



Legal and Technical Commission

Distr.: Limited
19 July 2011

Original: English

Seventeenth session

Kingston, Jamaica

11-22 July 2011

Evaluation of the annual reports submitted by contractors

Report and recommendations of the Legal and Technical Commission

I. Introduction

1. Pursuant to section 10 of annex 4 to the Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area, all contractors are under the obligation to submit their annual activity reports by the end of March each year.
2. The contractors are: Yuzhmorgeologiya (Russian Federation); Interoceanmetal Joint Organization (Bulgaria, Cuba, Czech Republic, Poland, Russian Federation and Slovakia); the Government of the Republic of Korea; China Ocean Mineral Resources Research and Development Association (China); Deep Ocean Resources Development Co. Ltd. (Japan); Institut français de recherche pour l'exploitation de la mer (France); the Government of India; and the Federal Institute for Geosciences and Natural Resources (Germany). As of 6 June 2011, annual reports had been received from all contractors.
3. At its meeting during the sixteenth session, the Legal and Technical Commission made a number of comments and suggestions on the annual reports submitted for the year 2009. These comments are contained in ISBA/16/LTC/6 and were conveyed in writing by the Secretary-General to the individual contractors on 4 October 2010, along with specific comments relevant to each contractor.
4. As a result of its analysis, the Commission herewith submits the following general observations and recommendations on the annual reports for 2010 to the Secretary-General.



II. Evaluation of annual reports and recommendations

A. Deep Ocean Resources Development Co. Ltd.

General

5. The contractor submitted its annual report for 2010 in English, on 29 April 2011. The report includes headings for exploration activities, environmental studies, mining tests, a training programme and a financial statement. The report is structured in line with the headings and content list recommended by the Commission in the annex to document ISBA/8/LTC/2.

Exploration work

6. The annual report for 2010 indicates that Deep Ocean Resources Development Co. Ltd. (DORD) did not carry out any field activities during that year, and mainly presents the historical background of the exploration work carried out by the contractor. DORD has not carried out any fieldwork since it entered into contract with the International Seabed Authority.

7. During the second five-year phase of the contract (2006-2011), DORD carried out a study to assess the overall viability of deep-sea commercial mining operations. This included a study of the current status of mining technology, smelting and refining nodules, an environment assessment related to nodule exploitation operations and the value of the metals in the nodules. The Government of Japan is currently in the process of building a survey vessel that could conduct exploration activities in the Area as of 2012.

8. The annual report for 2010 provides a summary of activities completed between 1975-1996, covering a period prior to the entry into contract with the Authority. The summary provides details of the cruises conducted, vessels employed and equipment used in the survey vessels. These surveys resulted in a series of maps on the bathymetry; moisture content in nodules; nodule abundance (in different segments of the area); and corresponding metal grade distribution for manganese, nickel, copper and cobalt. However, no raw data is provided. The report also provides an evaluation of resources based on free-fall grab sampler data and tables showing the average nodule abundance of the four metals. After gridding the data over the entire contract area, a table showing a summary of resources was generated and provided with the report. Though the entire area is mapped using multibeam echo sounders, the contractor considers that a more detailed survey is required. The report also suggests that sampling at lesser intervals would provide the required data resolution for understanding the area under consideration for development as a mine site. The contractor did not carry out exploration activities in 2010.

9. As in previous years, the annual report for 2010 provides an assessment of the economic viability and improving economic efficiency associated with nodule mining. An assessment of the economic viability of nodule mining was carried out in 1992 using a discounted cash flow method. The latest study uses data up to 1996. The report mentions that as the assessment is based on previous methods and mining and smelting costs, the results are not current. The report also presents several scenarios using different metal values and calculating the internal rate of return.

Mining tests and proposed mining technologies

10. No mining tests were conducted during the reporting period. However, the report provides information on work carried out by the contractor during the period between 1981 and 1997. The research and development activities of the contractor were aimed at establishing effective and cost-efficient technology systems for mining manganese nodules. Details of the system and a schematic research plan are submitted as tables.

11. An explanation is provided on the development of a nodule collector system and an ore lifting system (pump lift method and air lift method) in the period between 1981 and 1997. The contractor also attempted to develop a handling system and an assessment of the operational systems. Verification experiments were carried out up until 1997, but thereafter, research and development activities were discontinued. However, the contractor proposes to conduct technological capability testing of the system at some future date.

12. DORD worked on the development of a metallurgical system during the period between 1989 and 1995. The report tabulates the work carried out during that period. The contractor carried out a detailed analysis of five existing methods for nodule metallurgy, and then examined a further three more methods. A summary of the evaluation of the eight methods is presented in the report.

Training

13. No training programme was carried out in 2010, since training obligations, as defined in the contract, had been completed in previous years. The training programme conducted by DORD as a pioneer investor in 1993 is provided in the report.

Environmental monitoring and assessment

14. The environmental work described by DORD in 2010 consisted of an evaluation of environmental studies carried out by Japan between 1989 and 1996. The work that had been carried out prior to the signing of a contract with the Authority included surface layer studies and benthic studies. The benthic studies comprised baseline surveys, impact experiments and impact predictions. The results of these studies were presented in an annex to the annual report for 2010. While the document contains some useful information, the results are not discussed here, as it is essentially a literature review of work carried out prior to the signing of the exploration licence.

15. Greater detailed information and analysis is required at the species level for biological studies and for all faunal size classes (microfauna, meiofauna, macrofauna, megafauna). New studies on molecular biology are required as indicated in the revised guidelines to contractors. Scientific research in biogeochemistry and benthic biology has advanced considerably in the last 15 years. The previous results need to be interpreted in the context of new knowledge, with up-to-date references. Greater harmonization with the results of other contractors is important.

Financial statement

16. In the previous year's report, the Commission noted that the breakdown of expenditure provided by the contractor was not in line with the format recommended in ISBA/15/LTC/7.

17. For 2010, the contractor reported a total expenditure of ¥2,024,022 (US\$ 20,240.22) in a financial statement that is not in the format recommended in ISBA/15/LTC/7. The contractor also included a table on exploration costs for the period from 2001 to 2010 under one or two headings with a partial breakdown, but not in the format recommended in ISBA/15/LTC/7. The contractor submitted a certificate of the audit of the accounts of the contractor for the fiscal year from 1 April 2010 to 31 March 2011. The certificate was established and signed by a certified public accountant of the Onozawa Yoshiji Office of Certified Public Accountants. The certified financial statement was submitted in Japanese and accompanied by an English translation that was not certified. As the Commission recommended last year, an appropriate body should certify all translations.

Proposed adjustment to the programme of activities

18. The contractor has not proposed any change in the programme of activities.

Comments

19. The annual report provides a perspective of the data collected during the period prior to the contractor entering into contract with the Authority and the review work performed during the reporting period. Some results and analysis of the data are also presented. The report indicates that a new research vessel is being built and that this ship will be used in future exploration activities. The Commission appreciates the information but, as specified in previous requests, would also appreciate if the work performed during the reporting year was set in context to earlier work.

20. The report did not provide any newly collected data. No digital information that could be used in the International Seabed Authority database was provided.

21. The Commission recommends that the contractor provide a detailed expenditure statement, as specified in ISBA/15/LTC/7. The certified financial statement was submitted in Japanese and accompanied by an English translation that was not certified. For future reference it is recommended that an appropriate body should certify all such translations.

B. Federal Institute for Geosciences and Natural Resources**General**

22. The contractor submitted its annual report for 2010 in English, on 6 April 2011. The report contains information on exploration, mining tests and environmental activities, as well as a financial statement. The report is broadly structured in line with the headings and content list recommended by the Commission in the annex to document ISBA/8/LTC/2.

Exploration work

23. During the reporting period, the contractor conducted a 41-day exploration cruise to its area with RV *Sonne*, in April and May 2010. to carry out multidisciplinary work such as: (a) investigating the formation of manganese nodules through the study of the microbial and the abiotic early diagenetic processes; (b) reconstructing processes controlling the formation of nodules, such as deep water circulation, bottom water ventilation and paleoproductivity; and (c) studying the diversity of benthic and faunal assemblages. Twenty box corer, fifteen multicorer deployments and eight piston/gravity corer deployments were used during the sampling operations. The report provides details on sampling locations and a description of recovered samples, as well as the areas covered, detailing the different topographic domains ranging from flat plains to seamount regions. The report also provides detailed ship tracks overlaid on multibeam bathymetry maps, sampling stations on bathymetry and backscatter maps.

24. A detailed cruise report is provided along with information on the equipment used, for example ocean floor video and photo mapping, chain bag dredges and the different types of corers. Details of the equipment, samples obtained and corresponding nodule abundances were measured and presented in tabular form.

25. During the exploration survey, five seafloor areas were studied using the vessel-based backscatter and the deep-towed sidescan sonar records. Video footage, sampling data and sidescan data from previous cruises were also used for the data analysis. Image processing was carried out to distinguish nodules from sediments that provided percentile nodule coverage on the seafloor. Examples of the analysis are provided in the report. A comparison was carried out between the vessel-based backscatter and the deep-towed sidescan imagery and the results were found to be comparable. The study also established a linear relation between nodule coverage based on video imagery, sidescan sonar data and actual nodule abundance measured from coring devices.

26. The inspection of video images showed that areas of medium-to-high nodule coverage were linked to high backscatter values. The size of nodules appears to play a significant role in the backscatter values for a particular area. Backscatter mapping may possibly be used as an exploration tool for larger areas to distinguish areas with small nodules and lower nodule abundance from those with larger nodules and higher average nodule abundance. However, appropriate pre-processing of backscatter into standard grey scales is required.

27. The report includes a detailed table showing the chemical analysis carried out on nodules collected during the reporting period. Manganese/iron ratios versus nickel/copper content for nodule samples from the area are presented. The average composition for different type of nodules (discoidal, spheroidal and large nodules with rough surface texture) were measured and presented in the report. A total of 228 kg of nodules was collected during the cruise.

28. A nodule distribution model using an artificial neural network was developed in order to address the fact that the contractor considered that their area did not have sufficiently dense sampling information. The objective of the applied method was to investigate if the application of neural networks is appropriate for resource estimation, to identify controlling parameters of metal distribution and to analyse the areal distribution of nodule abundances in order to calculate the resulting metal

tonnage. The exercise was limited to the south-eastern section of the area. The methodology used in the survey is described and the predicted resources for the different cut-off grades and average metal content and resources are presented in the form of a table. The report indicates that further improvements to the model are needed and that the addition of more parameters and ground truthing will be essential to make it more robust.

29. The future exploration strategy for the next 10 years is presented in the report. The contractor intends to perform a yearly research cruise in coming years.

Mining tests and proposed mining technologies

30. In accordance with the programme of activities under the contract, no mining tests were carried out during 2010. The Institute engaged a contractor to study the technical development and economic feasibility of mining of nodules. The contract involved evaluating existing technologies and assessing techniques related to environmental issues, safety, capital expenditure and operating costs and profitability. A detailed conceptual design for a nodule mining and lifting system with computer simulations of important subsystems and components was prepared. The work was completed during the reporting period and a 656-page report was produced. The annual report presents a summary of the larger report prepared for the Institute, with a focus on the conceptual design of the nodule mining and lifting system. Details of the system components, along with an evaluation of the production costs and economic efficiency of the system, are provided. The report concludes that, all things considered, an amount of US\$ 47.38 per ton is required for production of the ore and its transportation to shore.

Training

31. No training programme was carried out in 2010, since training obligations as defined in the contract had been completed in previous years.

Environmental monitoring and assessment

32. In 2010, the environmental work carried out by the Institute consisted of examining the physical oceanography (temperature, salinity and oxygen profiles), chemical oceanography (neodymium profiles), sediment properties (shear strength), pore water and biodiversity of their claim area. The vertical profiles of temperature, salinity and oxygen for the eastern and western regions of the claim area are presented graphically with descriptions. Vertical profiles of neodymium are presented, with the report stating that the results are the first complete seawater depth profiles of neodymium from the western equatorial Pacific. Neodymium can be used as a water mass tracer, with the contractor noting that the results provide insight into the origin of the current water masses and the history of deep water circulation. The methodologies of the sediment shear strength experiments were described along with a description of the results and graphical interpretations. The methodology of the pore water analysis was described along with a description of the results including graphs, including an analysis of the effect of nodule presence on the vertical chemical profiles within the sediment. The biodiversity studies presented include generalized methodology and a brief graphical and descriptive analysis of the results. The biodiversity studies showed that meiofauna abundance is significantly higher in areas with low nodule cover and that within the claim area

there are no barriers to inhibit recolonization subsequent to any disturbance as a result of possible future mining.

Financial statement

33. The contractor reported a total expenditure for 2010 of 4,684,390 euros and provided a detailed breakdown of expenditure, although this was not in the format recommended in ISBA/15/LTC/7. The financial statement is signed by the financial management director and chief financial officer of the Institute, who is responsible and liable for the budgetary aspects of the Institute's activities. The Commission requests the Secretary-General to contact the sponsoring State to provide a clarification of the relationship between the chief financial officer, the Institute and the sponsoring State.

Proposed adjustments to the programme of activities

34. The contractor completed a research cruise during the period, which was originally planned for 2008, and also received funding for the acquisition of deep-tow equipment to conduct studies on mining concepts.

Comments

35. The annual report follows the established format and provides all relevant information, including analysis and, in some cases, raw data. The contractor also completed analytical work on a conceptual mining system but has yet to carry out work on the metallurgical segment of the mining process. It is reported that a similar analysis for metallurgy may also be undertaken at some future time.

36. In its evaluation of the annual report for 2009, the Commission recommended that the Institute complete the assessment of nodule coverage described in the 2009 report. The 2010 report indicates that this task is now completed. The evaluation for the entire area can only be completed once the box core sampling is sufficiently large to carry out such a study. Regarding analysis of Acoustic Doppler Current Profiler (ADCP) data, the contractor has assured that a detailed analysis will be provided in the annual report for 2011.

37. The report provided analysis of the collected data but no digital information. Such data should be provided for the International Seabed Authority database.

38. The report was comprehensive and included a detailed cruise report of activities carried out in 2010. In relation to environmental research, greater detail is required regarding the seabed fauna at the species level. The work reported on megafauna requires good quantitative data for comparison of the fauna between the German and French claim areas.

39. The Commission recommends that in future, the contractor follow the recommendations in ISBA/15/LTC/7 with regard to the format of the financial statement. The Commission also recommends that the sponsoring State identify the competent authority for the certification of financial statements.

C. Government of India

General

40. The Government of India submitted its annual report on 5 April 2011, in English. The report contained information on survey and exploration work, on mining and extractive metallurgy technologies, an environmental impact assessment and a financial statement. The report is structured in line with the headings and content list recommended by the Commission in the annex to document ISBA/8/LTC/2.

Exploration work

41. The exploration activities of the contractor are concentrated on a first-generation mine site, which has previously been reported. The main thrust of the Government of India's exploration activities is the completion of multibeam bathymetric surveys to map microtopographic features. The exploration section of the report once again presents the same bathymetry map of the first-generation mine site, as reported in the previous year's report. No analysis of the data is provided.

42. The contractor intends to use a remotely operated vehicle to generate detailed bathymetry maps in the areas of specific interest. Plans are in hand to undertake regular updates of the database in the year to come.

Mining tests and proposed mining technologies

43. The underwater mining machine developed during the first phase of the exploration programme has been modified with the addition of a collector, a crusher, an enhanced slurry pump, a new hydraulic power pack and a new chassis, with increased width. These enhancements have meant that its weight has now risen to about 23 tons (air). Extensive engineering analysis was carried out prior to the modifications. The nodule pickup, collector, crusher and pumping system in integrated form were further tested in the test pond at the National Institute of Ocean Technology.

44. The underwater data acquisition and control subsystem of the underwater mining machine was enhanced with the latest hardware and software to meet all the additional requirements of the new collector and crusher system. Owing to the expansion of the telemetry system components, the hardware has been split and distributed in two parts, with two separate high-pressure rated enclosures. The two data acquisition and control subsystems work in tandem. The figures of the tested system have been provided in the report.

45. The underwater mining systems, along with handling and subsystems such as winches, control consoles, electrical distribution modules, buoyancy modules and launch recovery platform structures, were tested at depths of 512m on the west coast of India in October 2010. The successful collection, crushing and pumping of artificial nodules, using a single stage positive displacement pump, was achieved during that cruise, thereby validating the concept and qualifying the system for mining operations. Detailed analysis of the subsystems will be carried out and the system will be updated for operations at depths of 6000m at some future date. Many trials are proposed to be conducted to perfect the functioning of the system for long-term operations, during the course of future development for 6000m.

46. Sea trials of the soil tester were continued during the reporting period and were carried out in port. Additionally, further research was performed to characterize soil machine interaction, aluminium structures for a deep-sea mining system, as well as modelling and analysis of subsea drive systems. Preparations for a remotely operated vehicle (ROSUB 6000) have reached the trial stages and the system was tested at nodule locations, at depths of 5000m. Details of those tests and preliminary results are presented in the annual report. Future mining technology developments include the construction of a mining system for operations at 6000m, a survey of the first-generation mining site using the ROSUB, and testing of the modified soil tester.

47. Technology development related to metallurgy continued during the reporting period, with work on flowsheet improvement and the generation of value-added products. An attempt was made to separate metal using a hollow fibre non-dispersive extraction module, as well as to extract molybdenum from nodule leach liquor. The results obtained in the course of these experiments will be used to separate molybdenum on a larger scale. The preparation of electrolytic manganese dioxide from manganese cake and the utilization of nodule leach residue for fine chemicals also continued at one of the participating laboratories. An attempt was made to recover ammonia from liquid effluent containing ammonium sulphate. A few novel smelting approaches were attempted, for example the development of direct smelting and smelting in a graphite-lined arc furnace. It was observed that recovery efficiency increased by up to 7 or 8 per cent by the non-addition of dolomite and by increasing the holding time. About 90.5 per cent copper, 92 per cent nickel and 86.6 per cent cobalt could be recovered, with 7 per cent coke and a 20 minute holding time. Future activities will include the recovery of an ammonia preparation of electrolytic manganese dioxide from manganese cake development of modified leaching schemes for a roast-leach-electrowin process, the optimization of recovery procedures and the recovery of rare earth elements from nodules by solvent extraction or the fibre membrane technique.

Training

48. No training programme was carried out in 2010, since training obligations as defined in the contract had been completed in previous years.

Environmental monitoring and assessment

49. The environmental work carried out by the Government of India in 2010 consisted of evaluating data collected during two cruises in 2009. The contractor examined sedimentological properties, geotechnical properties, the geochemistry of sediments and pore water, microbial and biochemical parameters, fungal and macrofaunal diversity and the fauna associated with nodules. For all of the non-biological studies, the results were briefly discussed, with average values, ranges and graphs. Microbial and biochemical parameters were given for two sites, without detail or graphical representation, although the description states that there was annual/seasonal variation in the results. Fungal diversity was discussed, without data or graphs. Macrofaunal diversity and the fauna associated with nodules were described, without data or graphs. In all cases the report omitted to discuss the methodology that had been used and no raw data was submitted. The report concludes that the studies showed that environmental conditions varied over

different timescales (seasonal and annual) but neither data nor graphs are presented in the report to support these statements.

Financial statement

50. In the previous year's report, the Commission noted that a detailed expenditure statement, as recommended in document ISBA/15/LTC/7, was required for 2009. In response, the contractor has provided a table showing reported expenditure, but not under the headings recommended in document ISBA/15/LTC/7. With respect to cruise expenses, the table does not specify the actual day rate for ship time and for large equipment items for each of the two cruises in 2009. No capital expenditure is itemized.

51. The contractor reported a total expenditure of US\$ 5,980,000 for 2010. A financial statement is provided, containing a breakdown of expenditure but not under the headings as recommended in document ISBA/15/LTC/7. Cruise expenses did not specify the actual day rate for ship time and the day rate for large items of equipment. The contractor stated that the reported expenditure did not include non-technical manpower and administrative manpower. Furthermore, no distinction is made between operational and capital expenditure. No capital expenditure is itemized. The financial statement is signed and certified by the Secretary of the Ministry of Earth Sciences.

Proposed adjustment to the programme of activities

52. The contractor has not proposed any change in the programme of activities.

Comments

53. The bulk of the work carried out by this contractor in 2010 consisted of research and development activities for nodule collection and processing. Little exploration work took place and activities that took place in 2009 are reported once again, without any additional analysis. A substantial amount of detail is given on mining technology and metallurgy but it appears to be a continuation of the work already reported in previous years. No raw data and analysis are provided for the environmental work carried out during the reporting period.

54. The report only provided analysis of the collected data but no digital information. Such data should be provided for the International Seabed Authority database.

55. It was encouraging that mining and metallurgical activities were carried out during the reporting period.

56. The Commission was concerned about the status of the environmental data that was provided. The report of progress in environmental issues was very poor. It was impossible to assess the quality of the research owing to the lack of data on methods (sampling and analysis protocols). Average values were presented without standard deviations. Proper statistical comparisons, including multivariate statistical analyses, which meet current international standards and follow the revised guidance for contractors, are required. A discussion of the results in relation to current knowledge (with references) is required. An analysis of the work carried out by this contractor by an independent scientific panel could probably lead to serious challenges being made to any exploitation phase.

57. The Commission recommends that the contractor provide a detailed expenditure statement as recommended in ISBA/15/LTC/7.

D. Interoceanmetal Joint Organization

General

58. The Interoceanmetal Joint Organization (IOM) submitted its annual report on 4 April 2011, in English. The report contains information on contract-related activities, geological exploration, environmental research, mining and processing technologies and a financial statement. The report is structured in line with the headings and content list recommended by the Commission in the annex to document ISBA/8/LTC/2.

Exploration work

59. The contractor carried out data processing and an analysis of samples collected during a cruise in 2009. No fieldwork was carried out during the reporting period. The analysis of data from the 2009 cruise included a geostatistical assessment of nodule and metal resources in the contract area. The block kriging method was used to calculate mean abundance and metal concentrations as well as nodule and metal resources in seafloor blocks. The procedure takes into account: (a) the distribution of sampling sites relative to the mining blocks being sampled and relative to each other; (b) the shape and size of the blocks; and (c) the structure of the variability of a parameter in question, as expressed with the geostatistical variability model (semi-variogram model). The report contains a table showing the results of a geostatistical exercise on the resources calculated in area H1 (in sector B2) of the IOM contract area.

60. The other studies included analysis of grain size distribution and mineral composition of sediments. IOM also continued geochemical research in its contract area. The physical properties of seafloor sediments and nodules were measured in laboratories, and 69 sediment samples were analysed for density using pycnometric analysis. Slightly siliceous silty clay was the dominant type of sediment, followed by siliceous silty clay. Thirty nodule samples were analysed for density by means of pycnometric analysis and through calculations. The instrument measurements are lower than those obtained by calculations. The density of zeolitic crusts is considerably higher than that of non-aggregated sediments.

Mining tests and proposed mining technologies

61. The contractor analysed the results of a workshop, sponsored by the International Seabed Authority, on the theme “Polymetallic nodule mining technology: current status and challenges ahead”, held in Chennai, India, in 2008. The contractor reported that there are few results and no critical technological developments to show for the past 15 years of research, despite the large sums of money expended. IOM has concluded that it should focus its mining technology research on conceptual designs, since the construction of experimental miner systems to be tested in only shallow water conditions, even when scaled down, are major capital investments. During 2010, a retrospective analysis of IOM research on mining technology was carried out in order to identify unsolved problems in the deep-sea mining system development. The contractor notes that the computer

models required to design and validate this entire “at-sea operation” also need to be developed.

62. Two lines of technological research have been followed for polymetallic nodule processing: pyro-hydrometallurgical nodule processing and hydrometallurgical nodule processing. The supplementary studies included autoclave nodule leaching with sulphuric acid, with sugar cane industry wastes utilized as reducing agents. A techno-economic assessment of these technologies will be carried out. A large amount of nodules (5-8 tons) will be collected for laboratory testing of the processing technologies.

Training

63. No training programme was carried out in 2010, since training obligations as defined in the contract had been completed in previous years.

Environmental monitoring and assessment

64. The environmental work carried out by IOM in 2010 concerned analysis of the megafauna observed on photographic transects performed on a cruise in 2009. A description of the observations was presented along with photographic images, graphs and maps. The report states that an atlas of megafaunal communities in the IOM exploration area is being prepared and will include photographs and descriptions of identified fauna.

Financial statement

65. The approved financial statement for 2009 was received on 25 June 2010.

66. For 2010 the contractor reported a total expenditure of US\$ 754,344. A detailed breakdown of expenditure was provided. Although expenditure was reported under the recommended headings, each heading was not broken down as recommended in ISBA/15/LTC/7. On 1 June 2011, the Director of IOM advised the Secretary-General that the Council of IOM had approved the financial statement on 20 May 2011.

Proposed adjustment to the programme of activities

67. The contractor has not proposed any change in the programme of activities.

Comments

68. IOM carried out its activities in accordance with the programme of activities under the contract. As no fieldwork was carried out during the reporting period, the work mainly involved analysis of the previous year's data. Desk research was conducted on mining technology and slow progress has been made in developing mineral processing technology.

69. The report only provided analysis of the collected data but no digital information. Such data should be provided for the International Seabed Authority database. Furthermore, much of the report concerned data that had been collected in previous years, as no fieldwork was performed in 2010.

70. For the environmental work reported on the photo-transects, greater quantitative analysis and better taxonomic resolution are required. Reference should

be made to several recent workshops on the conduct and analysis of photo-transects for environmental impact assessments. The contractor should engage with the wider scientific community for better taxonomic resolution of the fauna identified in the photographs.

71. Although expenditure was reported under the recommended headings, each heading was not broken down, as recommended in ISBA/15/LTC/7. This should be addressed by the contractor in future reports.

E. The Government of the Republic of Korea

General

72. The contractor submitted its annual report on 6 April 2011, in English. The report contains details of exploration work, environmental studies, mining technology work, training and other activities and a detailed financial statement. A summary of the report is also provided at the beginning of the report. The report is structured in line with the headings and content list recommended by the Commission in the annex to document ISBA/8/LTC/2. The report includes relevant figures and tables.

Exploration work

73. The contractor carried out 84 days of field survey in blocks KR2 and KR5 on board RV *Onnuri* during the reporting period, as part of its exploration and environmental work. The survey operations were carried out on two cruises in July and August 2010. The objective of the first cruise was to collect environmental data, while the second cruise focused on geological and geophysical surveys in order to understand the geotechnical properties of sediments and nodule distribution in the allocated area. Sidescan and bathymetry data were collected, using a deep-tow sidescan sonar system. These surveys were conducted in the KR5 block. The report provides maps of the sampling sites and track lines from the survey.

74. The results of the deep-tow survey efforts are presented in the report in the form of two maps illustrating sidescan data and colour-coded bathymetry. Multiple and box corers were used for sediment sampling and the collected sediment samples were analysed for shear strength, grain size and water content to determine basic geotechnical parameters. Shear strength was measured using a viscometer, grain size using the sedigraph and water content by the weight difference between wet and dry sediments. The sediments had 66.9 per cent of clay. The report provides a table of geotechnical properties of sediment samples.

75. Manganese nodule distribution was studied by means of nodule sampling. The objective was to make a precise assessment of the mining potential of the allocated area. Nodule sampling was carried out during the cruise at 24 stations in the KR5 and KR2 blocks. The nodule samples collected have been classified based on their surface texture, morphology and sizes. A table showing the results is contained in the report. The metal content of manganese nodules was measured for major metals and results are presented in tabular form. Nodules were generally enriched in copper, manganese, nickel and zinc and depleted in cobalt and iron in the southern block (KR5), indicating a dominant diagenetic origin.

Mining tests and proposed mining technology

76. In accordance with the programme of activities under the contract, no mining test was carried out during the reporting period. However, the contractor continued work on the collector and integrated mining operation technology. The programme is developing a self-propelled miner model that sweeps polymetallic nodules from the seafloor and disposes of them through a flexible pipe into a buffer station for lifting, as well as the creation of the methodology required to perform at-sea mining operations. During the reporting period, the test collector *MineRo* underwent driving tests for 135 hours. A seafloor navigation algorithm was developed and verified. Based on the results of performance tests, the concept and basic design of a pilot mining robot capable of diving to depths of up to 500m were drawn and construction of the core design technology for a propelled mining robot system was completed. For the lifting technology, a shallow lifting system was tested in 2009 to confirm its performance characteristics. During 2010, a detailed hydrodynamic design was carried out on impellers and guide vanes of deep ocean multistage lifting pumps. The contractor plans to test a pre-pilot lifting at depths of 1000m in 2012.

77. The contractor conducted scaled-up testing (200kg/day) of the reduction smelting-leaching process to recover cobalt, copper, manganese, molybdenum and nickel. The report includes data on the equipment used and the alloys produced. The results can be summarized as follows:

- (a) The scale-up test (capacity: 200kg/day of manganese nodules) of solvent extraction was carried out to separate copper from a leaching solution with a continuous mixer-settler;
- (b) The electro-winning system for the scale-up test was designed and manufactured to recover metals (cobalt, copper, nickel) from a purified solution;
- (c) The autoclave (15 litre) was purchased to leach matte phase for the scale-up test;
- (d) The process to recover molybdenum from a leaching solution as molybdenum trioxide (MoO_3) was developed with solvent extraction technology;
- (e) The process for selective production of cobalt, copper and nickel powders from a leaching solution was developed and optimized;
- (f) The process to remove the remaining copper in the solution after solvent extraction was studied, using an ion exchange method.

Training

78. No training programme was carried out in 2010, since training obligations as defined in the contract had been completed in previous years.

Environmental monitoring and assessment

79. In 2010, the Government of the Republic of Korea carried out a research cruise to investigate the physical, chemical and biological conditions of their claim area. The physical assessment involved conductivity, temperature and depth (CTD) profiles and current measurements, including an evaluation of seasonal variability in currents. Spatial variation was also addressed by comparing CTD profiles obtained along a North-South transect. The chemical assessment involved collecting water

samples from the CTD castings to measure inorganic nutrients, organic carbon and chlorophyll-a, with vertical, longitudinal and latitudinal transects all presented. Annual variation in nutrient profiles and temperature are presented. Biological studies involved an examination of the meiofauna, macrofauna and micro-organisms in the water column. Geochemical analysis of the sediment consisted of an analysis of the lithologic and biogenic compositions of sediment cores. Carbon and nitrogen were also measured in sediment samples, including an analysis of temporal and spatial variability. The geochemical properties of the sediment are presented but included in the exploration section of the report. The seasonal and vertical variability of particle flux from the surface to the seabed is also presented.

80. Extensive graphical and descriptive analysis were provided along with some raw data, including the geographic location of sample sites. Of particular note is that the Government of the Republic of Korea is providing raw biological data in the format requested by the Secretary-General of the International Seabed Authority.

Financial statement

81. In last year's report, the Commission concluded that a detailed expenditure statement for 2009 needed to be provided. The contractor has not provided it.

82. The contractor reported for 2010 a total expenditure of US\$ 8,622,300. A financial statement is provided, containing a detailed breakdown of expenditure, but not in the format recommended in ISBA/15/LTC/7. The certificate of expenditure is signed by the Director of the Marine Policy Bureau of the Ministry of Land, Transport and Maritime Affairs of the Government of the Republic of Korea.

Proposed adjustment to the programme of activities

83. The contractor does not foresee any changes in the near future and therefore it has not proposed any change in the programme of activities.

Comments

84. The quality of the data presentation in the form of tables and figures is good. It would be useful if the locations of the sampling stations for the tables shown in the exploration section were provided in that section, in addition to the environmental section, although all other details are provided. The report presents bathymetry and sidescan imagery maps of the surveyed areas but no analysis or explanations are presented.

85. The report contains a detailed section on environmental studies. All the relevant sampling locations are provided in the form of tables. The contractor is providing raw biological data in the format requested by the Secretary-General of the International Seabed Authority.

86. The report only provided analysis of the collected data but no digital technical information. Such data should be provided for the International Seabed Authority database.

87. The Commission appreciates that the contractor provided raw environmental data in the report.

88. The Commission recommends that the contractor provide a detailed expenditure statement for 2009 and a detailed breakdown of expenditure for 2010 in the format recommended in ISBA/15/LTC/7.

F. China Ocean Mineral Resources Research and Development Association

General

89. The China Ocean Mineral Resources Research and Development Association submitted its annual report for 2010 on 28 March 2011, in English and Chinese. The report contains information on exploration work, environmental baseline studies, research and development of deep-sea mining systems and metallurgical processing technologies, on other activities, training, the 2010 workplan and a financial statement. The report is structured in line with the headings and content list recommended by the Commission in the annex to document ISBA/8/LTC/2.

Exploration work

90. The Association did not conduct any at-sea field survey operations during the reporting period. During 2010, the contractor completed the data processing of deep-tow high resolution bathymetric trial survey data collected in 2009. The length of the survey line was 48 km and the coverage width was 500m. The coverage width of the sidescan was 700m. The report provides details of the methodology employed in the bathymetry and sidescan data processing. The report presents a figure comparing the results of deep-tow survey with the hull-mounted multibeam system. The detailed survey site was divided into four segments and the average slopes for each segment were calculated. Relief maps of the segments are presented in the report. The deep-tow survey operations did not have accurate acoustic navigational positioning of the deep-tow and therefore the accuracy of the data collected is low. The contractor carried out sea trials and 17 dives at depths of 2000-3000m in the South China Sea with the submersible *Jiaolong*.

Mining tests and proposed mining technologies

91. In 2010, the Association carried out research and development on nodule transportation safety in the recovery process. The results will provide technical reference for the design of safe and efficient transportation of nodules in the vertical riser pipe from the seafloor to the surface vessel. Research and development was also carried out on the integrated motion of the mining system to ensure the system would be operational in various sea states. To perform a fast simulation, a single-body rigid model for a deep-sea mining system was constructed. The contractor has indicated in its next five-year plan that it intends to build a laboratory for the exploitation and utilization of deep-sea minerals. The laboratory will serve as a platform for the development of deep-sea mining technology and for research on the processing of deep-sea resources.

92. The Association continued its metallurgy experiments with studies on technologies for self-catalysis reduction ammonia leaching and smelting of polymetallic nodules. The results on self-catalysis reduction ammonia leaching are presented in the form of precipitate and precipitate leached with common ammonia

solution. Further improvements over previous studies were conducted on smelting technology of polymetallic nodules, and an improved flow chart of smelting of polymetallic nodules is presented in the report.

Training

93. No training programme was carried out in 2010, since training obligations as defined in the contract had been completed in previous years. However, two Pakistani scientists were trained on board.

Environmental monitoring and assessment

94. The environmental work carried out by the Association in 2010 consisted of the continued analysis of data collected in 2009 and additional data collected on chlorophyll-a, meiofaunal communities and chemical parameters. Chlorophyll-a size fractionation was presented descriptively and graphically, comparing the vertical profiles through the water column at the eastern and western areas of the contractor's claim area. Data on meiofaunal community structure, depth profiles and size fractionation are presented graphically and descriptively. The chemical baseline data presented includes vertical phosphate profiles, information on nutrient enrichment experiments, the mineral composition and origin of suspended particles in the surface water and patterns in particle export fluxes. The information obtained is described and complemented with graphs and photographs but does not include raw data.

Financial statement

95. In last year's report, the Commission noted that a detailed expenditure statement as recommended in ISBA/15/LTC/7 had not been provided. The contractor has provided a table on expenditures for 2009 in the five-year periodic report for 2006 to 2010, but not in the format recommended in ISBA/15/LTC/7.

96. The contractor reported for 2010 a total expenditure of US\$ 5,302,800, under seven headings, with a partial breakdown. The contractor submitted a certification by the financial Department of the State Oceanic Administration. The certification indicates that it has been established in accordance with Chinese national standards and that proper books of account have been kept.

Proposed adjustment to the programme of activities

97. The contractor has not proposed any change in the programme of activities.

Other activities

98. The contractor undertook a study on the economic prospects of polymetallic nodule exploitation, which included an exhaustive market survey for cobalt, copper, manganese and nickel. Data is provided on land-based mining production levels, consumption, projected production and price fluctuation, over the past five years, for each of the metals. The survey indicates that land-based resources of cobalt, copper, manganese and nickel are presently quite abundant and will meet demand for the next 50 years. It is the rare earth elements contained in the polymetallic nodules and cobalt-rich crusts that may become the new driver for the development of seabed resources. Global demand for rare earth elements is likely to continue to

increase in the future. The main factors that affect the economic benefits of nodule mining are the quality of resources, mining scale, fixed assets investment, operational costs, metal prices and interest rates. The economic analysis shows that the exploitation of nodules requires substantial investment and risk-taking. The technology is still uncertain and operational and environmental management costs cannot be accurately determined at this stage; however, high metal prices are likely to boost investor confidence in the development of seafloor mining.

99. The Association continued to work on the development and operation of an ocean information system; this includes managing China's ocean sample repository and updating the ocean sample information system. China and the Republic of Korea have continued to collaborate within the framework of international cooperation agreement on deep-sea mineral resource development.

Comments

100. The Association provided an informative report. The work was carried out according to the programme of activities set out in its contract. In the absence of any fieldwork, the exploration work was limited to the processing of deep-tow sidescan and bathymetry data collected in 2009. The figures and maps in the report are generally good. The contractor is making steady progress in mining and processing technologies. The analysis on the economic potential of nodule mining, although not part of its contractual mandate, is very useful.

101. The report only provided analysis of the collected data but no digital information. Such data should be provided for the International Seabed Authority database.

102. The report was concerned with the processing and analysis of data collected in 2009. In addition, the contractor provided information of a feasibility study on mining. Particular attention was given by the contractor to rare earth elements within the deposits and the contractor mentions future work on the generation of a spatially referenced database.

103. Data provided in environmental research should feature better statistical analysis, including quoting mean values with standard deviations. The relevance of some data to mining activities needs to be made clear. All data need to be discussed in relation to current knowledge and to its importance in the environmental management of seabed mining. Further work at the species level, with consistent taxonomy and following international standards, is required. Data on sampling locations and sampling protocols (methods) is required in order to assess the data.

G. Institut français de recherche pour l'exploitation de la mer

General

104. The contractor submitted its annual report for 2010 on 6 June 2011, in French. The report contains information on exploration activities, mining technology, training, environmental assessment and monitoring, other matters and a financial statement. The report is broadly structured in line with the headings and content list recommended by the Commission in the annex to document ISBA/8/LTC/2.

Exploration work

105. The Institut français de recherche pour l'exploitation de la mer (IFREMER) did not carry out any oceanographic campaign during the reporting year. IFREMER did not report any exploration activity during the reporting period.

Mining tests and proposed mining technologies

106. In accordance with the programme of activities under the contract, no work was carried out.

Training

107. No training programme was carried out in 2010, since training obligations as defined in the contract had been completed in previous years.

Environmental monitoring and assessment

108. The section of the annual report of IFREMER in relation to environmental work consisted of abstracts from papers published in the scientific literature, based on the results of sampling carried out during the oceanographic campaigns of IFREMER in previous years. The two published papers for which abstracts were presented concerned meiofaunal abundance and diversity. The report states that a meeting was held with the Federal Institute for Geosciences and Natural Resources to prepare a proposal for a collaborative study, but the proposal had not been finalized.

Other matters

109. The contractor reported that in June 2010, the group on national perspectives on marine mineral resources completed a study, conducted by 30 experts over a period of 10 months, on the economic forecast of mineral resources. The report ("Les ressources minérales marines profondes") was published in 2011. The contractor has developed a bibliographic database of 7,800 documents and a Geographic Information System (GIS). The GIS nodules programme continues with the transformation of picture files from earlier cruises, in order to georeference and integrate them with other historical data.

Financial statement

110. In the previous year's report, the Commission noted that a detailed expenditure statement, as recommended in ISBA/15/LTC/7, the proper certification for the 2009 financial statement and clarification regarding the mention of permits for exploitation in the 2009 annual report of the contractor should be provided. The contractor has not provided them.

111. The contractor reported for 2010 a total expenditure of 108,910 euros. The financial statement contains a breakdown of expenditure under the five headings recommended in ISBA/15/LTC/7. The financial statement is certified by the Agent Comptable Principal of IFREMER. Overhead costs are not certified.

Proposed adjustment to the programme of activities

112. The contractor has not proposed any change in the programme of activities.

Comments

113. The report is extremely brief and no work has been reported in relation to exploration, mining and processing technology. The format of the report is structured according to the recommended template.

114. The report on environmental research is very disappointing. While the listing of scientific publications is encouraging, full copies of the papers cited are required, and the results should be discussed in the context of all knowledge of the Clarion-Clipperton Zone. Raw data should be supplied to the Authority, or access to the Biocean database should be discussed.

115. The contractor is again requested to provide clarification regarding the mention of permits for exploitation in the 2009 annual report.

H. Yuzhmorgeologiya**General**

116. Yuzhmorgeologiya submitted its annual report for 2010 in Russian, on 4 April 2011. The contractor was requested to provide an English translation, which has to date not been received. The report was subsequently translated by the United Nations translation services and the translation received on 31 May 2011. The report contains an introduction, a financial statement and sections relating to exploration work, environmental studies, research activities, mining tests and a personnel training programme. The report also includes a brief on the work programme for 2009. The report is structured in line with the headings and content list recommended by the Commission in the annex to document ISBA/8/LTC/2.

Exploration work

117. The exploration work during the reporting period was mostly confined to an area of 3,670 km² in the eastern polygon of the Russian exploration area, adjacent to the area surveyed in the two previous years. The field investigation was carried out on board RV *Gelendzhik*. The map of the area is presented in the report along with the coordinates of the polygons, provided separately in a table. During the field surveys, the emphasis was on deep-tow photography, video and acoustic surveys in the selected sites. Details on the vessel employed and the equipment used has been presented in the report. Geo-acoustic scanning was carried out using sidescan sonar with a signal frequency of 30 kHz. Some 13 geo-acoustic scanning profiles were completed in the area of research, over a total length of 425 km. The scan lines on a contour map have been provided in the report. Photo- and video-scanning was performed in the southern and northern section of the operational area, and a total of 19 photographic and video profiles were prepared, totalling a length of 535 km. A map of profile tracks have been presented in the report. Samples collected during the 2010 cruise have been analysed in the laboratory. The study covered sediment grain size, structure analysis, calcium carbonate content and microfaunal age determination, as well as an analysis of nodules and igneous rocks. Work was also concluded on the processing of 2008 and 2009 video- and sonar-profiling. Data collected during 2010 are still being processed for geological interpretation. Charts of the geomorphology, seafloor formation and mining and geological conditions are presented in the report, along with a brief interpretation and analysis of the relief

and geological maps. The number of positive features, flat and valley features observed from the map have been tabulated and presented in the report, indicating the percentage of area covered by each of the different features.

118. The structure of the sedimentary cover was studied by processing the data from seabed sonar-profiling carried out by the deep-tow system. A figure illustrating seabed relief and the structure of sedimentary cover in the gradient zone between the ridge and a valley with all layers is presented in the report. An assessment of the mining and geological factors for determining the distribution of nodules deposited on the seabed is largely dependent on the geomorphology and lithology of the area. A map showing the geological conditions of varying difficulty is presented in the report. A total of 32 ore deposits with development potential have been identified in the area. These areas range from 7 km² to 129 km². Work has been carried out to collect, analyse and organize data generated by the geological, geophysical and geochemical studies of nodules and baseline characteristics of the geological environment of prospecting areas. A comparison is also made of the areas with lenticular, striated and nest-like nodules. A comparative description of the sites is presented in the form of a table. The physiographic maps of the areas are presented in the report. The geotechnical and physical-chemical properties of seabed deposits have been tabulated and analysis is presented in the report.

119. A comprehensive table showing the parameters of ore-bearing capacity is presented and includes parameters such as morphological, mineralization, scale of mineralization, spatial variability and quantitative characteristics of mineralization. Mass concentration values of wet nodules within individual ore deposits are presented in the form of a figure. The contractor states that zonal anisotropy could be detected in the distribution of quantitative parameters of ore-bearing capacity in the area. This highlights the need to factor in the results of variability analysis of the scale of mineralization in the area of individual clusters when planning prospecting networks in any given area of the deposit.

Mining tests and proposed mining technologies

120. According to the programme of activities, no mining activity or metallurgical processing activity was scheduled for 2010.

Training

121. No training programme was carried out in 2010, since training obligations as defined in the contract had been completed in previous years.

Environmental monitoring and assessment

122. The environmental work carried out by Yuzhmorgeologiya in 2010 consisted of an examination of the benthic biology and meteorological conditions. The benthic biological work involved the analysis of photographic transects and physical samples obtained in 2008 and 2009. This included an examination of the megafauna, macrofauna, meiofauna and organisms associated with the nodules. Abundance, species structure and diversity were presented graphically and in tabular form, along with a description for all groups, and some raw data was provided. In addition, information on vertical distribution within the sediment was provided for the meiofauna. Meteorological conditions were presented descriptively, with associated graphical representations. The report states that, in 2010, work was completed on

the environmental analysis of the different regions of the eastern claim area. The areas were classified based on nodule characteristics. The information presented to compare each deposit classification included a summary of the chemical properties of the sediment and the abundance of megafauna, macrofauna and meiofauna in each region. Average values were presented in tables along with vertical profile graphs of sediment chemistry.

Financial statement

123. In the previous year's report, the Commission noted that a detailed expenditure statement for 2009 had not been provided, and this was not provided in 2010.

124. The contractor reported for 2010 a total expenditure of US\$ 5,446,750, with a partial breakdown, but not in the format recommended in ISBA/15/LTC/7. The reported expenditure is certified by the General Director of Yuzhmorgeologiya and confirmed by the Chief of the Department of Continental Shelf and Oceanic Mineral Resources, Federal Subsoil Agency of the Russian Ministry of Natural Resources and Environment.

Proposed adjustment to the programme of activities

125. The contractor has not proposed any change in the programme of activities.

Comments

126. The annual report is very detailed. The report provides a number of figures and tables showing the work accomplished during the reporting period. While the report mentions the field survey, it does not specify the number of cruises undertaken nor the number of days spent in the area; instead, it presents details of survey track and sampling sites. The contractor has carried out extensive work on the data collected from field surveys in previous years and the results are presented in the report. The geographic location of the sampling sites is not provided.

127. The report only provided analysis of the collected data, but no digital information. Such data should be provided for the International Seabed Authority database.

128. The taxonomic resolution of the fauna identified in the photo-transects is of a particularly high quality.

129. A detailed expenditure statement for 2009 has yet to be provided. The Commission recommends that the contractor provide the financial statement in the format recommended in ISBA/15/LTC/7. In order to facilitate the work of the Commission, the contractor is requested, in future, to also provide an English translation of the report.

III. General comments and recommendations

130. The majority of reports largely follow the general format prescribed by the Commission, and generally confine themselves to work carried out during the reporting year under consideration, in accordance with the suggestions made by the Commission after previous evaluations. A few reports were limited to reviewing work that had been carried out in earlier years.

131. Six of the eight contractors are entering the final five-year phase of their respective contracts. It is to be expected that, by the end of their contracts, they will have identified a first-generation mine site, obtained good baseline environmental data and developed a mining system prototype and arrangements for processing.

Geological work

132. In general terms, exploration work proceeded slowly during the reporting period. Annual reports by most contractors are directly related to fieldwork and the absence of this type of activity means that they have little to report. In fact, some report not having conducted any form of geology, mining or metallurgy-related activity.

133. The annual report submitted by some contractors does not provide the locations of nodule and sediment sampling.

134. As pointed out in earlier Commission evaluations, no uniformity exists in the classification of nodules based on morphology, shape or size. A standard needs to be established at the earliest opportunity.

Mining tests and proposed mining technology

135. Progress still remains to be made on technology-related issues, particularly with respect to the mining and metallurgical processing of nodules. A few contractors have yet to begin to develop their technological capacity and it may therefore be beneficial if such contractors made a concerted effort by pooling their resources.

Environmental monitoring and assessment

136. The environmental work reported by contractors in 2010 is generally of better quality than that reported in previous years. However, there is still a lack of raw data being provided by contractors. This raw data is essential for evaluating the potential impact on the marine environment and also for the development of the environmental management plan for the Clarion-Clipperton Zone.

Financial statements

137. Not all contractors have provided a breakdown of expenditure, as recommended in document ISBA/15/LTC/7. Such a breakdown is needed to conduct an evaluation of the reported expenditure and facilitate comparisons between the different contractors.

138. The Commission recommends that the Secretary-General request sponsoring States to identify the correct authority for certification of financial statements.

Other matters

139. Despite repeated requests from the Commission, only one contractor has provided a list of research published in peer-reviewed journals during the reporting year.

140. Few examples currently exist of any collaborative work between contractors. While not required by the Regulations, the Commission encourages greater levels of collaboration by sharing manpower and resources among contractors.

141. A positive trend observed during the reporting period is that some of the contractors have started analysing data on the economic feasibility of nodule mining, thereby generating analysis on market trends, metal values, investments required and expected returns.
