

Mining Marine Minerals From Deep Seabed Implemented by International Seabed Authority

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SEG NEWS

The purpose of this article is to contribute to informing our community of a regime that is in place and functioning with reference to allocation of marine mineral deposits beyond the areas of jurisdiction of coastal states. Areas of jurisdiction of coastal States are defined by the 200 nautical mile wide Exclusive Economic Zone (EEZ; UNCLOS articles 55-75, Part V, United Nations, 1997) and its extension. The regime is managed by the International Seabed Authority (ISA or Authority) established by the United Nations Convention on the Law of the Sea (UNCLOS or Convention). The Authority is an autonomous agency independent of the United Nations with headquarters in Kingston, Jamaica, that administers "on behalf of mankind" as the "common heritage of mankind" the mineral resources of the international "Area" (UNCLOS articles 136, 153 and 156, United Nations, 1997; <http://www.isa.org.jm>). The Area is defined as the seabed and ocean floor and subsoil thereof, which is beyond the limits of national jurisdiction (UNCLOS article 57, United Nations, 1997).

The Convention is described as "the constitution for the oceans" because it pertains to all aspects of ocean space and maritime issues. The Convention entered into force and the Authority was established in 1994 (UNCLOS article 308, United Nations, 1997). Presently 164 countries and the European Union are parties to the Convention and thus are ipso facto members of the Authority (UNCLOS article 156, paragraph 2, United Nations, 1997; International Seabed Authority, 2013). The United States has not yet signed the Convention; when signed the United States will be able to partake in mineral allocation in the Area under the Convention. In addition, the United States will have governance over the largest EEZ and continental shelf in the world, extending national sovereign rights over ocean resources to an area greater than the Louisiana Purchase and Alaska combined. A provision provides for extending the continental shelf beyond the 200 nautical mile limit (UNCLOS article 76, Part VI).

The Authority's management of potential marine mineral resources of the Area primarily deals with mining polymetallic nodules ("manganese nodules"), polymetallic sulfides, and cobalt-rich ferromanganese crusts (maps shown at URL <http://www.isa.org/m/en/scientific/exploration/maps>). Management involves granting exclusive 15-year exploration contracts based on rules, regulations, and procedures adopted by the Authority following Convention guidelines (UNCLOS, Part XI, 1997) preliminary to mining. Part XI of the Convention pertains to rules and regulations for marine mining and was rejected in its original form in 1982 as antithetical to industrial interests with reference to technology transfer and other proprietary issues by a large number of States mainly from the industrialized countries. The conditions for acceptance of Part XI were set by then President Ronald Reagan and were resolved by negotiation and adopted by the UN General Assembly in 1994 with entry into force of the Convention as the Agreement Relating to the Implementation of Part XI of UNCLOS (Agreement articles 1-10; sections 1-9; United Nations, 1997). The Agreement resolved the outstanding marine mining issues and opened the door to universal participation in the Convention. The United States was given the only permanent seat (with veto) on the Council of the Authority set up to facilitate deep seabed mining (contingent on ratification; Agreement, Annex, paragraph 15a; United Nations, 1997).

The Authority functions by yearly meetings of its governing bodies, the

Assembly consisting of all members of the Authority, the Council consisting of 36 members elected by the Assembly, a Legal and Technical Commission (LTC), and a Finance Committee. The LTC reviews applications for mineral exploration preparatory to exploitation, makes recommendations to the Council for decision on approval of the applications. Five exploration contracts were approved at the last session (Eighteenth session; 9-27 July 2012; Figure 1) based on plans of work submitted by the contractors. A plan of work involves identification of the applicant, sponsorship by a member State, definition of the seabed area of application, and submission of information documenting that the applicant is financially and technically capable of carrying out the proposed plan of work for exploration. The plan is accompanied by an assessment of the potential environmental impacts of the proposed activities and by a description of a program for oceanographic and environmental baseline studies to ensure that the exploration activities cause minimal impact on the marine environment (Agreement, Annex, Section 1; United Nations, 1997). The duration of a plan of work is 15 years with the possibility of extension, to be followed by a plan of exploitation, meaning mining. The earliest exploration contracts concluded with the Authority will expire in 2016. Framing of detailed regulations for the anticipated future deep seabed mining of the three types of mineral deposits is an upcoming challenge for the Authority.

Three of the five work plans approved at the last session were for polymetallic



FIGURE 1. Assembly of International Seabed Authority at Eighteenth session, 9-27 July 2012.

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nodules. The plans comprise UK Seabed Resources Ltd, a company sponsored by the government of the United Kingdom of Great Britain and Northern Ireland and a wholly owned subsidiary of Lockheed Martin UK Holdings Ltd.; Marawa Research and Exploration Ltd, State enterprise of the Republic of Kiribati; and by G-Tec Sea Minerals Resources NV, a Belgian company sponsored by the Government of Belgium. Polymetallic nodules are golf-ball to tennis-ball sized spherules with regionally variable contents of nickel, copper, cobalt, manganese, iron, and rare Earth elements (REE) that lie on sediment in vast expanses of abyssal plains, potentially covering some 60% of the ocean basin at a typical water depth of about 5 kilometers. The nodules are precipitated from metals dissolved in seawater and sediment pore water typically on time scales of millions of years in various concentrations (Morgan, 2012). The regions considered most prospective contain nodules with combined copper, nickel, and cobalt content >2.5% by weight and manganese with abundance > 10 kg m². REEs may be produced as a byproduct of the extraction of the other metals (Hein, 2012.)

In 2001 the Authority granted seven national and industrial groups of "pioneer investors" exclusive 15-year exploration contracts for polymetallic nodules. Six of the contracts are for tracts in the eastern equatorial Pacific between Hawaii and Central America (Clarion-Clipperton zone). One of the contracts is in the middle of the Indian Ocean. The three recent contracts are for tracts in the Clarion-Clipperton zone. A total of twelve exploration contracts have been issued to date for polymetallic nodules (International Seabed Authority, 2013). Each exploration contract may consist of tracts of 150,000 square kilometers each.

The remaining two of the five applications for exploration contracts approved during the Eighteenth session of the Authority are for polymetallic sulfides. The two applications approved were from IFREMER (Institut français de recherche pour l'exploitation de la mer) sponsored by the Government of France for polymetallic sulfide deposits at sites on the north central Mid-Atlantic Ridge, and by the Government of the Republic of Korea for sulfide deposits at sites on the Central Indian Ridge, respectively. The French exploration contract includes the TAG (Trans-Atlantic Geotraverse) hydrothermal field that hosts one of the largest and possibly the largest known polymetallic sulfide deposit on an ocean ridge (Rona et al., 1986; Rona, 2008).

TAG was discovered and first described using National Oceanic and Atmospheric Administration (NOAA) research vessels with NOAA and National Science Foundation (NSF) support.

Polymetallic sulfides are precipitated beneath and on the seafloor from high-temperature hydrothermal solutions driven by magmatic activity in two settings: 1) sites on ocean ridges primarily situated within the Area; and 2) sites associated with volcanic island arcs primarily situated within the EEZs of island States of the western Pacific. The sulfide deposits contain iron, copper, zinc, silver, and gold in variable concentrations and trace quantities of other metals of electronic interest (cadmium, cobalt, gallium, germanium, indium, selenium, and tellurium). The high-temperature hydrothermal solutions deposit sulfides as they circulate beneath the seafloor and discharge from black-smoker type chimneys that grow at rapid rates in real time. However, deposits of prospective grade and tonnage involve sub-seafloor zone refinement and other processes that take thousands of years to accumulate and concentrate. Two exploration contracts for polymetallic sulfides have been issued by the Authority to date to the Peoples Republic of China (Southwest Indian Ridge), to the Russian Federation (north central Mid-Atlantic Ridge) exclusive of the three more recent applications for contracts cited (France, Korea, India). The contracts may cover an area of not more than 100 blocks each approximately 10 km by 10 km (ISBA/16/A/12/Rev.1, Regulation 12).

The LTC considered and recommended for approval by the Council at the upcoming Nineteenth session of the Authority (15-26 July 2013) the first two applications of plans of work for exploration for cobalt-rich ferromanganese crusts (International Seabed Authority, 2013). The applications were submitted by the Japan Oil, Gas and Metals National Corporation (JOGMEC) and the China-Ocean Mineral Resources Research and Development Association (COMRA). Three further applications for approval of plans of work for exploration for consideration at the Nineteenth session of the Authority have been submitted by the Russian Federation (cobalt-rich ferromanganese crusts), the United Kingdom Seabed Resources, Ltd. sponsored by the United Kingdom (polymetallic nodules), and the Government of India (polymetallic sulfides; International Seabed Authority, 2013).

Cobalt-rich ferromanganese crusts are typically up to 25 cm thick and like manganese nodules typically precipitate

over millions of years from dissolved metals in seawater, but on bare volcanic rock substrates exposed on seamounts and on ocean ridges (Hein, 2009). The most favorable sites for the occurrence of these crusts occur in the volcanic island arcs of the central equatorial Pacific and on volcanic seamounts in the equatorial Indian Ocean. Metals in the crusts comprise cobalt, nickel, platinum, and titanium in addition to iron and manganese and REEs depending on proximity to different sources (Hein 2012).

States Parties have the general right to conduct marine scientific research in the Area (UNCLOS articles 87, 143 and 256). Freedom to conduct scientific research in areas under exploration contracts is stated in the Nodules Regulations (Part 1, paragraph 4), the Sulphides Regulations (ISBA/16/A/12/Rev.1, Part I, paragraph 4), and the Draft Cobalt-rich Ferromanganese Crust Regulations (ISBA/18/C/L.3, Part 1, paragraph 4). A US role in the ISA and participation in the Agreement awaits ratification or accession to the Convention as a treaty requiring approval by a two-thirds majority of the US Senate, where the Convention has yet to be voted on. An extensive list of US supporters of the convention includes all living Chiefs of Naval Operations, all living Secretaries of State, the Joint Chiefs of Staff, the Coast Guard, the Oceans Policy Commission, the National Ocean Industries Association, the Chamber of Commerce, the Financial Roundtable, and the National Governor's Association.

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Preface to SEG Compilation 7

Porphyry Copper, Gold, and Molybdenum Deposits: 1905–2012

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CODES—The Australian Research Council's Centre for Excellence in Ore Deposit Research, University of Tasmania, Private Bag 126, Hobart, Tasmania 7001, Australia

Porphyry deposits are the world's principal resources of Cu, Mo, and Re, and are major resources of Au and Ag. Since 1905, more than 700 articles concerning porphyry deposits have been published by the Society of Economic Geologists in its various publications (*Economic Geology*, Anniversary Volumes, *Economic Geology Monographs*, *Reviews in Economic Geology*, *Special Publications*, *Guidebooks*, and the *SEG Newsletter*). This DVD is a compendium of those papers, dating back to the historical

studies of Bingham, Butte, Chuquibambilla, El Teniente, and other major districts, and continuing through to the latest Special Publication, no. 16—*Geology and Genesis of Major Copper Deposits and Districts of the World*, and the 2013 special issue of *Economic Geology*, on Pebble, Alaska. The DVD is subdivided into three sections and 16 subsections:

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