International Seabed Authority ISBA/14/LTC/3

Legal and Technical Commission

Distr.: General
23 April 2008

Original: English

Fourteenth session
Kingston, Jamaica
26 May-6 June 2008

Report on the International Seabed Authority's workshop on polymetallic nodule mining technology: current status and challenges ahead

Prepared by the secretariat

1. The objective of the technical workshops convened by the Authority is to obtain the views of recognized experts in specific subjects under the Authority's consideration, including the most recent scientific research results on marine mineral deposits, protection of the marine environment from the impacts of mining deposits in the Area, and information on costs and environmental considerations associated with developing mineral resources in the Area (e.g., cost models). Since 1998, the Authority has convened 10 international workshops on specific issues related to deep seabed mining, with participation by internationally recognized scientists, technologists, researchers and members of the Legal and Technical Commission, as well as representatives of contractors, the offshore mining industry and member States. The most recent workshop took place in February 2008 in Chennai, India, in cooperation with the National Institute of Ocean Technology of India.

2. A preliminary cost model for a deep seabed polymetallic nodule mining and processing venture (with a 20-year life, and producing 1.5 million tons per year) was developed at the Authority's eleventh workshop on polymetallic nodule mining technology — current status and challenges ahead, in cooperation with the Ministry of Earth Sciences of the Government of India, at its National Institute of Ocean Technology, in Chennai, from 18 to 22 February 2008.

3. Inputs to the model came from 16 technical and legal presentations made by participants. Presentations were made on, inter alia, technologies that had been tested at water depths of 5,200 metres in the Clarion-Clipperton fracture zone of the Pacific Ocean and had successfully mined 800 tons of polymetallic nodules; the availability of riser technology, subsea power systems and pumps of the magnitude required for polymetallic nodule mining that are currently available on the market; a pilot processing plant with a capacity of 500 kg per day that over a five-year period was used to test various hydrometallurgical processing routes; and supply and

demand for nickel, cobalt, copper, manganese, silicomanganese and ferromanganese. The majority of the inputs, however, were developed in three working groups that were established at the workshop to deal with:

(a) Mining technology to address, inter alia, achievements and outstanding issues related to the collector device, power generation and riser technology;

(b) Processing technology to address, inter alia, the status of nodule processing technology development and resource requirements for three- and four-metal plants with a view to ascertaining possible cost-cutting methods to reduce the overall cost of processing, the feasibility of designing a processing plant so that with modest incremental investment it can be converted to process land-based nickel laterite ores, the feasibility of designing the processing plant to operate on blended nodules and laterite ores, and the feasibility of converting an existing nickel laterite facility to accept nodules;

(c) The current economics of a polymetallic nodule mining venture to establish a new cost model, as appropriate, or to update an earlier cost model for such a venture, including the scenarios of a non-integrated venture comprising a nodule-mining venture in its own right and a nodule/laterite-processing venture to receive nodules from a deep seabed nodule miner.

4. Most of the presenters also submitted papers that will be published in the proceedings of the workshop, along with a summary of their oral and visual presentations and related discussions.

5. There were 48 participants at the workshop, with representatives of six of the eight exploration contractors for polymetallic nodule development in the Area (China, Germany, India, the Republic of Korea, Poland and the Russian Federation) presenting papers that, inter alia, described the status of their efforts to develop a cost-effective configuration of technology to facilitate exploration, mining for polymetallic nodules and their processing into copper, nickel, cobalt and manganese. Contractors were also requested to provide estimates of capital and operating costs based on their selected configurations and production scales and to identify those areas of activity where collaboration could enhance the viability of their ventures. There were also nine other presenters whose papers focused on: an analysis of mining technologies developed in the 1970s and 1980s and model mining units envisaged in the 1970s and 1980s; project economics and cost models that had been developed in the past for deep seabed mining (Flipse (1980), Nyhart (1980), Hillman (1981), Ingham (1985) and Massachusetts Institute of Technology (MIT) (1985)); the economic and technical considerations underpinning the pioneer regime and the International Seabed Authority regulations for prospecting and exploration for polymetallic nodule deposits in the Area; possible applications of space applications to deep seabed mining; the status of lift systems for polymetallic nodule mining; advances in nickel laterite processing and possible applications to polymetallic nodule processing; technology development for polymetallic sulphides and possible applications to nodule mining, and advances in riser technology for oil and gas and possible applications to nodule mining.

6. Working Group I provided information capital expenditure and operating expenditure for polymetallic nodule mining ventures that would recover 1.5 million and 1.2 million wet tons of nodules a year from a site approximately 6,000 nautical

miles from a land-based processing facility.[1] The Group estimated that CAPEX for a passive collector system (mining ship and mining system) would be approximately $552 million, for a tracked collector system approximately $562 million, for a system designed around the Chinese collector system approximately $372.6 million and for a system utilizing the Indian flexible riser approximately $416 million. With regard to OPEX, the Group estimated $94.5 million for the passive hydraulic collector system, $95.7 million for the tracked collector system, $69.5 million for the Chinese collector system and $89.9 million for the Indian flexible riser system.

7. The costs for the transportation system were estimated at $76.7 million per year for three vessels leased each year or $495 million if purchased. The estimate provided by the Government of India was $600 million if the vessels were purchased. The annual OPEX for the transportation system was estimated as $93.2 million by the Group, compared with $132.7 million by the Government of India.

8. Working Group II provided CAPEX and OPEX information for a probable polymetallic nodule processing plant with an annual capacity of 1.5 million tons, producing nickel, copper, cobalt and manganese. To facilitate comparison with nickel laterite processing plants, both CAPEX and OPEX were reported on a nickel equivalent basis.[2] The Working Group estimated the capital cost per kg of nickel equivalent at $10 to $14 per nickel equivalent. For a 1.5 million-ton capacity polymetallic nodule processing plant, the Group estimated capital cost at $750 million (CAPEX) and the cost of processing at 3.9 dollars per kg of nickel equivalent, resulting in OPEX of $250 million.

9. To initiate its work, Working Group III reviewed models of first-generation polymetallic nodule mining systems (Texas A & M University), United States Bureau of Mines and Australian Bureau of Mines, MIT, 1984) and selected the 1984 MIT report "A pioneer deep ocean mining venture" as the basis upon which to assess systems proposed by participants in Working Groups I and II. Working Group III evaluated trends in metal prices, taking into account increasing demand for nickel and the other metals in nodules by China, India and the Russian Federation, and decided to use a range of prices rather than attempt a single projection.[3] The range of cost estimates from Working Groups I and II and the MIT model were incorporated into the International Seabed Authority model along with metal prices representing the lower and upper values in recent years. The range of mining operations, from 1.2 to 3 million short tons per year for a 20-year mine-life was also incorporated into the model. Internal rates of return for 12 alternative scenarios produced outcomes ranging from a low of 14.9 per cent to a high of 37.8 per cent.

[1] An operating expense, operating expenditure, operational expense, operational expenditure (OPEX) is an ongoing cost for running a product, business, or system. Its counterpart, a capital expenditure (CAPEX), is the cost of developing or providing non-consumable parts for the product or system.

[2] To obtain the nickel equivalent of the nodule ore, the recovered tonnages of nickel, cobalt, copper (for a three-metal recovery process) and manganese (for a four-metal recovery process) are multiplied by the price ratio of the recovered metal and nickel to obtain the nickel equivalents.

[3] The lower limit of the range was determined by indexing the metal prices from the MIT report using the consumer price index, and the upper limit by using 2007 metal prices that are regarded as the peak prices.

10. Working Group III noted that the internal rate of return provided a measure for comparison with land-based operations for mining ores of the respective metals. The Group further noted that the internal rate of return is used to set a threshold that potential mineral development projects must surpass before they receive serious consideration and investment. In this regard, it was brought to the Group’s attention that Antam, an Indonesian State-owned mining and metals company that produces nickel ore and processes ore into ferronickel, has established an internal rate of return of 15 per cent as the lower limit. The Group found that, with the exception of the scenario where the lowest metal prices and highest costs were used, the cases evaluated exceeded the cut-off value, with some resulting in internal rates of return of about 30 per cent. Indeed, the Group pointed out that only mining operations that required three transport vessels to service a single processing plant while recovering only nickel, copper and cobalt from nodules, in conjunction with low metal-price conditions, failed to exceed the 15 per cent cut-off value.

11. Finally, Working Group III emphasized that metal prices, particularly nickel prices, are a major factor in the profitability and attractiveness of investments in deep seabed polymetallic nodule mining ventures. The Group also noted that the industrialization of large developing countries, demand from China and India and the reindustrialization of the Russian Federation will drive demand upward for decades to come. Further noting that there are no large deposits of nickel sulphides to be developed, it emphasized that oxide ores (laterites and polymetallic nodules) are the future source of nickel to meet world demand.