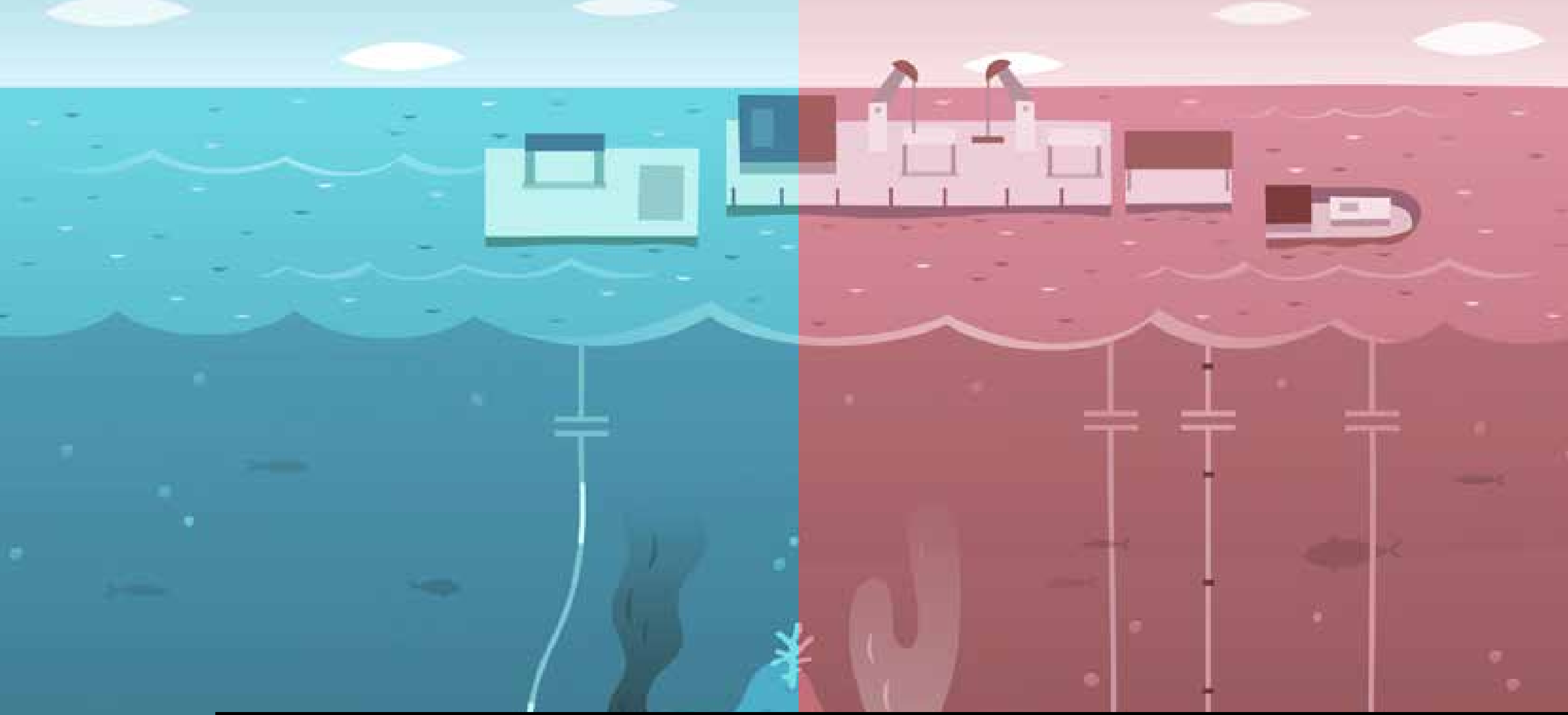
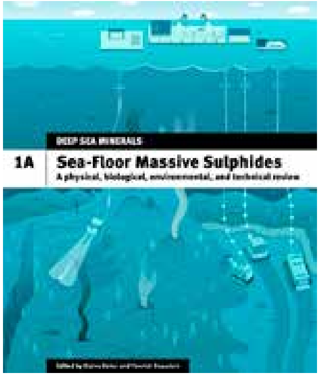
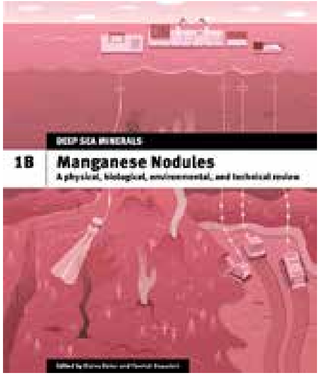


DEEP SEA MINERALS

SH Summary Highlights



Volume 1A: SPC (2013). *Deep Sea Minerals: Sea-Floor Massive Sulphides, a physical, biological, environmental, and technical review.* Baker, E., and Beaudoin, Y. (Eds.) Vol. 1A, Secretariat of the Pacific Community.



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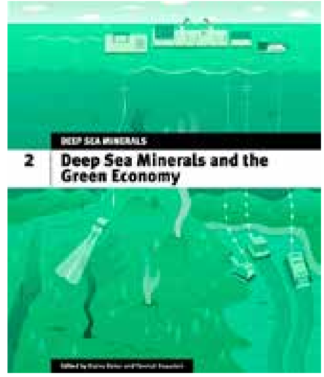

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SPC CPS
SECRETARIAT OF THE PACIFIC COMMUNITY
SECRÉTARIAT GÉNÉRAL DE LA COMMUNAUTÉ DU PACIFIQUE

The Secretariat of the Pacific Community-European Union Deep Sea Minerals in the Pacific Islands Region: A Legal and Fiscal Framework for Sustainable Resource Management Project (the DSM Project) is being implemented in the following 15 Pacific ACP states: Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Timor Leste, Tonga, Tuvalu, and Vanuatu.

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Foreword

Over the last half-century metal grades in terrestrial mineral deposits have been decreasing steadily. Due to the progressive increase in metal prices, triggered by the growing demand, which has been accompanied by the improved efficiency in mining technologies, massive low-grade deposits are now becoming economical. However, mining these deposits, which often occur in remote and challenging terrain, produces large volumes of waste material that can cause environmental degradation if poorly managed.

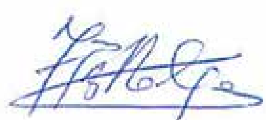
On land mining of large low-grade copper deposits is often cited as an example of this and has led to some of the largest and deepest man made holes on earth. Mining, processing and disposal of very large tonnages of rock materials at such mines involve the mass movement of mountains of waste rock. However, as required under modern mining laws, recent mining is designed to undertake these processes in as environmentally and socially acceptable a manner as possible but the sheer scale of operations presents many challenges.

These factors have turned the attention of investors and developers to alternative sources of metals, including the deep sea. The existence of minerals on the seabed has been known for many years and there have been numerous research cruises in the Pacific region aimed at understanding and documenting these potentially rich deposits. In fact, more mineral deposits have been discovered in the Pacific Ocean than in any other ocean. They represent a potential source of important industrial and “high tech” minerals, including copper, nickel, zinc, gold, silver, manganese, cobalt, molybdenum, rare-earth elements, and others.

The Pacific Islands have an opportunity to benefit from the development of these deep sea mineral deposits, but it is essential that comprehensive information on all aspects of the mining process is available. The Secretariat of the Pacific Community (SPC) Applied Geoscience and Technology Division (SOPAC Division), through the European-Union funded Deep Sea Minerals Project, has been working in the region to disseminate information, build capacity, and provide assistance in the development of national seabed minerals policies and legislation. This report series is part of that process.

The Deep Sea Minerals Project has made significant progress by convening regional and national consultation workshops; developing the Pacific ACP States Regional Legislative and Regulatory Framework for Deep Sea Minerals Exploration and Exploitation; providing assistance in drafting national seabed minerals policy, legislation, and regulations; and coordinating awareness of deep sea minerals and information-sharing initiatives. Capacity-building initiatives are also underway and include deep sea minerals training workshops, establishment of a legal internship program, and support for shipboard training. In addition the project has established a regional marine minerals database that will assist in the management of the resource.

We should not miss the opportunity for people of the Pacific to participate fully in deep sea mineral activities and explore the potential benefits emanating from this new industry. Indeed we have the chance to be leaders in this new industry. But we must not ignore the environmental risks involved with a new and untested industry. The region is committed to developing relevant environmental and social laws and regulations and building capacity and institutional arrangements to evaluate, monitor and regulate deep sea mining. The goal is to establish responsible governance and management of the deep sea mineral resources of Pacific Island states and to build an industry that provides prosperity now and for future generations of Pacific Island peoples.



Dr Jimmie Rodgers
Director General
Secretariat of the Pacific Community

For many of the countries in the Pacific, mining represents a new endeavour, and, for all, deep sea mining is a first. In fact the Pacific leads the world in this venture. Since its inception in 2011, the Secretariat of the Pacific Community Applied Geoscience and Technology Division's Deep Sea Minerals Project, with funding support from the European Economic Union under the 10th European Development Fund (EDF), has been working with a broad range of stakeholders from the western and central Pacific region – to share knowledge, seek common ground, and develop comprehensive national seabed mining policies, laws, and practices to be implemented by participating countries.

Several countries in the region are issuing deep sea mineral exploration licences, and Papua New Guinea (PNG) has issued a pioneering lease for deep seabed mining (the Solwara 1 Project). Pacific Island countries have also been granted exploration contracts (in partnership with commercial contractors) in the International Seabed Area (commonly known as the Area), the open ocean beyond national jurisdictions. To help prepare for these activities, the Deep Sea Minerals Project, in collaboration with members of the African, Caribbean and Pacific (ACP) Group of States, has developed a regional legislative and regulatory framework and facilitated a range of training workshops focused on specific themes relating to technical, policy and management aspects of deep sea minerals. During the process, there have been important recurring questions. Can minerals be extracted from the deep ocean seabed without adversely affecting environmental sustainability, marine life, and local communities? Can revenue support long-term development goals? Is it a good idea to start a new industry when exploitation of other resources in the region, such as fishing and forestry, has unsolved problems?

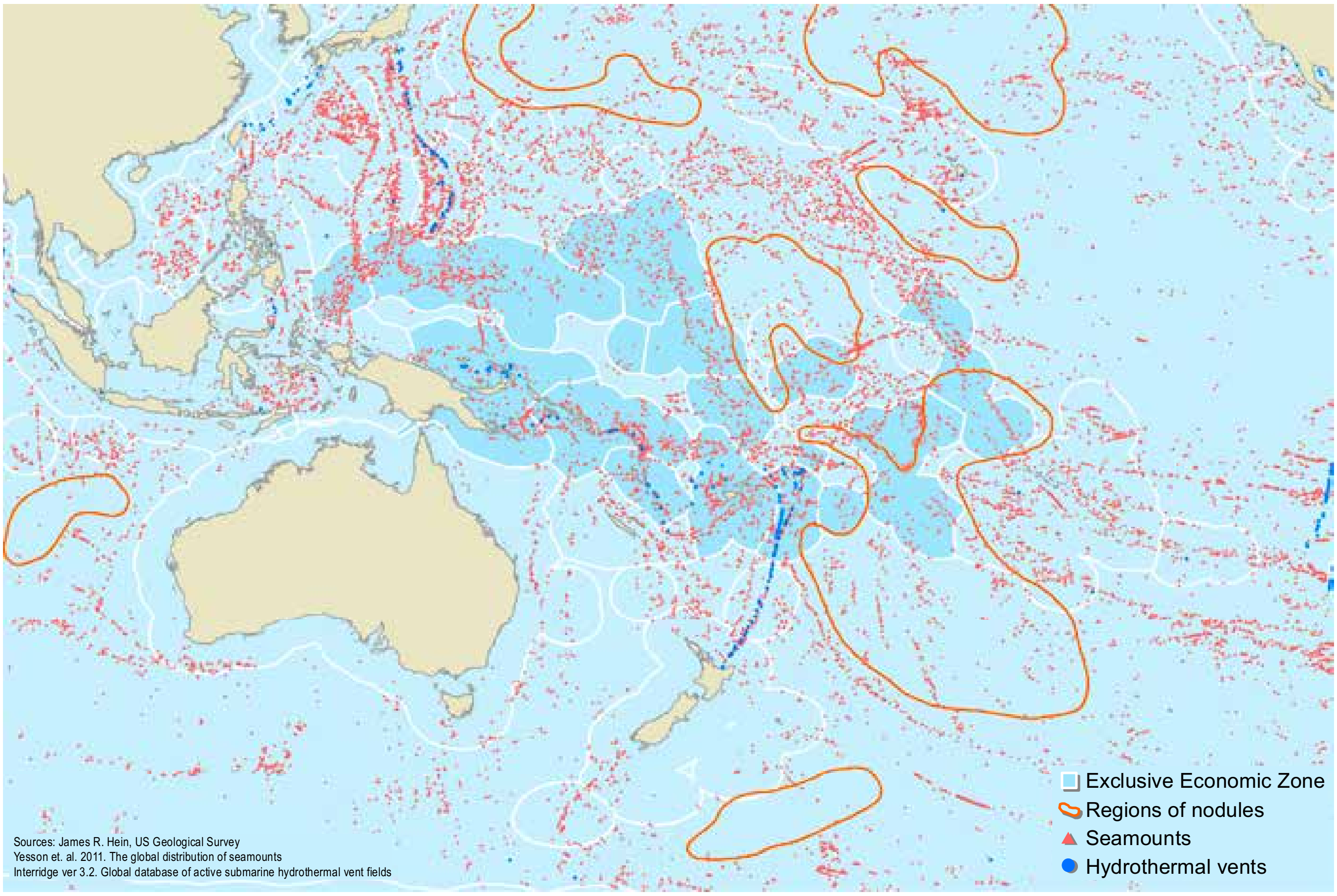
This report series collates information on the physical, biological, and technical aspects of deep sea mineral exploration and extraction and also investigates possible social, economic, and fiscal impacts and benefits to help find ways to answer these questions.

Pacific Island states wish to engage in a viable and mutually beneficial way with the deep sea minerals industry, while operating within the physical limits of sensitive island ecosystems and ensuring an equitable distribution of wealth and benefits without causing major, permanent damage to deep ocean living resources and habitats.

Flange crabs. Photo courtesy Chuck Fisher.

Deep sea minerals in the Pacific – 3 types of deposits

There are three main kinds of deep sea mineral resources that have been discovered within the national jurisdictions of several Pacific Island countries. Sea-floor massive sulphide deposits – containing localized concentrations of copper, lead, and zinc, with significant amounts of gold and silver and manganese nodules and cobalt-rich ferromanganese crusts containing notable concentrations of nickel, copper and cobalt, coupled with significant concentrations of rare-earth and other rare metals.



Deep sea environments associated with the 3 types of mineral deposits found in the western Pacific. The abyssal areas – where manganese nodules may be found, seamounts – where ferromanganese crusts can form, and hydrothermal vents – the site of sea-floor massive sulphides.

Sea-floor massive sulphides

- Sea-floor massive sulphides (SMS) form on or below the seabed where hydrothermal vents release mineralized seawater.
- Most SMS deposits have been found along mid-ocean ridges, but they are also found in back-arc basins and along submarine volcanic arcs.
- Deposits found to date are small in size and tonnage, compared to land-based deposits.
- The hydrothermal vents associated with SMS deposits represent an extreme environment that is toxic to most animals, but some species have evolved to thrive there.
- There is a gradient of animal communities from low diversity and high abundance near vent sites to higher diversity but lower densities of species away from the vent sites.

Metal concentrations vary with depth in the deposit.
Solwara 1 surface concentrations:
Copper 9.7%
Zinc 5.4%
Gold ~15 ppm
Silver ~174 ppm
(Source Lipton 2012)

Photo courtesy Chuck Fisher.

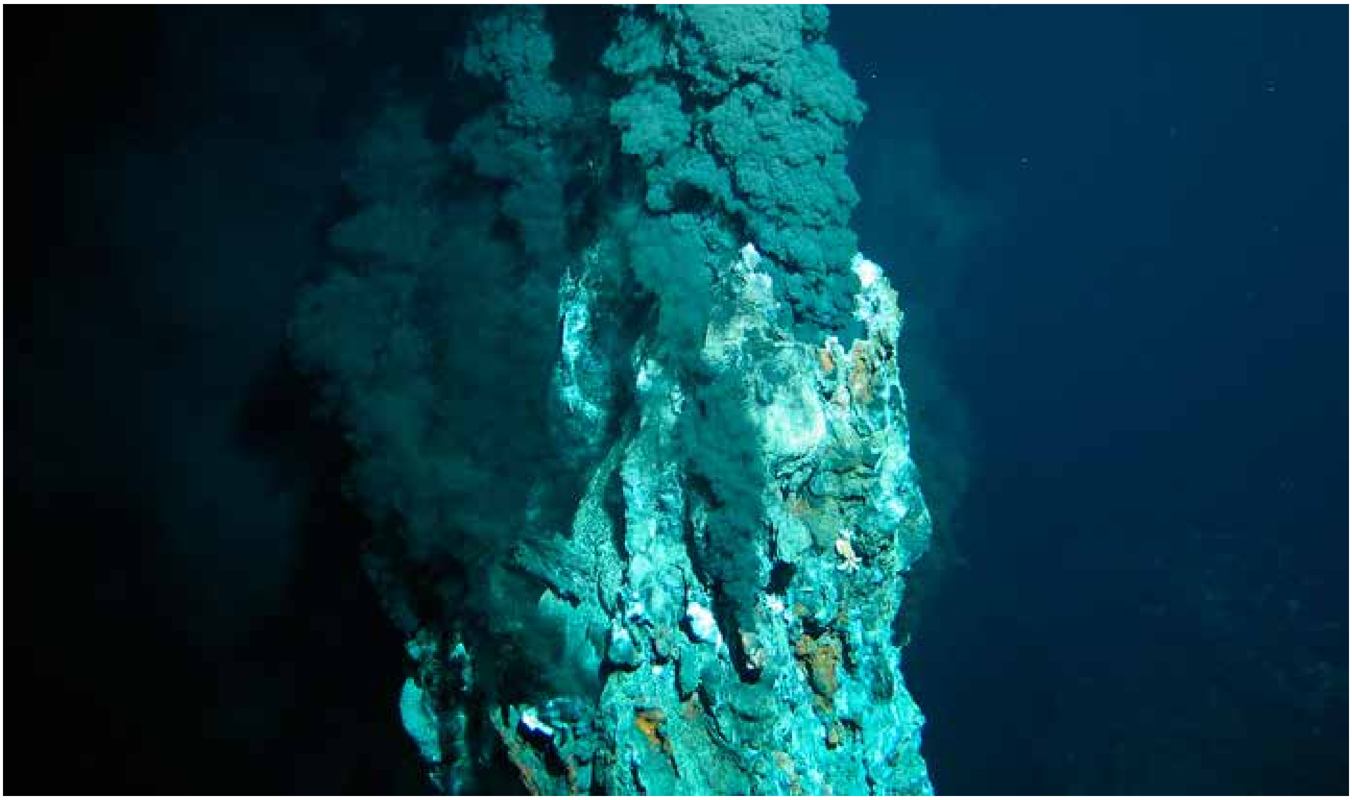


Photo courtesy of GEOMAR.

Manganese nodules

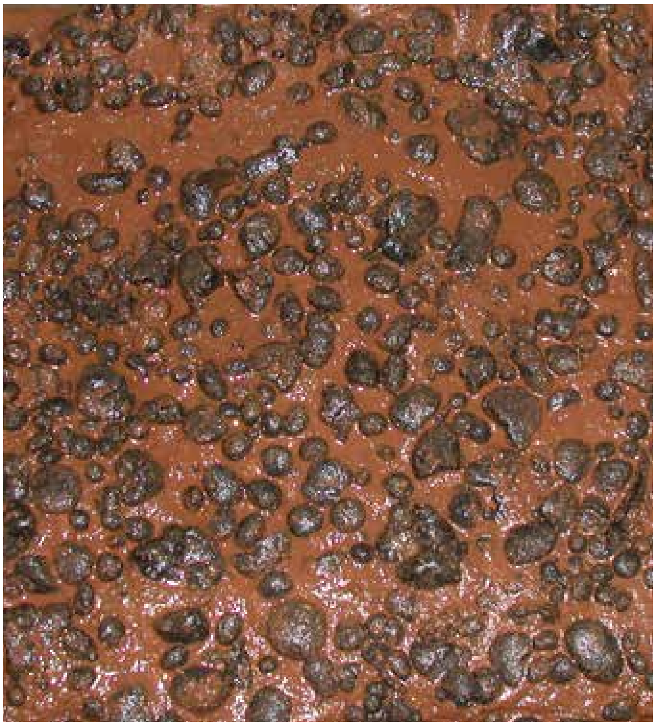


Photo courtesy of Craig Smith.

- Manganese nodules are found in very deep parts of the ocean – on the abyssal plains in water depths of 4 000 to 6 000 metres.
- Metal concentrations vary, but current estimates suggest they contain potentially more manganese, nickel, and cobalt than land-based reserves.
- Nodules accrete slowly, at rates of millimetres per million years.
- Animals live on the nodules, on the surface of the sediment, and within the sediment where nodules are found.
- Animals rely on organic material sinking into the depths, and, despite the food-limited environment, species numbers and diversity are high.

Metal concentrations vary with location.
Cook Islands:
Manganese 18%
Iron 16%
Cobalt ~4 000 ppm
Nickel ~4 000 ppm
Copper ~2 000 ppm
Total rare-earth elements ~1800 ppm
Molybdenum ~280 ppm
(Source Hein and Koschinsky 2013)

Cobalt-rich ferromanganese crusts

- Cobalt-rich ferromanganese crusts form on bare rock on the sides of seamounts and other undersea elevations in water depths from 600 to 7 000 metres, but are thickest at depths of 800 to 2 500 metres.
- Crusts contain manganese, cobalt, nickel, rare-earth elements, and other rare metals that are gaining importance for use in green technology products.
- Crusts accrete slowly, at rates of millimetres per million years.
- Organisms live on the rocky substrate, and the wide depth range supports a large variety of animals. Filter feeders, such as sponges and corals, can thrive in the fast-flowing currents associated with elevated topography and seamounts.

Metal concentrations vary with location.
South Pacific:
Iron 18%
Manganese 22%
Cobalt ~6 000 ppm
Copper ~1 000 ppm
Rare-earth elements ~1500 ppm
(Source Hein and Koschinsky 2013)


Photo courtesy of Evelyn Mervine.

Outlook for deep sea mining in the Pacific

A decision by a country to proceed with deep sea mining requires careful assessments of the broad range of economic and social consequences that could result, and analysis showing that the overall benefits are greater than the potential costs associated with mining.

A green economy can be achieved if an equitable portion of the economic proceeds of deep sea mining is reinvested in other forms of economic, social, and natural capital to ensure that societal well-being is improved and made more sustainable and resilient.

Finding a balance between:

Source: GRID-Arendal

Drivers and restricting forces of deep sea mining

	Global	Industry	Pacific Island countries
Primary drivers	Global economic growth: supply and demand, population and consumption, increased industrialization and urbanization	Innovative, frontier field in an industry used to high-risk investment	Alternate development option: alleviate poverty, meet rising aspirations, lack of comparative advantage in other areas
	State actors: securing access to essential resources, capable of vertical integration of resource extraction and processing with product manufacture	Increasing difficulty and complexity of terrestrial mining: increasing costs, decreasing grade, slowing discovery, environmental issues, social and cultural issues	Marine minerals are a new natural resource capable of commercial exploitation in a region with few economic industries/choices
Secondary drivers	Growing societal aspirations for environmental and social sustainability	Technological improvements and scalable applicability	National independence and autonomy
	New uses/markets, the green economy		
Restricting forces	Price volatility	Availability of finance, financial uncertainty	Increasing community concerns about governance of, impact and returns from extractive industries
	Concerns over threats to marine environment, lack of marine science to inform conservation planning	Regulatory uncertanty in EEZ and the Area Significant obligations to share knowledge proceeds	Lack of governance, capacity, and regulation

Source: Charles Roche

Environmental management

The fundamental objectives of environmental management are to maintain biodiversity and ecosystem structure and function, while avoiding significant adverse impacts on the ecosystem.

Scientific knowledge of deep sea environments is limited, but sufficient knowledge exists to guide initial environmental management decisions. Baseline studies of composition, distribution, and abundance of organisms are necessary before exploitation begins, and they must be followed by regular monitoring programs.

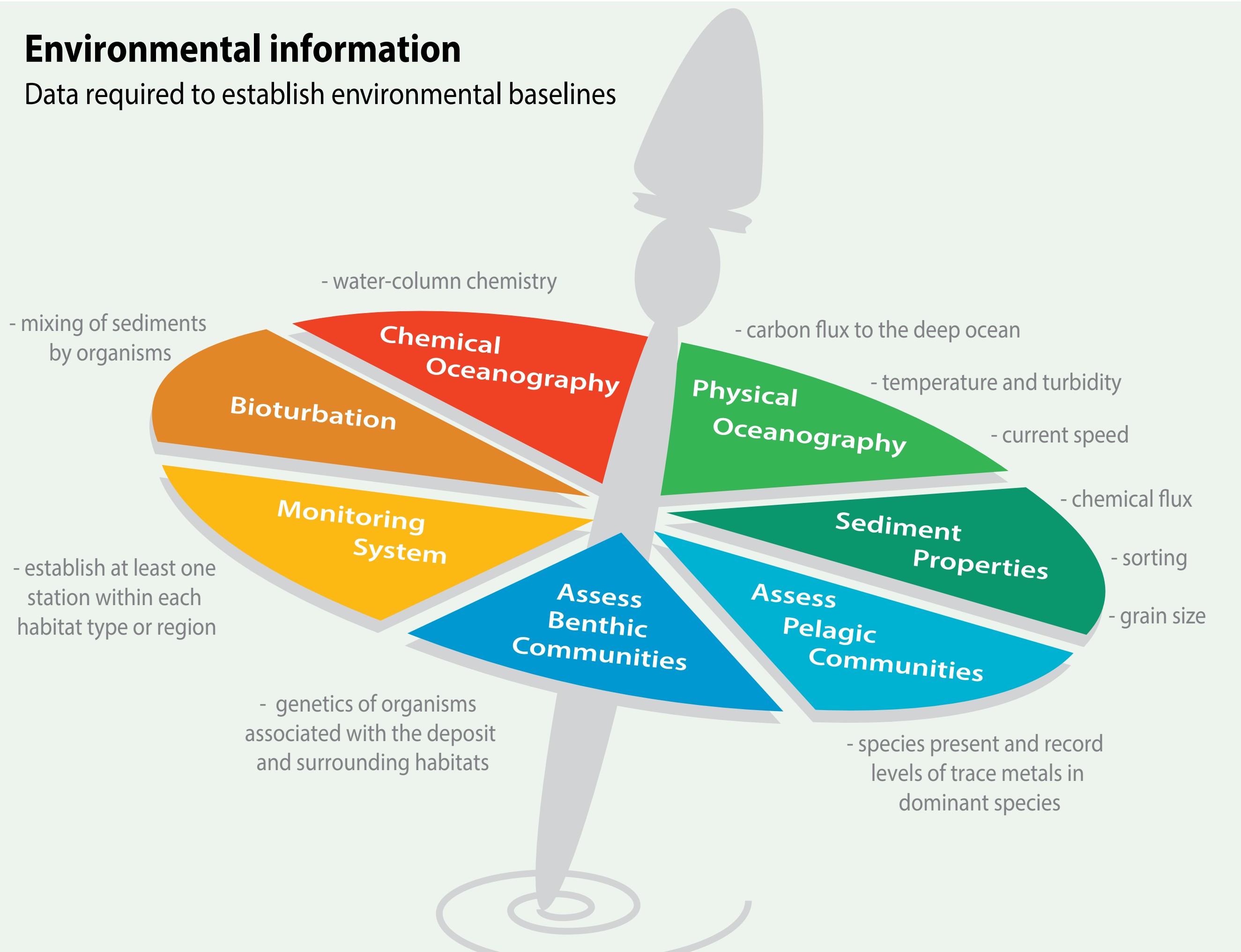
Multidisciplinary science is required, involving collaboration among industry, academia, research organizations, relevant communities or interest groups, and government agencies with a duty to protect and preserve the marine environment.

Environmental management plans will be situation-specific, but they should combine best-practice mining operations that reduce environmental impacts with spatial management that protects representative areas of similar communities from impact. A precautionary approach must also be applied.

Continuation of wide-ranging involvement from mining companies, policy makers, lawyers, managers, economists, scientists, conservation agencies, NGOs, and societal representatives will be important in successful management of the deep sea minerals sector in the Pacific Islands region.

Environmental information

Data required to establish environmental baselines



GRID-Arendal

Impact of mining on the marine environment

The impacts of mining will differ among the three types of deposits. Mining of sea-floor massive sulphides will leave permanently disturbed areas at the mine site with a surrounding area potentially impacted by debris plumes. The spatial scale of the impacted zone is difficult to estimate and will vary in relation to the volumes of mobilized sediments, sediment grain size (finer particles are more easily transported over greater distances), and the bottom current regime. In areas of active hydrothermal venting, species may be adapted to natural changes in the environment, and be able to recolonize more rapidly than the more regional deep-sea fauna.

Mining of manganese nodules on the abyssal sea floor will remove the nodules upon which animals live. Removal of the nodules renders the habitat unsuitable for these animals and leaves behind a sediment plain suitable only for a subset of the original benthic community. The impact is permanent, as the nodules will not re-form for many millions of years. Sediment mobilized by the mining operations will be dispersed over an area of unknown spatial extent, and the benthos will potentially be buried by sediment or affected by turbid water.

Mining of cobalt-rich ferromanganese crusts involves removal of material from the summit of flat topped seamounts, called guyots.. The technology for this type of mining is still in the development stage but will typically involve scraping the crusts off the underlying rocks. Sessile marine life will be killed by the mining operation, and if there is sediment in the mined area, a plume of mobilized sediment will impact life in the surrounding area. The rock surfaces left behind will be recolonized over time frames that are currently largely unknown (but likely to be slow).

Mining for the community

Current proposals for seabed mining in the Pacific Islands region appear to involve little or no onshore presence, so the direct social impacts may well differ from those that have been felt with terrestrial mining projects. However, as deep sea mining exploration and development proceeds, it will be important for all parties involved to create an environment of transparent and open information-sharing, consultation, investigation, and reporting. This environment will enable continuous prediction and assessment of benefits and negative impacts to ensure that related plans – including impact assessment and mitigation, community relations plans, and closure/rehabilitation plans – take into account the considerable range of issues that may be associated with mining projects.

Deep sea mining governance

Although deep sea mining can bring wealth to a country, fulfilling this potential is neither assured nor automatic. The extraction of non-renewable natural resources has often led to political instability, revenue management challenges, corruption, and increased social tension.

It is therefore necessary for resource-rich countries to improve legislative and regulatory frameworks, build institutional capacity, and strengthen governance in order to ensure that the endowment of natural resources translates into a benefit and does not become a curse. In particular, an effective and transparent fiscal regime is necessary to ensure that the government shares in the wealth of its deep sea mining resources and long-term revenue management mechanisms are in place to ensure that there is inter-generational benefit from this wealth.

Examples of legal, fiscal, and regulatory frameworks to underpin successful mining activity

Legal and contractual	Fiscal regime	Environmental and other regulations
Mining policy	Royalties	Waste disposal
Mining law	Income tax, resource rent	Health and safety
Licensing and mineral rights	Tenement fees	Environmental impact assessment
Contractual arrangements	Local procurement and employment	Environment management plans

Key governance principles for sustainability

Decision making	Democracy, subsidiarity; meaninful public and stakeholder participation; transparency; international cooperation; holistic approaches; policy coordination and integration; internalization of environmental and social costs
Precaution	Decision making under uncertainty, indeterminacy, irreversibility; adaptive approaches
Responsibility	Polluter pays; responsibility of generating knowledge; burden of proof; common but differentiated responsibilities; liability; accountability
Management	Prevention; rectification of pollution at source; adaptability; ecosystem approaches; partnership; mechanisms for regular review of the regime´s effectiveness and of the performance of the state institutions involved
Distribution	Intra-generational and inter-generational equity; capacity building

GRID-Arendal

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