



Legal and Technical Commission

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Evaluation of the annual reports submitted by contractors

Report and recommendations of the Legal and Technical Commission

I. Introduction

1. The Legal and Technical Commission ("the Commission") met during the sixteenth session of the Authority to consider and evaluate the annual reports of the contractors submitted pursuant to the Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area ("the Regulations"). The contractors are: Deep Ocean Resources Development Co. Ltd. (DORD) (Japan); the Federal Institute for Geosciences and Natural Resources (BGR) (Germany); the Government of India; Interoceanmetal Joint Organization (IOM) (Bulgaria, Cuba, Czech Republic, Poland, Russian Federation and Slovakia); the Government of the Republic of Korea; China Ocean Mineral Resources Research and Development Association (COMRA) (China); Institut français de recherche pour l'exploitation de la mer (IFREMER) (France); and Yuzhmorgeologiya (Russian Federation).

2. Pursuant to section 10 of annex 4 to the Regulations, the contractors are under an obligation to submit their annual activity report by the end of March each year. As of 31 March 2010, all eight of the current contractors had submitted their annual reports for 2009.

3. The Commission's deliberations on the reports took place in informal closed meetings on 19 and 20 April 2010, and in formal closed meetings on 21, 22 and 23 April 2010. The Commission followed a suggested template for its report and recommendations to the Secretary-General with respect to the contractor's reports, as set out in the annex to document ISBA/15/LTC/2. To conduct the analysis, and following its usual practice, the Commission divided itself into working groups. This year, three working groups, on legal, environmental and technological aspects, carried out a preliminary study of the annual reports and prepared a thematic draft evaluation for consideration by the full Commission. The secretariat also provided the Commission with a preliminary analysis of the status of annual reports



submitted by contractors (ISBA/16/LTC/CRP.5). On 26 April 2010, the Commission adopted the present report.

II. Evaluation of annual reports and recommendations

A. Deep Ocean Resources Development Co. Ltd. (DORD)

General

The contractor submitted its annual report for 2009 in English in electronic and hard copy format on 19 March 2010. The report includes details of a study of the technological and economic conditions for nodule exploration 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

5. DORD reported that no field activities were carried out in 2009.
6. DORD continued studies during the year on data collected in previous years. A discounted cash flow method was used, with assumptions of different parameters, including ore to be mined, abundance and grade of deposits, processing costs, recovery percentages and metal prices. The relevant figures have been listed in the report. The evaluation arrived at figures for mining construction and operational costs of US\$5,630 million and US\$1,280 million, respectively. The contractor is of the opinion that the results do not encourage further investment at this point.
7. As an annex to the report, the contractor has provided the results of an exercise in the three parts of the contract area displaying slope angles of less than 5°. The bathymetric map shows areas with cut off slopes higher than 5° as white patches. Figures showing average grades of nickel, copper, cobalt and manganese for different slope angle ranges, and their averages in the three contracted areas, are provided.

Mining tests and proposed mining technologies

8. No mining tests were conducted during the reporting period.

Training

9. Training obligations under the contract have been completed. Accordingly, no training was envisaged in the programme of work.

Environmental monitoring and assessment

10. In accordance with the programme of activities under the contract, no work was carried out. A survey of environmental factors to establish a baseline will be carried out in parallel to detailed exploration. The report mentions support from JM Kaplan to carry out environmental work however it was not reported herein.

Financial statement

11. The contractor reported a total expenditure of ¥1,436,595 (US\$15,962.17) under two headings relating to analysis of technologies and miscellaneous expenses, but the breakdown is not in the form requested in ISBA/15/LTC/7. The contractor submitted a certificate of the audit of the accounts of the contractor for the fiscal year from April 1, 2009 to March 31, 2010. The certificate has been established and signed by a certified public accountant of the Onozawa Yoshiji Office of Certified Public Accountant. The certified financial statement was submitted in Japanese and accompanied by an English translation that was not certified. For future references it is recommended that an appropriate body should certify all such translations.

Comments

12. The contractor has carried out a very preliminary analysis of the grade data with respect to the slope angles in the area. DORD has continued to monitor the mining and processing technologies currently available and under development. Furthermore, the contractor has indicated that its activities will remain suspended until the economic situation in relation to deep sea mining is conducive to commercial operations. A request to postpone submission is cited by the contractor in their report.

B. Federal Institute for Geosciences and Natural Resources of Germany (BGR)

General

13. The contractor submitted its annual report for 2009 in English in hard copy and electronic format on 23 March 2010. The report contains information on exploration, mining tests and environmental activities, 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

14. During the reporting period, the contractor conducted a second exploration cruise to its area with RV *Kilo Moana*, involving 20 working days (35 cruise days). The main work carried out during the cruise was multibeam mapping and side-scan sonar mapping. No samples were collected during the cruise. Other objectives of the cruise were: to generate a Digital Terrain Model (DTM) using bathymetry and backscatter data; to carry out meter resolution seafloor mapping using side-scan sonar; and to collect sediment thickness data with a 3.5 kHz sediment echo sounder and magnetic anomaly mapping to determine crustal ages. High resolution mapping of both East and West blocks was completed during the research expedition. The report presents the track map, bathymetric and backscatter maps generated from the data collected during the cruise. It also briefly provides information on the major equipment used during the survey.

15. Evaluation of the backscatter, bathymetry and sediment thickness record and the side scan tows suggest that the surface characteristics of the seafloor and the vertical sequence of the sediment may indicate nodule abundance. The plain areas display homogeneous backscatter. The report provides the side-scan data, multibeam

data and sediment thickness analogue data juxtaposed side by side for the tracks running in north-south and south-north directions. The contractor observed strong reflections for high nodule abundance areas of 10-21 kg/m². Low nodule abundance was observed in areas with outcrops of old consolidated sedimentary data. The contractor concluded that the strong backscatter suggests the presence of a relatively young, muddy sediment sequence covered with high nodule abundance and, conversely, that weak backscatter indicates old sedimentary strata and low nodule abundance.

16. The magnetic anomaly mapping has helped in reconstructing the paleogeographic age history of the area. In the contractor's western area, the northernmost survey lines show high amplitude positive anomaly with an ancient fracture zone crossing the area. The age of the crust on the southern side of these areas is estimated to be 52-54 ma, corresponding to anomaly number 24. The crust in the contractor's eastern area is calculated to be of magnetic chrons 6B and 5E. This corresponds to the increased magma production along the Pacific spreading centre, and the effects can be observed in the form of a number of small fracture zones striking at irregular angles. Magmatic lineation also reveals a change in strike direction between chrons 7 and 6C and a ridge jump between chrons 6A2 and 6. The report presents the wiggle traces of the magnetic data, generated from the data collected during the 2008 and 2009 cruises.

17. Worldwide demand for high technology metals such as tellurium, indium, germanium, gallium, platinum group metals and rare earth elements is increasing. All these metals are present in polymetallic nodules and BGR has decided to include these in the economic evaluation of the nodules. During 2008, BGR carried out an international inter-laboratory analysis comparison of these trace metals. During the reporting period, the contractor further evaluated the analytical methods of the 69 laboratories involved in order to investigate inter-method discrepancies and sample preparation techniques. The results do not vary much for most major elements, but significant discrepancies were observed for the trace metals. An unusual oxide matrix of the nodules generates unexpected interferences and results in method bias. The report includes as an annex a publication on the analysis of analytical methods used in relation to trace elements.

18. Pore water collected from sediments during the 2008 cruise was extracted from a specifically designed pore water press and stored for analysis. It should be noted that no sampling station map for the pore water samples was provided by the contractor therefore bringing into the question the validity of the data. Metal ions were analyzed using inductively coupled plasma-optical emission spectrometry (ICP-OES) and anion analyses were conducted using ion chromatography. Figures showing the results of the analyses on pore water samples from two cores are presented in the report. The results show that oxic conditions prevail on the seafloor except in one sample. The conclusion is that, with the exception of one instance, slightly lower Eh conditions in the licensed area, when compared to completely oxidized deep sea sediments, do not record suboxic conditions.

19. The contractor has proposed another cruise in the area to carry out environmental research on, microbiological and abiotic early diagenesis processes controlling the formation of nodules. The research will include investigations on taxonomy and biodiversity utilizing photographic and video surveys, baseline environmental data collection and high resolution bathymetric data collection in

selected areas, as well as evaluation of the hydrothermal effect on growth rates of nodules and chemical composition.

Mining tests and proposed mining technologies

20. In accordance with the programme of activities under the contract, no mining work was carried out. However, the contractor has entered into a contract with a private firm to carry out a technical development and economical feasibility study of mining polymetallic nodules from the deep sea. The contract involves evaluating existing mining techniques and assessing techniques relating to environmental issues, and covers safety, capital expenditure, operating expenses and profitability, and survey-related technological factors regarding transfer of technology. The contract will also develop a conceptual design for a nodule mining and lifting system. The results are expected by November 2010.

Training

21. The contractor imparted laboratory training to four selected trainees during the current year. Cruise participation by these trainees was completed during 2008. During this post-cruise training, the trainees were initiated in activities including the compilation of data, preparation of the cruise report, interpretation of results and seismic data, and training in micropaleontological methods. A detailed report on the completion of the training programme pursuant to the programme of work accompanies the present annual report. The training report is also reproduced in document ISBA/16/LTC/5.

Environmental monitoring and assessment

22. BGR carried out limited environmental work in 2009. The work that was carried out concerned examining pore water chemistry, with the results discussed and presented graphically in the report. In addition, BGR provided a CD of raw Acoustic Doppler Current profiler (ADCP) current data obtained during its exploration cruise. In addition, fauna and sediment sample analysis efforts are presently in progress. Microbiological analysis will start in 2010 with the addition of new samples from the 2010 SONNE cruise.

Financial statement

23. The contractor reported a total expenditure of €2,631,118, with a detailed breakdown under different expenditure headings but not as recommended in ISBA/15/LTC/7. The contractor did not provide certified financial statement from an appropriate body for the resubmitted 2008 and newly submitted 2009. Financial statements have to be certified by a proper authority in accordance with the Regulations.

Adjustments to the programme of activities

24. The contractor has received a grant for a three-year project to study nodule formation and the benthic community. The contractor is likely to conduct another cruise during 2010. The report lists the main objectives of the project and the contractor wishes to modify the work Programme Plan for 2010-2012 to reflect these new objectives.

25. The scientific focus of the proposal is the influence of hydrothermal activity on the growth rates and chemical composition of polymetallic nodules. The programme of work includes the:

- (a) Acquisition of seafloor photographs and videos for the calibration and ground truthing of digital acoustic data sets;
- (b) Gathering of biological and ecological baseline data; and
- (c) Acquisition of additional high-resolution bathymetric data of selected areas.

Comments

26. The contractor has indicated that its work on nodule coverage could not be accomplished, as the reflectivity survey was only completed in November 2009. The report presents a detailed account of the cruise carried out during the reporting period. The figures in the report are clear and informative. The contractor has also provided ADCP data, the analyses of the data are not provided. The contractor has continued to work on standards for the measurement of trace metals in polymetallic nodules. The contractor should provide the meteorological and other routine environmental data collected during the cruise.

27. The contractor has sent a detailed response to the queries raised by the Commission last year, and has also provided all relevant data, as requested.

28. A statement of expenditure containing a detailed breakdown is provided, and is signed by the head of the organization. Financial statements must be certified by a proper authority in order to follow the Regulations.

29. Some of the information contained in the report had very little to do with the study of nodules in the contractors area. The report lacks of analysis of the data collected.

C. The Government of India

General

30. The Government of India submitted its annual report in electronic format on 9 April 2010 in English. The report contains information on survey and exploration work and 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

31. The Government of India performed two research cruises in 2009.

32. The exploration activities were concentrated in the First Generation Mine (FGM) site reported upon previously. The main thrust was the completion of multibeam bathymetric surveys to map microtopographic features. During the reporting period, an expedition was undertaken to remap the area using an advanced hydrosweep multibeam system to fill data gaps. The data from the cruise is still being processed. The FGM data indicate a total of 30 million metric tonnes of

nodules with abundances in the range of 5.14 to 13.23 kg/m². The other major work during the year was the retrieval of bathymetry data from magnetic tapes. The report presents the flow chart of the scheme employed to convert magnetic tape data on to DVDs. The exercise is being conducted to identify data gaps where additional information may be required.

33. The contractor has plans to continue detailed topographic investigations in the next year and to undertake additional cruises to fill the data gaps in high resolution bathymetry.

Mining tests and proposed mining technologies

34. During the reporting year, the existing mining system has been modified with the addition of a collector, crusher, enhanced slurry pump and new hydraulic power pack. All of the components are rated, and have been tested for 6,000 meters of seawater (msw) with a system output of 8 tons/hour pumping capacity. Stability and stress analysis of the system was also carried out. The collector head has a mechanical tined pick-up device that has been designed, fabricated, assembled and tested in a bentonite soil bed seeded with nodules to evaluate its performance. The collector belt unit with cleated belt conveyor system has been manufactured and integrated into a newly fabricated superstructure. A scaled down model of a spike crusher capable of crushing and laterally transporting nodules was fabricated and tested with charcoal, and artificial and real nodules. This has been integrated in to the existing superstructure and positioned below the collector. The slurry pump system has been modified to handle solids sized 30 mm. A power distribution sub-system for the mining system on the technology demonstration vessel was installed during the year. The report includes several pictures of the different mining technology components fabricated during the year.

35. The contractor plans to modify the configuration of the in situ soil tester to reduce the weight of the structure and minimize the complexities of the system to enable continuous use.

36. The contractor is also working on the remotely operated submersible *ROSUB 6000*. The system is being developed in collaboration with the Russian Federation. The system is comprised of an ROV, subsea tether management system, launching and recovery system including a large umbilical winch, high frequency high voltage power conversion and transmission, and data telemetry and acquisition. Sea trials for *ROSUB* were carried out twice during the reporting period, at depths up to 5,200 m. The report includes the relevant figures for *ROSUB* at different stages of deployment. The report also provides the ROV manoeuvring test results. The results of the tests on *ROSUB* components such as sonar and video are also provided in the report. During the next reporting year, the contractor proposes to test the mining system at 500 m depth. In addition, the in situ soil tester will be operated in the first generation mine-site (FGM), and work will be initiated for the development of an integrated deep sea mining system prototype for 6,000 m depth.

37. The technological development of nodule processing continued with the main objective of improving the existing flow sheet. During this process the contractor reviewed the creation of value added products from exit process streams, utilization of waste, and development of novel flow sheets for better techno-economics. The separation of metal values using a hollow fibre, non-dispersive extraction module is now ready for integration into the flow sheet of the pilot plant and necessary scale

up studies are being undertaken. The contractor has also attempted the preparation of electrolytic manganese dioxide from manganese cake. The experiment was successful at the pilot stage and efforts are ongoing to obtain high discharge capacity electrolytic manganese dioxide that can be used for the preparation of batteries. The method has also been tried with added dopants such as titanium doped electrolytic manganese dioxide. The dopants help to achieve higher discharge capacity. The contractor is now attempting the recovery of manganese metal from synthetic manganese sulphate solution as an option for the recovery of manganese metal from leach solution generated from polymetallic nodule residue. Other activities presently being pursued by the contractor are: utilization of nodule leach residue for chemicals; recovery of ammonia from liquid effluent containing ammonium sulphate; and the development of a modified leaching scheme for roast-leach-electrowin process. As part of the programme to develop novel approaches, the contractor is attempting the development of direct smelting. Investigations are underway to explore a reduction smelting-matte formation-ammonical pressure leaching-hydrothermal reduction method to recover copper, nickel, cobalt and manganese from nodules, and the report provides a description of the process being employed. In the future, the contractor proposes to work on the generation of optimal process parameters for process improvements as well as the development of novel approaches.

Training

38. Training obligations under the contract have been completed. Accordingly, no training was envisaged in the programme of work.

Environmental monitoring and assessment

40. In its annual report, the Government of India notes that a research cruise was carried out to collect environmental data during 2009. The cruise investigated sediment characteristics including geotechnical properties and geochemical characterization of the sediment chemical structure, and benthic biology. Much of the report is concerned with describing the methods of sampling, and it states that assessment of the samples collected is expected to continue in the years to come. The few results provided are in descriptive form, unaccompanied by graphical representation or raw data.

41. Undrained shear strength measurements were carried out on board after each sediment core was collected. The shear strength varied from 3 to 8 kPa. Subsamples have been preserved at 4° for further study at inshore laboratories.

Financial statement

42. The contractor reported a total expenditure of US\$9.58 million but not broken down as recommended by the Commission in ISBA/15/LTC/7. The statement is signed by the Secretary of the Ministry of Earth Sciences, Government of India.

Comments

43. The work performed by the contractor during the year was mostly on research and development. As per the request of the Commission, the contractor has now provided a separate and detailed account of the mining and metallurgy technologies being developed. The work under the exploration component is mostly on detailed

bathymetric surveys. The report does not provide any results from the exploration cruises. It should be noted that no sampling station map for the samples collected was provided by the contractor. The contractor is requested to provide this information to the Authority. The contractor has made significant strides in the metallurgical processing component and is now concentrating on alternative routes and value added by-products. It is important to note that long-term time series of certain data series are available.

44. With respect to the request for additional information on the 2008 report, the contractor provided a note. The details of the mooring locations for time series analysis of currents carried out during the period 1996-1997 are provided. The information provided does not address the detailed request from the Commission pertaining to benthic sampling.

45. The contractor has to provide a detailed expenditure statement as recommended in ISBA/15/LTC/7.

D. Interoceanmetal Joint Organization (IOM)

General

46. IOM submitted its annual report on 1 April 2010, in hard copy and electronic format 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

47. The contractor carried out field studies for 58 days of the reporting period. The work included: side-scan surveys (295.8 line km); photography (344.3 line km); sediment and nodule sampling (51 stations); bulk nodule collection (740 kg); meteorological observation; and sediment sample collection followed by laboratory analysis. The report lists the equipment used for the side-scan survey and the data collected in different tracks. Similarly, the number of frames, track distance and the average distance between frames has been listed for photographic data for each track. The surveys show the seafloor surface to be punctuated by longitudinal ridges and depressions, with 100 m to 200 m crack fractures. The sedimentary cover varies from 0 m to 85 m. Four types of sediment complex have been identified from the survey data. The sediment sampling stations show the geochemically active sediment layer to be 2 cm to 14 cm thick. The number of stations and thicknesses are listed in the report. The active layer mostly consists of siliceous argillaceous silt and argillaceous siliceous silt. Of the 51 sediment core stations, nodules were recovered from 50. The report provides a table showing information on items including abundance ranges, nodule type and depth ranges. The dominant nodule morphologies are discoidal, ellipsoidal and fragmentary. A study of nodule abundance in the area shows that across the entire contract area, abundance is independent of the thickness and type of active sediment layer. Thirty-two stations had buried nodules with abundances as high as 7.62 kg/m². The buried nodules were found up to 35 cm to 45 cm deep at five stations. The composition of the nodules collected during the cruise has been shown in tabular form. No sampling station

locations are provided. The survey shows that of the 5,400 km² area surveyed, 950 km² had slopes higher than 7° (the contractor considers this the cut-off point for mining). Of the total area, 4,000 km shows an abundance of over 9 kg/m² (considered the minimum for mining). The report provides a table showing the classification and characteristics of nodule types and some photographs of different nodules. During the cruise, IOM also carried out studies on geotechnical properties. A table showing the variation of sediment volume density with the percentages of amorphous silica is provided in the report. Another table showing the physico-mechanical properties of different types of sediment is also provided.

48. IOM mentions working on a database of nodules and bottom sediments in its area in the future. However, its 2008 report mentioned that this work was complete. Some of the conclusions drawn in the 2008 report are repeated in this year's report.

49. IOM also entered into an understanding with COMRA to cooperate on exploration activities during 2008-2010. IOM collaborated with BGR on geotechnical studies.

Mining tests and proposed mining technologies

50. A conceptual mining system design was developed based on fundamental data parameters relating to the mining sub-systems for the hydraulic nodule lift mechanism, the collector, preparation of nodules for lifting, and control system energy supply. The research mainly related to the movement of fine and coarse particle suspensions in the pipes, and problems related to nodule transfer to risers. Research on nodule processing concentrated on updating and optimizing major technologies. The results of pyro-hydrometallurgical research were similar to those of the Government of India and COMRA. Research in this area centred on updating and optimizing selective metal extraction during electro-thermal nodule processing and subsequent processing of complex copper-nickel-cobalt alloy. The report provides details of the work carried out, and includes flow charts. In the hydro-metallurgical processing sector, nodule leaching with iron sulphate solutions was attempted. Overall, the results show both technologies to be effective. The main tasks that IOM plans to complete before 2013 are updating and testing basic technology, collecting data that is indispensable for the development of techno-economic assessments of nodule processing technologies, and analysis of existing facilities for semi-industrial tests. IOM's analysis of world metal prices indicates that apart from nickel, copper, cobalt and manganese, molybdenum and titanium and zinc should be included in the group of potentially useful metals.

Training

51. Training obligations under the contract have been completed. Accordingly, no training was envisaged in the programme of work.

Environmental monitoring and assessment

52. The environmental work carried out by IOM in 2009 concerned hydrometeorological observation, photo-video profiling and sediment sampling. Preliminary processing and analysis of photographs is scheduled to be completed in 2010. The methodology for the video profiling was presented in the report, together with some typical images of organisms. No sampling station location data has been provided with the contractor's report. The sediment samples were used for analysis

of chemical properties and future biological analysis with the methodology presented. The geochemical properties of the sediment were presented descriptively with summary data provided in tables.

Financial statement

53. The contractor reported a total expenditure of US\$2,263,112.21, and provided a detailed breakdown, but not in the form requested in ISBA/15/LTC/7. The financial statement also includes a breakdown of the usage of ship time and also the details of the amount of data collected.

54. The contractor reported that the IOM Auditing Commission reviewed and approved the expenditure during its meeting in March 2010. The approval of the statement by the IOM Council is expected during a meeting scheduled for June 2010. The contractor indicates that this will be submitted after the sixteenth session of the Authority.

Comments

55. IOM carried out its activities in accordance with the programme of activities under the contract. The contractor provided all the necessary data, information and maps, especially in relation to the exploration activities. Some work seems to repeat information and data that was included in previous reports. The contractor has provided details of the cruise, but actual sampling locations and track line end points for different data collected are not provided. The contractor has to provide a detailed expenditure statement as recommended in ISBA/15/LTC/7. The contractor has not provided specific answers to the points raised by the Commission in its evaluation of reports from 2008.

E. The Government of the Republic of Korea

General

56. The contractor submitted its annual report on 19 March 2010 in hard copy and in electronic format in English. The report contains details of exploration work, environmental studies, mining technology work 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

57. The contractor carried out 84 days of field survey work in blocks KR2 and KR5 on board RV *Onnuri* during the reporting period as part of its exploration and environmental efforts. The survey was carried out over two separate legs. During the cruise, various geological, geophysical, biological and chemical data were collected in the contract area. In addition, sampling of surface sediments and nodules was performed. Underwater photographic and video study was planned using a deep sea camera system. The report presents the cruise tracks and sampling locations for the data and material collections during the at-sea operations. It also provides details of the research vessel deployed and specifications of the survey equipment (including

that relating to positioning, depth sounding, coring, free fall grabs, CTD, side scan sonar, and the camera system).

58. The contractor had intended to use a multi-sensor deep tow system during the surveys. However, due to telemetry communication problems, the equipment had to be recovered from 3,500 m and no data could be collected. To study the geotechnical properties of sediments, 34 core samples were collected and shear strength was determined on board. Grain size analysis was performed using a particulate size analyzer. The procedure adopted has been explained in the report. Another sediment parameter measured was water content. The results show that the sediments consisted of 0.6 per cent sand and 40.8 per cent silt, while the remainder consisted of clay with an average grain size of 7.66 phi. The water content decreased with depth. Average void ratio and porosity of the sediments in the KODOS 09 areas were 6.7 per cent and 86.3 per cent respectively. A detailed list of measured parameters (composition, size, water content, bulk density, grain density, void ratio and porosity) and the results are shown in a table. A graph showing the distribution of shear strength against depth in the studied area was also presented.

59. 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 21 stations, and samples totalling 46.5 kg were collected. The collected nodules were classified based on their surface texture, morphology and size. The results are presented in tabular form. The major and minor metal contents of nodules were analyzed using the inductively coupled plasma- atomic emission spectrometer (ICP-AES) and the results are presented in the report. The nodules were grouped into d, r, s and t based on surface texture, and D, E, I, P and T based on morphology. The metal contents of nodules are also presented in a table. Nodules are generally enriched in manganese, nickel, copper and zinc and are depleted in iron and cobalt in the southern area (KR5), indicating a dominant diagenetic origin.

Mining tests and proposed mining technology

60. In accordance with the programme of activities under the contract, no work was carried out. However, the contractor continued working on the collector and integrated mining operation technology. The objective is to develop a self-propelled miner model that sweeps polymetallic nodules from the seafloor and transports them through a flexible pipe into a buffer station for lifting. This system is being developed to provide an integrated mining operation technology and methodology. The test collector *MineRo* has been developed. *MineRo* is 5 m long, 4 m wide and 3 m high, and was tested at Hupo off the Republic of Korea during 2009. Its performance was evaluated during the sea trials with all of the sub-systems (vehicle tracks, hybrid pick-up device, posture control cylinders, thrusters and hydraulic assemblages) performing creditably. All other required functions were performed by the test collector. The viability of a continuous mining system combining a self propelled miner and slurry lifting through an arched, flexible hose has thus been confirmed in a small-scale sea test. During 2009, the lifting and collecting technology were integrated and tested. The lifting system includes flexible hoses, pumps, a buffer, lifting pipes and control devices. The lifting technology was also tested independently to confirm its performance. Other necessary design developments for lifting technology were carried out during the year.

61. The contractor conducted scaled up testing (200 kg/day) of the reduction smelting-leaching process to recover copper, nickel, cobalt and manganese, and of the preparation of alloy and matte. A study of processes to remove impurities in alloy and matte and to prepare copper, nickel and cobalt powder from leaching solution by selective reduction was carried out during the year. The results show the rate of recovery of copper and nickel to be higher than 92 per cent, and the rate of copper recovery was around 84 per cent. The removal of impure metals such as zinc and iron in leaching solution was studied using a solvent extraction process. The report includes figures relating to the equipment used and the alloys produced.

Training

62. Training obligations under the contract have been completed. Accordingly, no training was envisaged in the programme of work.

Environmental monitoring and assessment

63. In 2009, 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 annual variability in temperature profiles. Spatial variation was also addressed by comparing the CTD profiles obtained along a North-South transect. The chemical assessment involved collecting water samples from the CTD castings to measure inorganic nutrients and organic carbon. Carbon and nitrogen in sediment samples were also measured. Annual variation in nutrient profiles was presented. Biological studies included an examination of the meiofauna, macrofauna and microorganisms, and a microcosm experiment to understand the effect of mining on microorganisms. The final section of environmental work concerned the particle flux from the surface to the seabed, which was measured using sediment traps that had been deployed at various heights above the seabed for 12 months.

64. Graphical and descriptive analysis was provided, along with some raw data including the geographic location of sample sites. Of particular note is that the Republic of Korea is providing raw biological data in the format requested by the Secretary-General.

Financial statement

65. The contractor reported a total expenditure of US\$ 5,900,700. A financial statement is provided, containing a detailed breakdown of expenditure, but not as recommended in document ISBA/15/LTC/7. The certificate of expenditure is signed by the Director of the Marine Policy Bureau of the Government of the Republic of Korea.

Adjustment to the programme of activities

66. The contractor does not foresee any changes in the near future.

International cooperation

67. Cooperative research work with National Metallurgical Laboratory of India is presently underway. The programme is for two years duration and will develop a

method for the selective reduction of copper, nickel and cobalt from aqueous solutions through hydrothermal route for production of metal powders.

Comments

68. The report is detailed and contains relevant information. The quality of the data presentation in form of tables and figures is good. The locations of the sampling stations are provided for the tables shown in the exploration section. The section on environmental studies provides considerable detail. All the relevant sampling locations are provided in the form of tables. It is important to highlight that long term monitoring (1995-2008) is available and used to interpret changes and natural variability. The sediment analysis includes calibration mechanisms to guarantee that the information is of good quality. The contractor has to provide a detailed expenditure statement as requested in ISBA/15/LTC/7.

F. China Ocean Mineral Resources Research and Development Association (COMRA)

General

69. COMRA submitted its annual report for 2009 on 30 March 2010 in hard copy and electronic format in Chinese and English. The report contains information on exploration work and environmental baseline studies. In addition, work was carried out in support of research and development of deep sea mining and metallurgical processing technologies. Other activities were presented that included the work plan for 2010 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

70. COMRA conducted a 51-day field survey cruise during the reporting period. The work included deep tow topographic survey, sediment sampling, CTD measurement, seawater sampling and biological sampling. The amount of work performed and coordinates of the deep tow survey lines are listed in the report. The deep tow survey system used in the cruise was explained along with a figure illustrating the system. The survey results show the relation between topography and nodule abundance. The survey line is 48 km long, with depths ranging between 5,120 m and 5,280 m. The results of the bathymetric survey are consistent with the earlier multibeam survey. Different topographic maps of the surveyed area are presented in the report. Resource evaluation work continued during the reporting period; with data from seven lines deep tow video observations done during earlier cruises. Nodule coverage was calculated using an image processing system. Coverage in the southern part of the contract area is higher than in the northern part. There is positive correlation between the terrain and nodule abundance. The report reproduces several photographs captured from the video survey used for the analysis. Nearly 50 per cent of the data shows close to 50 per cent coverage. Variation of nodule coverage in successive captured photographs is presented.

Mining tests and proposed mining technologies

71. During the year, COMRA carried out research and development on obstacle-crossing performance, steering stability, and obstacle avoidance control. Studies also concentrated on wheel-track compound walking, and planet wheel-track compound walking using virtual technology. A hydraulic drive system for the seafloor collector system was designed and manufactured. A nodule lifting test system was deployed and tested in a mine shaft to characterize performance. The system included subsystems for collection, lifting, launch and retrieval, feeding, manual calibration and control. A schematic and the system above ground are reproduced in the report, and each subsystem has been explained. Artificial nodules were dumped in the mine shaft and the performance of the entire system was evaluated. Studies were also conducted on mechanical modelling and an experimental study of ocean sediment and multi rigid body walking dynamic simulation was carried out.

72. COMRA continued its metallurgy experiments with an evaluation of process technology. Leaching on a mixture of nodules and cobalt-rich crusts with ammonia was attempted. The disadvantage of the process is that the leach rate is relatively slow, especially for high grades of cobalt ore. The nodules and crusts were mixed to a 3:1 ratio. The process achieved recovery of elements at the following rates: nickel 96.65 per cent; copper 94.85 per cent; cobalt 89.25 per cent; zinc 82.3 per cent; and molybdenum 94.55 per cent. A flow chart of this study, which is still in progress, is shown in an accompanying figure. Smelting was also attempted on the mixture of nodules and cobalt-rich crusts. This achieved slightly higher recovery rate compared to leaching. COMRA also continued to study the comprehensive utilization of leaching residues, and the report presents the results of the study. Studies were also conducted on the treatment of industrial waste water.

Training

73. Training obligations under the contract have been completed. Accordingly, no training was envisaged in the programme of work.

Environmental monitoring and assessment

74. The environmental work carried out by COMRA in 2009 consisted of the collection of a set of environmental baselines including meteorological conditions, and physical, chemical, geochemical and biological data. Physical data included vertical profiles of temperature and salinity. While chemical data was collected for the water column and sediment, geochemical analysis of the sediment is to be carried out in 2010. Biological measurement included vertical chlorophyll profiles, and the report states that other biological samples were collected and will be analyzed in 2010. All data is presented graphically and descriptively but without raw data.

Financial statement

75. The contractor reported a total expenditure of US\$2,893,800 under six headings with a partial breakdown but not as requested in ISBA/15/LTC/7. The report includes 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.

Other activities

76. The report briefly explains studies on synergic key technology data processing and its application to areas including the assessment and prediction of deep seabed resources, the development of ocean data and information sharing technology management standards, the development of an ocean information system, and a shipboard data visualization system. COMRA has also evolved and promulgated rules and procedures for ocean sample management. It is important to mention that experiments were carried out to evaluate the treatment of industrial waste water.

Adjustments to the programme of activities

77. No adjustments were requested of the contractor. Research and development activities relating to geology, environmental research, mining and the metallurgy of polymetallic nodules will continue in 2011.

Comments

78. COMRA provided an informative report of the work that was carried out in accordance to the programme of activities under the contract. The main thrust of the work related to the activities carried out during the cruise, including the collection of data. The locations of the sampling and other stations are not provided in the report. This information must be reported in the future to ensure the Authority has a clear view of the area under consideration. Generally, the quality of figures and maps is good but raw data is lacking. The contractor has to provide a detailed expenditure statement as recommended in ISBA/15/LTC/7.

G. Institut français de recherche pour l'exploitation de la mer (IFREMER)**General**

79. The contractor submitted its annual report for 2009 on 2 April 2010 in English in hard copy and electronic format in French. The report was translated into English in-house. The report contains information on exploration of seafloor massive sulphides and academic work, and a financial statement.

Exploration work

80. IFREMER did not carry out any oceanographic expedition in their lease in the Area during the reporting year. IFREMER has included the study of mineral and energy resources as a priority subject in its strategy plan for 2020. Among the priorities are: (a) the development of knowledge concerning specific geological issues in relation to various mineral and energy resources; (b) a contribution to the discovery of new mineral and energy resources in order to determine their potential industrial interest; and (c) to study of the impact of exploitation resources. In a programme for the coming four years, IFREMER will try to demonstrate the potential of the resources and the feasibility of their exploitation by means of multidisciplinary research in marine geoscience, biology and technology. The report also mentions a new project on hydrothermal seafloor massive sulphides, which is likely to be undertaken in collaboration with the Russian Federation. The report also details the recent IFREMER activity in surveying sulphide resources — namely the

SERPENTINE cruise and the *TRISKELL* proposal for a cruise in collaboration with the Russian Federation.

Mining tests and proposed mining technologies

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

Training

82. Training obligations under the contract have been completed. Accordingly, no training was envisaged in the programme of work.

Environmental monitoring and assessment

83. The only environmental work carried out with reference to polymetallic nodules mentioned in the annual report is a list of three publications and one doctoral thesis produced related to nodules as a result of the *NODINAUT* cruise. All of the primary authors of these publications are collaborators from other institutions. However, the report notes that a cruise proposal has been prepared with the Senckenberg Institute (Germany) to carry out an environmental assessment of an area that has been identified by the Commission as a potential “area of particular environmental interest”, equidistant between the French and German contractor areas.

Financial statement

84. The contractor reported an expenditure of €201,553.65 under five headings. Some of the reported expenditure is not related to the exploration work of polymetallic nodules for the contract with the Authority. The financial statement is not properly certified.

Adjustment to the programme of activities

85. The proposed cruise with Germany to the Clarion-Clipperton Fracture Zone has been rescheduled for 2012.

Other matters

86. Among other matters, the contractor has listed REMIMA (the group on national perspectives on marine mineral resources). A report on IFREMER’s participation in the workshop on deep sea mining of seafloor massive sulphides organized by InterRidge, and the International Seabed Authority Secretary-General’s visit to IFREMER for its 25th anniversary celebration have also been presented. IFREMER is also in the process of collaborating with China and Germany in nodule exploration and exploitation.

Comments

87. The report is very brief, and has no new work to report. The format of the report is structured according to the recommended template. Many paragraphs in the “exploration” section of the report explain the contractor’s efforts relating to polymetallic sulphides. No results of any work are provided in the report. The contractor has not provided a detailed breakdown of expenditure for activities

carried out in 2008 as requested. On page 10 of the report, the contractor implies that France, China and Germany hold permits for the exploitation in the Clarion-Clipperton Zone, the Commission requests additional information for clarification of this. The research performed on seafloor massive sulphides, although important, is not part of the scope of the nodule report under the current contract with the Authority. The contractor has to provide the proper certification for the financial statement of 2009.

H. Yuzhmorgeologiya

General

88. Yuzhmorgeologiya submitted its annual report for 2009 in Russian on 31 March 2010, both in hard copy and electronic format. The contractor was requested to provide an English translation for the same, which was received by the Authority on 16 April. The report contains an introduction and a financial statement, and sections relating to exploration work, environmental studies and research activities. 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

89. The exploration work during the reporting period was mostly confined to an area of 3,540 km² in the eastern polygon of the Russian exploration area. 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 photo-TV profiling along nine tracks (346 km providing 14,435 photographs) and geological sampling at 70 locations. The sampling was carried out using grab samplers, box corer, gravity corer and cube-type rock dredge. The report provides information and pictures of the equipment used during the survey. The track line coordinates and station locations are all provided in the report. During the field cruise a total of 251.6 kg of nodules were collected, and in addition, dredging yielded around 51 kg of samples. Laboratory investigation of the samples collected is proposed during 2010. The processing of data from the 2008 cruise is also in progress, and both 2008 and 2009 data analyses are likely to be completed in 2010. During the cruise, granulometric and morphometric analysis, sample preparation for chemical analysis, and specimen preparation for nodules and Eh and pH tests were conducted, and physical and mechanical property measurement of sediments was completed.

90. The report provides the results of processed data from 2007 cruises, and preliminary analysis of data from the 2009 field work. Additionally the 2007 data pertained to the western polygon of the Russian area is presented in this years report. The results of multi-beam echo sounding are presented in the report. The area is broadly classified into two, as ridge-valley and flat plain punctuated by volcanic edifices. The geomorphological scheme for the area and the bottom formations are also provided in the report. The geo-acoustic survey has helped in classifying the area into four based on sediment thickness. Geomorphology and lithology influences the abundance of nodules. The area has been divided into

favourable and unfavourable zones based on the abundance of nodules. Overall, the report shows that 80 per cent of the area is favourable for nodule occurrences.

91. Preliminary analysis of data collected in 2008 and 2009 is also presented in the report. A study of the clay and carbonate sediments in the area is elaborated with appropriate supporting tables and figures. The nodules were recovered from 65 of the 70 sampling operations, five of which also reported buried nodules. Nodule morphology and distribution studies have been carried out and the results are shown in the report. No sampling station location data has been provided.

Mining tests and proposed mining technologies

92. According to the programme of activities, no mining activity or metallurgical processing activity was scheduled for 2009.

Training

93. Training obligations under the contract have been completed. Accordingly, no training was envisaged in the programme of work.

Environmental monitoring and assessment

94. The environmental work carried out by Yuzhmorgeologiya in 2009 consisted of analysis of the sediment properties and biological communities observed both in 2009 and during exploration cruises in previous years. Vertical profiles of sediment characteristics, including redox potential and density were discussed, and tables containing summary conditions are supplied. Biological studies consisted of the analysis of mega-, macro- and meiofaunal communities and the fauna associated with manganese nodules, including addressing variation with sediment depth. Descriptive analysis was provided along with some graphical representation and example photographs. Raw data was provided for meiofaunal studies and nodule epifauna and infauna. In addition, the contractor provided information on meteorology and sea state conditions. Yuzhmorgeologiya states in the report that in 2010 it expects to complete the analysis of all environmental data collected to date.

Financial statement

95. The contractor reported an expenditure of US\$ 4,172,733 with a partial breakdown but not in the format recommended in document ISBA/15/LTC/7. For at-sea operations, the actual expenses made in connection with the use of the ship must be specified. The financial statement is established by the Director General of the State Scientific Centre Yuzhmorgeologiya, and confirmed by the Head Department for Mineral Resources Utilization in the Continental Shelf and the World Ocean of the Federal Agency of Mineral Resources of the Ministry of Natural resources of the Government of the Russian Federation.

Adjustment to the programme of activities

96. The contractor does not propose any adjustments to the programme of activities. During 2010, exploration and environmental work will continue in the eastern polygon of the Russian area, as well as processing of data collected earlier.

Comments

97. The annual report is very detailed. The report provides a number of figures and tables showing the work accomplished during the reporting period. Though report mentions the field survey cruise, it does not clarify the number of cruises and days spent at the area. The contractor has also provided an addendum to the 2008 report in response to a query from the Commission. The contractor has to provide a detailed expenditure statement as recommended in ISBA/15/LTC/7.

III. General comments and recommendations

98. As a result of its analysis, the Commission would offer the following general observations on the annual reports for 2009:

(a) The reports largely follow the general format prescribed by the Commission, and seem to confine themselves to work from the reporting year, in accordance with the suggestions made by the Commission after previous evaluations.

(b) Generally, work is progressing at a varied pace, with many contractors progressing slowly. The contractors' work on exploration and environmental aspects of their efforts are not satisfactory and considerable work needs to be done with regard to technology. Few of the contractors have even commenced working on this area, so it may be beneficial to make a concerted effort by pooling human resources.

(c) Only some contractors have provided the lists of publications in peer-reviewed journals published during the reporting year, in spite of repeated requests from the Commission.

(d) Some of the contractors have not conducted any kind of field work for many years and have no plans to perform any new work at this time. The Commission suggests that for the submissions by the contractors for the following five years, work plans containing no activity should be questioned. If no activities for exploration including environmental research are submitted in a working plan, the secretariat should request a mandatory minimum plan of activity in the contractor's area.

(e) Some contractor reports do not specifically provide the locations of nodule and sediment sampling.

(f) As pointed out in earlier Commission evaluations, no standardized classification of nodules exists based on morphology, shape or size. A standard needs to be developed at the earliest opportunity.

(g) Details of the formal collaborative programme presently underway between some contractors should be provided in the annual reports.

(h) The periodic review of contracts is due for seven contractors next year. The contractors should provide a concise list of work carried out so far, and provide a detailed work plan for the next five-year phase of their contracts. When the plans of work are presented, the contractors must take into account that the contracts are for exploration with a view to beginning mining in the short term. The contractors should provide the raw data previously collected and additional data to be collected in the future pertaining to their individual areas under contract with the Authority.

(i) Some of the reports mention the work in progress related to surveys of seafloor massive sulphides, although this is not covered by the contract. This will be required when the Regulations for Sulphides are adopted and the Authority encourages all contractors to provide all data for consideration.

(j) Some contractors only partially followed the recommendations issued in 2009 in document ISBA/15/LTC/7, and some did not follow the recommendations at all. In some cases sub-totals were provided but not the detailed breakdowns by category as requested by the Commission. Some contractors reported expenditures that are clearly not “actual and direct exploration expenditures” as defined in the regulations and the 2009 Recommendations.

(k) There are significant variations in reported financial expenditure among the different contractors for the same item; for example in the differences between the cost per day of at-sea exploration. The largest area of expenditure in 2009 was on exploration cruises to contract areas.

(l) Those contractors that did not comply with the 2009 recommendations are requested to provide more accurate breakdowns of expenditure. The Commission asks the contractors as far as possible to provide a revised historical breakdown of reported expenditure to date according to 2009 Recommendations.

(m) The Commission asks the secretariat to provide in 2011 a more detailed analysis of reported expenditure by contractors for each reporting year to date. This should be provided against the recommended headings of expenditure set out in the 2009 recommendations. In 2011, the Commission will consider the analysis and elaborate a document to provide guidance to the incoming Commission on the treatment of the reported exploration expenditure to date.

(n) All contracts between the Authority and contractors are based on the standard contractual requirements contained in the Regulations: annex 4, section 10, Annual Report, which clearly lay out the reporting requirements. The Commission requests that all contractors provide all of the data as outlined in the annual reporting requirements and any other data requested.
