We Are (mostly) All Stakeholders

In 2016 c. 24 million tonnes of copper was produced. This is the tip of an exponential growth trend from 1900 when only 0.5 million tonnes was produced and is a proxy for global population and consumer trends (CDA 2017). The range of minerals and metals used is also widening, particularly with the advent of smartphones, tablet and laptop computers, green energy devices and so forth. A modern smartphone, depending on the model, can use over 70 metals, as well as a range of non-metallic commodities. Modern life relies on a range of minerals to make houses, cars, transport infrastructure, ICT devices, aeroplanes etc. This In Brief aims to provide insights into the nature of deep sea mining and some of the challenges ahead from a technical perspective. It is part of the SSGM Ocean Governance series, which emerged from a joint Ocean Governance workshop held with the University of the South Pacific.

Drivers for Deep Sea Mining

Presently, the vast bulk of minerals are mined on land. However, there are a range of drivers for serious consideration of mining within the deep sea environment. One driver is grade (i.e. the metal concentration in rock materials): the average grade of copper minerals has declined from over 4% in 1900 to less than 1% today (SPC 2013:30): for comparison polymetallic sulphide copper grades can often be over 7%, and involve much less (orders of magnitude) mining waste. The number of new finds of high grade copper deposits in the world has greatly reduced with time (ibid.).

Another driver is geopolitics: over 90% of rare earth metals are produced by China (BGS 2017), and it is rarely wise to be dependent on one country for supply. The ocean is an increasingly attractive new frontier: the deep oceans comprise most of the 71% of the earth’s surface covered by water. Alongside deep space mining (e.g. of asteroids and the Moon), the deep ocean is a new economic frontier. Deep sea minerals are defined literally as ‘minerals that occur in the deep ocean’, with ‘deep’ generally meaning between 500 and 6000 metres beneath the ocean surface. There are three broad generic groups of deep sea minerals: polymetallic sulphides, polymetallic (manganese) nodules and cobalt rich crusts. Ore grades of all deep sea minerals can be relatively high.

Distribution of Deep Sea Minerals in the Pacific Islands Region

These three main generic types of deep sea minerals occur in different situations and environments. Sulphides are linked to tectonically active and recently active parts of the ocean floor, for example in mid-oceanic ridges and back-arc rift zones. This includes the Exclusive Economic Zones (EEZs) of PNG, Solomon Islands, Vanuatu, Fiji, Marianas Islands and Tonga. Solwara 1 situated close to New Ireland and New Britain in PNG may be the site of the world’s first deep sea mine, at an average sea depth of 1600 m. Polymetallic nodules are particularly prevalent in the deep waters (>4500 m) of the Cook Islands and Kiribati. Cobalt rich crusts, formed on the surface of subsiding oceanic volcanoes, are present in the Federated States of Micronesia, Marshall Islands, Kiribati and French Polynesia.

Opportunities in International Waters (‘The Area’)

The seabed area beyond national jurisdiction is commonly known as ‘The Area’ by the United Nations Convention on Law of the Sea, and mineral resources that occur therein are administered by the International Seabed Authority, based in Kingston, Jamaica. Whilst most EEZs of small island states are in the Pacific (representing an area of 28 million km², or an area equivalent to 70% of the Moon’s surface), there are small island states in the Indian and Atlantic Oceans, and large swathes of ocean under international jurisdiction. Exploration and research activities are occurring in all oceans. Within the international waters in the Pacific Ocean, one area is of particular interest for polymetallic nodules: this area is called the ‘Clarion-Clipper-
ton Zone’ or CCZ, extending east–west between Mexico and the Line Island Group of Kiribati. A large area of the CCZ is under licence with a range of mining companies (private sector and state owned), mainly from developed countries, that are exploring the deep sea floor in detail and defining areas of particularly high mineral grade.

**Challenges for Mining**

There are many challenges for mining in the deep sea (Filer and Gabriel 4/1/2017). Mining activities will have to be undertaken at very high pressures (every 1 kilometre of sea depth is approximately equivalent to a pressure of 100 atmospheres) and low temperatures within environments only suitable for remote robotic work. There are numerous deep sea mining machines under development, and being tested in oceanic environments. However, the real test will be when mining begins. There will be a whole host of technical mining challenges: mining operations will consist of ocean bed mining and exploration activities, connections to a ‘mother mining ship’ at the ocean surface and transport of mined materials to refineries.

There will, of course, be commercial pressure to make profits. Mining companies all need a social licence to operate, which will mean negotiations with governments, international bodies and communities. Addressing environmental issues will be a major challenge: how to mine with minimal disturbance to the natural environment? There are multiple ocean activities, primarily fishing and shipping, which will have to be accommodated by mining companies. Many stakeholders in the Pacific are concerned about the potential impacts of deep sea mining on the ocean’s living resources particularly fishery stocks.

**Social, Environmental, Fiscal & Governance Issues**

Mining can be controversial. Mining operators in well-regulated parts of the world must seek a social licence to operate, and comply with strict environmental and social regulations. This situation is not necessarily the case in less well-regulated environments, and there are examples of mining finances being utilised unwisely. Nevertheless, there are many examples of good fiscal, social and environmental practice and these are the models all mining operations must aim for. The SPC–EU Deep Sea Minerals Project which has been operational between 2010 and 2016 has achieved more than any other initiative in advising and preparing the Pacific region for a range of governance challenges that may be faced should deep sea mining occur.

Deep sea mining will occur in environments that are unique on earth, supporting unique ecosystems. It is difficult to assess all the potential environmental challenges and it will also be difficult to environmentally-regulate a brand new industry. Similarly, from a developmental perspective, many hope deep sea mining will improve the economic and social well-being of Pacific countries, but this will require best-practice government regulation, capacity development, and genuine, open and transparent community engagement. There will be tensions between commercial (company) and development (host country) stakeholders that must be carefully monitored (Filer and Gabriel 4/1/2017; KPMG International 16/9/2015).

Extractive industries have operated globally for thousands of years as well as in the modern era, and this experience suggests that they will, most probably, exist into the future, including in new frontier environments. There was no deep sea oil industry prior to the 1960s and early 1970s and now it is a multi-trillion dollar worldwide industry: this is possibly an analogue for a future global deep sea minerals industry. It is therefore judicious and prescient to prepare the Pacific region for associated activities that will link to deep sea minerals in order to maximise the potential for positive nation and region-building, while minimising potential negative impacts.

**Notes on Authors**

Michael Petterson is a Professor of Geology at the Auckland University of Technology and previously held positions as Director of the Geoscience Division of the Pacific Community, as a Government Geologist in Solomon Islands, and Head of Economic Geology with the British Geological Survey. He has published widely on the Geo-Tectonics of the SW Pacific and Sustainable Minerals.

Akila Tawake is currently the Acting Director for the Geoscience Division of the Pacific Community and was previously head of an EU-funded Deep Sea Minerals project for the Pacific region. He has been an economic geologist for most of his career with private and government sector experience.

**References**


