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Recommendations for the guidance of the contractors for the assessment of the possible environmental impacts arising from exploration for polymetallic nodules in the Area

Prepared by the Legal and Technical Commission

I. Introduction

1. On 13 July 2000, the International Seabed Authority adopted the Regulations on Prospecting and Exploration of Polymetallic Nodules in the Area (“the Regulations”) (ISBA/6/A/18). The Regulations require the Authority to establish and keep under periodic review environmental rules, regulations and procedures to ensure effective protection for the marine environment from harmful effects which may arise from activities in the Area. They also provide that every contract for exploration for polymetallic nodules shall require the Contractor, in cooperation with the Authority and the sponsoring State or States, to establish environmental baselines against which to assess the likely effects of its programme of work on the marine environment and a programme to monitor and report on such effects. The Contractor shall report annually on the results of its environmental monitoring programmes. Furthermore, when applying for approval of a plan of work for exploration, each applicant is required to provide, inter alia, a description of a programme for oceanographic and environmental baseline studies in accordance with the Regulations and any environmental rules, regulations and procedures established by the Authority that would enable an

assessment of the potential environmental impact of the proposed exploration activities, taking into account any recommendations issued by the Legal and Technical Commission, as well as a preliminary assessment of the possible impact of the proposed exploration activities on the marine environment.

2. Pursuant to the Regulations, the Legal and Technical Commission may from time to time issue recommendations of a technical or administrative nature for the guidance of contractors to assist them in the implementation of the rules, regulations and procedures of the Authority. Under article 165, paragraph 2 (e), of the 1982 United Nations Convention on the Law of the Sea, the Commission shall also make recommendations to the Council on the protection of the marine environment, taking into account the views of recognized experts in that field.

3. In June 1998 the Authority convened a workshop on the development of environmental guidelines. The outcome of the workshop was a set of draft guidelines for the assessment of possible environmental impacts from exploration for polymetallic nodules. The workshop noted the need for clear and common methods of environmental characterization based on established scientific principles and taking into account



oceanographic constraints. The draft guidelines were considered by the Legal and Technical Commission at its meetings in August 1999 and July 2000. The Commission was mindful of the need to provide simple and practical recommendations to assist contractors in carrying out their obligations under the Regulations to establish environmental baselines. The Commission felt that, given the technical nature of the recommendations and the limited understanding of the impact of exploration activities on the marine environment, it was vital to provide, as annex I to the present document, an explanatory commentary on the technical recommendations. The explanatory commentary is supplemented by a glossary of technical terms contained in annex II to the present document.

4. The purpose of these Recommendations for Guidance is to describe the procedures to be followed in the acquisition of baseline data, including the monitoring to be performed during and after any activities in the exploration area with potential to cause serious harm to the environment, and to facilitate reporting by the Contractor. As these Recommendations were based on the current scientific knowledge of the marine environment and the technology to be used, they may require revision in the future taking into account the progress of science and technology. In accordance with the Regulations, the Legal and Technical Commission may from time to time review the present Recommendations taking into account the current state of scientific knowledge and information. It is recommended that such a review be carried out at intervals of five years. To facilitate the review, it is recommended that the Authority convene a workshop in which the members of the Legal and Technical Commission, contractors and recognized experts from the scientific community are invited to participate.

II. Scope

A. Purpose

5. The purpose of the present Recommendations for Guidance is:

(a) To define the biological, chemical, geological and physical components to be measured and the procedures to be followed by contractors to ensure effective protection for the marine environment

from harmful effects which may arise from the contractors' activities in the Area;

(b) To provide guidance to potential contractors in preparing a plan of work for exploration for polymetallic nodules in conformity with the provisions of the Convention, the 1994 Agreement relating to the implementation of Part XI of the United Nations Convention on the Law of the Sea, and the Regulations.

B. Definitions

6. Except as otherwise specified in this document, terms and phrases defined in the Regulations shall have the same meaning in these Recommendations for Guidance. A glossary of technical terms is contained in annex II to the present document.

C. Environmental studies

7. Every plan of work for exploration for polymetallic nodules shall take into consideration the following phases of environmental studies:

- (a) Environmental baseline studies;
- (b) Monitoring during and after testing of collecting systems and equipment.

III. Environmental baseline studies

A. Baseline data requirements

8. To set up the environmental baseline in the exploration area as required under regulation 31, paragraph 4, the Contractor, utilizing the best available technology, shall:

- (a) For physical oceanography:
 - (i) Collect information on the oceanographic condition along the entire water column, including the current, temperature and turbidity regimes above the seafloor;
 - (ii) Adapt the current measurement programme to the topography and regional hydrodynamic activity in the upper water column and on the sea surface;

(iii) Measure the currents and particulate matters at the depth of the forecasted discharge during the testing of collecting systems and equipment;

(iv) Measure the particulate distribution to record particulate concentration along the water column;

(b) For chemical oceanography: collect information on the water-column chemistry, including the water overlaying the nodules;

(c) For sediment properties: determine the basic properties of the sediment, including measurement of soil mechanics, to adequately characterize the surficial sediment deposits and the potential source of deep-water plume; sample the sediment taking into account the variability of the sediment distribution;

(d) For biological communities:

(i) Gather data on biological communities, taking samples representative of the variability of bottom topography, sediment characteristics, abundance and types of nodules;

(ii) Collect data on the seafloor communities specifically relating to megafauna, macrofauna, meiofauna, microbial biomass, nodule fauna and demersal scavengers;

(iii) Assess benthic, benthopelagic, meso- and bathypelagic communities;

(iv) Record levels of trace metals found in dominant species;

(v) Record sightings of marine mammals, identifying the relevant species and behaviour;

(vi) Establish at least one station to evaluate temporal variations;

(e) For bioturbation: gather data of the mixing of sediments by organism;

(f) For sedimentation: gather data of the flux of materials from the upper-water column into the deep sea.

IV. Environmental impact assessment

A. Activities not requiring environmental impact assessment

9. The following activities, which have no potential for causing serious harm to the marine environment, do not require environmental impact assessment:

(a) Gravity and magnetometric observations and measurements;

(b) Bottom and sub-bottom acoustic or electromagnetic profiling or imaging without the use of explosives;

(c) Water and biotic sampling and mineral samplings of a limited nature such as those obtained using core, grab or basket samplers to determine seabed geological or geotechnical properties;

(d) Meteorological observations and measurements, including the setting of instruments;

(e) Oceanographic, including hydrographic, observations and measurements, including the setting of instruments;

(f) Television and still photographic observation and measurements;

(g) Shipboard mineral assaying and analysis;

(h) Positioning systems, including bottom transponders and surface and subsurface buoys filed in Notices to Mariners.

B. Activities requiring environmental impact assessment

10. The following activities require prior environmental impact assessment, as well as an environmental monitoring programme to be carried out during and after the specific activity, in accordance with the recommendations contained in paragraphs 14 and 15:

(a) Dredging to collect nodules for on-land studies for mining and/or processing;

(b) Use of special equipment to study the reaction of the sediment to disturbances made by collecting devices or running gears;

(c) Testing of collection systems and equipment.

11. The environmental impact assessment and the information set out in the recommendation contained in paragraph 13 and the relevant environmental monitoring programme is to be submitted by the Contractor to the Secretary-General at least one year before the activity takes place, and in the case of integrated tests, at least two years in advance.

12. Each Contractor should include in its programme specification of events that could cause suspension or modifications of the activities owing to serious environmental harm if the effects of the events cannot be adequately mitigated.

C. Information to be provided by the Contractor

13. The Contractor is to provide the Secretary-General with some or all of the following information, depending on the specific activity to be carried out:

(a) Nodule collection technique (passive or active mechanical dredge, hydraulic suction, water jets, etc.);

(b) Depth of penetration into the seabed;

(c) Running gear (skis, wheels, caterpillars, Archimedes screws, bearing plates, water cushion, etc.) which contacts the seabed;

(d) Methods for separation on the seafloor of the nodules and the sediment, including washing of the nodules, volume of the discharge of sediment mixed with water, concentration of particles in the discharged mixture, height of discharge above the seafloor, etc.;

(e) Nodule crushing methods;

(f) Methods for transporting the nodules to the surface;

(g) Separation of the nodules from the fines and the sediment on the surface vessel;

(h) Methods for retention of the abraded nodule fines and sediment;

(i) Volume and depth of overflow discharge, concentration of particles in the discharged water and chemical and physical characteristics of the discharge;

(j) Location of the mining test and boundaries of the test area;

(k) Probable duration of the test;

(l) Test plans (collecting pattern, area to be perturbed, etc.).

D. Observations and measurements to be made while performing a specific activity

14. The Contractor is to provide the Secretary-General with some or all of the following information, depending on the specific activity to be carried out:

(a) Width, length and pattern of the collector tracks on the seafloor;

(b) Depth of penetration in the sediment, lateral disturbance caused by the collector;

(c) Volume of sediment and nodules taken by the collector;

(d) Ratio of sediment separated from the nodule on the collector, volume of sediment rejected by the collector, size and geometry of the discharged plume, behaviour of the plume behind the collector;

(e) Area and thickness of re-sedimentation by the side of the collector tracks to the distance where re-sedimentation is negligible;

(f) Volume of overflow discharge from the surface vessel, concentration of particles in the discharged water, chemical and physical characteristics of the discharge, behaviour of the discharged plume at surface or in mid-water.

E. Observations and measurements to be made after the performance of a specific activity

15. The Contractor is to provide the Secretary-General with some or all of the following information, depending on the specific activity to be carried out:

(a) Thickness of re-deposited sediment on the side of the collector tracks;

(b) Behaviour of the different types of benthic fauna subjected to re-sedimentation;

- (c) Changes of the benthic fauna in the collector tracks, including possible recolonization; the protection and preservation of the marine environment.
- (d) Possible changes in the benthic fauna in adjacent areas apparently not perturbed by the activity;
- (e) Changes in the characteristics of the water at the level of the discharge from the surface vessel during the mining test, and possible changes on the behaviour of the corresponding fauna.

V. Data collection, reporting and archival protocol

A. Data collection and analysis

16. The types of data to be collected, the frequency of collection and the analytical techniques in accordance with the present Recommendations for Guidance should follow the best available methodology and the use of an international quality system and certified operation and laboratories as recommended.

B. Data archival and retrieval scheme

17. The Contractor should provide the Authority with all the relevant data, data standards and inventories.

C. Reporting

18. Assessed and interpreted results of the monitoring shall be periodically reported to the Authority in accordance with the prescribed format.

D. Transmission of data

19. All data relating to the protection and preservation of the marine environment, other than equipment design data, collected pursuant to the recommendations contained in paragraphs 14 and 15 should be transmitted to the Secretary-General to be freely available for scientific analysis and research subject to confidentiality requirements as contained in the Regulations.

20. The Contractor should transmit to the Secretary-General any other non-confidential data in his possession which could be relevant for the purpose of

Annex I

Explanatory commentary

1. The aim of the Recommendations for Guidance is to define the biological, chemical, geological and physical components to be measured and the procedures to be followed by the Contractor to ensure the effective protection of the marine environment from harmful effects which may arise from its activities in the Area, and to provide guidance to prospective contractors in preparing plans of work for exploration for polymetallic nodules.

2. It was considered that there was a need to clearly define the various stages of exploration. Different environmental consequences would result from engineering tests of mining equipment and tests of the integrated mining system. The scale of the tests is crucial for the assessment of their environmental consequences. Any plan of work for exploration will take into consideration the following phases of environmental studies:

(a) Environmental baseline studies;

(b) Monitoring during and after testing of collecting systems and equipment.

3. The purpose of environmental baselines is to ensure that measures can be taken to evaluate the impact of exploration activities on the marine environment. Although the actual technology that will be used for some exploration activities, namely the one which will be embodied in the collecting systems and equipment, is not currently known, and current knowledge of the deep-sea environment is insufficient to predict the real impacts of tests of such technology, the environmental disturbances, based on the experience and knowledge gathered from previous activities carried out by the registered pioneer investors and by the scientific community, may be forecast to some extent. The main impacts are expected to occur at the seafloor, with minor impact expected at the tailings-discharge depth. The nodule collector will disturb the semi-liquid sediment-surface layer and will create a near-bottom plume. The nodule collector will compress, break up and squeeze the harder underlying sediment layer. For predicting the effects of the activities and to manage them in such a way as to prevent serious harm to the environment, the critical issues are the following:

(a) The dose-response function for the sediment communities for a single deposition event. The dose-response and modelling of the amount of sediment that would settle in a particular area would help predict the impacts;

(b) The chronic disturbance effect, i.e. the disturbance effect of multiple sediment depositions in a given area, which would yield information on how frequently a plume is produced in an area that yields a small amount of sedimentation, without having a negative impact upon the ecosystem;

(c) The time scale of community recovery after a very intense disturbance. The sediment transported to the surface with the stream of polymetallic nodules may be discharged into the ocean together with nodule fines. Disposal in the surface waters would possibly interfere with primary productivity by increasing the nutrient levels and decreasing light penetration into the ocean, or enter the food chain and disturb vertical migration. The discharge should occur below the thermocline layer and the oxygen-minimum zone. Since the thermocline and the oxygen-minimum zones vary regionally and to some extent seasonally, environmental studies must:

(i) Determine the depth range of the thermocline and the oxygen-minimum layer at each mining area;

(ii) Concentrate on the oceanographic properties around the discharge depth;

(iii) Include oceanographic parameters in the upper-water layer because of the potential for accidental discharge.

4. Part III deals with the baseline data requirements. The Contractor, utilizing the best available technology, shall set up the environmental baseline in the exploration area. The baseline data requirement shall take into consideration six groups of data: physical oceanography, chemical oceanography, sediment properties, biological communities, bioturbation and sedimentation.

5. The first baseline data group (physical oceanography) is a general requirement targeted to collect the physical data prior to any disturbance in

order to model and to value the potential influence of the physical environment. Information on the physical oceanography is required to estimate the potential influence of the mining plume. This information includes the current conditions, temperature and turbidity regimes above the seafloor. At the depth of discharge, measurements of the currents and particulate matter are required as basic information to predict the behaviour of the discharge plume. At the upper layers these studies are required to characterize the baseline environmental conditions. Surface oceanographic structure is measured by conductivity-temperature-depth (CTD) systems studies. Temporal aspects of the surface structure need to be addressed. The CTD profiles and sections should be performed from the surface to the bottom, to characterize the stratification of the entire water column. Current and temperature field structures can be inferred by the long-mooring data and from supplementary acoustic doppler current profilers (ADCP) and other current measurement methods. The number and location of the moorings need to be appropriate for the size of the area to adequately characterize the current regime. The number of current meters on a mooring is dependent upon the characteristic scales of topography of the area studied (difference in heights from the bottom). The suggested location should be as close as possible to the seafloor, normally 1m to 3m. The location of the upper current meter should exceed the highest element of the topography by a factor of 1.2 to 2. Along with this, the basic levels of the current meters should be 5m, 15m, 50m and 200m above the seabed. A satellite-data analysis is recommended for understanding synoptic-scale surface activity in the area and for larger-scale events.

6. The second baseline data group (chemical oceanography) is a specific requirement targeted to collect the data prior to any discharge in the water, including the water overlaying the nodules. The data gathered are important for assessing the possible influence of the modification of the water composition by the mining tests on the biological activity. The water overlying the nodules should be characterized chemically to evaluate processes of chemical exchange between the sediment and the water column. Dissolved oxygen concentration as well as nutrients including nitrate, nitrite, phosphate, and silicate, and total organic carbon (TOC) for the water overlying the nodules, are to be measured. Characterization of the water-column chemistry is essential for assessing

background conditions prior to any discharge in the water. Vertical profiles of TOC nutrients, including phosphate, nitrate, nitrite and silicate, as well as temperature, salinity and dissolved oxygen concentration, are necessary. Temporal variation also needs to be addressed in the field measurement programme. Trace metals need not be determined if their seasonal and inter-annual variability is proven negligible.

7. The third baseline data group (sediment properties) is targeted to collect the basic information to predict the behaviour of the discharge plume. In this context, the following parameters should be measured: specific gravity, bulk density, shear strength and grain size as well as the sediment depth of change from oxic to suboxic conditions. Additionally, organic as well as inorganic carbon in the sediment and nutrients (phosphate, nitrate and silicate), carbonate (alkalinity) and the redox system in the pore water should be measured to at least 20cm or just below the suboxic layer. The geochemistry of the pore water and sediments should be determined at least as far down as 20cm or below the suboxic layer, if it exists. Sampling strategies should also take into account variations in sediment structure.

8. The fourth baseline data group (biological communities) is targeted to collect the “natural” data, including “natural variability” to evaluate the effects of the activities on the pelagic fauna. Seabed mining will have its greatest impact on the seafloor biological community. The test of components (engineering tests) will provide a first analysis of this impact. Subsequent integrated tests will yield a deeper knowledge of this impact. For sampling, different kinds of corers can be used depending upon the size of the fauna to be collected. The use of multiple corers allows the distribution of different sampling tubes from the same station among the specialists that used different techniques for fauna identification and counting. However, it should be stressed that the diameter of the tubes must be adjusted to avoid excessive disturbance of the sediment or obstruction by the nodules. The data to be collected and the corresponding methodology for the various classes/sizes of fauna should be as follows:

Megafauna. Data on megafauna abundance, biomass, species structure and diversity are to be based on photographic transects. Photographs need to have a sufficient resolution in order to identify organisms greater than 2cm in their smallest dimension. The

width covered by the photographs should be at least 2m. As for sampling stations, the pattern of the photographic transects should be defined taking into account the different features of the bottom, such as topography, variability of the sediment characteristics and abundance and type of nodules.

Macrofauna. Data on macrofauna (>250µm) abundance, species structure, biomass, diversity and depth distribution (suggested depths: 0-1, 1-5, 5-10cm) are to be based on box cores (0.25m²). Macrofauna should be gently processed on nested 500µm and 250µm sieves.

Meiofauna. Data on meiofauna (<250µm, >32µm) abundance, biomass, species structure and depth distribution (suggested depths : 0-0.5, 0.5-1.0, 1-2, 2-3cm) are to be based on cores. One tube per station of a multiple corer-sampling pattern could be devoted for this purpose. Meiofauna should be processed on nested sieves of 1,000, 500, 250 and 32µm sieve.

Microbial biomass. Microbial biomass should be determined using adenosine triphosphate (ATP) or other standard assay for 0-1cm intervals of cores. One tube per station of a multiple corer-sampling pattern could be devoted for this purpose. Suggested intervals for sampling are 0-0.5, 0.5-1.0, 1-2, 2-3, 3-4, 4-5cm.

Nodule fauna. Abundance and species structure of the fauna attached to the nodules should be determined from selected nodules taken from the top of box corers.

Demersal scavenger. A time-lapse camera should be installed at the study area for at least one year to examine the physical dynamics of surface sediment and to document the activity level of surface megafauna and the frequency of re-suspension events.

Baited-camera systems may be used to characterize the demersal scavenger community.

9. The fifth baseline data group (bioturbation) is targeted to collect the “natural” data, including “natural variability” to model and to value the effects of the activities (bottom plume). Rates of bioturbation, i.e., the mixing of sediments by organisms, must be measured to analyse the importance of biological activity prior to a mining disturbance and can be evaluated from profiles of excess Pb-210 activity from cores, taking into account the variability in the sediment. Excess Pb-210 activity should be evaluated

on at least five levels per core (suggested depths are 0-1, 2-3, 4-5, 6-7, 9-10 and 14-15cm). Rates and depth of bioturbation are to be evaluated by standard advection or direct diffusion models.

10. The sixth baseline data group (sedimentation) is targeted to collect the “natural” data, including “natural variability” to model and to evaluate the effects of the activities (mid-water plume). It is recommended that deployment of moorings with sediment traps on a mooring line should be undertaken, with one trap below 2,000m to characterize the particulate flux from the euphotic zone and one trap approximately 500m above the seafloor to characterize the flux of materials reaching the seafloor. The bottom trap must be high enough above the bottom so as not to be influenced by sediment re-suspension. Sediment traps should be installed for at least a 12-month period with samples collected monthly to examine the seasonal flux. The trap installation may share the same mooring as the current meters described above. As the flux of materials from the upper-water column into the deep sea is ecologically significant in the food cycle of bottom-dwelling organisms, an adequate characterization of the material flux in the mid-water and flux to the seafloor is necessary for a comparison with the effect of the tailings discharge.

11. Part IV of the Recommendations for Guidance deals with environmental impact assessment. Certain activities have no potential for causing serious harm to the marine environment and therefore do not require environmental impact assessment. Such activities are listed. In regard to activities that require environmental impact assessment, a monitoring programme is needed during and after a specific activity. Two kinds of operations are involved. The first is the observation and measurement of parameters that must be carried out during the performance of the activity in order to determine the extent of the disturbances created by that activity. The second is the periodic observation and measurement of parameters after the performance of the specific activity in order to determine the effects of the activity on the biologic activities, including the recolonization of the disturbed areas.

12. The environmental studies during exploration will be based on a plan proposed by the Contractor and reviewed by the Legal and Technical Commission for completeness, accuracy and statistical reliability. The plan would then be incorporated into the programme of activities under the contract. The environmental studies

to be conducted during exploration will include, among other things, the monitoring of environmental parameters so as to confirm the findings that activities not expected to cause serious environmental harm do not in fact cause harm. The studies will be devoted primarily to the collection of data which can address concerns of the potential for serious environmental harm, in respect of benthic, mid-water and upper-water column impacts, resulting from the use of the proposed technologies.

13. Mining system tests are viewed as an opportunity to examine the environmental implications of mining. The Contractor will submit to the Authority a test-mining plan sufficiently in advance. Preliminary descriptions of test mining, if they exist, should be submitted to the Authority with the application for approval of a plan of work for exploration; the details for monitoring the environment during the test mining shall be submitted at least two years before testing begins. A test-mining plan shall include provision for monitoring of those areas impacted by the Contractor's mining activities where the proposed activities have the potential to cause serious environmental harm, even if such areas fall outside the proposed mine site. The programme will include, to the maximum extent practicable, specification of those activities or events that could cause suspension or modification of the tests owing to serious environmental harm if the specified activities or events cannot be adequately mitigated. The programme will also authorize refinement of the test-mining plan prior to testing and at other appropriate times, if refinement is necessary to reflect proposed operations accurately or to incorporate recent research or monitoring results. The test-mining plan will include strategies to ensure that sampling is based on sound statistical methods, that equipment and methods are scientifically accepted, that the personnel who are planning, collecting and analysing data are scientifically well qualified and that the resultant data are submitted to the Authority in accordance with specified formats.

14. During the mining tests, delineation of the impact reference zone and preservation reference zone is recommended. The impact reference zone should be selected based on the area being representative of the environmental characteristics, including the biota, of the site to be mined. The preservation reference zone should be carefully located and be large enough so as not to be affected by the natural variations of local

environmental conditions. The zone should have species composition comparable to that of the test-mining area. The preservation reference zone should be outside the test-mining area and areas influenced by the plume.

15. The monitoring programme proposed by the Contractor must provide the means to assess the importance of the perturbations created by its activities during the specific activity. This information is essential for assessing the effects of such activity on the environment and predicting the effects of similar activities in the future, including at the time of commencement of a commercial operation. It must be noted that some of the observations or measurements are beyond the capabilities of currently available technology. Consequently, the present proposals will have to be adjusted depending upon the improvements in the technology at the time of the activity.

16. Part V of the Recommendations for Guidance deals with data collection and reporting. It is recommended that collection and analytical techniques should follow best practices such as those developed by the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) and available at World Data Centres and Responsible National Oceanographic Data Centres, or those established or recommended by the Authority. An inventory of the data holdings from each Contractor should be accessible on the World Wide Web Metadata that will detail the analytical techniques, error analyses, descriptions of failures, techniques and technologies to avoid. Comments on sufficiency of data and other relevant descriptors should also be included in addition to the actual data.

17. A data archival and retrieval scheme could assist all contractors in the search for environmentally significant indicator elements. The environmental baseline studies and the monitoring programmes represent an important source of data and knowledge. Synthesis of such data and experience can work to the advantage of all contractors. As an example, synthesized data on bathymetry, currents, winds, salinity and temperature fields can form critical inputs for the modelling of regional- or basin-scale oceanographic processes. Models can be validated and fine-tuned by these sea truth data and can then partially supplement costly data-collection exercises. Increased

data accessibility increases the likely accuracy of models and will assist in:

- (a) Identification of best practices;
- (b) Development of a common approach to an acceptable database;
- (c) Multilateral exchange of views and data leading to international cooperation;
- (d) Savings of time, effort and costs in alerting the community to failures;
- (e) Savings through reduction of measurement of some parameters.

Annex II

Glossary of technical terms

ATP	Adenosine triphosphate, a complex organic compound which serves for short-term energy storage and conversion in all organisms. The amount of ATP present can be used as a measure of total microbial biomass in the sediment, as it corresponds to the number of active cells, most of which are bacteria.
Bathypelagic	Pertaining to open-ocean environments at depths greater than 3,000m, deeper than mesopelagic zone.
Benthic	Pertaining to the ocean bottom.
Benthic boundary layer	Pertaining to the layer of water immediately above the ocean bottom water layer; sediment interface.
Benthopelagic	Pertaining to the zone very close to, and to some extent having contact with, the seafloor of deeper portions of the open ocean.
Benthos	The forms of marine life that live on, or in, the ocean bottom.
CTD	Pertaining to a system for measuring conductivity (indicator of salinity), temperature and depth (defined from pressure measurements). The first two parameters are essential in oceanographic observations and the depth profile is required to delineate the vertical structure of the ocean. Additional parameters, such as pH and dissolved oxygen concentration, can be measured if optional sensors are installed.
Diel	Involving a 24-hour period that usually includes a day and the adjoining night.
Embolism	The blood and tissues of fish contain dissolved gases. If fish from the deep ocean are brought to the surface, the decrease in pressure allows the dissolved gas to expand in the form of bubbles (embolism), causing disfiguration and protrusion of the internal organs through the mouth and other orifices.
Epifauna	Animals that live on the bottom, either attached to the seafloor or freely moving over it.
Epipelagic	Referring to the upper region of the ocean depths, above the mesopelagic and generally below the oxygen-minimum zone.
Euphotic zone	The upper section of the ocean which receives sufficient light for photosynthesis. In clear oceanic waters, the euphotic zone can extend to a maximum water depth of 150m.
Halocline	A layer of water in which there is a steep gradient in salinity.
Hydrodynamic	Referring to any event relevant to the movement of sea water.
Infauna	Organisms that live within the sediment.
Macrofauna	Animals large enough to be seen by the naked eye, up to 2cm long.

Megafauna	Defined as animals large enough (larger than 2cm) to be determined in photographs, proposed as key taxon (see taxonomy) for environmental impact assessment in deep-sea mining.
Meiofauna	Animals of the benthic community that are intermediate in size between macrofauna and microfauna. Operationally defined as >32µm and <250µm.
Mesopelagic	Referring to the portion of the oceanic province that is below the epipelagic and above the bathypelagic, usually corresponding to the dimly lit ocean or “twilight zone”.
Microfauna	Organisms invisible to the naked eye, smaller than meiofauna. Operationally defined as <32µm.
Nekton	Fish, squids, crustaceans and marine mammals that are active swimmers in the open ocean environment.
Nematoda	The class of roundworms; a dominant meiofauna constituent.
Oxygen minimum	A water layer present in all oceans at depths between 400 and 1,000m, caused by the sinking and degrading by bacteria of organic matter produced in the surface ocean. The oxygen scarcity can cause particulate metals to dissolve.
Pelagic	Pertaining to the open ocean environment.
pH	A measure of acidity or alkalinity.
Photosynthesis	The biological synthesis of organic material using light as energy source. Plants convert carbon dioxide and water, in the presence of chlorophyll and light energy, into carbohydrate food and oxygen.
Phytoplankton	Microscopic plants that are primary producers in the oceans.
Plankton	Passively drifting or weakly swimming organism.
Plume	A plume is a dispersion of seawater that contains dense sediment particles. Benthic plume is a stream of water containing suspended particles of seafloor sediment, abraded manganese nodules and macerated benthic biota that emanates from the mining collector as a result of collector disturbance of the seafloor and spreads in a zone close to the seafloor. The far-field component of the benthic plume is termed the “rain of fines”. Surface plume is a stream of water containing suspended particles of seafloor sediment, abraded manganese nodules and macerated benthic biota resulting from the separation, on board the mining ship, of the nodules from the water carrier and spreads in a zone closer than benthic plume to the ocean surface.
Pycnocline	A layer of water in which there is a steep gradient in density with depth. It separates the well-mixed surface waters from the dense waters of the deep ocean. Density of the water is a function of temperature, salinity and, to a lesser extent, pressure.
Rain of fines	Far-field component of the “benthic plume” that consists mainly of fines; sedimentary particles which drift with the bottom current and slowly settle to the sea floor, generally outside the specific mining area.

Redox system	One essential chemical reaction is oxidation (giving electron) and reduction (removing electron). The chemical tendency (environmental strength) of oxidation can be expressed by redox potential (mv) that can be measured by an Eh/Ph meter. Eh is strongly correlated to the dissolved oxygen concentration in the sediment.
Spatial scales	Scales characteristic of dimensions in space, as of oceanic phenomena, for example, the diameter of an eddy or the length of a wave. Also pertains to the geographical arrangement of sampling stations.
Synoptic scales	Scales of hydrodynamic variability or events encompassing temporal scales ranging from one to two weeks to one to two months and spatial scales of one to several hundred kilometres. A typical feature is synoptic eddies 100-200km in diameter passing through the north-east tropical Pacific from east to west and often penetrating to the seafloor.
Taxonomy	Orderly classification of animals or plants according to their presumed natural relationship.
Thermocline	A layer of water in which there is a rapid change of temperature with depth.
Transect	The vertical plane (reference for all the measures and sampling taken during the survey), from surface to the sea bottom, of the route of a survey oceanographic vessel, from point A to point B.
Transmissometer	Device used to measure the attenuation of light through a given path, as of water. Data can be correlated to the amount of particles present.
Zooplankton/Animal plankton	Unlike phytoplankton, these organisms cannot produce organic matter on their own and thus feed on other organisms.
