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Deep-Ocean Exploration of Metals Ore Deposits Controlled by the International Seabed Authority: Selected Aspects of the Present State and Possible Mining

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INTRODUCTION

Ocean floor and continental shelf are rich in metals ore deposits and gas hydrates. Among metals, the most well known and economically promising are polymetallic nodules (Fig. 1). Less known, but also considerable promising for economical mining, are polymetallic sulphides and cobalt-rich ferromanganese crusts. Polymetallic nodules are concretions formed on the surface of deepwater sediments, composed mostly of metallic oxides and hydrooxides, particularly manganese (27–30%), nickel (1.25–1.5%), copper (1–1.4%) and cobalt (0.2–0.25%) iron (6%), silicon (5%) and aluminium (3%). The polymetallic sulphides form mostly veins found in mid-oceanic ridges and around volcanic hot springs. The cobalt-rich crusts are mostly found on guyotes (beside Co contains also copper, zinc, silver and gold).

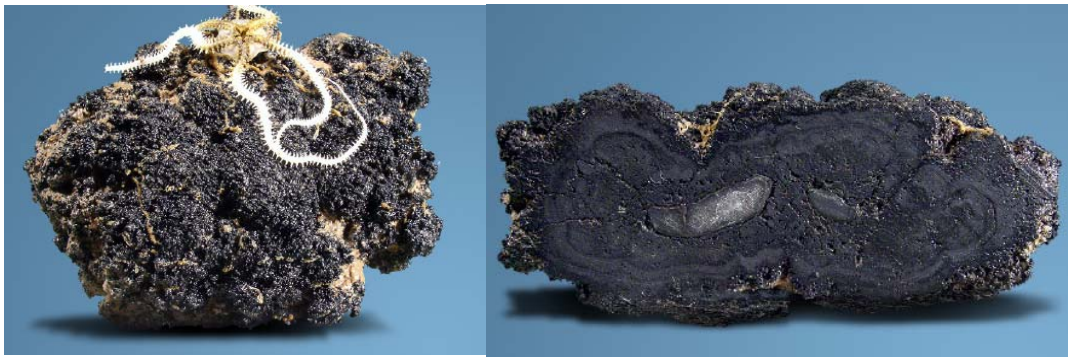

Figure 1. Mn-rich polimetallic nodules (about 30 cm each) from the exploration area of the Interoceanmetal Joint Organization in the Clarion-Clipperton Zone (received from R. Kotlinski)

Geological exploration of the international seabed (ocean floor), beyond the limits of national jurisdiction (continental shelf) is controlled by the International Seabed Authority (ISA). Due to

ISA activity, exploration of polymetallic nodules ore deposits is regulated since 2000 by international low, while works on regulations covering polymetallic sulphides and cobalt-rich ferromanganese crusts barely began in August 2002. These works were very slow, thus in 2006 it was decided to prepare for sulphides and for crusts two separate sets of regulations, with priority given to sulphades. It devoted most of ISA sessions in 2007 and 2008 to this task, but several issues including such basic one as definition of polymetallic sulphides or configuration of the area, remained unresolved. Surprisingly, some progress on ferromanganese crusts is reported. Because polymetallic nodules are extensively explored and legal aspects for mining are advanced, as compared to polymetallic sulphides and cobalt-rich crusts (e.g. still debates on legal regulations determine area of exploration), the author will focus in this paper particularly on polymetallic nodules. Keep in mind that in this paper no results of scientific research are presented and the paper rather reports selected information tailored for the mining interests. Most of information presented in this paper is available on the ho-mepage of the International Seabed Authority http://www.isa.org.jm/en/home.

LEGAL ASPECTS

The International Seabed Authority

To organize and regulate all mineral-related activities in the international seabed area, beyond the limits of national jurisdiction, the International Seabed Authority (ISA) has been established in 1994 by the UN Convention. However, the ISA tasks were defined much earlier (1982). The Authority, located in Kingston (Jamaica), currently has 155 members i.e. it is composed of all parties to the Law of the Sea Convention. It is an autonomous intergovernmental organization having a relationship agreement with the United Nations. Biennium budget is about 11 mln USD (the adopted in 2008 budget for 2009-2010 is 12,516,500 USD).

The International Seabed Authority has three organs: the Assembly, in which all members are represented, the Council composed of 36 elected members, and Secretary General. All decisions and undertaken under consensus what makes most steps sluggish but in the UN practice this method is the only acceptable. Council members are elected from regional interest groups including those engaged in seabed mineral exploration, pioneer investors and the land-based producers of minerals found on the seabed, separately. One country in one moment can be the member of the only one interest group. The Authority holds one annual session (initially were two sessions per year), usually of two weeks' duration (fourteen annual sessions till now took place). One of the most important activity carried out during ISA sessions is considering draft, and adopt final, regulations on the ocean-floor exploration, and election to the powers especially President of the Assembly, the President of the Council (both for one year terms) and Secretariat ISA headed by the Secretary General (four years term). The author of this paper served in 2006–2007 as the president of the Council, and in 2007–2008 represented Poland as vice-President of the Assembly. This is thanks to strong position of Poland resulted from significant activity of members of Polish delegations to all session, especially R. Kotliński (participated in about 20 sessions, heading IOM, represented Poland as the President of the Assembly in 2008–2009), T. Bachleda-Curuś (represented Poland as President of the Assembly and served as the President of the Council), Z. Galicki, K. Karski, M. Dragun-Gertner (very active members of Polish delegation) or A. Przybycin (member of the Legal and Technical Commission of ISA). In practice decisions are made by the Assembly and the Secretary General but they are later discussed, modified and adopted by the Assembly.

The first Secretary-General of the Authority, since the first election in 1996, is Satya Nandan (Fiji) – now at he end of his third term. During the May/June 2008 session, the Assembly of the Authority elected Nii Allotey Odunton (Ghana) for a four-year term beginning 1st January 2009. Since 1996, he is serving as Deputy to the Secretary-General.

Convention on the Law of the Sea

The most important legal basis of the activity of all ISA organs is the United Nations Convention on the Law of the Sea (UNCLOS), called The Law of the Sea Convention. The Convention defines this deep seabed area and its resources as "the common heritage of mankind". It is the international agreement that resulted from the third United Nations Conference on the Law of the Sea (UNCLOS III), which took place from 1973 through 1982. The Law of the Sea Convention adopted in 1982, defines the rights and responsibilities of nations in their use of the world's oceans, establishing guidelines for businesses, the environment, and the management of marine natural resources. To date 155 countries have joined in the Convention including the European Community which is the full member regardless membership of most of the EC countries. The United States has signed the treaty, but the Senate has not ratified it, so USA is not a member of ISA. Nevertheless, USA sends delegations (2–3 persons) to participate in meetings as an observer and show high activity. On October 31, 2007 the Foreign Relations Committee of the United States Senate, by a vote of 17 to 4, recommended ratification; no date has yet been set for action by the full Senate. Recently, the United States is the only major maritime power that has not ratified the Convention, with one of the main anti-ratification arguments being a charge that the ISA is flawed or unnecessary.

MINING

Exploration and Mining Contractors

One of the most important goal of the Authority is to control, by contracting with private and public corporations and other entities, and authorizing them to explore and eventually exploit, the deep seabed for mineral resources. The exploration system came to life with the signature in 2001/02 of 15-year contracts with seven organizations that had applied for specific seabed areas in which they were authorized to explore for polymetallic nodules. In 2006 Germany has been approved by the Council as contractor. The eight current contractors are: Yuzhmorgeologya (Russian Federation); Interoceanmetal Joint Organization (IOM) (Bulgaria, Cuba, Czech Republic, Poland, Russian Federation and Slovakia – the headquarter is Szczecin (Poland) and the head is Prof. Ryszard Kotliński); the Government of the Republic of Korea; China Ocean Minerals Research and Development Association (COMRA) (China); Deep Ocean Resources Development Company (DORD) (Japan); Institut français de recherche pour l'exploitation de la mer (IFREMER) (France); the Government of India, and the Federal Institute for Geosciences and Natural Resources of Germany.

Exploration and Mining Areas

Nodules, in the highest concentrations occur at abyssal plains between 4,000 and 6,000 meters depth. They are formed on the seabed sediment covers sometimes more than 70 per cent of the bottom, or//and buried within 1 meter the uppermost layer of the sediments. They vary greatly in abundance. Currently, the concentrations are of particular interest of international or national mining consortia, and the most promising nodule occurrence is the Clipperton Fracture Zone (the eastern equatorial Pacific) – see Figure 2. Beside the Clarion-Clipperton Zone (see Introduction) the current area of exploration is in the Central Indian Basin of the Indian Ocean. Each area is limited to 150,000 square kilometers, of which half is to be relinquished to the Authority after eight years of exploration. Each contractor is required to report to the ISA once a year on its activities in its assigned area. In 2006 the Authority established an Endowment Fund to Support Collaborative Marine Scientific Research on the International Seabed Area. The Fund will aid experienced scientists and technicians from developing countries to participate in deep-sea research organized by international and national institutions. A campaign was launched in February 2008 to identify participants, establish a network of cooperating bodies and seek outside funds to augment the initial $3 million endowment from the Authority.

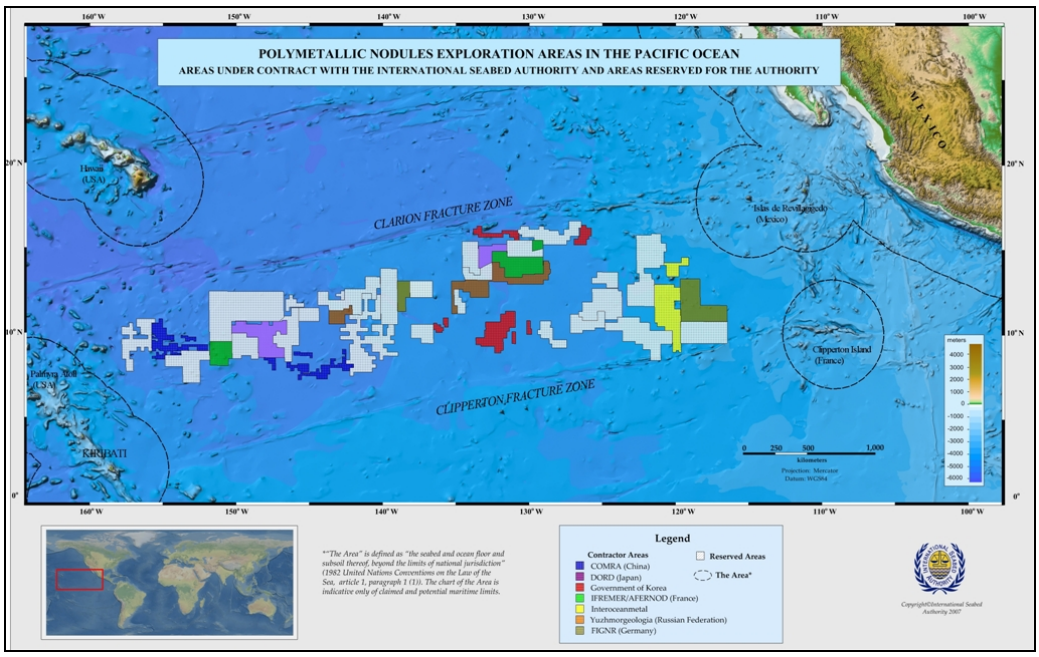

Figure 2. The current areas of exploration in the Clarion-Clipperton Zone

In the mid-seventies, a $70-million international joint venture succeeded in collecting multi-ton quantities of manganese nodules from the abyssal plains (5.5 km depth) of the eastern equatorial Pacific Ocean. Significant quantities of nickel (the primary target) as well as copper and cobalt were subsequently extracted from this “ore” using both pyro- and hydro-methods. In the course of this 8-year project, a number of ancillary developments evolved. The technology developed was never commercialized because the last two decades of the 20th century saw an excess of nickel production. The estimated $3.5-billion (1978 US dollars) investment to implement commercialization was an additional factor. Sumitomo Metal Mining continues to maintain a small (place-keeping) organization in this field. A company by the name of Kennecott Copper had explored the potential profits in manganese nodule mining and found that it wasn't worth the cost. Other than the environmental issues and the fact that the profits had to be shared, there was not any cheap way to get the manganese nodules off the sea floor (no operating technology for economical mining). In recent years, however, interest in deep-sea mining, especially with regard to ferromanganese crusts and polymetallic sulphides, has picked up among several firms now operating in waters within the national zones of Papua New Guinea, Fiji and Tonga. Papua New Guinea was the first country in the world to grant commercial exploration licenses for seafloor massive sulphide deposits when it granted the initial license to Nautilus Minerals in 1997. Japan’s new ocean policy emphasizes the need to develop methane hydrate and hydrothermal deposits within Japan’s exclusive economic zone and calls for the commercialization of these resources within the next 10 years. A few months ago (early 2008), the ISA Secretary General received two new applications for authorization to explore for polymetallic nodules, coming for the first time from private firms in developing island nations of the Pacific. Sponsored by their respective governments, they were submitted by Nauru Ocean Resources Inc. and Tonga Offshore Mining Limited. However, in the absence of consensus on the complex technical issues raised by these applications, the Authority's Legal and Technical Commission decided to defer action, probably until 2009.

In contrast to forecasts made in ‘70s till ‘90s, that seabed mining would generate extensive revenues for both the exploiting countries and the ISA, no technology has yet been developed for mining deep-sea minerals. Nevertheless, although none of contractors has indicated any serious move to begin commercial exploitation, experimental exploitation begins. To accelerate works and exchange information, in addition to its legislative work, ISA organizes annual workshops on various aspects of seabed exploration. The most recent workshop, held at Chennai, India, in February 2008, concerned polymetallic nodule mining technology, with special reference to its current status and challenges ahead. The upward trend in demand and prices for the main metals that would be derived from seabed mining, and new technologies being developed for offshore mining and metals extraction, there are opinions, that economic mining of the ocean depths might be not decades but rather years away.

Environmental Protection

Undersea habitats as seamounts, nodule-covered abyssal plains, smokers, ridges etc supports exceptionally unique and potentially valuable organisms. It is well known that such exceptional biodiversity can be destructed due to exploration and seafloor mining scheduled to begin within next decade. Moreover, benthic ecosystem recovery from mining impacts will be very slow, requiring decades or more for the soft-sediment fauna and thousands to millions of years for the biota specializing on manganese nodules. Therefore, the mentioned above workshops concern also measures to protect the marine environment from any harmful consequences. At Manoa, Hawaii workshop (2007) it was recommended to establish “preservation reference areas” in the Clarion-Clipperton Zone, where nodule mining would be prohibited in order to leave the natural environment intact. It is requested that experts with broad expertise should design Marine Protected Areas (MPAs) for seamounts and the abyssal nodule regions in international waters. Each mining area consists of 75,000 km^2 of seafloor (half of 150 km^2 explored). Therefore, over the time scales of benthic ecosystem all current mining claim areas will potentially be exploited. In fact, abyssal nodule mining will affect large areas of the seafloor due to direct mining disturbance (estimated scales of 300–600 km^2 per year) and dispersed re-deposition (even 100 km) of the sediment disturbed.

CONCLUSIONS

1. Following factors slow down Mn-nodule exploitation: (i) developing and operating mining technology that could economically remove the nodules from depths, (ii) high ISA taxes to be charged for the mining, (iii) availability of ore deposits from land-based mains at economic prices, (iv) unavoidable serious harm to the marine environment resulting in potential future conflicts between environmental organizations and mining companies.
2. Marine Protected Areas (MPAs) for seamounts and the abyssal nodule regions in international waters are necessary to be organized.
3. Significant environmental problems will be fuelled by some land-based producers of minerals found on the seabed to keep high price of metals.
4. Successfully terminated contract for exploration is the first order condition to start with expoitation, and contracts for exploration will finish in 2015. Therefore, the commercial extraction of polymetallic nodules is not considered likely to occur during the next decade, but experimental extraction will start very soon.
5. It is very probable that a large scale economical exploitation of Mn-nodules may start about 2020 at costs that will be able compete with land-based mines.

BIBLIOGRAPHY

Cronan D.S. (ed.): Marine Mineral Deposits. CRC Press Marine Science Series, 2000.

Homepage of the International Seabed Authority: http://www.isa.org.jm/en/home (most of information presented in the paper are available on the homepage of the International Seabed Authority).

Glover A.G., Smith C.R. 2003: The Deep Seafloor Ecosystem: Current Status and Prospects for Change by 2025. Environmental Conservation 30(3), pp. 1–23.

International Seabed Authority, 1999: Deep-Seabed Polymetallic Nodule Exploration: Development of Environmental Guidelines. Office of Resources and Environmental Monitoring, International Seabed Authority, Kingston, Jamaica, 289 p.

Jędrysek M.O. 2007: (an interview by I.B. Litwin with M.O. Jedrysek – Deputy Minister – Chief National Geologist and the President of the Council of ISA): Poland in the Activity of International Seabed Authority – ISA. (In Polish), Przegląd Geologiczny, Vol. 55, pp. 619–622.

Kotliński R. 1999: Metallogenesis of the World's Ocean against the Background of Oceanic Crust Evolution. Polish Geological Institute, Special Papers, 4, Warszawa 1999, pp. 1–70.

Kotliński R. 2003: Relationships Between Nodule Genesis and Topography in the Eastern Area of the C-C region – Meeting of Scientists for the Preparation of a Programme of Work for the Development of a Geological Model of the Clarion-Clipperton Fracture Zone. International Seabed Authority, Nadi, Fiji, 2003.

Kotliński R. and Stoyanova V. 2006: Buried and Surface Nodule Distribution in the Eastern Clarion-Clipperton Zone: Main Distinctions and Similarities. Singapore, Advances in Geosciences, Vol. 9, Solid Earth. Ocean Science & Atmospheric Science (2006), World Scientific Publishing Company, 2006, pp. 67–74.

Kotliński R. 2007: (an interview by I.B. Litwin with R. Kotliński – the Director General of Joint Organisation INTEROCEANMETAL – IOM): Exploitation of Mineral Resources from the Ocean. (In Polish), Przegląd Geologiczny, Vol. 55, pp. 625–627.

Ledwell J.R., Montgomery E.T., Polzin K.L., St. Laurent L.C., Schmitt R.W., Toole J.M. 2000: Evidence for Enhanced Mixing over Rough Topography in the Abyssal Ocean. Nature 403, pp. 179–182.

Lijnzaad L. 2008: Statement of the President of the Council of the International Seabed Authority on the Work of the Council during the Fourteenth Session. Document ISBA/14/C/11, 5 June 2008.

Lodge M.W. 2001: Website of the Centre for Energy, Petroleum and Mineral Law and Policy (CEPMLP), Vol. 10, Abstract 2, 18 December 2001, The University of Dundee (United Kingdom). Article on the Regulations (2001) by Michael W. Lodge – Chief of the ISA Office of Legal Affairs.

Nandan S. 2008: Statement by the Secretary-General of the International Seabed Authority to the Eighteenth Meeting of States Parties to the 1982 UN Convention on the Law of the Sea. New York, 16 June 2008.

Nauru Ocean Resources Inc.: Application for Approval of a Plan of Work for Exploration. Document ISBA/14/LTC/L.2, 21 April 2008.

Pitcher T., Morato T., Hart P., Clark M., Haggan N., Santos R. 2006: Seamounts: Ecology, Fisheries & Conservation. Blackwell, 536 p.

Rolinski S., Segschneider J., Sundermann J. 2001: Long-Term Propagation of Tailings from Deep-Sea Mining under Variable Conditions by Means of Numerical Simulations. Deep-Sea Research II (48), pp. 3469–3485.

Smith C.R. (ed.): Biodiversity, Species Ranges and Gene Flow in the Abyssal Pacific Nodule Province: Predicting and Managing the Impacts of Deep Seabed Mining. ISA Technical Study, No. 3, Kingston, 2008.

Smith C.R., Gaines S., Friedlander A., Morgan C., Thurnherr A., Mincks S., Watling L., Rogers A., Clark M., Baco-Taylor A., Bernardino A., De Leo F., Dutrieux P., Rieser A., Kittinger J., Padilla-Gamino J., Prescott R. and Srsen P. 2007: Preservation Reference Areas for Nodule Mining in the Clarion-Clipperton Zone. Rationale and Recommendations to the International Seabed Authority, Pew Workshop to Design Marine Protected Areas for Seamounts and the Abyssal Nodule Province in Pacific High Seas, October 23–26, 2007, University of Hawaii at Manoa.

Smith C.R., Galeron J., Gooday A., Glover A., Kitazato H., Menot L., Paterson G., Lambshead J., Rogers A., Sibuet M., Nozawa F., Ohkawara N., Lunt D., Floyd R., Elce B., Altamira I., Dyal P. 2007: Final Report: Biodiversity, Species Ranges, and Gene Flow in the Abyssal Pacific Nodule Province; Predicting and Managing the Impacts of Deep Seabed Mining. J.M. Kaplan Fund and the International Seabed Authority, 41 p.

Tonga Offshore Mining Limited: Application for Approval of a Plan of Work for Exploration. Document ISBA/14/LTC/L.3, 21 April 2008.