

DEEP SEA MINING

The New Frontier of Mineral Extraction



As quality land-based ores become increasingly rare and inaccessible, state governments and private companies are turning their attention to the treasures under the sea.



On 24th April 2014, Toronto-based Nautilus Minerals signed an agreement with the State of Papua New Guinea to move forward to production at its 1600-meter deep Solwara 1 project.

The agreement comes after a two-year legal dispute with the PNG government and marks a step forward for the fledgling deep-sea mining industry with Nautilus at the vanguard. Interest in marine mining emerged in the late 1950s and offshore diamond mining has taken place since the early 1960s in shallow waters down to 35-meters deep.

Only in the past five years, however, have technological advancements in the oil and gas sector and rising commodity prices as a result of booming demand for metals, made deep-sea mining economical. Furthermore, as quality land-based ores become increasingly rare and inaccessible, state governments and private companies are turning their attention to the treasures under the sea.

Nautilus Minerals' progress is testament to the feasibility of deep sea mining in the private sector. The company was awarded its environmental permit from the PNG government in December 2009 and its first mining lease in January 2011.

The company then came up against a prolonged legal dispute over costs Nautilus claimed the State was obliged to meet. That dispute was resolved in April 2014 through an agreement that the State will take an initial 15% in the project in exchange for \$120 million to complete the development phase up to first production. The State will then have an option to acquire another 15% within 12 months of the agreement becoming unconditional.

Having secured this agreement, Nautilus Minerals aims to become the first company to mine the seabed using three pieces of pioneering remote-controlled equipment. The first and most important of these robots, the bulk cutter, was completed in April 2014 by Newcastle Upon Tyne-based subsea vehicle designer and manufacturer, Soil Machine Dynamics (SMD). The bulk cutter, or 'beasty' as creator Keith Franklin calls it, weighs 310 mt and is the heaviest of the three machines. The machine is equipped with four-meter wide cutting blades, cameras and 3D sonar sensors which enable the crew to navigate when soot emitted from the hydrothermal vents being mined makes visibility impossible.

Operated remotely via a giant power cable by two people sitting in a vessel on the surface, the bulk cutter works along the seabed, disaggregating ore and pumping it as slurry up a 1.6 km steel riser pipe to the surface. The ore is then separated from the water and loaded onto barges for shipment to treatment facilities in China; the water is pumped back down another pipe to the seabed.

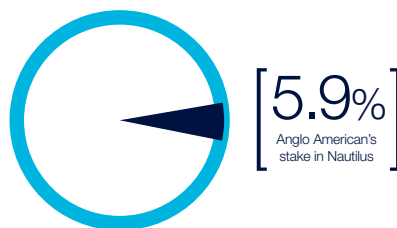
“The Company is now focusing its attention on securing a suitable vessel arrangement and is continuing its discussions with potential vessel partners while also undertaking a tender process with shipyards experienced in building offshore construction vessels.”

No chemical treatment or processing will take place on-site. Nautilus aims to shore around 1.3 million mt of ore per year from Solwara 1, producing up to 100,000 mt of copper and 200,000 oz of gold. The company secured Tongling Nonferrous Metals Group Co. Ltd as its first customer in April 2012 and hopes to be mining in the next two to three years.

[Cu 100,000mt]
 [Au 200,000oz]

“The Company is now focusing its attention on securing a suitable vessel arrangement and is continuing its discussions with potential vessel partners while also undertaking a tender process with shipyards experienced in building offshore construction vessels. The Company intends to have a vessel solution in place before the end of the year,” said CEO, Mike Johnston, April 24, 2014, Nautilus Minerals News Release, “Nautilus Minerals and State of PNG Resolve Issues and Sign Agreement.”

Other forerunners in the deep sea mining race include UK Seabed Resources, a subsidiary of American defence giant Lockheed Martin. In partnership with the Department for Business Innovation and Skills, the company has secured licences in the Pacific to explore for polymetallic nodules in an area larger than the size of the UK. The company plans to harvest the seabed and bring the nodules up from depths of 4,000 meters to the surface using remotely operated or autonomous underwater vehicles, pumps, suction and riser pipes. A process which the company claims will have marginal impact on the marine environment.



Privately-owned Neptune Minerals, based in Florida, is exploring for Seafloor Massive Sulphide deposits in tenements covering 175,000 km² around several South Pacific countries and plans to excavate minerals using a grab that loads seabed material into buckets that are then transferred to the surface.

Interestingly, none of the world’s mining giants have entered the space, although Anglo American is watching closely with a 5.9% stake in Nautilus. It is possible that the majors will capitalise on the opportunity through acquisition of these early pioneers, or their assets, once concept is proven. IHC Merwede, a Dutch maritime equipment manufacturer looking to capitalize on the deep sea opportunity, says that many of its contracts are with technology-based companies as opposed to mining firms. IHC is leading ‘Blue Mining’, a four year project signed off and funded by the European Commission in April 2014, to develop breakthrough solutions for mining the seabed sustainably and cost-effectively.

SYNERGIES IN THE INSURANCE MARKET

In spite of these recent developments, deep sea mining is a relatively unknown risk in the insurance market. A few specialist marine underwriters are, however, eying up the space with excitement and the general consensus is that coverage for deep sea mining will have many synergies with current policies for marine hull and offshore oil and gas.

"Much in the same way as the offshore energy insurance market for mobile drilling rigs evolved out of the traditional marine market to become a separate class of business, I could see the risks for the large mining vessels initially being catered for by the offshore energy market and then evolving into a specialist class of its own.

Sub-sea mining equipment risks will equally be catered for by the more specialist niche 'underwater equipment' market," said John Cooper, Senior Partner, Energy & Marine at Lloyd & Partners Limited.

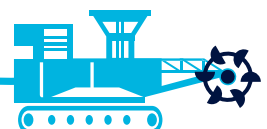
Watkins Syndicate, the Lloyd's managing agent for Munich Re, also acknowledges the potential opportunity in deep sea mining through the pulling together of expertise from well-established insurance classes: *"We have the subsea and ROV expertise and we are the largest energy insurer in Lloyd's so we have plenty of offshore experience – we have a lot of marine business too so in my view deep sea mining is going to be the bringing together of several skillsets,"* said Dominick Hoare, Joint Active Underwriter.

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The London insurance market specializes in adapting to new risks and pulling together expertise to develop innovative products.

The first ever offshore oil rig was insured out of London, as was the first helicopter, so there is no reason why the market cannot write deep sea mining when the industry takes off.

Premiums are likely to be high at first, however, due to the unknown nature of the risk and the highly hostile environment in which these machines will be operating. The market will need to build up some risk history and get comfortable with the sector before rates start to soften.



“One of the major problems the industry faces is that insurers are reluctant to look at pollution and environmental liability coverage.”

One of the leading underwriters for subsea marine risks is The Leviathan Facility, a specialist insurance facility set up to understand the needs of the subsea industry. Leviathan has been working with a deep sea mining client for the past 25 years.

[ The policy limit for deep sea mining equipment, per unit, such as a Bulk Cutter **\$50m**]

[**2010** Year of the Deepwater Horizon disaster, which caused huge environmental liability costs ]

“From an insurance perspective, there is physical damage to the equipment, which is being covered by three specialist markets, and there is loss of hire where the deploy vessel or unit itself fails to work due to an insured peril. But that is about it,” said Simon Edwards, Founder and Principal Underwriter. The policy limit for deep sea mining equipment, such as the Bulk Cutter, is around \$50 million per unit.

While physical damage and loss of hire limits may be insurable, environmental liability cover is not so enticing. As evidenced by the Deepwater Horizon disaster in 2010, environmental liability costs can reach the tens of billions and the unknown nature of deep sea mining will attract few underwriters willing to write it.

“One of the major problems the industry faces is that insurers are reluctant to look at pollution and environmental liability coverage,” said Michael Kingston, Partner specializing in dispute resolution at law firm DWF. “The same problem exists in the oil and gas sector with insurers covering only up to a minor limit.”

“...mining could create alleged damage to sea beds, coral reefs and the sub-sea environment...”

“Assessing the environmental impact of deep-sea mining will be tricky for underwriters. They are used to giving cover for seepage and pollution from wells being drilled, but mining could create alleged damage to sea beds, coral reefs and the sub-sea environment, and that will be harder for insurers to get their heads around because it’ll be difficult to prove and quantify,” said John Cooper in a [recent interview with Lloyd’s Market Magazine](#).



“There is always a fear of sitting down with competitors for commercially sensitive reasons, but there are times when it is essential for the industry to prosper collectively.”

Deep sea mining companies should be looking to group together to create a facility that has the capacity and skillset to cover an environmental disaster. An example could be taken from OPOL (The Offshore Pollution Liability Association) in the North Sea where operators have come together to create a mutual which will cover environmental damage up to a certain limit. Each member makes a commitment to a level of funding which is pooled together and used to support an incident, regardless of who is responsible. *“There is always a fear of sitting down with competitors for commercially sensitive reasons, but there are times when it is essential for the industry to prosper collectively,”* said Kingston.

Underwriters are also likely to err on the side of caution when it comes to business interruption cover. Like any new technology, there will be a reluctance to provide long periods of business interruption cover for equipment insurers are not familiar with. Historical data is needed to underwrite properly and the business interruption for deep sea mining is still not accurately known. Pioneering underwriters are going to have to take a stab in the dark to begin with. *“We will take a bit of a hit to start with to learn what everyone needs to learn. There will be teething problems for the first few projects but that is what we are good at - we do prototypical,”* said Keith Broughton, Principal Underwriter at The Leviathan Facility.

The transfer of business interruption cover to the insurance sector will be critical to getting the industry off the ground. Banks want to lend for these projects but they do not want to carry all the risk. Most underwriters will be cautious to begin with however, as pioneers have been badly hit in the past writing new industries without enough prior knowledge: *“You can draw an analogy between deep sea mining and the offshore sector such as offshore wind. In the early days, insurers came rushing in to take the premium but got burnt badly by bad technology and reversed out of the market. They are now coming back in with more tried and tested equipment now some of the lessons have been learnt,”* said Kingston.

“You can draw an analogy between deep sea mining and the offshore sector such as offshore wind.”

The big corporate underwriters will also be careful about how they approach deep sea mining due to its controversial nature. *“There might be a bit of an issue with reputational concern – do you want to be associated with an industry that could be considered controversial?”* said Hoare. Conversely, companies will want to make sure their underwriting partners are fully aligned with the concept behind what they are doing. Deep sea miners must take extra caution to avoid a public outcry when getting the industry off the ground. An example of how not to do it is Cuadrilla, who caused an earthquake when trying to introduce fracking to the UK in 2011. It takes a long time for industry to convince people that what they are doing is legitimate and a single mistake can undo everything.

SECTOR REVIEW

OPPORTUNITIES AND CHALLENGES

The untapped mineral wealth on the seabed is vast.

Two sources of sub-sea minerals are creating excitement: polymetallic nodules formed on the seafloor between 4,000 and 6,000 meters below sea level, and Seafloor Massive Sulphide (SMS) deposits between 1,000 and 3,700 meters below sea level. Polymetallic nodules are the size of tennis balls and formed of concentric layers of iron and manganese hydroxides around a core such as a chip of shell. SMS deposits are formed by hydrothermal vents (or ‘black smokers’) exhaling hot, sulphide-rich mineralizing fluids, which when mixed with colder more alkaline seawater form deposits on the seabed.

“If only 10% of that resource can be recovered it will be one of the largest mineral deposits ever discovered...”

These sources can contain very high concentrations of copper, nickel, cobalt, manganese, zinc, rare earth elements, gold and silver, all of which are fundamental to the products society depends on today such as copper wire, batteries, jet engines, drinks cans, steel and magnets. As the earth’s population continues to burgeon and become ever more consumerist, demand for these minerals is curving exponentially.

This demand can be met by the untapped mineral wealth on the seabed so long as the industry is developed sustainably.

The value of deep-sea SMS ores average \$500 to \$1500 per mt compared with \$50 to \$180 per mt for their land-based counterparts (volcanogenic massive sulphide deposits), reports the [Guardian](#). Nautilus’ Solwara 1 project is an SMS deposit boasting grades of 7% copper (land-based mines average 0.6%) and gold grades averaging 6 g/mt with some intercepts in excess of 20 g/mt. Estimates of the total quantity of polymetallic nodules on the seafloor range from billions to trillions of tonnes.

A recent assessment of the Clarion-Clipperton Zone, a five million square kilometre zone in the eastern pacific between Hawaii and Mexico, found more than 27 billion mt of nodules alone – 340 million mt of nickel, 290 million mt of copper and 78 million mt of cobalt. It is estimated that 10 billion mt of nodules sit on the seafloor in 750,000 km² of territorial waters around the Cook Islands Continental Shelf – *“if only 10% of that resource can be recovered it will be one of the largest mineral deposits ever discovered...”* said the [Cook Islands National Seabed Minerals Policy](#). David Cameron believes that mining nodules could generate £40 billion for the UK economy over the next 30 years.

A recent assessment of the Clarion-Clipperton Zone, a five million square kilometre zone in the eastern pacific between Hawaii and Mexico, found:

27Bn
metric tonnes
of nodules

340M
metric tonnes
of nickel

290M
metric tonnes
of copper

78M
metric tonnes
of cobalt

With potential access to such a wealth of minerals under the sea, could we expect a glut in supply and plummeting commodity prices for the future?

Are the days numbered for conventional land-based mining?

As it stands today, the abundance of polymetallic nodules must be at least 10 to 15 kg/m² to make deep sea mining of economic interest according to the **International Seabed Authority (ISA)**, the body created under the United Nations Convention on the Law of the Sea to oversee all legal and environmental matters relating to deep sea mining beyond any nation's territorial waters.

The race to the seabed is now on with 26 exploration licenses already approved, each valid for 15 years, covering 1.2 million km². According to Nii Odunton, Secretary General of the ISA, interest in deep-sea mining from state governments and private enterprise has "catapulted" in the last five years.

To apply for a deep sea mining exploration license through the ISA, companies must be sponsored by, or partnered with a nation-state. Contracts have thus far been awarded to China, India, Brazil, South Korea, Singapore, Japan, Eastern Europe, Russia, Germany, France, the UK and Pacific Island nations Tonga and Kiribati. The USA has not yet been allotted an exploration area because it has not ratified the UN Convention on the Law of the Sea.

Most contracts have been awarded to search for polymetallic nodules in the Clarion Clipperton Fracture Zone, although they have also been awarded to explore for polymetallic sulphides and cobalt-rich crusts in the Indian Ocean, the South West Indian Ridge, the Central Indian Ridge, the Western Pacific Ocean, the Mid-Atlantic Ridge and the Rio Grande Rise in the Southern Atlantic. The contracts allow for exploration on 75,000 km² of seabed for polymetallic nodules and 10,000 km² of seabed for SMS deposits.

The ISA is now working on the framework behind the legal, environmental and commercial terms for assessing and allocating mining licenses. They advise that companies should be able to apply for mining licenses by 2016 and commercial mining is expected to take off in between five and ten years' time. In deciding who to submit permits to, the ISA is faced with the predicament of establishing which companies are skilled enough to carry out the work despite none having had experience of deep-sea mining on an industrial scale.

They are considering offering provisional mining licenses at first, requiring companies to prove their mining and environmental competence, before becoming eligible to apply for a full license. A key focus is also on finding the right balance between allowing operators enough incentives to justify their investment in a risky new industry whilst ensuring a portion of the proceeds is seen by developing and landlocked nations.

DEEP SEA MINING EXPLORATION AS IT STANDS

26

exploration licenses approved at present

15yrs

of exploration is valid on each license

1.2M^{km²}

of explorable area covered by current licenses

USA

The USA has not yet been allocated an exploration area

ONUS ON SUSTAINABILITY

The scale of mineral wealth on the seabed renders deep sea mining inevitable; developing the industry sustainably will be the key to its success.

Despite the industry having a lower social and environmental impact than land-based mining due to it not involving the movement of people and on-site chemical treatment, concerns are understandably high as the exact impact on the environment is still unknown. Major questions lie around damage to the seafloor environment and the impact plumes of sediment will have on marine life, particularly if they get caught up in currents.

“There is just so much that we do not know about the deep sea, and we need that basic research before we form policy, but we urgently need policy before this window of opportunity closes.”

The worry is that that scientific research cannot keep up with the advance of the industry. Policy is guided by scientific research, which for the deep seas is still very embryonic: “*There is just so much that we do not know about the deep sea, and we need that basic research before we form policy, but we urgently need policy before this window of opportunity closes,*” Cindy Lee Van Dover, deep-sea biologist at Duke University, North Carolina, told the [Independent](#).

“We have seen bursts and then we have seen periods of inactivity when the industry has almost looked like it has gone backwards because of some of the legal issues that have occurred.”

The ISA recognizes that deep sea mining will cause “*inevitable environmental damage*” and is focused on ways to minimise the repercussions. “*One of the most important responsibilities of the Authority is to develop rules, regulations and procedures for the protection of the marine environment from adverse impacts of mining,*” said Odunton in a statement at the relaunching of the UK Seabed Resources in March 2013. When mining licences are issued, they will come with a raft of environmental conditions and detailed pre and post- impact surveys of the seabed are likely to be a requirement.

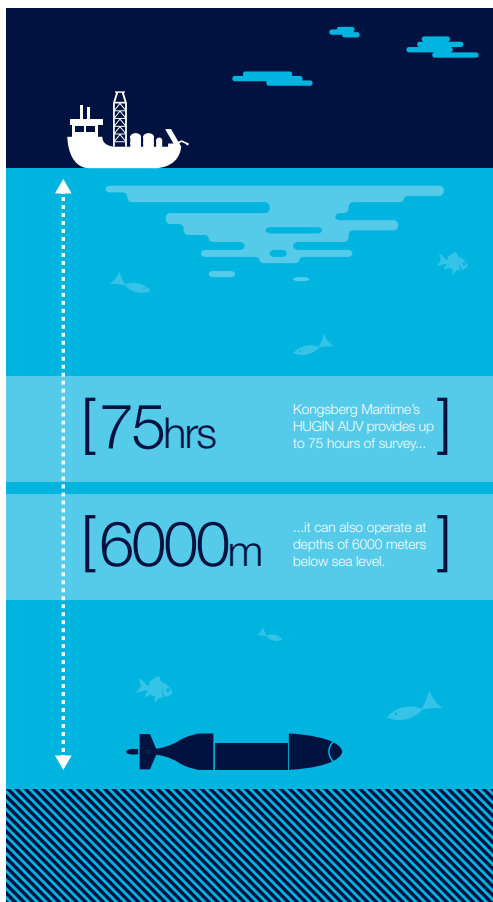
Companies like Nautilus and Neptune Minerals are looking into using AUVs (Autonomous Underwater Vehicles) not just for detecting and identifying mass sulphide deposits but also for environmental surveys. Kongsberg Maritime, a Norwegian manufacturer of AUVs, mostly used in the offshore oil and gas sector, is seeing slow but steady growth in the deep sea mining space.



“We have seen bursts and then we have seen periods of inactivity when the industry has almost looked like it has gone backwards because of some of the legal issues that have occurred. Things have started to pick up slightly over the past three to four years. The industry is currently in the transition phase between feasibility and practicality and then operating,” said Richard Mills, Product Sales Manager for AUVs.

“One of the most important responsibilities of the Authority is to develop rules, regulations and procedures for the protection of the marine environment from adverse impacts of mining.”

Kongsberg Maritime’s HUGIN AUV can operate at depths of 6000 meters below sea level, provides up to 75 hours of survey and carries a myriad of payload sensors including multi-beam echo sounder, camera and turbidity sensor. The HUGIN can survey for mineral reserves and environmental impact at the same time because all its payload sensors operate concurrently.



For deep sea mining to be sustainable, it needs to be a safety case approach but whether individual jurisdictions will implement these requirements remains to be seen. Ideally, the ISA will regulate over and above individual jurisdictions but this is unlikely.

“The industry is currently in the transition phase between feasibility and practicality and then operating.”

Many state authorities are exercising caution, however, as evidenced by the case of Trans-Tasman Resources (TTR) in New Zealand whose application was rejected on 18th June 2014 on grounds that the company did not provide sufficient evidence that “the life-supporting capacity of the environment would be safeguarded or that the adverse effects of the proposal could be avoided, remedied or mitigated”.

The Cook Islands are also taking a slower approach and working on a robust set of regulations before allowing mining in their pristine waters. South Korea has spent \$5 million on deep sea mining research but is waiting until 2016 before deciding on whether to apply for a mining licence once its exploration license expires. The Namibian government last year issued a moratorium on phosphate mining off the coast for 18 months over fears that it could destroy the fishing industry. In Australia, the Northern Territory has also issued a moratorium on seabed mining which is due to expire in 2015.

A COLLABORATIVE APPROACH

Insurers and industry must work together to develop deep sea mining sustainably, ensuring standards are as high as possible to prevent catastrophe.

“Insurance is about risk and opportunity – you have to measure the risk and sometimes you have to encourage responsible behavioural patterns to make that return workable.”

“Insurance is about risk and opportunity – you have to measure the risk and sometimes you have to encourage responsible behavioural patterns to make that return workable. Working with insurers, the underwater mining industry should declare a standard, which goes beyond regulations, to create political legitimacy and foster an atmosphere of positive behavioural responsibility. Brokers and insurers have a key role in fostering the correct behavioural atmosphere by working with industry to close the knowledge gap and create a standard that insurers are happy with, that industry are able to comply with, and that will then put pressure on everyone else to raise the bar to the same standards,” concluded Kingston.

We can learn through the lessons of history that international cooperation, and particularly conventions, do not always go far enough and often come into play after something has gone wrong. The right to resources is an age-old problem and there will always be players that take shortcuts. Mistakes are inevitable.

The success and longevity of the industry will boil down to a robust set of regulations demanding effective risk management protocols from industry and comprehensive policy coverage from the insurance market.

Innovative brokers must work closely with entrepreneurial insurers to understand the sector and their clients’ needs. This is an exciting new space with huge profits at stake, those who recognize the opportunity and position themselves to capitalise early on have the potential to make substantial returns.

SIMON DELCHAR

JLT Mining

Tel: 44 (0) 20 7466 6226

Email: simon_delchar@jltgroup.com



JLT Mining

The St Botolph Building

138 Houndsditch

London EC3A 7AW

Tel 44 (0) 20 7466 6226

www.jltgroup.com

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