uses in Indonesia. For example, through my seabed collaboration, I engaged with multiple governance actors such as one mining company, two undersea cable companies, the Indonesian Association of Submarine Cable), undersea cable experts, the Ministry of Fisheries and Marine, the Ministry of Environmental Protection, the University of Bangka and Belitung (UBB), and Institute of Technology Bandung (ITB). This opportunity also allowed me to access their information through interviews, participant observation, focus group discussions, and seabed use reports online and offline. Most of the seabed actors here did not require me to contribute to their work like the previous potential collaborators. Instead, they allowed me to engage with them, especially given that my work can bridge the communication with other seabed actors. For example, through my interview with mining companies, they wanted me to communicate the issues related to the conflict of seabed space between seabed tin mining and undersea cables. In many ways, seabed collaboration here enables me to contribute to their governance of seabed activities.

Of course, one collaborator asked me to do certain politics that mirrored their interests. However, they suggested I do their favors instead of making such a request obligatory for me. For instance, one mining company asked me to write about the positive impacts of offshore tin mining operations on infrastructure development on the Bangka and Belitung islands, such as hospitals, roads, and schools, on my Instagram. Despite that, I did not perform such a campaign significantly because doing so may harm my collaboration with other seabed actors (e.g., WALHI and Indigenous communities). Instead, I offered this mining company a PhD scholarship application seminar for their staff who wanted to study abroad. In this way, I could negotiate how I could contribute to the mining company without necessarily putting myself at risk of being excluded by anti-mining groups.

3.5 Ethical consideration

In the previous section, it was noted how my seabed collaborator signed the informed consent letter for this project. The informed consent letter here refers to the ethical clearance form signed by ethical committees at the University of Oldenburg, Germany (see Appendix 6). However, I would argue that ethical consideration does not end with ticking off an ethical clearance form (Dowling et al., 2016). That is because ethical considerations should also manifest in research activities (Peters, 2017). The reflection on ethical research praxis in this project has been imperative, primarily given that research activities involving offshore tin mining operations, tin diving, and undersea cables are relatively sensitive topics. Therefore, the real challenge in considering ethical research practices in the geopolitics of the seabed uses is how to navigate diverse ethical boundaries in each seabed use, how to maintain ethics as part of research integrity, how to balance between being ethical and being truly constrained with the politics of ethics itself. By the constraint of the politics of ethics, I mean the definition of '*ethical*' is largely depending on who defines whether the research activity is ethical or unethical. For example, given that conducting research concerning offshore tin mining operations is controversial, collecting data to contest the capitalist assumption of the seafloor as none other than the seafloor tin mining sites can be ethical or unethical.

For offshore tin miners, the collection and interpretation of empirical data here can be unethical because the interpretation may be used to oppose offshore tin mining operations. Meanwhile, for coral reef conservationists and Indigenous shrimp fishers, the objective of this research and research activities is ethical because this interpretation of empirics may open up discussion on how to re-govern the seafloor uses off the Bangka and Belitung islands as the aim to contest capitalist imagination of the seafloor means exploring other ways of seeing and imagining the seafloor beyond the dominant capitalist imagination. Therefore, I argue that just because offshore tin mining operations are sensitive and controversial, this does not mean that conducting research about seabed tin recovery and how the practice of seabed sensing and extracting is, by default, unethical. This, of course, becomes unethical when this study targets one mining company to blame the change of the seabed environment as, in practice, the territory production of the seafloor for the offshore tin recovery, as mentioned earlier in Chapter 1 exists through multiple geopolitical entanglements from the tin end-users and producers (see section 1.4.2).

Whilst conducting research on offshore tin recovery does not immediately mean unethical research practices, I acknowledge that ethical boundaries exist in each of the seabed uses. That is because different ethical research approaches are required to engage with one interlocutor and another interlocutor. For example, employees of the undersea cable and offshore tin mining companies are mostly literate and able to understand the content of the research ethical clearance form as these interlocutors graduated from senior high schools and universities. However, I should not homogenize the textual literacy of these interlocutors with tin divers off the Bangka and Belitung Islands, Indonesia. Primarily, given that tin divers are mostly illiterate, signing a written informed consent agreement may present concerns for their mining operations. In this way, they gave their informed consent, which was verbally recorded by a recording device. The same is true for the low-ranking workers in offshore tin mining operations. This was captured in my ethical approval at the University of Oldenburg. Not only does giving textual consent, such as signing off the ethical form, potentially harm their job security but also their hectic tin recovery activities and their level of education do not allow them to read the content of the ethical clearance form. As such, I also received verbal consent from low-ranking seabed mining workers. Additionally, since I had to move from one mining ship to another to conduct semi-structured interviews and participant observation on the process and practice of seabed tin ores recovery, I could only include some essential necessities in my bag, such as a GoPro camera, Gopro accessories, a laptop, a recording device, a notebook, an eBook reader, first aid equipment, and snacks. This is also not to mention that I had to carry my helmet and life jacket. This means that I brought my notebooks and two printed informed consent letters. In this way, for practical reasons, I collected verbal consent from my interlocutors on the mining ship by explaining the information of the content letter and asking their permission to record their voices before recording the interview. On top of that, I already received the informed consent letter from the company of the mining ship per se, technically then covering all research activities onboard (see Appendix 7).

Ethical considerations in qualitative research, indeed, tend to be human and legal-centric, given most qualitative studies that follow the American Psychological Association's ethical guidelines (APA) to minimize psychological and physical harm to human participants (Akbar et al., 2024; Scheytt and Pflüger, 2024). This ethical reflection is imperative to ensure that a researcher conducts their research with recognition of their research's potential consequences on their participants (Fiesler et al., 2024). During the fieldwork on the mining ships, the main risks for workers were they were moved to another mining ship or being laid off by the mining company if they were smuggling tin ores or if they did not use personal protective equipment (PPE). In this way, of course, my presence changed the situation for the workers on mining ships. For example, there was no tin theft, and every worker wore their life jackets and helmets. To minimize such risks, I always asked their consent whether I could take a picture or notes on their activities (e.g., tin washing and sensing). Meanwhile, conducting fieldwork in seabed tin mining also requires me to engage with non-human ethical considerations. That is because the Indigenous community working in offshore tin mining operations believes in the spirits of the seabed. This means that everyone who wanted to enter the seabed mining ship should ask permission from the spirit of the seabed to avoid misfortune in the process of recovering tin ores, such as mining accidents, ship sinking, and the lack of tin production. For example, during my car journey to the mining site with the head of the mining ship. He explained to me that the head of the mining team would go to the head of the Indigenous tribe, usually located near the seabed tin mining site, for mining permission.

Of course, such a permission is contradicting the notion of the Indigenous resistance toward the seabed tin mining operations. However, the permission here plays a key role in getting access to the seabed and reducing potential conflict between the Indigenous community and seabed tin miners. But also, according to his experience, without having the Indigenous tribe leader's permission, the operation of the seabed tin mining operation can find any hindrance from inoperable engines to the absence of tin deposits on the seabed. The head of mining operations believes in the spirit of the seabed because they are also an Indigenous youth working in the seabed tin mining operations. Indeed, given that they are Indigenous, the Indigenous tribe leader helped them to get the permission of the seabed spirit. As a researcher, I respect such a belief to ask permission from the spirit of the seabed. For example, the head of the mining ship asked me to say "asalamulaikum" (peace be upon you) as I entered the village border where the sea harbor for the cutter suction dredger (CSD) ships is situated. In my view, this practice of respecting the seabed spirit is also part of ethical consideration, even though such ethics are not written on the informed consent letter. Therefore, I call such an ethical consideration an invisible ethic because oftentimes, we cannot see that there is an ethical process of accessing the seabed, like respecting the spirit of the seabed.

Given the understanding of the invisible ethical rules of accessing space, I became careful with my research activities during my trip with mining ships. That is because I did not want to exploit my position as a researcher to exploit people on the mining ship. My position as a researcher from Germany and a Javanese person, as explained earlier in the preface, allowed me to be situated in a high position in the mining ship hierarchy. Perhaps, this is the case due to diverse assumptions of me as a researcher introduced by the head of mining ships. For example, low-ranking miners had thought I might be a mining consultant, the right hand of the directorate, good practices investigator, and so on. With these diverse social labels given to me, low-ranking miners treated me well, although sometimes they became too shy to talk to me. Of course, with such expectations and power relations, obtaining information from seabed tin miners was accessible. However, I also reflected on this unequal power relation often embedded by the mining company. In other words, I attempted to reduce my research activities as extractive as that of seabed tin mining itself. By extractive here, I mean that I could ask everyone for an interview and for help with taking videos and pictures. But I did not want to be such an extractive researcher. For that reason, I always asked their permission whenever I wanted to access certain spaces, such as the mining bridge and washing plant site. I would also remind them to say ‘no’ if they did not want to be observed. This endeavor echoes the argument of Manning (2021) about how a researcher should consider their positionality in the matrix of power relations. Additionally, to reduce the hierarchy, I also tried to immerse myself in their everyday activity on mining ships, such as cooking, washing tin ores, and washing clothes together. Such an ethical consideration toward the positionality of me and my interlocutors on the mining ship has allowed me to build a strong kinship with low-ranking tin mining workers, helping me with recent updates on everyday issues of seabed tin mining.

Even though I could navigate diverse ethical considerations and challenges with interlocutors and non-humans in the seabed tin mining, the most challenging part of ethical consideration is also about how I can treat myself ethically. Considering ethical treatment poses an ethical dilemma. An ethical dilemma is often studied in the context of educational ethnography by which ethnographers are constrained to respond or react to the unequal conflict between students and teachers and vice versa (also called “the heated moment”) by certain ethical regulations (Thériault and Mercier, 2023). I reflected on my experience observing and interviewing tin miners on the mining ship and the floating raft of artisanal seabed tin mining. While offshore tin mining operations (the large-scale seabed tin mining operations) treated me well with food and personal protective equipment, such a kind of treatment did not necessarily mean ensuring my well-being (see Figure 9). For example, I had to stay up at night to capture the real-time conflict between the large-scale seabed tin mining operations and artisanal seabed tin mining operations. Despite that, I also had to maintain my health by getting enough sleep on other nights, eating vitamins, and eating healthy foods. This aligned well with AWI's health and safety recommendation.

Figure 9: a life jacket and a safety helmet provided by the mining company

Despite having ethical considerations, an ethical dilemma also exists in the interpretation of the empirical findings in my intensive ethnography of the seabed tin mining operations. That is because, as explained in the Prologue, I have positioned myself to align with the offshore extractive industry resistance. This means that my interpretation of data can challenge and contest the existence of offshore seabed tin mining operations. This research activism here is in line with the work of Jenkins (2024) on using women's photography as an act of resistance to the idea of mining-led development. Meanwhile, in the context of ocean uses, according to Satizábal et al. (2020), contesting the dominant narrative of the economic development in ocean extractive activities is crucial because such work enables us to understand how socially just ocean governance is often neglected. Of course, there is a tension between activist research and industry research in how their work may contribute to the local community's resistance and affect the extractive industry. For instance, Hine et al. (2022) argue that mining companies are made of complex people who might not all share the same view concerning resource extractive activities. This means that such an activist work may indeed reconstruct a fixed imaginary of environmental resistance, which may kill regional economic futures in favor of protecting certain habitats.

With such consideration of such an ethical dilemma, I also considered that my work may affect the economy of miners who rely on the seabed tin mining operations. However, I would argue that conducting ethical research should not necessarily mean constraining myself as a researcher to respond to the issue concerning the use of the seabed and the geopolitical governance enabling the seabed. Instead, conducting ethical consideration should mean acknowledging the risk of creating a new geopolitical understanding to push back how the current geopolitical governance has, for example, normalized the impacts of the seabed tin mining operations by creating regimes of visibility and invisibility, echoing the work of Barry (2010) on transparency as a political device, that maintains the appearance of seabed tin mining as governable and manageable. In this way, my scholarship work helps to unfold the geopolitical issue of the seabed uses that may be occluded by the current geopolitical governance of the seabed tin mining operations in Indonesia. Therefore, while it may affect some economies of the seabed tin miners, my work can still contribute to locating and sensing where the problems are often neglected by the geopolitical governance of seabed tin mining. This way can provide feedback on the current way of governing the seabed geopolitically.

While I acknowledge that my work in this research may affect certain groups of people's economies, especially those who work on offshore tin mining operations, I have tried to reduce the risk of creating harm directly to the individuals and companies who become the interlocutors of my ethnographic work. For example, I changed interlocutors' personal names with pseudonyms and anonymity, such as Ahmad, Rudy, and Wawan, tin divers, tin miners, geologists, and governmental employees. As mentioned in my ethical form submitted at the University of Oldenburg, I stored these qualitative data in AWI's next cloud and Atlas.TI software. The recorded data will remain in AWI Next Cloud (online drive) and Atlas.TI software (see 3.7.2) and be deleted for two years (1 December 2024) after the fieldwork. AWI, as my research institute, will be responsible for protecting and processing the data stored in the AWI NextCloud. AWI storage has followed data protection according to Article 6 (1) (a) (b) (f) of the EU General Data Protection

Regulation. Therefore, the ethical committees of the University of Oldenburg have decided and considered such data storage is ethical.

Despite using pseudo-names (anonyms) and European standard of data storage, this attempt does not mean I can completely prevent the resistance toward the seabed tin mining operations that might be informed by my interpretation of my empirical evidence. In this way, I acknowledge that anti-mining groups such as environmental NGOs and academics may use my information to underpin their arguments in resisting the expansion of offshore tin mining operations. Additionally, since the work on seabed tin mining in Indonesia is emerging, this also means that it is not only me who pushes for a better geopolitical intervention on the seabed tin mining operations and other seabed uses, but also other current and previous scholars such as Ramadhanti (2024), Rosyida et al. (2018), and Erman (2017b) are also aligned with my work. This is also creating a contested field itself as to whether my research will change the geopolitical governance of seabed use in Indonesia, further potentially affecting the process and practice of recovering ores on the seabed or other scholarly work that may disrupt current seabed tin mining practices. Therefore, I would argue that providing knowledge about the seabed uses that are mostly inaccessible for public scrutiny is creating a regime of ethics in itself. For example, Chapter 5 and Chapter 6, about the bodily experience of tin divers in artisanal seabed tin mining and sediment plumes, provide knowledge of the seabed uses often occluded by geopolitical governance. Therefore, providing knowledge of the two issues means that the current regimes of geopolitical governance should improve so that they have to consider why specific issues are excluded in their governance processes.

3.6 The enactment of and the reflection on qualitative methods

This dissertation draws on qualitative methods such as in-depth interviews, focus group discussions (FGD), participant observation, mobile video ethnography (MVE), and research diary excerpts. The overarching aim was to use these methods to form an understanding of the convergence of benthic phenomena and geopolitics within diverse seabed uses such as large-scale seabed tin mining operations, artisanal seabed tin mining operations, and undersea cables. As argued earlier in Chapter 1 and Chapter 2, given that diverse geopolitical interventions such as blue economy initiatives, the international price of the mineral market, and the global demand for internet and telecommunication have driven and enabled such diverse seabed uses in Indonesia, particularly of the Bangka and Belitung Islands, such phenomena of the seabed utilization here mark the intersection between benthic phenomena and geopolitics. For that reason, attending to the seabed uses on a daily basis, I argue, allows us to capture such an interaction between benthic and geopolitics. Through the dissertation chapter, benthic geopolitics has manifested in the inextricable relation between mining observers, their human sensors, and mining technologies on the seabed (Chapter 4), the volumetric-bodily-geologic relation in tin diving (Chapter 5), and sediment plumes produced by seabed tin mining operations (Chapter 6). Each of the chapters materializes our knowledge of how benthic phenomena and geopolitics co-produce the seabed and, at the same time, provide a new geopolitical orientation beyond top-down and bottom-up geopolitics. Instead, we can understand how such interaction and socialization of the seabed creates dynamic relations and an active process of geopolitical interventions, which decenter the notion of the seabed as a mere top-earth surface beneath the sea (Banet, 2020).

To collect this information concerning the convergence of benthic phenomena and geopolitics in the seabed uses, I conducted intensive ethnographic fieldwork on and off Bangka and Belitung Islands, in Jakarta (the capital city of Indonesia), in person and online, over six months from the spring to early fall/autumn of 2022. This intensive ethnographic fieldwork matters as the process of data collection provides me with diverse sources of data, as mentioned earlier. Additionally, the intensive practice of collecting data and engaging with seabed users also allowed me to continue gathering empirical evidence even after the fieldwork ended through WhatsApp and emails. For example, I received images of black tin ores (Chapter 4) in 2024 and coral reef restoration conditions (Chapter 6) in 2023 via WhatsApp messages. This means that the ethnography was extended through the help of social media. Even though such digital geography enabled me to continue the ethnography[24] beyond the material site of the case study, Begueria and Beneito-Montagut (2024) reflect that the use of digital social media here can create discomfort for the researcher as the interface between the researcher and interlocutors breaks the boundary between personal and professional life. However, in my experience, such interactions also create a strong bond between me and my interlocutors as we begin to share our live progress within and

[24] This digital method is ethnography in itself. As Forberg and Schilt (2023) argue that ethnography does not talk of 'the field' as a sealed place we enter and leave. The field is all spaces and places through which research is conducted.

beyond the seafloor's topic, for example, we often shared our anxiety about the corruption issues in offshore tin mining operations.

Indeed, as mentioned briefly in Chapter 1, corruption issues existed in offshore tin mining operations through selling concession areas to private actors. I acknowledge that the word corruption here is a strong word and could have ramifications. However, in this ethnography, my discussion with my interlocutor was a matter of concern on why a few high position individuals only enjoyed the profit of the offshore tin mining operations. Meanwhile, someone like my interlocutor should work all day and night to find seafloor tin ores. But at the end of the day, his effort would be irresponsibly utilized for individuals' interests. This means as part of my ethics and care, I tried to listen to what my interlocutor was concerned about this corruption issue and what they hoped to change in offshore tin mining operations. Besides, as the issue of corruption here was beyond the scope of my study, I only collected miners' everyday experiences, perspectives, and technologies they used to interact with the seafloor. That being said, despite encountering legal issues like corruption and illegal issues, my study on benthic geopolitics allowed me to redirect myself to focus on how the seafloor has become a contested territory. Therefore, I did not aim to expose diverse marine actors' legal issues. Instead, I aimed to understand how and why the seafloor mattered to them.

Meanwhile, in practice, I was not the only one who relied on the digital media. Instead, the data and report sent by mining crews offshore were also used to estimate and determine the budget, a new location of mining sites, and the strategy of conducting seabed tin mining ships in the conflicted sea. Furthermore, my research engagement with the large-scale seabed tin mining operations not only allowed me to understand better the conflict of the seabed uses but also allowed me to track other seabed uses that are competing with offshore tin mining operations to access the seabed of Bangka and Belitung Islands. For example, since my interview with interlocutors on the large-scale seabed tin mining ship? My participant observation demonstrated how these operations often competed with the artisanal seabed tin mining and submarine cables; this information encouraged me to engage with these seabed uses. To engage with artisanal seabed tin mining operations such as tin diving and tower-dredging, I relied on the information from low-ranking mining workers and my collaboration with the University of Bangka and Belitung (UBB). That is because low-ranking mining workers such as tin washers and engineers are often from the Indigenous community on the Bangka and Belitung Islands. They mostly have their families that work in artisanal seabed tin mining operations. However, since the distance of the mining site is often far away from my flat in Pangkal Pinang City, my seabed collaborator from the UBB, a sociologist, helped me to reconnect with the artisanal seabed tin miners. Indeed, in my previous research, as mentioned in Chapter 1, about offshore tin mining operations, I have engaged with the artisanal seabed tin miners. With my seabed collaborator from the local university, I could gather more interlocutors and their addresses for direct interviews and understand many research challenges in governing the seafloor off Bangka and Belitung islands through the list of the seafloor collaborators. This is also not to mention, for instance, my seabed collaborator also researched artisanal seabed tin mining operations. Therefore, my interaction with my seabed collaborator from the local university also made artisanal tin miners as part of my seabed collaborations and gave valuable information regarding the current conflict and how they negotiated access to the seabed.

Given that the large-scale seabed tin mining operations not only have seabed access problems and conflict with the artisanal seabed tin mining operations but also undersea cable companies, I continued my research engagement with submarine cable interlocutors in Indonesia. This insight is crucial for understanding how the seafloor's access has been contested by many seabed users. For example, my seabed collaboration allowed me to engage with elite interlocutors such as ASKALSI (the Indonesian Association of submarine cables), Telkom, the Institutes of Technology Bandung, BRIN, and Trans, playing an integral role in negotiating the marine spatial planning policies of the seabed and the conflict between large-scale seabed tin mining operations and undersea cables. I consider these seabed collaborators as elite actors because not only do they have knowledge and expertise about the undersea cables, which not many people in Indonesia have, but they also have their financial power and physical infrastructure that allows them to lobby the state governmental actors of Indonesia on the process of governing and managing seabed uses for Indonesia. For example, during the national conference of centralized marine spatial planning (MSP) on 7 June 2022, these actors were invited to respond to whether they agree with the current rules on seabed use corridors and routes, while others, such as tin divers and low-ranking tin miners are not. Additionally, although these actors generally reside in the Java Islands, their submarine cable projects also exist across the Indonesian sea, including offshore Bangka and Belitung Islands. This showcases how exclusive submarine cable businesses as only a few can access the seabed.

My engagement with the submarine cable and offshore tin mining companies also enabled me to continue my research engagement with the state governmental employees in charge of governing and managing seabed uses, such as the Ministry of Fisheries and Marine Affairs (MMF) and the Ministry of Environmental Protection (MEP). Indeed, my seabed collaboration above also allowed me to engage with the governmental representatives as it provided the contact person of the governmental employees and the status of when and where I could discuss the regulation of the seabed space in Indonesia with them. During my fieldwork, I was invited to go to their offices to discuss why the conflict of seabed uses exists despite the fact that the central and provincial governments have regulated seabed uses through marine spatial planning (MSP). The discussion with state governmental employees here also allows me to understand the conflict of authority in governing the seabed. For example, even though the Ministry of Energy and Mineral Resources allows the existence of the seabed tin mining operations off Bangka and Belitung Islands through their concession areas, the Ministry of Fisheries and Marine Affairs questions how the large-scale seabed tin mining operations pay the taxes of the seabed sites especially given that the concession areas cover over 45% of the sea off Bangka and Belitung Islands.

3.6.1 In-depth and semi-structure interview

While the previous section has already mentioned how I could interview my seabed collaborators, I will explain the type of interviews, such as in-depth and semi-structured interviews, and why I use two different types of interviews. In general, 40 interlocutors participated in this research. The in-depth and semi-structured interviews with them lasted between 40-70 minutes (see Appendix 2 for the interview guideline). The in-depth and semi-structure interviews enabled me to answer research questions in Chapter 1 through how spatial, technological, temporal, and material dimensions of the seafloor are used to reshape the meaning of the seafloor and how this materiality of the seafloor can get entangled with certain geopolitics of the seafloor. In this research, in-depth interviews refer to the practice of talking and thinking with the interlocutors by which the questions of the interviews are pre-defined. As such, the previous studies concerning the geo-politics of seabed mining have become a way of establishing a set of pre-defined questions in in-depth interviews. This technique aligns well with the work of Deterding and Waters (2021) arguing that the set of in-depth interview questions reflects the researcher's assumption about the topics informed by previous research on similar topics. The set of previously made questions here in the field is critical as the questions guide interlocutors to provide information relevant to the objective and the research question of this study (see Appendix 2). For example, the in-depth interview questions inquired whether the government employees govern the space and time of the seabed tin mining sites and what and how mining technologies access the depth of the seafloor. The topic here aligns well with current research on the geo-politics of seabed mining concerning how spatial, temporal, and technological dimensions are deployed as a way of securing seabed access (Childs, 2018; Sammler and House-Peters, 2023).

On other occasions, especially during my research visits to mining companies and on mining ships, in-depth interviews are not always possible. That is because even though I had already planned the meeting of the interviews at the interlocutors' location, their work forced my interlocutors to remain responsive toward their duties. For example, during my participant observation on mining ships, I have already set up the interview session with the head of the mining ship. However, since he had to manage his seabed mining crews by reporting the number of tin ores to the head office on land using his mobile phone, checking engineers working on fixing the pump of the cutter suction dredger, and ensuring the effectiveness of tin washing process on mining ship, I relied on semi-structured interviews. Semi-structured interviews here are almost similar to the in-depth interview. The difference is the set of research questions in semi-structured interviews reflects and rephrases according to the interlocutor's answers and spatial contexts (Gallata, 2013). For example, during the interviews, strong winds and high sea waves hampered the process of tin recovery in offshore tin recovery. For that reason, I asked a set of questions concerning whether the sea weather became their consideration to cease or continue the process of the tin recovery. The questions further iteratively also added more dimension of the seabed tin mining regulatory interventions. Thus, this technique enabled me to develop a set of questions and narratives grounded in interlocutors' experiences and perspectives (Simpson et al., 2021) (see Appendix 2).

While I created such a binary between in-depth and semi-structured interviews, in practice, the interview process often oscillates between the two types of interviews. This means in-depth interviews became semi-structured interviews, and vice versa, semi-structured interviews became in-depth interviews. That is because the temporality (time) and spatiality (space) of the interlocutors also defined the process of discussion, 'thinking with them,' and the duration of the interviews. For example, on the mining ship, I tried to collect information regarding the experience of the low-ranking mining workers. During the interviews, due to the cutter suction dredger malfunction, my semi-structured interview with them transformed into an in-depth interview. This is because the head of the mining ship allowed the low-ranking mining workers to continue the interviews. During the interview, they acknowledged that the seabed tin mining operations changed and damaged benthic habitats. The low-ranking mining workers here refer to those who work on the mining ship as tin washing crews and engineers. In the hierarchy of seabed tin mining organizations, their positions were deemed lower than the geologists and the head of mining ships because the latter often became the mastermind of where and how these workers conducted their work.

3.6.2 Focus group discussion

Since the hierarchy of seabed tin mining means offshore tin mining operations consist of diverse people with different backgrounds and expertise, shaping the way they perceive their seabed tin mining and seabed differently, to capture such a difference of views on the seafloor, I also conducted a focus group discussion. Therefore, the focus group discussion can provide empirical data (materials) that allowed me to address the research questions in Chapter 1. For example, focus group discussions conveyed various materials such as human bodies, tin ores, mining technologies, the sea waves, and mining policies that reshape or redefine the seafloor (benthic phenomena). Meanwhile, in FGD, one may understand how the production of tin matters for the global tin demand. Such information also indicates the geopolitical intervention of the offshore tin industries. In qualitative research, focus group discussion is a technique where a researcher gathers a group of individuals to discuss a specific topic and to understand participants' experiences (experiential knowledge) and perspectives (Nyumba et al., 2018). In focus group discussion, a researcher should become a facilitator who moderates the discussion about the topic and ensures a comfortable environment for participants (Paddock and Bell, 2024). During my fieldwork, the head of the mining ship helped me to recruit participants in the focus group. The first focus group discussion consists of the heads of mining ships, mining navigators, and mining engineers. Before the discussion started, I explained the purpose of the focus group discussion and asked their permission to record the discussion using my recording device.

To steer the discussion, I offered guiding questions where each participant could respond and refuse to respond. I decided who should answer the question first, and further, every participant could take their turn to answer the question. In this discussion, I questioned what are the challenges of tin extractions? How do they perceive the seabed? Do they ever encounter conflict with other seabed users? And how do they overcome such a spatial conflict? From this focus group discussion, for example, they used the metaphor of kitchen (*dapur*) to indicate the importance of the seabed for their livelihoods. That is because they acknowledged that through the seabed tin mining, they could send their kids to school, feed their families, and purchase a modest house on the Bangka and Belitung Islands. Additionally, I also developed a set of FGD questions based on the actual issues on the mining ships. For example, given the weather of the sea, such as high sea waves and strong wind, I also asked their opinions on how such weather also affects their ways of accessing the seafloor to extract tin ores. Do you stop your seafloor extraction practice or do you continue extracting seabed tin ores despite the bad weather? Each of the FGD participants oftentimes discussed with their peers to construct their ideas to answer the questions. Such group discussions are crucial because the participants start to confirm and validate each other's answers.

Figure 2. Focus group discussion. How to mine the seabed. (personal documentation on 5 July 2024 at the conference room of Bucket Wheel Dredging ship).

Meanwhile, the second focus group discussion consisted of geologists (tin exploration team) and the head of the mining ship. In the discussion, I questioned how the seabed tin mining could secure the seabed for their mining activities. Such information is crucial because we can understand even though seabed tin mining has created the seabed as an arena of conflict, borrowed from Weizman (2004), and violence between seabed tin miners and the Indigenous fishers, they could still access the seabed for the process and practice of recovering tin ores. For example, through this focus group discussion, I obtained information concerning how the depth of the sea regulation can be a way to avoid the conflict of fishers relatively situated near onshore and how environmental regulation, such as the ownership of mining permits and environmental impact assessment (EIA) has been used to secure the seabed for their mining practices if the conflict is inevitable. The latter is because, for instance, seabed tin mining must operate in the area of fishing to collect tin ores.

3.6.3 Participant observation

While the previous section has briefly mentioned the physical sites where the interview was conducted, such as mining company offices and mining ships, this section specifically focuses on how I observed and interacted with my seabed interlocutors in those sites using participant observation. This was part of my larger seabed ethnography. Specifically, participant observation aims to capture the daily experience of those encountering the seabed through their seabed uses (see Appendix 3 for the participant observation guideline). Therefore, as participant observation enabled me to document human bodies, tin ores, seawater, coral reefs, and technologies and how certain geopolitics of the seafloor shape the materiality of the seafloor, participant observation provides material evidence to respond to research questions in Chapter 1. According to Hurst (2023), participant observation is a research tool kit to engage and disengage with interlocutors in their spaces to understand how they act and behave. For that reason, before conducting participant observation, a researcher should plan on how to conduct the participant observation, including determining how to engage and disengage with interlocutors. For example, in my fieldwork, I used my notebook as a guideline tool for my participant observation, such as observing how mining navigators mine using their digital twin technologies and mining technologies and how miners separate their sediments. Simultaneously, to understand the mechanism of such tin deposit sensing and extraction as well as sediment separation, I also learned the operational knowledge of this activity with my interlocutors. Indeed, ethnographers have divided engagement and disengagement in their research activities into two categories: participant observation and observant participation (Seim, 2024). Participant observation means the researcher only observes their observed activities, whereas observant participation means the researcher joined their observed activities. In this study, I do not intend to differentiate between participant observation and observant participation as I argue that conducting participant observations in my fieldwork already contained a dialectical relationship between observing participants' activities and involving myself in their activities.

Supporting my argument above, Rossetti (2024) also does not see engagement and disengagement in participant observation as an opposing binary between participant observation and observation participation. That is because performing participant observation, according to her, not only means looking at and taking notes on participants' practices and behaviors but also talking and interacting with them in their activities. To immerse myself in my interlocutors' culture on the mining ship, I also participated in their mundane activities, such as cooking, eating, and washing clothes together on the mining ship. Involving in this everyday activity, I observed and collected notes from their mining activities and their everyday life activities (see Appendix 4 for the number of day trips with mining ships). This means that I can capture everyday conversations that may inform me to evaluate my research question. For instance, the discussion of the shifting working system in the navigation room enabled me to ask questions concerning how my interlocutors benefit from such a system. This engagement and disengagement with seabed mining activities here are crucial in order to build rapport and trust between me as a researcher and seabed mining workers as my research participants. The rapport and trust building here is crucial because it defines whether I could collect additional and important information, such as the experience of seabed tin miners and their different perspectives on what seabed means for them. Thus, my participant observation enabled me to visualize the daily process of offshore tin extractions that may not be explained during the interview.

The process and practice of participant observation above seem doable because one may assume that everyone can perform such a task to collect information. However, in my case, the participant observation forced me to challenge the boundaries of my comfort zone. This has to do with my personality as an introvert. Indeed, introvert does not necessarily mean socially awkward (Godfrey and Koutsouris, 2024). Instead, as an introvert, I tend to prefer a small group of people to interact with and primarily, this group of people should be those who I am used to socializing with in my everyday life. Yet, the place of my participant observation, the mining ship, did not provide such conditions. As such, I had transcended my introversion toward my extrovert attitude. For example, I had to actively re-introduce myself and my work in this research to a diverse group of mining workers and join their daily conversations during praying time and lunchtime. Also, since I was a researcher from Germany and Javanese, one of the heads of mining ships who studied in the Java Islands often treated me as a special guest by providing me with a special place to sleep. But I did not want to sleep at my own berth on mining ships. Instead, I slept with the low-ranking workers in their berth and on the floor of the praying room at the mining ship with them. The series of efforts to be part of mining ship communities enabled me to feel more comfortable conducting my participant observation at the same time as my interlocutors started to acknowledge me as their colleague. However, the hierarchy of me as a researcher and mining workers as interlocutors continues to exist and is maintained by the organizational culture of the mining company and this research project itself.

Although indeed participant observation can be a tool to confirm whether what interlocutors align well with what they are doing in their practice of collecting tin ores on the seabed, my participant observation has also become a tool of reflection on daily seabed uses and expand the knowledge about seabed uses beyond topics discussed during the interview. That is because while I observed their activities on operating the mining ship, suctioning sediments, and separating tin ores from adjunct sediments back to the sea, I could reflect on how the cutter suction and dredging transformed the materiality of the benthic environment as "anything but mine" as discussed by Sammler and House-Peters (2023). By anything but mine, Sammler and House-Peters argue that the combination of the digital twin technology and mining technology has transformed the representation of the seafloor as an always extractive landscape, manifesting how the seafloor is exploited. In the seafloor tin mining operation, specifically, the process of so-called "*kupas*" (peeling) in seabed tin mining has confounded my thoughts on what we mean by seabed. Peeling is broadly defined as the combination of digging, removing layers of seabed to reach target seabed tin deposits, reducing the size of the seabed tin into granular sizes, hovering and discharging the sediment back to the ocean. That is because peeling the seabed transformed the materiality of the seabed from a material space, granular materials, toward sediment plumes (as explained in Chapter 6). This transformation enabled me to reflect on whether tin ores are still on the seafloor, how the process of grounding the seabed into granular scales of sediments has not only removed our understanding of what the seabed was prior to the mining, and if tin ores are still the seabed, these ores can further travel beyond the site of the seabed mining enabled by the geopolitical governance intervention such as ITA and OECD. Thus, the seafloor is not just discursively fluid as the meaning of the seafloor depends on who assigns certain meaning to this space but also materially, the geo-physicality of the seafloor is changing.

The process of peeling and washing seabed sediments in the seabed tin mining has also recreated the construction of an essentialist view by separating commercial ores and non-commercial sediments. This means that I can capture how essential political assumptions permeate across multiple scales by observing the practice and process of seabed tin mining operations. That is because, during my participant observation, the process of tin recovery has always aimed to separate essential (desirable) and non-essential (un-desirable) seabed materials for the creation of the economy in mining companies. Such a dichotomy also interacts with how marine spatial planning (MSP), as a top-down geopolitical approach, divides the seabed for diverse seabed uses. The separation of commercial and non-commercial seabed sediments here indicates that the capitalist lens of the seabed has dominantly shaped the way the seabed tin miners perceived the seabed. Such reflection, I would argue, would not be possible if I did not perform participant observation by which I could observe and immerse in the culture of extracting tin ores on the mining ships.

3.6.4 MVE (Mobile Video Ethnography)

Given that my participant observation, focus group discussion, and interview allowed me to move multiple places and spaces, such as mining ships, floating rafts of tin mining, and mining offices, during my fieldwork, I employed mobile video ethnography (MVE) to capture videos and pictures of spaces, places, and human activities. Indeed, videos and pictures have become a crucial source of information because these digital mediations allow me to memorize and reflect on certain events from my research fieldwork, aligning with the work on the importance of photos and videos in the ethnography study (Cairns, 2024). More importantly, as the materiality of the seafloor also means the immaterial quality of the seafloor (see Chapter 2), such videos and photos here indicate the materiality of the seafloor. Therefore, MVE provides material evidence on benthic phenomena and how benthic phenomena are entangled with the geopolitics of the seafloor off the Bangka and

Belitung islands. In other words, the data of MVE enables me to answer a set of research questions in Chapter 1.

In this MVE, I utilized the Go-pro camera because this device has a set of accessories (mounts) that allow its users to adjust their Go-pro camera according to the places and spaces of the seabed uses. For example, on the mining ship, I often attach a Go-pro camera to my body to capture the situation and practices of seabed tin mining. Additionally, during participant observations, a waterproof GoPro camera was attached to a tin diver's body to capture how they engaged with the seabed pits to recover tin ores. Therefore, the mobile video ethnography (MVE) is crucial, primarily when accessing a social practice in an unsafe and difficult space (Spinney, 2015; Squire, 2017; Dickson et al., 2024) like the seabed pit (further discussion concerning what the seabed pit is provided in Chapter 5) or mining ships and boats where taking notes on research diaries are sometimes less possible.

Table 3. Table of photos and videos captured through MVE.

Data types of MVE	Number (n)	Recording Devices	Data storage
Photos	>100	Go-pro and mobile phone cameras	Atlas.Ti, a hard drive, AWI next cloud[25]
videos	28	Go-pro camera	Atlas.Ti, a hard drive, AWI next cloud

The challenges of taking notes on the mining ships and boats is because of the movement of the ocean and the splash of seawater that can make the research note wet. In this way, using the MVE, I could still capture human activities at unstable and moving oceans. Additionally, during my research, the MVE also allowed me to capture the sound of mining ships and the flow of minerals, indicating the active process of interaction between humans and the seabed mediated by mining technologies paired with the digital twin of seabed tin mining. The sound turns out to be one of the important parameters to detect (sense) the abundance of the tin ores on the seabed, as explained in Chapter 4 on large-scale seabed tin mining and Chapter 5 on tin diving.

[25] All data are encrypted according to AWI's data protection and EU data regulations.

3.6.5 Research diary excerpt

While the MVE in the previous section allowed me to memorize and reflect on certain events of actual practices in the seabed uses, I also employed a research diary excerpt inspired by the work of Peters (2017). I used two types of thick notebooks to record important argumentation and quotations from my literature reading and to document and reflect on my research activities. Such a research diary excerpt is crucial for me. That is because writing on the fieldnote not only helps to collect information spoken by the interlocutors during the interview and participant observation but also provides time for reflection. Indeed, given that this research project requires me to be continuously on the move from onshore and offshore, observing and talking with diverse interlocutors. These research activities are, by default, mentally overwhelming. By mentally overwhelming here, I mean that a social researcher can feel drowning and lost in the sea of information. Thus, a research diary excerpt is a tool to take me back to the main objective of the research at the same time as I could still document the complexity, messiness, and chaos of human activities and conflicts on the seabed. This complexity of materials from the research diary excerpt further underpins data from previous methods to address research questions in Chapter 1.

Meanwhile, even though the MVE provides the practicality of capturing the events in the seabed uses, the research diary excerpt provides a different experience to memorize and reflect on research activities in the field. That is because I argue that traditional writing through a pen and a piece of paper requires the movement of fingers. This means that I should calm down my rushing mind, overstimulated by the sea of information from my research activities, to synchronize my finger movement with my mind. In other words, this writing was also forcing me to pause and think first before writing on the field note. For that reason, the writing practice on research diary excerpts is the first step of analyzing information simultaneously, as it can capture the complexity and multi-dimensional information of research activities. For example, my writing practices through my field notes allowed me to create poetry about what seabed tin ores are and also to reflect on how the process of seabed tin mining operations does not happen from a vacuum but is enabled by a broader geopolitical configuration of intervention. The latter is because, during my fieldwork, the conversation and discussion with my interlocutors have showcased how the international market, including tin buyers and investors, also defines whether the continuation of the seabed uses (this discussion is elaborated through Chapters 4, Chapter 5, and Chapter 6).

3.6.6 Seabed policy and tin mining document gathering

While indeed engaging with diverse interlocutors from different marine uses and policy experts through seabed collaboration is physically and mentally demanding, these seabed actors provide crucial regulation and policy document recommendations, enabling me to understand the most updated version of seabed governance in Indonesia. For example, while during my desk study, I performed environmental policy analysis related to seabed tin mining, undersea cables, and undersea pipelines based on provincial government (PERDA, 2019), my seabed interlocutors informed me that PERDA (2019) has been amended and rectified as PERDA (2020). Additionally, my interlocutors in submarine cables have also given me information regarding the latest governance of the seabed uses in Indonesia. Indeed, since 2000, the decentralization of authority has given the provincial government autonomous decision-making and policy to govern their ocean and seabed uses, including seabed tin mining (Rosyida et al., 2018). However, given their interest in securing tax payment and ambition to organize the disorganized seabed uses such as seabed tin mining, undersea pipelines, and submarine cables, the central government has also created an integrated marine spatial planning map and policies, so-called KKPRL (Ketentuan dan Kesesuaian Penggunaan Ruang Laut). Thus, such a seafloor policy analysis here provides material evidence on particular state-geopolitics of the seafloor and how their regulatory interventions shape the seafloor uses in the material sites. For that reason, such analysis also provides crucial findings that helped me to address a set research question in Chapter 1 by providing information on which spatial regulatory interventions existed and ceased to exist and how they assist or resist certain seafloor uses.

Since every seabed use contributes to diverse socio-economic and ecological impacts, such as the displacement of fishing grounds for fishers and marine pollution during and after the process of marine infrastructure on the seabed (e.g., oil rigs and undersea cables), I also collected information concerning environmental impact regulations and reports. For example, my seabed collaborator from the Ministry of Environmental Protection helped me to access the current environmental impact assessment regulation (*Peraturan Analisa Dampak Lingkungan*, 2021). The environmental impact assessment regulation and report are crucial because they define whether seabed users can utilize the seabed or not based on their measurement to mitigate their environmental impacts. This environmental policy analysis through environmental impact assessment regulation and report enables me to understand why sediment plumes, for instance, are excluded in the current EIA, albeit seabed tin mining operations produce more plumes than tin ores (this information becomes underpinning data for Chapter 4).

Whilst I performed environmental policy analysis on marine regulation and EIA policy documents, I also collected information related to seabed tin mining through a museum visit to the Tin Museum. That is because the existence of tin mining off the Bangka and Belitung islands is inextricably linked to the Dutch and British colonial tin extraction and trade controls, Dutch-East Indies and British-East Indies, in the 18th century. For example, since visitors are allowed to record pictures and videos of museum artifacts such as the miniature of mining technologies (diorama) and painting illustrating how White colonial settlers forced Native Malay and Chinese slaves to work in tin mining, I could collect images and videos for my additional qualitative data analysis for this research. This museum visit enabled me to visualize how offshore tin mining operations looked like in the past and how such tin extractions are linked to the European slavery system. To justify my information regarding the history of seabed tin mining, I also reviewed the work of Indigenous scholars on the history of seabed tin mining operations (Swastiwi et al., 2017; Gunawan, 2019; Sya et al., 2019; Dunia Tambang, 2020; Irzon, 2021; Danur, 2023).

The information related to the colonial histories of seabed tin mining operations also encouraged me to perform policy and document analysis on current geopolitical governance such as OECD (the Organization for Economic Collaboration Development), RMI (Responsible Mineral Initiatives), and BGI (Blue Growth Initiatives). To do that, I collected these documents from their official websites. Such information is crucial because it allows us to understand how seabed tin mining exists due to the colonial histories and colonial-geopolitical relations. For example, even though the Netherlands and the UK could not govern through their direct colonial tin extraction and trade control off the Bangka and Belitung Islands, given the independence of Indonesia, they could still govern the seabed tin mining operations through their market intervention. This is not to mention, for instance, that Indonesia does not use the raw tin ores extracted from the seabed for their domestic uses. Instead, Indonesian mining companies must trade their tin ore to global electronic device companies. To be able to do that, they have to comply not only with governance regimes such as mining and EIA regulation but also with the international good mining practices prescribed by the OECD and RMI. Thus, by analyzing their mining policies, I could expand my knowledge on how the top-down geopolitical governance interventions from global, national, and provincial scales shape the practice of tin recovery off Bangka and Belitung Islands and what issues have been excluded and included and why.

3.6.7 Scuba diving (auto-ethnography)

To add empirical information from interviews, participant observation, focus group discussion (FGD), and research diary excerpt about the materiality of the seafloor, I employed diving as a method inspired by Squire (2017) as material ways and means of knowing and bodily experiencing the benthic environment. That is because my engagement with my seabed collaborators has mediated the interaction between me as a researcher and seafloor through their mining technologies and policies. Meanwhile, diving enabled me to provide a different experience and perspective of the benthic environment through being bodily present in the seabed. This means that I encounter the volume, depth, temperature, sands, coral reefs, and animals on the seabed corporeally. If the previous section argues that certain reflection can be possible when we are in the physical setting, diving enables me to reflect on the benthic habitats beyond the hegemony of offshore capitalist industries. Additionally, by diving, I also decenter the presumed human dominance because, on the seafloor, I realized that I could not move and breathe as on the surface. Here I started to understand how the benthic environment created an affect on me, and the water current under the sea has explained that the ocean has its agency beyond the capability of human control and prediction. Therefore, scuba diving embodies the intersection between benthic phenomena and geopolitics. In other words, the diverse materiality and embodied experience of scuba diving proffered supporting reflective data in response to research questions in Chapter 1.

As the environment of the seabed is hardly controlled despite the fact that I already have my diving equipment, this situation creates fear and anxiety of drowning and running out of oxygen. When my anxiety emerged under the sea, I started to forget to breathe calmly. Meanwhile, the air regulator only allows us to inhale and exhale air with certain temporality (i.e., every 3 seconds, I have to inhale the air, and another 3 seconds, I have to exhale). This limitation means that, as a human, the ocean occupies me and not vice versa. Such a discussion has become an epistemological debate between political geographers and Latour (Elden, 2021). By occupying, the fluid materiality of oceans could enter my body anytime as I am beneath the sea. Of course, I reflect on our construction of power that puts humans above others. Yet, diving disrupts such a myth of hierarchical power and becomes an important reminder that the agency of the ocean can transcend the assumed capability of human power to control this watery world (Squire, 2021).

When I mention the statement about oceanic agency beyond the power and control of humans, I do not mean to deny human agency to govern and control the ocean. In fact, I acknowledge that relations between humans and the ocean are not hierarchical but dynamic. For example, the current work of Helmreich (2023) has demonstrated how the geoengineers in the Netherlands create a digital wave of ocean waves and further recreate the material simulation of ocean waves to design the strength of ocean walls to enable the Dutch government to transform oceans into land. However, while humans have the agency to seemingly subjugate, control, and recreate the ocean as a hospitable and inhabitable landscape, issues such as sea level rise, ocean acidification, and marine biodiversity loss have showcased how the oceanic agency can go beyond the agency of humans. That is because humans' knowledge and technologies cannot necessarily address such ocean issues. For that reason, scholars have tried to conceptualize such non-human agency by different concepts such as the force of things (Bennett, 2004), entanglement (Tsing, 2015), and agential-realism (Barad, 2007) to indicate that agency is not human-centric with their conscious thinking and intention to act (Chapter 5 discusses more about how non-human agency and human agency interacts with each other and matters for tin diving operations).

To experience the benthic environment and to experience the agency of my body, I participated in a scuba diving course for four days in Jakarta for closed-water training and open-water training. The latter refers to indoor scuba diving training, while the former is in the sea. The open water training was performed in the *Kepulauan Seribu* (Thousand Islands), still part of Jakarta's administrative province. The scuba diving training here indicates the benthic environment is an exclusively accessible space. That is because to dive and experience the benthic habitats intimately requires a comprehensive procedural, practical knowledge of scuba diving and an expensive investment in practicing scuba diving. Procedural knowledge here means that I have to understand how a set of diving devices such as an air regulator, air tank, mask, fins, boots, buoyancy compensator, gauge, gloves, computer, wetsuit, and boots work. For that reason, it required me to read and learn how to operate these scuba diving devices. Additionally, it also required me to understand scuba diving risks and how to address and reduce the risk in scuba diving, especially given that scuba diving is considered an extreme sport. The risk of scuba diving varies from fatigue, decompression sickness, nitrogen narcosis, drowning, and air embolism. For example, drowning can happen when divers cannot operate the buoyancy that can balance their bodies or if they are running out of air in their air tank. The latter usually happens when they do not check the level of air use through their diving computers. Indeed, such incidents can be fatal given that the oceanic current could also drag the divers' bodies from the location of the scuba diving. However, understanding such procedural knowledge and the risks associated with scuba diving is not enough. After passing the examination of procedural knowledge, I had to enact my understanding of scuba diving procedural knowledge by diving. This echoes the notion of learning by doing but in risky ways. This has to do with practicing what I understand in the scuba diving handbook scuba diving is a totally different experience. By bodily presence, borrowed from Pérez and Zurita (2020), at diverse depths from 5 to 18 meters, my fear deviated my attention from what I had learned about the fear of drowning. This made me unable to breathe, driving me to escape from my fear of going to the surface of the in-door diving water.

At that moment, I realized how vulnerable I was to being underwater despite the fact that scuba diving devices and knowledge promised my safety if I followed their instructions. Such a fear continued later during my open water training in the sea. While, indeed, the beauty of exotic tropical fishes and coral reefs had hypnotized my scuba diving buddy and trainer, the fear of the depth was giving a deep emotional and psychological scar. The emotional and psychological scar here means that the fear of the oceanic depth outcompeted the romanticization of the sea through recreational diving. Indeed, such a fear hampered my scuba diving practice. For example, many times during my open water scuba diving training, I was drinking too much water, suffocating and hindering myself from breathing calmly as I forgot to dry up my air regulator. This is also not to mention, for instance, that my anxiety of drowning and running out of air has also pushed me to breathe air frantically, reducing air concentration in my air tank. My scuba trainer told me that it took an hour to reduce the air concentration from 300 to 50 psi (pounds per square inch). 50 psi is the threshold of scuba diving duration. That means if scuba divers' air concentration reached this amount, they had to perform a surface interval for 3 minutes at a depth of five meters before going to the sea surface. The surface interval is necessary to release the nitrogen residue in our bodies while we are underwater. The amount of 50 psi is used to allow us to perform a safety ascend by using the remaining air to bring us to the surface. But despite such scuba diving theory, my anxiety has deviated from the common relation between air concentration and scuba diving duration. In fact, I reached 50 psi quicker than my scuba diving buddy and trainer. Indeed, at this moment, I disappointed them. However, my anxiety about drowning activated my survival instinct. As I was having a panic attack during my diving training and saw my air concentration running low (50 psi), I did not perform the safety ascend and the surface interval, leaving my scuba diving buddy and trainer beneath the sea.

While indeed my scuba diving buddy and trainer blamed me for my sudden ascend, ignoring the surface interval practice, this disappointment of my scuba diving action could emerge given that we are only reorientating on me, a human with his agency (rational and subjective thinking). In this case, they expected me to use my intention and conscious thinking, or "being rational", to respond appropriately to my irrational behavior, such as my panic attacks and the fear of depth. Meanwhile, they forgot that the benthic environment, such as the depth of the sea, its cold temperature, and pressures, have shaped such conditions under which such fear and panic attacks can appear beyond my rational control, aligned with the work of Squire (2021) on the relation between irrational behaviors of aquanauts and the seafloor environment. Of course, in the current epistemological debate of agency, we often privilege human agencies given their subjective and rational thinking. However, in this scuba diving, we ignore that humans can also be irrational, especially when exposed to benthic environment conditions through such embodied experience. Additionally, my fear and panic attacks here have explained how the oceanic depth has an affect on me. While the current social scholarship debate in psychology, law, and anthropology on emotion and affect, for example, as discussed by Stenner (2018) and Schulz and Thies (2024), could also complicate my understanding of whether my anxiety and fear of depth during scuba diving here is personal feeling or an affect, I acknowledge that my irrational and subconscious action such as fear of depth and anxiety as pre-personal (an affect), echoed by the work of Hayward (2012) and Aubry (2024). The affect in my case, has to do with recognizing the agency of oceanic depth and benthic environment shapes my behavior. This is not to mention, for instance, that my irrationality here means that the agency of oceanic depth and my human agency coproduces my anxiety, deviating from the notion of personal. Thus, if Schulz and Thies (2024) argue that "an affect is a psychological reaction to the stimuli", my affective experience during scuba diving, I would argue, is not personal but pre-personal because the affect indicates that being anxious requires interacting with the depth of the sea to emerge instead of it is solely coming from my thinking. Thus, without going into diving, such an affect such as fear and anxiety leading to irrational thinking cannot exist. This argument aligns well with the argument of Pile (2010) in conceptualizing affects for human geography:

"Affect refers to the production of a capacity of a body, a capacity that is defined by its radical openness to other bodies. Affect is not simply personal or interpersonal (along the lines of emotional geography's conception of emotion); it is transpersonal, drawing in many bodies. Affect, then, is both within and between bodies" (Pile, 2010: 8).

With regard to Pile's explanation of affect above, I argue that the affect in my scuba diving exists as I expand the capacity of my body to other bodies. Of course, in this case, my body also intimately interacts with the water body of the sea. Such openness between my bodies and water bodies creates the situation within and between bodies: an affect. That is because the fluid water of the sea can permeate through my body via my skin pores, eyes, nose, and mouth. Such a condition further led to fear and anxiety. This makes me go to the surface while ignoring the rational instruction of scuba diving safety.

Meanwhile, since scuba diving has been deemed to be a masculine practice, given diving risks and accidents, scuba diving and like other diving, force me to fit in with the social construct of masculinity (Pérez and Zurita, 2020). Such anxiety and fear of depth have showcased that I did not fit in such a social construct. The social category is believed and agreed upon socially in scuba diving. Instead, I was always compared to my scuba buddy, a woman-identifying person, by my scuba trainer. That is because my scuba diving buddy did not experience the anxiety and fear of depth during the open-water scuba diving. For example, her process of ascending, descending, and diving could go really well. Of course, such a situation gave me a kind of peer pressure during the scuba diving training as I, as a man, should ideally be able to overcome my fear. However, the practice of scuba diving here also taught me to accept my vulnerability and, perhaps, contest the notion of masculinity in the practice of scuba diving. Throughout my scuba diving, I also learned how the masculinity identity inserted into scuba divers has also led to mining accidents and death in tin diving. For that reason, if my scuba diving is mostly for recreational purposes and implies the relation between economic class and benthic environment access, it also teaches me that not all divers, especially tin divers, experienced the training and diving equipment that reduce their risks of diving accidents. As such, my scuba diving here provides a better reflection to understand what tin divers experienced during their descent and ascent from and to seabed pits through diving. Of course, I do not argue that tin diving and scuba diving are comparable because diving to recover tin ores does not have adequate safety measures and training. However, what I want to argue is that we can imagine better what it feels like to be under the sea with modern scuba diving equipment and training, let alone only using the rudimentary equipment in tin diving. Such a reflection is thus not only coming from the interviews concerning tin divers' experience but from our embodied experience engaging with our fear of depth and anxiety and the risk of scuba diving itself (Straughan, 2022).

3.7 Qualitative coding analysis

3.7.1 Navigating through the sea of information

While previous sections have showcased how diverse qualitative methods have their practical and logistical challenges to capture the materiality of the seafloor (benthic phenomena), such as mining area access permits and research equipment (e.g., Go-pro, a first aid box, and a notebook), organizing and analyzing multiple information from various sources of qualitative methods are also equally challenging. That is because the number of documents such as transcripts, research diary excerpts, videos, and pictures create their own regimes of practical and logistical difficulties. By regimes of practical and logistical difficulties here, I mean how I could save massive qualitative information, how I could analyze the information and when information should I should read and perform my qualitative analysis. Such an overwhelming amount of information could stall my research data analysis progress if I could not overcome such practical and logistical difficulties that emerged from diverse sources of qualitative data information. However, indeed, obtaining adequate information related to the geopolitical governance of seabed uses here means creating both safety and insecurity. The former and the latter have to do that without proper tools and strategies to organize and analyze the qualitative documents, such a sea of information will remain to be information and will not transform into the knowledge that contributes to better our geopolitical understanding of the seabed uses.

In fact, I would argue that such qualitative information can be knowledge if the organization and analysis tool enables me (the researcher) to socialize and routinize my interaction with the qualitative data on a daily basis so that such socialization and routine not only connects me with my research project but also allows to me see both the critical and crucial quality of data and the overarching picture of how each qualitative data interact with each other. Since capturing the critical and crucial quality of data from qualitative information sources is subjective, this means that I often focus on interpreting the data, which most likely helped me answer the research questions in Chapter 1. Having said that, if such sources of data are interpreted by other researchers, the knowledge produced from the collected information could be different from what I have interpreted. Therefore, the subjective nature and culture of my qualitative data interpretation here imply that I do not aim to create such objective knowledge as how quantitative researchers would aim for by, for example, analyzing the correlation between one variable and other variables within the qualitative information. Instead, I focus on creating in-depth and critical knowledge of the seabed through qualitative data analysis, aligning well with the argument of Verschuren et al. (2010) on the difference between qualitative and quantitative studies.

3.7.2 Atlas.ti mac 24

Given that organizing various sources of qualitative information is as crucial as conducting a qualitative analysis of the collected information, I relied on Atlas.ti mac 24 to organize various information. While I can indeed use other current qualitative data software (e.g., MAXQDA and NVivo) or even perform traditional qualitative data analysis by printing transcripts, policy and regulation documents, images, and videos and storing them in physical folders, I prefer Atlas.Ti over other means of organizing and analyzing qualitative data due to several reasons. First, I have been familiarized with Atlas.ti tools and menu as I have utilized such qualitative data analysis software since my master's study. Indeed, familiarity with the software here is crucial because I could save my time efficiently since I do not need to learn how to operate Atlas.ti. Second, Atlas.ti has a feature that enables me to create project folders. In this project, not only does Atlas.ti allows me to create a project folder for my qualitative data methods and also some project folders for my literature review reading.

The latter is as crucial as the former because research is also a conversation with other researchers in the field of geopolitical studies, for instance. As such, I could see whether my qualitative data interpretation from my sources of information is relevant and contributing to current academic debates in geopolitical studies. Third, since I could organize various types of qualitative data such as transcripts, videos, pictures, seabed policy, and regulation in one project folder, this means that I analyze these sets of data in one platform, enabling me to see how data relate to and contradict with each other. For example, the transcript interview showcases cutter-suction-dredging miners who argue that sediment plumes attract squid and pelagic fish. This statement aligned with the statement of marine ecologies explaining why sediment plumes attract fish in another transcript and underpinned by a research diary excerpt on daily mining activities, showcasing miners and fishers caught fish and squid as mining discarded tailings. Finally, the Atlas.ti provides comments, coding features, and notes that can be summarized in one report. Such a report summary is crucial because I just need to revisit the summary report to take important quotations, notes, and comments instead of going through each document again. Indeed, the latter is possible as the research folder has brought diverse data in one platform.

3.7.3 Coding and codes on Atlas.ti mac 24

While the previous section has already mentioned briefly about coding in Atlas.ti, in this section, I will explain the practice of coding using Atlas.ti software. However, before I explain further the practice of coding my qualitative data sources such as transcripts, videos, images, research diary excerpts, and seabed policy and regulations using Atlas.ti software, understanding the difference between coding and code is also essential. That is because we can understand how certain types of coding produce certain types of codes and why codes are crucial in qualitative data analysis. According to Gupta (2024), a code is broadly defined as a word or short phrase that represents summative, salient, essence-capturing, and evocative attributes to a portion of text-based or visual data. For that reason, codes often mirror the lens of a research objective (Saldaña, 2016). For example, since investigating the convergence of benthic and geopolitics within seabed uses often require understanding how certain seabed uses to access the sea depth to use or extract seabed spaces for enabling certain geopolitical projects, codes emerge from the data-based text are 'oceanic depth and access.' Meanwhile, if codes are symbolic words or short phrases that indicate summative and evocative attributes of quotations from transcripts, images, videos, and seabed policy and documents, coding refers to the practice of creating certain codes on textual and visual data. According to Berthet et al. (2023), coding helps to organize dense data into manageable amounts and to understand the meaning of the data by revealing trends and patterns.

Indeed, diverse coding in qualitative data analysis literature exists, but the common coding techniques consist of three types of coding such as deductive, abductive, and inductive (Silver et al., 2023). While deductive coding refers to how a researcher prepares a certain set of prior codes to be implemented on their textual or visual data, inductive coding means that a researcher reads the data first to produce certain ad-hoc codes used to label quotations, images, and videos. Since the practice of qualitative analysis should align my data interpretation with the frame (lens) of my research objectives and, at the same time, should also capture 'unexpected and crucial information,' I utilize abductive coding. The abductive coding is the integration between deductive and inductive coding. This means that not only did I prepare a set of prior codes that I use to mark quotations on sources of qualitative data, but I also allowed certain information from the textual and visual data to be their own codes. To make the information their own codes, I often relied on the Atlas.ti feature, so-called "In-vivo" codes, or I used the salient phrase that existed in the text as a code. The in-vivo codes mean that certain quotations become their own codes. For example, in the participant observation notes, miners explained, "Before we extract tin ores, we have to peel the layers of the seabed". With the in-vivo code feature, the whole sentences become their own codes. Meanwhile, using abductive coding, I labeled the sentence in the quotation as "peeling". Meanwhile, since digging the seabed provides information related to the oceanic depth, I have prepared the oceanic depth as one of the prior codes that I utilized to code the text.

Figure 4: a code cloud using Atlas.ti 24 Mac. Note: red (the most frequently appearing codes), green (the second most frequent important codes), and grey (the least frequent codes).

As the main goal of coding is to develop clear themes and patterns of information-based text and visual data, the practice of abductive coding on Atlas.ti further enabled me to make diverse codes. Such a set of deductive and inductive codes from the qualitative information is both challenging and beneficial for this research. That is because I could see how my prior codes interact with ad-hoc codes and how such interaction enabled me to find the main theme that I can tell in every Chapter of this monograph in conversation with existing concepts in the new materialist interpretation of geopolitics literature. Thus, both prior and ad-hoc codes play an integral role in not only allowing me to reflect and create meaning out of the information to generate certain knowledge but also allowing me to memorize certain events I encounter during my fieldwork. This aligns well with the statement of Silver et al. (2023) on how codes in qualitative analysis enable reflection to capture the deeper meaning of the information. For example, I prepared the interview questions related to the oceanic depth, such as what the estimated depth of the sea is and what seabed miners could access to recover tin ores. In which the prior code would be “oceanic depth”, the miners explain that oceanic depth is relative as, according to them, entering the seabed pit is like entering the void. The latter was then coded as “depth and emotion”. The interaction between oceanic depth code (prior code) and “depth and emotion” here further allowed me to reflect on how the embodied experience of tin divers is often neglected and how such negligence in current geopolitical governance has been maintained. This reflection contributes to Chapter 5.

Even though codes allowed me to reflect, such reflections are less likely to emerge if I observed prior and ad-hoc codes separately. For that reason, using Atlas.ti enabled me to save time in creating patterns of codes through its network analysis feature. The network analysis feature here refers to creating a map of prior and ad-hoc codes, allowing a researcher to see how each code relates to or contradicts each other. In the qualitative process, while indeed Atlas.ti provides features to create a default command on whether codes relate to or contradict each other, Atlas.ti also allows a researcher to customize what types of relations each codes have. That is because, as I argued earlier, the qualitative analysis here means that the interpretation of the data depends on the subjective interpretation of the researcher. Thus, the researcher could create certain relations between one to another according to the objectives of the research. However, in my case, I only use relation and contradiction. For example, when mining operators mentioned, “SIOPL [the digital twin] in mining operations provide a real and actual image of the seabed [empty space without coral reefs],” I code this quotation as an actual image and empty space. But such a statement is contradicted by the quotation of the marine ecologist, arguing that “the sea of Bangka and Belitung islands is home of coral reef diversity”. I marked the latter as “coral reefs”. Thus, the code between coral reefs and actual images contradicts each other. In this way, the network analysis of the Atlas.ti allowed us to reflect on how codes communicated with each other, representing the agreement and disagreement on the current status and knowledge of the seabed off Bangka and Belitung islands.

3.8 QGIS (quantum geographical information system)

Since conducting the fieldwork required me to move from one site to another site, from onshore to offshore, I also relied on QGIS (quantum geographical information system) Mac version 3.34 to visualize the location of my field site. I can operate this offline mapping software because I received a three-day intensive QGIS training season (n=18 hours) from my research institute, AWI (Alfred Wegener Institute) in Germany. Of course, while QGIS enables me to locate and map the areas of my conducted fieldwork, I acknowledge that utilizing QGIS to map my research areas can put me at risk of reproducing a colonial view. This means the act of mapping my case study areas here can recreate the practice of seeing the case study areas from nowhere (Sammler and Lynch, 2021) and God's eyes views (Sammler and House-Peters, 2023). In other words, I can flatten and erase the struggle of the Indigenous people affected by offshore tin mining operations and other capitalist extractive industries. For example, since I often used symbology features on the QGIS to mark the location of the field site, such mapping practice using this software can create a reductionist view on the place of the Indigenous communities and transform the site we encounter bodily the colonial violence such as their sea and seabed dispossession and transformation into mining areas. However, I do not intend to reproduce such intentional colonial violence erasure by using the QGIS because throughout my work in this monograph, what happens is the opposite. I demonstrate the interaction and tension between such reductionist view using such a hierarchical geopolitical mapping process and the experience of those who are affected by the practice of mapping the sea and the seabed and creating top-down geopolitical regulatory interventions (for example, it can be seen on Chapter 5 benthic bodies: from seafloor to seafloor).

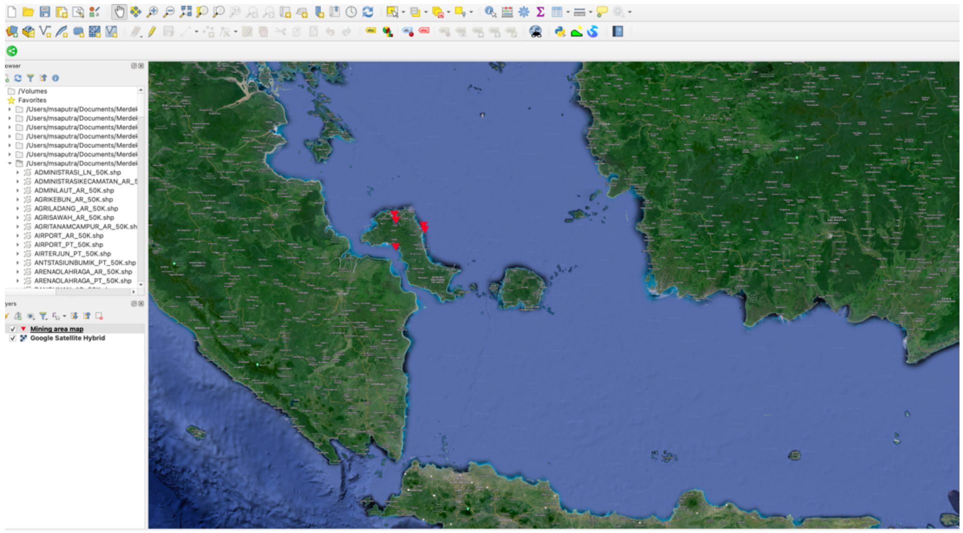

Figure 10: QGIS user interface and the example of case study area mapping.

My careful consideration of using QGIS here echoes current work on decolonial cartography that reminds us how we have to be careful with the use of GIS to avoid repeating colonial views on case study areas. This statement aligns well with the argument of Unangst (2023), responding to the work of Tolia-Kelly et al. (2020) on inserting anti-racist and anti-colonial values in the praxis of geographical scholarships:

“[while] GIS may appear to be a neutral tool for use that is not necessarily political, it repeats the work of the colonial state in turning spatial knowledge that requires understanding the cultural frameworks in which that information is embedded into something that can be easily consumed by people working in a European frame” (Unangst, 2023: 77).

However, since GIS is not neutral, I argue that the purpose of making maps using GIS is also tied to the positionality of the GIS users. This statement echoes the work of Gibson (2014), arguing:

“[T]hey are still accounts of space, these new kinds of maps, but they do not stay still. They alter from moment to moment, tracking time, showing—albeit mainly at the somewhat occluded level of metadata—a record of everyone who visits them, who gets folded into them. an interactive map stores a narrative that involves you as a character. Indeed, with each newly recorded visitation from you, the narrative grows around your character” (Gibson, 2014: 251).

In other words, as I do not intend to reproduce the colonial view, I do not aim to use the GIS mapping practice to recultivate the view from nowhere to flatten existing experience. Therefore, I utilized GIS to provide visualization of my field study sites and specific sites of ethnography.

Concurrently, as I conducted fieldwork, I practiced in my scholarship what Pérez and Zurita (2020) argue as being "bodily present". By being bodily present in research sites, of course, I could feel and encounter the struggle of those accessing the seabed. Indeed, even though being bodily present does not mean that it is less colonial than the use of GIS, my endeavor to not rely merely on GIS to map the sea and the seabed, but being bodily present in the field can capture what GIS cannot. For example, how Indigenous fishers encounter sediment plumes produced by the seabed tin mining operations in Chapter 6. As such, as GIS helps me better visualize field sites, my direct encounters with those experiencing the sea and the seabed add what may have been erased or removed from the praxis of mapping using this technology. Hence, the iterative process of making the map using the QGIS and my reflection on my fieldwork reproduces my endeavor in this Chapter to adopt or think like benthic phenomena. That is because the interaction between the top-down view using QGIS and my ethnographic study has dispelled the colonial view of seeing from nowhere. In fact, I observed the lived experience of my interlocutors dealing with their seabed uses directly at somewhere such as their offices, houses, mining ships, restaurants, floating wooden rafts, and boats.

3.9 Conclusion

This chapter translates and operates benthic phenomena as a methodology to obtain empirical data from the fieldwork and desk study by thinking with benthic phenomena. This means that I not only rely on discourses such as written and spoken texts from marine policy and regulation that govern the seabed off Bangka and Belitung Islands in Indonesia. Instead, I also investigated and experienced the everyday experience of the seabed tin miners on mining ships and wooden rafts, and in fact, I had to encounter the seabed by myself. The combination between policy analysis and ethnography here, I argue, contributes to creating a dialectical interaction between discourse-based geopolitical analysis and embodied geopolitics. In this chapter, my significant and original contribution to knowledge is to showcase that by enacting the way benthic phenomena permeate through multiple boundaries, one can gather empirical evidence from the top-down geopolitical interventions and collect the intimate embodied experience of the seabed where the geopolitical interventions manifest in the field site. Thus, one can understand how the experience of the seabed is often untold in the top-down geopolitical intervention and, at the same time, sees the connection between the top-down geopolitical interventions and the politics of the seabed in the field. In this way, I argue that the combination of the material knowledge of the seabed from the policies and the embodied experience can provide holistic data to understand whether the current global, national, and provincial policies capture the spatial conflict of offshore industries.

Combining geopolitical analysis from official reports, policy analysis, and ethnography above also provides empirical evidence that can underpin the arguments of this study. That is because not only one can capture the perspective of the policy-makers on governing the seabed through their top-down geopolitical approach. But one can also capture the perspectives, interests, and experiences of the seabed users on enacting certain geopolitical interventions in the field. For instance, by analyzing marine spatial planning policies and regulations as well as the global mining standards, one can obtain that the discourses of mining permits, personal protective equipment (PPE), and mining concession areas are the main focus of the decision-makers. Meanwhile, during the ethnography on the mining ship, one can record videos and sounds and capture pictures of the seabed mining operations crucial for narrating the story of the seabed tin mining. Additionally, one can also link how the mining requirements and the practice of sensing and extracting activities are not separated. That is because the practice of sensing and extracting the seabed also contributes to providing revenues for tax payments and international corporation memberships to certain geopolitical interventions (see Chapter 4).

While, indeed, performing document analysis and ethnography on the seabed uses provides diverse empirical findings, there exist limitations to such methods. For instance, the policy and regulatory intervention has to be specifically focused on seabed uses. This is to ensure that the environmental policy analysis can indeed link to the seabed uses. However, while it helps to delimit the work regarding the utilization of the seabed. This also means that it excludes marine transportation and marine tourism policies in KKPRL (2021). Meanwhile, maritime and tourism policies also play a vital role in contesting the use of the seabed. For that reason, the benthic methodology here can also capture other actors outside the selected seabed uses that may result in the seabed as a contested and conflicted space. Additionally, since there are many governance actors concerning offshore tin mining operations, this study also focuses on mining policy interventions such as OECD and ITA. This means that other policy interventions from other international organizations and market interventions concerning offshore tin mining operations are also not properly studied. For that reason, this study also encourages future researchers to add other mining organizations that also focus on governing the seabed tin mining operations off the Bangka and Belitung Islands in Indonesia.

Another limitation of such methodology is also tied to the new materialist geopolitics in itself. That is because the qualitative methods in this research above focus on collecting empirical evidence that represents the materiality of the seafloor. As mentioned earlier in the previous chapter, the materiality of the seafloor refers to the intersection between geopolitics and geo-physicality. This means that the materiality of the seafloor consists of the immaterial and material quality of the seafloor, as also explained by Sammler (2016b) and Peters et al. (2018). For example, I only collected how the provincial and central regulations portray the seafloor through marine spatial planning (MSP) policies. But also gathered information concerning sands, sediments, and embodied experience on the seafloor. However, since the focus is to obtain the materiality of the seafloor that represents the belief that the global scales of geopolitics consist of bodies and material interactions (Dittmer and Klinke, 2014), this methodology does not dive further into the power relationship between human actors in detail. Of course, this does not mean to remove and neglect the existing power hierarchy within the geopolitics of the offshore tin operations. Instead, the power hierarchy within actors already manifests in how the materiality of the seafloor is deployed to enable seafloor access and produce territory for certain marine uses (e.g., offshore tin mining operations and tin diving operations) and, at the same time, marginalize other marine uses (e.g., benthic habitats and the Indigenous fishers).

Chapter 4 Benthic apparatuses: sensing, sense-ability, and insensitivities toward benthic habitat degradation

"Science [and technology]is politics by other means. It offers other means"(Latour, 1993: 229).

"*On one hand, as a discipline, we are now well aware of science's entanglements with imperial projects and racist logics, not to mention the omissions and silenced voices propagated by the 'view from nowhere.' On the other, it is difficult to imagine environmental geographies and politics that are not tethered to technoscience – however implicitly or transgressively*" (Lehman and Johnson, 2022: 23).

4.1 Introduction

On 25 May 2022, by the end of the afternoon, entering the mining ship, I saw two mining navigators. One was navigating the ship and operating the cutter suction dredger (CSD)—locally known as *kapal isap* (suction ships). The other was waiting for his turn while helping the navigator read the tin deposit map and the screen of the digital seafloor simulation. Indeed, navigating a mining ship and operating CSD for extracting tin ores are separate yet intertwined expertise. This is because being capable of navigating a mining ship does not necessarily mean someone can navigate the seafloor dredging and suctioning technology. However, operating the mining technology most likely means the navigator is able to navigate the mining ship as a mining navigator needs to navigate the ship to locate the tin deposit sites. During my period of ethnographic work, see Chapter 3, seeing diverse buttons and monitors, I observed how the mining navigator checked sea weather parameters (e.g., sea wave height and wind strength), noted the depth of the sea, and located the seabed tin ores. As I noted, in the process of navigating a mining ship, the mining navigator introduced me to their digital sensing technology. He said: "You see this seabed and mining simulation here, we call this remote digital sensing technology, SIOPL, standing for *Sistem Informasi Operasi Pertambangan Laut* [see Figure 14]. We have installed this sensing technology in our mining ship for a few months already" (Mining navigator, 2022b: participant observation on 22 May 2022). The practice of sensing using the SIOPL indicates the co-becoming between sensing devices, mining technologies, and mining navigators.

Co-becoming here means the dialectical interaction between mining technologies, sensing devices (e.g., SIOPL, CCTV/closed-circuit television, and sound recorders), and mining navigators in finding tin deposits beneath the seafloor. This conceptualization aligns well with Ballestero (2019) argument on how the space sensing combines human senses and sensing devices, connecting abstraction[26] and embodiment[27]. Such interaction not only focuses on detecting the presence of the tin ores beneath the seafloor but also on dredging, suctioning, and cutting the seafloor and its benthic habitats into granular sediments (e.g., sands, tin ores, and rare earth elements). Therefore, as the act of sensing here involves changing the benthic environment into a digital seafloor simulation and physically changing the seafloor into sediments, the sensing practices here affect benthic habitat health. As the mining navigator explains: "Before we mine the seafloor, we should peel the seafloor. Peeling means removing the outer layer of the seafloor through digging, cutting, and suctioning seafloor sediments...indeed, sometimes we also need to dredge the coral reefs when the reefs exist in a planned mining site" (Mining Navigator, 2022c: Interview on 22 June 2022). In response to this issue, this chapter frames the co-becoming between miners, sensing devices, and the observed seafloor as an 'apparatus' (Barad, 2007; Sammler and Lynch, 2021). Using the concept of apparatus, this chapter aims to highlight how entanglement between observers (mining navigators), observing instruments (e.g., SIOPL and sound recorders), and an observed object (seafloor) creates the paradox of sensing: the convergence of sense-ability and insensitivities toward benthic habitat degradation and how such a paradox transcends beyond the material site and moment of the offshore tin extractions.

While sensing practices on land and sea has been in the province of the physical sciences more than social sciences (Helmreich, 2009; Gabrys, 2019), Sammler and House-Peters (2023) remind us that seabed sensing in onshore and offshore extractive industries is situated within political and social contexts. In other words, the culture of seafloor sensing is never neutral but is always political, especially given only those with sensing infrastructure[28] (see: for instance,Carse, 2012; Starosielski, 2015; Prabaharyaka, 2021) can generate data in this space for certain interventions and manifests in particular geopolitical implications (Lehman, 2020b). For example,

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[26] The abstraction here refers to how sensing devices (e.g., digital remote sensing technologies and cameras) converts material spaces into digital and pixelated pictures and maps.
[27] The embodiment refers to the way humans operate to sense the material space.
[28] Indeed, infrastructure has no one-size-fits-all meaning. According to Starosielski (2015), infrastructure is, by default, invisible as it is often taken for granted. Taking the idea of taken-for-granted-ness in infrastructure, Carse (2012) argues that nature itself is infrastructure. Meanwhile, considering the active and living processes within the infrastructure, Prabaharyaka (2021) argues that infrastructure is a process instead of a physical space. Infrastructure, in this case, is mining navigators and their sensing devices.

in the seabed tin mining operations, one should understand that seafloor sensing here serves the interest of tin mining companies, tin buyers, and tin tax income-collecting state agencies by providing these actors with information such as estimated tin amount, the depth of the tin ores, and productive tin mining sites (see Chapters 5 and Chapter 6 for the relation between tin mining and tax payment collection). This geodata (see Monteiro 2022) can, of course, be put to use by mining companies and governments to negotiate whether extracting tin ores from the seabed can generate revenues and contribute to income tax payment and corporate social responsibility (CSR). As one geologist mentioned, "[T]he tin deposit map is very powerful because we can use them to lobby the government and attract the tin investors" (Geologist, 2022: Interview on 15 July 2022). This means the data from sensing seabed activity matters for a pre-requirement of the geopolitical interventions on offshore tin mining operations. By the pre-requirements here, I mean that without the geodata from the seafloor sensing, the practice of offshore tin mining operations cannot exist as they cannot predict whether extracting the seafloor is profitable and compensate for their operational costs (e.g., labor, food, insurance and fuel costs). Likewise, the geopolitical intervention of the offshore tin industries on provincial, national, and global scales can also not determine the size of the concession permits without the geodata produced by the apparatus of the offshore tin mining operations. Thus, the seafloor sensing of the offshore tin industries matters in the production of the seafloor mining territory.

Despite the political implications and the importance of seafloor sensing, little attention is given to the culture of seafloor sensing in offshore tin mining operations off the Bangka and Belitung islands. The lacuna here exists especially, given that social scholars focus on analyzing the perception of coastal communities and environmental non-governmental organizations on the Bangka and Belitung islands (Rosyida et al., 2018; Ranto et al., 2023; Putri et al., 2023). For that reason, these social researchers are missing analyzing the seafloor sensing in offshore tin mining operations and its broader entanglements. In other words, the nexus of the seafloor sensing devices, mining navigators, and observed seafloor in offshore tin mining operations is overlooked in bringing the seafloor to the surface and recreating this oceanic space as an extractive landscape. In this chapter, I argue framing the seafloor sensing as an apparatus will help to see the larger picture of the seafloor sensing. Primarily, one may understand how the apparatus of the offshore tin mining operations extends spatially and temporally. This means as the geopolitical intervention requires geodata produced by the apparatus of the offshore tin mining operations, the way of seeing the seafloor as tin extractive sites does not end in the material sites of offshore tin mining operations. Instead, particular regulatory interventions using such geodata also further promote the seafloor as a mineral extractive landscape. Therefore, framing the seafloor sensing enables one to grasp how the paradox of sensing above transcends within and without the seafloor tin mining sites.

Despite the importance of examining seafloor sensing in offshore tin mining operations, another constraint to conducting such ethnography on the culture of seafloor sensing in offshore tin mining is the practicality of conducting this research activity. This is because joining on-board operations to observe and collect videos, pictures, and notes on the interaction of the sensing devices, mining navigators, and their observed seafloor demands research permits from mining companies (see Appendix 7). In this research, despite the competition with physical scientists in seeking permits (e.g., geologists and geo-engineering researchers), I was able to secure research access on mining ships (see Chapter 3). This research access is hard to obtain as mining companies mostly prioritize geological mining scholars (e.g., interns and researchers) for informing the technical problems of their seabed tin mining operations. Examining seabed sensing activity through the lens of an apparatus (Barad, 2007), in this chapter, my significant and original contribution to knowledge is that I expand the current work of media studies, science technology studies (STS), and political geography (Helmreich, 2011a; Sayers et al., 2015; Lehman, 2018; Hawkins, 2020; Sammler and Lynch, 2021; Sammler and House-Peters, 2023) to shine light on how seabed sensing activities play an integral role in Indonesian seabed mining and its transforming of the seafloor into contested and degraded sites. Additionally, I contribute to showing the political and social context of the mining ships, mining companies, and the global tin market within which the seafloor sensing is situated.

Concurrently, this chapter expands our understanding of how seabed sensing in offshore tin recovery not only renders *sense-able* the geopolitical importance of the seabed (Hawkins, 2020) and creates the seafloor as none other than a mineral extractive site (Sammler & House-Peters, 2023). But also, the culture of seafloor sensing in offshore tin mining operations posits *the paradox of sensing*. This means the more tin ores are sense-able, the more they are accessible for mining companies and broader interests. At the same time, these actors are more *insensitive*[29] (James

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[29] While being insensitive has been the property of humans as it pertains to an affective blindness to other human feeling, James (1989) argues that humans can be insensitive to non-humans: "[t]*he blindness in human beings, of*

1989) to the benthic habitat damages caused by their tin extractions. Indeed, miners would not say that they are insensitive to benthic habitats explicitly. Instead, the insensitivity is a rather implicit than explicit discourse. This implicit discourse here is also part of a deeply material practice, as Barad (2007) argues that discourses are not always about spoken or written texts. Therefore, I argue that in offshore tin mining operations, benthic insensitivities are the product of seafloor sensing through the apparatus of the offshore tin mining operations, which make visible tin ores and invisible benthic habitats. The process of occluding benthic habitats and simplifying the seafloor into mining sites is what renders miners insensitive, as their concern is directed at target tin production. For instance, one head of mining ship operations said: "[O]ur motivation is the black tin ores. When we see the pipes in the washing plants through CCTV, we become so happy and it motivates to keep digging" (Head of mining ship 4, 2022: Focus group discussion on 30 June 2022). This sentiment on seabed tin ores indicates how the existence of benthic habitats is not represented through such apparatuses. The process and practices of sensing the seafloor are insensitive to the effects of seafloor extraction on benthic habitats.

To demonstrate this main argument, I divide this chapter into seven sections. The first section (4.2) contextualizes seabed sensing through and within current critical sensing literature. This literature also explains why and how seafloor sensing of offshore tin mining operations is an apparatus. In this way, this analysis bridges offshore sensing with current sensing literature in political geography, media studies, and science and technology studies. Meanwhile, the following sections explain how the working shift (4.3), the history of sensing (4.4), the adoption of the digital twin technology (4.5), and the tin deposit maps (4.6) are part of apparatuses in offshore tin mining operations. As the concept of the apparatus also focuses on the social and political context within which seafloor sensing exists, the following section also focuses on how seafloor sensing as an apparatus of offshore tin mining operations creates a contested view of the seafloor (4.7). Thus, framing seafloor sensing as an apparatus demonstrates how the political and social context of this sensing activity gets entangled with broader scales of geopolitical interventions. Finally, this last section (4.8) will conclude by tying this chapter's findings back to the thesis research questions.

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which this discourse will treat, is the blindness with which we are all afflicted in regard to the feelings of creatures [e.g., animals and forest] and people different from ourselves" (p.1).

4.2 Seafloor sensing as an apparatus

While the act of sensing has recently garnered much traction in media studies, science and technology studies (STS), and political geographers (Vallee, 2023; Sammler and House-Peters, 2023; Westerlaken, 2024; Strausz, 2024), these scholars have no universal agreement on what sensing means. That is because the definition of sensing depends on the objective of the researcher and their understanding of a particular sensing activity. For example, Wilke (2017), building on *professional vision* (Goodwin, 1994), argues that sensing means a vision [that] is "trained [and] shaped by professional norms about focusing attention, reading visual data, and using the lenses and filters that yield professionally appropriate results. [Hence] vision is collective, collaborative, and discursive" (1041). Gabrys (2019) disagrees with this argument, especially given that sensing is not merely about vision but a complex configuration of human senses, sensors, and sensations. She argues that sensing practices are "an analytical device for thinking through how experience and relations are reworked across entities, environments, and technologies. Rather than reinscribe the classification of 'the senses' from the universal human reference point" (724). In line with Gabrys's (2019), Vertesi (2012) asserts that "the instrument [a sensing device] mediates the tension between visualization practices and local sense-making on the one hand, and the social order imperatives on the other hand" (397). In other words, as Vallee (2023) argues, "[sensing] instrument(s) transcend their material nature as hardware and software, infrastructure, and labor relations" (1). Whilst such sensing scholarship enables us to understand the social and political context of sensing, how to sense, and what is sensed, these studies have largely focused on land-based sensing and outer space. Meanwhile, the political, historical, and social context of the how and why of seabed sensing are still understudied within the body of critical sensing literature. Therefore, I argue that the practice of offshore sensing in tin mining operations is also vital to expand the current work of critical sensing literature.

This chapter aims to critically assess how the practice of sensing in offshore tin mining operations enables mining companies to expand existing mining sites, displace other marine uses, and impact benthic habitat health through the focus on ore location at the exclusion of other benthic worlds. This chapter may, thus, contribute to the current critical sensing literature in human geography and science and technology studies (STS). Indeed, whilst I have mentioned critical sensing literature, I have not explained what this field of study is yet. Therefore, building on the convergence of analog and digital processes (Sayers et al., 2015), the concept of wave buoy

(Helmreich, 2019), Google Ocean (Helmreich, 2011a), and autonomous recording unit (ARU) (Vallee, 2023), Google Ocean (Helmreich, 2011a), smelling and memory (Tsing, 2015), chimeric sensing (Helmreich et al., 2013), and intimate sensing (Helmreich, 2009) matters in particular knowledge production, I argue that critical sensing literature often suggests the *geo-political* implications of sensing (Lehman, 2020b). This means critical sensing literature does not end its analysis on where the sensing practice is situated but continues in how the product of sensing (e.g., geodata and maps) has been used and interpreted by the professional vision (Goodwin, 1994). That is a trained expert on viewing and interpreting data produced by the act of sensing, to serve the interest of certain actors (Wilke, 2017; Sammler and House-Peters, 2023). This argument helps for thinking about offshore tin mining operations because the seafloor sensing creates the imaginary of the seabed devoid of benthic habitats by primarily recentering the view of the observer on the flows of seabed minerals and sands.

The epoch of critical sensing literature comes into being given the critical work of Litfin (1997). This feminist STS scholar showed the untold political implication of seemingly neutral and apolitical remote sensing in the post-cold war era:

> "[N]o doubt, remote sensing, and computerized data processing techniques will generate hitherto unknown quantities of information and hitherto unknown power for the scientist… But there is good reason to be wary of a celebratory discourse that stifles critical thinking about the nature of these technologies. Must we not be skeptical of a technology that promises so much? If celebratory discourses serve a masking function, then, what might be said of the shadow side of remote sensing. [Indeed] a science and technology based upon the same assumptions that have been instrumental in causing global environmental problems will be instrumental in solving those problems" (Litfin 1997: 29).

Following Litfin's provocation above, diverse scholars in STS, media studies, and political geography have challenged the neutral notion of sensing to showcase the political implications of sensing. Indeed, deconstructing neutrality in sensing here echoes feminist tenets on the situated and incomplete knowledge produced by the act of sensing (Haraway (2020). Such an argument also fits in with the work of Peters (2016) arguing that our understanding of the sea has been understood through physical mediations (e.g., ships and underwater sensing technologies) and metaphorical mediations (e.g., poets and stories). In short, knowledge is never ‘pure’ and almost always partial. In this regard, such incomplete and situated knowledge becomes political as the knowledge becomes accepted or normative in governing certain marine spaces. For that reason, Harley (1989) has argued in relation to maps, as the product of the act of sensing, that scholars should read and treat “such maps as a text rather than as a mirror of reality so that we can understand how their rhetoric has narrowed the practice of historical geographies” (80). Barnes and Duncan (1992) also argue that “maps, in spite of the rhetoric of many positivistic cartographers, [are] not mimetic (to mirror in summary form an objective world beyond the map), but communicate ideas within a cultural and political context” (xii). Indeed, treating a map as a text within the practice of sensing and extracting tin ores is crucial because it indicates how the practice of sensing does not mirror some ultimate reality of the seabed. Instead, it mirrors the specific interests of the mining company and global tin mining demand. Therefore, sensing in offshore tin mining operations results in the representation of the seafloor, such as cartographic maps and other imaginaries, which serves the interests of mining actors’ interests.

Such data produced from extractive industries, according to Monteiro (2022), showcases the qualitative, non-neutral, and political nature of geodata production. As he argues, “the everyday practices in present-day commercial oil activities offer rich opportunities to trace the interplay between somewhat caricatured qualitative sentiments and the quantification inherent in the digital representation of geodata” (41). This means that while quantification of the geodata often underpins the notion of objectivity in the practice of sensing, there still exists qualitative and non-neutral elements to the interpretation of geodata. Lehman (2018) applies such political understandings to ocean sensing.

> “New ocean sensing technologies give us the digital representations of the sea that have now become commonplace in web interfaces such as Google Ocean, as well as the more specialized forms of mapping and modeling software that inform planning, mapping, and resource governance, among other activities” (Lehman, 2018: 9).

In this way, the act of sensing is politically powerful because it informs, and is informed by, certain decision-making in ocean governance. This means despite the partial and situated knowledge produced by sensing, representational products from sensing serve as the dominant knowledge of certain spaces. This is indicative of the relation between knowledge and power that exists in the act of sensing because certain actors can still use the knowledge of the space, informed by the practice of sensing, in their decision-making. As Hawkins (2020) explains, "[Sensing or] how it is we know these spaces – render them [e.g., seafloor and subterranean] visible (or better sensible) and calculable – so making them available for exploitation and control" (2). Hence, sensing can help to recreate specific meanings that justify the exploitation of space. In offshore tin mining operations, seafloor sensing senses the depth and location of tin ores beneath the seafloor and this oceanic landscape. This partial knowledge is further used to create decisions on allocating concession areas (i.e., permissible mining sites) for offshore tin mining operations.

As Liboiron (2021) argues colonialism is, by nature, about stealing land from Indigenous communities through creating certain structures and systems that sustain and normalize violence, the act of sensing in offshore tin mining operations above also enables mining companies to secure seafloor access from the Indigenous communities. Thus, the act of sensing not only embodies the practice of colonialism but also enables territorializing the seafloor space. In this way, sensing dictates or creates the meaning by which 'we' come to know certain spaces. In other words, it can change, erase, remove, and above all, decontextualize understandings of the landscape into anything else but the Indigenous interpretation or those who reside and live intimately on the landscape. Diverse scholars have underpinned this premise on the relation between colonialism and the act of sensing. For example, drawing on Barad's concept of the apparatus (Barad, 2007), Sammler and Lynch (2021) argue that: "the projects of scientific observation and colonial occupation are co-constituted through the production and maintenance of space science infrastructures on colonized lands. In turn, we consider how these infrastructures reproduce the subject-object relations key to settler colonial projects – the view-from-nowhere (or Archimedean point) and embodied colonizer subjectivities" (40). In other words, the practice of sensing is possible given the erasure of the local context of the colonized land, which is used to justify colonial projects there. Beyond the colonized space, sensing practice also indicates the enforcement of colonial time. For instance, investigating 'the real-time' alert system in the Amazon forest Lewis and Gabrys (2024) reveals that "these temporalities valorize immediate, continuous forest data that can be mobilized for understanding and protecting forests, while simultaneously glossing over durational colonial and capitalist framings of forests that rely on dispossession, extraction, and enclosure" (1). In offshore tin mining operations, the act of sensing not only embodies colonizer subjectivities given that the expert in tin ore sensing often reduces the seabed into mine areas, but also also follows enduring colonial and capitalist framings of the seabed through sensing and reducing the seafloor as mere tin sites.

As the act of sensing is key for capitalist actors to exploit the seabed, Hine and Edwards (2023) argues, "how image-making practices [within the sensing practice] for the promotion of deep-sea mining are socio-political practices embedded in a long architectural lineage of 'worlding', which have consistently failed to imagine future possibilities beyond globalized capital" (1). Since sensing provides information concerning the estimated commercial values of seabed minerals for global capitalist industries, this information also enables them to construct the seabed as a place of capital accumulation. For that reason, the geodata generated by the act of sensing have become crucial for certain capitalist actors to geopolitically secure and justify the exploitation of the seabed space. This argument on the relation between geopolitical intervention and the technological construct of the seabed echoes the work of Lambach (2022), arguing that: "[S]patial constructions of the seabed emerge from the interaction among human actors, technologies, and the material environment. This interaction generates representations, which are then fed into the overall process of spatializing the seabed. Claims for undersea territories [here] have [hence] been made possible by advances in bathymetry, i.e., the study of undersea topography, whose development has itself been spurred by political ambitions of Arctic littoral states" (49). This means the practice of sensing not only helps to construct the seabed but also enables certain actors to claim the seabed as their territory. Adding to this, Sammler and House-Peters (2023) have showcased how the act of sensing is recreating the reality of the seabed into mine areas. They write, "not only does the god's-eye-view transform into the hand-of-god when paired with automation, but as digital recreations of the target environment are abstracted and compressed into a digitally mediated mine site, it becomes an always-already extractive landscape reducing its capacity to be known as anything else than as mine" (9). In this way, the convergence of the sensing practice and geopolitical intervention (i.e., the use of partial knowledge or representation to control and govern the seafloor) takes place to recreate the meaning of the seabed into anything but commodifiable spaces. This statement echoes how the act of sensing contributes to decontextualizing and transforming the benthic habitat into seabed tin mining sites.

Since the act of seafloor sensing in offshore tin mining operations consists of multiple sensing technologies (e.g., SIOPL, CCTV/ Close-circuit telecommunication camera, loudspeaker) and human sensors (e.g., haptic, touching, tasting, and observing the seabed sediments), I frame the complex configuration of sensors and bodily sensing here as an apparatus (Barad, 2007). According to Barad (2007), "apparatuses are not mere instruments or devices that can be deployed as neutral probes of the natural world…Rather apparatuses are specific material reconfigurings of the world that do not merely emerge in time but iteratively reconfigure space-time-matter as part of the ongoing dynamism of becoming" (141). In this chapter, the apparatus is the seafloor sensing itself. However, framing seafloor sensing as an apparatus does not mean that one only focuses on the configuration of sensing technologies and human sensors. Instead, as the nature of an apparatus, according to Barad (2007), has the agential realism or relational ontology, framing seafloor sensing as an apparatus allows us to understand that seafloor sensing is not separated from its social and political context. This means the social, political, and cultural context of the observers and their instruments in offshore tin mining operations cannot be separated from the way they observe, measure, and interpret the seabed through the assistance of sensing devices.

The entanglement of the mining navigator, sensing devices, and the seabed within the apparatus defines what matters or not about the seabed. More importantly, the seafloor does not pre-exist from such a techno-scientific measurement. For instance, if the mining navigator and sensing devices only focus on recreating the reality of the seabed as mine areas and the location of the tin ores, this not only changes the material reality of the seabed but also how the reality of the seabed only serves the interest of tin mining operations. Engaging Barad, Meesters et al. (2022) explain how "measurement and materials co-constitute each other at the moment that matter is measured. Materials and measurement therefore do not *interact*, which assumes preexisting entities, but they *intra-act*, as measurements interfere with the material, alongside related process in the domain of human politics" (299). Even as mentioned in Chapter 2, the way the UNCLOS measures and maps the seafloor by separating the seafloor and the sea also indicates that this international treaty uses the apparatus to create metrics for measuring and defining the seafloor. This also applies to the case of offshore tin mining operations. If the seafloor sensing does not detect and measure the benthic habitats as it orientates observers' view on tin ores' locations (e.g., at what depth and layers of the seafloor) and tin ores, benthic habitats are thus excluded in this act of sensing. The seafloor is, therefore, created as an object, a mineable surface, out of the broader phenomenon. This enactment of the seafloor object excludes the benthic habitats which are outside the capability of seafloor sensing.

The way the apparatus can include the tin ores' locations and exclude benthic habitats above is due to, what Barrad (2007), argues that despite the agential realism (the ontological relationality), the agential cut also exists within the apparatus. The agential cut indicates that "apparatuses are not mere observing instruments but boundary-drawing practices" (Barad, 2007: 140). The boundary-drawing practice here refers to how the apparatus enacts the agential cut to delineate the subject (observers) and object (observed seafloor). Even such delineation isolates seafloor from benthic habitats. Therefore, given the agential cut existing within the apparatus, the paradox of sensing above exists as this boundary-making practice makes sense-able the seafloor and its tin ores and sediments while making invisible the damaged benthic habitats caused by the offshore tin mining operations. In this way, I argue that when such delineation between seafloor and benthic habitats is enacted, this apparatus in offshore tin mining operations produces insensitivity toward sensitive benthic habitats. Meanwhile, in this study, as I am also part of the apparatus, I also use such agential cuts to include or exclude what I consider the apparatus of the seafloor tin mining operations. As I mentioned earlier seafloor sensing is the apparatus. This means anything related to seafloor sensing, such as sensing devices, human senses, and the political and social environment of the observers, are also parts of the apparatus. This is because these techno-scientific-social-political dimensions of seafloor sensing also define how and why the mining navigators observe, produce, and use the seafloor.

Framing the act of sensing in offshore tin mining operations as an apparatus is useful as this concept not only enables us to understand how the entanglement between mining navigators' senses, sensing devices, and observed seabed recreates certain reality of the seabed. Rather, it also allows us to grasp how the production of a seabed reality can transcend beyond the temporality and spatiality of seabed tin mining sites. This means the act of sensing the seabed produces the product of sensing (e.g., geodata and seabed maps) that informs other actors beyond the place of mining navigation rooms to make decisions about the use of the seabed. This argument echoes the argument of Sammler and Lynch (2021): "[Conceptualizing sensing activities as an apparatus] traces techno-scientific production as part of broader apparatuses extending spatially and temporally from what is traditionally understood as the sites and moments of scientific practice" (947). As such, one can understand why such sensing practice is crucial as the product of sensing cannot merely make sensible the commercial value of the seabed but also structure and sustain the exclusion of benthic habitats. In short, the apparatus of offshore tin mining operations produces insensitiveness toward sensitive benthic habitats. In this chapter, while insensitivity means the inability to imagine and feel benthic habitat degradations caused by the process of seafloor sensing and extractions, sensing is the material practice of knowing the seafloor to detect seafloor tins ores. Therefore, sensing makes sense-able the seafloor tin ores. Such capability of bringing to the surface the seafloor tin ores beneath the sea is, I argue, known as sensibility. In the following sections, not only do apparatuses come to life, but they also indicate how the social and political conditions within which the act of sensing in offshore tin mining operations is situated perpetuates the paradox of sensing: sensing, sense-able, and insensitive to benthic habitats. I start my empirical discussion with my experience observing the apparatus of offshore tin mining operations. This experience enabled me to understand that I also become an apparatus that observes another apparatus: the seafloor sensing on mining ships.

4.3 Observation, work shift, and hours as parts of apparatus

The act of sensing the seabed cannot exist without mundane activities such as going from home to work. For that reason, these everyday work life cycles of miners are parts of the apparatus in offshore tin mining operations. That is because the daily returning to offshore routine here is crucial for every miner and primarily mining navigators to maintain their performance of sensing the seafloor. For instance, since the practice of sensing is the combination of observing the sediments on CCTV (Close-circuit telecommunication camera), seeing the position of the CSD's ladder on the SIOPL, and navigating the CSD ship, the working duration matters for ensuring the productivity of tin ores. As one mining navigator explains:

> Before we worked for 12 hours. With the current worker well-being policy, this working duration has been cut in half by our head of mining ship. We only work for 6-8 hours. This means not only can we spend more time with family and have more resting time but also, we can come back to work again with a fresh mind to sense and find the seafloor tin ores (Mining Navigator: Interview on 22 June 2024).

Understanding the importance of the working hours for the apparatus of offshore tin mining operations enables us to understand that the well-being of the mining navigator also defines their seafloor tin production. This means analyzing the culture of sensing as an apparatus here also showcases the process of observing the seafloor through sensing devices such as CCTV, the SIOPL, and loudspeakers cannot be separated from the social environment of this seafloor sensing activity. The social environment primarily refers to the well-being of the mining navigators managed by the working hour policy. That is because when they overwork, they often tend to lose their concentration (Borovnik, 2022). For example, as one mining navigator on the Bucket Wheel Dredging (BWD) ship argues:

> "[I] am quite jealous for the work duration of those miners [and mining navigators] in CSD. They work 6 hours less than us. Meanwhile, we have to maintain our focus observing the screen. I think working too long also reduce our concentration and tin production. Given that we always work with a lack of rest, we do not produce as many [tin ores] as those on CSD ships. While they can produce many amples [amples are the unit of tin ores collected. One ample is equal to roughly 60 kg], we produce few amples" (Mining Navigator: Interview on 22 July 2022).

As mentioned in Chapter 1, the owners of the CSD and BWD mining ships are state-owned, private, and private-state partnership companies. Meanwhile, the difference between BWD and CSD lies in the size, the depth of the seabed tin mining operations, the movement, and the number of crews. For instance, while the ladder of the CSD enables the head of the CSD to dig up to 25 meters below the sea, the ladder of BWD allows miners to extract tin ores from the depth of the sea up to 60 meters. The ladder of CSD and BWD is the structural device that retracts and extends the suction pipes and the head of CSD and BWD towards the seabed. Additionally, CSD and BWD mining ships also operate a different dredging technology. From its name, CSD mining ships mean that the mining ships use cutter suction dredging technology. The cutter suction dredging technology consists of the head of CSD (see Figure 11), pipes to vacuum tin ores, and dredging devices to dig and drill the seafloor. Meanwhile, BWD uses buckets with conveyor belts to scoop and dig the seafloor. Therefore, while CSD can move 180 degrees and 360 degrees, BWD only moves forward and backward to mine the seafloor. To operate BWD and CSD, mining companies hire well-trained domestic and Thai migrant workers.

Figure 11. The head of CSD

Despite the capacity for mining deeper beneath the sea, during my participant observation, miners on CSD could produce 20 amples per hour, while BWD did not even produce one ample of tin ores. That is because the age of the BWD's engine is older than that of the CSD's engines. In fact, BWD has become the Dutch technological inheritance for Indonesia. This means the operation of BWD often encounters machinery problems such as broken suction pipes and gears of the BWD. Therefore, mining navigators have to cease the process of tin recovery due to the inoperable BWD engines. In other words, mining navigators could not attain the tin production target for BWD. If the tin production target on a CSD mining ship is about 120 amples per day, considering the capacity of BWD's reservoir to accommodate more minerals than CSD's reservoir, the BWD should attain about 600 amples a day to compensate the operational costs of the offshore tin mining operations (e.g., labor and fuel costs). This finding showcases the apparatus of the offshore tin operations are neutral sensing practice as the issue of the seafloor sensing does not end on how the mining navigator observes the seafloor. Instead, less tin production above, given the aging mining technologies and working hours, indicates that seafloor sensing is operated within the political and social interests of offshore tin industries to meet global tin market demands (see Figure 5).

This condition, of course, makes the mining company audit and evaluate BWD mining performance. However, since the mining company auditing team enforces tin ores-centric views, they often assume that the lack of tin production in BWD has to do with the working performance of mining navigators on observing and extracting the tin ores from the seabed. Indeed, they understand that the BWD and CSD are different. However, the operation of BWD demands more operational costs (e.g., electricity, staff, and fuels), given the size of the BWD. Hence, the assumption of the lack of the BWD’s performance becomes an excuse to reprimand the staff working in BWD mining ships. This means the mining company auditing team discounts the technological performance of BWD in extracting tin ores from the seafloor. As one geologist in a focus group discussion explains, “we have to consider that if you do not keep the BWD running [this means also making the mining navigator continue to sense and extract the seabed], it is increasing the operational cost of the BWD” (FGD 2022, focus group discussion at BWD ship on 5 July 2022). Following up on this explanation, I asked a geologist why when miners did not stop the operation of BWD, it did not reduce the operational cost of this mining operation. My underlying reason for this question is that I assumed that running the engines of BWD means paying for fuel, food, electricity, workers, and boats. However, according to one geologist (2022):

> "Indeed, I agree with you that ceasing the operation of BWD should ideally mean that we can reduce the operational cost. However, we fund the operation of BWD by taking bank loans. In other words, stopping the operation of BWD means that not only will we reduce the possibility of producing tin ores but also we pay the interest of the bank loans without even using it" (Geologist: Interview on 15 July 2022).

In response to the tin production evaluation, the head of the BWD mining ship maintained the 12-hour working duration policy to increase tin production. Of course, he understood that the cause of the lack of tin production had nothing to do with the working duration. Instead, the decreasing number of the BWD here is due to recurring inoperable gears and pumping devices of the BWD. Despite that, the auditing team argued that terminating or reducing the working operation of BWD means that the operational costs of the BWD, such as food and maintenance costs, keep rising. For that reason, the head of the mining ship encounters the mining dilemma between continue operating BWD with a lack of tin ore production and reducing the working hours of BWD with the unavoidable rising operational costs.

Beyond the working hour policy, the notion of going to work in offshore tin mining operations deviates from normative ideas of going to work. That is because while going to work can mean someone goes to their office on land, going to work for miners and mining navigators means that they return to the sea. During my fieldwork, a common phrase they utter is *melaut or* return to the sea. For example, miners asked me, "Mas [sir], will you join us to return to sea tomorrow? I answered, "I am not sure. It depends if the head of the mining ship allows me, maybe I can join you" (Research Diary: participant observation on 22 May 2022). The routine of going home and returning to the sea here has created a circulation of people going from and returning to the sea. Primarily, since returning to sea for miners means that they will perform sensing and extracting materials from the seabed, such a flow of humans from land to sea indicates the inextricable relation between them and the seabed in their everyday lives. This reminds me of my everyday journey from my small flat to a shuttle bus stop to the mining sites and return to the flat. The cycle repeats, which showcases how my interaction and relation to the seabed is shaped by my ethnographic study, observing everyday commutes to the ocean and back to land.

With such consideration, I also become part of the apparatus in the offshore tin mining operations. That is because I (the researcher), with my senses (e.g., eyesight, hearing, and smells), technology (Go-pro camera), and knowledge systems (e.g., STS and marine governance expertise), observed mining navigators and mining crews that also observed the seafloor using mining technologies and their bodily sensories to find the seabed tin ores. This means my ethnographic work is also inseparable from the seafloor sensing in offshore tin mining operations. Meanwhile, speaking of my sensing technology, the Go-pro camera is a versatile action camera. The word 'versatile' here means that the user can modify the way of using the Go-pro accessories, depending on the user's preference. For instance, during my participant observation, I often mounted my Go-pro camera on my body with GoPro's body mounting accessory to extend my sense to see, listen, and feel the quotidian event of the mining journey and seafloor sensing. With such sensing technologies, I could record their activities and take pictures of their activities. Indeed, before recording their activities, I always asked miners' consent to record their activities in their specific spaces (e.g., on the bus, boats, and mining ships) (I also explained why I used Go-pro in this fieldwork in Chapter 3). Therefore, my ethnographic work observing daily seafloor sensing also indicates that the apparatus of the offshore tin mining operations span beyond the material site and time of the seafloor tin extractions. The entanglement between me and the miners manifests in my daily go-home and go-to work (see Figure 12). As my research diary excerpt explains below:

“[J]une 20 2022. Although usually I go to the sea harbour with the head of mining ship car, I have decided to join mining crews going home with mining company shuttle bus. Next in the morning, I have to wake up at 5 a.m. to go to the shuttle bus stop, about 2 km from my flat. I have to be on time this time. Otherwise, I cannot go to the mining site because they have scheduled when the wooden boat picks us up from the harbour. Arriving at the shuttle bus stop, I am waiting [for] the bus together with miners, mining navigator, and interns. They work in different mining ships. Some of them I have already recognized during my previous mining ship trip but most of them, I do not who they are. Waiting for 15 minutes, the bus arrives to pick us up and take us to the sea harbour. On the bus, everyone is listening to the video and others are sleeping. Indeed, the early morning wake up and two-hour bus journey from Pangkal Pinang to Belinyu make everyone wants to sleep. However, sleeping is not my privilege this time. I have to record the journey to go to the sea harbour using my Go-pro and write this research diary. My brain keeps thinking” (Research Diary: participant observation on 20 June 2022).

Figure 12: Journey to the sea harbor (personal documentation, 2022)

Even though the apparatus of offshore tin mining operations enables one to understand the social and political environment within which the seafloor sensing and extractions are situated, such apparatus also conditions the paradox of sensing: the convergence between sense-ability and insensitivity toward the benthic habitat degradations. That is because the mundane work routine of mining navigators diverts my attention and, perhaps, anyone's attention toward how their practices shape and change benthic habitats through the movement of sensing devices and cutter suction dredgers. For example, my observation using a Go-pro camera on the routine of returning home from the sea only directed my observation on the working hours and concentration issues of the mining navigators that contribute in some ways to the lack of tin production. Meanwhile, the auditing team and the head of mining also focus on how to improve tin ore production through their seafloor sensing and extracting activity. Therefore, the damaged benthic habitats caused by the apparatus of the seafloor tin mining operations are not being discussed through such everyday technical problems of the offshore tin mining operations.

Of course, beyond the everyday technical problems above, mining navigators and other miners cannot see or sense the benthic habitats through their sensing devices. That is because, using their seafloor map simulation and loudspeakers, they can only see and make sense of the size of the planned mining sites, the ladder's position, the depth of the sea, and the estimated layers of the seafloor (i.e., the location of the seafloor tin ores). Meanwhile, the CCTV only records the flow of the sediments from the pipeline of the CSD toward the designated space of tin washing plant. This means that the benthic habitats are indeed made invisible or excluded from such apparatus of offshore tin mining operations (the direct quote and further analysis of this statement are further provided in sections 4.6 and 4.7 in this chapter). In this way, the apparatus indeed creates a delineation to include the seafloor and exclude benthic habitats from the daily concerns in offshore tin mining operations.

Meanwhile, hierarchically, as the head of the mining ship and the audit team is higher than that of the mining navigators, their decision to increase working duration in the hope of increasing tin production means that the mining navigators should work longer to observe and extract the tin ores. In this way, the diverse configuration of the apparatus from my observation of seafloor sensing and extraction, the observation of the head of mining and audit team on the tin production, to the observation of the mining navigators on the seafloor here makes visible the working environment and tin production issues, while simultaneously make invisible the benthic habitats continuously dredged using BWD and CSD. This statement fits in with the work of Wilke (2017) on how the culture of sensing certain spaces using visual technologies recreates what is visible and desirable and what is invisible and killable. Therefore, the apparatus of the offshore tin mining operations creates the conditions under which the damaged benthic habitats are invisible, and the insensitivity toward such benthic habitat damages is subconsciously maintained by such seafloor sensing.

This argument above also underpins the work of Squire (2021) on how the stress of the undersea world is often invisible and neglected in the process of seafloor sensing. Primarily, in offshore tin mining operations, whilst the stress of miners on offshore tin mining operations due to working hours can be captured through my ethnographic study, the stress of benthic habitats given the dredging process of the offshore tin mining operations is not detectable or to some extent, is removed. Despite understanding the relationship between the banal work lives of miners and the apparatus of the offshore tin mining operations, the history of the sensing devices in the culture of the tin ore extractions has not been discussed in the section. Meanwhile, given the importance of the seafloor sensing device, in the next section, I revisit the history of seafloor sensing. The following sections will enable one to capture the wider entanglement of the seabed tin mining apparatus with the particular geopolitical intervention of the offshore tin mining industries.

4.4 The history of seafloor sensing: Migrant workers and their technologies as parts of the apparatus

The knowledge of how sensing tin ores is performed in offshore operations is possible due to the flow of migrant workers. That is why as the knowledge of seafloor sensing and migrant workers are inextricably intertwined, such knowledge and human bodies are also part of the apparatus in offshore tin mining operations. This also means that the inseparability of migrant workers, sensing devices, and sensed seafloor tin ores also recreates what the seafloor is and how this oceanic space emerges in current offshore tin mining operations. Additionally, as under certain depths (e.g., beyond 20 meters), seafloor sensing requires knowledge and technologies, migrant workers contributed to the knowledge of identifying the quality of tin ores and how other geologic parameters can be sensed via sound, texture, and taste of seabed materials to identify tin ores. However, unfortunately, the knowledge of the seabed tin ores also came from colonial power. For example, in 1880, British and Dutch colonial governments brought enslaved Chinese people to the Bangka and Belitung Islands in Indonesia because of their expertise in tin mining. As one geologist explains:

> "[D]uring British and Dutch colonial era, Chinese people brought the geological knowledge of tin ores. For instance, they know about the concept of *kong* we use today and how to separate quality tin ores from less quality tin ores. The concept of *kong*, now bedrock in modern geology, makes me fascinated by how advent Chinese geological knowledge was. Chinese people sense bedrock with their tongue. They tasted the clay obtained from the seabed. If the taste of the clay is not salty, this means that we do not reach the bedrock yet. This is because the bedrock is impenetrable by saline water. Thus, it does not taste salty. Since the salt water cannot penetrate the bedrock, this means that tin ores cannot penetrate it, too. In other words, we should not continue to dig in after we have reached the bedrock" (Research Diary: 20 June 2022).

The knowledge of sensing bedrock (*kong*) has saved offshore tin mining operations from being ineffective in extracting tin ores by understanding when miners reach the bedrock of the seabed. In fact, this knowledge is arguably the bedrock or foundation of decision about mining tin ores as miners use bedrock as their measuring indicators to stop their seafloor extractions. That is why they can reduce their operational costs as mentioned earlier and focus on mining the seafloor tin ores.

While Chinese people contributed to the knowledge of sensing these days, Thai migrant workers have modernized seabed tin mining operations by introducing unmanned digital sensing technology. Indeed, the digital twin technology here as explained in the first section refers to the SIOPL (*Sistem Informasi Operasi Pertambangan Laut*). This digital sensing device in offshore tin mining operations cannot be separated from the migration and establishment of Thai mining companies and Thai cutter suction dredging ships off the Bangka and Belitung Islands. As Mining corporation representative (2022) explains, "[S]ince Thai government has banned tin mining operations in Phuket Thailand in 2010 as they have allocated the Phuket's coastal environment for marine tourism, their tin mining operations have moved to the Bangka and Belitung Islands in Indonesia" (Interview on 24th April, 2022). The shift of offshore tin mining operations from Phuket to Bangka and Belitung Islands in Indonesia is possible because Thai mining companies collaborate with domestic (Indonesian) mining companies. The Thai and domestic mining collaboration here has grown successfully, especially due to the legal commodification of the seabed through the auction of concession areas as outlined by Energy and Mineral Resource Ministry Regulation (2018) and allocated by the provincial government (PERDA 2020). For example, article 1 number 7 in Energy and Mineral Resource Regulation (2018) explains: "[C]oncession areas for commercial and adjunct minerals are granted for enterprise, co-operation, and individuals through auctions". In this case, concession areas are commercial minerals (e.g., iron, tin, and rare earth elements) and adjunct mineral (i.e., monazite) mining sites permitted by the central and provincial government. The central and provincial governments hold annual auctions for the concession area. This means if Thai mining companies can win the process of bidding the auction, they can recover tin ores.

As Thai mining companies are equipped with the digital twin technology, allowing them to sense, predict, and estimate the number of tin ores beneath the seafloor, Thai mining companies were willing to bid the highest price for the concession areas sold in the auction (Geologist 2022, interview on 15 July 2022). With this sensing technology, the Thai mining companies and partners could locate and identify the location and the amount of the tin ores during their tin explorations. This means that before the auction is held, they have already prepared necessary information including maps and geodata as to whether the seabed sites are worthy or unworthy for their tin extractive industries. Meanwhile, their domestic mining counterparts did not have such technology enabling them to record, estimate, and predict the tin ores since they did not have the sensing technology yet. Indeed, before the domestic mining counterparts possessed this sensing technology, they relied on the conventional ways of sensing through sampling seabed sediments and tasting the clay to identify the *kong*. In other words, using digital sensing technology, Thai mining companies were ahead in searching for tin ores in comparison with their Indonesian mining counterparts. For that reason, Thai mining companies often won auctions, allowing them to secure productive mining sites. As a mining representative explains: “[W]e were so impressed why and how Thai mining companies can know more about the tin ores in our seabed than we did. Until I realized that their best tin wealth estimate was given that they have the digital twin technology, while we do not” (Mining corporate employees 2022, interview on 24 April 2022). Therefore, digital technology has played a crucial role not only in finding tin ores but also in securing the material sites where tin ores exist.

With the lack of digital twin technology, domestic seabed tin mining could not produce the number of tin ores to the extent of Thai mining companies and their domestic partners. Tin ore sensing that relies on the conventional techniques of taste is unable to estimate the depth of the seafloor layers without direct contact with humans and recovered seafloor *kong*. Technological prostheses, like the ladder of the CSD, can only determine the seafloor depth, not whether they reached the target mining environment. In this way, of course, the existence of Thai mining companies has become a business threat for domestic seabed tin mining as this means that the wealth of tin ores is flowing to the Thai economy through the use of digital twin technology, which facilitates a broader multisensory process of extracting seabed tin ores. With more Thai companies entering into Indonesian offshore tin mining, they also bring Thai migrant workers. For that reason, analyzing the entanglement between the digital sensing device, the Thai mining navigator, and the observed seafloor as part of an apparatus allows us to see how this apparatus transcends beyond the moment and material site of seafloor sensing toward the politics of securing the seafloor access. Sammler and Lynch (2021) argue that analyzing observation infrastructure as an apparatus (Barad, 2007) enables one to understand how the entanglement between observers, observing instruments, and observed spaces are an entanglement of, and entangled with, wider social and political context beyond the physical site of the observation infrastructure. For offshore tin mining operations, the apparatus of Thai offshore tin mining operations enables one to understand how the geodata produced by the apparatus of the seafloor tin mining, like the digital twin technology, enabled Thai mining companies to access the seafloor mining sites.

Additionally, as observing such seafloor sensing as an apparatus not only focused on the observed seafloor but also on the social and political context of Thai workers, the observer of the observed oceanic space. This means one can begin to understand how the process of seafloor sensing cannot be separated from the working environment of Thai workers. Thus, one can capture the social and political condition of the Thai migrant workers, which may be excluded from the current regulatory intervention of the global tin industries. In the field, indeed, while the Thai mining companies generate revenues from offshore tin mining operations, the Thai migrant workers themselves do not have the freedom to get off of their mining ships. With a seaman working permit, Thai migrant workers can only work on the ship. They are not allowed to go onshore. As Mining navigator (2022b) mentioned: "[W]hile we are paid less than Thai migrant workers, we were lucky that we can return onshore and spend days with our families. These Thai workers, however, cannot go to the beach or go to the city because their working permit only allowed them to stay offshore" (Interview on 22 May 2022). In fact, according to the account of Mining engineer (2024a), Thai migrant workers can only go home to Thailand once every six to twelve months.

Working in such a closed environment and only meeting the same people (mining crews) for the offshore tin mining operations indicates how their lives revolve around the act of sensing the seabed. Sammler and Lynch (2021) argue that as the process of observation only focuses on knowledge production, one neglects that the social context of the material site also defines the practice of space sensing in itself. That is why, according to Gabrys (2020), how enacting the objective notion of sensing practice make one unable to understand how particular political interventions that drives sensing practice to happen in the first place. In Thai offshore mining, the apparatus reminds us that the confinement of the Thai workers is often ignored as the seafloor sensing only orientates on finding seafloor tin ores. By the confinement, I mean the physical and political boundary emerging from Thai's sea man working permit, which bounds Thai migrants' bodies to mining ships.

Figure 13: Thai mining ship surrounded by artisanal seabed tin mining operations (personal documentation, 2022)

Concurrently, while visiting the beaches and cities of the Bangka and Belitung islands seems an ordinary thing, from my experience being onboard mining ships, the setting was indeed emotionally and psychologically tiring. Not only because one may encounter the same activities comprising of sensing and mining practices but also because one could barely access the internet for entertainment and only talk to the same people. This means that Thai migrant workers incessantly repeat such routines without having the privilege of visiting land or their domestic counterparts. Of course, the question of this condition exists. What makes Thai workers concerned about benthic habitat health while their own well-being working is often neglected? For that reason, examining seafloor sensing as an apparatus, I argue, give us the understanding of how social and political contexts such as poor working environment and physical confinement may also structure the paradox of sensing: the convergence of sense-ability and insensitivity toward sensitive benthic habitats.

Meanwhile, such a confined working environment also makes Thai miners violate migrant work regulations. For instance, in the evening, especially when the sea police officers were not patrolling around the harbor, Thai workers could go onshore and interact with Bangkanese people sneakily. This is the time when they can go to *warung* (a food stall and prostitute site). Prostitution in offshore tin mining operations is not uncommon. Most miners from Thailand and Indonesia are both men. They often mention that the women are their medication for loneliness and tiredness, and sexual intimacy is a rarity offshore. As one miner (2022) said: "Thai migrant workers are customers of those ladies on the food stall near the sea harbor. They go there not only to buy food and drink but also to have company and sexual intimacy. Like all miners here, perhaps, women are the only way we treat our tiresome and loneliness from working in the seabed tin mining" (participant observation on 10 July 2022). Perhaps this is the case for many heterosexual miners[30] because only male workers work in offshore tin mining operations. Therefore, visiting the prostitution site could also indeed become a way for Thai workers to get physical intimacy with their opposite sexes.

Furthermore, Thai migrant workers do not speak Bahasa, and vice versa; Bangkanese people also do not speak Thai. For that reason, Thai migrant workers use tin ores as the universal language for their daily transactions, including for buying food and sexual intimacies (Chapter 5 will elaborate on the issue of prostitution whereby the bodies of women are also crucial for securing tin ores). In this case, since Thai migrant workers can operate digital twin technology and detect tin ore on the seabed, they can collect more tin ores than domestic offshore tin operations, allowing them to buy food and sexual intimacy. Therefore, given that an apparatus allows us to understand the social and political context within which Thai workers as observers in the sensing practice are situated, one can start to comprehend how the Thai workers have been reorientated toward their life struggles.

Whereas the apparatus in offshore tin mining operations has enacted an agential cut to delineate or isolate the seafloor from the benthic habitat, the nature of the apparatus enables the analysis of the apparatus in offshore tin mining operations beyond the seafloor sensing. This means, as argued earlier, one should also understand the inseparability of the migrant workers' social life and their seafloor sensing. Like the sensing and mining ships as part of the apparatus in offshore tin mining operations that require physical maintenance, Thai migrant workers as part of the apparatus demand physical and social intimacy beyond the social mining environment. For that reason, Thai migrant workers visited sex workers to satisfy their sensory bodies (e.g., eyes, skin,

[30] Indeed, according to mining navigator, there are also gay (queer) people on mining ships. However, this study does not collect more information about this group. Thus, it would also be interesting for the future research to investigate how these groups cope with the heterosexual dominant environment.

taste, and smells), which otherwise may or may not be possible on mining ships. Such social occurrence can also be linked to the harsh working conditions and the desire to enjoy life beyond the space of the mining ships and seafloor sensing.

Moreover, as mentioned earlier, examining seafloor sensing as an apparatus also means that one recognizes that Thai migrant workers are part of the apparatus in offshore tin extractions. In this way, one can also analyze how the desire for sexual intimacy here also indicates that the human sensing of Thai mining navigators senses both tin ores and women's bodies. That is because human senses such as taste, touch, and vision here are also used to sense the body of female sex workers in a food stall. This means as their physical intimacy with sex workers is obviously a crucial part of maintaining their seafloor sensing performance, such practice of sensing female bodies here is also entangled with the apparatus of the offshore tin mining operations. This is not to mention, for instance, in the case of Thai workers, they may not be able to buy sex services without their seafloor sensing. Therefore, their sexual interaction becomes part of the apparatus, given their bodily sensors are also entangled with seafloor sensing.

The culture of sensing prostitutes and engaging in sexual intimacy not only happens for the group of Thai mining navigators. Tin miners, in general, interact with sex workers in sexual activities (see Chapter 5 for how tin divers also have sexual relationships with female prostitutes). Indeed, speaking of such sex selling profession, other studies, in gold mining case studies in South Africa and Zimbabwe, have revealed how female sex workers are indeed vulnerable not only due to poverty that forces them to sell sex but also these sex workers often could not choose for having a safe sex with condoms, picking up preferred clients, avoiding verbal and physical harms, and preventing STD (sexually transmitted disease) (see, for instance,Campbell, 2000; Shaba and Swart, 2024). In offshore tin mining operations, according to Sukarno et al. (2023), while prostitution happens everywhere, their studies showcased the dialectical relationship between offshore tin mining operations and sex commercial transactions.

With the vulnerable and precarity of the female sex workers profession, the social and political context of the Thai mining navigator, such as the power difference between Thai workers and sex workers and the need for sexual intimacy in the scant sexual interaction, also situates their seafloor sensing practice. For instance, when in offshore tin mining operations, the social and political context of the offshore tin mining operations directs Thai mining navigators' views on finding tin ores, while on shore, the social and political context of a food stall redirects their sensory and sensing to their desire of the sexual intimacy. By redirecting here, I mean the shift of the bodily senses from observing male ores toward observing female bodies and engaging in sexual activities.

Meanwhile, analyzing the human senses of Thai miners as part of the apparatus also means that they enact the same agential cut to make the exploitation of bodies and seafloor possible. For instance, while the seafloor sensing through Thai workers' human sensing delineates the seafloor from benthic habitats to render the seafloor into a mineable environment, this agential cut is also put to use to isolate sex workers' bodies from their dignity and respect. This means these sex workers' bodies are seen through the human senses of miners as mere flesh and a source of sexual desire for satisfying their sexual needs. Thus, such apparatus indeed enables the exploitation of the seafloor and human bodies. In this matter, the apparatus of the offshore tin mining operations changes according to the social and political environment of the material sites. As this section explains migrant workers' knowledge and digital twin technology as part of the apparatus and their wider political and social entanglement, the next section focuses on how such digital twin technology is further adopted in domestic mining ships.

4.5 The adoption of digital sensing technology as part of an apparatus in domestic offshore tin mining operations

Understanding how Thai mining ships can produce tin ores effectively with the assistance of digital twin technology, domestic mining companies in 2011 established mining partnerships with Thai mining companies, the so-called *Kapal Mitra* and *Kapal PEMDA*. The two categories represent how central state-owned mining companies, provincial government state-owned mining companies, and domestic private mining companies created partnerships with Thai mining companies in terms of capital investment (e.g., staff and funding) and technologies. In this section, primarily, such political and social collaborations are also part of the apparatus in offshore tin mining operations as this partnership can expand the scale of the seafloor sensing. By the scale of the seafloor sensing, I refer to how this corporation partnership has increased the collection of tin geodata as more mining ships have also adopted the digital sensing device.

Simultaneously, through such a partnership, domestic mining companies began to learn that the digital twin technology of the Thai mining ships enabled them to sense, map, and estimate the seabed tin deposits. For that reason, domestic tin mining companies have started to invest in digital twin technology for their tin exploration. The domestic mining companies installed the digital sensing devices on CSD and BWD mining ships. Domestic mining companies named the digital sensing technology SIOPL – *Sistem Informasi Operasi Pertambangan Laut*, meaning Marine Mining Operation Information System. The word 'system' within the SIOPL indicates the SIOPL is not just a mere digital seafloor simulation. Instead, the SIOPL can display seafloor information through its interplay with hardware devices, like the multi-beam echo sounder.

The multi-beam echo sounder and SIOPL play different roles in the process of sensing the seafloor. While the multi-beam echo sounder is an acoustic device that beams sonar to the seafloor, the SIOPL transduces the sonic waves into a seabed map and mining simulation (Geologist 2022, interview on 15th July 2022). The way the SIOPL transduces the sonic waves here can be explained by Helmreich (2007) work on transduction, where he notes: "[T]ransduction names how sound changes as it traverses media, as it undergoes transformations in its energetic substrate (from electrical to mechanical, for example), as it goes through transubstantions that modulate both its matter and meaning" (1). For that reason, given such a transduction, the SIOPL can be understood as a *remote* digital sensing technology as operating this sensing device does not require tin miners to dive to see the seabed physically. With this capability of sensing the seabed, the SIOPL enables the mining navigator to avoid the ladder of CSD and from potentially being trapped by the collapsing walls of the seabed pit tin recovery. To put it more simply, if the CSD is the hand and fingers of the mining ship (collecting the ores), the *ladder* is the arm, or access technology, that allows miners to reach and collect tin ores from the deep. As Mining Navigator (2022) explains: "[B]efore utilizing the SIOPL, we only rel(ied) on our feeling(s) to indicate whether our ladder of cutter suction dredger [CSD] is getting clamped by the collapsing wall of the seabed during the process of digging and mining" (Interview on 27 May 2022). In this way, one begins to understand how the SIOPL has become an important component of the apparatus in offshore tin mining operations.

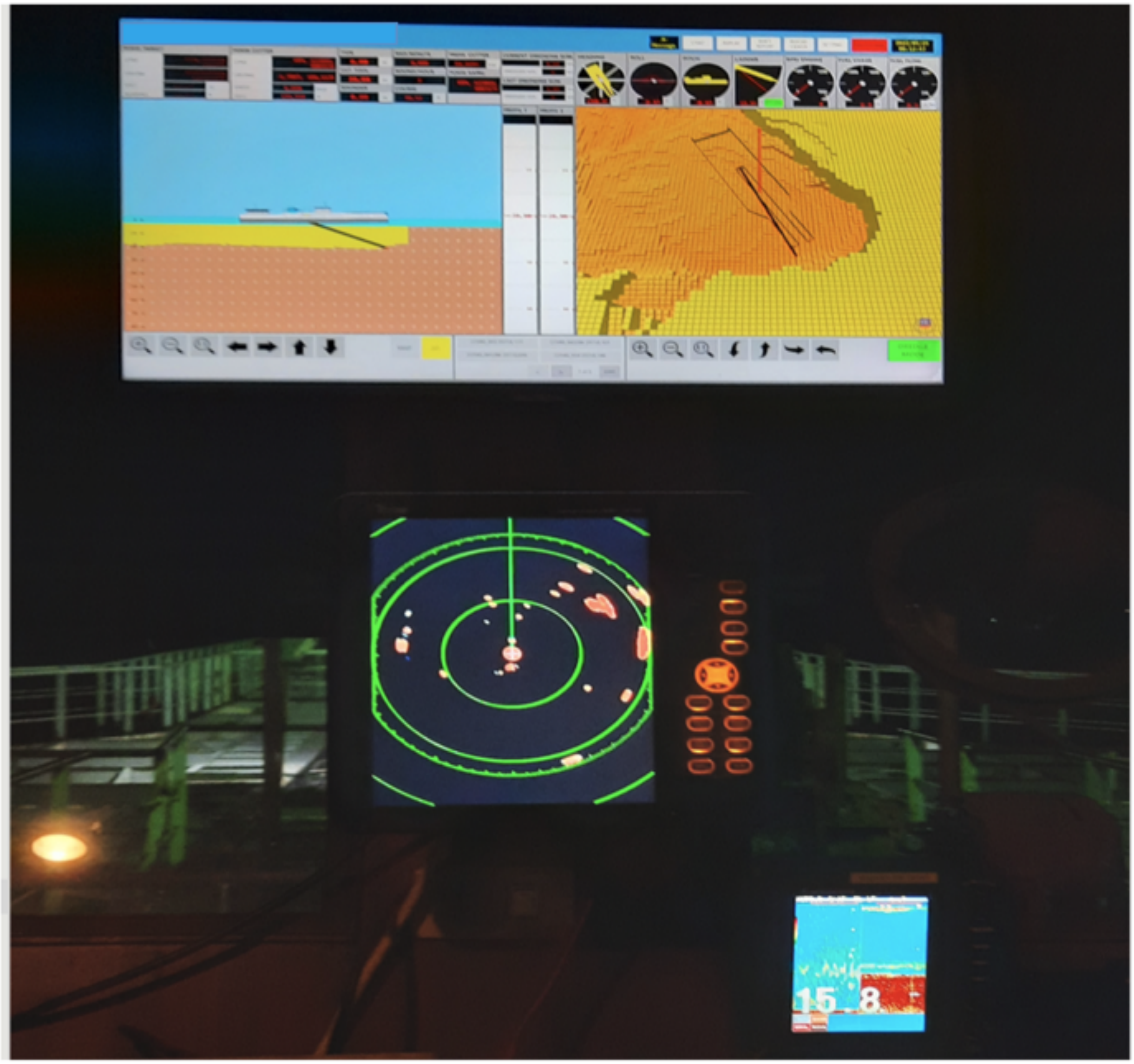


Figure 14: SIOPL (digital twin technology).

The practice of seafloor sensing to extract tin ores in offshore mining operations does not merely rely on the digital seafloor and mining simulation of the SIOPL. Instead, seabed sensing activities combine sensing devices (e.g., SIOPL, loudspeakers, and CCTV—Closed Circuit Television) *and* human senses (e.g., taste, touch, and even feeling). While SIOPL and CCTV allows miners to visually monitor their seafloor extractions, loudspeakers enable miners to identify the sound of seafloor sediments (e.g., rough and smooth sound). Rough sound means miners suctioned pebbles and dredged rocks. As tin ores have a heavy molecular weight, almost similar to pebbles', rough sounds are an indicator of existing tins. Meanwhile, smooth sounds mean they suctioned mud, and too often, there are no tin ores (this rough and smooth sound is also explained in Chapter 5). As Mining Navigator explained to me: “Indeed, the SIOPL helps us to better visualize the seabed. But as you can see here in this room [mining navigation room], we also have to rely on loudspeaker, CCTV, our taste, touch, and feeling to optimize the process of locating the tin ores” (Interview on 27 May 2022). From these explanations, I further asked a follow-up question: “Can you tell me what the role of loudspeaker, taste, touch, and feeling is for recovering the tin ores?” (interview on 27 May 2022). His reply was insightful,

> “While SIOPL provides information such as the position of the CSD's ladder, the depth of sea [bathymetric], and three-dimensional seabed map, loudspeaker helps us to hear rough and soft sounds. Rough sounds mean we collect pebble and often time, they are indicators of tin ores. That is because tin ores have heavy molecular weight. This means they often reside on heavy seabed materials such as pebbles and rocks. Meanwhile, soft sound means that we hover [over] muds. There are almost no tin ores in muds [Chapter 5 will explain further how soft and rough sound matters on finding the tin ores]. CCTV helps us to calibrate whether rough sound indeed means tin ores. We install CCTV on the washing plant downstairs. Through the CCTV, you see the pipelines connecting to CSD. If the pipelines turn black, it means we extract tin ores. Taste and touch. We use them to touch and taste clay. Tasting and touching clays provide us crucial parameters because if the texture and taste of the clay is semi-solid and soft and taste plain. This means we have reached the bedrock of the seabed. As the bedrock is impenetrable for both saline water (marine water) and tin ores, they become the indicator that the digging process should stop and thus, we avoid digging too deep but have no tin ores. On top of that, feeling is crucial. Feeling, I cannot explain in detail, but feeling comes from operating CSD experience. We know whether we hit the jackpot (tin deposit) or not. For that reason, different people produce different amount of tin ores despite they use the same technology and extract tin ores from the same location” (Mining Navigator 2, 2022: Interview on 27 May 2022).

This explanation indicates how examining sensing seabed activities in offshore tin mining operations, as part of the apparatus, challenges the hierarchical binary assumption between human senses and sensing devices, feeling and thinking, and digital and material seabed. However, the most crucial part of this sensing practice is to understand that this observation activity is far from the notion of neutral and apolitical (Gabrys, 2019). That is because whilst the culture of seafloor sensing accentuates the seafloor and the location of the tin deposit (SIOPL, CCTV), this way of knowing the seafloor serves the interests of the mining companies and mining navigators in tin ore accumulation.

This means that the seafloor sensing here mainly directs their vision, taste, touch, feeling, and thinking on a digital seabed simulation, clays, sands, and black tin ores. This apparatus reduces the reality of the seabed into, what Sammler and House-Peters (2023), argue as “an always ready extractive landscape” (9). In other words, the seafloor’s simulation also reflects on global tin capitalist imaginations as such seabed sensing practice techno-scientifically creates the seafloor as none other than tin extractive sites. Meanwhile, as components of seafloor sensing such as sensing devices (e.g., SIOPL, CCTV, and loudspeaker), mining navigators, and observed seafloor maps and tin ores focus on the tin flows, this apparatus here creates the regime of visibility and invisibility. That is because while the apparatus makes visible and sense-able the sound, taste, and view of the seabed sediments, including black tin ores, such seafloor sensing practice also makes invisible the benthic habitat damage caused by the process of sensing.

Indeed, the process of seafloor sensing can degrade benthic habitats indirectly and directly. For instance, indirectly, such apparatus enacts the agential cut to separate the seafloor from benthic habitats. In this way, the apparatus also isolates tin ores from its broader entanglement of benthic habitats, especially since SIOPL, CCTV, and loudspeakers are not designed to capture benthic habitats. This impartial knowledge of the seafloor directs miners’ views on tin ores beneath the seafloor and excludes benthic habitats. That is why this impartial knowledge may drive miners to mine the seafloor tin ores, even though mining sites are situated in coral reef benthic habitats. Therefore, the apparatus of the offshore tin mining operations indirectly conditions the benthic habitat degradation. Beyond an indirect way of the seafloor sensing impacts on the benthic habitats, seafloor sensing and extractions are, as mentioned earlier in the introduction, not separated activities. Instead, the process of sensing and extracting are also inextricably part of the apparatus. This means this apparatus reduces benthic habitats into digital seafloor simulation and physically maim benthic habitats (see Figure 15). This is also not to mention, for instance, this apparatus also produces sediment plumes (as discussed in Chapter 6), creating aphotic zones deadly for coral reef habitats and other benthic species (e.g., clamps and shrimps) (Sari et al., 2022).

Figure 15: The footprint of seafloor sensing combined with seafloor extractions (Personal documentation, 2022). Note: As the movement of the ladder and head of CSD is unseparated from the process of seafloor sensing. The seafloor sensing simplifies the damaged benthic habitats (e.g., coral reefs and benthos) and also enables dredging the benthic environments.

Concurrently, as the seafloor is flattened into a seafloor map and mining simulation (see Figure 15) and sediments, the damage of the benthic habitats from the process of dredging, cutting, and suctioning the seafloor is distorted. Therefore, the apparatus of offshore tin mining operations produces the paradox of sensing: sense-able and insensitive toward benthic habitat degradation. Even though this section has showcased how the digital twin technology stitched together with other sensing devices, as well as indicated the political implication of such apparatuses, it does not delve into how the data produced by the apparatus entangles other actors beyond the physical site of the offshore tin mining operations. For that reason, in the next section, I explain how such an apparatus gets entangled with the wider geopolitical implication of these seafloor tin mining operations through the geodata like tin deposit maps.

4.6 Tin deposit maps as parts of an apparatus

The apparatus of the offshore tin mining operations transcends spatially and temporally beyond the site of the offshore tin mining operations. That is because the tin exploration uses apparatus to observe and take seabed sediments to produce a tin deposit planning map. This map further becomes a mining guideline used by offshore tin mining operations to sense and extract seabed tin ores. This means that what has been observed (e.g., tin ore concentration, the location of the tin ores, the seafloor's depth) in the tin explorations becomes part of the apparatus of the offshore tin mining operations. This has to do with the fact that tin miners use a tin deposit map as part of seafloor sensing and extractions. Therefore, the tin deposit maps enable miners to sense the seafloor tin ores and also exclude the benthic habitats. As one Geologist (2022) explains:

> "[B]efore the process of extracting tin ores is possible. We identify, calculate, and estimate tin deposits in each station in a planned seabed mining site. Such an identification process also relies on the SIOPL, taste, vision, and feeling. We further wash the sediment sample and weigh how much gram of tin ores from the one-hundred-gram sample. This measurement then becomes the basis of estimating how many tin ores are potentially contained in each station of seabed and at what depth of the seabed tin ores exist. Finally, we put this information on the map of these mining sites using our GIS (geographical information system) software and then print them for the offshore tin mining team" (Geologist: Interview on 15 July 2022).

The map produced by the exploration team here is called *peta perencanaan cadangan timah* (tin deposit planning map). This map not only becomes the guiding instrument for offshore tin mining operations to extract tin ores but also helps miners to identify whether particular mining sites are worth exploiting. However, such guiding maps cannot be construed as a factual mirror of the number of tin ores because the mining navigator and the head of the mining ship should prove the existence of tin ores through the practice of recovering tin ores. Such an activity of checking the real status of tin deposits here refers to *pengecekan cadangan aktual* (actual tin deposit check). In other words, the tin deposit planning map provides the assumption of how many tin ores are contained at a particular depth, with the actual tin deposit check providing a ground truth.

With the role of the tin deposit planning map in estimating tin deposits and locations, the act of sensing in the process of tin recovery can exist. This is because this map plays an integral role as a guiding map to orientate where the mining navigator should navigate the mining ship to and what depth the mining navigator should dig and mine tin deposits. A tin deposit could be compared to the idea of a bank deposit in that it refers to the amount of tin ores that have not yet been extracted but are stored in the seabed awaiting withdrawal. In this way, the apparatus in offshore tin mining operations has produced the imagination of the seafloor and even the earth as nothing but a reservoir of human taking. As head of mining ship (2022) explains:

> "[T]in deposit is like bank deposit, mas [brother]. Of course, suppose you have your bank deposit, this means you have to be able to withdraw the amount of your money you keep in the bank as a deposit when you need it. The concept of the deposit also goes the same for tin deposit. Tin ores in the seabed can be tin deposit if mining companies can access and extract the tin ores. In other words, inaccessible tin ores are not tin deposit but tin reserves. Sometimes lay people are confused between the term tin deposit and tin reserves. For that reason, extracting tin ores from the seabed not only requires mining technology but also the tin exploration team to transform tin reserves into tin deposit. That is because they create a tin map that provides the practical guideline on how to access tin ores and the exploitation team [offshore tin mining operations] that proves the actual amount of the tin deposit by following their mining map guideline" (Head of miningship: Interview on 22 June 2022).

The role of the deposit map is thus equally crucial to the act of sensing in offshore tin mining operations. As my research note demonstrates:

> "[T]he mining navigator looked at the coordinate point and codes [the symbol indicating the number of tin ores] of mining sites using the tin deposit planning map. Understanding the location of the tin deposit, he began to navigate the mining ship to the coordinate point. The SIOPL also helped him to match the real (actual) coordinate point with the one on the tin deposit map. Arriving on the mining site,

he further checked on the legend of the tin deposit planning map to know the depth of the sea, the depth of the seabed, and at what seabed layers the tin deposit exists [this process is complex and iterative until they are convinced because they had to check other indicators such as the height of the wave, the wind direction, and strength, and looked at the CCTV if they pumped black sediment and produced rough sound]. With this information, he positioned the ladder of CSD from 90 degrees vertically to 40 degrees to dig the seabed and reach 30 meters below the seabed. Reaching the depth of the estimated tin location, he moved the ladder of the CSD from 360 degrees to open up the area of the mining site and facilitate the movement of the mining ship. Finally, he performed 180-degree movements to continue cutting, suctioning, and dredging the seabed sediment at the target tin mining site" (Research Diary, 2022: Participant observation on 25 May 2022).

Figure 16: Black tin ores. Tin ores are categorized by their colors such as white, grey, and black. Black tin ores are the most valuable tin ores because they are more moldable and durable (miner's documentation, 2024).

Such a practice of moving the cutter suction dredger above fits in with the argument of Sammler & House-Peters (2023), who argue that the digital twin paired with digital mining technology transforms sensing through visual technology to dredging the seafloor. In the offshore tin mining operations, primarily, as the mining navigator checked the guiding mining map and observed the SIOPL, they also operated the ladder of CSD to continue shrouding and changing the seabed into mining areas. As such, the more tin ores they make *sense-able,* the more insensitive miners are to the fragile benthic habitats. As the mining navigator explained: "[W]e are happy today because you can see that on the CCTV, the pipeline of the cutter suction dredgers turns black. This means that we accumulate tin ores for our mining ships" (Mining Navigator 2, 2022: Participant observation on 27 May 2022). This means that seeing the black ores through their apparatus, miners continue to dredge and suction the seafloor. In this way, they damage the benthic habitats. However, as the representation of the seafloor is a mere digital seafloor simulation and a flow of sediments and tin ores, the existence of the benthic habitat damages is rendered invisible. This is why the insensitivity to the benthic habitat damage here is the product and part of the apparatus in the offshore tin mining operations. With such a role of the apparatus, one may also understand the insensitivity is partially the purpose of the apparatus. This means the insensitivity here is built within the apparatus as the apparatus created "the seafloor" by isolating this space from benthic habitats via its sensing practices. As such, there is no seafloor before the apparatus. This argument resonates well with my argument in Chapter 2 on the global geopolitical construct of the seafloor. That is because the UNCLOS also creates "the seafloor" through its metrics of mapping and dividing up ocean space for property. In offshore tin extractions, especially, the tin deposit planning cartography maps and divides the seafloor as none other than the physical reservoir of the tin ores.

While the tin deposit planning map has often given satisfactory predictions on the number of tin ores, indeed, sometimes, what has been predicted on the map does not mirror the reality of tin deposits in the field. In other words, the amount of tin ores can be higher or lesser than what the tin deposit planning map shows. The issue matters especially when the production of the tin ores is less than the prediction of the tin deposit planning map. That is because the lack of tin ore production means that the mining companies cannot compensate for the operational cost of tin mining operations. For example, as Mining navigator 4 (2022) explained: “[T]his is indeed a bit awkward situation when you are here because we face real problems. We do not produce a lot of tin ores despite the fact that we have followed the tin deposit planning map. Our boss [the head of the mining ship] has contacted the exploration team to visit us and to prove whether it is our fault or their fault” (Interview on 30 June 2022). During my observation, such conditions also bring a lot of shame on the mining crews and the head of mining ships. That is because if the planning map does not give them high amounts of tin production, their performance begins to be compared to other mining ships. The head of mining ship 4 (2022) mentioned:

> “[Y]esterday, you went to the cutter suction dredging ship number 7 before you came here; our tin production performance is always compared to their tin production performance. Especially, because we mine relatively on the same location" (interview on 30 June 2022). Indeed, based on my participant observation, "upon observing the SIOPL and navigating the mining ship, the cutter suction dredger did not produce enough tin ores. Meanwhile, the mining company has set a minimum tin production target of about 120 kampel per day. Kampel is a unit of measuring the amount of tin ores introduced since the Dutch colonial tin extraction and trade control. In this way, if one kampel is equal to roughly about 60 kg of sack, 120 kampel is equal to 7200 kg. Subsequently, if the price of the tin ore per kg at this time is 200,000 rupiah (13 USD), one kampel is worth 1,500,000,000 (94,000 USD)” (Research Diary: Interview on 30 June 2022).

With the lack of tin production, this situation also means that their mining crews cannot obtain extra bonuses such as money and free vacations abroad. The lack of production also manifests in whether they have extra food in the kitchen, a clean prayer room, and a proper berth. In this way, seeing the act of sensing as an apparatus, one can see how the act of sensing also transcends spatially and temporally (Sammler and Lynch, 2021). Of course, what I mean by apparatus here does not only mean the sensing devices (e.g., SIOPL, CCTV, and mining navigators’ senses). As Barad (2007) argues the apparatus is the entanglement between observers, observing instruments, and observed objects, as well as the social and political context within which such observation is situated. In the context of offshore tin mining operations, the process of seafloor sensing through sensing devices and the subjective feeling are also situated within the space and time governed by the mining companies. For that reason, since offshore tin mining operations focus on the process of tin accumulation, seeing the culture of the sensing as an apparatus is not just about how the seafloor sensing enables tin ore accumulation.

Instead, seeing the apparatus of the offshore tin mining operation is also about how such an act of sensing spans within and beyond the issue of the seafloor tin sensing. For example, as the act of sensing tin ores defines the performance of collecting tin ores, the success of finding and extracting tin ores also defines the well-being of those miners working on particular mining ships. In fact, mining companies create a trophy along with these bonuses to the highest tin producers among over 21 CSD mining ships. In this competitive environment, the lack of tin production also meant that they did not feel happy with my presence because they were afraid of me telling the director of the mining company about the lack of tin production. Of course, even though they felt unhappy with my presence, they understood from the director of the mining ship that I had my research permit. For that reason, they allowed me to observe their mining activities. However, in my ethnography fieldwork on mining ships, I only felt unwelcome on one mining ship. While they did not prevent me from joining their mining ship, nor did they provide an unsupportive environment, there was a lack of engagement between me, the mining navigators, and the head of the mining ship. Partly, that is because they have focused on increasing their tin production, and they had anxiety about if I might inform the director of the mining ship about their low tin production. In reality, of course, I would not tell because my main objective is to understand the culture of seafloor sensing, including what has been made visible and invisible through their sensing technologies.

Meanwhile, as I continued writing about the situation in the bridge (mining navigation room where the operation of the sensing devices is situated on the mining ship,

> In a few minutes, the exploration team arrived; they then checked and matched the actual and the plan map. One of the explorations went back and forth from the mining reservoir, the tin washing plan, to the mining navigator. Indeed, they enact the practice of sensing here. Seeing the SIOPL, CCTV, taste, and touch clay and

seabed sediment. After some minutes, they proved that the issue is the mining navigator" (Research Diary 2022, 30 June 2022).

Upon redoing the practice of sensing, the exploration team showcases that the tin ores are rich because they can pump in many black tin ores. Through seeing the CCTV, the pipe becomes black. This black indicates that they suctioned the tin ores. As such, given the subjective feeling and interpretation of the guiding map, mining companies often blame the lack of tin production on the mining crews instead of acknowledging that the sensing practice is dependent on both the mining navigator and the guiding map. Of course, when the exploration team arrived, they made some adjustments that helped them find the tin ores from the previously assumed poor tin deposit condition. This revision is possible because the mining team was also trained to find tin ores by tin geologists and mining experts in the company. This finding also supports Wilke's (2017) that sensing is indeed a trained practice. However, despite the fact that the mining navigator is not the sole actor defining the production of the tin ores, as the strata of the exploration team is higher than the mining navigator, the mining navigator instead was blamed for the lack of production. By the strata here, I mean how the staff profession of the mining ships is vertically arranged. Within the profession hierarchy, the head of mining ships and the exploration team have a higher position than mining navigators and miners. This indicates that the decision of whether to cease or continue sensing and extracting tin ores on the mining ship is defined by the head of the mining ship and the exploration team. However, the exploration team only visits the mining ship when the tin deposit map is not producing tin ores according to the estimated tin production.

The hierarchical strata of the mining profession here align well with the work of Wilke (2017), arguing how the power hierarchy of experts in the act of sensing is often excluded from the notion of objective-ness in sensing practice as one assumes that the practice of sensing certain space is objective and neutral instead of situated and incomplete. In the offshore tin mining operation, the situatedness of the sensing practice refers to how the geologists in the tin exploration have a higher position than the mining navigator. Indeed, I would also argue that such power positions can possibly be captured by framing the act of sensing in offshore tin mining operations as apparatus because it counts the positionality and power position of the observers. As Barad (2007) argues an apparatus is not a neutral probing device. Instead, an apparatus is operated and situated within political and social contexts. In the offshore tin mining operations, seeing the act of sensing in offshore tin mining operations as an apparatus can allow us to focus on the configuration of mining navigators, sensing devices, and observed seafloor and also the power hierarchy within which the decision of the seafloor sensing is hierarchically defined by the vertical hierarchy of the mining staff profession. Thus, power here can also be linked to the way the mining company construes the geologists as experts, given their educational background and their crucial roles in finding tin ores, although the mining navigators themselves are also experts, given their practical everyday training in sensing the seabed and tin ores. While the educational background matters to be part of the exploration team, one mining navigator has been successfully beating the odds. As my research note explains:

> "[A] former mining navigator named Ali [pseudo-name] has successfully claimed the ladder of mining position. That is because he showcased how he had been able to predict the location of the tin ores through the practice of sensing. Ali's experience here might fit in with the English phrase, beating against the odds because even though he was not getting a formal university education in geology like his other mining colleagues. He could operate the sensing devices well and accumulate tin ores. That is why given his pure talent in finding tin ores, he was selected as one of the elite members in tin exploration team" (Research Diary: 30 June 2022).

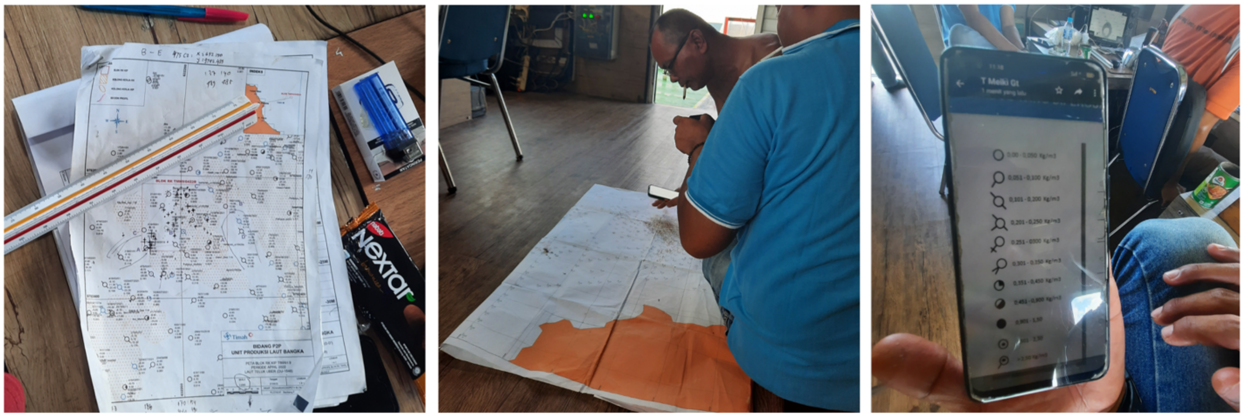
Given how rare non-university degree holder becomes part of the tin exploration team, the successful experience of Ali (pseudonym) in climbing the ladder of the mining profession without a formal university education has also underpinned the argument of Gabrys (2019) and Lehman (2018) on how sensing practice is often considered apolitical by scientists because it neglects the inequality between gender and social class within which the act of sensing is operated (Hägele and Hornidge, 2024). That is why seeing the act of sensing as an apparatus here allows us to probe the position of the mining navigators and, thereby, allow us to bring to the surface the inequality within the seafloor sensing. Of course, in the case of Ali, he has successfully beat the odds. However, individualizing such success here can also mean neglecting the fact that the system and structure of the mining company often privilege higher degree-holding geological experts. For that reason, geology and formal university education are also part of the apparatus as they also define the role of miners to have the authority to map and predict the amount of seafloor tin ores.

Given the importance of geology expertise and the formal university education, most of the tin exploration experts do not come from the Bangka and Belitung Islands. Instead, most of them also come from Java, especially because quality universities such as the University of Indonesia, the University of Gajah Mada, and the Institute of Technology Bandung are situated in Java Islands. In fact, only those born in a rich family can pursue their education to be a geologist, while most of the Indigenous people in the Bangka and Belitung Islands cannot because the price of education is high. Therefore, examining the act of sensing in offshore tin mining operations as an apparatus also showcases how the product of sensing practice comes into being from inequality and different power relationships between the Indigenous and the non-Indigenous. But, indeed, such a story is not considered as important as the practicality of sensing and the product of sensing, such as the tin deposit planning map and the tin ores by the mining navigator. That is because offshore tin mining operations operate through the capitalist narrative of extracting tin ores and earning more revenues for the company and for the Indonesian economy.

Speaking of the product of sensing, the tin deposit planning is equally as critical as the price of tin ores and the revenue generation. As argued earlier, the tin deposit planning map is even more critical than the unequal power hierarchy within offshore tin mining operations and perhaps even more essential than conserving the benthic habitat. In fact, this argument reminds me of my talk with a Geologist (2022). He called the tin deposit planning "a 50-million-dollars map". He explained:

> "[E]veryone wants to mine. But they cannot mine the seabed because they do not have the tin deposit map that enables them to locate and find tin ores. That is why, we [different mining companies] often call this map 50-million-dollars map. That is because with this map, you can generate as much money as you want. The map can even counterargue on what anti-mining calls ecosystem service. If ecosystem service such as coral reefs and mangroves can provide us economy contribution because these habitats are crucial for marine tourism. Come on, how much you want to invest in marine tourism on Bangka and Belitung islands. The revenues from marine tourism here means nothing compared to our economy contribution" (Geologist: Interview on 15 July 2022).

This quote illustrates how the tin deposit map is a powerful apparatus because it defines whether the mining company can or cannot access the seabed tin deposit. However, such arguments on how important the tin deposit planning map indicate how the seabed has been reduced into a pure site of economic accumulation. In fact, before competing to access the seabed, mining companies and other types of miners compete to get an accurate tin deposit map. Therefore, the tin mining map is treated as a discrete tool. However, while the mining companies try to keep the tin deposit map confidential, some within their mining companies can sell the tin deposit planning map to other actors without the consent of the mining company. As a Geologist (2022) explains, "[S]ometimes, even though we have promised not to tell anyone about our tin deposit planning map. Somebody else leaks tin deposit planning map" (Interview on 15 July 2022). Indeed, the tin deposit maps attract almost everyone. For instance, during my fieldwork, my landlord in my flat approached me with his colleague. He forced me to spill the information concerning the tin deposit planning map. Of course, I felt uncomfortable with this sudden interrogation. "[T]hey asked me, "Mas, do you have the tin map? We can share the profit of the tin extraction. You can be rich". I realize that such a conversation showcases how the product of sensing is as crucial as the process of mining the seabed in itself. I do not judge my landlord's desperation over the tin ores here because, during my fieldwork, we faced post-COVID-19" (Research Diary 2022, 22 June 2022). My landlord's restaurant business was negatively impacted by rising inflation and by the cost of his children's education. In this way, the tin deposit planning operates as if a holy book that may save them from the precarity of economic conditions. Despite that, I did not share the information concerning tin deposit map as sharing such discrete information was neither ethical nor did I have tin deposit maps.



a b c

Figure 17: a. a printed one-dimensional tin deposit planning map; b. matching estimated tin deposit, and actual tin production, c. guidance on reading the symbols of maps (personal documentation, 2022).

The interest of non-mining experts in owning the tin deposit planning map above has indicated how they did not merely underestimate the act of sensing, demanding specific training and continuous practice to become mining navigators, but also the difficult ways of reading and translating mining symbols on tin deposit planning maps. In other words, non-miners often assume that having a tin deposit planning map is enough for them to extract tin ores, while in actuality, it is still insufficient. As the head of the mining ship 1 (2022) explains: “[N]ot only does the act of sensing the seabed tin ores require a specific expertise but also they have to learn how to read mining symbol” (Interview on 26 May 2022). One of the expertise is to read the symbol of the tin deposits. During the interview with the head of the mining ship, he explained about the symbols on the tin deposit planning map:

> "[S]o, the symbols here represent the richness level of tin ores in the seabed. The richness of tin ores is symbolized by these codes here [pointing his index finger]. For the detail of how much tin ore is in each symbol, you can check on the table, and I can break down into different types of symbols and their meanings. If the code looks like this [circle symbol or no branch], this means empty or no tin ores. This one has four branches. The code has a plus symbol. I will break down codes and the meaning of the codes in detail. This one is a five-branch code. After a five-branch code, it becomes a quarter-black code. It looks like this: the shape is like a circle, with a quarter of the circle being black. Following that is a half-black circle. Finally, it jumps to the symbol of a full black circle. The last one contains a very rich amount of tin ores" (Head of mining ship 1, 2022: Interview on 22 May 2022).

Applying the symbols as the language of reading the tin deposit planning map not only makes the process of coding tin deposits on each station of tin exploration more practical but also indicates the politics of mapping the seafloor and knowledge of the tin deposit. By political here, I refer to the fact that not everyone will understand the symbols of the tin deposit planning map as they need to understand the meaning behind each symbol of this product of sensing. Thus, those who know the meaning of the symbol hold power over those who do not because they are capable of reading the map. The capability of reading tin deposit maps here enabled miners to identify whether extracting tin ores in particular sites is or is not worth doing. This means the expertise of reading the tin deposit map here allows them to fund future mining projects given that the capability of reading the tin deposit map symbol also indicates one understands the tin deposit extraction can compensate the operational cost of the offshore tin mining operations. Meanwhile, non-experts unable to read the symbols cannot secure tin ores. While non-experts can experiment by digging and separating tin ores and sediments, the utilization of tin deposit maps provides greater effectiveness in finding tin ores. Since the effectiveness also relates to the duration of mining, those who own and understand the way to read the tin deposit planning map can reduce the operational costs of tin mining, such as working hours, fuels, and food that keep the offshore tin mining operating.

The process of reading the tin deposit map represents apparatus because there exists the entanglement between the head of the mining ship and the mining navigator (observer), the tin deposit map (observing instrument), and the seabed (an object). This apparatus of offshore tin mining operations connects the observer with the seabed but also allows them to change and recreate the seabed as none other than an extractive frontier (Sammler and House-Peters, 2023). Indeed, this argument on how this act of sensing through reading tin deposit planning maps and translating their symbols also fits in with the argument of Hawkins (2020) about how sensing the seafloor and subterranean makes visible or better sense-able the geopolitical importance of these physical spaces. Sense-able here means that the tin ores are detectable and able to be estimated for tin revenues and national income generation through tax payment. When it comes to the geopolitical importance of the seabed, Lambach has argued that making sense-able the seabed is crucial for maritime security and war operations (Lambach 2022).

Even though Lambach's geopolitical argument above on the relationship between sensing and maritime security can still be the case in Indonesia as 70% of Indonesian territory is ocean (Fatimah, 2015), the geopolitical importance of the seabed in offshore tin mining operations instead specifically pertains to the abundant level of tin ores, which are political and economic bedrock for the Indonesian economy. The notion of the crucial political and economic bedrock here refers to the logic of the geological commodity. For instance, as mentioned earlier in Chapter 1, Indonesia has now become the world's largest tin ore producer, exporting over 30% of the tin ores worldwide (OEC, 2022), the Indonesian government can use tin ores to continue, discontinue, or even ban its tin export to certain countries. For example, this tin embargo happens to EU (European Union) countries, given that EU countries also embargo palm oil with the allegation of unsustainable palm oil production (Setiawan 2023). In this sense, sensing the seabed is also a matter of improving the bargaining power in international commodity exchange. Hence, this argument meets how framing the act of sensing the seabed in offshore tin mining operations as an apparatus enables us to understand how the act of sensing can transcend spatially and temporally. In this case, as the practice of sensing is crucial for finding tin ores and global tin supply, the practice of sensing is also entangled with wider political issues like the commodity embargo between Indonesia and the EU. This argument aligns well with the argument of Sammler and Lynch (2021), arguing how framing the practice of sensing space as an apparatus can offer an understanding to see *beyond* the material site within which the observation is situated. However, since the apparatus orientates views on sensing the seabed tin deposit through reading and translating the tin deposit planning map, such cultures of sensing flatten and remove the benthic habitat damages caused by offshore tin mining operations. Hence, such apparatus suggests how translating and reading the symbols of tin deposit planning maps creates the paradox of sensing because it makes sense-able (Hawkins, 2020) the location of tin ores and, at the same time, insensitive toward the damaged benthic habitats. For example, Sari et al. (2022) showcased that the offshore tin mining operations indeed dredge the benthic habitats and result in sediment plumes, obscuring the sunlight penetration, leading to the coral reef mortality. More importantly, such benthic habitat damage is the byproduct of how the apparatus of the offshore tin mining operations has flattened the seafloor as a digital, visual, and empty representation. In fact, the presence of benthic habitats is occluded and flattened as mere minerals and mining data (i.e., tin deposit data in Figure 17).

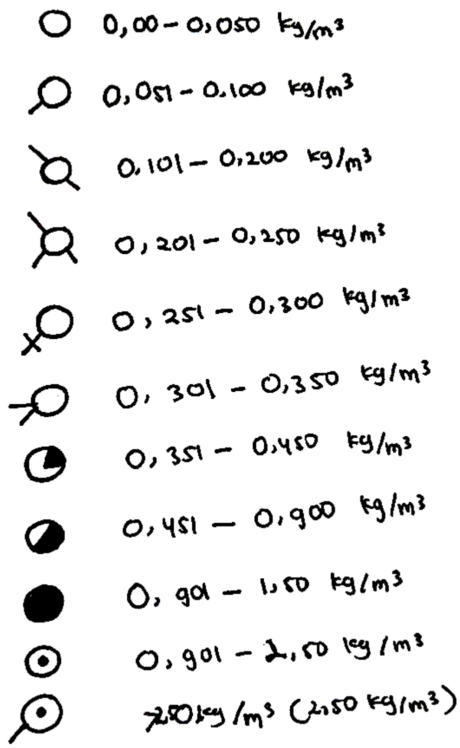


Figure 18: the symbol of tin deposit mining maps (personal documentation, 2022). I am redrawing the symbol of the tin deposit for clarity for readers.

The issue of the geopolitical decision-making on banning and exporting tin ores to EU countries is the Indonesian government itself most likely misunderstanding the symbol on the tin deposit planning maps, as reading the tin deposit symbol requires training and hands-on experience in navigating mining ships and observing seafloor tin sediments. As such, this situation creates an assumption that celebrates the glorifying notion of the world's largest tin producer. This means that the Indonesian government may think that having the tin deposit map means having the actual high amount of the tin deposit beneath the seafloor. While indeed, to some extent, this notion can still be true given the current Indonesian tin export mentioned previously, such a top-down geopolitical view has often removed the practicality of interpreting tin deposit symbols and proving the actual amount of the tin ores through seafloor tin extraction. For example, in practice, tin miners could not find on the map a circle with one dot and one branch, the symbol of the richest amount of tin deposit. Instead, when they often found a black circle, this finding has been considered luck in the tin deposit map. The rarity of the black circle here emerges given that the tin exploration exists mostly in the previously mined sites and the technological and depth constraints. The technological and depth constraint here refers to how current mining technology and sensing technology can solely detect the tin ores at a depth of up to 60 meters. This means the tin ores situated deeper than 60 meters are often undetectable. As the head of mining ship (2022):

> "[W]e only now wish to encounter the legendary symbol in our lives; a one dot in circle with one branch symbol. Because they are so rare. Perhaps, this is because the tin exploration has not revealed the amount of tin ores at the depth of over 60 meters. That is why until we have the deep-sea mining technology and sensing technology to collect the information about the abundance level of tin ores and how to extract the tin ores deeper than 60 meters. This resource will not become seabed tin deposit yet" (Head of mining ship: Interview on 26 May 2022).

The quote above shows that the sensing instrument and mining technology also define whether the tin exploration team can find the tin deposit that can be marked with a one dot in a circle with one branch symbol. This means without the sensing instrument and mining technology here, the tin ores in the seabed would not appear in reality. For that reason, apparatus not only indicates the inseparable relation between the mining navigator (observer), the observing instrument, and the seabed but also defines how certain abundant levels of tin ores come into being. This argument is reflective of the work of Meesters et al. (2022), arguing that if the act of sensing measures certain materials in mining sites, then only these materials come into being. In other words, other materials are excluded from the act of sensing because they are not seen through visual and digital sensing devices. As such, due to the selective nature and constraint of apparatus to represent the seabed, the paradox of sensing also comes to exist, in which the benthic habitats are excluded.

Since the practice of sensing in CSD mining ships not only enables the detection of the location of the tin ores but also produces a tin deposit mining plan, the estimation, and prediction of tin abundance level on the seabed through the symbology. The product of sensing (e.g., tin abundance level estimation and tin deposit planning map) here plays an integral role in lobbying, negotiating, and attracting governance actors in allowing, investing, and expanding offshore tin mining operations. As one Geologist (2022) explains:

> "[N]ow almost every ministry except the ministry of religion has become against offshore tin mining operations. However, whenever the provincial and central government aims to complicate the access of the offshore tin mining operations to extract tin ores in particular seabed tin mining sites. I utilize this tin deposit plan to show them that the commercial value of tin ores that might not be lost or not captured. For example, here [pointing on the map], we predict that we have over 200,000 kg of unexploited tin ores. This amount of tin ore is of course crucial for paying mining taxes and corporate social responsibility. They should know that we contribute to the economy and their tax payment requirement" (Geologist: Interview on 15 July 2022).

This argument echoes the work of Gabrys (2019) on how sensing practice creates the politics of data. In the context of the offshore tin mining operation, with the data of tin ores from the tin exploration, mining companies can be reminded of the commercial value of the tin ores for the local and national economy. Hence, the provincial and central governments can hardly counter-argue for a seabed access ban on offshore tin mining operations. In fact, since 2021, the provincial government has enacted marine spatial planning (MSP) under provincial regulation (PERDA 2020) (Chapter 5 explains the issue concerning MSP). This provincial regulation has also marked the expansion of offshore tin mining sites, resulting in conflict between the Indigenous people and the mining company (Babel 2021). Of course, since the offshore tin mining companies contribute to the local economy, job opportunities, and infrastructure, the offshore tin mining operations are prioritized in the use of marine space. This prioritization can exist given that the exploration team has showcased the tin deposit map and the potential economic contribution of tin ores to the local communities. Therefore, framing sensing practice in offshore tin mining operations as an apparatus enables us to see the political implication of the sensing practice that can travel spatially and temporally beyond where the practice of sensing takes place. This also means the paradox of sensing: sense-able and insensitive also spans beyond the physical space of the offshore tin mining operations toward the global geopolitics of the offshore tin industries. Of course, such a paradox of sensing creates the contesting view of what the seafloor is. For that reason, the next section discusses the contesting views of the seafloor imagined and exhibited through the apparatus of the offshore tin mining operations. This discussion marks the argument of how the apparatus of the offshore tin mining operations is not a neutral probe but political.

4.7 Apparatus: contesting the uncontested views of the seabed

As mentioned previously, the act of sensing enables the process of extracting tin ores by providing geodata indicators (e.g., sea wave's height, sea depth, and CSD’s ladder position). This apparatus of offshore tin mining operations defines whether miners can or cannot extract tin ores and guides the tin deposit map. However, as the reality of the seafloor is portrayed as a digital seafloor simulation through the SIOPL, the visual representation of the seafloor here has become a significant debate among tin miners on the cutter suction dredgers (CSD), especially regarding the current seabed conditions (i.e., benthic ecosystem status) off the Bangka and Belitung Islands in Indonesia. As my research note explains:

> “The head of Indigenous tin washing crews, approached me during the last day of my stay on the mining ship 7 after lunch, where he always offered me free meals, he told me that mining companies should continue funding the program of the coral restoration project off Bangka and Belitung Islands. He said that, mas [brother, could you please persuade our mining boss to continue funding the coral reef restoration? My family members and communities feel the benefit of the coral reef restorations. I believe despite the rising number of seabed mining operations, there is still coral reef worth protecting. I believe that coral reefs and fish still exist down there [on the seabed]. Meanwhile, he argues that the mining ship operations should be selective in determining the mining sites to avoid dredging coral reef habitats”(Research Diary: Participant observation on 1 June 2022).

His concern on benthic habitats here not only deviates from the homogenizing view that every miner does not care about the health of benthic habitats but also showcases how certain miners *do* care about the coral reefs off Bangka and Belitung Islands. In this way, this finding demonstrates how the positionality of who sees the seabed also defines what matters or does not matter about the seabed. As Rudy (pseudonym) is Indigenous and grew up in a fishing family, he still cares for the benthic habitat. However, as his position is lower in the hierarchy of the mining company profession, his voice is often unheard in the practice of seafloor sensing and extracting.

Even though Rudy has tried to explain and convince that the coral reef restorations are crucial for the coexistence between mining and fishers, the mining navigator believes differently about the condition of the benthic habitats. For example, during my observation, pointing to the seabed simulation on the SIOPL, the mining navigator explains: "[D]o you see the seabed on SIOPL (the marine mining operation information system)? Every seabed here has had no life since a long time ago. The SIOPL will not lie about the seabed condition; it gives a real image of the seabed. If it lies, how can we mine safely and avoid the betting (the shallowing seabed due to discharged tailing)?" (Interview on 22 June 2022). The notion of real-time seabed sensing has become a way of arguing that SIOPL displays the *actual* truth of the benthic habitat condition. Hence, the real-time notion embedded in the act of sensing can create the notion of certainty that might obscure other notions of uncertainty, for instance, whether coral reefs still exist on the seabed. In this way, such apparatus again underpins the insensitive feelings that develop towards benthic habitat degradation. This aligns well with the argument of Lewis and Gabrys (2024), arguing that real-time sensing fits well with colonial temporality because the real-time notion indicates the colonial duration of dispossession and extraction. In this case, as the real-time sensing and visual representation in offshore tin mining operations assumes that the act of sensing mirrors the benthic habitat condition, this assumption enables offshore tin mining operations to continue expanding mining sites and exploiting tin ores. For that reason, the suffix 'real-time' on the digital seafloor simulation produced by the SIOPL here becomes a political way of justifying the seafloor exploitation as mining navigators interpret that as the actual benthic habitat conditions. Thus, the real-time seafloor sensing here is considered an objective way of understanding the current condition of the seafloor off the Bangka and Belitung islands.

Whilst the mining navigator's assumption on the objective and neutral notion of seeing the seabed through the SIOPL seems a trivial matter, in practice, such apparatus plays a vital role in resisting the anti-mining group. That is because as the act of sensing on the mining ship is considered objective and neutral, this means that the data generated by the act of sensing, such as the tin deposit map and the seabed condition information, are considered objective, too. In this way, given that the data informs decision making, there exists the politics of data (Beer, 2013; Kitchin, 2013; Peters, 2020). For example, since the provincial government and non-governmental organization do not have their sensing devices to prove the status of the benthic habitat by generating data on the condition of the seabed off the Bangka and Belitung Islands, they do not have the evidence to show the condition of the benthic habitats before and after mining operations. As WALHI (2022) explains:

> "[E]very now and then mining companies will show the map of the seabed including the status of the seabed. Indeed, they have the sensing technology while we do not have. Of course, since sensing technology also provides scientific data, they often use the scientific data they have to negate our allegation on the existence of the coral reefs on the seabed. Meanwhile, our data only relies on the courtesy of the Indigenous fishers. The mining companies often accuse that the courtesy of the Indigenous fishers from their daily fishing on the status of the benthic habitats are not objective, while their data using non-human technology is objective" (Interview on 5 June 2022).

This politics of data supports the work of Lehman (2018), arguing that the data from oceanic sensing is crucial because it informs the governance of the ocean. Adding to Lehman's argument, I argue that while, indeed, sensing data informs the governance of the oceans, the data generated by the act of sensing in offshore tin mining operations defines how the mining company can steer the decision-making of the seabed regulation to serve their interests. For example, as Geologist (2022) explains: "[A]s the act of the seafloor allows us to produce tin deposit maps to estimate the abundance level of the tin deposits. This map has become our way to communicate and negotiate with the Ministry of Marine Affairs and Fisheries on the marine spatial planning (MSP) on our concession areas" (Interview on 15 July 2022). For that reason, seeing such sensing activities as apparatus can showcase that the act of sensing orientates not only the mining navigator's view but also the provincial government's view on seeing the seabed as mining areas. The paradox of sensing is, thus, reproduced within the domain of marine policy governing the utilization of seabed mining.

4.8 Conclusion

This chapter has demonstrated how apparatus enables us to not only understand how sensing practice in the process of tin recovery has allowed miners to transform the seabed into mine areas but also, how apparatus hides, excludes, and obscures the existence of benthic habitat damages. In this way, given that hiding the benthic habitat damages from anyone's ways of sensing, thinking, and feeling the seabed, I argue that, the process of the seabed sensing activities here creates the paradox of sensing. This means the more the act of sensing makes *sense-able* tin ores, the more power mining companies have and the more insensitive they become to the benthic habitat damages caused by their tin extractive operations. As mentioned earlier, offshore tin miners in this study will not mention that they are insensitive to benthic habitat damage. That is why the insensitivity here is not the product of a direct word expression from miners. Instead, the product of how the apparatus of offshore tin mining operations, such as sensing devices, human senses, and observed seafloor, has fixed and orientated miners' views only on tin ores beneath the seafloor to meet the global tin demands. That is because as the culture of sensing the seafloor merely emphasizes the geo-physicality of the seafloor and tin ores, such apparatus removes the existence of the benthic habitats. Therefore, since benthic habitats are made invisible by apparatus, miners likewise become insensitive toward the benthic habitat damage within which the practice of sensing and extracting seabed within which tin recovery is situated.

While apparatus such as seafloor sensing devices (e.g., SIOPL, sound recorders, and CCTV), mining navigators, and observed seafloor are installed and operated in the mining ship, sensing practice temporally and spatially transcends the confined time and space of offshore tin mining operations. That is because mining companies have used the geodata produced by apparatus to negotiate and lobby the provincial government to open up new mining areas and allow offshore tin mining operations in the future. In other words, the product of sensing in offshore tin mining operations has informed the decision-making on the seabed regulation. Such politics of data based on apparatus is possible given the notion of objectivity that inheres in the act and result of seabed sensing. The objective notion here has been used by mining companies to contest human experience-based information. For example, even though non-environmental organizations have tried to prove how Indigenous fishers are affected by seabed tin mining, mining companies have challenged such evidence in the stakeholder hearing by arguing that fishers are subjective. As mentioned earlier, during the designation of MSP and the allocation of concession areas, the

Department of Fisheries and Marine conducted a stakeholder hearing inviting governmental employees, tin mining company representatives, non-governmental environmental organizations, and fishing community representatives. The goal of the stakeholder meeting here is to have a mutual agreement on the allocation of ocean space for offshore tin recovery and other marine uses (e.g., coral reef restoration and fishing grounds). While mining company representatives accused that fishers' experience on the impacts of offshore tin mining operations are subjective, the apparatus of offshore tin mining operations also shows how the personal feelings of mining navigators and the interests of tin mining companies also shape the way they sense and recreate the reality of the seabed as tin extraction sites. Therefore, the data produced from the apparatus of offshore tin mining operations are not away from the subjectivity of the mining navigators and in a broader context, the interest of the mining companies.

Since examining an apparatus also enables us to understand the social and political context within which the seafloor ensing is situated, this chapter has also showcased the under-documented social and political context of the migrant workers that contribute to forming the knowledge in sensing the seabed. For instance, enslaved Chinese brought by the Dutch colonial government in tin industries have given important insight, including how to identify *kong* (bedrock) through tasting and quality tin ores through seeing the tin's color. Such knowledge of sensing the seabed has transcended temporally and spatially as current tin exploration teams still apply it even though they also learn the modern geology of tin from their formal education. Additionally, the act of sensing becomes more effective given the fact that Thai companies and migrant workers share their knowledge on using the SIOPL in offshore tin mining operations. Indeed, as explained earlier, these Thai migrant works are not allowed to go on land because they work under seaman permit regulations. In this way, seeing the seabed sensing activity as an apparatus enables us to understand how the act of sensing is inseparable from social justice issues within offshore tin extractive industries. That is because seeing through apparatus (Barad, 2007) means seeing from the entanglement between observers (mining navigators), observing instruments (i.e., sensing devices in offshore tin mining operations), and observed objects (i.e., seafloor). Therefore, one should also rethink the social and political context of the apparatus. In this case, one not only sees how three factors operate and create the reality of the seafloor, but such representation of the seafloor is also intertwined with the social and political challenges of Thai migrant workers.

While the apparatus highlights certain aspects of the seafloor, such as seabed sediment sound, seabed geography, and tin ores, and occludes the benthic habitat damages, this act of seabed sensing activity also creates a relation between humans and seabed. That is because the apparatus of the offshore tin mining operations makes apparent the complex and inseparable relation between miners and the seabed and how the data from the apparatus also mediates geopolitical interventions on the seabed. This understanding also enables us to address the overarching line of the inquiry. So, *how do the geopolitical interventions of offshore tin mining operations count and discount such benthic phenomena?* That is because the apparatuses of the offshore tin mining operations are benthic phenomena in this chapter as the sensing devices, mining navigators, and observed seafloor represent the inextricable relation between humans, technologies, ideas of the seafloor, event of sensing, and the seafloor. In this way, the apparatus of offshore tin mining operations provides geo-data crucial for determining whether the offshore tin mining operations are profitable for tax payment and CSR. Therefore, they count the role of mining navigators, sensing devices, and observed seafloor in producing such geo-data. However, the geopolitical intervention does not necessarily focus on the social and political issue of the observers (i.e., Thai migrant workers) as they only care about their roles in producing and mapping the seafloor and how such seafloor is imagined through such apparatus. With such understanding, the geopolitical interventions of the offshore tin recovery have focused on the product of the offshore tin recovery or tin-centric seafloor intervention.

Even though the apparatus of offshore tin mining operations is a benthic phenomenon, this understanding also leaves one question. *How do such benthic phenomena get entangled with the multi-scalar geopolitics of seafloor tin extraction?* The key to answering this is to understand how the geo-data (e.g., seabed tin deposit map, the estimated amount of tin ores, and the site of the tin deposit) produced by the apparatus of offshore tin mining operations have also reproduced another apparatus on multiple scales. For example, the tin exploration team produces the seabed tin deposit maps using their apparatus, such as SIOPL, sampling, and human senses (e.g., tasting and seeing). The tin deposit maps further become the guideline for offshore tin recovery. To confirm whether the estimated amount of the tin deposit map matches the actual tin production, mining navigators follow the tin deposit map as a way to locate and extract tin ores. When miners can produce tin ores higher or equal to the estimated tin deposit, such data are crucial for mining companies to pay corporate social responsibility, revenue taxes, and ITA memberships. This also means that the production of tin ores is useful for mining companies to negotiate the expansion of the seabed tin mining sites. For instance, mining companies can use the geo-data of tin ores as a way of communicating with other actors, such as business actors and provincial government, to invest and allow the extraction of seabed tin deposits. For that reason, each scale of the apparatus from tin exploration, offshore tin mining operations, and the decision on concession areas here relies on the geo-data of the tin deposit to facilitate or hamper the production of tin mining sites territory. Meanwhile, as mentioned in Chapter 1 and Chapter 2, the main purpose of geopolitics is to produce and defend a territory. Therefore, as apparatus is a benthic phenomenon and used by tin explorers, miners, mining companies, and governmental employees to produce and justify the expansion of the offshore tin mining territories, the use of the apparatus from offshore tin mining operations indicates that the entanglement between benthic phenomena and multi-scalar geopolitics. The multi-scalar geopolitics here consist of the geopolitics of miners in recreating the seafloor as tin mining sites and extracting this oceanic space and the geopolitics of mining companies, business actors, and governmental employees to enable the expansion of the seabed tin mining territories.

Concurrently, the apparatus of the offshore tin mining operations here does not exist without the multi-scalar geopolitics of the seafloor tin recovery. That is because the multi-scalar geopolitics of the offshore tin recovery, global, national, and provincial geopolitical also encourage the process of the seabed tin sensing and extractions through their ways of governing the flow of tin ores from tin miners to the end users, such as automobile and electronic device manufacturers. This understanding helps address the next inquiry of this research. *How does the multi-scalar geopolitics of seafloor extraction manifest benthic phenomena?* For example, whilst the ITA and OECD focus on governing the global tin supply demand through their mining standards (e.g., owning mining permits, paying governmental taxes, and submitting environmental impact assessments), complying with such geopolitical intervention demands producing more tin ores. This has to do with the fact that securing mining permits, tax payments, and EIA reports requires tin-based revenues. Therefore, such compliance with the global geopolitical interventions of the tin ores demands mining companies to survey and map the tin deposits that can generate revenues to follow such regulations. Additionally, the global geopolitical interventions of the ITA and OECD also interact with the provincial scale of mining area policies as outlined in PERDA (2020) and the national scale of the Energy and Mining Regulation (2018), given that the provincial and national geopolitical intervention of the tin ores also require the same mining standards (e.g., mining permits, tax payment, and EIA reports). In this way, the multi-scalar geopolitics of the tin industries from global, national, and provincial scales indeed manifests in the apparatus of offshore tin mining operations to generate tin deposits. To put it another way, these multi-scalar geopolitics produce benthic phenomena emerging from the apparatus of tin recovery.

As the apparatus of the offshore tin recovery is a benthic phenomenon, this insight also allows me to address the next research inquiry. *How do benthic phenomena redefine the meaning-making and territory of the seafloor?* That is because one understands how the apparatus of the offshore tin recovery, such as sensing devices, mining navigators, and observed seafloor, have transformed the seafloor from the material space, granular sediments, to tin ores through the process of sensing, dredging, and cutting the seafloor. In this way, the meaning of the seafloor has changed from oceanic space to geologic materials for the global tin industries. Additionally, as the process of sensing reduces the seafloor into digital seafloor simulation and mining simulation and literally, the material site of the offshore tin mining operations, this apparatus also redefines the territory of the seafloor as the territory of the offshore tin mining sites. Therefore, the apparatus of offshore tin extraction also enables offshore tin mining operations to secure access to the seafloor for their mineral extraction purposes. Meaning that through the generation of tin deposit data and their tin extraction practice, mining companies can also defend their mining sites from other marine users such as fishers and coral reef restorations.

Since the apparatus of the offshore tin recovery indicates the entanglement between mining navigator, sensing devices, and observed seafloor with the geopolitical intervention of the offshore tin recovery, such benthic phenomena provide the ecological understanding of the seabed in line with the argument of this monograph. Such ecological understanding here deconstructs essentialist views separating human and seabed, benthic habitats and geopolitics as the act of sensing in the seabed tin mining mediates such entanglement. In this way, my original and significant contribution to knowledge is even though the act of sensing the seabed in offshore tin mining operation is a location-specific practice, viewing this sensing practice as apparatus enables us to reveal the wider inseparable relation between human and seabed beyond the material site within which the practice of tin recovery is situated. This means that this chapter allows us to become sense-able on how the insensitivity of the benthic habitat degradation has been reproduced on the broader scales of geopolitics and how there exists co-becoming between geopolitics and the act of seabed sensing. Hence, we realize that the geopolitical intervention of the seabed cannot exist without the act of sensing tin ores, and vice versa; the act of sensing cannot also exist without the geopolitical interventions.

Chapter 5 Benthic bodies: From the seafloor to the seafloor

"*Their presence [feminist activists] ruptured the process that shaped where and whose bodies were worth rescuing*"
(Satizábal and Melo Zurita, 2021: 270).

5.1 Introduction

Whilst Chapter 4 previously presented how the apparatus of offshore tin mining operations has mediated the way the geopolitical interventions (e.g., OECD and ITA) of the offshore tin industries reshape the reality of the seabed into tin extraction sites, this chapter departs from these indirect ways of knowing the seabed toward the embodied experience of this oceanic space. By the embodied experience here, I mean being a bodily intimate presence in one specific site (Satizábal and Melo Zurita, 2021). In other words, human bodies touch and encounter the seafloor corporeally with their skins. Indeed, this chapter emerges from my mining ship ethnography, as explained in the previous chapter. On the ship, I encountered and observed over a hundred wooden floating rafts of tin diving operations surrounding the CSD mining ship on an everyday basis. In fact, wherever CSD mining ships operate, there exist tin diving operations. That is because tin divers follow wherever the CSD mining ships operate unless these large-scale seabed tin mining operations suction their tin ores from the sea depth of or below 25 meters. As the head of the mining ship explains, "[T]in ores are like sugar, mas [brother], attracting many people. We, humans, are the ants. That is why, if we [mining crews] find a site of tin deposit under the seabed, a couple of hours, there will be tin divers" (Head of mining ship, 2022: Interview on 26 June 2022). In this way, the existing tin diving showcases the inseparable relation between CSD mining ships and tin divers through the apparatus of the offshore tin mining operations (an explanation about the apparatus of the offshore tin mining operations is explained in Chapter 4). Both of these offshore tin mining operations, indeed, contest the notion of the seafloor devoid of human interventions because, in part, there exist human and seafloor relations emerging from the large-scale and artisanal scale seabed tin mining operations.

Witnessing a high number of offshore tin operations, during my ethnography, one can hear the sound of boat engines and see moving sediments everywhere. On the bridge, I remember that the mining navigator told me, "[t]here are so many *TI selam* (literally translated as tin divers), everywhere here, they dive in our concession areas" (Mining Navigator, 2022a: Interview on 22

June 2022). Going outside the bridge, I saw tin divers dove into the sea, dug, and suctioned seafloor sediments from the seafloor. The seabed sediments flow through their suction pipes to carpets, separating non-commercial sediments and tin ores. The flow of tin ores produced by tin diving operations here does not end at the material site of this offshore tin extraction. Instead, the tin ores here continue to the global tin market through the global tin supply chain, such as domestic tin collectors, international tin buyers, and high-end industries (see Chapter 1). While tin diving operations contribute to the global tin supply and demand, the Organization Collaboration for Economic Development (OECD) and International Tin Association (ITA) merely pay attention to governing the large-scale seabed tin mining operations. This has to do with the fact that most of the large-scale seabed tin mining operations possess mining permits and follow OECD and ITA mining standards (e.g., owning concession areas and using personal protective equipment—PPE), whilst tin divers do not. Therefore, the existence of tin diving operations and the way they operate to collect tin ores are often excluded from the global, national, and provincial geopolitical attention of offshore tin industries.

In response to this issue, this chapter focuses on analyzing the tension between current global, national, and provincial interventions such as OECD and MSP mapping policies and tin diving operations. This chapter argues that the nexus of human bodies, tin ores, and the volumetric space of the seabed in tin diving operations has become a crucial tactical point (Barry and Gambino, 2020) for many actors in creating their seafloor tin mining territory. According to Barry and Gambino (2020), the tactical point here means different actors can use the material relation of seawater, sands, plants, and animals to resist or assist state geopolitical projects. In the case of offshore tin mining operations, the volumetric space of seabed, tin ores, and tin divers can be used to enable and constrain the seabed access and secure the seabed tin sites, the territory of the global tin industries. That is because the provincial government, OECD, mining corporations, tin divers, and other mining actors depend on what I call the 'volumetric-bodily-geologic materiality' of the seabed in the tin diving operations to access tin ores and obscure their activities from public scrutiny. Revealing how the nexus of tin divers, tin ores, and the volumetric space enables and constrains the production of the seafloor tin mining territory, my significant and original contribution to knowledge in this chapter is that I have conceptualized the nexus of tin divers' bodies, tin ores, and the volumetric space of the seabed to shine light onto why these three factors are crucial in the geopolitical interventions of the offshore tin mining operations.

This analysis is crucial because it reminds us that tin divers are not solely flesh and bones but also bodies with a category (e.g., illegal mining) prescribed by the provincial, central authority, and OECD members. This chapter provides an understanding of the struggle of how their activities persist through time, given the broader geopolitical interventions of the seabed tin operations. This academic contribution specifically adds critical analysis of bodies and territory interplay in the current work of feminist new materialist geopolitical studies (Squire, 2021; Satizábal and Melo Zurita, 2021; Jackman and Squire, 2021). That is because the knowledge of this study expands feminist geopolitics to explain why and how the dangerous labor practices of tin diving operations are sustained and maintained by the current geopolitical interventions of offshore tin extractions. Analyzing tin diving from a geopolitical perspective here is also the first study ever conducted for the seabed tin mining operation issues off the Bangka and Belitung Islands in Indonesia. Meanwhile, whilst Chapter 2 has showcased the seafloor is not exterior to human bodies through the process of carbon and oxygen cycle the benthic habitats maintain, this chapter illuminates how the intimate relations of tin divers and seafloor indicate not only tin divers' bodies mediate our relation to the seafloor of the Bangka and Belitung islands through tin ores they produce but also how their bodies can literally become part and parcel of the seafloor in itself. Therefore, this chapter contributes to the main argument of this study to provide the ecological understanding of the seabed in the current new materialist geopolitics.

This chapter is divided into seven sections that underpin the main argument above. The first section (5.2) contextualizes the intertwined materiality of volumes, bodies, and geologies in tin diving within the new materialist geopolitics to conceptualize these factors as tactical points. Having the volumetric-bodily-geologic material approach for examining the geopolitical intervention of the seafloor tin extraction, the next section (5.3) revisits how the materiality of tin ores complicates the geopolitical governance of seabed tin mining in Indonesia. While this enables one to understand the flow of tin ores to the international tin market, understanding the materiality of tin ores here do not show how such global tin supply and demand depends on human bodies. For that reason, the section that follows (5.4) shows how the material and vertical arrangement of the physical space (the sea's surface, the water column, and the seabed) interacts with the hierarchical arrangement of human and tin ores. Of course, the notion of the vertical and material arrangement here only pay attention to the social hierarchy between male tin divers' bodies and tin ores. For that reason, to bring to the surface the role of women in tin diving operations and their relations with the seafloor, the next section (5.5) demonstrates how women also use their bodies as the tactical point to secure the seabed tin mining sites indirectly. Moving beyond the hierarchical and material arrangement of human and tin ores, the following section (5.6) explains why the volumetric space of the seafloor is crucial for geopolitical consideration in the seabed tin mining operations. This analysis showcases how the volumetric space of the seafloor is not an apolitical space. Instead, this oceanic space is a crucial tactical point to assist and resist the state-regulatory intervention on the seafloor. As the stream of the tin ores are also crucial for resisting the state regulatory interventions, the subsequent section (5.7) focuses on the material agency of the tin ores that allow miners to challenge the unfair taxation system in the current geopolitical intervention of the offshore tin mining operations. Ultimately, the last section concludes this chapter by linking the analysis to the line of overarching research inquiries (5.8).

5.2 Volumetric, bodily, and geologic materiality as tactical points in geopolitics

As mentioned in Chapter 1 and Chapter 2, new materialist interpretations of geopolitics have focused on examining how the materiality of a physical space. Given that the materiality of the physical space is used by mining actors (e.g., mining companies, tin divers, and even provincial governmental employees) to secure, defend, access, and produce the state and non-state territory, this means that the materiality of this material site is the hybrid between material and political agency. However, whilst analyzing dialectical relations between material and political agency has offered a new way of rematerializing the *geo* of geopolitics (Peters et al., 2018; Jackman and Squire, 2021; Sammler and House-Peters, 2023), there exists an epistemological debate on the use of the material (non-human) agency. That is because agency, "the capacity to act", is often considered "*a solely human property*" (Knappett and Malafouris, 2008: ix) as the agency is often considered strictly connected to a conscious subject and their intention to act (Barad, 2007; Yusoff, 2013).

The narrow scope of agency focusing only on humans comes about partly because such a formulation does not necessarily reflect how non-human (material) has agency in enabling, constraining, or imbricating political and human agency (Hickey-Moody, 2020). For that reason, understanding material agency requires expanding the scope of agency beyond human-centric subjectivity (Scott, 2009; Peterson, 2019; Dasgupta, 2021; Crane, 2021; Nowak and Roynesdal, 2022; Fredriksen and Kuhn, 2023). With a new scope for considering multiple agencies, diverse scholars often think with different material qualities of sites such as depth, height and volume, non-human bodies, and geologic materiality to understand how such physical properties are not just a backdrop of human-centric geopolitics but also can manifest as a way to control access to a physical space (Peters and Steinberg, 2019; Sammler, 2020a; Elden, 2021; Squire, 2021). Therefore, I utilize new materialist interpretations of geopolitics to analyze how the nexus of human bodies, volumetric space of the seabed, and tin ores have shared agencies in enabling, constraining, and complicating the territory production of the seafloor mining sites in this monograph and primarily in this chapter.

In Chapter 2, since rematerializing geopolitics offers geopolitical studies an understanding of the significance of physical spaces and landscapes such as mountains, atmospheres, undergrounds, and infrastructures for the processes and practices of state-making and colonial control, social scholars have utilized such a material analysis of geopolitics in the context of political strategies in a conflict and military campaigns. For example, Weizman (2004) argues that those who secure the underground and elevated spaces can control those within and without them from military and terrorist attacks, destabilizing the state sovereignty. Such control of the elevated space and the underground is possible due to the use of technologies that support the state to use and access the air and subterranean spaces (Wilke, 2017; Klinke, 2021). Meanwhile, reflecting on securing the 'area' during conflicts Elden (2013) provides a thought-provoking reflection on the relationship between height, depth, and power in subterranean and vertical territories by seeing an area as a volume instead of a flat surface. Following Elden's argument, Squire and Dodds (2019) also showcases how subterranean spaces inspire the development of the military bunker and the discharge of chemical agents as weapons to poison the underground water of an enemy. Inspired by the work of Sloterdijk (2016) thinking with a foam as interlocked territory, such a volumetric space can be employed as a military weapon as such used as poisonous gas during the world war. This means, as also argued in Chapter 2, that the materiality of the physical space is always entangled with the geopolitical project. In the seabed tin mining operations, the seeming neutral volumetric space of the seabed can also be utilized as a way of securing access for particular tin recovery practices while hampering other practices (e.g., coral reef restorations, fishing, and ocean use surveillance).

While the new materialist interpretation of geopolitics has been mostly the purview of combat and defense, other scholars have expanded the theoretical application of new materialism in geopolitics within and beyond the scope of state interests. For example, Scott (2009) has described how some terrains have particular materialities that can either assist or hinder a state's territory-making practices and colonial controls (e.g., taxable rice paddies in the valley versus camouflaged cassava plantings up the mountains). Squire (2021) also showcases how extreme pressure, temperature, and depth on the seafloor have resisted and complicated the production of state territory. More recently, Pauwelussen (2022) and Satizábal and Melo Zurita (2021) have demonstrated that non-state actors like divers can also utilize subterranean and seabed spaces for their own territory-making practices. This insight also means enacting alternative territorial practices beyond state reach that can open up another geopolitical understanding of the intertwined bond between gender and space. This is because certain spaces have been framed *"in masculine terms",* as a frontier to be invaded, attacked, and domesticated (Squire, 2020: 2). These works have demonstrated how such materiality of the physical spaces and non-human actors can come together to create a way of assisting or resisting hierarchical and dominant state geopolitical interventions over the physical space, yet there is still work to be done conceptualizing the role of material relations in geopolitics. That is because even though the analysis of the material relations of the physical space has shifted from terrestrial lands to offshore, the role of material relations on the seabed has gained inadequate attention on how they matter for geopolitical projects. In this way, Barry and Gambino (2020) assert that the material relations of seawater, oceanic depth, sands, seagrasses, and pipelines can disrupt or facilitate the state-geopolitical project by being deployed as a 'tactical point,' by different actors, as "subsurface materials acquire geopolitical consequence" (110). In other words, the subsurface materials not only have material agency but also political agency that is crucial for resisting and assisting certain geopolitical interventions. Understanding multiple material and political agencies of the seafloor, this chapter expands this analysis to understand how human bodies, tin ores, and volumetric of the seabed as part of the seabed materiality matters in the geopolitical intervention of the seabed tin recovery.

Building on feminist, volumetric territory, and social ocean studies in new materialist geopolitical studies, this chapter expands the concept of a tactical point as to how seabed spaces of invisibility are found or created at the nexus of volumetric space with embodied and material relations in the seabed tin mining. This means that different actors from the provincial government, central government, mining corporations, and tin divers utilize the volume-bodily-geologic materiality of the seabed as a tactical point to put the seabed to use for their mineral interests. In other words, the volume-bodily-geologic material approach in this section enables us to understand why the body of tin divers, the materiality and spatiality of tin ores, and the volumetric space of the seabed matters in the geopolitical intervention of the seabed uses. That is because these seabed material relations are a hybrid of material and political agencies. Meaning the tin divers' bodies, the tin ores, and the volumetric space of the seabed are not a mere physical property. Instead, the tripartite also has a political agency that defines whether one can secure and access the seabed. These three factors become the tactical point that may define whether the OECD and MSP can or cannot manage and govern the utilization of the seabed. In the following sections, the empirical findings of the research explain how such tactical points have materialized in seabed tin mining.

5.3 The geopolitical governance of the seabed tin mining in Indonesia

As mentioned in Chapter 1, Indonesia does not use tin ores for its domestic markets but instead relies on the international markets for tin export. As this mineral is explicitly an export commodity, Indonesian mining exporters and miners should comply with the standard mining practices set by the Organization for Economic Collaboration and Development (OECD). The OECD is an international organization comprising 38 member countries that commit to specific rules regarding trade and economic development. Specifically, using their mineral price framework, they set rules for metals extraction and trade that include not purchasing metals from dangerous mines nor those in conflict areas (OECD, 2022), shaping metal trades with impacts on their market price. Among their metal interests, OECD members are also focusing on governing tin mining. Tin is an important strategic metal for global electronic devices, automobiles, and weapons manufacturing, worth over 20,000 USD per metric ton (Tresiera, 2019). The mineral price framework of the OECD not only considers global tin demand but also whether tin mining complies with their personal protective equipment (PPE), safe working environment, and conflict-free mineral sourcing standards, shaping the global tin price and the domestic Indonesian tin price. To export tin ores from Indonesia to OECD members, Indonesia is presumed to comply with their standards (Ibrahim, 2015), which then fetch high prices from OECD members (e.g., international tin buyers and electronic device corporations) (Yulianti, 2020).

While Indonesian tin mining operations are obliged to comply with OECD mining standards to export this tin ore to OECD members, there are ways this mining compliance is subverted. For example, although the industrial-scale tin mining practices in Indonesia meet OECD standard mining practices, such as using PPE and having legal permits, artisanal mining, like tin diving, does not. That is because not only do tin divers cannot afford to pay the cost of PPE and legal permits but also, tin divers do not meet international and national mining standards (e.g., health and safety standards) (PERDA, 2020; OECD, 2022). However, large-scale mining companies and international tin buyers still purchase tin ores from such tin diving operations by buying tin ores from tin collectors, purchasing tin ores from tin divers, and shipping their tin ores and ingots from Bangka Islands to the OECD country members (see Chapter 1 for information on the importers of tin ores). Tin divers can also trade their tin ores to Singaporean and Malaysian collectors and mining companies there. In other words, even though Singaporean and Malaysian collectors have already passed and met the OECD standard practice assessment and possess mining permits, they can mix their tin ores with the tin ores extracted from tin diving operations (Marjaya, 2020). With such a complex chain of international tin collectors, ores collected from tin diving continue to reach the OECD members (Ranto et al., 2023). International tin collectors primarily prefer to purchase tin ores from artisanal tin divers since they can extract it from the seafloor without expensive technological and legal requirements, producing more affordable tin prices than their large-scale counterparts. That is because large-scale seabed mining must also pay revenue taxes and contribute to corporate social responsibility (CSR) payments (Jihan et al., 2021). This configuration of the legal and technological requirements has raised the large-scale seabed mining's operational costs and, thus, increased their tin price. Beyond just the price, purchasing tin ores from tin divers is more accessible, given the materiality of tin ore itself (Nugraha and Purwanto, 2020). That is because once legally extracted tin ores are mixed up with illegally extracted tin ores, the tin ores are then hard to distinguish through OECD's standard mining assessment to trace their origin.

Meanwhile, in addition to the physical property of the tin ores, regulatory intervention challenges also exist in governing and managing offshore tin mining operations in the field. With the current rising number of artisanal seabed tin mining activities, the provincial government only uses marine spatial planning (MSP) as a tool for governing activities offshore (see Figure 19). MSP, in this case, is a marine spatial policy designed, coded, and charted by the Department of Fisheries and Marine Affairs and implemented by the provincial government. It allocates seabed space for tin mining and other marine uses, such as the fishing of seabed-dwelling marine organisms (e.g., shrimps and sea cucumbers) and marine conservation. For instance, according to (PERDA, 2020), MSP determines the site of the seabed tin mining operations from 3-12 miles off coastal lines. However, this spatial regulatory intervention does not take into account the accessibility of the seabed sites for governmental surveillance purposes on the tin recovery activity. Meanwhile, the hard-to-access seabed hampers the enforcement of the MSP interventions because seabed properties often destabilize the assumed power of central and provincial state governments to control and manage the seabed space (due to depth) and the invisibility of the seabed depth defies direct governmental control and monitoring. A governmental employee (2022) confirms this argument:

> "We always think within our MSP team that our seas are flat; that is our limitation. In general, I understand that we have to see the sea and seabed as a volume because, indeed, it has depth and height. Current MSP does not consider this volumetric space as part of crucial consideration to govern the seabed and marine uses" (Governmental employee: Interview, 21st July 2022).

While the region's MSP map delineates explicit spaces of use and jurisdictions of control, the provincial government does not have the undersea water sensing technologies to detect the existence of tin diving operations nor to prevent mining accidents. Indeed, the provincial government employees could see floating rafts from the sea surface. However, given the enormous number of floating rafts and the dispersed spatiality of the rafts, the provincial government officers also do not have adequate personnel and boats to access, monitor, and enforce their mining rules for tin diving. This surveillance dilemma echoes the work of Peters (2017) and Nyman (2019), working separately, arguing that the sea's geo-physicality complicates the state intervention in monitoring marine uses (e.g., the mobility of boats and ships). As Peters (2017) argues: "[T]he challenges of surveilling mobilities at sea are different from those on land or air (although these spaces are often connected to the sea through processes of mobility and surveillance) because the sea has a particular legal, fluid and material composition" (1). Additionally, while surveying technologies can potentially increase the capacity of state-government surveillance, the ocean still offers a difficulty in ocean monitoring. As Nyman (2019) argues:

> “[M]any are optimistic about the potential for technology to prevent crimes at sea or marine resource theft, given that unmanned technological systems are cheaper and more accessible for states than traditional maritime coverage in manned ships. However, while these technologies may allow for monitoring, they do not solve the problem of enforcement, making it difficult to estimate their impact on resource theft and other maritime crime” (Nyman, 2019: 30).

Apart from that, as the provincial government considers tin diving illegal, given the non-compliance of the OECD’s personal protective equipment standard and their lack of mining licenses, the provincial government does not bother to stop the operation of tin diving operations. While the seabed's volumetric space complicates tin diving surveillance, this monitoring difficulty is further amplified by the geopolitical notion of “illegality”. For that reason, the volumetric space of the seabed, from the surface to below the sea, has arguably become an essential tactical point, especially for tin divers and buyers to resist regulatory intervention. Indeed, this tactical point emerges from the convergence of the material agency (e.g., volumetric space, tin ores, and tin divers) and political agency (i.e., the illegal label attached to tin divers' bodies). However, with the adversity in monitoring tin diving operations, mining corporations are enabled to employ tin divers’ bodies as extensions of their industrial extraction activities. Therefore, the invisibility of tin diving activities challenges enforcement by the Indonesian government (MSP) and international governance apparatuses like the OECD.

The complexity of governing tin diving not only comes from technical difficulties but also whether the current governance regimes should include their activities and accidents in legal reports. That is because, similar to the work of Klein (2022) on tin mining in Madagascar, formalizing tin diving can enable the state government to extract tax-based revenues from tin trade transactions while maintaining the dangerous activities that exploit miners’ bodies. For that reason, legalizing tin diving means tin divers’ bodies can still be exploited through governmental tax payments while they remain susceptible to working accidents (Ibrahim, 2015). Regardless of legalizing or not legalizing tin divers does not reduce the number of tin diving accidents, this situation demonstrates that the regulatory intervention only benefits the government in collecting taxes from tin trade transactions. Thus, the inability to govern tin diving contradicts and challenges the ambition of the OECD and MSP, as these geopolitical governance instruments aim to reduce dangerous mining practices and spatial conflict. Additionally, due to the lack of measures to reduce tin diving accidents, they have failed to address tin diving safety and conflict issues. However, despite this failure, the relationship between geopolitical intervention and tin diving operations through tin trade transactions and taxation systems showcases how bodily scales of tin diving and the global scale of geopolitics are connected by seabed space and the flow of seabed mineral resources.

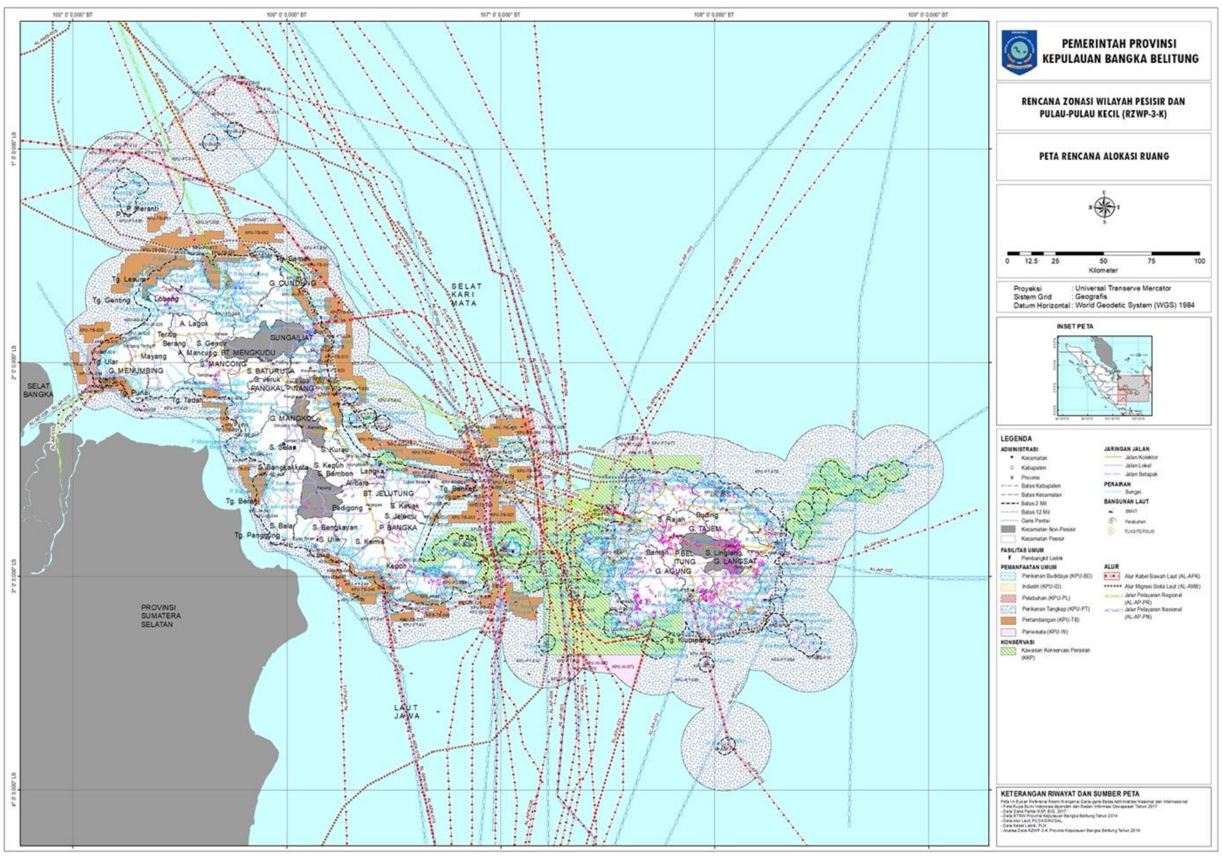


Figure 19: A flattened, two-dimensional map representing Marine Spatial Planning (MSP) off and on the Bangka and Belitung Islands (image credit PERDA, 2020). Details of MSP map codes: KPU-BD (aquaculture), KPU-D (industry), KPU-PL (seaports), KPU-PT (capture fish).

5.4 The material and vertical arrangement of bodies

Before the 19th century, as previously mentioned in Chapter 1, British and Dutch settlers depended on enslaved Chinese and Native Malay people to accumulate tin ores off the Bangka and Belitung Islands (Dunia Tambang, 2020; Erman, 2017). European settlers categorized enslaved people into a social hierarchy. The social strata of enslaved Native Malay people were lower than that of enslaved Chinese people, given that enslaved Chinese people could identify tin ores as opposed to *Kong* (Ancient Chinese language for bedrock) in seabed sediments. Even though the strata of the enslaved Native Malay and Chinese people were different, their bodies were both lower in the strata than the bodies of Dutch and British settlers and tin ores. This way of creating a dichotomy between which bodies are worth protecting and sacrificing echoes the work of Yusoff (2018) on Black Anthropocene, arguing:

> "[I]t is predicated on the presumed absorbent qualities of black and brown bodies to take up the body burden of exposure to toxicities and to buffer the violence of the earth. Literally stretching black and brown bodies across the seismic lines of the earth, Black Anthropocenes subtend White Geology as a material stratum (Yusoff, 2018: 11)".

In tin diving operations, the native Malay (brown bodies) encountered the seabed pits directly, exposing their bodies to the collapsing walls of the seabed. Such socioeconomic stratum manifested in a material and vertical arrangement as the enslaved Native Malay people were tasked with diving into the seabed pits, where enslaved Chinese people stayed at the sea's surface, charged with collecting the tin ores from tin divers (Research Diary, 2022). As my research diary on the museum of tin in Pangkalpinang on Bangka and Belitung islands in Indonesia explains:

> "Visiting the museum of tin (museum timah), I read the description and picture displaying a Dutch man in a white suite ordering enslaved Chinese people to identify seabed sediments. The sediments were collected by enslaved Malay people. Indeed, with the knowledge on the tin geology, Chinese people could have the privilege to check the quality of tin ores without diving into the seawater or the underground" (Research Diary: 23 April 2022).

Figure 20. The history of tin mining. The colonial power and the native Malay.

On the surface, enslaved Chinese people would wash the sediments to separate tin ores from sand and other minerals. They also tasted the clay with tongues to determine whether the divers had reached *Kong* (bedrock). Salty clay meant they could continue digging, whereas tasteless clay implied that they had reached bedrock. Geologically, this saline sensing worked because the bedrock's porosity is impenetrable to saline water and tin ores (Geologist, 2022: , interview on 15th July 2022). There are no tin ores below the bedrock, so it is no longer worth digging. After the tin diving operations, the enslaved miners gave the collected tin ores to the Dutch settler-owned companies such as Banka Tin Winning Bedrijf (BTW), Mijnbow Maatschappij Biliton (GMB), and Singkep Tin Explitatie Matschappij (NV. SITEM) (Ibrahim et al., 2018; Gunawan, 2019). Tin divers still continue the practice of detecting tin ores and bedrock as one Geologist (2022) explains:

> The first author: "I wonder how tin divers actually could identify the tin ores although they mostly do not go to formal school to study geology?"
> Geologist: "We [the Indigenous Malay] actually learn how to identify Kong and Tin ores from the knowledge of enslaved Chinese people about tin geology that is passed from generation to generation. Kong, in current geological knowledge, is bedrock. You could taste the clay collected by tin divers using your tongues. If it is not salty, it is Kong. Meanwhile, you could identify the tin ores from the black colour of tin ores and usually, tin ores could resist the water flow from the suction pipes" (Geologist: Interview on 15th July 2022).

With such geological knowledge of tin ores, many on these islands could partake in seabed mining. However, these days, to minimize the seabed tin mining operations' detrimental impacts on the marine environment, the provincial government obligates every tin miner and corporation to possess mining licenses (PERDA, 2020). However, most tin divers cannot compete to acquire the permits because private and state-owned mining companies own most concession areas. Without mining licenses, the provincial government labels tin diving as illegal. Marking their tin extraction as illegal, the provincial and central governments have made tin diving operations invisible to the administration. As Marine Ecologist I (2022) explains: "[G]iven that so many tin diving operations on Bangka and Belitung Islands in Indonesia do not have legal mining permits, the government does not record the number of tin divers" (Interview on 11 May 2022). A governmental employee (interview on 21st July 2022) also confirms this statement: "[W]e do not record any tin diving operations because it is not according to international mining health and safety standards; for mining corporations, if they buy tin ores from tin divers, they risk to destabilize Indonesian tin price".

This distinction between legal and illegal mining has created the assumption that tin ores exported worldwide from Indonesia are not coming from 'illegal' tin diving. This maintains the appearance of seabed mining that complies with OECD standard mining practices, allowing tin exports to this important market and stabilizing Indonesian tin prices. However, if the OECD acknowledged the trade between tin diving and large-scale tin mining operations, Indonesian tin exports would be jeopardized. While legal large-scale tin mining often complies with the OECD's PPE requirement, tin diving operations do not meet their health and safety protocols (OECD, 2022) because they lack the financial resources to purchase PPE and high-risk working environment.

Whilst the tin divers' bodies are excluded geopolitically through the rendering of them as invisible and 'illegal,' large-scale private tin mining operations have primarily relied on tin diving operations, given the cheap labor and affordable tin ores that tin divers produce (Environmental Sociologist, 2022: Interview on 24 April 2022). To supply tin ores to private tin mining companies, tin divers enter into the seabed pits and vacuum tin ores. However, this corporeal human and seabed interaction is not without consequences. Their bodies, while descending to and extracting tin ores from the seabed pits, can be buried by the collapsing seabed pit walls. Survivors often suffer psychological, physical, and physiological trauma. As Marine Ecologist 1 (2022) explains: "[M]any tin divers experience decompression sickness due to the long duration of diving [seven to eight hours per day]. It is the condition by which nitrogen residues flow excessively into their bloodstreams. Consequently, they mostly suffer from a heart attack, numbness (stroke), and hearing impairment" (Interview on 26 April 2022).

Moved by the lack of official tin diving accident reports, the Indonesian Forum for Living Environment (*Wahana Lingkungan Hidup Indonesia*, WALHI), a non-governmental organization, began collecting data. They reported that tin diving operations claim the lives of at least one hundred people per year, likely more than that in actuality (WALHI, 2022). To this end, what remains the same from the colonial era to the present moment is that through vertical and material arrangement, tin divers' bodies are made less important than the tin ores they collected. This has to do with the provincial government and mining corporations focused on collecting revenues and taxes from tin accumulations without consideration for tin divers' bodies recovering tin ores, often injured, trapped, and buried alive under the seabed (WALHI, 2022). The provincial government does not publish official reports on the number of current tin diving operations or their mining accidents. The non-profit organization WALHI recorded that tin diving can claim 100 lives annually, with many of them undocumented in the official governmental mining reports and their bodies are rarely recovered, becoming lost to the seabed pit, becoming part of it (WALHI, interview on 5th June 2022). Meanwhile, the narrative of illegality in tin diving has further become a tactical point for justifying the government's decision not to record tin diving accidents, excluding the already invisible tin divers' bodies on the seabed (WALHI, interview on 5th June 2022).

5.5 Women's bodies and the seabed intimacy: women's bodies as a tactical point

In the previous section, miners have argued that tin and seabed tin mining in general are men's work. However, such an argument has existed due to the dearth of attention and recognition of female contributions in seabed tin mining operations. That is, in part, because women have, in actuality, contributed to the practice of tin diving indirectly. As my research diary note explains:

> "[W]ives of tin divers have always got up early in the morning at 3 a.m. to prepare lunch boxes and beverages for their husbands, working in tin diving. They will bring the food at the sea harbor where their husbands are waiting for the food before heading to the seabed tin mining sites with their wooden boats" (Research Diary: 16 July 2022).

Such women's contributions to tin diving here are, indeed, indirect, yet they are vital for the practice of extracting tin ores from the seabed. This is because women sacrifice waking up in the morning and cooking for their husbands can sustain the operations of tin diving. This has to do with the lack of food sellers at sea, and given that tin diving is a physical practice requiring physical energy, food plays a key role for tin divers to recover tin ores from the seabed. This also indicates that while geopolitical interventions such as OECD and MSP neglect the existence of tin divers or mark them illegal and, thus, sacrificable, the wives of tin divers provide care for their bodies vulnerable to mining accidents. Indeed, this politics of care here echoes the work of Satizábal and

Melo Zurita (2021) on “bodies-holding-bodies”, arguing that care is political as one can decide who is worth caring or not worth caring for. In tin diving operations, as the provincial and central authority did not care for the tin diving operations especially through the lack of the mining accident documentation in tin diving operations, the wives of tin divers provide care to the bodies of tin divers. Beyond that, the relationship between tin divers, tin ores, and the seabed creates an extended relationship between women and the seabed. Thus, such interaction between women and the seabed are mediated by tin diving operations and vice versa, the interface between tin divers and the seafloor are also mediated by their wives.

Figure 21: the sea harbor where women gave a package of lunch to their husbands (tin divers).

The invisible role of women not only exist in the process of cooking and preparing meals for miners and tin divers but also in other relatively riskier roles. During the fieldwork, women also work as “preman” (literally translated as gangsters). Coastal communities call these women working on the coast Preman because they work in groups and visit the site of the floating wooden rafts. They offer food and sex services for tin divers. As the mining navigator said: “[B]e careful mas, many preman [gangsters] are here on this beach and at sea”(Research Diary, 2022: May 2022). The profession as *preman* exist given, culturally, only men working as tin divers and the seabed tin mining operations. Becoming *preman* allows these women to collect tin ores from the seafloor without physically diving into the sea. That is because they only want to get paid using tin ores for their food and sexual services. Perhaps this has to do with the price of tin ores, which is relatively more stable than the currency value of the Indonesian rupiah. As the tin diver I explain:

> "[P]reman here do not aim for money from tin divers. Their transaction is often done using tin ores. [In this way], they can collect one scope of tin ores. One scope here is as big as a half of a baby milk tin. Piling up a scope after a scope from one tin diving to another, they can get more than a kilogram of tin ores a day" (Tin diver 1, 2022: Interview on 26th April 2022).

By collecting a kilogram of tin ores a day, they could earn two hundred thousand rupiah. Indeed, this price of tin ores also depends on the international tin price forecast as mentioned in Chapter 1. Hence, women's bodies have become a tactical point for collecting tin ores from tin diving practices without diving into the seabed pit.

Such profession as *preman*, nonetheless, is equally as risky and exploitative as tin diving itself. That is because they can have sexually transmitted diseases and simultaneously have a negative stigma from society on land. Meanwhile, these women working are often invisible and occluded in the governance of the seabed tin mining operations. As such, their risk of getting sexual harassment, violence, and sexually transmitted diseases is also often unrecorded. Additionally, the sexual intimacy between *preman* and tin divers can also result in wider social issues and even affect other women. For instance, the sexual relationship between *preman* and tin divers can also break the relationship between tin divers and their wives. As the Indigenous fisher explains, "[s]ome of tin divers fall in love with those preman. They leave their wives and marry preman"(Indigenous fisher, 2022: Interview on 29 June 2022). Therefore, preman can also secure the seabed tin mining sites and collect tin ores by sacrificing their bodies and other women's bodies. This indicates that the interface between tin divers, tin ores, and the volumetric space of the seabed continues beyond the material site of the seabed. This means such human and seabed relations also reproduce the relationship between men, women, and other bodies. In this section, primarily, one understands that the female bodies of *preman,* I argue, become the tactical point that enables them to secure the territory of the seafloor tin mining operations indirectly through their ways of collecting tin ores with their bodies.

5.6 The volumetric space of the seabed as a tactical point

Whilst the bodies of tin divers and women become part and parcel of the geopolitical production of the seafloor territory, the volumetric space of the seafloor is often overlooked in such geopolitical considerations. Meanwhile, the difficulty in accessing the volumetric space of the seabed, as mentioned earlier in the previous section, indicates the volume of the seabed is also geopolitically entangled with the interest of tin mining actors (e.g., government, business, and tin divers). Indeed, this means that the volumetric space of the seabed is not neutral material space because it defines who can or cannot access the seabed, to what extent the regulatory intervention exists and ceases to exist, and who benefits from the access of the volumetric space. Whilst the volumetric of the seabed is political as it becomes part of the tactical point in safeguarding the seabed sites and their tin ores, in practice, such geo-political entanglement is rather implicit. That is because one may only see the process of the tin recovery using tin diving equipment as mundane and, as such, neutral practices. In other words, our sights are only orientated on the culture of men descending into the seabed pits. For example, Tin Diver 2 (2022) explains:

> "At 7.00 a.m., we, tin divers, descend to the seabed pits with the approximate width and depth of 15 and 18 meters, respectively. It is always scary to be in this hidden space yet, at the same time, the seabed pits provide us an opportunity to improve our livelihoods. Within this seabed space, we feel the water pressure and temperature (15°C), rocks, sands, and sea urchins with our physical bodies. We can only feel the physical properties of the seabed pits with our skins but cannot see as they are completely dark" (Tin diver 2: Interview on 20th June 2022).

While seabed access can often benefit mining corporations by not requiring them to collect tin from the seabed but instead relying on tin divers, this volumetric space here can be useful for different actors. That is because the seabed's volume and materiality can become tactical points for tin divers, mining corporations, and the governing authority to secure tin ores. The notion of who benefits from the seabed pits depends on how they use the volumetric space of the seabed, how they are used in larger mining markets, and the hierarchy of bodies in colonial relations. This echoes the work of Jackman et al. (2020) arguing that securing vertical spaces to survey and constrain mobility can be applied to tin diving operations because the provincial government uses the capability to control the mobility of tin divers from land, via legal taxation, to secure continued benefits from tin diving operations. Indeed, while, in the previous section, the provincial government excludes tin diving operations by labeling their bodies as illegal, the provincial government also obtains benefits from the existence of the tin ores produced by the tin diving operations. That is, of course, linked to the fact that the provincial government here does not have a singular voice regarding the practice of the tin diving operations. For instance, as the head of CSD ships explains:

> “[W]hile the CSD ships are legal, the provincial government has made the process of tin recovery for illegal tin mining operations less possible given their strict requirement concerning where to mine, for instance. However, they do not give much attention to tin diving operations. I know the existence of tin diving operations here, though illegal, are backed up by many military apparatus, governmental employees, and tin collectors. That is why they are rising in number. Therefore, if they are backed up by a five-star military general, we only have those stars in the sky” (Head of mining ship 2, 2022: Interview on 26 June 2022).

This statement indicates that certain groups of governmental actors also use tin divers' capability to access the seabed's volumetric space for their benefit by providing security for their activities. At the same time, tin divers can also share their tin revenues by paying the military apparatus. Therefore, apart from the legal taxation above, certain governmental actors also obtain benefits from tin diving operations through obscured taxation. I call this obscured taxation as the military apparatus from behind the scenes supports the existence of tin diving operations to derive profits from the culture of tin recovery using diving equipment. But, despite legal and illegal tin taxation here, the governmental actors also directly benefit from the inaccessibility of the seabed's volumetric space. This means that the volumetric space of the seabed also becomes their tactical point.

Figure 22: A tin diving member sitting atop seabed sediments mixed with tin ores on a wooden floating raft, holding a yellow breathing pipe (Personal documentation, 2022).

Tin divers stay in the seabed pits for about two to seven hours, either all in one go or diving up and down for several hours, depending on the pit's productivity. Once they recover tin ores, they must swim to the surface to rest and perform tin transactions with large-scale mining corporations on the coast. Meaning they return to land, where their activities are more easily regulated and controlled by the provincial government. Meanwhile, under the seabed, they can resist regulatory interventions by diving, digging, and extracting invisibly. Although they kick off sediment plumes as an outcome of their extraction practices, their invisibility showcases the difficulty of enforcing any regulatory intervention at sea. As the research diary explains,

> "From the mining ship, I asked the CSD operator, are they (tin divers) not working today? CSD operator replied they were still collecting tin ores. But indeed, they are invisible due to being under the sea. It is interesting, isn't it? We cannot see how chaotic and busy their work is on the seabed. However, from a governmental perspective, not only [do] they have difficulty controlling tin divers due to their numbers but also due to their hidden mining sites" (Research Diary: 22 May 2022).

Tin diver 1 (2022) confirms this note:

> "When I was under the seabed, it was *liberating*. Nobody, including the government officers and my wife, can tell me what I should or should not do. I can focus on listening to the flow of tin ores through my suction pipes; it makes me happy, though I know the risk of getting buried alive under the seabed can happen anytime" (Tin Diver 1: interview on 26th April 2022).

The liberation referred to here means that tin divers can escape family conflict and expectations given unstable economic pressures. In this way, they are willing to take risks in performing tin diving to prove themselves and even their masculinity. For example, tin divers have associated tin diving with the notion of 'the man's work' (Tin diver 1 interview on 26th April 2022). As Tin diver 2 (2022) explains, "Tin diving is a man's work. Not only because only men collect tin ores, but you have to accept also the uncertain dangers associated with this practice that make us a real man (interview on 22nd June 2022)". This finding echoes Melo Zurita's (2019) and Paulwelusen's (2022) arguments about how masculinity construction has been used to normalize dangerous underwater labor practices. The risk of tin diving is, primarily, getting buried by the collapsing seabed walls (Marine Ecologist I interview on 11 May 2022).

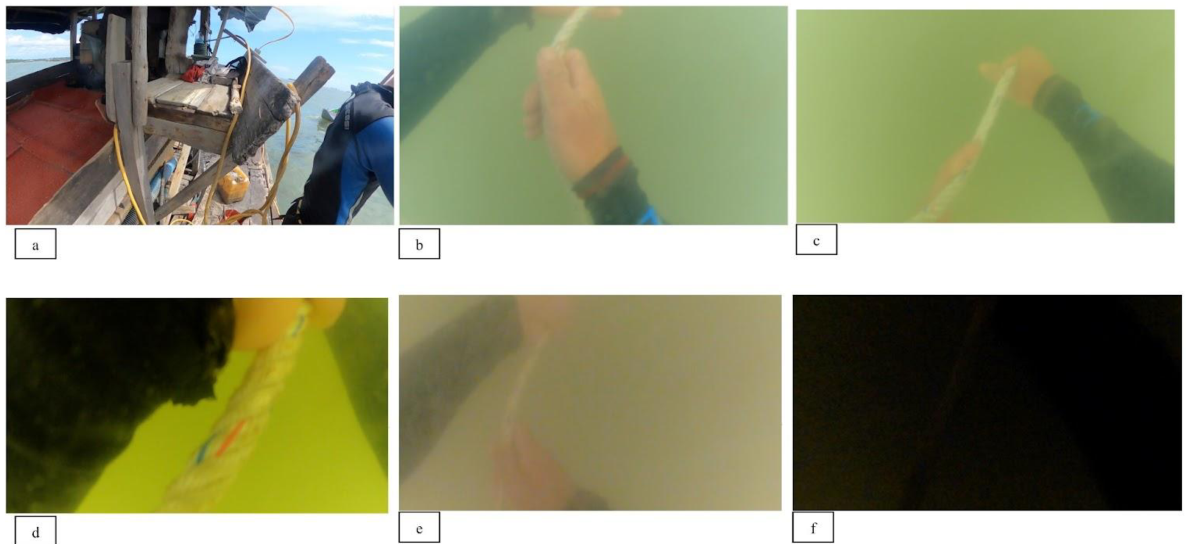


Figure 23: the process of descending into the seabed pit. a. wearing the wet swimsuit; b. using the rope to orient the diver's body to the seabed pit; c. green water; d. yellow water; e. milky water; f. a. water dark water (Personal documentation, 2022).

While tin divers are prone to be buried by the precarious wall of the seabed pits, they are also susceptible to exploiting the ruling bodies back on land. By focusing on generating tin ore tax revenue, the provincial government reduces tin divers' bodies into living tools to collect tin ores from an extremely hostile environment. Additionally, the volume of the sea can help the provincial government mask its incapability to minimize the number of mining accidents in the seabed pits because the pits are often invisible due to their depth and the opaque waters above, obscured by sediment plumes.

Figure 24: Tin floating rafts operating offshore Bangka and Belitung Islands (Personal documentation, 2022).

Given active tin removal in tin diving, the agency of the seafloor becomes activated by its various characteristics, such as depth, volume, and the materiality of the seabed pits. These variables can be harnessed to benefit mining corporations and central and provincial governments. But it also can become a space of resistance for tin diving operations because it is, in practice, ungoverned, allowing divers to extract an artisanal livelihood from the seabed pits. The depths and volumes under the sea challenge top-down political interventions due to the difficulties surrounding the control of seabed access. The provincial and central government often cannot access the unstable and undulating sea surface nor the seabed pits, let alone control the access of others. With this hard-to-access seabed site, tin divers can utilize these limitations as an opportunity to extract tin ores without rule enforcement and surveillance. For example, as marine ecology explains, "[G]iven the difficulty of accessing and controlling the seabed tin mining sites, tin divers can export the surplus of tin ore production using boats to tin collectors in Singapore and Malaysia without getting caught by the marine police" (Marine Ecologist II, interview on 26 April 2022). Therefore, whilst mining corporations and the government can use the material relation between tin divers, tin ores, and the volumetric space of the seabed as their tactical point to gain benefit from the seabed access, tin divers also deploy this tripartite to resist unfair tax system and also to find a better price of the tin ores from the international tin collectors.

5.7 Tin ores and their geopolitical complications

While the two previous sections have focused on embodied experiences and volumetric spaces concerning practices on the seabed (and links between them), tin ores must also be considered the tactical point in the politics of territory-making on and through the seabed. Tin ores within the seabed pits complicate the calculation of seabed tin deposits. This complication comes about because the alluvial tin ores follow the gravity rule: their molecular density (7.28 grams per cubic centimeter) is heavier than clays and sands (Taylor, 2014), sinking the ore deeper than the overlying materials. Tin ores situated deep beneath the seabed and combined with the fluid materiality of the sea resist straightforward state regulatory interventions and calculative tax estimations. This technical challenge of securing the seabed pit and calculating the tin reserve value has often posed a tremendous economic and ecological threat for the provincial government. They cannot secure the seabed space for either legal seabed mining or marine conservation projects. Yet tin divers and mining corporations can benefit because they are the actors that can calculate and access tin ores at the seabed.

In this respect, the relationship between the (in)accessibility of particular landscapes and the ability to resist state surveillance and intervention (Scott 2009), tin ores shrouded by multiple layers of seawater and seabed sediment, can sometimes help tin divers resist unfair regulation and taxing systems. This argumentation echoes the work of Peters and Steinberg (2019) on how the wet, fluid, deep, and churning quality of the ocean destabilizes a direct governance of the oceanic space. Meanwhile, I describe the process of charging the tin divers and tin collector transaction as an unfair system because it extracts resources for the state without the government providing services, such as safety in the offshore mining industry. Tin diving operations are also influenced more by the spatiality of seabed tin deposits in the seafloor than the surficial ordering of MSP maps. This is one of many ways that tin ores have material agency that shapes the politics of territory-making practices in marine space. As one mining corporation representative explains (2022):

> "[F]or all tin miners, regardless of the large and artisanal scales, we follow alluvial tin ores. Alluvial here means the stream or the flow of the tin ores…like a river of tin ores beneath the land. It flows from the terrestrial land and rivers to the sea. Theoretically, tin deposits in the terrestrial land and nearshore were exhausted, and thereby, we went offshore and deeper beneath the sea" (Mining corporation representative: Interview on 24th April 2022).

That said, the tin divers do not follow MSP maps, which assumes that tin divers do not go to fishing or marine protected areas off the Bangka and Belitung Islands. Instead, they follow alluvial tin ores regardless of their location. As the discussion with tin diver explains:

> Me: "[W]hat motivates you to dive and collect tin ores from the seabed? (in person)".
> Tin Diver I: "[Y]ou can say that it is because tin ores are our means of providing livelihoods to our families. So, tin ores have become our main motivations to continue diving as a means of providing a living to my family" (Tin Diver 1: Interview on 26th April 2022).

In this way, tin ore's value encourages tin divers to continue to dive, tin ores also perpetuate conflicts between tin divers and other marine users. The conflict here is urgent because it can involve verbal and physical violence between tin divers and other marine users (Mining corporation representative, interview on 24th April 2022). In addition, tin ores' existence changes the seabed's topography because wherever tin ores exist, and the depths are accessible, there will be tin divers and other seabed tin mining operations dredging and vacuuming the seabed. Thus, tin ores and seabed tin mining operations co-shape the features and geography of the seabed. The product of the tin ore and seabed tin mining operation co-production is the seabed pit in itself. Thus, the spatiality of this mineral challenges the effectiveness of flat geopolitics on the Bangka and Belitung Islands.

5.8 Conclusion

This chapter examines volume, bodies, and tin ores within the tin diving operations. Such an analysis provides a crucial geopolitical reflection of how the seabed has become a geopolitical site because it demonstrates how the material relation of tin divers' bodies, tin ores, and volumetric space of the seabed have become the tactical points in the politics of seabed territory-making. While a flat geopolitical approach such as marine spatial planning mapping policies and OECD occludes tin divers in their seabed interventions, examining tin divers' embodied experiences reveals how human, water, and ore bodies have been arranged vertically and materially, starting with British and Dutch colonial settlers, and still existing today. Of course, MSP and OECD are not, by default, geopolitical. Instead, as argued in Chapter 2, the marine spatial planning policies and mining guidelines become geopolitical given the fact that certain actors (e.g., provincial, central government, and mining companies) develop such policies hierarchically. The hierarchical development of such interventions means that the actors of MSP and OECD are not necessarily situated within the material site of the seafloor uses (e.g., offshore tin mining operations and coral reef restorations). Instead, they use the report about the activities to decide the regulatory interventions. This means the actors creating the MSP and OECD have power given their position and expertise to indirectly regulate the offshore tin mining operations; thus, miners in the field are assumed to comply with their interventions.

Meanwhile, aligning with the material world and bodies, this chapter showcases that the convergence of human bodies, tin ores, and volumetric space in tin diving operations contests such a hierarchical assumption on governing the seafloor off the Bangka and Belitung islands. This chapter even makes visible, or sense-able, tin divers' bodies, which are often left officially undocumented and ungoverned within the current regulatory intervention. Meanwhile, from the perspective of mineral extraction, the politics of making tin divers' bodies invisible are crucial for the provincial government and mining corporations that collect taxes and profit from their hidden labor. Removing and erasing tin divers from official record-keeping maintains the appearance of compliant seabed mining with OECD's standard mining practices and the stability of Indonesian tin price, though it also means normalizing the death and dangers of tin diving. If the provincial government reports the number of tin diving operations and their mining accidents, this evidence will undermine the Indonesian tin ore price because the OECD ideally only recommends international tin buyers to purchase from miners using PPE. However, the issues with tin extraction are complex because tin divers trade their ores to domestic large-scale mining corporations and tin buyers in Singapore and Malaysia.

This chapter has demonstrated the interface between tin divers, tin ores, and the volumetric space of the seafloor in this chapter is benthic phenomena emerging from tin diving operations. That is because, as mentioned earlier in Chapter 1 and Chapter 2, benthic phenomena mean measuring factors and process interacting with, related to, and associating with the seafloor that reconfigures multiple realities of the seafloor. In this case, the three factors such as tin divers, tin ores, and the volumetric space of the seafloor are measuring factors that reconfigure the reality of the seafloor. Of course, in this way, this understanding defamiliarizes us from our imaginations on what the inhabitants and the habitats of the seafloor are as tin diving operations exist on the seafloor and mediate our relations to the seafloor through their bodies and tin ores they produce. Such an understanding of such benthic phenomena that emerge from tin diving operations enables us to address the first research inquiry. *How does the geopolitical intervention of offshore tin extraction count and discount benthic phenomena?* In tin diving operations, indeed, OECD and the MSP consider the flow of tin ores from tin diving operations to the global tin market crucial given their geopolitical interventions governing the practice and spatial interventions of offshore tin extractions. This geopolitical intervention does not take into account the bodies of tin divers within the seafloor. Of course, the bodies of the tin divers here are benthic phenomena because they change the geo-physicality of the seafloor through suctioning using their rudimentary diving equipment. Additionally, their embodied experience also contests the notion of the benthic habitats are mere marine animals and their surroundings. Instead, as mentioned previously, they interact with the seafloor on a day-to-day basis and others even remain being part of the seafloor.

Moving from human bodies to tin ore bodies, the OECD and MSP also do not count how the stream of tin ores complicates their interventions in governing offshore tin extractions. That is because tin divers and miners follow the existence of the seafloor more than the seafloor space allocated by the MSP mapping policies. This means that when the interface between active streams of tin ores and tin divers is considered in the geopolitical interventions of the offshore tin mining operations, the fixed and static geopolitical interventions such as marine spatial planning mapping policies and OECD mining standards (e.g., owning mining permits and concession areas) can hardly govern the dynamic and complex interactions between tin divers and seafloor tin ores. Beyond geologic materiality and human bodies in tin diving operations, the volumetric space of the seafloor also becomes a benthic phenomenon. That is because the volumetric space of the seafloor challenges the idea of the flat seafloor imagined through the MSP mapping policies. Thus, the volumetric space of the seafloor produced by the offshore tin mining operations also reconfigures the reality of the seafloor. However, as the volumetric space of the seafloor is invisible and often accessible through mining technologies such as CSD and BWD in Chapter 4 and tin diving operations, benthic phenomena emerge from the volumetric space of the seafloor are often neglected or occluded from the geopolitical intervention of the offshore tin mining operations. Meanwhile, this chapter has demonstrated how the volumetric space of the seafloor also becomes a site of where and when the provincial and central regulatory intervention of the seafloor ceases to apply. This has to do with the fact that the volumetric space of the seafloor complicates the monitoring and control of the tin diving operations and the estimation of tin values beneath the seafloor. Thus, tin divers and mining companies can secure the territory of the seafloor as these actors can access this oceanic space.

Of course, such benthic phenomena such as tin divers' bodies, tin ores, and volumetric space are not a natural probe. Instead, they are entangled with the multi-scalar geopolitics of the seabed tin mining operations. This understanding helps to address the second research inquiry. *How do benthic phenomena get entangled with the multi-scalar geopolitics of the seafloor tin mining operations?* Indeed, as mentioned in Chapter 1 and Chapter 2, what makes the materiality of the seafloor geopolitical is the way state and non-state actors use the material qualities of the seafloor to secure, access, defend, and produce their seafloor territory. In tin diving operations, benthic phenomena have become a way of accessing and securing the territory of the mining sites. For example, while mining companies cannot access particular seafloor spaces, they use tin divers' bodies to access and recover tin ores from the seafloor. In this way, they use benthic phenomena emerging from the interface between tin divers and the seafloor to extend their mining territory. Thus, benthic phenomena of tin divers' bodies get entangled with the bodily and geological geopolitics of the offshore tin mining operations. The bodily and geological scales here refer to the bodies of tin divers and the tin ores the mining companies use to access and secure their seafloor mining territories.

Given the bodily and geological scale of the geopolitics here is also part of the geopolitical interventions of the offshore tin mining operations on a global scale. That is because the tin ores produced from tin diving operations also contribute to the global tin supply and demand through mining companies, domestic tin collectors, and international tin buyers. This insight enables us to address the third research question. *How does the multi-scalar geopolitics of the offshore tin extractions manifest in benthic phenomena?* To address this, one should realize that while the OECD does not take into account the existence of the tin diving operations, their OECD members (e.g., international tin buyers and mining company members) can purchase tin ores from tin diving operations. That is because, as this chapter explains, the materiality of the tin ore is complicating the separation between legally and illegally extracted tin ores. In this sense, as the OECD members have purchasing power to buy tin ores from legal mining companies and indirectly, tin diving operations, such geopolitical interventions of the OECD members manifest in how tin divers dive and risk their lives to extract tin ores, trace the location of the seafloor tin ores, and access the volumetric space of the tin ores. Therefore, the global geopolitical interventions permeate into bodily, geological, and volumetric scales of geopolitics in tin diving operations. Such connections between global, bodily, geological, and volumetric scales of geopolitics in tin diving operations, in turn, shapes the benthic phenomena of the tin diving operations to change the geophysical of the seafloor and sustain current dangerous labor conditions.

So, why does understanding the intersection between tin divers, tin ores, and volumetric space matter in this study? That is because these benthic phenomena from tin diving operations enable us to address the final inquiry. How do benthic phenomena redefine the meaning-making and territory of the seabed? As mentioned earlier, tin divers have experienced being buried alive under the seabed. Some of them can survive and escape from the precarious wall of the seabed. From these benthic phenomena, one can rethink and reimagine what the seabed means, as the tin diving accident has challenged the geopolitical construction of the seabed as mere tin extraction sites. Instead, reflecting on the convergence between tin divers, tin ores, and the volumetric space of tin ores, one can realize that the seafloor is also a site of livelihood for tin divers and tragically, even a site of undersea cemetery. As Chapter 2 indicates how our genes and amino acids imply our inextricable relation to the seafloor, this chapter demonstrates that tin divers become literally part and parcel of the seafloor. These benthic phenomena, theoretically, expand the work of Peters et al. (2018) on territory beyond terra. That is because whilst Peters et al (2018) expands the geo beyond earth ground to recognize other elements such as water, fire, air, and seabed as territory, this chapter indicates how the seabed through the benthic phenomena appearing from tin diving also consists not only water and land but also fleshy matter (the body of tin divers). Ultimately, as understanding benthic phenomena means understanding that we are the seabed, caring for the seabed here also means that one should also care for those tin divers trapped in the seafloor in search of tin ores for the global tin supply and demand. This means that part and sum of their tin ores also may flow to our everyday infrastructure including the computer I use to write this story of tin divers. Understanding this issue, of course, does not directly change the situation of tin divers. However, since understanding provides us knowledge on how geopolitical interventions often erase such mining accidents, the knowledge hopefully can inspire those readers to contest and challenge such structural violence that excludes the existence of tin divers' bodies in their benthic environment.

Chapter 6 Benthic defiance: the geopolitical understanding of sediment plumes

"*Language matters. Discourse matters. Culture matters. There is an important sense which the only thing that does not seem to matter anymore is matter*" (Barad, 2007: 1).

6.1 Introduction

The seabed sensing and extracting in Chapter 4 and the tin diving operations in Chapter 5 continuously and inevitably produce sediment plumes. That is because sensing and mining seafloor tin deposits also means producing these non-commercial fine particle sediments through dredging, cutting, suctioning sediments, and discharging tailing back to the ocean. While sediment plumes are mostly studied by physical science (i.e., marine science and oceanography) through the distribution modeling of plumes (See, for example: Spearman et al., 2020; Munoz-Royo et al., 2021), plumes produced by offshore tin mining operations are the intersection between physical and political. By political, I mean plumes create controversial knowledge, obscuring who is and is not discarding plumes and how plumes have been used as a way of resisting and assisting the territory expansion of offshore tin mining operations. As one Indigenous fisher at his cottage explained during the interview: *"*[D]o you know why sediment plumes are everywhere? I asked. He stopped and felt hesitant to reply. "It was because of the weather change (*perubahan cuaca*) or perhaps due to cutting suction dredger ship, tin diving, and tower dredging…I do not know. He laughed." (Research Diary, 2022, 26 April 2022). The mixture of material and political within plumes here echoes the work of Law (2019) on material-semiotic: objects are an interwoven thread that weaves together material (because they have physical properties) and meaning (because they are relational and/or carry meanings). Whilst plumes are, hence, mobile, shifting forms of matter that arise – literally – with the seabed tin mining, plumes are less popular than tin ores in the global, national, and provincial regulatory intervention of offshore tin mining operations. From OECD, ITA, and central and provincial mining regulations, plumes are not mentioned in their offshore tin mining interventions. Instead, their interventions only focus on producing generic mining governance interventions. As Marine Ecologist 1 (2022) mentions:

> "[O]ur environmental impact assessment (EIA), marine protected area (MPA), and spatial planning [concession areas] as well as corporate social responsibility (CSR) are [marine governance regimes] mostly based on land-based good mining practices. For example, they [provincial and central government] have now focused on restoring coral reef restorations in the previously mined seabed. However, they do not understand that plumes produced by offshore tin mining operations can travel beyond mining areas and enter restoration sites. From my experience, it is hard to cultivate coral reefs given the high turbidity of the water. Beyond that, coral reefs also cannot survive with the high turbidity" (Marine Ecologist 1: Interview on 26 April 2022).

While global, national, and provincial scales of geopolitical interventions have prescribed such mining governance regimes enacted globally, nationally, and provincially, this governance has assumed that complying with their mining standards means that the seabed tin mining operations and the seafloor are governable and mitigable. In this way, the governance of offshore tin mining operations produces static and linear assumptions of the seabed. This aligns well with the argument of Farrales et al. (2021), arguing that environmental regulations often function through reproducing discrete linear, static, and fixed space and time. For example, in offshore tin mining operations, offshore tin mining operations have concession areas. Under PERDA (2020), the Indonesian central and provincial governments define, control, and govern the size of the mining sites and the duration of mining operations. Despite the fact that plumes continue to exist even after offshore tin mining operations cease and can move beyond the target mining environment (Sammler and House-Peters, 2023), current social science communities have not examined how plumes contest such dominant geopolitical assumptions of the seafloor and offshore tin extraction.

This dearth of attention to rethinking plumes in offshore tin mining operations is partly because current social science literature concerning offshore tin mining operations still relies on a human-centric approach. For example, as mentioned in Chapter 1, Erman (2017a), Sulista et al. (2019), Rosyida et al. (2018), and Ranto et al. (2023), among others, only focus on the perception of the coastal communities and mining stakeholders on understanding the social conflict between the seabed tin mining operations and other marine uses. That is because, perhaps, their scope of conceptualizing agency, as mentioned in the previous chapter, is still centered on humans. However, in this regard, I do not argue that their work is not vital in producing knowledge of the offshore tin mining operations and their environmental impacts. Their scholarships have, indeed, contributed to the issues of the offshore tin mining operations. Instead, what I aim to argue here is that this social scholarship limitation not only leaves sediment plumes as the mere backdrop of their analysis but also makes one unable to highlight why plumes are removed in current regulatory interventions and what one can learn from plumes to re-imagine the seafloor and its environment beyond current tin-centric regulatory interventions.

In response to this lacuna, I conceptualize and utilize queer spatial-temporal-material approach informed by queer feminist ecology scholars (Ahmed, 2006b; Mortimer-Sandilands and Erickson, 2010; Barad, 2011; Neimanis, 2018) to examine how spatial, temporal, and material dimensions of plumes deviate from a straight and fixed imagination of the ocean and seafloor prescribed by offshore tin mining operation governance. Analyzing the tension between the spatial-temporal-material dimension of plumes and the governance of offshore tin mining operations, this chapter argues that sediment plumes *queer* the dominant discrete fixed and straight assumption of the seafloor and ocean constructed and enacted by global, national, and provincial regulatory interventions through good mining standards. In this chapter, I use '*queering*' in reference to subverting normative, essentialized knowledge, embracing that this term offers the potential for '*radical critique'* (Hunt and Holmes, 2015: 156). For that reason, in this chapter, plumes have become a source of radical critique on the governance of offshore tin mining operations that exclude plumes to make the responsible appearance of offshore extractive industries (Barry, 2010). Revealing how plumes challenge the accepted knowledge of the seafloor tin mining operations, my original and significant contribution to knowledge is that I expand the queer concept to explore the material and political agency (see Chapter 1 and Chapter 5 on what agency here means in this study). This academic contribution is crucial because this approach encourages social scholars studying offshore tin mining operations to pay attention to not only human but also non-human actors as a way of analyzing the issue of sea and seafloor use. Beyond that, empirically, this chapter also provides critical feedback that might be used by policy-makers to consider plumes in their governance regimes, including exposing a crucial challenge of how to reduce plumes.

To underpin the main argument above, I divide this chapter into seven sections. The first section (6.2) introduces why this chapter is crucial in response to the lacuna of the social science perspective on plumes. The next section contextualizes sediment plumes in current queer feminist ecology studies. As current queer scholarships focus on queering spatial binaries between marine death and life, queering ocean colour, and queering oceanic linear time, using these themes, I develop a queer spatial-temporal-material approach to analyze these dimensions of plumes. Before using such queer approach, in the subsequent section (6.3), I revisit what plumes are and why considering plumes matters in the offshore tin mining governance. Understanding why plumes matter, the next section (6.4) reflects on where plumes originate from.

Concurrently, in the following section (6.5), this analysis focuses on how plumes challenge and deviate from oceanic linear time embedded in the concession areas of offshore tin mining operations. This is crucial to highlight how plumes complicate the current governance of offshore tin mining operations. Meanwhile, as the seabed tin mining operations have been deemed to represent blue growth initiatives (BGI) ambition in itself, (Ciptono and Cahyacipta, 2021) given their national economic contribution (see Chapter 1), the next section (6.6) reflects on how plumes produce sea color gradation, resulting in revenues generation in offshore tin mining operations and economic loss in shrimp fisheries. Thus, in this sense, plumes queer the straight assumption of "blue" and "economic growth" in blue growth initiatives. Beyond queering linear assumption of oceanic time and color, the subsequent section (6.7) demonstrates how plumes queer the spatial binary between life and death as plumes provide nutrients to pelagic species and deadly conditions in coral reef habitats. This understanding is crucial because one can understand that plumes can underpin offshore tin mining operations resistance and assistance. Ultimately, the last section (6.8) concludes why and how plumes offer multiple ways of imagining ocean, sea, and seafloor relations and links to the research questions in this dissertation.

6.2 Contextualizing plumes in current queer ecology and governance

Whilst there is ample literature that challenges the status quo of existing governance regimes, demonstrating their Western embeddedness and offering radically relational understandings for how oceans and life coalesce, here often from decolonial scholarship (See for example:George and Wiebe, 2023), I contend that queering may be useful means by which to further upend 'accepted' knowledge of, in this case, what the seabed is, and hence, how it is governed (see Conde et al. 2019). In offshore tin mining operations primarily, I argue that a straight and fixed line of space, time, and matter manifests in the linear and stable notion of mineral exploitation control, economic contribution, and coral reef restoration through concession areas, tax payment, and post-mining restoration requirement. While governance can mean many things, I refer to the term governance based on what Peters (2020) argues:

> "[G]overnance refers to a process of deciding, managing, controlling, and organizing a set of activities...an art or a practice of governing that is not wholly top-down but rather involves 'a wide range of actors in the production of policy outcomes including NGOs, private companies, pressure groups, and social movement as well as those state institutions traditionally regarded as part of government. Governance [hence] is complex" (Peters, 2020: 1).

The way governance regimes of offshore tin mining operations maintain the practice of tin recovery industries above echoes the work of Liboiron (2021) on pollution is colonialism: "[C]olonialism is a set of specific, structured, interlocking, and overlapping relations that allow these events [sediment plumes produced by seabed mining operations] to occur, make sense, and even seem right to some" (16). However, since sediment plumes defy 'good' mining standards above because they spatially extend and materially exceed the defined parameters of governance, plumes queer the discrete notion of seabed space-time-matter enacted by environmental governance. Thus, plumes caused by offshore tin mining operations represent the notion of queer nature.

Speaking of queer nature, Barad (2015) argues that queer nature refers to how nature defies the logic of a fixed line (linearity): "[A] queer origin, an original queerness [queer nature], an original birthing that is always already a rebirthing. Nature is birthed out of chaos and void, tohu v'vohu, an echo, a diffracted/differentiating/différancing murmuring, an originary repetition without sameness, regeneration out of a fecund nothingness" (393). This argument echoes the origin of plumes as these fine particles also birth out from chaos between mining and marine uses due to the dissimilar and similar constructions of plumes and what they do to the environment. In this way, as the queer nature of plumes has the capacity to contest certain linear construction of nature, I refer the notion of queer here to the work of Sarah Hunt and Cyndy Holmes (2015), arguing:

> "[W]hile queer is often used as an identity or umbrella term for non-normative sexual and gender identities, it emerged as a critique of the essentialist constructs and identity politics. As a verb, queer is a deconstructive practice focused on challenging normative knowledge, identities, behaviors, and spaces, thereby unsettling power relations and taken-for-granted assumptions. Queerness is then less about a way of being and more about doing and offers the potential for radical critique" (Hunt and Holmes, 2015: 156).

To put it simply, essentialist constructs mean that material entities such as space and bodies are assumed to have specific normative attributes that appear to be naturalized.

To challenge the essentialist construction of nature, current queer ecology scholarship has expanded the use of queer to think alongside non-humans (Garvey, 2012) to challenge normative knowledge and politics. According to Mortimer-Sandilands and Erickson (2010), "queer ecology suggests a new practice of ecological knowledge, spaces, politics that places central attention on challenging hetero-ecologies [nature/culture, politics/environment, and bio/geo divides]" (20). This understanding also means acknowledging relations between ontology and epistemology, in which, in this case, a researcher (culture) and their observed object (nature) are entangled to form certain knowledge. For example, Hazard (2024) thinks with the unruliness of river underflows to resist the colonial settler knowledge that normalizes the practice of industrial pollutant discharge on the river's bed, affecting the Indigenous communities living next to the river.

Such a queer approach has currently transcended the landscape toward seascape. The current queer work has contributed to conceptualizing queer materiality of the sea and the seabed. In this matter, Barad (2015) offers an understanding of why the quality of matter is queer, arguing: "Matter is promiscuous [alive and dead] and inventive [multiple im/possibilities] in its agential wanderings: one might even dare say, imaginative. Imaginings, at least in the scientific imagination, are clearly material [given material exploration of the mutual indeterminacies of being and time]" (387). As such, what makes matter queer is that it opens up different possibilities of interpretation rather than fixed and linear interpretation of the matter. For example, while marine biologists have focused on understanding the asexual reproduction of cup corals in their experiment, Hayward (2010) has reinterpreted the asexual reproduction of cup corals to contest the essentialism of nature, separating natural and non-natural reproduction in everyday life. Beyond this work, offering political perspectives on the visible and untouchable queer materiality of the sea, Cohen (2013) reflects on sea color gradation made by deep-seabed bioluminescent organisms to unsettle the idealized green color that inheres in the notion of nature. As such, since plumes also create the sea gradation, implying diverse impacts on marine uses and life, I also argue that plumes can offer a way of deconstructing and challenging dominant stable and linear imaginary of blue and growth in the blue growth initiatives ambition. Even though attending to the queer materiality of the seabed highlights the diverse colors of nature beyond the essentialist construction of green nature, other queer works also focus on queering space and matter *spatiality*. Queering spatiality here refers to contesting the uncontested notion of space (Oswin, 2008). In seabed mining, for instance, Conde et al. (2022) argue that the definition of the seabed has become an accepted knowledge, despite that the fixed quality and oceanic quality of the seabed challenges the current definition of the seabed that centers on the fixed quality of the seabed. In this way, since plumes move many places and times, plumes offer a way of contesting this dominant notion of this oceanic space.

Whilst the queer spatiality can also be understood by how the volcanic seamount eruption and sea level rise event can transform terrestrial land to the seabed and vice versa, the seabed to terrestrial land (Hawkins, 2018; Sammler, 2020), different scholars also focus on the social construction of spatiality, especially in establishing a boundary between live and dead non-humans (Yusoff, 2013).The politics of death and life dichotomy here are not uncommon political strategies for mineral extractivism and marine conservation (Zalik, 2018). For example, seabed minerals are considered dead matter and, thus, are allowed to be exploited, yet the boundary of the dead from life often neglects that seabed minerals exist with living benthic animals (Childs, 2018). Such a political assumption often decides whether non-humans are worth rescuing or killing (Fry, Marino, & Nijhawan, 2022). Especially, the politics of death inserted into geologic material has often been put to use to normalize the exploitation of the minerals, arguing that dead minerals are sacrificable for the sake of human well-being (Yusoff, 2018). Pushing back on the politics of life and death, Hayward (2012) reflects on the immortal colony of jellyfish polyps (*Turnitopsis dohrni*) attached on the seafloor, budding off genetically identical clones (e.g., polyps and medusa), deviating from the death and life dichotomy. This means that as an integrated system, both live and dead matter are crucial in benthic habitats and even the earth's planetary system. In seabed tin mining, since sediment plumes hinder sunlight penetration and smother benthic habitats and, at the same time, provide organic and inorganic compounds for the phytoplankton population, sediment plumes also deviate from the dichotomy of life and death. Thus, I argue that considering how sediment plumes create living and dead conditions can also align well with the current queer ecology work on queering life and death dichotomy.

Beyond the queer spatiality, queer scholars have focused on rethinking the temporality of the seabed to challenge the dominant linear temporality of space used to manage ecological impacts. Since time has been constructed as a linear progression of past, present, and future time to render certain events predictable, queer temporality challenges such a linear notion of time and embraces the uncertainty and unpredictability of oceanic temporality (Neimanis, 2018). For example, given that constructing a future ecological disaster has become a hegemonic idea in seabed uses, the construct of disaster temporality has normalized the ongoing ocean degradation (Sammler, 2020b; Radomska and Åsberg, 2021). To decenter such a politics of futurity (Sammler, 2020), Braverman and Johnson (2020), for example, reflect on asexual sea slugs' slow metabolism and movement to slow down the fast-paced time of nascent environmental impact assessment (EIA) implementation used for permitting offshore extractive industries. The queer temporality shares a commonality with zombie studies. While, indeed, the zombie metaphor has been vastly interpreted in cultural theories and academics, Vervaeke et al. (2017) argue that: "[t]he zombie is a versatile enough symbol to stand for many kinds of human defilement, the symbol ultimately draws its aptness from being a perversion of the Christian mythos of death and resurrection, and that most of its traits and features have emerged from, and harken back to, the matrix of the Christian worldview" (Vervaeke et al., 2017: 10). Building on the work of Vervaeke et al. (2017 and queer scholars, Mayo and Miah (2021) argue that the zombie metaphor allows us to capture how colonialism and racism, despite their dangerous and violent implications, continue being reanimated and reproduced through time. In this way, as tin recovery often mixes the already-settled (past) sediment plumes and current (present) sediment plumes, the temporality of sediment plumes also echoes both queer time and zombie. Thus, plumes continue to exist through time and contest the temporal boundary, isolating the past from the future and present.

Understanding how current queer scholarships queer spatiality, materiality, and temporality of the benthic environment to contest normative and essentialized knowledge of the environmental governance above, we argue that current queer scholarship here informs our queer spatial-material-temporal approach in this chapter. In this way, I argue that attending to the governance of offshore tin mining operations via a queer spatial-material-temporal approach makes it possible to think alongside plumes to contest the dominant construction of the seabed tin mining sites. I am inspired to use this queer approach in relation to the plume to make better sense of how environmental governance regimes are too *rooted* in their own constructions. The next section deeply explains what sediment plumes are and why thinking alongside plumes matters in the current governance intervention of offshore tin mining operations.

6.3 What are sediment plumes and why thinking alongside plumes matter in current offshore tin mining operations governance

Sediment plumes are organic and inorganic materials produced by ocean mixing and the process of mineral extraction. In seabed tin mining, for example, as tin removal processes require removing multiple layers of seabed to reach the target ore, such a culture of digging, cutting, and suctioning (hovering) minerals produce more sediment plumes than tin ores (Puspitawati, 2018). Since plumes are fine and light particles, Sammler and House-Peters (2023) argue plumes results in two fluids of different momentums, densities, and viscosities. Interested in such material characteristics of plumes produced by seabed tin mining operations, Sagita et al. (2023) measure plumes' size using a separation device, so-called "shieve shaker". They documented that the size of plumes off the Bangka and Belitung islands is about 0,063 mm. However, indeed, such size also depends on the capability of the instrument and the observer who observes and notes the diameter of plumes. In other words, plumes smaller than the capacity of this measuring apparatus may not be able to be documented. Meanwhile, since the weight of plumes also defines the temporal settlement and dispersal of plumes, Rachman et al. (2021) provide information about the weight of plumes. According to them, the weight of plumes is roughly around 50 micrograms. Continuing the work of Rahman, Ambalika et al (2021) record that the settlement velocity of these medium-weight plumes is about 1.9 ml/hour. This means it takes one hour for 1.9 ml of plumes to settle on the seabed. While current studies here do not explain how deep and height plumes can disperse, as the tin recovery operates at the depths of the sea from 15-60 meters (Ranto et al., 2023), plumes may traverse the seafloor, water column, and ocean surface in-between this depth.

Given their emergent and moving characteristics, plumes contradict assumed knowledge of the seabed constructed by the governance of the seabed tin mining operations. That is because while the governance intervention constructs the seabed as static, fixed, and linear as a space-time-matter (see Peters 2020 on the flat approaches of managing deep sea mining) through dividing and allocating the seabed with marine zonation planning policies and mapping, sediment plumes deviate from such a geopolitical imaginary. In practice, for instance, even though the concession area designated for mining (*Wilayah Izin Usaha Pertambangan*—WIUP) can last over 30 years, depending on tin productivity (PUSHEP, 2020), Sagita et al. (2023) showed that given the ocean mixing process, sediment plumes can continue to exist *even after* the seabed mine ceases to operate. For instance, since most mining sites are on previously mined seabeds (post-tin mining sites), which have been mapped and exploited since Dutch and British colonial tin controls, extracting tin ores from these locations means mixing the already settled plumes with the present plumes.

Beyond such temporal and spatial complexities, sediment plumes can extend over sixteen miles beyond the footprint of a stated mining site (Sari et al., 2022), creating sea color degradation and affecting benthic habitat health (e.g., shrimps, shellfish, and coral reefs) in the site of coral reef restoration. Yet, they can also provide food to pelagic species (Syari and Nugraha, 2022) because sediment plumes contain organic and inorganic materials important for primary production (phytoplankton), which further move through the food web. In this way, sediment plumes are also beneficial for pelagic fish species (Al-Risqia et al., 2021). However, despite the fact that sediment plumes challenge regimes of typical terrestrially-inspired governance, these fine particles are not considered in regulatory interventions. For example, current environmental impact regulations do not provide seabed plume impact mitigation and assessment guidelines (PLHK, 2021). Indeed, not including sediment plumes in written governance interventions not only stabilizes the process of tin mining and understanding of the seabed (see Conde et al. 2019), but also indicates environmental governance relies on fixed, area-based, zonal demarcations of marine resources and lands (Peters, 2020). Therefore, thinking alongside sediment plumes is crucial to reorientating views beyond just tin-centric economic interventions toward sediment plumes-centric interventions and from bounded and static notions of what constitutes the seabed to a more dynamic understanding. While this section explains what plumes are and briefly mentions the relationship between plumes and seabed tin mining operations, the next section dives further into the origin of plumes.

6.4 The queer origin of sediment plumes

On 5th June 2022, I visited the headquarter of WALHI, the non-governmental environmental organization working on land and sea environment protection. I was accompanied by a sociologist from the University of Bangka and Belitung Islands. The clock showed that it was at 11.00 in the morning. After having a free cup of sweet tea, the secretary called the director of WALHI to discuss it with me. In the discussion, he explained the struggle of resisting the expansion of offshore tin mining operations. Especially, his concern was about the current expansion of offshore tin mining operations. That is because the offshore tin mining operations slowly changed the marine environment. As he explained: “[W]e have tried to discuss to the provincial government and set up a multi-stakeholder hearing to postpone, review, and moratorium the current rising number of large-scale and artisanal seabed tin mining operations”(Interview on 5th June 2022). Even though they have tried to advocate the Indigenous fishers’ concerns on the provincial and regulatory intervention of current offshore tin mining operations, the expansion of the offshore tin mining operations continues. In the discussion, I also asked him about his view on the rising amount of sediment plumes off the West Bangka. He replied that “sediment plumes. We really indeed obtain many reports from the Indigenous fishers concerning the increasing turbidity of their seawater given the rising plumes caused by offshore tin mining operations” (Interview on 5th June 2022). However, the most challenging part of managing sediment plumes is also about the origin of plumes. As he explained:

> “[A]s you drove there in Belinyu [he pointed to the Bangka and Belitung Islands map on his office walls], you also saw that land tin mining and river tin mining are still occurring in this tin mining prevalent area. Indeed, tin mining in rivers and on land also causes sediment plumes. Sediment plumes further end to the ocean. Meanwhile, the offshore tin mining operations continue operating, and they continue producing plumes. Here, in the sea of Belinyu, for instance, is the meeting point of plumes from river, land, and sea. This means that sediment plumes from different locations mix in this sea. It increases the turbidity of the sea. We don't know how much sediment plumes can be cleaned up.” (WALHI: Interview 5th June 2022).

This explanation enables us to reflect on the queer origin of sediment plumes. That is because sediment plumes caused by the land, river, and seabed tin mining operations challenge the dichotomy between land, river, and seabed by how sediment plumes continue flowing to the ocean. Since, of course, one cannot distinguish whether sediment plumes come from the river, land, or sea, especially once sediment plumes unify and assemble in the ocean, this means that sediment plumes from river and land have also complicated the way of knowing whether the sediment plumes caused by offshore tin mining operations, land tin mining operations, or river tin mining operations.

Figure 25: Belinyu Sea: the meeting point of sediment plumes from lands, rivers, and sea

Even though such issues sound trivial, in practice, the queer origin of sediment plumes here also means that the offshore tin mining operations can use such confounding origin of plumes for their benefit. As the WALHI director argues: "[I]ndeed, sediment plumes not only make the sea murky. But also, it…makes..one cannot blame the offshore tin mining operations as they also argue that the sedimentation and turbidity of the sea also exist in the sea also given the practice of tin recovery in land and river" (Interview on the 5th June 2022). In this way, the queer origin of sediment plumes also recreates the hindrance for the activist resistance to the seabed tin mining operations.

The queer origin of sediment plumes here, I argue, not only complicates what we mean by the seabed because the existence of sediment plumes has indicated that plumes not only seep through the water column and sea surface but also seep through land, river, and sea. This reflection on plumes here echoes the work of Hawkins (2020) and Sammler (2020c) on where the seafloor ends and begins as the undersea volcanic eruption creates lands and the sea level rise turns lands into the seafloor. The hard-to-distinguish land, river, and sediment plumes have also added to the dynamic relationship between land, sea, and seabed. However, beyond that, the most important thing is to understand how such queer origin of the sediment plumes here has also provided the geo-political justification for the existence of offshore tin mining operations. That is why plumes are a hybrid of material given their physical and oceanic qualities, and politically given plumes are used to justify offshore tin mining operations. Understanding the queer origin of plumes, the subsequent section showcases how time (queering linear oceanic time), space (queering death and life), and matter (i.e., queering ocean color) of plumes contests normative construction of the seabed constructed by the governance of offshore tin mining operations off Bangka and Belitung Islands in Indonesia.

6.5 Plumes as deviations from linear temporality of mining concession areas

The governance of the offshore tin mining operations controls, monitors, and manages the temporality of the seabed tin mining operations with a discrete straight line of time from when the mining permits are given to when the mining should end. For instance, at the Department of Marine Zonation in Jakarta, a Ministry of Marine Affairs and Fisheries representative explained the importance of considering the temporality of sea space in current marine zonation planning, explaining:

> “[W]hile we are thinking that governing the utilization of the seabed including seabed mining is all about spatiality, in actuality, it is also about their temporality. By temporality, I mean that we have to understand whether, under certain sea weather, seasons, and high waves, they move to other mining sites. And how long we give them permission to mine the seabed” (The Indonesian Ministry of Fisheries and Marine representative: Interview on 5 August 2022).

However, this governmental representative did not discuss the temporality of sediment plumes that cause spatial conflict and violence between Indigenous fishers and seabed miners in the field. According to Sari et al. (2022), the temporality of sediment plumes is different than the temporality of seabed tin mining as plumes can move beyond the temporal remit of mining concession areas and exist long after the mining operations cease to operate.

Given the unruly temporality of sediment plumes and their impacts on the surrounding area, environmental government officials and NGOs on Bangka and Belitung islands often frame sediment plumes as “a future ecological disaster”. This is to raise awareness of sediment plumes’ impacts in the hope of reducing the seabed mining operations and sediment plumes in the oceans. As Marine Ecologist 2 explained:

> Official: “In the future, Bangka and Belitung Islands will be sinking”.
>
> Me: “Please enlighten me on what you mean by sinking”.
>
> Official: “Since the COVID-19 pandemic, politicians, local people, and international tin buyers have invested in offshore tin mining operations, buying more cutter suction dredgers (CSD). The rise of the seabed mining operations, however, means an increased amount of sediment plumes in our oceans. Destroying our marine habitats…contributing to climate change...and making us more dependent on offshore tin mining operations. That is what I mean by sinking: we are not ready for such a future ecological disaster” (Marine Ecologist 2: Interview on 11 May 2022).

Underpinning this argument, the WALHI representative also argues that "the source of sediment plumes from both the artisanal to large-scale seabed tin mining operations will damage benthic habitats and create the sea level rise, swallowing Bangka and Belitung Islands. This future ecological disaster will be inevitable" (WALHI, 2022, interview on 5 June 2022). However, I argue that the notion of a future ecological disaster here often undermines that the ecological disaster, given the increasing amount of sediment plumes, has continued existing through time, impacting the already marginalized benthic habitats (Rosyida et al., 2018; Sari et al., 2022). In other words, the operation of time in the notion of ecological disaster is often bounded and sealed – the future and past, rather than recognizing a continuum, an arrangement the physicality and materiality of sediment plumes embody.

Indeed, most mining corporations, governmental officials, and NGOs forget the temporality of sediment plumes defies such a Western linear conception of past, present, and future, inspiring the future ecological disaster notion (Neimanis, 2021), especially through the process of continuous seabed mineral removal and disposal performed by 24/7 non-stop mining operations. As noted in my research diary:

> "For every morning, at 5 a.m. and at 19.00 p.m. on the mining ship, I observed the flow of seabed minerals pumped up on the mineral reservoirs; these ore bodies went down to the washing plant whereby five to eight people took seabed minerals with buckets, put them on a sloppy designated washing place and washed them with seawater. The water helped to sort out tin ores from adjunct minerals as, with the help of gravity, the water flowed to lower areas to discharging holes; it carried the adjunct minerals and organic materials having lower molecular density than tin ores. The adjunct minerals and organic materials (known as tailing) were further sent back to the sea, creating sediment plumes. At the same time, the process of cutting, dredging, and suctioning seabed minerals with 360^0 and 90^0 movements also released sediment plumes, changing the blue water into milkish water. These seabed mineral removal and disposal practices have been inherited since Dutch and British colonial mineral extraction and trade control" (Research Diary: 25 May 2022).

Figure 26: Mining navigation room (Personal documentation, 2022). Details: the navigation room is where the head of the mining ship navigates the ship, instructs mining workers using microphones, and operates the cutter suction dredger.

The process of such mundane seabed mineral extractions arguably makes sediment plumes hard to distinguish whether sediment plumes are from current seabed tin mining operations or from past Dutch and British offshore tin mining operations. Primarily, although sediment plumes have a settling time from the water column, the sediment that becomes plumes can be remnants from colonial times and are being remixed with current sediment plumes by ongoing seabed mining endeavors.

While the interaction between Dutch mining technology and seabed mixes sediment plumes from past and current sediment plumes, the source of sediment plumes is also from the same previously mined seabed sites (known as post-tin mining sites) mapped and charted by Dutch and British colonial trade and extraction controls. Meanwhile, as most mining technologies and companies are inherited by Dutch East Indies mining companies, the dependence on Dutch mining technologies still exists even until the present moment. For instance, the IHC, a Dutch mining and maritime technology company still supplies the spare parts of CSD and BWD gears and suction pipes to current offshore tin mining operations. Therefore, the use of Dutch mining technologies and previously mined seafloor complicate the dichotomy between past and present as well as the construction of linear future time in offshore tin mining operations. That is because the past and present plumes are connected through ongoing colonial relations via mining technologies and mapped seafloor tin mining sites. In this way, not only do the hard-to-distinguish past and present plumes exist due to ongoing offshore exploitations, but the production of plumes also takes place given the relationship between the continuous use of Dutch mining technologies and Dutch East Indies inherited mining sites. A mining corporation representative explains this:

> “Due to being constrained with the depth of the sea and the hypothesis of every seabed tin deposit is not effectively mined… The ladder of our current cutter suction dredger can only reach the depth of the sea, 50 to 60 meters below the seabed [since Billiton Maatschappij (Dutch mining company)] introduced and used the current cutter suction dredging ship mining ships operate today, the colonial-time miners can access the same depth as the CSD today]. That means we could not go beyond this depth. Not without deep-sea mining machines. For that reason, we often mined the post-seabed tin mining sites [previously mined seabed sites] with the assumption of ineffective tin ore mining. What I meant by ineffective here is tin ores escape from CSD (Cutter Suction Dredger) washing plants, or the suction of the tin ores cannot reach some sides of the seabed tin deposits. The post-tin mining sites are the Dutch colonial inheritance; our ancestors had mined since centuries ago, and we continue it now” (Mining corporation representative: Interview on 24th April 2022).

This statement explains how the seabed tin mining operations revisit the post-tin mining sites, mixing the past and present sediment plumes through ongoing offshore tin mining operations that continue to exist throughout time. That is because revisiting the post-tin mining sites means that they dredged, cut, and suctioned the Dutch East Indies seabed mining sites (Mining corporation representative, 2022, interview on 24th April 2022). In this way, the current offshore tin mining operations not only mine and kick off sediment plumes using Dutch inherited mining technologies but also sediment plumes are continuously animated and reanimated from previously mined seabed mining sites by current offshore tin mining operations. Such phenomena of mixing sediment plumes deviate from the linear concept of the past, present, and future times as the past and present seabed mining impacts, the plume pollution, become indistinguishable.

Understanding how the temporality of sediment plumes defies – or queers – the politics of a future ecological disaster is crucial. That is because the temporality of sediment plumes reminds us how sediment plumes are material colonial souvenirs and also scars on the landscape (seascape) and zombie waste sands that get reanimated. In this regard, I argue that sediment plumes are material-colonial souvenirs, mainly because the Dutch government, using funding from the Dutch East Indies company, not only bought the Bangka and Belitung Islands from the British Empire, especially given the London Convention treaty on 28 December 1816 (Sya et al., 2019) but also reproduced and inherited sediment plumes off these islands. London Convention Treaty, also known as the Anglo-Dutch Treaty or *Verdrag van Londen,* is the treaty that promised the Netherlands to receive back its colonialized land, including the Dutch Indies (*Nusantara* before Indonesia's independence) (Wulandari, 2021). However, the ongoing Dutch and British colonial relations with sediment plumes still persist throughout time through their control of international tin ore prices due to the ITA (the international tin agreement) signed by Dutch-East Indies and British-East Indies in Geneva in 1956 (Ibrahim et al., 2018). In this sense, the Dutch and British colonial authorities maintained an indirect influence on offshore tin ore removal and seabed plume disposal to the ocean (see Figure 27 below).

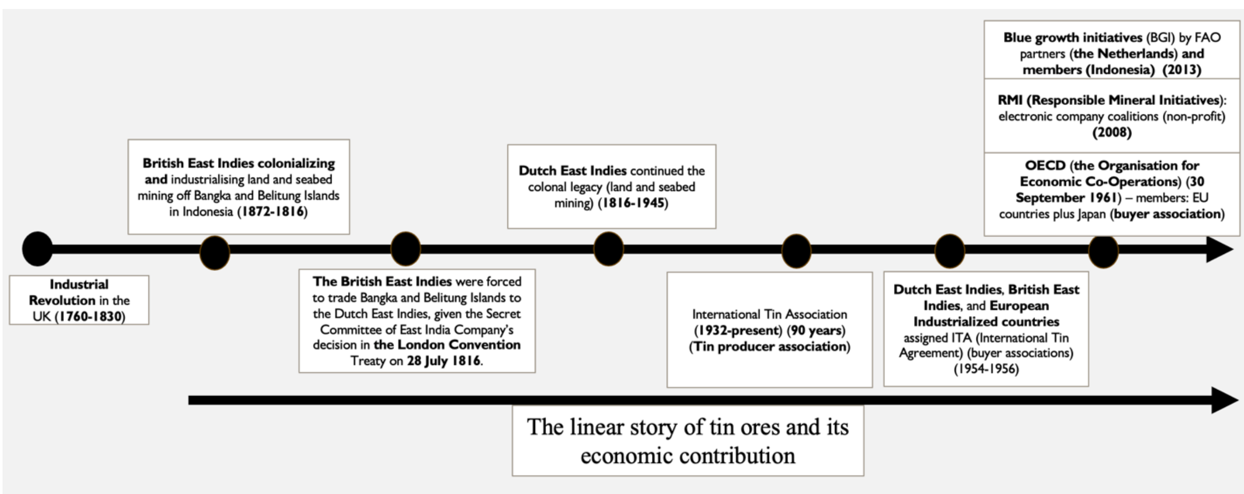


Figure 27: The straight line of tin-centric governance interventions (source: personal analysis using Atlas.Ti).

This market-based governance has inspired other ongoing colonial top-down interventions, including the Responsible Mineral Initiative (RMI) and the International Tin Association (ITA), privileging the power of European colonial power to dictate offshore tin producers off Bangka and Belitung Islands in Indonesia (Erman, 2017a). While this top-down hierarchical geopolitical approach has the ambition to maintain the stable price of tin ores and implement good mining operations (ITA, 2021b; RMI, 2023), I argue that these political governance interventions have also maintained the process of kicking off sediment plumes from the post-tin mining sites. That is because no offshore tin mining operations recover tin ores *without* mixing sediment plumes. In this way, the governance structure of the offshore tin extractions catalyzes and maintains the process of mixing sediment plumes off the Bangka and Belitung Islands, Indonesia. At the same time, since no one can distinguish between old and new mine tailings that are revived, revitalized, reanimated, and reagitated by recent mining endeavors, and neither can one control and cease the movement of sediment plumes, sediment plumes disrupt the social construction of the future ecological disasters and the clear temporal borders produced by such governance interventions. Instead, through their volatile movement defying spatial and temporal boundaries, sediment plumes produce continuously existing ecological disasters felt by generations of Indigenous communities on and off the Bangka and Belitung Islands. Therefore, the top-down geopolitical interventions from the International Tin Agreement, RMI, and ITA represent the relationship between colonialism and sediment plumes. This echoes the work of Liboiron (2021) on pollution is colonialism.

As thinking about the temporality of sediment plumes enables us to decenter a hegemonic future ecological disaster notion, I argue one can start to acknowledge that such an ecological disaster produced by sediment plumes is not confined to the past, present, and future events, especially given that sediment plumes defy ocean clean-up (Sammler, 2016). That is especially because current ongoing colonial relations maintain offshore tin mining operations. Framing sediment plumes as a non-linear continuous (queer) ecological disaster rather than a future ecological disaster makes us aware that producing sediment plumes is far easier than anticipating the unwieldy impacts of sediment plumes. The ecological disaster has happened throughout time, affecting the marginalized benthic habitats (Ranto et al., 2023). For instance, Syari & Nugraha (2022) argue that sediment plumes can hamper the sunlight penetration imperative for the coral reef ecosystems and seagrasses. Coral reefs and seagrasses are crucial benthic ecosystems for shrimps, sea cucumbers, and sea slugs, to name but a few. The degradation of the coral reefs and seagrass ecosystems can further affect the health population of the benthic species.

6.6 Plumes contest a straight line of blue and growth in blue growth initiatives

While offshore tin mining operations can signify the ambition of blue growth initiatives for ocean-use-based economic growth, such a top-down geopolitical frame often creates a linear notion of ocean uses that romanticizes the sustainable blue ocean and economic growth (Childs, 2020). Meanwhile, these hierarchical interventions often ignore that offshore tin mining operations do not always result in economic growth nor maintain the blue ocean color (Banu, 2020), as sediment plumes result in sea color gradation (see Table 2 below), representing the mining impacts, leading to economic growth and degrowth, depending on the type of marine use. Economic degrowth here refers to the disappearing revenue generation in other sectors, like shrimping, given the impacts of particular marine activities, such as seabed mining operations (Childs, 2020). While Hayward (2012) argues that the Western imagination of the ocean environment has always been blue and clear, such stabilized and essentialized oceanic imaginations neglect dynamic ocean colors often produced by polluting marine activities. In this way, sediment plumes queer the straight line of blue and growth in blue growth initiatives.

Table 4. The sea gradation of five seabed tin mining sites[31]

No.	**Mining sites**	**Sea colors**
1	*Matras* Sea I	Blue, greyish
2	*Matra*s Sea II	Blue, milkish
3	*Belinju* Sea (Kelabat Bay)	Yellowish, blue, dark
4	*Bakit* Sea	greyish
5	*Tempilang* Sea	brown

[31] Table 2: The sea color is based on my participant observation. The sea color signifies the noticeable color, although the sea color changes over time depending on the moving cutter suction dredgers and water turbulence. The color identification can be biased because I am a partially blind color person. But the purpose of the table is to showcase sea color gradations, implying the active movement of sediment plumes and their potential ecological impacts.

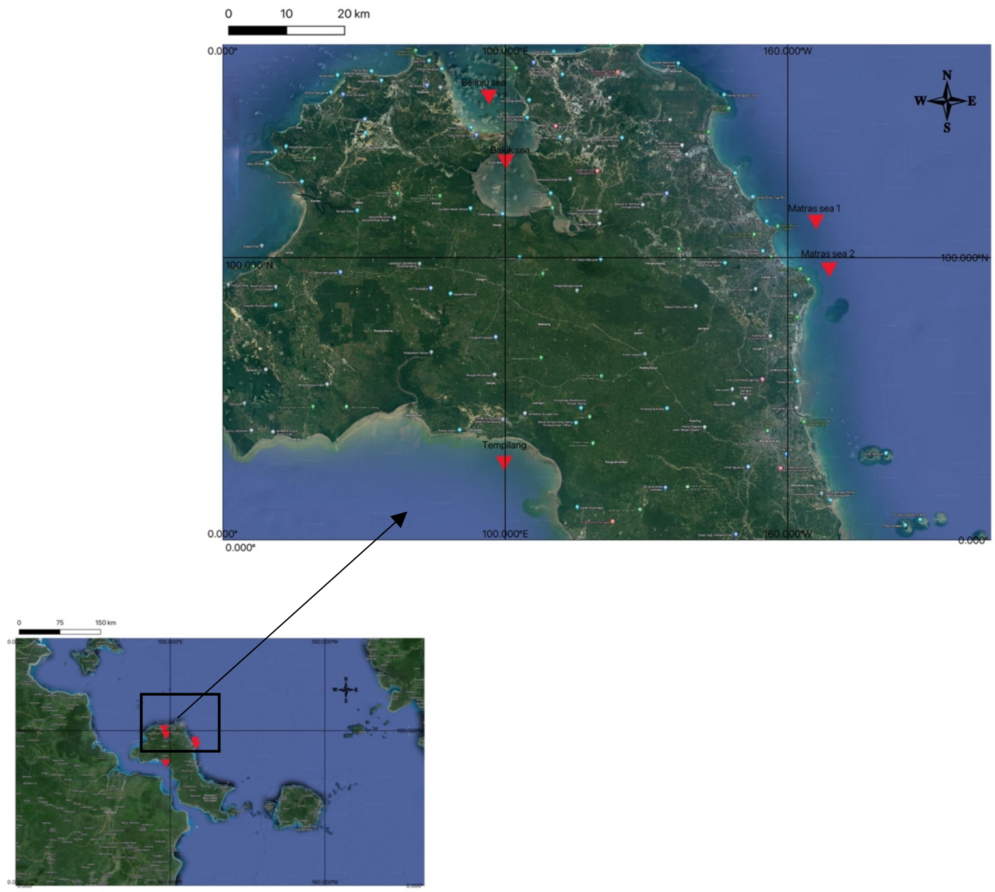


Figure 28: Five seabed tin mining areas. The map is made by the first author using QGIS (Quantum Geographic Information System).

Sediment plumes also enable us to question critically and push back on the accepted knowledge of blue imaginary in blue growth initiatives because plumes produce the sea color gradation, moving beyond the stable blue sea to diverse sea colors (e.g., milky, yellowish, and dark). For example, from the GoPro camera's vertical point of view (see Figure 29), sediment plumes produce a gradient of sea color, such as relatively blue and green on the sea surface, yellow in the water column, and completely dark on the bottom of the sea. The dark colors are both due to the depth of the seabed and the presence of sediment plumes, but particulates can block sunlight from reaching marine life whose lives rely on it for photosynthesis. Meanwhile, blue is also not the color of the most biodiverse and biomatter-rich oceans. Waters with enough critical nutrients produce algae blooms, also known as eutrophication, as the nutrients help the algae grow (Mardones et al., 2023).

Figure 29: Sediment plumes' color degradation from a vertical point of view using a Go-pro camera (photos by the author). a: from the surface boat, b: just below the surface or with a meter from the surface, c: several meters below the surface

The diversity of the sea color also exists during active CSD mining operations. As I noted:

> "At 5 a.m., after sipping my free cup of coffee at CSD mining kitchen, the mining ships move in 360^0 (circular movement) and a couple of hours move in 90^0. The movement of the ships means the ladder of the cutter suction dredgers also moves. The ladder of the CSD is the long neck of the cutter suction dredgers that helps the head or known as the crown of CSD, to reach the seabed. The sea has changed from blue to milky and grey color" (Research Diary: 26 May 2022).

Figure 30. The gradation of the sea colors on active CSD movement (Personal Documentation, 2022).

Thinking with sediment plumes through a queer lens allows us to unpack how the blue growth initiatives erase the complex dynamic sea color caused by plumes and also how the seemingly trivial sea color gradation affects marginalized bodies, such as wild shrimps and Indigenous shrimp fishers. As an Indigenous fisher explains,

> “[D]o you still catch any shrimp? No, I can hardly find shrimps. As there are many offshore tin mining operations: Kapal Isap [private cutter suction dredgers] and artisanal seabed tin mining operations [tin diving and tower-dredging operation], water has become murkier, no shrimp can be found in our seas. We further rely on the compensation of these offshore mining operations for our living” (Indigenous fisher: Interview on 16 July 2022).

This means sediment plumes do not abide by the hegemonic linear imagination of the sustainable blue sea color and economic growth as narrated by blue growth initiatives. In fact, the mineral removal and disposal process and practices kick off sediment plumes, creating phenomena out-of-line with blue sea color (e.g., yellow, milky, and dark color). In this light, for Indigenous shrimp fishers and the wild shrimp population, the sea gradation can be harmful to their lives as sediment shadows and smothers the coral reefs and benthic habitats. Meanwhile, for seabed tin miners using CSD mining ships, the sea gradation only obscures the access to collecting tin ores. That is because the multi-beam echo-sounder cannot interpret the depth of the sea and the seabed mining site precisely. That said, as long as they can recover tin ores, the sea gradation does not affect their livelihoods. Additionally, the decreasing number of Indigenous shrimp fishing, given the existing sediment plumes, means more fresh mining sites for offshore tin mining operations. That is because seabed tin mining operations can then transform the area of shrimp fishing into their mining areas.

During the fieldwork, the sea color gradation also created tension between miners and Indigenous shrimp fishers. But because the low-rank tin miners are also part of the Indigenous community, who mostly gave up their shrimp fishing due to the existing sediment plumes, the Indigenous shrimp fishing communities often reconciled this tension. Not to mention, the mining corporations also provide monthly compensation of about 100 USD to Indigenous fishing communities, whose seas are invaded by sediment plumes, though not every Indigenous shrimp fisher could receive the money because only those fishers listed by mining corporations could acquire the financial support (Rosyida *et al*., 2018). I argue that the complex relationship between sea color gradation caused by sediment plumes and benthic organisms often slips away from the scrutiny of the blue growth initiatives policy-makers, converting the dynamic and changing sea into a stable and governable ocean.

6.7 Plumes complicate spatial binary between life/death in coral reef restoration

Given that the process of offshore tin mining operations produces tailing, resulting in plumes, resistance toward offshore tin mining operations appears from the environmental NGO (WALHI), pro-environmental academics, and even the central government. Especially the resistance group here is concerned about the coral reef health in the coastal environment. For that reason, the central government has fined the offshore tin mining operations to compensate the impacts of plumes. As Mining corporation employees II (2022) explained during his explanation about mining concession areas:

> “[Y]esterday, our director of cutter suction dredging mining ship went to Jakarta because we had to pay environmental compensation of one billion rupiah (63,000 USD) to the Ministry of Fisheries and Marine Affairs. According to their employees, we have harmed marine environment because we discharge our tailings directly to the ocean. They argue that tailings can result in plumes and cover the sunlight penetration important for marine habitats. Thus, they suggest us to discharge our tailing directly to the bottom of the sea. But what difference does it makes. They just need our money” (Mining corporation employees II: Interview on 23 May 2022).

Indeed, the payment of the environmental compensation here neither deters offshore tin mining operations nor does the central government use the financial retribution to fund coral reef restoration. That is because the coral reef restoration funding often comes from the mining company as part of their corporate social responsibility program and part of environmental impact mitigation.

The compulsory coral reef restoration requirement in post-tin mining sites exists since WALHI, working together with Indigenous shrimp fishers and pro-environmental academics, has pushed the provincial government to take action. With such social and political pressures, the provincial government has issued provincial regulations (PERDA, 2020). This provincial regulation not only enables the provincial government to divide and allocate marine spaces for diverse marine uses including offshore tin mining operations but also require offshore tin mining operations to conduct coral reef restoration especially in previously mined seabed. Despite that, distrust exists among the environmental NGOs toward the provincial regulation. As WALHI director explains:

> "[I]ndeed, we have RZWP3K (Rencana Zonasi Wilayah dan Pulau-Pulau Kecil—provincial marine zonation plan). But what difference does this legal instrument make? Tailing production happens both offshore and onshore. Sedimentation everywhere from the river to the sea. Our ocean has become opaque and our coral reefs may not survive. They will be dead" (WALHI: Interview on 5 June 2022).

This statement above means that even though the spatial planning tries to confine the location of the seabed tin mining and allocate coral reef restoration, plumes can invade the area of coral reef restoration. In this way, the politics of dead on the impact of coral reefs promoted by the environmental non-profit organization and Indigenous fishers have indeed encouraged the provincial government to create the regulation that enables coral reef restoration.

The regulation on pushing mining company to restore coral reef habitats has also divided resistance group into extremely anti-mining group (WALHI) and pro-mining group. For example, coral reef lover association on Bangka and Belitung Islands have collaborated with one of mining company to restore coral reef habitat in the coastal environment. As the coral association director (marine ecologist) explains:

> "Before I was so anti to the seabed tin mining because their process of cutting, suction, and dredging disturbs coral reef habitats. In the past, we could see many coral reefs but now it was very rare. However, I started to realize that my anti-mining behavior did not make any difference. For that reason, I have now instead focused on helping them to install fish aggregating device and coral reef restoration" (Marine Ecologist 1: Interview on 26 April 2022).

While one mining company performed such a coral reef restoration project by funding the installation of reef substrates and paying marine ecologists, many mining companies on Bangka and Belitung islands have not contributed to the coral reef restoration project. Additionally, according to marine ecologist, even though the objective is to restore the life of coral reefs in the previously mined seabed, such ambition in practice is not possible. As Marine Ecologist 1 explains: "[E]ven though our task is to help mining company to grow coral reefs in the post-tin mining sites, such restoration project often fails due to the high turbidity produced by sediment plumes. For that reason, we always choose other sites that are possible for coral reef restoration"

(Interview on 26 April 2022). In this way, plumes also complicate the realization of coral reef restoration.

While the coral reef restoration project exists, given that plumes can cause the mortality of the coral reefs, plumes also challenge the politics of death inheres in the notion of restoring this benthic habitat. For example, a focus group discussion in the mining ship with a group of CSD tin mining crew, including low-rank tin miners, engineers, and mining navigators, explains:

> "Anti-mining group often accuses offshore tin extractions of kicking off sediment plumes, killing and reducing fish population. They use sediment plumes as an excuse to moratorium our offshore tin mining operations. However, in reality, this is not true, because after turning off cutter suction dredger engines, the moving sediment plumes attract many fish and squids. [Pelagic species] fishers even often catch fish and squid with us" (Focus group discussion on 22 May 2022).

In this way, from the account of the mining corporation representative, sediment plumes indeed create life because they can see that fish and squids always appear after they cease their mining operations. This argument contradicting environmental activists on how sediment plumes lead to the death (mortality) of marine life is not a mere claim from the miners. That is because, during the fieldwork, the CSD tin miner confirms this evidence: "[M]as [brother], you missed the chance of fishing squids since you left the mining ship early [back to land]. At night, we caught big fish and squids after recovering tin ores. Please eat the squids my wife cooked for you [the CSD tin miner offered me the squids" (Interview on 26 May 2022). According to marine ecologist, sediment plumes aggregate fish and squids due to the sediment plumes' vertical movement in the water column and at sea surface. As he explains:

> "[I]ndeed, cutting suction dredgers (CSD) lead to the [so-called] artificial upwelling. It is the vertical movement of the seabed particulate matters, circulating organic and inorganic materials from the seabed. The organic materials primarily attract zooplankton and phytoplankton. Through complex marine food web, this microscopic organism further attracts fish and squids" (Marine Ecologist 1: Interview on 26 April 2022).

In other words, sediment plumes can indeed become an excuse to contest the politics of death asserted by anti-tin mining groups.

During the fieldwork, I witnessed the relationship between the moving sediment plumes and existing squids and fish; pelagic fishers and offshore tin miners coexisted to catch fish during my participant observation. Whilst sediment plumes providing food for humans and non-humans seem trivial, sediment plumes have become an excuse for offshore tin mining corporations and groups to insist that the provincial government open offshore mining concession areas. For example, the pro-mining group here often argues that sediment plumes do not affect marine life instead sediment plumes create life (Mining corporation representative, 2022). This is primarily because existing sediment plumes provide fish and squids for fishers and miners contesting common narratives of destructive sediment plumes (Mining corporation representative, 2022, interview on 26 May 2022). As a mining corporation representative explains:

> "[P]rovincial and central government should not complicate the offshore tin mining operations permit. They buy the idea of an anti-mining group using sediment plumes as an excuse to restrict the movement of offshore tin mining operations. It is so untrue that sediment plumes kill fish. The anti-mining group, in fact, becomes against mining not because of existing sediment plumes. Instead, it is because they do not get shared revenues from us. The government should remember that the entire infrastructure (e.g., roads, hospitals, and schools), happens thanks to the recovery of tin ores and seabed sediment disposal" (Mining corporation representative: Interview on 26 May 2022).

Contradicting this statement, the WALHI (2022) argues:

> “The west Bangka and Belitung Islands, fishers complain that high seabed plume sedimentations have decreased their fish catch. You can imagine that they directly discharge adjunct (residual) minerals into the oceans. However, indeed, we need more reports to prove the relationship between sediment plumes and marine habitat degradation” (WALHI: Interview on 5 June 2022).

The life and death contradictions of sediment plumes have become deeply politicized by seabed tin mining operations and local environmental NGOs. This is because environmental activists and mining operations utilize the fragmented knowledge of sediment plumes. For environmental activists, sediment plumes lead to the death of coral reefs, which may reduce fish and shrimp catch, while offshore tin mining corporations focus on how sediment plumes bring pelagic species to the dinner tables. Meanwhile, in actuality, sediment plumes themselves make both death and life exist. In this way, sediment plumes queer the spatial boundary isolating the death from the life and vice versa, the life from the dead. Indeed, queering the death/life dichotomy here means creating conditions that assist or resist offshore tin mining operations.

Figure 31: The artificial upwelling offshore Bangka and Belitung Islands in Indonesia

Despite the controversy of death and life affected by sediment plumes, sediment plumes indeed have complicated the benthic habitat restoration project process. A marine ecologist agreed with this statement:

> "The challenge of performing coral restoration off Bangka and Belitung seas is the existence of sediment plumes because most coral reefs, including (Arcopora Formosa), cannot stand with the high turbidity of sediment plumes. Thus, we do not have the clear outcome of the coral reef species restoration project yet" (Marine ecologist 1: Interview on 26 April 2022).

While environmental activists and coral reef conservationists may focus on the material agency of sediment plumes in killing coral reef habitats, the way sediment plumes create a chain of life has often outweighed the importance of protecting the coral reef life itself (Mining corporation representative, 2022, interview on 24 April 2022). This is because life creation does not end with specific marine species such as pelagic fish and squids (Research Diary, 2022, 26

May 2022). Instead, the process of kicking off sediment plumes has benefited a particular economic chain from livelihood for tin workers, small-scale pelagic fishers, coral conservationists[32], to large-scale offshore tin extraction and even the life of local citizens on the Bangka and Belitung Islands in Indonesia (Mining corporation representative, 2022, interview on 24 April 2022).

Figure 32: the coral reef restoration project (Marine Conservationist, 2022).

[32] In the fieldwork, coral reef conservationists depend on the corporate social responsibility (CSR) from offshore tin mining operations to fund their coral reef restoration project. Thus, if offshore tin mining operations and sediment plumes are inseparable, I argue that the financial support for the coral reef restoration also benefited from sediment plumes (Research Diary, 2022, 26 May 2022).

6.8 Conclusion

This chapter has thought with plumes – themselves rather rarer in the critical seabed literature. It has demonstrated the necessity of deconstructing, challenging, and destabilizing [qeering] the essentialist construct of the seabed as a bounded and static space represented by the governance of offshore tin mining operations and doing so through an attention to plumes. Sediment plumes play a crucial role in showcasing how the impacts of the past and ongoing colonial Dutch and British mineral extraction and trade can still be felt through time on and off the Bangka and Belitung Islands in Indonesia. The process of mixing and remixing sediment plumes queers the temporality of supposed future ecological disaster as timeliness where the past and present are actively animated and reanimated through current offshore tin mining operations, controlled indirectly by the top-down geopolitical interventions and blue growth initiatives (e.g., ITA and RMI). Beyond their queer temporality, thinking with sediment plumes allows us to also critically question blue growth initiatives imposed in governing offshore tin mining operations. That is because sediment plumes produce sea gradations such as yellowish, milky, and grey colors that challenge dominant norms about the ocean that are rendered commercial in the imagination. At the same time, sediment plumes result in the growth of offshore tin mining operations and the demise of benthic habitats as plumes not only block light but also physically smother benthic life. In this way, reflecting on the queer nature of sediment plumes demonstrates that the blue growth initiatives often neglect how sediment plumes create sea color gradation, signifying their ecological impacts, leading to economic growth and degrowth, depending on whether marine and seabed uses are affected by sediment plumes.

Meanwhile, within the current coral reef restoration project, sediment plumes are often linearly interpreted to be useful for the politics of saving brown coral reef habitats off the Bangka and Belitung Islands in Indonesia. However, in practice, sediment plumes are useful for the politics of offshore tin mining operations. That is because sediment plumes not only obscure and fail the coral reef restoration project but also, given through artificial upwelling, sediment plumes provide food for squids and fish as well as pelagic fishers. Beyond the marine life food web, the active process and practices of seabed mineral removal and disposal kicking off sediment plumes mean maintaining infrastructure, relying on tin production and export, within and beyond the Bangka and Belitung islands. In this way, sediment plumes set conditions under which life and death exist at the same time, leading to the controversy on whether to assist or resist offshore tin mining operations.

With the use of queer tempo-spatial-material approach, this chapter expands and pushes the territory of queer geographies beyond classic queer space (e.g., urban parks and gay bars) (Nowak and Roynesdal, 2022) to bring attention to plumes that challenge its straight imaginaries of the seabed. In fact, sediment plumes represent the interaction between seabed, sea, other space, and human and non-human entities. This means that the analysis of sediment plumes expands the concept of queer as a critical deconstructive practice to unsettle and challenge current normative and linear political assumptions about the seabed and other spaces. Meanwhile, even though sediment plumes exist in the ocean, this study about sediment plumes becomes a reminder of interlocked territories and the dynamic, mobile, and voluminous materiality and physicality of the ocean (Steinberg and Peters, 2015). This understanding challenges and decenters the myth of separable and bounded categories such as space, time, bodies, and materiality (Farrales et al., 2021), often prescribed by top-down geopolitical approach in environmental governance (see Peters 2020) to create division used to manage resources and vitally, to distinguish which spaces and bodies are worth sacrificing or rescuing (Klinger, 2018, Satizábal and Melo Zurita, 2021). For that reason, this study becomes an invitation to rethink seabed governance and environmental governance norms.

Beyond its specific literature contribution to queer ecology and governance studies, this chapter also showcases how plumes provide an ecological understanding of the seabed in new materialist geopolitics. In other words, this chapter aligns well with the main argument of this study. That is because plumes explicate the benthic phenomena that emerge from offshore tin mining operations. Additionally, plumes are the material evidence that plumes are not only physical but also political. This has to do with the fact that whilst plumes are the byproduct of offshore tin recovery and oceanic turbulence and currents, plumes exist in the interplay between the geopolitical intervention of the tin industries and the practice of tin recovery. Meaning plumes cannot exist without the governance regimes prescribed by the ITA and OECD that enable offshore tin mining operations to operate. However, since the geopolitical interventions of the tin mineral production here focus on governing the tin production by enforcing mining standard requirements such as mining permits, personal protective equipment (PPE), and EIA, to name but few. This regulatory intervention does not consider plumes in offshore tin mining operations. This is because the current EIA, for instance, does not consider the existence of the plumes. Arguably, removing plumes from their offshore tin operations is also part of the tactical points in their geopolitical interventions. The reason is even though the governance regimes (i.e., mining standard requirements) can create the responsible appearance of offshore tin mining operations given that complying with these extractive requirements creates an assumption that the offshore tin recovery is governable and manageable. Plumes remind us that their volatile and moving agencies defy such a straight line of space and time inserted in the geopolitical intervention of the offshore tin mining operations.

So, why does attending to plumes in this chapter allow us to address the overarching line of inquiries in this study? This chapter enables one to address research questions because volatile, moving, and oceanic plumes represent and are benthic phenomena. That is because plumes can be measuring agencies interacting with, related to, and associated with the seafloor that reconfigure the multiple realities of the seafloor. Plumes also indicate the seafloor is volumetric as it moves above the seafloor, through the water column, and beyond. As plumes are benthic phenomena, this understanding enables me to address the first research question. *How do the geopolitical interventions of the offshore tin mining operations count and discount benthic phenomena?* As mentioned previously through this chapter, the governance of offshore tin mining operations, such as through concession areas, OECD mining guidelines, and blue growth initiatives (BGI), mostly considers how offshore tin mining productions result in economic contributions. Therefore, while plumes are literally emergent with the seabed tin mining operations, plumes are not taken into account in their interventions. For instance, environmental impact assessment (EIA) does not explain in detail how plumes are produced and how to address plumes in the ocean. Therefore, in this way, the global, national, and provincial geopolitical interventions of offshore tin mining operations discount plumes emerging from benthic phenomena.

Even though the global, national, and provincial geopolitical interventions of the offshore tin mining operations, these geopolitical interventions are entangled with plumes. That is because excluding plumes in the multi-scalar geopolitical interventions does not mean removing existing plumes produced by offshore tin mining operations. This understanding, for that reason, enables me to answer the second research inquiry. *How do benthic phenomena get entangled with the multis-scalar geopolitics?* Of course, as mentioned earlier, whilst global, national, and geopolitical interventions create their good mining standards (e.g., owning mining permits, possessing concession areas, and reporting EIA) away from the material site of the tin extractions, such geopolitical interventions do not end the material site of their decision-making process on these mining interventions. Instead, in practice, mining companies, the head of mining ship, and mining crews enact such mining standards to maintain their good business appearance. Complying with such good mining standards here also allows the mining actors to secure the seafloor as their mining territories. For example, having EIA reports and concession areas, mining companies can access and defend their seafloor tin extraction sites. In this case, the global, national, and provincial geopolitical interventions permeate through bodily, technological, and granular scales. Bodily, technological, and granular scales here refer to how miners' bodies, mining and digital technologies, and tin ores are used to justify the use of the seafloor as mining territories. This means benthic phenomena emerging from plumes not only get entangled with global, national, and provincial scales of geopolitics but also bodily, technological, and granular scales of geopolitics.

This entanglement between the multi-scalar geopolitics of the offshore tin mining operations and plumes further also enables me to address the third research inquiry. *How does the multi-scalar geopolitics of the offshore tin mining operation manifest in benthic phenomena?* That is because the geopolitics of the offshore tin mining operations across global, national, provincial, bodily, technological, and granular scales, in practice, not only help secure the seafloor for tin mining operations and for catalyzing the production of the tin ores and sediment plumes. In this way, diverse geopolitical interventions here manifest benthic phenomena emerging from volatile and oceanic plumes. Beyond such manifestation of geopolitics in benthic phenomena, as plumes are also used to assist and resist the territory production of the seafloor tin mining operations, plumes become a crucial geopolitical way of securing and defending the seafloor access. Thus, plumes extend the scales of geopolitics from global, national, provincial, bodily, technological, and granular to molecular scales. That is because plumes are, by size, molecular particles. Meanwhile, as the molecular size of plumes also means that plumes have their own spatiality and temporality. Plumes also indicate each of geopolitics in offshore tin mining operations have multiple spatial and temporal regimes of seafloor interventions.

Concurrently, as plumes move within, through, and beyond ocean floor and column, such benthic phenomena queer spatial categories between sea, seafloor, and land. This understanding enables me to address the final research inquiry. *How do benthic phenomena redefine the meaning-making and territory of the seafloor?* That is because as plumes are benthic phenomena, plumes become measuring agencies that reconfigure the multiple realities of the seafloor. For example, as plumes are part and parcel of the seafloor getting dredged, cut, and discarded back to the ocean, this contests the geological definition of the seafloor beneath the sea as outlined by the UNCLOS and the Law of the Seabed (book). That is because plumes indicate that the seafloor is not static and fixed but volatile and oceanic. Additionally, plumes also queer the idea of the seafloor as mere geological space (e.g., sands and minerals). Instead, plumes remind us that the seafloor is a hybrid of geological (e.g., sands and minerals) and biological (e.g., coral reefs and clamps) compositions. Beyond such material measuring agencies, plumes not only make the ocean column and surface murky but also such murkiness recreate knowledge controversy on the status of the seafloor. For mining navigators, the murky sea caused by plumes means coral reef restorations, and protecting coral reefs is not worth the effort as such conservation endeavor may cost much money to restore benthic habitats. Meanwhile, for conservationists, this means that offshore tin mining operations should be terminated to enable marine restorations. Thus, plumes not only redefine what the seafloor means and the contested territory between mineral extractions and coral reef restorations.

My significant and original contribution to knowledge in this study is I demonstrate that sediment plumes off Bangka and Belitung islands are not mere physical oceanic materials. Instead, plumes are entangled with broader scales of geopolitical interventions. Empirically, this understanding is crucial to rethink the existence of plumes off these islands as the byproduct of the geopolitical interventions of offshore tin mining operations. This chapter also encourages that current geopolitical interventions of the tin industry should count how their seabed tin mining standard requirements reduce plume production in the practice and process of the seabed tin recovery. Theoretically, rethinking plumes in this study contributes to the current new materialist interpretation of geopolitics. That is because plumes indicate that geopolitics is not only material (Bobbette, 2023), geological, and elemental (Yusoff, 2013; Peters et al., 2018), but queer the distinction as plumes are an in-between geological and biological. Primarily, this has to do with plumes oscillating between biological and geological beings, complicating the way offshore tin mining operations are governed.

Chapter 7 Benthic ending and beginning

7.1 Introduction

This study has demonstrated that examining and reinterpreting seafloor sensing and extractions as benthic phenomena offers a radical way of conceiving the seafloor (ocean floor) beyond its dominant legal and geological definition: the top-earth surface under the sea (Chapter 2). This understanding matters because the seafloor is not a flat space with static meaning. Instead, what the seafloor means changes through particular benthic phenomena. In this thesis, the conceptualization of benthic phenomena builds on critical ocean studies, science and technology studies (STS), and islands studies, which are contextualized within the new materialist geopolitics. By expanding the concept of "benthic" in marine science toward social science, my original and significant contribution to knowledge is the concept of benthic phenomena allow us to understand how the seafloor permeates through multiple spatial, material, and temporal boundaries (e.g., seafloor, sea, land, air, and beyond). In other words, existing benthic phenomena present active, emergent, and relational interactions between the seabed and our bodies. This means benthic phenomena defy the static and binary land-bias logics. Land-bias logic is, according to Childs (2018), Squire (2021), and Sammler (2020), used to construct the seabed as a passive and ready-to-exploit object. Therefore, addressing such land bias here is crucial as one realizes that what happens to this oceanic space (the seafloor) extends beyond its material site. This study also showcases the interplay between benthic phenomena and geopolitics—benthic geopolitics—off the Bangka and Belitung islands. This insight is vital since benthic geopolitics indicates that the spatial conflict and violence of the seafloor off the Bangka and Belitung islands are emerging through multi-scalar geopolitics.

In this chapter, I will primarily reflect on how the research questions of this study were met (section 7.2), why the empirical investigation of this study matters for caring benthic habitats (section 7.3), and suggest lines of future research (section 7.4). This means I also reflect on how this study proffers a broader research agenda for future investigation on benthic geopolitics within and beyond the seafloor off the Bangka and Belitung islands. This insight further adds critical knowledge in a growing area of geography that has paid attention to oceanic space and, specifically, the seafloor. This knowledge is crucial and urgent because investigating benthic geopolitics from emerging and long-standing seafloor uses may reveal modes of scientific and technological apparatuses, dangerous labor, and human and seafloor relations, which otherwise are covert by the depth of the sea and the dominant geopolitics of the seafloor. Hence, such research contribution debunks the myth of the seafloor devoid of humans and, hopefully, may encourage other actors to put current offshore extractive industries under public scrutiny. This means this work on benthic geopolitics may promote care for those (e.g., humans and non-human bodies) affected by particular geopolitics of offshore extractive industries.

7.2 Addressing research questions and reflection on benthic geopolitics

Whilst the geopolitical interventions of global tin industries obviously demand the seabed off the Bangka and Belitung islands to keep their tin market intervention operating, the story of those (e.g., humans, marine animals, and minerals) on this oceanic space is often obscured by the dominant capitalist narrative of the seabed. Indeed, current social studies concerning offshore tin mining operations have shown socio-economic and ecological impacts (e.g., offshore tin mining impacts on coral reef habitats and recentralizing effects in offshore tin mining management) (See for example: Ibrahim, 2015; Rosyida et al., 2018; Sulista et al., 2019). However, their studies only confine the offshore tin mining operations in site-specific studies without considering the geopolitical entanglement of seabed tin operations. Meanwhile, through conceptualizing benthic phenomena, one starts to realize that the use of the seafloor extends spatially and temporally. This means existing benthic phenomena emerge in offshore tin mining operations due to the geopolitical interventions of offshore tin mining operations. **So, *how do the geopolitical interventions of global tin industries count and discount benthic phenomena emerging from offshore tin mining operations?*** Responding to this first research question requires a profound reflection on inextricable relations between humans, non-humans, and seabed through the practice of offshore tin mining operations. That is because seabed tin mining operations have also exemplified emergent human-seafloor relations.

Such spatial relation does not end in the material site of the tin recovery process and practice (e.g., tin mining sites and concession areas). Instead, this benthic phenomenon transcends beyond the physical place of the seabed tin mining operations. As Chapter 4 has demonstrated how the geo-data such as the seabed tin deposit maps and the estimated tin wealth can be used to inform the provincial and central government, domestic and international tin buyers. This means the data collected from offshore tin mining operations can span beyond the site of the tin recovery, creating different seabed and sea relations on multiple scales. This finding aligns well with the work of Sammler and Lynch (2021), arguing that: “[T]echno-scientific production as part of broader apparatuses extending spatially and temporally from what is traditionally understood as the site and moment of scientific practices” (941). In this way, as the flow of tin ores data produced by seabed sensing activities creates complex interactions and relations between the seabed and diverse tin players, the geopolitical interventions such as OECD, ITA, and MSP indeed count these benthic phenomena as, what Peters et al. (2018) argue, the material foundation of power. This means to materialize their tin market interventions; the hierarchical geopolitical approach here demands information about the seabed tin wealth off the Bangka and Belitung islands. Otherwise, they cannot predict whether this physical space matters for their international tin user members.

While benthic phenomena appearing from the flow of the seabed geo-data are considered matter by the ITA, OECD, and MSP for allocating marine space and informing the international tin buyers, this geopolitical intervention does not pay attention to how the tin geo-data shapes the seabed uses. For instance, these global geopolitical interventions do not count how the inextricable relation between tin experts (e.g., mining navigators and tin geologists), mining technologies, and the seabed has transformed the reality of the seabed into a mere tin site. In other words, the global geopolitical interventions do not concern or do not indicate how such a process of mapping and estimating the seabed tin deposits has also enabled offshore tin extractions not only to secure the seabed access but also potentially displace other marine users (e.g., coral reef restorations and Indigenous shrimp fishing) (see Chapter 4, Chapter 5, and Chapter 6). This is because, in practice, the geo-data of the seabed tin deposits shapes the temporality and spatiality of offshore tin recovery. For instance, CSD (cutter suction dredger) mining ship and tin diving operations follow the spatiality and temporality of the seabed tin deposits instead of the MSP mapping policies (see Chapter 4 and Chapter 5). In this way, the geo-data concerning the map of the alluvial tin deposits and estimated tin wealth play a central role in guiding offshore tin removal practices. However, consequently, since the tin geo-data does not necessarily match with the spatial allocation of the seabed, the offshore tin mining operations often infiltrate the allocated seabed space for non-offshore tin mining operations (e.g., fishing areas and marine protected areas) (Chapter 5). Therefore, despite the fact that tin geodata matters for the hierarchical geopolitical interventions of offshore tin mining operations, such tin deposit information also complicates or renders ineffective the process of governing the seabed space through marine spatial planning regulatory intervention.

The infectiveness of the MSP intervention alone is also structural. This is because this geopolitical intervention is solely designed by provincial and central authorities to govern the legal large-scale seabed tin mining operations. In this way, the provincial regulatory intervention disregards existing human bodies on the seafloor through tin diving operations. For instance, the MSP policies only record the number of the large-scale seabed tin mining operations and their mining sites, while they do not provide official reports on the number of tin diving and their mining accidents. With the lack of information about tin diving operations, ITA and OECD also do not count the existence of tin diving operations, though tin recovery using diving techniques also contributes to the global tin supply and chain. This has to do with mining companies and domestic and international tin collectors that also purchase tin ores from tin diving operations, given the affordable price of tin ores tin divers produce (Chapter 5). For instance, Chapter 5 showcases how tin divers smuggle the surplus production of tin ores to the international tin collectors in Malaysia and Singapore. Indeed, such tin smuggling, in this case, also expands the interaction between the seabed off the Bangka and Belitung islands and humans beyond the national borders of Indonesia. The flow of the seabed tin ores connecting the seabed and the international tin collectors underpins how benthic phenomena seep through multiple spatial and temporal boundaries. However, indeed, such benthic phenomena are often discounted by the MSP, OECD, and ITA as the hierarchical geopolitical approach here is a site-specific geopolitical intervention. This means that such geopolitical interventions have limitations in controlling the flow of tin ores beyond Indonesia and cannot distinguish legal and illegal tin sources. The geopolitical intervention's incapability here also exists, given that the materiality of the seafloor tin ores ruptures such dichotomy between legal and illegal tin ores. That is because once tin ores are mixed, these minerals become indistinguishable.

Beyond leaving out benthic phenomena emerging from tin diving operations, the OECD, ITA, and MSP regulatory interventions also exclude the complexity of governing the unwieldy nature of sediment plumes. Perhaps that is because of land bias logic that informs the top-down geopolitical interventions of the seabed. For instance, while provincial and international tin mining requirements from geopolitical interventions require mining companies to submit the environmental impact assessment (EIA) report (Chapter 6), this report does not explicitly explain how the offshore tin mining operations should reduce their sediment plumes production through their seabed mineral extraction and tailing technologies. Also, other mining standards, such as mining permits and concession areas, create a static and straight line of the assumption that complying with these governance regimes means offshore tin mining operations are governable and manageable. This argument echoes the argument of Farrales et al. (2021) how environmental regulation functions through discrete linear time and space.

Furthermore, excluding seafloor plumes indeed creates a responsible appearance for offshore industries. Such argumentation fits in with the argument of Barry (2010) how governance regimes create regimes of visibility and invisibility. In offshore tin mining operations, tin productions and their global tin market contributions are made visible by such international, national, and regional geopolitical interventions while simultaneously obscuring the existence of sediment plumes. Meanwhile, from the seabed sensing (Chapter 4), tin diving operations (Chapter 5), and the large-scale offshore tin recovery (Chapter 6), these seabed and human relations result in the production of sediment plumes. In this way, as sediment plumes seep through the seabed, water column, and sea surface, sediment plumes are also benthic phenomena emerging from offshore tin recovery. This means sediment plumes destabilize the assumed control of the geopolitical interventions on the offshore tin recovery. That is because sediment plumes can span beyond the temporal and spatial remits of offshore tin mining operations. Additionally, sediment plumes can continue existing and recirculating even long after offshore tin operations cease to operate (Chapter 6).

Even though the hierarchical geopolitical interventions do not consider the unruly nature of benthic phenomena of seabed sensing practice, embodied seabed experience, and plumes, given their tin-centric views, mining actors consider the complex and active interaction between seabed, seawater, and humans matters. That is because geo-data, bodies, volumetric space of the seabed, tin ores, and even plumes can be a source of tactical points (Chapter 5) to assist and resist the territory formation of offshore tin mining operations. For instance, tin patrons and mining navigators use plumes as an excuse to justify and continue the operation of the seabed tin extractions. This is because as plumes move to the surface, organic and inorganic materials of these fine particles attract phytoplankton, zooplankton, and squids. In this way, mining actors argue that plumes caused by seafloor tin extractions and tailing contribute to the livelihood of the Indigenous fishers. As such, plumes challenge and contest WALHI's account of how sediment plumes result in fishery catch reduction. Meanwhile, since plumes exist and obscure the benthic habitat from time to time, these particles have also created the seabed as a contested space. Especially this has to do with the lack of understanding of the status of the benthic habitats. For mining actors, conserving benthic habitats is a futile attempt as plumes complicate the coral reef growth and restoration. Thus, this oceanic space is, according to mining actors, better used as the site of seafloor mineral exploitation (Chapter 6). Disagreeing with mining actors, for WALHI, the government should reduce and even cease the issuance of mining permits, given that plumes hinder coral reefs. Apart from plumes, human bodies, geologic ores, and volumetric space of the seabed are also crucial to hinder and facilitate seabed access. Therefore, this study demonstrates that emerging benthic phenomena from the seabed in recovery not only shape the geo-physicality of the seabed but also are part of the tactical point to secure and contest the territory of the seabed.

Given that multiple benthic phenomena in offshore tin mining operations become the tactical point, this creates the entanglement between benthic phenomena and geopolitical interventions. In this way, such interactions between benthic phenomena and geopolitical interventions enable us to address **the subsequent research question from this study.** ***How do benthic phenomena get entangled with the multi-scalar geopolitics of the seabed tin recovery?*** Of course, regarding the geopolitics of offshore tin extractions, one can focus on the global geopolitical interventions of offshore tin industries such as ITA and OECD. This has to do with the fact that these institutions are intergovernmental frameworks. This means that country and mineral buyer representatives have the power to decide what sort of mining guideline interventions should seabed tin mining operations follow and how much mining guidelines shape the physical site of the seabed in recovery (see the definition and discussion of power in Chapter 1). This echoes the argument of Elden (2013), arguing that geopolitical analysis tends to focus on the global politics writ large. Meanwhile, Peters et al., (2019) argue that the global (macro-scale) of geopolitics consists of trans-local relations of bodies and materials. For that reason, while the ocean territories are divided by the global scale of geopolitics through, for instance, the international sea treaty agreement, Sammler (2020) has showcased that the delimiting territory process exists through the geopolitical entanglement between ocean experts, measuring instruments, and maps.

Understanding the interaction between benthic phenomena and multi-scales of geopolitics, one can understand that the interface between seafloor sensing, tin diving, and sediment plumes do not appear from a vacuum. Instead, these benthic phenomena emerge from or get entangled with inequal geopolitical power relations and different constructions of the seafloor. This means that these benthic phenomena cannot exist without global geopolitical interventions such as ITA and OECD that enable or constrain the flow of the tin ores and vice versa; ITA and OECD cannot also exist without benthic phenomena. Therefore, benthic phenomena emerging from the process and practice of the seabed tin extractions is not just material but also geopolitical. For instance, while indeed, ITA and OECD develop their geopolitical interventions of offshore tin industries away from the material site of the seafloor tin mining operations, these interventions do not end in their offices. Instead, their market interventions, like the compulsory for mining companies to have mining permits and concession areas, are enacted in the area of offshore tin mining operations. Meanwhile, to access concession areas, mining companies require a tactical point to secure their seafloor tin mining sites and displace other marine users (e.g., fishers and coral reef habitats). To do that, miners construct the notion of plumes differently from fishers and WALHI, as earlier mentioned. In this way, this geopolitical construct of plumes defines whether the seabed tin recovery can or cannot access the sea off Bangka and Belitung islands. Plumes are, thus, a hybrid of material and political agencies (see what agency means in Chapter 5) because these particles exist from the active interventions between international, national, provincial, and bodily scales of geopolitics.

The convergence of material and political agency also emerges in the everyday process and practice of tin recovery using rudimentary diving equipment. That is because human bodies, tin ore bodies, and the volumetric space of the seabed have become a tactical point for mining companies, tin divers, and provincial authorities to secure seabed access. Given the depth (distance) of the seabed and the height of oceanic waves, tin divers can resist MSP regulatory interventions to constrain their process of tin recovery. This has to do with the fact that the volumetric space of the seabed sets up conditions under which their mining sites are inaccessible to provincial authority surveillance. In other words, tin divers can defy spatial and temporal regulatory interventions of the MSP mapping and spatial policies. Additionally, the site of tin ores also provides another tactical point for tin divers. That is because the stream of tin beneath the seabed complicates the tax calculation and estimation of how much tin ores contain in seabed sites. While tin divers can use volume and stream of tin ores as their tactical points, their bodies are also tactical points for mining companies. This is because, as mining companies and tin buyers cannot go directly to the seabed tin mining sites without concession areas and mining permits, they can purchase the tin ores tin divers collect. In other words, mining companies and tin buyers use tin divers' bodies to access the seabed and thereby, circumnavigate the MSP regulatory interventions. However, defying the spatial and temporal regulatory intervention of MSP here does not mean that the provincial government cannot benefit from the tin diving operations. This has to do with the fact that the tin collectors and mining companies have to pay tax to the provincial government. In this way, even though provincial authorities cannot monitor tin diving operations and calculate tin values, they can still benefit from tin diving through the tin supply chain.

This insight above explains how benthic phenomena get entangled with the multi-scalar geopolitics of seabed tin extractions. The interaction here blurs the line between benthic phenomena and the geopolitical intervention of the seabed. This is because the geopolitics of the seabed tin extractions are part of benthic phenomena, and benthic phenomena are part of geopolitics. **In this way, this understanding enables us to address the next research question.** ***How does multi-scalar geopolitics of the seabed tin recovery manifest in benthic phenomena?*** This has to do with the fact that not only multi-scalar geopolitics of the seabed tin recovery using benthic phenomena as their ways of securing seabed access but these geopolitics also reproducing benthic phenomena. For instance, the interaction between sensing devices, human senses, and the seabed recreates the reality of the seabed as mere tin deposit sites. These benthic phenomena also not only enable international and national investment in offshore tin industries but also drive more tin diving operations and plumes. That is because the geo-data produced by the seabed sensing practice also encourages tin diving operations. The complex human, non-human, and seabed interaction here further produces sediment plumes (Chapter 6). Hence, the multi-scalar geopolitics of the tin recovery not only uses these benthic phenomena to access and control the seabed but also maintains the existence of benthic phenomena in this mineral extraction.

As the multi-scalar geopolitics of the seabed tin recovery manifest and get entangled with diverse benthic phenomena, this indicates that the meaning-making of the seafloor is plural rather than singular. **In this way, this understanding further allows us to answer the last research question of this study.** ***How do benthic phenomena redefine the meaning-making of the seabed?*** That is because different benthic phenomena recreate various realities of the seabed depending on digital, bodily, material, spatial, temporal, provincial, national, and global scales of human and seabed interactions. For instance, digitally and materially, the meaning-making of the seabed has changed from the digital seabed simulation maps, seabed sediments, tin ores, to tailing and even sediment plumes. In other words, despite the physical process of transforming the seafloor into granular forms, this cannot exclude the origin of the seabed materials: the seabed and benthic environment.

Concurrently, the process of the seafloor and mineral separation here also decontextualizes the seabed as benthic habitats since this extractive activity only highlights the seabed materials used and discarded by offshore tin extractions. In this way, the meaning-making of the seabed is largely also dependent on the technological and scientific representation and process of transforming the physicality of the seabed. This echoes the work of Sammler and House-Peters (2023), arguing that: "[The] digital recreations of the target environment [seafloor] are abstracted and compressed into a digitally mediated mine site, it becomes an always-already extractive landscape reducing its capacity to be known as anything else than as mine" (9). Of course, other modes of the seafloor and human interactions also change what the seafloor means. For example, for tin divers and their families, the seabed can be either the site of their livelihood sources, the evidence of male masculinity, or, even worse, the burial of their sons, fathers, and grandfathers (Chapter 5). The various realities of the seabed here are not a sole metaphor. Instead, these diverse realities of the seabed are material. In other words, they are tied to the material practice of tin recovery and change the physical geography of the seabed off the Bangka and Belitung islands. Given that tin recovery produces more plumes than tin production, the seabed can also mean the site of sediment plumes. Therefore, the series of benthic phenomena also recreate the reality of the seabed as an arena of conflict, a site of dangerous labor, and environmental violence depending what measuring agencies (e.g., minerals, human bodies, and benthic animals) are used.

The multiple ways of making sense of the seabed through multiple benthic phenomena above are crucial for remediating the capitalist notion of the seabed off the Bangka and Belitung islands. That is because while the current capitalist narratives of the seabed, as mentioned in Chapter 1, have flattened the seabed as mere tin extraction sites, benthic phenomena remind us of the complex interaction and relation between humans, non-humans, and the seabed. In other words, as the capitalist notion of the seabed assigns the global capitalist tin imaginations through highlighting the importance of the seabed tin ores, this hegemonic notion of the seafloor has excluded moving bodies, geologic materiality, non-humans, and technologies on this submarine space. Such an exclusionary view has further excluded existing seabed conflict and violence.

However, indeed, while this study contests the uncontested notion of the seabed as tin extraction sites, one can understand that the process of the human, non-human, and seabed interactions in offshore tin industries changes the physical reality of the seabed to fit in with the capitalist notion of the seabed. Despite that, what is the point of understanding multiple realities of the seafloor? The next section explains how understanding multiple meaning-making of the seafloor may encourage us to care for benthic habitats within and beyond the Bangka and Belitung islands.

7.3 Why should you care?

Why should you care for this oceanic space's complex and ongoing issues off the Bangka and Belitung islands? The significant constraint of caring for the seafloor issues here exists as the physical site of the offshore tin mining operations is situated in the Indonesian territorial sea and is also physically distant from everyday life. Unless one is a miner or fisher off these islands. This also means that I agree that the Indonesian central and provincial authorities should manage and reduce the issue emerging from the contested benthic territory given existing seabed uses. But one should also understand how such notion of the territorial sea has isolated the seafloor off these islands from the rest of us, albeit through infrastructure we use in everyday life, we are connected to this space, as mentioned in Chapter 1. Meanwhile, such isolation of this material site can happen given that Indonesia, like other UNCLOS members, has adopted the international treaty (UNCLOS) in its ocean governance. This international treaty promotes separation logic to allocate the ocean into multiple categories such as seabed, sea, and islands (see Chapter 2).

While such categorical logic is, in some ways, crucial to enable pragmatic ways of governing, controlling, and monitoring the territorial sovereignty of the sea, its inhered binary logic divides and confines the seabed off these islands. In other words, the geopolitical construct of separable oceanic space here cuts or even neglects existing and emerging relations with the seabed off the Bangka and Belitung islands through existing global tin supply and demand. This means that the separation logic not only isolates the physical site of the seabed tin recovery but also results in apathy on what is going on in this site. As Hau'Ofa (2008) argued, such a separation logic is dangerous as this notion can result in apathy toward fatalism through how it isolates and confines particular spaces and places. In this way, dead bodies, dangerous labor practices, the damage to the benthic habitats, and everyday marine spatial conflict off these islands are naturalized and normalized through the apathy stemming from the binary logics. That is partly, also, because, in the context of the seabed tin mining, while indeed everyone benefits from the exploitation of the seabed through how tin contributes to automobile, electricity, and electronic device manufacture, one does not consider how this infrastructure comes at the expense of human and non-human bodies on this oceanic. Therefore, the binary logic enables us to divide which space and bodies (e.g., ocean, seabed, humans, and animals) are worth sacrificing and protecting.

To contest hierarchical spatial divide logic, this study has demonstrated the importance of expanding the benthic phenomena to make visible how the seabed off these islands is geopolitically entangled with our everyday lives despite the physical distance of the seabed tin mining sites. Thus, the seafloor is not exterior to our bodies. This means this study addresses the binary logic inhered to the notion that what happens in the material site of offshore tin recovery off these islands remains on the offshore of these islands. Additionally, this study has demonstrated that the movement of humans, ships, floating rafts, tin ores, and even plumes, changing the geo-physicality of the seabed are not only driven by the offshore tin recovery but also the multi-scalar geopolitical interventions of the offshore tin recovery. This means that as long as high-end tin users and consumers exist, geopolitical interventions such as ITA and OECD, among others, will continue intervening in the offshore tin recovery to sustain the global tin and supply chain. In this way, as most of our infrastructure depends on tin production, this potentially means that directly or indirectly, we also contribute to the existence of the offshore tin recovery, existing seabed violence, and conflict. Thus, one should indeed care about the process and practice of offshore tin mining operations in Indonesia.

Even when one argues that the source of tin ores can exist from other countries, this argument does not change the fact that the benthic habitat damages of the seabed off these islands can further affect our bodies intimately. That is because as coral reefs, mangroves, and other marine photosynthetic organisms (see Chapter 1) off these islands play vital roles in carbon and oxygen cycles as well as the atmospheric carbon sink, the disturbance of the benthic habitats given the tin recovery activities may also lead to reducing the natural carbon burial capacity of the seabed. In fact, this is where the site-specific tin recovery and their conflicts get entangled with the current geopolitical agenda of IPCC on reducing carbon emission to achieve 1.5°C of increased global temperature in the mid-century (IPCC, 2018). This is because when coral reefs, seagrass, and mangroves in shallow coastal areas (Kuwae and Hori, 2019; Yang et al., 2024) are crucial for absorbing global carbon emission, the benthic habitat damages off the islands can contribute to releasing atmospheric carbon dioxide. This means the existence of human, non-human, and seabed interactions off these islands also contributes to global warming and climate changes. In this way, whilst the conflict and violence of the tin recovery exists in the territorial sea, the manifestation of such contested benthic space can be felt intimately on our skins and our bodies. Therefore, the unexpected entanglement between our bodies and the seabed off these islands means these benthic phenomena disorientate us from the separation logic and orientate us toward our inextricable relations to this problem. This aligns well with the work of Ahmed (2006b) arguing, disorientation matters as disorientating our bodies can also mean reorientating our bodies to other spaces. Hence, we should care for the issues of the offshore tin mining operations, given that caring for the social conflict and violence also means caring for our own existence through the material relations we have with this space.

Indeed, even though caring of the seabed, humans, and non-humans off the Bangka and Belitung islands matter, how can our care be translated into a pragmatic way of reducing the seabed conflict and violence when the offshore tin operations are physically distant? While there is no one-fit-for-all solution to ensure that the mining accidents and benthic habitat damages are reduced significantly given the complex and systemic issues of the tin recovery, the good news is that the benthic environment issues emerging here are not pre-given and changeable. Meaning the condition of the seabed here is not inherently and, naturally, a site of offshore tin recovery. This is because this study demonstrates that seabed conflict, mining accidents, and plumes exist due to active interactions between the bodily, material, spatial, and temporal scales of geopolitics and the global, national, and provincial scales of geopolitics on the offshore tin recovery. In other words, the seabed conflict between miners and fishers, existing plumes, and habitat damages are geopolitical. For that reason, as the tin mining companies follow the global geopolitical interventions, current tin mining governance regimes should specifically create their mining requirement standards specifically for offshore tin mining operations. For instance, as this study showcases that the tin diving accidents, the existence of plumes, and the practicality of coral reef restorations should also become a consideration in the geopolitical interventions of the offshore tin recovery. Indeed, this may not directly change the condition of the seabed tin recovery as it requires time to adapt and adopt to these suggested mining requirements. However, considering challenging issues here can provide crucial feedback on the current geopolitical interventions of the seabed and its uses. The enactment of this feedback is beyond my capacity as a researcher.

This is because, in the real world, my body is also arranged by certain geopolitical constructs which constrains and enables how this study creates an intervention on this issue.

7.4 Future research recommendation

While, indeed, this study provides empirical and theoretical contributions, this study is still far from giving complete pictures of benthic geopolitics. That is because, as mentioned earlier, benthic phenomena exist everywhere in multiple spatial and temporal boundaries beyond the material site of the seabed off the Bangka and Belitung islands. Therefore, this study suggests future research to explore the intersection between benthic phenomena and geopolitics. For instance, during the fieldwork, this case study site is also entangled with other national and international geopolitical projects and interventions, such as the spatial conflict between trans-oceanic cable installation projects, undersea pipelines, and offshore tin mining operations. Beyond the site and practice-specific limitation, the analysis of the geopolitical interventions is also the limitation of this research. That is because even though this study has demonstrated the role of ITA, OECD, NGOs, provincial government, and central government on governing the seabed off the Bangka and Belitung islands, this study cannot explore emerging international organizations such as RMI (responsible mineral initiatives) and tin working group (TWG). For that reason, this study suggests future research to consider these geopolitical interventions to expand our understanding of benthic geopolitics off the Bangka and Belitung islands.

As the application of benthic phenomena, this study uniquely develops can be enacted to other case study areas and other seabed uses, other critical social scholars can use the concept of benthic phenomena to showcase benthic geopolitics beyond Indonesia. For instance, the emerging deep-sea mining issues on the area beyond national jurisdiction (ABNJ), transoceanic cable projects, undersea wine aging, and undersea cemetery can also be examined through benthic phenomena. This attempt is to showcase existing benthic geopolitics of these seabed uses. Therefore, more critical social scholars can use benthic phenomena to reveal diverse seabed and human relations and certain geopolitical constructions of the seabed. In this way, the knowledge production of the seabed through these future studies may raise public scrutiny on the practical, technical, and political mechanisms of how offshore industries construct, use, and manage the seabed as their territories, including closing or opening for other marine activities. These future studies using benthic phenomena may bring back the seabed intimately to the society living away from the sites of particular offshore extractive industries. With emerging studies focusing on the intersection between benthic phenomena and geopolitics (benthic geopolitics), one may convey how the seafloor gets geopolitically constructed by multiple offshore extractive industries. How does the geopolitical construct of the seafloor here align and misalign with the international treaty? How does it drive, normalize, and neutralize seafloor exploitation and extraction? These questions remain to be answered because this insight may show what other realities of the seafloor are excluded and made sacrificable in the process of constructing particular territories of the offshore industries. Understanding this partial knowledge of the seafloor, one can obtain a foundation to resist particular dominant meaning-making of the ocean floor, which normalizes or occludes benthic environment degradations.

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Appendix 1. An example [33] of the seabed collaboration

Seabed collaborator(s)	Planned interviews and discussion (date and time)	Contact person (name, telephone, and/or email)	Why did I need to collaborate with these actors?	Willingness to provide a platform for me (yes/or no)
Yayasan Konservasi Alam (YKN)	22 February 2022 at 07.00-08.00 p.m.	Laras, +62812-2787-972	Their separate agendas are they want to manage demersal fisheries especially grouper fish, snapper fish, and sea cucumber fish. They also make harvest strategy for benthic species. My benthic geopolitics and their non-profit organization projects also deal with the use of benthic habitats.	Yes
Badan Meteorologi, Klimatologi, dan Geofisika (BMKG)	15 February 2022 at 13.30 to 14.00 p.m.	Eka Andi Sakya, +628129437421 andi.eka.sakya@gmail.com	His research group focuses on the function of sub-sea cables for detecting tsunami, temperature, salinity and earthquake. As this undersea cable project also depends on the seafloor, their research group also becomes the users of the seafloor. For that reason, collaborating with their undersea cable projects may allow me to gain	Yes

[33] I call this table an example of the seabed collaboration. That is because, in the field, through the chain of seabed collaborators, the table of the seabed collaboration increases over time. Some of them, unfortunately, are not listed on the table.

			information how they use and deal with the spatial conflict of this oceanic space.	
UBB (University of Bangka Belitung)	23 February 2022 at 07.00-09.00 a.m.	Indra Ambalika, +6282175280815	His work focuses on demersal fishing gear (rumpon), coral reef, crabs, mangrove and marine biodiversity. Our common project is how we both also think how the government governs, uses and maintains benthic habitats and offshore tin extractions. Through this collaboration, I may know the progress of the coral reef restoration project and whether mining companies help restoring the benthic habitats.	Yes
Badan Riset dan Inovasi Nasional (BRIN)	25 April 2022, 4-5 pm	Sasono +628121135280	His work focuses improving the function of sub-sea cables for detecting tsunami, temperature, salinity and earthquake. Their organization and business depend on other seabed uses. As other marine users such as fishing and shipping industries may harm the undersea cables through anchoring	Yes

			their boats and ships, his information and network may help provide insight into how the undersea cables avoid such human disturbances and overcome particular spatial conflicts.	
BRIN	2 March 2022, 4-5 pm	Michael Purwoadi, +628119110908	His work focuses on the undersea network. He aims to make sure that every island in Indonesia obtains internet and telecommunication access through his project with submarine cables. With his long experience and expertise to deal with many undersea cable actors in Indonesia, he can connect me with other submarine cables. This may allow me to understand whether conflict exists between undersea cables and offshore tin mining operations.	Yes
Institut Teknologi Bandung (ITB)	26th April 2022, 16.00-17.00 pm	Syarif Hidayat, +628122044280	He has many undersea cable installation projects because he has his own undersea cable installation company. One of his	Yes

			submarine cable installation projects is off the Bangka and Belitung islands in Indonesia. From him, I can get information how the undersea cable companies can secure the seafloor access especially when the seafloor has already become the material site of the offshore tin mining operations.	
The University of Bangka and Belitung islands (UBB)	22nd May 2022 at 09.00-10.00 p.m.	Eddy Nurtjahya, eddy_nurtjahya@yahoo.com	His work has revolved around investigating socio-economic and environmental impacts of the offshore tin mining operations. Through him, I may understand where offshore tin mining operations are prevalent and how coastal communities perceive the seafloor extracting activities.	
Yayasan Konservasi Alam Nusantara (YKAN)	27 April 2022 16.00-17.00 p.m.	Glaudy gperdanahardja@ykan.or.id	As he focuses on improving grouper fisheries and coral reef fisheries, he is also the actor of the seafloor use. For that reason, collaborating with him, I may obtain information what the seafloor means through his expertise and praxis.	Yes

The Ministry of Fisheries and Marine Affairs (MMF) representative	July 2024	Fitri, +62 813-8624-7663	His work focuses on promoting integrated marine spatial planning, the spatial conflict between marine users (e.g., offshore tin mining operations, undersea cable installation projects, and coral reef restorations). Collaborating with her not only allows me to gain access regarding current marine spatial planning (MSP) policies in Indonesia and the Bangka and Belitung islands. But also, such collaboration may enable me to access marine stakeholders (the seafloor users).	Yes

Appendix 2. semi-structure and in-depth interview table

Interlocutors	Number (n)	Type of interviews (yes = ü and no = x)		Duration (minutes)	In-depth questions	Semi-structured interviews
		In-depth	Semi-structured			
Offshore tin mining representatives	17	ü	ü	40-70	1. What is your role and responsibility in offshore tin mining operations? 2. How long have you been working or operating mining ships? 3.Where do you mine the seabed and why? 4. At what depth do you operate your mining ships to recover tin ores? 5. What are the challenges to recover tin ores? 6.Do you know how wide the footprint of the seafloor extraction is? 7. What mining and digital twin technologies do you use? 8. How deep and large are your size of the seabed tin mining sites? 9. Do you have a spatial conflict with other marine users (e.g., other seabed tin miners and fishers)? 10. What are challenges of extracting the seafloor minerals apart from potential social conflicts with other marine users?	1. Today the weather is not good. Does this situation make you need to stop your process of extracting tin ores from the seafloor? 2. Do you consider the high sea waves and winds as a vital consideration to stop or continue your tin recovery? 3.You said that your mining companies were charged due to discharging tailing to the ocean. Could you please elaborate why this tailing discharge is problematized by the fisheries and marine department? 4. Do you consider discharging tailing directly to the sea a problem? 5. How large is your concession area? 6. Do you think having environmental impact assessment (EIA) and mining permits help? 7. What do you think about sediment plumes?
Marine Ecologist	2	ü		40-70	1. What is your role and responsibility in coral reef restorations? 2. What do you think of current benthic habitat status off Bangka and Belitung islands? 3. Do you think the current marine spatial planning help governing the oceanic space? 4. What do you think of tin diving operations? 5. How do you think one can restore benthic habitats when sediment plumes are everywhere? 6. Why do you care for the benthic habitats?	

					7. How do you restore coral reef ecosystems in the previously mined areas? 8. What diving technologies and coral reef restoration equipment do you use to put coral reef substrates on the seafloor? 9. What does the seafloor off the Bangka and Belitung islands for you?	
Department of Energy and Mineral Resources representative (provincial level)	1	ü		40-70	1. What is your role and responsibility in offshore tin mining operations? 2. How do you issue mining permits and concession areas for mining companies? 3. Do you increase the number of mining permits every year for the offshore tin mining operations? 4. What are current legal enforcement challenges to govern mining permits? 5. How do you deal with the spatial conflict of interest among other ministries in regulating the seafloor? 6. What are current spatial conflict in the use of the seafloor? Is there any recent project that disputes the spatial use of the seafloor?	
Department of Fisheries and Marine (provincial level)	1	ü		40-70	1. What is your role and responsibility in the current marine spatial planning (MSP) mapping policies and interventions? 2. How are the time and space of the seafloor managed and governed by the provincial authority through MSP mapping policies? 3. Do you think the depth and distance of the sea matter in the enforcement of the MSP? 4. How do you conduct monitoring and surveillance to the offshore tin mining operations? 5. What is the status of benthic habitats off Bangka and Belitung islands? 6. How do you reduce, manage, and govern sediment plumes off Bangka and Belitung islands? 7. Do you think current environmental impact (EIA) work to manage the existing plumes? 8. How do you govern existing illegal artisanal seabed tin mining operations	

					such as tower dredging operations and tin diving operations?	
The Ministry of Fisheries and Marine Affairs representatives (MMF) (central level)	3	ü		40-70	1. What is your role and responsibility in the current marine spatial planning (MSP) mapping policies and interventions? 2. How are the time and space of the seafloor managed and governed by the central authority? 3. How do you create imaginary borders on the ocean? Do you consult with the Indigenous? 4. Do you think the depth and distance of the sea matter in the enforcement of the MSP? 5. How do you conduct monitoring and surveillance to the offshore tin mining operations? 6. What is the status of benthic habitats off Bangka and Belitung islands? 7. How do you reduce, manage, and govern sediment plumes off Bangka and Belitung islands? 8. Do you think current environmental impact (EIA) work to manage the existing plumes? 10. How do you reduce and govern multiple seafloor uses off the Bangka and Belitung islands? 11. What do you think about the transoceanic cable installation, which will crisscross multiple islands' ocean territories including offshore the Bangka and Belitung islands?	
Environmental sociologist	2	ü		40-70	1. What is the focus of your study in offshore tin mining operations? 2. Why does the spatial conflict between offshore tin mining operations and other marine users take place? 3. How do the politics within provincial authority drive the existence of offshore tin mining operations? 4. Who are the key players in offshore tin mining operations? 5. Why do tin diving operations continue to exist? 6. Has there been any accident in tin diving operations? 7. Do you the provincial and central government record the number of	

					accidents in tin diving? Why or why not?	
The Ministry of Environmental Protection representatives	1	ü		40-70	1. What is your role and responsibility in the current marine spatial planning (MSP) mapping policies and interventions? 2. How are the time and space of the seafloor managed and governed by the central authority? 3. Do you think the depth and distance of the sea matter in the enforcement of the MSP? 4. How do you conduct monitoring and surveillance to the offshore tin mining operations? 5. What is the status of benthic habitats off Bangka and Belitung islands? 6. How do you reduce, manage, and govern sediment plumes off Bangka and Belitung islands? 7. Do you think current environmental impact (EIA) work to manage the existing plumes?	
Non-profit environmental organization representatives	2	ü		40-70	1. What is your role and responsibility in your non-profit organizations? 2. Why do you care about the issues of offshore tin mining operations and marine habitat conservations? 3. What are the biggest environmental threat to marine habitats? 4. How do you think the provincial and central government should manage the offshore tin mining operations? 5. Who do you think get affected the most from the increasing number of miners in offshore tin mining operations? 6. Do you think fishers understand the impact of sediment plumes and seafloor extractions? 7. Which area is getting affected the most by the offshore tin mining operations? 8. How do you produce reports related to mining accidents and environmental degradations? 9. Have you had discussion with other marine actors about governing and managing spatial conflict between offshore tin mining operations and	

					marine users and their environmental issues? 10. What are the most challenging part to advocate marine environment conservation off the Bangka and Belitung islands?	
Indigenous fisher	2	ü	ü	40-70	1. What is your main fishing target? 2. Do you still catch shrimps in your sea? 3. Do you receive compensation from the current offshore tin mining operations existing in your marine environment? 4. Do you know why your catch experiences decline? 5. Who does help you to relay your grievance to mining operations (if any)?	1. Do you know why plumes emerge everywhere? 2. Does every fisher in your community change their profession to tin diving operations?
Undersea cable association representatives	3	ü		40-70	1. What is your role and responsibility in the undersea cable project and associations? 2. What are the steps of laying submarine cables on the seafloor? 3. Could you please tell me what technologies are commonly used in the practice of the undersea cable installations? 4. Do you think the increasing use of the internet in Indonesia has led the rising number of the undersea cable installations in Indonesia? 4. What do you think about current spatial conflict between offshore tin mining operations and undersea cable installation projects off the Bangka and Belitung islands? 5. Do you think current integrated marine spatial planning (MSP) helps governing and managing the spatial conflict between undersea cables and other marine users? 6. What are the riskiest depth and distance to deploy undersea cables? 7.Why does the installation of the fiber optic cable on the seafloor increase? 8. Do you also consider the sea weave, the geo-physicality of the seabed (e.g., muddy and rocky seabed substrates matter in the process of laying the undersea network?	

Tin divers	3	ü	ü	40-70	1. Why do you become a tin diver? Or what motivates to become tin diver? 2. What are the most common risks of becoming tin divers? 3. How much amount of tin ores do you obtain from tin diving operations each day? 4. How do you know you suction tin ores when you dive? 5. How deep do you dive to extract tin ores? 6. How do you know that there are tin ores beneath the seafloor? 7. How long do you dive to recover tin ores? 8. Where do you sell your tin ores? 9. What technologies do you use to recover tin ores? 10. Do you know the history of tin diving operations? 11. How many tin diving crews are on one wooden floating raft? 12. What are the current challenges to dive and recover tin ores from the seafloor? 13. How do you reduce the risk of emboly (i.e., the air getting into your body while diving)? 14. How do new tin divers get training on how to dive and recover tin divers? 15. Do women also dive to recover tin ores?	1. I am sorry for your traumatic experience of almost getting buried alive during the process of tin recovery through diving. If I may and not trigger you, could you please tell me what does it feel like being under the ruins of the seafloor? 2. Were you still affected by that trauma in tin diving operations? 3. How did anyone help someone to get out from the seafloor? 4. You said many tin divers' bodies were trapped there, could their bodies finally get recovered? 5. Did the provincial government help providing safety for tin divers?
Coral reef restoration representatives	1	ü		40-70	1. What is your role and responsibility in coral reef restoration project? 2. How do you learn to grow the coral reefs on artificial substrates? 3. How deep do you dive into the coral reef restoration stations? 4. What do you feel when you are under the sea? 5. Do you feel anxious during the process of laying coral reef fragments and substrates on the seafloor? 6. What diving gears do you use to plant the coral reefs and their substrates? 7. Do local fishers help you to place the coral reef substrates? 8. What are challenges of growing coral reefs?	

					9. Do you think water turbidity, sea wave, and depth matter in the success of coral reef restoration project? 10. Why do you care for coral reefs? 11. Who does fund your coral reef restoration project?	
Badan Riset dan Inovasi Nasional (BRIN)—Indonesian National Research Agency representatives	2	ü		40-70	1. What is your role and responsibility in the undersea cable project and associations? 2. What do you think about current spatial conflict between offshore tin mining operations and undersea cable installation projects? 3. Do you think current integrated marine spatial planning (MSP) helps governing, managing, and reducing potential spatial conflict between undersea cables and other marine users (e.g., fishers, shipping, and seabed mining industries)? 4. What are the riskiest depth and distance to deploy undersea cables? 5. Where and how deep do you lay your undersea cables on the seafloor? 5.Why does the installation of the fiber optic cable on the seafloor increase? 6. Do you also consider the sea weave, the geo-physicality of the seabed (e.g., muddy and rocky seabed substrates) when laying your submarine cables? If yes, why?	
Total	40					

Appendix 3. A participant observation guideline

Location	Point to observe and note	Engagement	Disengagement	Duration
Mining ship environment	1. Observe mining facilities (e.g., kitchen, prayer rooms, and toilets) and note how such facilities are crucial for the well-being of the offshore tin miners. 2. Observe sounds and the movement of the mining ships and note whether the ship moves from one mining site to another. How does the ship move when extracting tin ores? 3. Observe the surrounding of the mining ships. Are there fishers and other offshore tin miners (e.g., tin tower dredging and tin diving operations)? 4. Observe the flow of sediments to the mineral reservoirs and the way mining ships discharge their tailing back to the sea. 5. Observe how many people work in mining ships and take a note. 6. Observe how many people work on separating tin ores and sediments on tin washing plants. 7. Take pictures and videos (ask their permissions before you document what you observe).	1. Ask how offshore tin miners navigate mining ships when there are other marine uses. 2. Ask why mining facilities matter to them. 3. Join their daily mundane activities (e.g., preparing meals and praying). 4. Participate in tin washing plants.	1. Do not ask about tailing until they start the conversation about the issue of the discharged seafloor sediments. 2. Do not disturb miners when they are performing their chores on the mining ship.	40 to 60 minutes
Mining navigation rooms	1. Observe if there are digital twin technologies (e.g., seafloor simulation and mining simulations). 2. Observe and note diverse mining technologies are used in mining ships. 4. Observe whether they have a table of mining reports and what data are there.	1. Ask what technologies help them to detect tin ores. 2. Ask how they get the seabed tin deposit maps. 3. Ask how long they work on navigating ships	1. Do not disturb mining navigators when they have to move mining ships to new mining sites. 2. Do not disturb or ask questions when they read the seafloor tin mining maps to locate where tin ores are beneath the seafloor.	40 to 60 minutes

	5. Observe if they use paper-based seafloor mining maps. 6. Observe and note how many people work in a mining navigation room. 7. Take pictures and videos (ask their permissions before you document what you observe).	and extracting tin ores and whether there are shifting systems on observing and extracting tin ores. 4. Ask what are challenges in navigating mining ships and extracting tin ores. 5. Ask whether mining navigators allow you to try navigating mining ships.		
Wooden floating rafts (e.g., tin tower dredging and tin diving operations)	1. Observe and note what diving equipment tin divers are using. 2. Observe other mining facilities (e.g., boats and mining technologies). 3. Observe and take a note how many people are working on a wooden floating raft. 4. Ask their permission to attach your Go-pro on their bodies to observe the seafloor and capture their experiences beneath the seafloor. 5. Ask their permissions to take pictures and videos.	1. Ask how they separate tin ores from the sediments, what mining technologies they use to do so, and whether their technologies are similar or dissimilar to large-scale seabed tin mining operations. 2. Ask how they give a sign to tin divers when they. successfully extract tin ores 3. Ask how long they usually work at sea.	1. Do not ask when they are busy in separating tin ores and sediments 2. Do not disturb people when they are descending to the sea.	40 to 60 minutes
Tin museum	1. Observe and note diverse representations of seafloor and seafloor tin mining operations (e.g., mining diorama, maps, and mineral representation). 2. Observe and notes the colonial history of the seabed tin mining. 3. Ask permission to take pictures, videos, and notes to Tin Museum keepers.	1. Ask tin museum tour guide when you have questions regarding the history of the seafloor tin mining ships.	1. If no questions, continue collecting notes, videos, and pictures	40 to 60 minutes

Mining companies' participant observation	1. Follow the guidance of mining companies' representative in their mining companies' facilities. 2. Observe and note physical infrastructure of mining companies (e.g., their offices and dormitories) 3. Participate on their everyday routine on going home and returning to the office. 4. Ask if they allow you to collect pictures and videos for certain physical infrastructure.	1. Ask how they organize multiple mining ships. 2. Ask what technologies and infrastructure mining companies provide for offshore tin mining operations. 3. Ask how they design their mining ships.	1. Do not disturb mining company representatives when they are communicating with their colleagues. 2. Do not disturb those who are working on their offices unless they initiate the conversation.	40-60 minutes
Boats' participant observation	1. Ask how many people operate a boat that take miners to mining sites. 2. Observe how they navigate the boat. 3. Observe the surrounding of the boat when voyaging. 4. Ask if they allow you take a picture and record videos on the entire voyages.	1. Discuss with miners on how they feel being on the boat.	2. Do not disturb miners when they are sleeping or resting during boats' voyages.	40-60 minutes
Scuba diving PADI training	1. Observe what scuba diving equipment they use for scuba diving training. 2.Observe what you feel under the sea water (e.g., water pressure and temperature). 3. Observe benthic habitat conditions. 4. Observe the duration of diving.	1. Touch the seafloor. 2. Take pictures and videos under the sea and above the sea surface.	1. Do not touch coral reefs and fish.	15 minutes to 18 minutes (depending on scuba diving trainers and remaining air in the air tank).

Appendix 4. Day trips with mining ships

Types of mining ships	Duration of ethnography (days) (n)	Seabed tin mining sites	Condition
CSD (cutter suction dredger) mining ship 1	14	Matras Sea (West Bangka islands)	Sea weather was friendly. There were no high sea waves and strong wind. That is why the head of mining ship allowed me to join onboard. Meanwhile, on the mining ship, the tin extraction produced about 1000 tons of tin ores a day.
CSD (cutter suction dredger) mining ship 2	14	Matras (West Bangka islands)	Sea weather was friendly. There were no high sea waves and strong wind. That is why the head of mining ship allowed me to join onboard. Meanwhile, on the mining ship, the tin extraction produced a lack of tin ores. The mining company evaluated seabed tin mining operation performance.
BWD (bucket wheel dredger)	14	Penganak (East Bangka Islands)	Sea weather was dangerous as strong wind and high sea wave complicated the access to the mining ship. But BWD's large size can handle the wind. However, the operation tends to be disturbed by inoperable mining gears and suction pipes. Therefore, the BWD did not produce tin ores.
CSD (cutter suction dredger) mining ship 3	1	Tempilang (East Bangka Islands)	Sea weather was too dangerous as strong

			wind and high sea wave complicated the access to the mining ship. All mining operations stopped. That is why the ethnography was shortly conducted.

Appendix 5. Estimated fieldwork cost

Budget items	Details	Total costs
Travel		
PCR test	Before departure from Germany	90 Euro
Taxi Oldenburg to Bremen Airport	AWI allows heavy luggage to use taxis.	136.83 Euro
International one-way flight ticket (Bremen & Jakarta)	16 April 2022	1,200.20 Euro
Domestic flight from Jakarta to Pangkal Pinang (Bangka Islands)	22 April 2022	184 Euro
Domestic flight from Pangkal Pinang to Tanjung Pandan (Belitung Islands)	22 July 2022	31 Euro
Domestic flight from Tanjung Pandan (Belitung Islands) to Jakarta	22 August 2022	31 Euro
Lodging		
Accommodation in Jakarta (from 17 to 22 April 2022)	6x67 Euro	402 Euro
Accommodation in Pangkal Pinang (from 22 April to 22 July 2022)	120x10 Euro	1200 Euro
Accommodation in Pangkal Pinang (from 22 July to 22 August 2022)	30x13 Euro	390 Euro
Accommodation in Jakarta (22 August to 31 August 2022)	9x22 Euro	198 Euro
Follow-up interview (online data costs) (31 August to 31 October 2022)	300 Euro	300 Euro
Equipment		
Digital voice recorder, microphone, camera, USB data stick, USB Internet Stick		Already purchased and received
Mask FFP2		14.40 Euro
Scuba diving course including equipment in Jakarta	5-day-practice plus certificate	393 Euro
Interview transcriber service	Contract from 21 April to 31 August	1,000 Euro
Foreign daily allowance per diem		
Daily meals and incidentals	120x12 euro	1440 Euro
Total		**7,010,43 Euro**

Appendix 6. Ethical clearance form approval

Carl von Ossietzky Universität Oldenburg

CARL VON OSSIETZKY UNIVERSITY OF OLDENBURG 26111 OLDENBURG

Mr
Merdeka Saputra
Carl von Ossietzky University of Oldenburg

Research Impact Assessment and Ethics Commitee

CHAIR
Prof. Dr.-Ing. Andreas Hein

ADMINISTRATOR
Zentrales Gremienbüro

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E-MAIL
gremien-ek@uol.de

OLDENBURG, 25/04/2022

Decision of the Research Impact Assessment and Ethics Commitee regarding the application Go Offshore Go Deeper: Making Benthic Geopolitics Matter; AN: Merdeka Saputra, Ewigkeit 9, 26133 Oldenburg, Tel.:017625561510, merdeka.saputra@hifmb.de, Dr. Katherine G. Sammler (Primary Supervisor), Ammerländer Heerstraße 231, 26129 Oldenburg, +4947148312512 katherine.sammler@hifmb.de, Prof. Dr. Kimberley A. Peters (Secondary Supervisor), Helmholtz Institute for Functional Marine Biodiversity at the University of Oldenburg (HIFMB), Ammerländer Heerstraße 231, 26129 Oldenburg, kimberley.peters@hifmb.de (Drs.EK/2022/032)

CENTRAL OFFICE OF COMMITTEES

POSTAL ADDRESS
26111 Oldenburg, Germany
PARCELS
Ammerländer Heerstraße 114 - 118
26129 Oldenburg, Germany
FAX
0441 798-2399
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www.uni-oldenburg.de

Dear Mr Saputra,

The Research Impact Assessment and Ethics Committee at the Carl von Ossietzky University of Oldenburg thoroughly examined the abovementioned research project during its meeting on 30.03.2022. The Committee has no objections to the implementation of the project.
Committee members who are involved in the research project or whose interests are affected by the research project did not participate in the discussion and decision-making process.
The Committee's positive assessment assumes conditions will remain unchanged.

Please note the following points:

- You must inform the Ethics Committee, immediately and voluntarily, of any changes to the research protocol and to the documents submitted as part of this application. Any serious adverse events that fall within its scope of responsibility must be reported

Page: 1/2

promptly to the Committee.

- The respective researcher remains fully responsible.
- The Ethics Committee may withdraw or change this decision at any time. You will be duly informed of any such decision.
- Please provide a copy of this decision and the documents on which the decision was based to all researchers involved in the project.

Please note that the project is subject to the EU's General Data Protection Regulation (GDPR). With regard to data privacy and declaration of consent, the following points in particular must be observed in addition to the measures already in place for ensuring data protection:

a) You must appoint someone to be responsible for data processing throughout the project. If this person becomes the project manager, he or she must nonetheless be explicitly mentioned by name as the person responsible for data processing.
b) You must publish the name and contact details of the relevant data protection officer (at the University and partner organisation(s)/principle investigator's institution).
c) Participants in the research must also be made aware of their right to complain to a data protection supervisory authority (state data protection commissioner or national data protection commissioner in the state/country in which the research centre, partner organisation(s) or principle investigator is located). The relevant data protection supervisory authorities must also be mentioned. This information must be adapted for each research/study centre.
d) The data subjects must be informed of their right to access (including the free transfer of a copy of) their personal data and their right to request that their data be corrected or deleted, if necessary.

For more information regarding your obligations towards research participants, please refer to Article 13 ff. of the GDPR. The Ethics Committee does not verify the accuracy of the information pertaining to the data protection commissioners and the supervisory authorities. For the Ethics Committee, it is sufficient to provide the area for the information concerning the regional data protection commissioner and the supervisory authorities.

I wish you every success in your project.

Kind regards,

signed.
Prof. Dr.-Ing. Andreas Hein

Appendix 7. A qualitative study permit on offshore tin recovery

Number : 1096 /Tbk/UM-4020/22-S8.11
Date : 23 Mar 2022
Attachment : -
Subject : Research approval

To :
Katherine G. Sammler, PhD
Research Group Lead
Marine Political Ecology

Responding to the letter from Katherine G. Sammler, PhD, on 21 February 2022, we hereby inform that we have approved the proposed research activity at Production Planning and Control Division for the following person:

Name : Merdeka Agus Saputra
Research Title : *Go Offshore Go Deeper: Making Benthic Geopolitics Matters.*
Length of activity : 22 April – 22 June 2022 (2 months)

Due to the limitation of facilities at Mining company the expenses for accomodation and transportation during the activities will be subjected to the person concerned. Besides, the health protocols of Covid-19 are strictly applied within the activities and mandatory to obey.

Following this, we also inform that prior to the activities at the work unit appointed, the person concerned needs to report first to HR Learning and Development Division (0717-4258000), Ext 10165 by bringing this letter. If the person are unable to come at the scheduled meeting, he will be considered to have resigned from the research activity.

Thank you very much for your kind attention and good cooperation.

Mining company
Head of HR Learning and Development Division,

Mining company

Head of Production

Copy:
- Head of Production Planning and Control Division

[34][35]

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[34] During my fieldwork, the length of activity was extended until the end of July because the head of mining ships allowed me to conduct more interviews and research activities on the ships and mining company environment.

[35] I intentionally censors the real name of mining company, the personal information, and the identification number with a pseudo-name because I intend to protect the mining company's name. The production on the letter refers to offshore tin mining operations as about 95% of the tin ores are extracted from the seafloor.

Appendix 8. The statement of authorship on published section on Chapter 5

Manuscript tasks	Roles
Data curation	Merdeka Saputra (lead)
Conceptualization	Merdeka Saputra (lead) and Katherine G. Sammler (advisor)
Problem analysis and writing	Merdeka Saputra (lead) and Katherine G. Sammler (advisor)
First and final draft editing	Merdeka Saputra (lead) and Katherine G. Sammler (advisor)
Grammar, spelling, and transition sentences editing	Merdeka Saputra and Katherine G. Sammler (equal)
A GPS map picture	Katherine G. Sammler (lead)
Submission process	Merdeka Saputra (lead) and Katherine G. Sammler (advisor)

Oldenburg, 7 August 2024

Co-author

Merdeka Agus Saputra

Katherine G. Sammler

Appendix 9. the license of Sn on the periodic table picture was purchased by AWI for me

1 von 2

Einkaufswagen 1000027561

Absender
AWI Helmholtz-Zentrum
Am Handelshafen 12
Bremerhaven 27568

Lieferanten-Informationen
Lieferant:
Name:

Information
Einkaufswagenname: M. Saputra Foto 30.08.2024 12:45
Erstellt am: 30.08.2024
Ersteller: Sarah Meiser
Anforderer: Sarah Meiser

Anzahl der Positionen: 1
Gesamtpreis des Einkaufswagens: 20.00 EUR

Pos	Beschreibung	Lieferant	Materialnr.	Menge	ME	Liefertermin		Ges. Preis	Währung
10	Periodensystem Foto			1,000	ST	04.09.2024	20,00	20,00	EUR

Texte zur Position

Lieferanten- (Positionstext):
https://www.alamy.com/tin-chemical-50-element-of-periodic-table-molecule-and-communication-background-chemical-sn-laboratory-and-science-background-essential-chemical-m-image258731559.html

Das Foto muss gekauft werden, sodass dieses im Anschluss gerdwonloaded werden kann.
Der
Kauf und die Rechte des Fotos werden benötigt.

2 von 2

Einkaufswagen 1000027561

Interne Notiz (Infonotiz):

Bedarfsbegründung :
Für eine Publikation und Research wird ein Periodensystem benötigt.

Hinweis an den Einkauf :

Anlieferadresse:
HIFMB

C/O: Sarah Meiser
Am Technologiepark 5
26129 Oldenburg
Kontierungsinformationen
Kostenstelle Sachkonto 4770 Auftrag/ Kostenträger EP79010007 PSP-Element

Appendix 10. A declaration that this thesis is independently written and without authorized external assistance

I hereby declare that I have written this thesis titled Benthic Geopolitics off the Bangka and Belitung islands: Go Offshore Go Deeper independently and without unauthorized external assistance. That is to say, I do not use any means other than the aids specified and have acknowledged and attributed all thoughts taken directly or indirectly from external sources.

Therefore, I hope you approve this thesis for the requirement of my thesis defense and for awarding my doctoral degree. Thank you very much for your consideration.

Yours sincerely, 30.09.2024, Oldenburg, Germany

Merdeka Agus Saputra

Appendix 11. A declaration that this thesis is not part of a Bachelor’s, Master’s, Diploma or similar examination paper

I hereby declare that the contents of this thesis titled Benthic Geopolitics off the Bangka and Belitung islands: Go Offshore Go Deeper, for the most part, have not been used by me, **Merdeka Agus Saputra**, for a Bachelor’s, Master’s, Diploma’s, or similar examination paper.

With this declaration, I hope you approve this thesis for the requirement of my thesis defense and for awarding my doctoral degree. Thank you very much for your consideration.

Yours sincerely, 30.09.2024, Oldenburg, Germany

Merdeka Agus Saputra

Appendix 12. A declaration that the regulations on good scholarly practice of the University of Oldenburg have been followed

I hereby declare that I have followed the regulations on good scholarly practice of the University of Oldenburg to research, write, synthesize, and abstract this thesis titled Benthic Geopolitics off the Bangka and Belitung Islands: Go Offshore Go Deeper. For example, this research has also received ethical clearance approval from the ethics committees at the University of Oldenburg.

Therefore, I hope you approve this thesis for the requirement of my thesis defense and for awarding my doctoral degree. Thank you very much for your consideration.

Yours sincerely, 30.09.2024, Oldenburg, Germany

Merdeka Agus Saputra

Appendix 13. A declaration that no commercial placement or consulting services (PhD counseling) have been used in connection with the doctoral project

I hereby declare that I do not use commercial placement or consulting services (PhD counseling) for designing, conducting, analyzing, and writing the findings of this doctoral research.

Therefore, I hope you approve this thesis for the requirement of my thesis defense and for awarding my doctoral degree. Thank you very much for your consideration.

Yours sincerely, 30.09.2024, Oldenburg, Germany

Merdeka Agus Saputra

Appendix 14. The letter of admission to a PhD program at Faculty 1 Education and Social Science

Carl von Ossietzky Universität Oldenburg

Fakultät I - Bildungs- und Sozialwissenschaften

Carl von Ossietzky Universität Oldenburg / 26111 Oldenburg

Mr.
Merdeka Saputra
Ewigkeit 9
26133 Oldenburg

Der Promotionsausschuss
Die Vorsitzende
Prof. Dr. Gisela C. Schulze

Geschäftsstelle
Inge Wiehebrink
Tel. 0441 798 - 4663
Ingeborg.gerdes.wiehebrink@uol.de

Oldenburg, den
27. April 2022

Standort
Campus Haarentor, Gebäude A02
Ammerländer Heerstraße 114 - 118
26129 Oldenburg

Postanschrift
26111 Oldenburg

Paketanschrift
Ammerländer Heerstraße 114–118
26129 Oldenburg

Bankverbindung
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IBAN DE46 2805 0100 0001 9881 12
BIC SLZODE22

Steuernummer
6422008701

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Your application for admission to a PhD programme at School I

Dear Sir,
on 27th of April 2022, the Doctorate Committee considered and approved your application for admission to a PhD programme. You have been admitted to the PhD programme*.

The working title of your thesis is:

"Go Offshore Go Deeper: Making Benthic Geopolitics Matter"

You received the copy of the signed Supervision Agreement with the admission as a doctoral candidate.

We would like to remind you that, in accordance with Section 9 (1) of the Doctoral Degree Regulations dated 21/04/2020, you must submit your application to initiate the doctoral procedure at the earliest one year after admission and at the latest within five years of admission to the PhD programme. Upon request, and in justified cases, these deadlines can be adjusted as appropriate. If the application to initiate the doctoral procedure is not submitted on time, or if it is submitted after the deadline and the period of grace, the application for admission will be deemed to have been withdrawn.

Kind regards

Schulze

Prof. Dr. Gisela C. Schulze
The Chair of the Doctorate Committee

A copy of this letter will be sent to Professor Sammler in their role as primary academic supervisor
A copy of this letter will also be sent to the Registrar's Office.

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*in accordance with Section 9 (2) sentence 4 of the Lower Saxony Higher Education Act (NHG): doctoral candidates must enrol as such.

Please note: This is an unofficial translation provided for your convenience only and does not have any legal binding effects! Only the German version is legally binding!