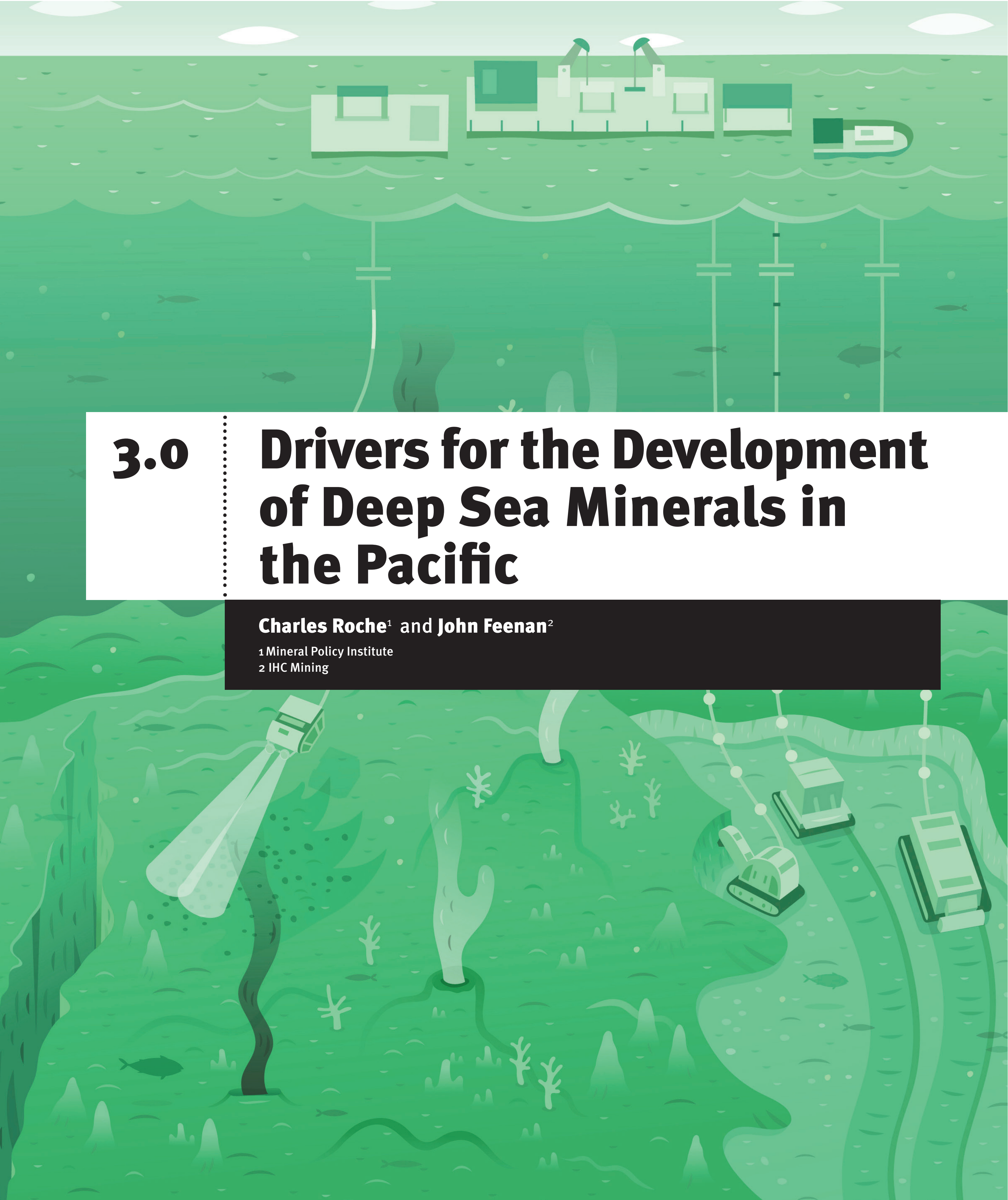

3.0 Drivers for the Development of Deep Sea Minerals in the Pacific

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Could the world's hunger for metals and minerals, and state strategies for securing access to them, propel the development of deep sea mining?

Identifying the drivers of a Pacific deep sea minerals industry requires a global perspective on metals demand, an understanding of the forces influencing the mining and minerals industry, and a regional perspective on need and opportunity in the Pacific. The combined picture is complex, with high levels of uncertainty, due to the dynamic and often interrelated nature of the drivers.

Long-term decreasing metal industry productivity, falling ore grades, and increased costs, combined with increased environmental, social, and cultural expectations for sustainability, create an opportunity for deep sea minerals as an alternate source of metal supply (along with reuse and recycling).

Across the Pacific Islands region, there is widespread and recognized need for alternative economic development to overcome poverty and meet the rising aspirations of Pacific islanders. Running counter to this is an increasingly vocal concern about impacts and a lack of communal benefit from development projects.

The focus of this chapter is the primary drivers of deep sea mining in the Pacific, with a shorter discussion on secondary drivers and the restrictive forces operating in the region (Table 1). Investigating these drivers provides an objective framework for improved understanding of the forces behind the industry, leading to better decision making. This investigation, like the industry, is in its infancy. Further work is required to better inform Pacific Island states of the factors influencing the future of the industry.

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

Table 1. Drivers and restricting forces of deep sea mining in the Pacific, 2013.

3.1 Primary drivers of deep sea mining

3.1.1 Global economic growth

Over the past 20 years, the economies of China, India, and emerging markets in Southeast Asia, Africa, and Latin America have grown quickly. They are expected to continue to outpace developed nations in the years to come (Figure 3.1). The growth of emerging market economies and the financial recovery of developed economies will be key determinants for future demand for the mining and metals industry.

The world population is growing faster than at any time in history (Figure 3.2), accompanied by an even more rapid increase in mineral consumption as the global standard of living increases and a growing number of consumers enter the market for minerals (Kesler 2007).

The World Bank identifies China as the chief driver of metal demand over the past decade (Burns and van Rensburg 2012). Between 2000 and 2009, Chinese consumption of the main base metals (aluminium, copper, lead, nickel, tin, and zinc) rose 17 per cent per annum, a trend that continued during the recovery from the global financial crisis (Figure 3.3).

Behind the rise in the economic importance of these emerging countries has been the ongoing movement of people from the countryside to the cities, strengthening the demand for the commodities needed to construct cities (Figure 3.4). Long-term growth in emerging markets has a more significant impact on the mining industry than short-term economic fluctuations in the developed world (PWC 2012).

Globally, the size of the middle class (defined as those households with daily expenditures between $10 and $100 per person in purchasing power parity terms) is predicted to increase from 1.8 billion people in 2009 to 3.2 billion by 2020 and to 4.9 billion by 2030, with the majority of the population growth (85 per cent) located in Asia (Kharas 2010). The purchasing power of this group is forecast to increase from US$21 trillion to US$56 trillion by 2030 (Kharas 2010). Rising incomes lead to changes in consumption, with increased demand for durable goods, such as cars and white goods (household equipment) with high mineral and/or metal content (Kharas and Gertz 2010).

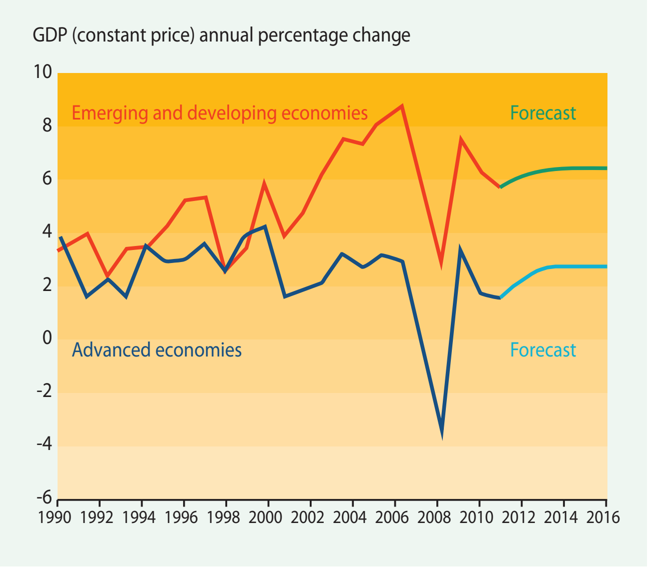


Figure 3.1 Gross domestic product: annual percentage change of emerging and advanced economies *(IMF 2013)*.

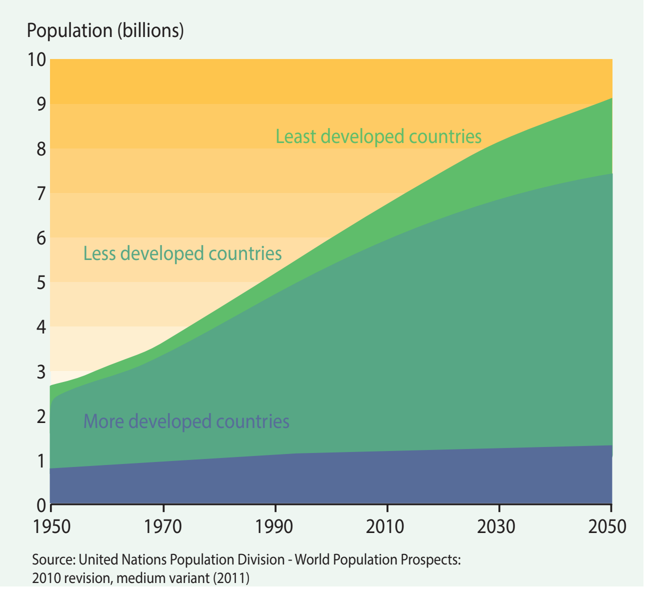


Figure 3.2 World population growth, 1950-2050 *(UNDESA 2011)*.

3.1.2 States securing access to resources

Exploration of the potential to mine the seabed has received investment and interest from both state and commercial actors. As countries develop, there is a national strategic interest in the minerals and natural resources that are key ingredients for the domestic manufacturing sector (Glasby 2000). To secure access to stable supplies of key commodities, nation states regularly support direct or indirect investment in resource projects. Japan is a case in point. It imports over 99 per cent of its oil and 96 per cent of its gas to support the domestic market. Key mineral resources used in Japanese manufacturing industries, such as copper and zinc, are also almost entirely imported.

Strategic investments for resource security may not be driven by an economic rationale for direct commercial profitability from mining if those investments sustain domestic industries, jobs, and living standards. China influences the commodities market through Chinese industry's heavy demand for raw materials and the timing of that demand, but also through its growing acquisition of shares in deposits and mining companies abroad (Buchholz *et al* 2012). The strategic interests of sovereign states like China, India, and Russia, which are seeking access to raw materials for infrastructure and manufacturing industries, may be a powerful driver for the future development of deep sea mining.

Today, the ownership of resources and changes to mining industry fiscal regimes are key issues for many governments around the world. States are generally looking for an increased share of mining profits as well as a secure supply of domestic resources. Ongoing discussions and debates, formal reviews of fiscal regimes, or legislative changes have been seen recently in Australia, Chile, Ghana, Peru, and South Africa. Increased export duties and export restrictions designed to encourage value-added downstream industries or protect security of domestic supply are being put into place in such countries as India and Indonesia.

At the more extreme end of resource nationalism, legislated local ownership and, in some cases, asset nationalization are impacting established producers in countries such as Indonesia and Zimbabwe. Governments are under pressure from local communities and other key stakeholders, with the result that the political and regulatory stability that previously existed in many mining nations is deteriorating. Nationalism continues to represent a significant risk for mainstream mining (E&Y 2012), although it is unclear whether this could have a positive or negative effect on deep sea mining.

3.1.3 Innovative frontier industry

There is a healthy appetite for risk in the mining industry, especially among start-ups and junior explorers. Trench (2011) acknowledges that successful explorers are in the minority, but sees many new mining frontiers. Deep sea mining is just another frontier in an industry that has thrived on risk and expansion into new areas. Indeed, finding new frontiers is a point of strength for the mining industry as a whole, even if many companies fail along the way.

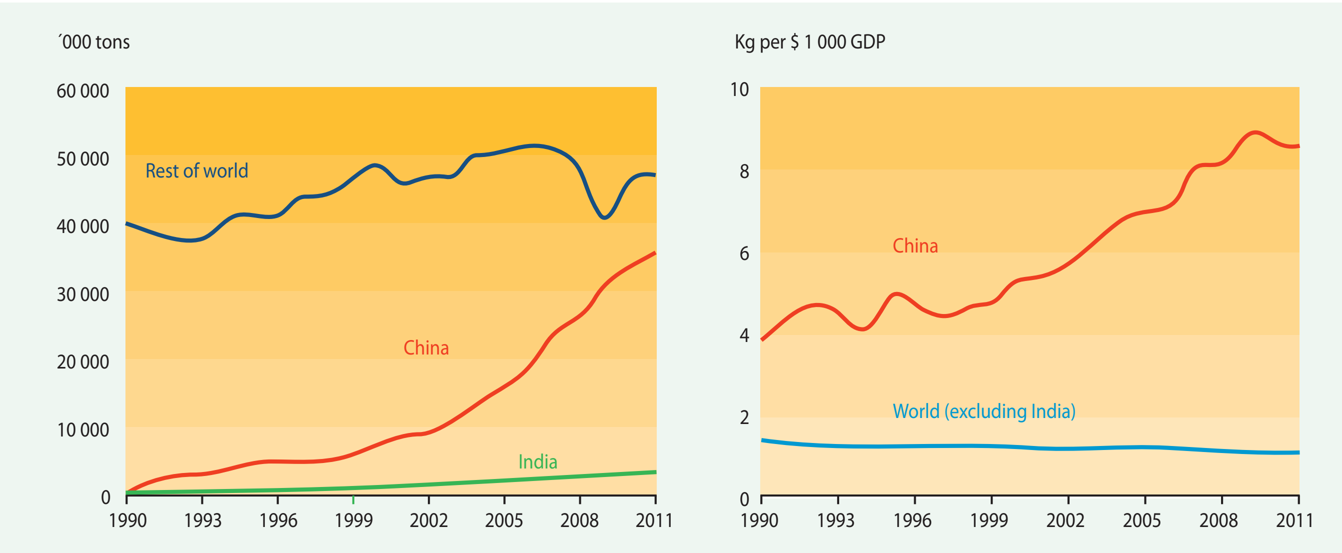


Figure 3.3 Refined metal consumption and metal consumption intensity *(World Bank 2012)*.

3.1.4 Increasing difficulty and complexity of terrestrial mining

The rate of discovery of accessible and high-grade terrestrial ore deposits is declining (Figures 3.5 and 3.6). The highest-grade ores have already been mined, and miners increasingly have to look at lower-grade deposits. Yield declines related to lower-grade ore increase the costs of production. If the grade is low, more waste is generated and processed to produce the same amount of a commodity (Figure 3. 7).

In conjunction with declining grades, input costs are rising. The largest 40 mining companies have widely reported increased contractor costs due to labour shortages and higher fuel and consumable prices. For non-US miners, this trend has been exacerbated by strong exchange rates against the US dollar. In the last decade, the mining industry has struggled to bring new mines into production on time and on budget (PWC 2012).

Despite record profits for the world's 40 biggest miners in 2011 (US$133 billion), market capitalization (the value of a company's shares) fell by 25 per cent (Figure 3.8) as shareholders demanding increased returns bought elsewhere (PWC 2012). Although net profits increased, net profit margins remained steady due to cost increases of 25 per cent. One implication of these trends is that investors might look for alternative mining investment opportunities, such as deep sea mining, if economic criteria demonstrate better potential returns.

While the sustained increase in consumption of metals and minerals is sending demand signals to the mining industry, it is becoming harder to extract ore on land economically and in an environmentally and socially acceptable way. Nevertheless, higher prices caused by the rapid growth in demand have led to a new mining boom, with companies expanding to newer mining countries in more remote and challenging geographic and geopolitical environments, such as Mongolia, Guinea, the Democratic Republic of Congo, Mauritania, and Afghanistan. There remains, however, a lag in supply, as new projects take years to be brought on-line (Giurco 2010).

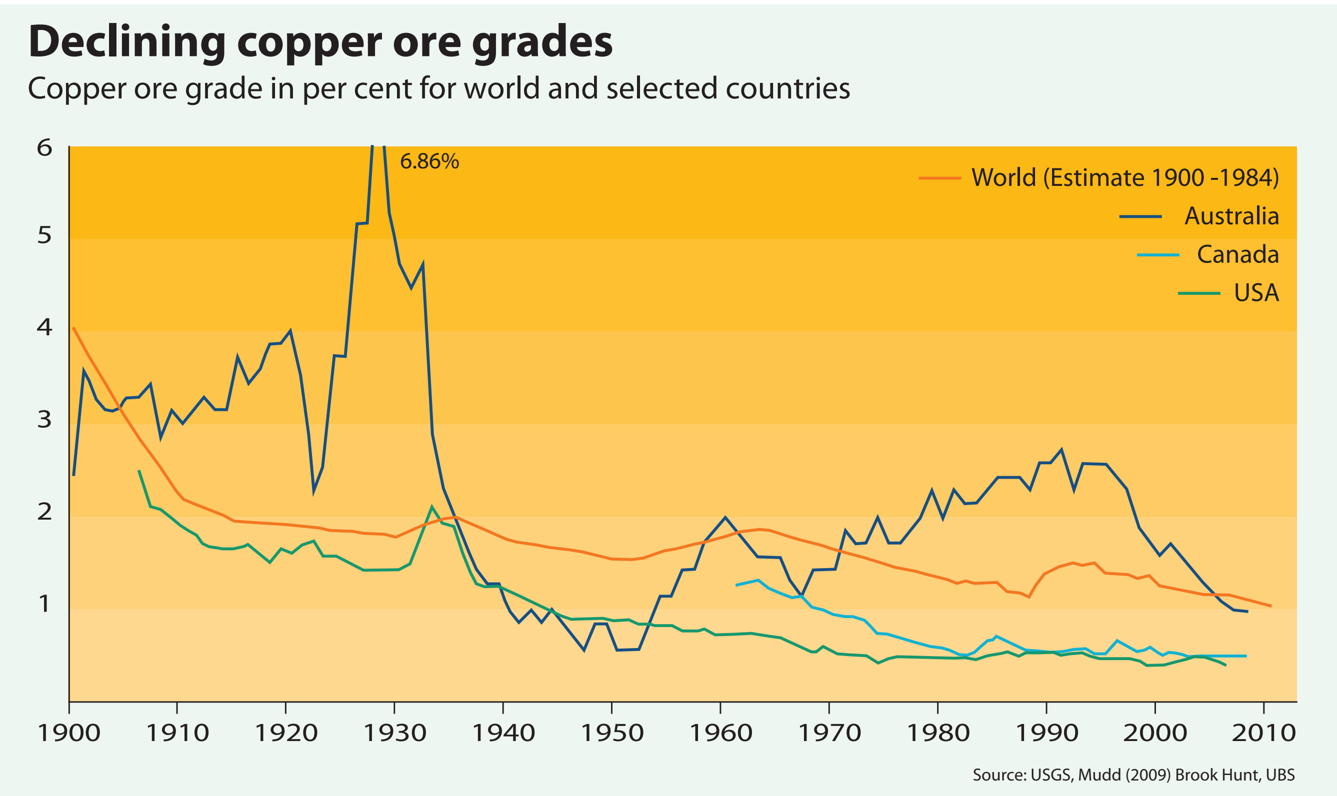


***Figure 3.5 Declining copper ore grade over time** (Mudd 2009).*

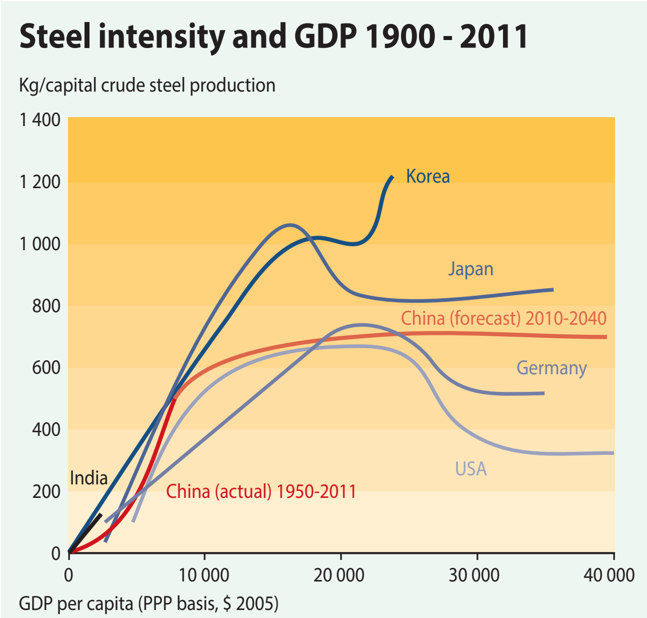


Figure 3.4 Relationship between steel production and GDP. *Steel intensity for China is yet to peak (Rio Tinto 2012)*.

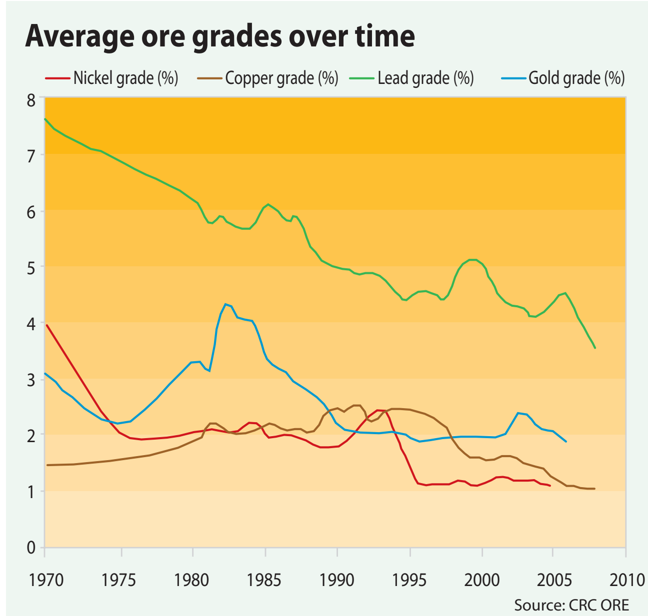


Figure 3.6 Declining average ore grades *(Mudd* et al *2013)*.

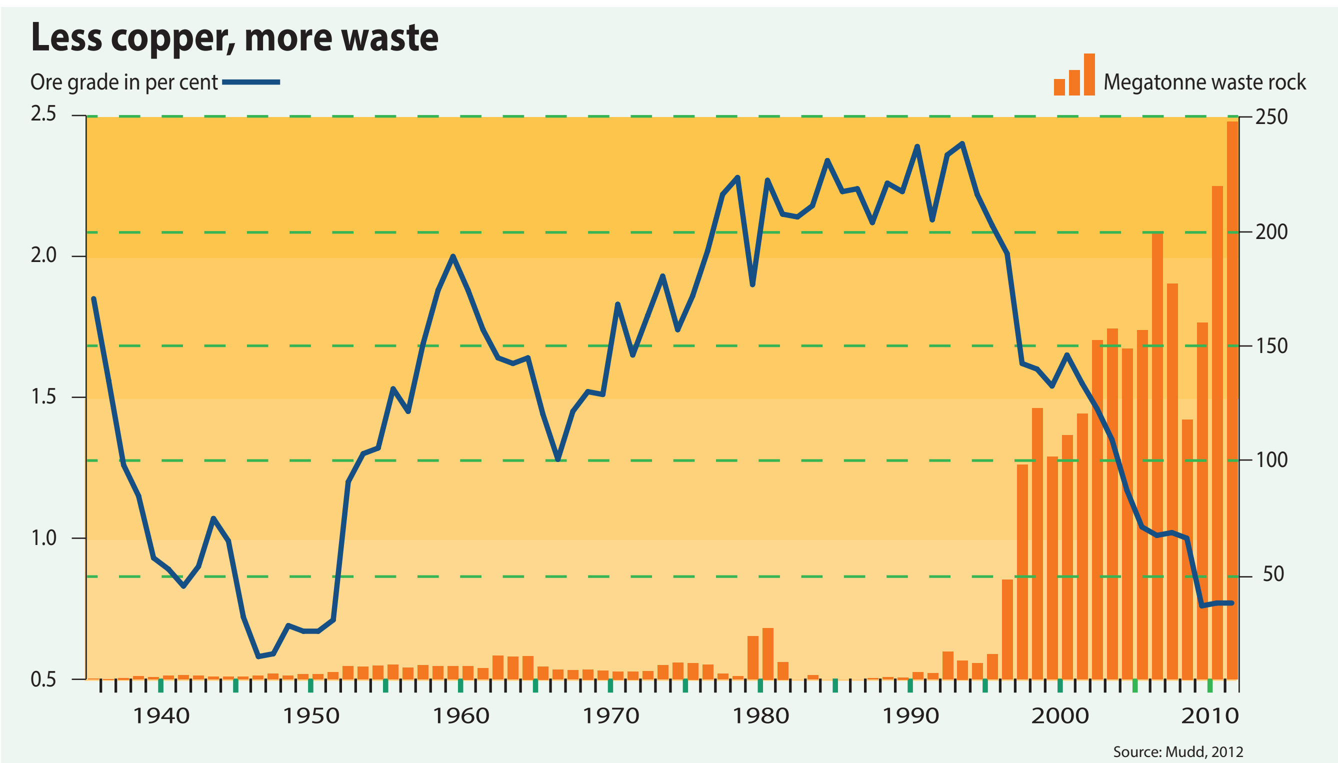


Figure 3.7 Increase in mine waste associated with lower ore grades *(Mudd* et al *2013)*.

3.1.5 Alternative development for Pacific Island states

The development of Pacific Island states is influenced by geography, geology, and economic size. The majority of states have a small land mass and population surrounded by a much larger marine jurisdiction (see SOPAC Division Strategic Plan 2011-2015 (SOPAC 2010) for details).

The main economic sectors for Pacific Island states are:

- services, such as remittances from the Pacific diaspora and tourism; and
- natural resource industries, such as agriculture, fishing, and forestry.

Data from 2010 (Figure 3.9) indicate that the Pacific Island states have a combined gross domestic product (GDP) of approximately US$15 billion, with US$11.7 billion coming from the region's two largest economies – Papua New Guinea (US$8.2 billion) and Fiji (US$3.5 billion). The remaining economies are much smaller, ranging from US$15 million in Tuvalu to US$668 million in the Solomon Islands. Most Pacific Island economies are relatively small, GDP per capita is low, and real GDP growth has been slow or negative for most over the last five years (UN ESCAP 2010).

Onshore mining industries are well established in Papua New Guinea and New Caledonia, and small, emergent, or inconsistent industries exist in Vanuatu, Fiji, and the Solomon Islands. However, for the majority of Pacific Island states, with their small land masses and low geologic diversity (including coral atolls), there is limited potential to develop onshore mines. The extraction of seabed resources could be especially important for those with limited land-based resources. Pacific Island states have responded cautiously but enthusiastically to the potential resource opportunity of deep sea minerals (Howorth 2011).

Deep sea minerals present Pacific Island states with an opportunity to diversify their economies and expand their mineral resource base, providing possible new revenue streams that could play an important role in meeting current and future development needs in the region. Deep sea mining is not, however, the only resource-based option available, and its viability and return to Pacific people need to be assessed against other, potentially competing opportunities.

While there have not been any deep sea mining profits generated to date, revenue and employment and education opportunities have arisen from exploration activities. If deep sea mining succeeds, it could provide income to states from multiple sources, including foreign investment, export earnings, and government revenues. Managed sustainably, this natural capital could be converted into jobs, infrastructure, public service improvements, and growth in the domestic private sector (Graedel *et al* 2011). The question for Pacific Island states is whether deep sea mining is currently viable and/or the most appropriate kind of development for meeting the needs of the Pacific.

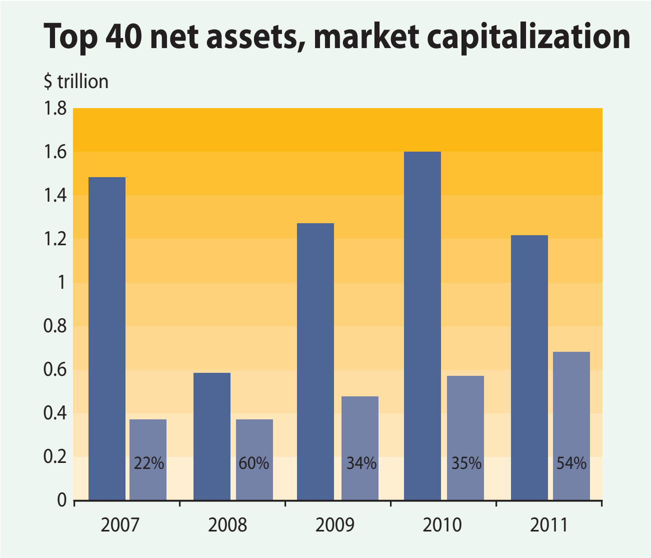


Figure 3.8 Top 40 mining companies' net assets as percentage of market capitalization *(PWC 2012)*.

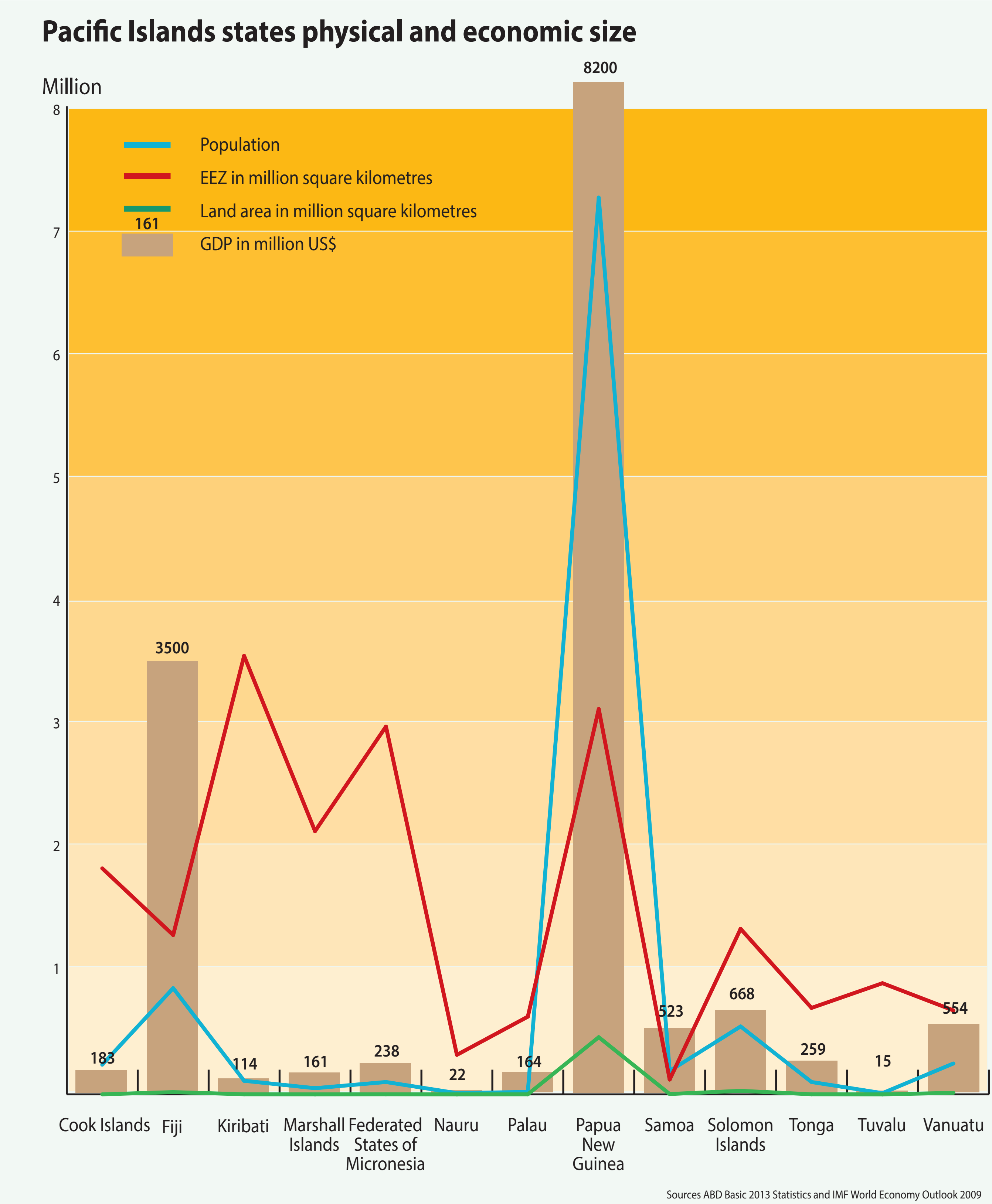


Figure 3.9 Pacific Island states: economic indicators.

3.2 Secondary drivers

3.2.1 Global: environmental and social sustainability, green markets

With its goal of intra- and inter-generational equity, sustainability has become a powerful social driver, able to influence projects, governments, and industries. This is evident in the increasing pressure on industry to comply with new community and government expectations and standards, despite the rising costs of complying.

Issues of sustainability are tied to, but not wholly concerned with, impacts from existing terrestrial mining. Sustainability is also linked with larger societal and global issues related to environmental impact, quality of life, and the transition to a green economy. Rising demand for clean-energy infrastructure to replace fossil fuels and reduce carbon emissions will place further demand pressure on metals. Many clean-energy technologies (such as wind turbines, solar power units, electric cars, etc.) are far more metal-intensive than traditional forms of energy, requiring far greater quantities of metal to produce an equivalent unit of energy output.

The transition to a green economy could drive deep sea mining in two ways. First, this global transition will place significantly greater demand on metal supply and will influence future metal price projections, thereby encouraging further investment in alternative sources of supply. Secondly, deep sea mining could provide Pacific Island states (many of which are particularly vulnerable to rising sea levels) with the opportunity to supply the world with the metals required to build these clean energy technologies.

3.2.2 Industry: technological improvements

Continued technological improvements are key to the successful exploration and potential exploitation of marine minerals. Since deep sea mining was first proposed, technologies have improved significantly (as demonstrated by depth capacities shown in Figure 3.10), largely driven by the oil sector. Some advances directly applicable to deep sea mining have become much more sophisticated and widespread, bringing the deep sea mining industry closer to commercialization. These include:

- subsea equipment (such as sonar, underwater servicing and repair equipment, high-power electro-optic umbilicals, subsea cables, electric motors, hydraulic power units, cameras, etc.);
- autonomous underwater vehicles (AUVs) and remotely operated vehicles (ROVs) for sea floor mapping;
- risers, pipe handling equipment, and pumping technology; and
- advances in vessel size and functionality, semi-submersibles, GPS systems, and bulk materials handling at sea.

More significant, novel or leap-frog advances in technology, such as bioprocessing or depth technologies, could make technological improvement a more significant driver of the industry. At this time, as deep sea mining competes with terrestrial and recycled sources of metals, the key issue is what is technically and economically feasible.

3.2.3 Pacific Island states: national independence and autonomy

The need for independence and autonomy is common to states of all sizes throughout the world. With its recent history of decolonization, much of the Pacific region is still struggling to achieve truly independent status. Many Pacific Island states are still dependent on development aid. While there is a desire for greater autonomy, few Pacific Island states currently have prospects capable of delivering genuine economic independence (Levine 2012). The emerging prospect of deep sea mining should be recognized, then, as a new possibility not just for development, but for empowerment and autonomy.

Worldwide progression of water depth capabilities for offshore drilling and production (as of March 2011)

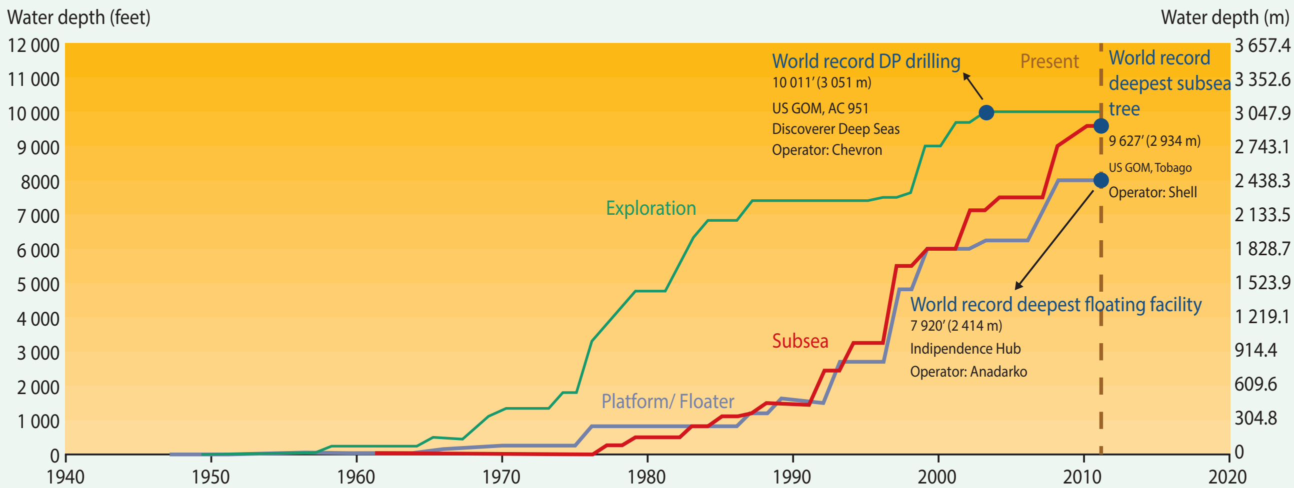


Figure 3.10 Worldwide progression of water depth capabilities for offshore drilling and production. *(Source: Mustang Engineering)*

3.3 Restricting forces on the development of deep sea mining

3.3.1 Global: price volatility and conservation

Commodity prices, as well as stock and currency volatility, represent significant risks to the mining industry generally, creating difficulties in financing and uncertainty for investment return ratios (E&Y 2012) – which is likely to pose a particular challenge for the pioneering and unproven seabed minerals industry. Indeed, (Glasby 2002) identified the collapse in world metal prices at the beginning of the 1980s as a reason for the indefinite postponement of nodule mining.

More recently, Martino and Parson (2012) have identified price volatility (Figure 3.12) as the most important parameter affecting investment in deep sea mining and predict that, without technical improvement or falling costs, we can expect a postponement of nodule exploitation for one or two decades, with greater uncertainty for crust exploitation.

3.3.2 Conservation movement

The importance of identifying and managing potential environmental impacts from deep sea mining has been recognized not only by international law (see Chapter 6) but also by proponents, financiers, and Pacific Island governments. In response, the industry has produced a voluntary code for environmental management, which identifies operating principles and guidelines for application (IMMS 2011). However, local concerned communities (see section 3.3.4 below and Chapter 5) are increasingly vocal, and opposition groups are joining with international movements to express concerns about the perceived lack of information on the potential impacts of deep sea mining and fears of adverse impacts (Small 2011; Van Dover 2011; Dawea 2013). Lack of in-country capacity, the nascent nature of seabed mineral activities, and the lack of a clear process for independently evaluating and sharing scientific research (non-commercial information) has hampered knowledge sharing and informed discussion among Pacific Island states.

3.3.3 Industry: financial uncertainty, regulations, and obligations

Since the global financial crisis, continued uncertainty is significantly diminishing the risk appetite of capital providers and the ability of junior miners (a term for small mining or exploration companies often relying on venture capital) to raise funds (E&Y 2012). Aspiring junior deep sea mining companies will have to compete for finance with mainstream mining, which has a more mature and understood risk profile.

The pressures on junior miners are evident in recent data that reveals the absence of initial public offerings on the Toronto Stock Exchange (TSX) and only three mining issues on the combined London Stock Exchange (LSE) in the first quarter of 2013 (LSE 2013; PWC 2013). This is a marked change from the same quarter in 2012, when 12 mining companies listed on the TSX and 8 on the LSE. While this represents a tightening financial market, there is anecdotal evidence of a shift to debt funding and increased activity from private equity firms, which could provide the required capital to commence deep sea mining (PWC 2013).

Regulatory risks are also a restricting factor for deep sea mining proponents. The lack of dedicated deep sea mining legislation, regulation, and enforcement regimes in many Pacific Island states' EEZs creates further uncertainty and could potentially hinder process and equipment transfer from one jurisdiction to another. Further complications can arise if official approvals of mining do not constitute community consent or a social licence to operate.

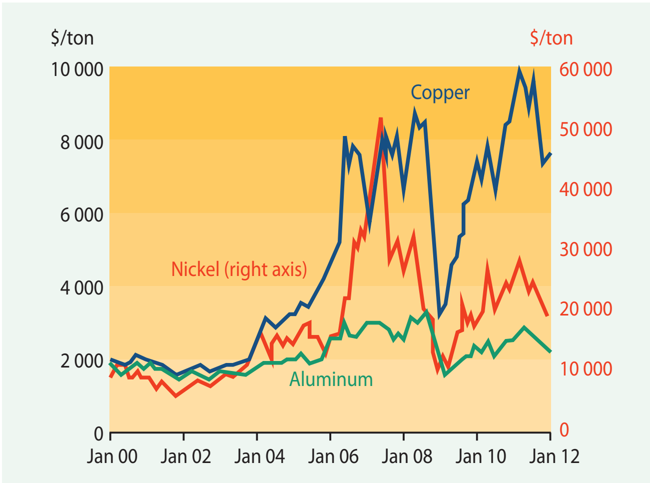


Figure 3.12 Metal price volatility *(World Bank 2012)*

Ironically, while the absence of dedicated legislation is problematic, so too is overly restrictive legislation. The provisions of the ISA's Mining Code, which force technology transfer and reserved site banking, are disincentives for the development of deep sea mining in the Area (Glasby 2000). These obligations could become a driver within Pacific Island national jurisdictions, where there might be greater legal and regulatory certainty, relatively unaffected by the global politics of the Area.

3.3.4 Pacific Island states: community concerns and governance

Community concerns about deep sea mining from Pacific Island states are a counter-force against the push for economic development. While the specific concerns are discussed elsewhere, it is salient to note the dampening effect that increased criticism of and opposition to deep sea mining could have on the currently high levels of enthusiasm from Pacific Island governments. The delay in project commencement at Solwara 1 in Papua New Guinea is a good example of this. While the relationship between community opposition, financial uncertainty, and the contractual grievance between Nautilus and the PNG government is unclear, the delay is, at least in part, attributable to community action.

The importance of addressing governance issues was made clear at the SPC-EU Deep Sea Minerals Inaugural Workshop held in Fiji in June 2011. Areas where the need for action was identified included:

- developing national policy and laws;
- ensuring adequate accountability and transparency;
- addressing undue political interference or corruption;
- building in-country or regional capacity to monitor operations and to enforce compliance;
- ensuring the presence of watchdogs, such as civil society and auditors;
- strengthening negotiations in order to strike an equitable balance between the needs of Pacific Island states and the interests of industry;
- establishing politically isolated sovereign wealth funds; and
- signing up to the international standard, the Extractive Industries Transparency Initiative (EITI) (Howorth 2011).

These points demonstrate a keen understanding by Pacific Island representatives of the need for effective governance to assess, regulate, or benefit from deep sea mining in the Pacific.

During a workshop on environmental needs, co-sponsored by the SPC-EU Deep Sea Minerals Project and the International Seabed Authority and held in Fiji November-December 2011 (ISA 2011), parallels were also drawn with the Pacific tuna fishing industry (ISA 2011). As a Pacific-wide industry, it provides a cautionary tale of development and governance. Briefly, despite high expectations of shared economic benefits from the fishing industry, the Pacific Island states were unable to convert their new marine rights into economic success. Weaknesses in governance made the countries vulnerable to corruption along the production chain. While some steps have been taken to improve governance and reduce corruption, it remains a significant issue (Schurman 1998; Barclay and Cartwright 2007; Hanich and Tsamenyi 2009).

Further concerns about the ability to respond effectively to the deep sea mining industry were expressed at the SPC-ISA 2011 workshop. In particular, current funding for monitoring, management, and regulation of mining-related activities within the Area was seen as inadequate. Furthermore, the ability of Pacific Island states to engage in either the national jurisdiction or the Area was hampered by gaps in current assessment and management structures and processes. Unless these capacity gaps are addressed, the Pacific Island states could struggle to respond to proposals effectively, which could result in poor outcomes, delays, and loss of confidence.

While governance is a national responsibility, mining companies are increasingly affected by and expected to deal with governance issues. In 2003, the World Bank's Extractive Industries Review recognized the importance of good governance by recommending it be included as an enabling condition, prerequisite to mining development (World Bank 2003). More recently, its importance is evidenced by its entry into Ernst and Young's top ten business risks for mining and metals in 2011 and its continued appearance in 2012, alongside social licence to operate, resource nationalism, and sharing the benefits (E&Y 2012).

3.4 Discussion

The factors driving and restraining deep sea mining in the Pacific are complicated, dynamic, and interrelated. Moreover, these factors may be global, industry-wide, or regional in scope and may leave smaller companies and states at the mercy of elements outside their control.

On one hand, a sudden change in demand caused by innovation or substitution, or a change in supply of an essential commodity – such as the pit collapse at the Bingham Canyon mine, which produced two per cent of global copper in 2010 and 2011 (Romboy 2013) – could provide an additional trigger for the adoption of deep sea mining. On the other hand, rising demand could shift from one commodity to another within the typical mine development schedule of 10 to 20 years or more, making it difficult to justify the investment in non-mainstream mining.

While the development of deep sea mining has so far been the province of small corporate entities, that is not the only option. A fast-tracked deep sea mining production scenario could result from the increased involvement of state-owned mining enterprises or the entrance of industry-dominating multinationals. Lockheed Martin's announcement in May 2013 that the company would be exploring in the Clarion-Clipperton Zone is an indication that larger companies could accelerate exploration and mining activity.

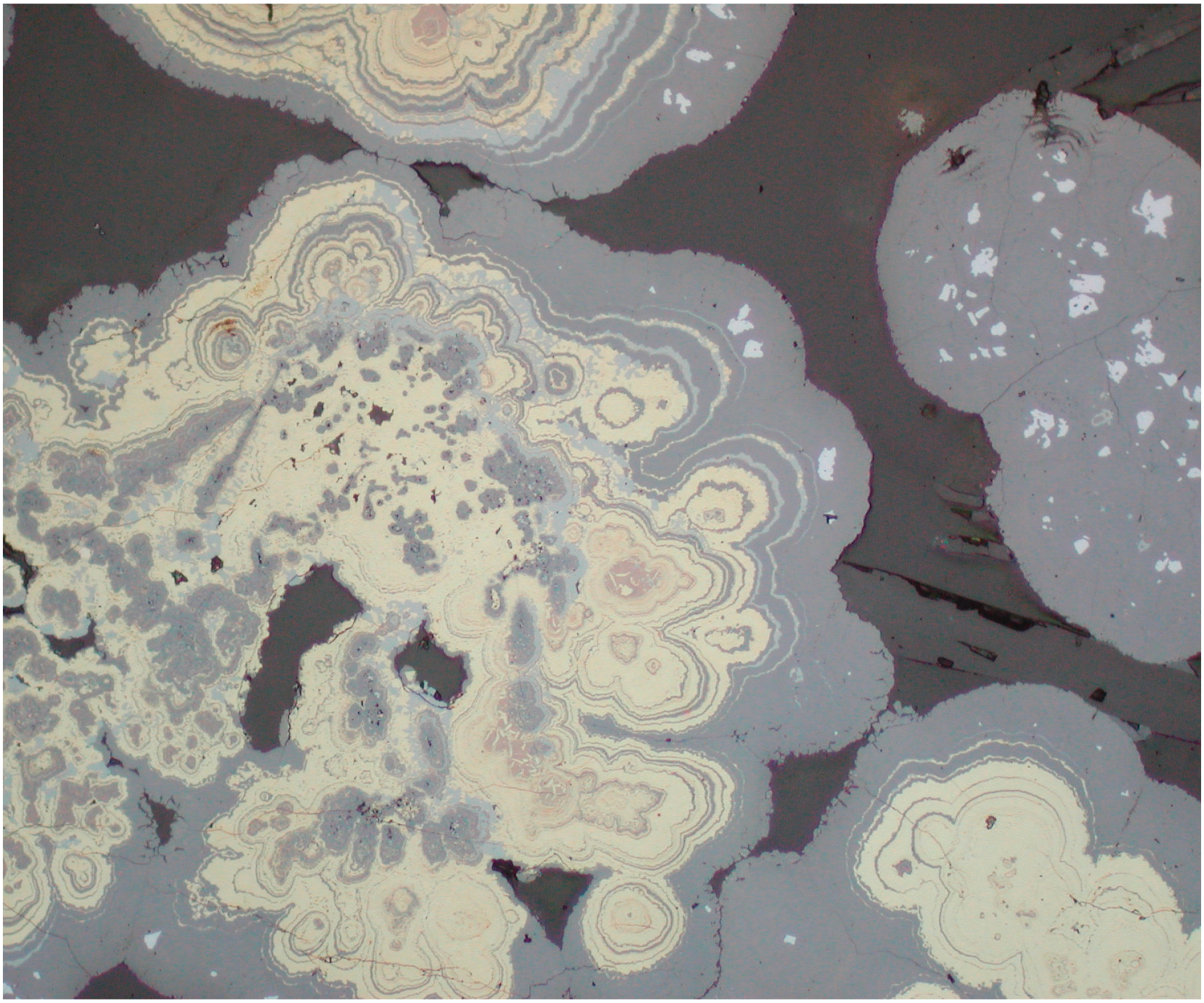
Without these actors, price volatility, market instability, and lack of finance, together with global and Pacific deep sea mining concerns, may combine to diminish the attractiveness of commercial investment in the industry and delay its development in the Pacific. Whatever the cause, ongoing delays in projects or unsuccessful project implementation could continue to erode confidence and further set back commercialization by many years.

Some commentators have suggested that deep sea mineral exploration is inevitable (Yeats 2012). Others are far less certain of its viability in the near future (The Economist 2009; Jha 2012; Martino and Parson 2012). The fact that seabed extraction is not mainstream mining is certain. The industry will require specialized knowledge, technology, regulations, and stakeholder support to generate sufficient confidence to invest in and develop deep sea mining projects. This is a "Catch-22": without successful projects in operation, there remains a substantial information and confidence gap between investors and stakeholders.

While there may well be environmental and social advantages to seabed mining in comparison to terrestrial mining, this remains to be tested in practice. However, the global focus on sustainability is unlikely to change. If the deep sea mining industry can prove its green credentials, it might secure better access to markets, access to essential finance, or even a higher price for a premium product.

In conclusion, there are significant, but not insurmountable, challenges to overcome before the deep sea mining industry is recognized as economically viable or as a sustainable industry that can make a positive contribution to Pacific Island communities. While deep sea mining represents a new opportunity for Pacific Island states, the situation will continue to be dominated by strong external influences over the key drivers. When combined with uncertainty and variability, this means Pacific Island states have little direct influence over many of the drivers of deep sea mining.

At the same time, however, there is some significant enthusiasm within Pacific Island states for deep sea mining and the contribution it could make to Pacific development. There are some factors that these countries can control and that will help the industry progress. They include continued knowledge sharing and the development of capacity and governance structures (including regional mechanisms) to ensure a stable and transparent environment that encourages industry participation.



Massive sulphide sample from PACMANUS PNG, viewed under the microscope. Photo courtesy of S. Petersen, GEOMAR.

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