POLYMETALLIC NODULES RESOURCE CLASSIFICATION

Report of an international workshop hosted by the Ministry of Earth Sciences, Government of India and the International Seabed Authority, Goa, India, 13 - 17 October 2014

ISA Technical Study: No. 19

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International Seabed Authority and Ministry of Earth Sciences, Government of India Workshop held in Goa, India, 13-17 October, 2014

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TABLE OF CONTENTS

OPENING STATEMENTS

Dr S.Rajan, Director, National Centre for Antarctic and Ocean Research (NCAOR), Goa

His Excellency Mr Odunton, Dr S.K. Das, distinguished delegates of the workshop, colleagues from the Ministry of Earth Sciences, NCAOR, friends from the media, ladies and gentlemen.

On behalf of Dr Shailesh Nayak, Secretary to the government of India - Ministry of Earth Sciences, the National Centre for Antarctic and Ocean Research, let me at the outset welcome you all to this very important workshop. We are honoured that the International Seabed Authority chose the state of Goa as the venue for this workshop. Nothing could be more befitting than this gesture. Not because Goa is one of the more touristy places in India, but more so because the history of deep sea mineral exploration by India was kick-started from the shores of Goa. That was way back in 1981 when the vessel *R. V. Gaveshani* set sail from the shores of Goa and recovered the first nodules from the equatorial Indian Ocean under the leadership of NIO. The rest as they say is history. I am glad to see that representatives of NIO also are here; Dr Prasad, Dr Sudhakar and Dr Jauhari. I am glad to see all of you are here.

India went on to attain pioneer investor status and entered into an exploration contract with the ISA, and has developed considerable expertise in the exploration of polymetallic nodules, environmental impact assessment, metallurgical processes, and demonstration of a flexible rising mining system concept. The story doesn't end there. A few years back, the Government of India decided to expand and build up on our expertise in deep water mineral exploration. Goa as the launching pad except the National Centre for Antarctic and Ocean Research, the Ministry's own R&D arm was chosen as the lead agency.

NA Odunton, SK Das, S Rajan

Based on the results of the geoscientific surveys carried out by India, an area of 10,000 sq.km in the Central and SW Indian Ridges was identified for hydrothermal exploration and an application was submitted to the Authority for grant of license in March 2013. On the 21st July 2014, the LTC recommended to approval of our plan of work for exploration for hydrothermal deposit, submitted by the government of India through the Ministry of Earth Sciences to Council.

As I mentioned before, it is only natural that Goa again finds a place in today's meeting. The workshop could not have been organized at a more appropriate time. Nearly half the contracts

entered into by the Authority by the various stakeholders would be expiring two to three years from now. While I understand, the contracts stipulate the kind of information and data that have to be submitted to the Seabed Authority on expiry of the contract, there is a need to develop internationally accepted standards and practices applicable to the assessment and reporting of mineral resources of the seabed and more importantly to sensitize all the stakeholders on these standards. This is vital not only for understanding whether the explored areas are indeed financial assets from a mining point of view but also for a seamless transition of a mining operation from exploration to exploitation stage.

Not only the policy aspects, but the technologies and our scientific knowledge itself has also had a quantum jump over the past four-odd decades, since the first trial of a prototype nodule- mining system was carried out on the Blake Plateau. Previous studies had predicted that the incidence of hydrothermal venting would be extremely low on ultraslow-spreading ridges. But we know better now. Abundant hydrothermal venting has been documented from the Gakkel Ridge of the Arctic, which is among the slowest spreading ridges (0.6-1.3 cm $yr.^{-1}$). So technology also has improved and we have to look back to what have we achieved, when the technology was at a rudimentary stage and where we stand now, so that we can develop a standard operating procedure for the years to come. I would say that is a critical component of this workshop. But I don't think I should be expounding on the objectives of this workshop or what is expected of it to you the experts who are assembled here today. Almost sacrilegious I should say, like carrying coal to New Castle. But from India's point of view, as one of the pioneer investors registered with the Authority, the deliberations hold out enormous significance for the country in its endeavours at exploring for non-living resources of the deep ocean floor . There is a lot we can learn from each other and a lot we can share with each other as befits the ocean space.

Two days back when I was discussing the workshop with secretary, Dr Shailesh Nayak, who very much regrets that he won't be in a position to participate in the deliberations of the workshop because he had to accompany the president of India to Norway, he said to give all support to this workshop and see what is expected of us, the Ministry of Earth Sciences, Government of India, as a research and development organization. All of us would be at the forefront to see that we have an important role to play and what is expected from India would not be found short of responsibilities.

To quote *Paul Snelgrove*, we know more about the surface of the moon or about Mars than we do about the deep seafloor. Despite the fact that we have yet to extract a gram of food or ore, a breath of oxygen or a drop of water from those bodies. So there is lot we have to learn, a lot we have to talk to each other about to understand its significance.

I hope you find the deliberations of the workshop and the ambience of the place equally exciting without one precluding or over-shadowing the other. Enjoy and relish your stay here. We realize that you have a rather heavy agenda before you over the next four days. Notwithstanding that, we have also chalked out an itinerary for you beyond the four walls of this hall including visits to the two Institutes - NIO and NCAOR. I would take this opportunity to extend you a warm welcome to my own institute NCAOR, which is very close to the airport. This is a unique institute in the sense that we look after all programs related to Antarctica, and Arctic, Southern Oceans. We are the only institute in the country which has people working in the North Pole, in the South Pole, oceans and the Himalayas. You name an area, we have couple of people working there. So again, I extend a warm welcome to you; I request you all to also take some time off to visit our own sister organization, the National Institute of Oceanography (NIO) which is where the action started. Talk about India's polymetallic nodule program, everybody understands NIO is the place where it all started.

As I sign off this welcoming address, let me also take this opportunity to thank the people who have been with me over the last several days on the forefront in organizing the workshop. I have with me a bunch of youngsters led by Dr John Kurian who have been shouldering all the responsibilities related to organizing this workshop. Incidentally these are the same people who would be carrying forward India's legacy of deep sea exploration in days to come. Thanks to everybody, my friends from the Ministry, Pratima Jauhari who has been constantly bombarding us with mails. Each morning I would expect a mail from her saying that this is what has not been done, this is what you should be doing and thank-you very much because that has kept us on our toes. And my friends, Dr SK Das, Dr Wakdikar and friends of the press who have been kind enough to come from all this way for this important event. Thank you so much! Keep the message across – which is what this workshop means for a country like India. Thanks very much, thank-you all.

Dr S. K. Das, Advisor/Scientific Secretary, ESSO, Government of India, Ministry of Earth Science

Good morning participants. It is a privilege to be a part of the distinguished experts and representatives from contractors. I also, on behalf of MOES thank the Secretary-General, Nii Allotey Odunton for choosing India for this collaborative workshop on classification of polymetallic nodule resources during 13-17 October 2014. The response to this workshop is a testimony of the work of the Authority.

The United Nations Framework Classification (UNFC) classification for reserve and resources is aimed at the digital code based system of classification of resources, taking into consideration the parameters of economics, feasibility and geological exploration.

Classification of mineral resources is an important aspect for investment decision in the present context of market economy. Proper resources classification will provide better understanding and firmer knowledge of exploitability of mineral resources available and serve to reduce risk of investment.

Unlike other seabed mineral resources in the Area, the regulation of polymetallic nodules prospecting and exploration adopted by the Council after exhaustive work carried by pioneer investors and also as a part of the relinquishment exercise, the review of the process and approach towards assessing resources at this stage would be an additional burden on the pioneer investors and needs to be viewed cautiously. The high, high gain characteristics of further exploration demands a more careful approach in its planning and execution.

I have great confidence that this workshop, designed by the Authority, for interaction among contractors, pioneer investors and experts will provide an excellent opportunity to discuss the matter in a constructive way to fulfil the objectives of the workshop.

H.E. Mr Nii A. Odunton, Secretary-General, International Seabed Authority

Good morning everybody. I am glad to see you all here. I believe it bodes extremely well for what I hope to be an interesting and progressive week to which the international community will begin to get a very good idea of the resources associated with polymetallic nodules that we have in marine areas beyond national jurisdiction.

Dr Rajan, Director, National Centre for Antarctic and Ocean Research of India, distinguished delegates from the Government of India, experts on classification and other aspects of deep seabed polymetallic nodule mining, eminent representatives of the Contractors for polymetallic nodules exploration, members of the Legal and Technical Commission of the Authority.

I wish to thank all of you for the effort that you have made to be present for the ISA workshop on polymetallic nodule resource classification. This is a very important workshop for the Authority. It is our very first cut at trying to establish standards for the classification of polymetallic nodule resources.

It has been polymetallic nodules that resulted in the establishment of the ISA. It was indeed polymetallic nodules that was an extremely important part of the Law of the Sea Convention. An entire section of Part 11 of the Convention is dedicated to polymetallic nodules which gave scientists and engineers an opportunity at that time to also become part of the deliberations leading to the adoption of the Convention on the Law of the Sea.

It has been a long road since. I recall when discussions were going on at United Nations. The idea that we could be mining 5000m underwater sounded strange at that time. We already had mountains of ore on land. We had technology for mining these resources. People were being taught how to apply the technology to mining these resources in schools all over the world. We could mine underground. We collected the minerals, processed them and got the metals. At this Law of the Sea Conference, we were talking 5000m, and several thousand km from land.

This July, the Authority celebrated its 20th Anniversary. I am indeed very grateful to be able to report that the Authority now has a considerable number of contractors for polymetallic nodule resources. We also have contractors for polymetallic sulphides as well as contractors for cobalt-rich ferromanganese crusts. We however started with polymetallic nodules.

The International Seabed Authority has been established for 20 years and we have contractors who are almost at the end of their exploration contracts for polymetallic nodules.

We've had problems. Problems going back to polymetallic nodules and while these have been discussed over long periods of time, the international communities' knowledge of resources *in situ*, as far as these nodules are concerned, has been limited.

One of the directives the Authority has, is to establish standards for resources in the Area. Our job is to administer these resources. As the exploration phase continues, more effort is being made to get a better idea of the resources that are on the deep seabed. We understand that this is a novel venture and that mining is yet to take place.

It is our hope that the technology development of our contractors will result in a better idea of what is available today to this community to mine at a profit, that are ISA reserves. We also are interested in the other resources – and to what extent any mining can take place for polymetallic nodules down the line.

I hope that at the end of this week we will have a basic framework for standards for resource classification of polymetallic nodules in the Area. We have contractors who have engaged in this exercise for over a year. Presently we have some that are close to their licenses coming to an end. It is not obvious in the reports we have that anybody is about to relinquish their areas. It is also not very clear what we actually have in place. For that reason we are holding this workshop with the following objectives:

- to ascertain the work being undertaken by contractors for polymetallic nodule exploration in the Area with a view to the standardization of the exploration and resource data required in Section 11 of the standard clauses of Exploration contracts;

- to review of current practice in land-based mineral development on national reporting standards for exploration results and resource classification;

- to identify of special aspects of polymetallic nodule deposits that should be addressed in resource reporting standards;

- to identify of any issues arising from differences in national reporting standards to which the Authority should respond;

- to assist contractors to identify and implement best practices in polymetallic nodule resource evaluation;

- to identify the work to be completed by contractors to fulfil item;

- to determine the time required to fulfil item (v), and for this workshop; and

- to provide guidance to the ISA regarding relations with mineral information standards organizations, including potential cooperation with Committee for Mineral Reserves International Reporting Standards (CRIRSCO).

I am very happy to have you all here. I have no expertise in this area and I am like many who have gathered here to listen to what the experts have to tell us about work in this area. I also am very interested to learn from what the contractors tell us of the results of their work to date and the practices they have been following. We will also hear from the experts about best practices in this regard.

To this end, we wish to take the results of our work this week and make them available to the entire body of the Legal and Technical Commission in February 2015 and have them make recommendations to the Council - a decision making body - on standards for the development of these standard classification of these resources, we hope to have this material as input for a decision that has to be taken by the Council in July 2015 regarding the extension of exploration contracts.

I have been following the work of the USGS resources and their distribution worldwide on land or

ocean and keep reading about inferred resources. I believe the contractors spend a lot of money and have a lot of work and with their role in economic development we can move this process further than merely inferred resources.

I would also like you all to consider how the Authority can continue to work on these standards. I do not expect it completed in four days for nodule resources when it has taken us a considerable period of time and knowledge to get us to where we are able to do what has been done for land-based resources.

I look forward to an exciting week. I see this as a great opportunity to learn something. For the experts, I hope the knowledge they may gain for marine mineral resources will be a little bit more than they had before they attended this meeting For the contractors, hopefully we will have standards. The reports you give the Authority for consideration by the Legal and Technical Commission will be a basis for the Authority to inform the international community as to what is actually out there.

Thank you.

EXECUTIVE SUMMARY

Following the adoption of the Regulations on Prospecting and Exploration for polymetallic nodules in the Area, in July 2000, the Authority has entered into thirteen exploration contracts for polymetallic nodules with entities from Belgium, China, France, Germany, India, Japan, Kiribati, Korea, Nauru, Poland, the Russian Federation, Tonga and the United Kingdom. As required by the regulations, these entities are engaged in assessing the resources in their respective exploration areas, developing technologies for mining their deposits and for processing nodules into the metals of commercial interest, and acquiring baseline environmental data for environmental impact assessments prior to obtaining contracts for mining.

Six of these exploration contracts expired in 2016 and another in 2017. A review of the resource assessment work reported in the annual reports of contractors show considerable variation, with no uniform standards applied. The development of a polymetallic nodules deposit on the deep ocean floor is expected to be a multi-billion dollar investment, making it important that investors, partners and lenders have clear guidelines with which to compare claims of resource endowment used to justify investment and loans. A classification system for deep sea minerals has yet to be developed.

The objectives of the workshop were to ascertain the work being undertaken by contractors for polymetallic nodule exploration in the Area with a view to standardizing the exploration and resource data required in Section 11 of the standard clauses of Exploration contracts; to review current practice in land-based mineral development on national reporting standards for exploration results and resource classification; to identify special aspects of polymetallic nodule deposits that should be addressed in resource reporting standards; to identify issues arising from differences in national reporting standards to which the Authority should respond; to assist contractors to identify and implement best practices in polymetallic nodule resource evaluation; to identify the work to be completed by contractors and determine the time needed to fulfil item; and to provide guidance to the ISA regarding relations with mineral information standards organizations, including potential cooperation with CRIRSCO[1] and UNFC's[2] work.

The five-day workshop was attended by 40 participants from 15 different countries and involved eleven presentations by experts and nine by the contractors addressing specific topics. The participants then formed three working groups to craft the workshop recommendations.

The first working group was tasked with addressing state of the art collector devices, possible collaboration among contractors to test their collectors with a view to identifying where standardization is required.

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1 For 20 years the *Committee on Mineral Reserves International Reporting Standards* (CRIRSCO) has surveyed professional practice, drafted guidelines and best practices, and prepared professional codes and procedures for the assessment and reporting of exploration results, mineral resources and mineral reserves that have been further refined over the years. CRIRSCO produced a robust international standard that provides a widely accepted international standard addressing public reporting of exploration results, mineral resources and mineral reserves. CRIRSCO was granted Observer Status to the ISA at the 21st session of the Authority.

2 The UN Economic Commission for Europe began work on a comprehensive Framework Classification for mineral and energy resources in the 1990s, preparing its "Framework Classification for Reserves and Resources of Solid Fuels and Mineral Commodities" in 1997. Continuation of this work led in 2009 to the release of "United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009". Consultations between CRIRSCO and the UNECE led to the incorporation of the CRIRSCO definitions of reserves and resources into the UNFC.

The second working group was charged to address the guidelines for estimation of mineral resources and reserves as per international reporting standards and the steps required to implement them for the deep seabed mineral resources, and to help the contractors to standardize the classification of polymetallic nodule resources into proven, probable and possible reserves of metals. This group was also asked to discuss any issues arising from differences in national reporting standards and how they can be resolved.

The third working group was to determine the amount of work required by each contractor to complete the resource classification exercise for their respective areas and how long it would take.

This technical study also includes a brief summary of the presentations given by the experts and contractors.

PRESENTATIONS

(i) International Standards for Resource and Economic Evaluation: Applications for Deep Seabed Mining

Caitlyn Antrim, Center for Leadership and Global Diplomacy, Virginia, USA

Dr Antrim's presentation provided an initial framework of standards as required by different stakeholders. She informed that at the beginning of the century mineral results were reported succinctly as proved, probable and probable reserves. By the early 21st century, governments applied two and three dimensional taxonomies to categories resources by economic value, technological feasibility and geological assuredness. The United States Geological survey published during 1976-80, known as the "McKelvey Box", which served as the basis for the modern public and private systems in use today.

Evaluations are required to be conducted by "competent" or "qualified" experts subject to professional discipline by their peers. Industry standards and best practices provide guides for evaluations and the national societies working together as the Committee for International Mineral Reserve International Reporting Standards (CRIRSCO) established a common template that could be adapted for use by other countries. Where the CRIRSCO standards addressed the resource assessment needs of developers, investors and regulators, a parallel development addressed needs of public resource managers. The United National Economic Commission for Europe undertook to develop a common "Framework Classification", known as the UNFC, for energy and mineral resources. UNFC added a third dimension that separated technical feasibility from economic factors to provide a more rich understanding of a national, regional or global resource endowment.

Collaboration between CRIRSCO and the UNECE provided links between CRIRSCO's categories of Proven and Probable Reserves and Measured and Indicated Resources and the related UNFC boxes in their three-dimensional matrix. Dr Antrim said that the CRIRSCO "Template" could provide the basis for conforming mineral reserve and resources reports required of Contractors to the Authority with the international reporting standards. If reports made by Contractors to the International Seabed Authority are consistent with the CRIRSCO standards, they will meet the needs of all stakeholders on one hand and mineral management and planning functions that may be undertaken by the Authority on the other.

(ii) Nodule Collector Sub-Systems – Organization of the OMI Pilot Mining Test Programme and Its Use in Collaborative Tests by Contractors

Ted Brockett, Sound Ocean Systems Inc. Redmond, Washington, USA

Dr Brockett presented the Ocean Management Inc. (OMI) collective development programme, which was a consortium in the 70s with 4 primary partners. In 1977, OMI conducted a test of high speed exploration with a 30 kHz side scan sonar based on a back scatter system. In 1978, it completed a pilot nodule mining test (PMT) project in the CCZ in 5,400m depth, aboard SEDCO 445. The primary collectors for the OMI PMT was an incredibly simple passively towed runner sled, called the 2M hydraulic collector, which had an active width of 2m and four independent dredge heads. Two submersible pumps, installed in line with rigid type riser system were used while testing the collector and 40 metric tonnes nodules an hour was expected. The moving water was used to separate the nodules and sediment from the seafloor and to transport the nodules within the collector both vertically and transversally and to introduce the nodules into the riser system.

Two key parameters had a big impact on the development of collectors - (i) nodules were considered to be a surface deposit only, (ii) a Monte Carlo approach to mining the mine site, had significant impact on the collector designs. Dr Brockett said that another issue (to consider) would have been the active width of the collector for increasing the collection efficiency. The bow waves have a very significant adverse impact on collector's efficiency. More needed to be done to eliminate or minimize bow waves, to reduce the bearing load even further, and a steerable collector with options of side by side tracks.

Dr Brockett said that the OMI favored hydraulic designs, and the key was the Collector's reliability.

(iii) Information Needs of Financiers, Investors and Resource Managers

Michael Stanley, World Bank

Mr Stanley said that there continues to be a global structural shift on what defines sustainable mining and the locations in which sustainable mining is taking place. The key challenges for going forward are – the financiers and investors assess investment opportunities viz. sector governance, with emphasis on environmental / social performance. Regulatory compliance no longer earns a social license to operate. As a result, governance and investment risks are inseparably intertwined with continued limitations in mining finance. For the purpose of resource planning, a resource classification system having accounting of socio-economic performance is needed.

Mr Stanley was of the opinion that the UNFC 2009 is a superior process for resource classification and resource planning, and that it would be an appropriate framework for understanding the environmental /social blockages (conflicts) that impede various mineral resources from moving to production. He concluded that consultants working on the pilot projects have found it preferable to begin with UNFC 2009, and then migrate information to be reported to security exchange commissions into the CRIRSCO template.

(iv) Public Reports and Studies in the Mineral Industry

Caitlyn Antrim, Center for Leadership and Global Diplomacy, Virginia, USA

Dr Antrim addressed the issues of mining in a commercial environment. She identified two broad categories: i) technical reports and ii) integrated economic assessments. An integrated economic assessment involves factors such as geology and resources of the property, infrastructure, management and labor, environmental and permitting requirements and overall budget economics. An integrated study involves the technical and economic scoping study on the potential viability of mineral resources at the introductory level, the prefeasibility study to assess the likelihood of a viable operation, a key decision-making full feasibility study and an engineering study, using the best design approach.

Dr Antrim stated that the scoping and feasibility studies are economic measures and serve design and decision functions. These studies may become public documents to inform investors and regulators and be governed by national reporting laws and international codes. The same rules would apply to a seabed miner wanting to be a part of the mining industry.

(v) United Nations Framework Classification (UNFC) – How it Works in Practice and Its Application to Seabed Mineral Resources

Charlotte Griffiths, UNFC & Resource classification

Dr Griffiths said that the UNFC is the UN framework classification for fossil energy and mineral resources. It's a global generic, principle based system, based on three fundamental criteria, represented by three axes. Dr Griffiths said that the UNFC has a powerful numerical quantification system. The fundamental principle of the UNFC is that resources are classified in a series of projects with differentiation on each of the three axes, the social and economic axis, the project feasibility axis and the geological knowledge axis. She said that three criteria or axes are the most real and that they're found in most other classification systems either as implicit attributes or as direct criteria. Dr Griffiths said that because the UNFC is direct on all three, it provides the framework through which other classification systems can be compared and harmonized, thus making the UNFC an extremely powerful tool. UNFC implicitly meant the CRIRSCO template as well, because the two were part of one package.

The UNFC is managed by the Economic Commission for Europe (UNECE), because of UN Economic and Social Council (ECOSOC) decision adopted in 2004. She said that the work on energy and on resource classification was the flagship of UNFC's activities, i.e. the development of laws and standards, best practice guidance, and conventions to provide a neutral platform for stakeholders through an open and transparent process.

She also said the UN had developed the system because of a demonstrated need for a common system for solid minerals and mineral commodities. She noted that the work on this resource management tool started in 1992 and that it had gone through inclusive and transparent processes over twenty years, resulting in a solid and robust volunteer system that was approved in 2009, and that became operational in 2013.

(vi) Resource Classification – Comprehensive Extraction and the Importance of Environmental and Social Issues

David MacDonald, Expert Group on Resource classification of the UNEC of Europe

Mr MacDonald described the UNFC as a framework classification that captured, measured and quantified reserves and resources. He said that it is based on a set of definitions for different categories; a list of specifications gave detailed application guidelines around these definitions with a series of bridging documents, that acted as guidelines and existing specifications for different commodities.

Mr MacDonald said that the UNFC system is based on three criteria represented by E (economic and social viability), F (feasibility) and G (geology) axes. Each of the axes is sub divided. The E axis has three and the F and G axes each have four major categories. In the UNFC system therefore, 111 would mean level 1 on the E, F and G axis and it would be the highest level of achievement. In the case of composites being discussed at the workshop, Mr MacDonald said most would fit E3, with some possible E2 cases. The largest concern in moving from E3 to E2 would be social licenses and environmental issues.

Commercial projects met the E and F axes at the highest levels, but were called reserves under conventional systems (under CRIRSCO or PRMS). Where non-commercial projects were not

captured within the CRIRSCO system, the UNFC system allowed those volumes through the categories. The UNFC system used generic specifications as the minimum standard for reporting and its categories deduced the estimates that were required by CRIRSCO for disclosure. There are 20 different generic specifications covering a number of different issues from disclosure to defining the levels of project maturity. The UNFC expert group are experts in their own commodities with the goal to having UNFC rely on existing systems as much as possible, through bridging documents.

Mr MacDonald said the UNFC system was a generic principle-based system which allowed some modification to make it more need specific. The system could be viewed as value added to the CRIRSCO system and could be suitable for application to seabed mineral resource, having the E and F axes and the ability to subdivide the F4.

(vii) The committee for Mineral Reserves International Reporting Standards (CRIRSCO) – Classification Code

Pat Stephenson, AMC Mining Consultants, Vancouver, BC V6C 1S4, Canada

Dr Stephenson, who made the presentation on behalf of Dr Harry Parker, incoming Chair of CRIRSCO, said that the CRIRSCO was a very simple system, well understood by the world's mining and finance industries. He noted that CRIRSCO is the commercial arm of the UNFC, managed under a separate authority than the CRIRSCO Committee. CRIRSCO, as an international coordination and advisory body in the area of Mineral Resource / Reserve classification and reporting, Dr Stephenson said, relies on its constituent members to ensure regulatory and disciplinary oversight at a national level. It promotes uniformity, excellence and continuous improvement in the public reporting of Mineral Exploration Results and Mineral Resources / Reserves, and represents the international minerals industry on Resources and Reserves issues with other international organizations. Its member countries are Australasia, Canada, Chile, Europe / UK, Russia, South Africa, USA and Mongolia. Mining companies listed on stock exchanges that use CRIRSCO-type reporting standards account for over 80% of the listed capital of the world's mining industry.

Dr Stephenson said that the indicated and inferred boundary was the most important separation in the CRIRSCO system, because it dictated what could be converted to mineral reserves. The CRIRSCO international reporting template (IRT) initiated in 2003 and its recent version in 2013 endeavors to promote *best practice* in mineral resource and reserve estimation and classification. The template could easily be adapted to seabed nodule reporting with the inclusion of clauses, after extensive discussion with interested groups on issues related to seabed nodule mining. Materiality, transparency and competency were the three principles that underline national reporting standards in all the CRIRSCO countries and the CRIRSCO template. The principles provide extensive guidelines with the *competent or qualified person* making his or her own judgment as to what is appropriate and applicable in the particular situation and taking responsibility for it.

(viii) The 'Competent Person' in Mine-Site Evaluation and Responsibilities for Study Design, Management and Findings

Matthew Nimmo, Golder Associates, Australia

Mr Nimmo said that the CRIRSCO template describes the 'Competent Person' (CP) as having three primary principles - transparency, materiality and competency. Being transparent is about providing clean, concise and accurate information that did not mislead the investor and that was clearly understood by the reader. Methods of sampling and procedures detailed, lab assays and repeats,

storage, maintenance, verification and security of the data in the public report subscribed to transparency. Materiality meant that all relevant information in the report that a reader expects, like QA/QC to be there. The competency is where the CP comes to work. CP would be minerals industry professional with experience in the mineralization type being addressed and who follows a code of ethics. The CP's role is to try and help extract the value out of the deposit, identify gaps in information and/or data and estimate it into a particular category to allow for economic assessments on that estimate.

For any project, a large number of competent people from project related aspects may be required, but there would be only one technical report containing all information related to the project. A competent person would need to visit the site, observe the sampling and verify the database recorded in the Assay certificates and, its suitability for mineral resource estimate and write it in the public report. A CP needed to understand all aspects of the resource estimate, the risks involved, the parameters that could affect the estimates, and the assumptions applied to it. In the public report, the reasons for prospects for economic extractions must also be stated. The CP has to build trust by performing the estimates using the best practices. In the end it is CP, not the company, who is legally responsible at the sign off the report.

(ix) Best practices – General and Specific Guidelines from CRIRSCO and its Member Organizations

Pat Stephenson, AMC Mining Consultants, Vancouver, BC V6C 1S4, Canada

Dr Stephenson presented a paper by Debra McCombe about best practices in two categories – (i) public reporting of exploration results and Mineral Resources/Reserves and (ii) estimation, classification and monitoring of Mineral Resources/Reserves.

He said that the first is achieved by: (a) the provision, in Table 1 of most mineral industry reporting codes / standards and the CRIRSCO International Reporting Template, of checklists of all important criteria to take into account when estimating Mineral Resources / Reserves; (b) publishing separate Best Practice guidelines (Canada); (c) publishing monographs that provide up to date, peer reviewed technical papers on best practice (Australia); and (d) the general body of mineral industry publications in this area.

The second is achieved by publishing and keeping up to date each of the CRIRSCO member countries' mineral reporting codes / standards, and the CRIRSCO International Reporting Template. These provide a minimum standard for the public reporting of Exploration Results and Mineral Resources / Reserves, ensuring that public reports on these matters contain all the information that investors and their advisers would reasonably require for the purpose of making a balanced judgement regarding the results and estimates being reported. They are supported by mineral industry regulatory bodies in the CRIRSCO countries, and underpinned by the Competent / Qualified Person system. This commitment to best practice in the mineral industry has contributed substantially to the improved confidence that investors now have in the estimation and reporting of Mineral Resources/Reserves.

(x) Identification of Special Aspects of Polymetallic Nodule Deposits of the Area that Should be Addressed in Reporting Standards

Matthew Nimmo, Golder Associates, Australia

Mr Nimmo said that the CRIRSCO code or the NI43101 was more than adequate and the differences were not significant enough to warrant a new code. Going through Table 1 of the CRIRSCO template, he demonstrated that while there are differences they are not significant enough to warrant major changes and could be well accommodated within the code. He said TOML had paved the way through the Canadian system, so it was possible for anyone else to do the same.

(xi) Identification of any issues arising from differences in national reporting standards to which the Authority should respond

Paul Kay, Offshore Minerals, Geosciences, Australia

Giving an example from Australia, Mr Kay said that in the annual national inventory of Australia's mineral resources, information from the Australia Stock Exchange is used because the material is certified with the Australian code which has an absolute mapping capacity with CRIRSCO and with UNFC. The national or jurisdictional inventory was about aggregating the resources of individual deposits by having a national inventory; a regular evaluation of resources would be available in the foreseeable future for mineral development. Individual deposits have inherent characteristics that need to be amalgamated and that once the assessment has been made on what an economically demonstrated resource is, one can then move toward reporting a number nationally. He said the whole issue was mapping to a universal template, harmonizing the various systems and working how to compare world inventories. He said that although CRIRSCO did not have as much granularity as UNFC, the two were interchangeable and could map from one to the other. Summarizing Australia's terrestrial experience, Mr Kay said it provided background in terms of how the JORC, CRIRSCO, UNFC systems could be incorporated to make a national or jurisdictional inventory.

(xii) Activities of the IOM Within the Scope of Geological Exploration for Polymetallic Nodule Resources.

Tomasz Abramowski, Interoceanmetal Joint Organization

Mr Abramowski said IOM signed the contract in 2001 and located the most prospected areas in H11 and H22. He informed participants that in the H11 area 21 ore deposits from 66 ore fields had been identified using geostatistical model equations including Kriging. He said that one of the most significant parameters for delineation of nodule fields was the slope angle, because the collector device needed to overcome different slopes. He told participants that IOM areas have slope angles of more than 4^{o}; 7^{o} and 10^{o} and based on calculations of the collector as well as information from scientific papers. He said that IOM selected 7^{o} but was optimistic that mining collectors could reach 12^{o}-15^{o}. Another uncertainty would be buried nodules.

He informed participants that IOM had initially had opted to produce four million metric tonnes (4Mt) of wet nodules per year for the commercial phase, but now it preferred to consider an approach based on the analysis of various alternatives. Mr Abramowski recommended that discussions on parameters affecting mining, such as design of ship and production rates; some kind of collaboration between contractors and the Authority may be useful.

(xiii) The Concept of the Russian Exploration Area Polymetallic Nodules resource and reserve categorization

V. Yubko and I. Ponomareva, Yuzhmorgeologiya (Presented by Sandor Mulsow of the ISA in Ms Ponomareva's absence)

The Russian Exploration Area (REA) incorporates an Eastern and a Western territory with assessed cumulative resources of 448 million tons nodules. The SSC Yuzhmorgeologiya used a Russian classification of mineral reserves and resources, developed by a competent organization - State Commission on Minerals. It identified four levels of resources, in order of decreasing knowledge (A, B, C1, C2) and three categories of 'prognostic' resources (P1, P2, P3). Resources of categories A and B were identified only in areas of detailed study for confirmation of C1 resource estimates.

In September, 2010 FGU "GKZ" and CRIRSCO agreed to a document which took into account the Guidelines categories of resources and reserves of hard minerals stipulated by the Russian classification and applied by Yuzhmorgeologiya to polymetallic nodules and the CRIRSCO Template.

Yuzhmorgeologiya demarcated deposits based on photo, video and acoustic surveys at 3 – 6 km spacing, and one sample per 36 km^2. Assessed resources and reserves in the studied areas were: P1 category (Inferred Resources) 414.3 and C2 category (Indicated Resources) - 144.2 Mt of wet nodules. It was expected that at the end of the contract, cumulative polymetallic nodules reserves with regard to C1 + C2 categories would reach 180 Mt, including C1 category of 36 Mt. Yuzhmorgeologiya qualified such reserves as sufficient for future mining enterprises processing 3 million tonnes of dry (4.3 Mt of wet) of nodules per year in the course of 20 years and the first 5-year period of the mining contract respectively.

(xiv) Status of Korean Activities in Resource Assessment & Mining Technologies

Dr Yoo and Dr Hong, KIOST

Dr Yoo presented the resource assessment activities of Korea and Dr Hong described its miner Robot, *MineRo*. Dr Yoo said that from 1992 to 2010, Korea focused on resource assessment and environmental baseline studies. During 2011, high resolution topography and acoustic seafloor surveys were carried out and environmental data for benthic impact experiment gathered.

He also said that sampling with free fall grabs (4 at each site) and box corers showed average abundance of 7.5 kg/m^2 at 4800-5100m depth. The slope gradient was less than 5^o in 90% of the contract area. The shear strength of the sediments was between 10 cm to 40 cm and 87% of the total area has over 5kpa. It was easier to operate the miner robot - *MineRo* in southern blocks covered with consolidated sediments.

Kriging and the conditional simulation methods showed that the differences in areas of low density data when compared with high density sampling data were less than 5%. Therefore, available resource data could be described as indicated to measured mineral resource.

Dr Hong said that a tentative production plan for nodule mining of 3 million tons/year for 30 years had been selected, based on previous studies. He also said that Korea's priority mining area was estimated as 18,000 km^2 with about 188 M ton of mineable resources. Dr Hong said that delineation of the mining area was directly coupled with mining technology. He elaborated on

Korea's pilot mining robot, *MineRo* which had undertaken two at sea trials in 2012 & 2013 at 130m depth. He noted that its collecting efficiency had been verified at the laboratory as 95%. Dr Hong said that the seafloor miner should be limited to high-tech robotics to enhance nodule pick-up, crushing, and discharging performances. He told participants that the ongoing technological development of 20 years would end next year.

(xv) COMRA'S Activities in Resource Assessment

Jincai Jin, Secretary-General, COMRA

Dr Jin informed that COMRA's western license area has lower grade, and the eastern area lower abundance. He said that the block with potential deposits were divided into six parts. The eastern part had 5 kg/m^2 abundance, about 1.8% grade and about 5^o slope, at 9.8 km x 9.8 km sampling grid.

An area of 217 km^2 with flat terrain was chosen for future environmental impact assessment together with equipment testing. Dense sampling and AUV measurements were carried out in this area in 2013 and will continue into 2015. He said that resources in the western part of COMRA's contract area were categorized as inferred, indicated and measured resources using the China (GT 1776-1999) that was based on UNFC 1997 with different categories of resources: 331, 332 and 333.

Dr Jin said that the resource classification between COMRA and CRIRSCO were comparable; and that COMRA was in the stage of pre-feasibility studies. He mentioned the LTC chairman report in 2006, where the need to establish mineral resources/reserve classification system for the Area was expressed and discussions around system with global applicability, e.g. the UNFC. Dr Jin presented COMRA's proposed mineral classification system.

(xvi) Polymetallic Nodule Resources Evaluation: How Are We Doing?

Masatsugu Okazaki, DORD

Dr Okazaki informed participants that DORD's first generation mining area was approximately 6,000 km^2 with high abundance. A prefeasibility study had been conducted in the area for a 20-year mining operation. He said that with an average abundance of 10 kg/m^2 and an annual production of 3 million tonnes, DORD would have to produce10,000 tonnes/day for 300 working days/year, with about 300 km^2/year coverage, totaling 6,000 km^2 in 20 years. Additionally, he said that DORD had also conducted a detailed survey in its proposed mining area using an AUV for nodule distribution, detailed topography and continuous photography.

He told participants that DORD constructed its abundance map by applying Kriging to free fall grab (FFG) samples and had used a continuous deep sea camera (CDC) for the photographs to estimate coverage, number of nodules, and abundance. The areas of mineable resources had less than 5^o slope gradient, 12.31 kg/m^2 average abundance, with 92.5% of the total mineral resources being mineable. He said the mineral resources drawn from the FFG were inferred, and from the FFG and CDC were indicated resources.

Dr Okazaki concluded that DORD's mineral resources were now more than inferred but not accurate enough for the indicated category. He said statistical treatment of this data was necessary to decide the criteria of the indicated category.

(xvii) Polymetallic Nodules Resource Classification: French Effort 1970-2014

Yves Fouquet, Ifremer

Dr Fouquet informed the workshop that Ifremer moved to large scale exploration in the CCZ during 1975-76, it had its first diving operation in 1989 using a manned submersible, and from 2001-2004 did environmental, economic and geochemical studies and near-seafloor geological mapping and photography. In 2012 the eastern section of the Area was surveyed by a multi-beam system. Ordinary Kriging and conditional simulation was done on the slope and then the density of nodules on the seafloor and mineable areas were defined.

Dr Fouquet told participants that Ifremer also worked on mining and processing technologies and techno- economic studies. Its next step, he said, should be pilot mining and prefeasibility studies He said that Ifremer envisioned mining about 1.5 Mt of dry nodules every year in areas with an abundance of about 14 kg/m^2, for about 50 years, requiring about 30,000 km^2. With inferred resource shown to be capable of supporting decades of mining, Dr Fouquet said upgrading this level of knowledge for the whole area was not necessary at this stage.

(xviii) Indian Polymetallic Nodules Programme

M. Shyam Prasad and Dr TRP Singh, INDIA

Dr Prasad informed participants that India had identified its first generation mine site (FGM) in 2009-2010 and subsequently a test mine site – a single block of 1/8 degree in 2013. He said over 2,500 stations were sampled mostly by free fall grab (5-7 at each site). Starting from a grid of one degree, it sampled at 14 km and 7 km grids in 18,400 km^2 area. He told participants that India undertook 76 expeditions for resource estimation and mineable area identification.

Dr Prasad said that single beam and multi-beam echo-sounding mapping was done for seabed topography to relinquish areas. Sampling at 0.125 degree grid, baseline environmental data at 64 stations in five candidate tests and reference sites was done and a simulated mining experiment was conducted in 1997. For a first generation mine site to sustain production for 20 years, 20% of the area was sampled at 7 km grid, with sufficient topographic information to eliminate adverse topography and areas of steep slopes. Dr Prasad informed participants that in 2010 India developed an underwater collector and crushing system and underwater mining machine, for mining nodules in 500 meters depth, and an unmanned ROV and *in-situ* soil tester for 6000m water depth. The integrated mining system for mining of nodules up to 6000m depth was still in progress.

Dr Singh advised that 15% of the grade qualifies for a measured category and that 10% of the Area (75 000km^2) will have sufficient resources for 20 years mine life.

(xix) CCZ Nodule Projects: 2013 Mineral Resource Estimate per N143-101 Tonga Offshore Mining Limited [TOML]

John Parianos, TOML

Mr John Parianos said that the TOML license has six blocks (A-F), returned (to ISA) by the Pioneer Investors. Area E and F have few samples, so were not included for classifying resources. Mr Parianos informed that for going through the code NI 43-101, TOML had done data verification by obtaining public data and preparing a completely independent data set. Similar results were obtained by interrogating the model picture with the International Seabed Authority's 2010 map;

using colour codes and comparing it to TOML's estimates model.

TOML took a block model approach in 10km x 10km, did Kriging and simulation for the purposes of an inferred resource. Mr Parianos said the TOML reported a range of results and used abundance as a cut-off, along with a grade/tonnage curve. He said the grade barely changed although the abundance, which is the key economic variable, did; and that the appropriate cut-off at this inferred stage was not known.

(xx) Lead up of the Polymetallic Nodules Project and Context

Jacques Paynjon, GSR

Mr Paynjon informed that the company signed the contract in early 2013. It has done a cruise in the Area for 55 days and while at the site, the group noticed that there was some sort of mechanism to define the presence/absence of nodules on the seabed and were able to confirm it with the box corers and dredges with cameras on board. He showed some sampling graphs.

WORKING GROUPS

Status of Contractor Activities in Resource Assessment

The third day of the workshop addressed the status of each contractor's efforts towards the classification of deep seabed polymetallic nodule resources in their exploration areas. Contractors were requested to indicate, in their presentation, the criteria that they have selected for the estimation of mineable areas, including, inter alia, production requirements (annual production rates and duration of mining), grade of nodules, abundance of nodules, and seafloor characteristics. Utilizing the average grade and abundance of nodules, contractors were requested to divide their exploration areas into areas where nodules have an average grade and abundance higher than a cut-off level, determined by the contractor and below this cut-off level. Based on seafloor characteristics, the contractor were requested to divide its exploration area into areas where seafloor characteristics (slope, number and size of obstacles and sediment shear strength) are (a) within an acceptable range and (b) are unacceptable.

In this context, mineable areas will be defined as having a combination of grade and abundance above respective cut-off levels and acceptable seafloor characteristics. A mine-site has to contain a sufficient number of mineable areas capable of supporting an economic mining venture.

Working Group Deliberations

Three Working Groups were constituted, that comprised of eminent experts, contractors and international resource classification experts, to examine the objectives of the workshop on nodule resource classification in the Area. These groups were constituted to address the following:

Working Group 1, chaired by Mr Ted Brockett was to address the state-of-the-art collector device, possible collaboration among Contractors to test their collectors, and analyze the exploration data & estimates of mineable areas presented with a view to identifying where standardization is required in the relevant areas of the CCZ and CIOB.

Working Group 2, chaired by Dr Pat Stephenson was to address the guidelines for estimation of mineral resources and reserves as per the international reporting standards and the steps required to implement them for the deep seabed mineral resources, and to help the contractors to standardize the classification of polymetallic nodule resources into proven, probable and possible reserves of metals.

This working group will also address any issues arising from differences in national reporting standards and how they can be resolved.

Working Group 3, chaired by Dr Georgy Cherkashov was to determine the amount of work required by each contractor to complete the resource classification exercise for their respective areas and how long it would take.

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RECOMMENDATIONS OF THE WORKING GROUPS

Working Group 1: State-of-the-Art Collector Devices

Members:
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Recommendations:

1) Working Group I welcomed the presentations from contractors on the State-of-the-Art of their collector development programs, and recommended that the Authority accept and make public this information.

2) There was general consensus among the State Owned Contractors of Working Group I to continue discussion of potential collaborative efforts associated with pilot mining tests and environment impact studies (benthic impact experiments) associated with collectors, and therefore the group recommended that such discussions be continued.

3) Working Group I recommended that the Authority continue to support collaboration amongst interested contractors with regards to pilot mining tests and environmental assessment efforts as a means of helping contractors, reduce risk, reduce cost, share/develop technology, and reduce collector related environmental impact. Such support might include such things as: Future workshops and Working Group I meetings, coordination of collaborative pilot mining and environmental impact assessment, etc.

4) Working Group I recommended that the Authority provide to the contractors in a timely manner copies of the draft rules and regulations, for the transition from exploration to exploitation, and for exploitation.

5) Working Group I recommended that the Authority support the recommendation of counsel and facilitate the review and release of the CCZ environment management plan taking into consideration the relevant proposal from the Netherlands.

6) The contractors within Working Group I were provided with a contractor PMT collector survey document. Each contractor was requested to fill out the survey on a voluntary basis and to provide the completed survey to the Authority prior to the end of November 2014.

7) The contractors within Working Group I were in general agreement that it was too early to identity where standardization is required in respect to collector systems, and recommended that work continue on this issue.

PMT Collector Survey Form (SAMPLE).

Name:
Email:

PMT Collector Description

Organization Name:

Collector Name:

Proprietary (Can this Information Be Shared?): Collector Type (Hydraulic, Mechanical, Hybrid, Other):

Describe:

Current Status:

Estimated Date of Completion: Annual Throughput: Horsepower:

Propulsion Type:

Number of Propulsion (Track, Screw, etc.) Elements: Active Width:

Modular Design:

Length Overall:

Width Overall:

Height Overall:

Estimated Weight in Air: Estimated Weight in Water: Estimated Seafloor Bearing Load: Maximum Hourly Throughput: Maximum Nodule Size:

Crusher Type:

Maximum Nodule Size after Crusher:

Sediment Rejection (If yes, how?): Oversize Nodule Rejection (If yes, how?): Maximum Speed:

Maximum Cross Slope Angle: Maximum Up-Slope Angle: Maximum Down-Slope Angle:

Minimum Turning Radius:

Obstacle Detection & Avoidance (Describe): Maximum Manageable Obstacle Size: Redundant Systems (Describe):

Describe Any Auxiliary Equipment Required:

Umbilical Requirements (Power, fiber, breaking strength, etc.):

Sensor Suite (List sensors & other components):

Are you willing to collaborate with other contractors (If yes, how?)?

Land Based Tests

Deep Sea Collector Tests (Ship, winch, umbilical?)

Pilot Mining Test

Describe any impediments to completion of collector development:

What specific data is required from exploration surveys?

Have you or do you plan to conduct a Benthic Impact Experiment?

Please include illustrations (or similar) showing function collector concept. What can ISA do to help your collector development program?

Working Group 2

1. Working group 2 was charged to address the guidelines for estimation of mineral resources and reserves as per international reporting standards and the steps required to implement them for the deep seabed mineral resources, and to help the contractors to standardize the classification of polymetallic nodule resources into proven, probable and possible reserves of metals. The working group was also asked about any issues arising from differences in national reporting standards and how they can be resolved.

2. The group began its work with the draft revision of the CRIRSCO International Reporting Template (Annex 1), prepared on Wednesday. The discussion began by adding clarity to the concept of "mineable areas", applying the definition used by the UN Ocean Economics and Technology Branch of that area "where four conditions are met:

   (a) nodules are known to be present;

   (b) the grade is above a pre-determined cut-off;

   (c) the abundance is above a predetermined cut-off;

   (d) the topography is of an acceptable nature.

3. The group found that resources of the mineable area correspond to the 'mineral resources' category of the CRIRSO template, including inferred, indicated and measured categories.

4. The group also found that the term "proven, probable and possible reserves" refers to the CRIRSCO categories of measured, indicated and inferred mineral resources and, if the pre-feasibility or feasibility studies supporting conversion of resources to reserves have been applied by the contractor, to proven and probable reserves.

5. The group recognized that materials that do not qualify as CRIRSCO mineral reserves or resources may be classified within appropriate categories of the UN Framework Classification.

6. The group found that in the application of the modifying factors listed in the template, the categories of weather, transportation, underwater topography and international benefit sharing should be considered.

7. The group found that in the case of non-Public reports to the International Seabed Authority, the "Competent Person" requirement to belong to a professional association with disciplinary power was not applicable. The group also reinforced the CRIRSCO provision that resource classification may be undertaken in a team approach utilizing several competent persons with expertise in different areas.

Working Group 3

1. Most contractors already follow the existing classification systems, either UNFC or CRIRSCO;

2. The ISA should prepare the guidelines for resources classification as soon as possible;

3. Such guidelines should not refer to any cut-off values since it will depend on geological, but also technological and economic factors. Those should be defined by contractors;

4. Contractors agreed to use the resources classification scheme issued by the ISA in their practice and in the reports to the ISA (annual, after five-year periods and upon expiry of the contract).

ANNEX 1 International Seabed Authority Reporting Standard for Polymetallic Nodules in the Area

Reporting standard of the International Seabed Authority for mineral exploration results assessments, mineral resources and mineral reserves

I. Introduction

1. The present document sets out the standard to be observed in all documents submitted to the International Seabed Authority that include the reporting of estimates of resources in the Area, which that are not intended for public release or for the prime purpose of informing investors or potential investors and their advisers. These estimates should be reported according to the Authority's resource classification system that is based on the three main resource categories: (a) mineral exploration results assessments; (b) mineral resources; and (c) mineral reserves (see figure below). It is based on the November 2013 edition of the international reporting template of the Committee for Mineral Reserves International Reporting Standards (CRIRSCO).[1]

2. In the present document, important terms are defined in paragraphs highlighted in bold. When appearing in the definition of other such terms, those terms are underlined. The template clauses are shown in plain font. Paragraphs in italics that are placed after the respective clauses are intended to provide assistance and guidance to readers for interpreting the application of the clauses in the reporting standard of the Authority. Enclosure 1 contains a list of generic terms, equivalents and definitions provided to avoid duplication or ambiguity.

II. Scope

3. The main principles governing the operation and application of the reporting standard are transparency and materiality:

(a) Transparency requires that the Authority and, particularly, its Legal and Technical Commission be provided with sufficient information, presented in a clear and unambiguous way, so as to understand the report and not to be misled;

[1] The present annex has been prepared at the request of the International Seabed Authority by a group comprising: C. Antrim, Executive Director at the Rule of Law Committee for Oceans, United States of America; H. Parker, Deputy Chair of the Committee for Mineral Reserves International Reporting Standards (CRIRSCO) and Consulting Mining Geologist and Geostatistician at Amec Foster Wheeler, United States; and P. R. Stephenson, former Co-Chair of CRIRSCO and Director and Principal Geologist at AMC Consultants, Canada; with input from CRIRSCO members. It follows guidelines drawn up by a working group at a workshop convened by the Authority, in collaboration with the Ministry of Earth Sciences of India, on the classification of polymetallic nodule resources, held in Goa, India from 13 to 17 October 2014. The working group members were: P. Stephenson; C. Antrim; M. Nimmo, Principal Geologist at Golder Associates, Australia; D. MacDonald, Chair of the Expert Group on Resource Classification of the Economic Commission for Europe; P. Kay, Manager at Offshore Minerals, Geoscience Australia; P. Madureira, Deputy Chief of the Task Group for the Extension of the Continental Shelf, Portugal; G. Cherkashov, Deputy Director at All-Russia Research Institute for Geology and Mineral Resources of the World Ocean, Russian Federation; T. Ishiyama, Deep Ocean Resources Development, Japan; T. Abramowski, Director General at the Interoceanmetal Joint Organization, Poland; J. Parionos, Chief Geologist at Tonga Offshore Mining Limited, Tonga; and J. Paynjon, G-TEC Sea Mineral Resources NV.

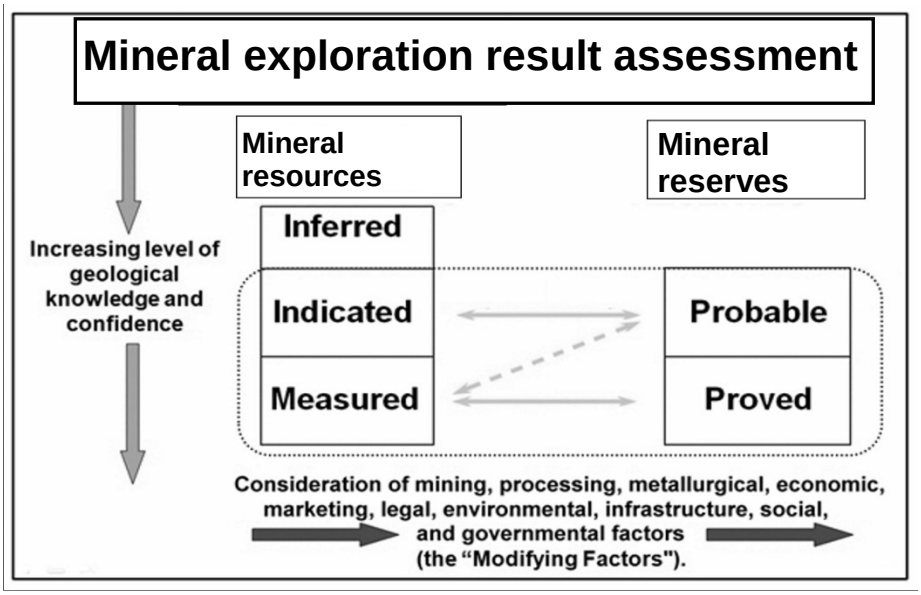
(b) Materiality requires that the report contain all the relevant information that the Authority and, particularly, its Legal and Technical Commission may reasonably require and expect to find in the report, for the purpose of making a reasoned and balanced judgement regarding the mineral resources or mineral reserves reported on.

4. The reporting standard specifies the required minimum standard for all documents submitted to the Authority that include the reporting of mineral exploration results assessments, mineral resources and mineral reserves. It is not intended for release to the general public or for the prime purpose of informing investors or potential investors and their advisers.[2] Reporting entities are encouraged to provide information that is as comprehensive as possible in their reports.[3]

5. The estimation of mineral resources and mineral reserves is inherently subject to some level of uncertainty and inaccuracy. Considerable skill and experience may be needed to interpret pieces of information, such as geological maps and analytical results based on samples that commonly represent only a small part of a mineral deposit. The uncertainty in the estimates should be discussed in the report and reflected in the appropriate choice of mineral resource and mineral reserve categories.

6. The reporting standard is applicable to all mineral resources for which the reporting of mineral exploration results assessments, mineral resources and mineral reserves is required by the Authority under its rules, regulations and procedures.

7. It is recognized that a further review of the reporting standard will be required from time to time.



[2] Where reports are prepared for the prime purpose of release to the general public or for informing investors or potential investors and their advisers, the Authority recommends that they comply with one of the reporting standards that are recognized by CRIRSCO has being consistent with its international reporting template.

[3] While every effort has been made in the reporting standard of the Authority to cover most cases likely to be encountered when reporting on mineral exploration results assessments, mineral resources and mineral reserves, there may be occasions when doubt exists as to the appropriate form of disclosure. On such occasions, users of the reporting standard and those who compile reports to comply with the standard should be guided by its intent, namely, to provide a minimum standard for such reporting and to ensure that such reporting contains all the information that readers may reasonably require and expect for the purpose of making a reasoned and balanced judgement on the mineral exploration results assessments, mineral resources or mineral reserves reported on.

General relationship between mineral exploration results assessments, minerals resources and mineral reserves

III. Reporting terminology

8. Modifying factors are considerations used to convert mineral resources into mineral reserves. These include, but are not restricted to, mining, processing, metallurgical, infrastructure, economic, marketing, legal, environmental, social and governmental factors.

Guidance

9. The figure in paragraph 6 illustrates the framework for classifying tonnage and grade estimates to reflect different levels of geological confidence and different degrees of technical and economic evaluation. Mineral resources can be estimated mainly on the basis of geological information with some input from other disciplines. Mineral reserves, which are a modified subset of the indicated and measured mineral resources (shown within the dashed outline in the figure), require consideration of the modifying factors affecting extraction and should in most instances be estimated with input from a range of disciplines.

10. Measured mineral resources may be converted into either proved mineral reserves or probable mineral reserves. Measured mineral resources may be converted into probable mineral reserves because of uncertainties associated with some or all of the modifying factors that are taken into account in the conversion from mineral resources into mineral reserves. This relationship is shown by the broken arrow in the figure. Although the trend of the broken arrow includes a vertical component, it does not, in this instance, imply a reduction in the level of geological knowledge or confidence. In such a case, the modifying factors should be fully explained (see also para. 21 for a subdivision of mineral resources).

IV. General reporting

11. Reports to the Authority concerning a contractor's mineral exploration results assessments, mineral resources or mineral reserves must include a description of the style and nature of mineralization.

12. A contractor must disclose any relevant information concerning a mineral deposit that could materially influence the economic value of that deposit to the contractor. A contractor must promptly report any material changes in its mineral resources or mineral reserves to the Authority.

13. Throughout the reporting standard, certain words are used in a generic sense when a more specific meaning might be attached to them by particular groups within the industry. In order to avoid duplication or ambiguity, those terms are listed in enclosure 1 together with other terms that may be regarded as synonymous for the purpose of the present document.[4]

[4] The use of a particular term throughout the present document does not signify that it is preferred or necessarily the ideal term in all circumstances. The contractors would be expected to select and use the most appropriate terminology for the commodity or activity reported on.

V. Reporting of mineral exploration results assessments

14. An exploration target is a statement or estimate of the exploration potential of a mineral deposit in a defined geological setting, where the statement or estimate, quoted as a range of tons and of grade or quality, relates to mineralization for which there has been insufficient exploration to estimate mineral resources.

15. Mineral exploration results assessments include data and information generated by mineral exploration programmes which might be of use to readers of the report but do not form part of a declaration of mineral resources or mineral reserves.[5]

16. This sort of data is common in the early stages of exploration when the quantity of data available is generally not sufficient to allow for any estimates other than in the form of an exploration target to be reached.

17. If a contractor reports mineral exploration results assessments in relation to mineralization not classified as a mineral resource or mineral reserve, then estimates of tonnage and associated average grade must not be reported other than in the form of an exploration target.[6]

18. Reports on mineral exploration results assessments relating to mineralization not classified as a mineral resource or mineral reserve must contain sufficient information to allow a considered and balanced judgement of the significance of the results. Reports on mineral exploration results assessments must not be presented so as to unreasonably imply that mineralization of potential economic interest has been discovered.

VI. Reporting of mineral resources

19. A mineral resource is a concentration or occurrence of solid material of economic interest in or on the Earth's crust in such form, grade or quality and quantity that there are reasonable prospects for eventual economic extraction.[7]

20. The location, quantity, grade or quality, continuity and other geological characteristics of a mineral resource are known, estimated or interpreted from specific geological evidence and knowledge, including sampling.

21. Mineral resources are subdivided, in order of increasing geological confidence into "inferred", "indicated" and "measured" categories.

22. Portions of a mineral deposit that do not offer reasonable prospects for eventual economic extraction must not be included into a mineral resource.[8]

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[5] It should be made clear in reports that contain mineral exploration results assessments that it is inappropriate to use such information to derive estimates of tonnage and grade. It is recommended that such reports carry a continuing statement along the following lines: "The information provided in the present report/statement/release constitutes mineral exploration results assessments as defined in the reporting standard of the International Seabed Authority, in relation to clause 24. It is inappropriate to use such information for deriving estimates of tonnage and grade".

[6] Descriptions of exploration targets or exploration potential given in reports should be expressed so as not to misrepresent them as an estimate of mineral resources or mineral reserves.

[7] The term "mineral resource" covers mineralization which has been identified and estimated through exploration and sampling and within which mineral reserves may be defined by the consideration and application of Modifying Factors.

[8] The term "reasonable prospects for eventual economic extraction" implies a judgement (albeit preliminary) by the contractor with respect to the technical and economic factors likely to influence the prospect of economic extraction, including the approximate mining parameters. In other words, a mineral resource is not an inventory of all mineralization drilled or sampled, regardless of cut-off parameters, likely mining dimensions, location or continuity. It is a realistic inventory of mineralization which, under assumed and justifiable technical and economic conditions, might, in whole or in part, become economically extractable. Any material assumptions made in determining the reasonable prospects for eventual economic extraction should be clearly stated in the report. Any adjustment made to the data for the purpose of making the mineral resource estimate, for example by cut-off or factoring grades, or the factoring of seabed nodule abundance measurements, should be clearly stated and described in the report.

23. An inferred mineral resource is that part of a mineral resource for which quantity and grade or quality are estimated on the basis of limited geological evidence and sampling. Geological evidence is sufficient to imply, but not verify, geological and grade or quality continuity.

24. An inferred mineral resource has a lower level of confidence than that applying to an indicated mineral resource and must not be converted into a mineral reserve. It is reasonably expected that, with continued exploration, the majority of inferred mineral resources could be upgraded to indicated mineral resources.[9]

25. The inferred category is intended to cover cases in which a mineral concentration or occurrence has been identified and limited measurements and sampling have been completed, but in which data are insufficient to allow the geological or grade continuity to be confidently interpreted. Commonly, it would be reasonable to expect that the majority of inferred mineral resources could be upgraded to indicated mineral resources with continued exploration. However, owing to the uncertainty of inferred mineral resources, it should not be assumed that such upgrading will always occur.

26. An indicated mineral resource is that part of a mineral resource for which quantity, grade or quality, densities, shape and physical characteristics are estimated at a level of confidence high enough to allow for the application of modifying factors in sufficient detail to support mine planning and the evaluation of the economic viability of the deposit.

27. Geological evidence is derived from adequately detailed and reliable exploration, sampling and testing and is sufficient to assume geological and grade or quality continuity between points of observation.

28. An indicated mineral resource has a lower level of confidence than that applying to a measured mineral resource and may only be converted into a probable mineral reserve.[10]

29. A measured mineral resource is that part of a mineral resource for which quantity, grade or quality, densities, shape, and physical characteristics are estimated at a level of confidence high enough to allow for the application of modifying factors to support detailed mine planning and a final evaluation of the economic viability of the deposit.

30. Geological evidence is derived from detailed and reliable exploration, sampling and testing and is sufficient to confirm geological and grade or quality continuity between points of observation.

31. A measured mineral resource has a higher level of confidence than that applying to either an indicated mineral resource or an inferred mineral resource. It may be converted into a proved mineral reserve or to a probable mineral reserve.

Guidance

32. *Mineralization may be classified as a measured mineral resource when the nature, quality, amount and distribution of data are such as to leave no reasonable doubt, in the opinion of the contractor determining the mineral resource, that the tonnage and grade of the mineralization can be estimated to within close limits, and that any variation from the estimate would be unlikely to affect significantly potential economic viability.*

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[9] Confidence in the estimate is usually not sufficient to allow for the results of the application of technical and economic parameters to be used for detailed planning. For this reason, there is no direct link from an inferred resource to any category of mineral reserves (see the figure in para. 7). Caution should be exercised if that category is considered in technical and economic studies.

[10] Mineralization may be classified as an indicated mineral resource when the nature, quality, amount and distribution of data are sufficient to allow for a confident interpretation of the geological framework and to assume continuity of mineralization. Confidence in the estimate is sufficient to allow for the application of technical and economic parameters and to enable an evaluation of economic viability.

33. *This category requires a high level of confidence in, and understanding of, the geology and the controls of the mineral deposit.*

34. *Confidence in the estimate is sufficient to allow for the application of technical and economic parameters and to enable an evaluation of economic viability with a high level of confidence.*

35. The choice of the appropriate category of mineral resource depends upon the quantity, distribution and quality of data available and the level of confidence attached to those data.

Guidance

36. *Mineral resource classification is a matter for skilled judgement and the contractor should take into account those items in enclosure 1 that relate to confidence in mineral resource estimations.*

37. *In deciding between indicated mineral resources and measured mineral resources, it may be useful to consider, in addition to the explanations relating to geological and grade continuity in paragraphs 26 and 29, the language in the guideline attached to the definition of measured mineral resources, namely that "any variation from the estimate would be unlikely to affect significantly potential economic viability".*

38. *In deciding between inferred mineral resources and indicated mineral resources, it may be useful to consider, in addition to the explanations in paragraphs 23 and 26 relating to geological and grade continuity, the guideline attached to the definition of indicated mineral resources, namely that "confidence in the estimate is sufficient to allow for the application of technical and economic parameters and to enable an evaluation of economic viability", which contrasts with the guideline relating to the definition of inferred mineral resources, namely that "confidence in the estimate of inferred mineral resources is usually not sufficient to allow for the results of the application of technical and economic parameters to be used for detailed planning" and that "caution should be exercised if that category is considered in technical and economic studies".*

39. *The contractor should take into consideration the style of mineralization, scale and cut-off parameters when assessing geological and grade continuity.*

40. Mineral resource estimates are not precise calculations, being dependent on the interpretation of limited information on the location, shape and continuity of the occurrence and on the available sampling results. The reporting of tonnage and grade figures should reflect the relative uncertainty of the estimate by rounding off to significant figures and, in the case of inferred mineral resources, by using terms such as "approximately".[11]

Guidance

41. *The contractor is encouraged, where appropriate, to discuss the relative accuracy or confidence level of the mineral resource estimates. The statement should specify whether it relates to estimates that are global (whole resource) or local (a subset of the resource for which the accuracy /or confidence level might differ from that of the whole resource), and, if local, state the relevant tonnage or volume. Where a statement of the relative accuracy or confidence level is not possible, a qualitative discussion of the uncertainties should be provided (see enclosure 1).*

42. Reports of mineral resources must specify one or more of the "inferred", "indicated" and "measured" categories. Categories must not be reported in a combined form unless details of the individual categories are also provided. Mineral resources must not be reported in terms of contained

[11] In most cases, rounding off to the second significant figure should be sufficient. For example, 10,863,000 tons at 8.23 per cent should be stated as 11 million tons at 8.2 per cent. There will be occasions, however, where rounding off to the first significant figure may be necessary in order to convey properly the uncertainties in estimation. This would usually be the case with inferred mineral resources. To emphasize the imprecise nature of a mineral resource estimate, the final result should always be referred to as an estimate and not a calculation.

metal or mineral content unless corresponding tonnages and grades are also presented. Mineral resources must not be aggregated with mineral reserves.[12]

43. Enclosure 1 provides, in a summary form, a list of the main criteria that should be considered when preparing reports on mineral exploration results assessments, mineral resources and mineral reserves. These criteria need not be discussed in a report unless they materially affect the estimation or the classification of the mineral resources.[13]

44. The words "ore" and "reserves" must not be used in providing mineral resource estimates, as those terms imply technical feasibility and economic viability and are only appropriate when all relevant modifying factors have been considered. Reports and statements should continue to refer to the appropriate category or categories of mineral resources until technical feasibility and economic viability have been established. If a re-evaluation indicates that any part of the mineral reserves is no longer viable, such mineral reserves must be reclassified as mineral resources or removed from the mineral resource and mineral reserve statements.[14]

VII. Reporting of mineral reserves

45. A mineral reserve is the economically mineable part of a measured or indicated mineral resource.

46. It includes diluting materials and allowances for losses, which may occur when the material is mined or extracted, and is defined by studies at pre-feasibility or feasibility level, as appropriate, that include the application of modifying factors. Such studies demonstrate that, at the time of reporting, extraction could reasonably be justified.

47. The reference point at which reserves are defined, usually the point where the ore is delivered to the processing plant, must be stated. It is important that, wherever the reference point is different, a clarifying statement be included to ensure that the reader is fully informed of what is being reported.

Guidance

48. *Mineral reserves are those portions of mineral resources that, after the application of all mining factors, result in an estimated tonnage and grade which, in the opinion of the contractor making the estimates, can be the basis of a viable project, after taking account of all relevant modifying factors.*

49. *When reporting mineral reserves, information on estimated mineral processing recovery factors is very important, and should always be included in reports.*

50. *The term "economically mineable" implies that the extraction of the mineral reserve has been demonstrated to be viable under reasonable financial assumptions. What may be "realistically assumed" will vary with the type of deposit, the level of study that has been carried out and the financial criteria of the individual contractor. For this reason, there can be no fixed definition for the*

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[12] Reporting tonnage and grade outside the categories covered by the reporting standard is not permitted.

[13] It is not necessary, when reporting, to comment on each item in enclosure 1, but it is essential to discuss any matters that might materially affect the reader's understanding or interpretation of the results assessments or estimates reported on. This is particularly important where inadequate or uncertain data affect the reliability of, or confidence in, a statement of exploration results assessments or an estimate of mineral resources or mineral reserves, for example, poor sample recovery, reliance on video or acoustic seabed reconnaissance results, etc. If there is doubt as to what should be reported, it is better to provide too much information rather than too little. Uncertainties in any of the criteria listed in enclosure 1 that could lead to under- or over-statement of resources should be disclosed.

[14] It is not intended that the reclassification from mineral reserves to mineral resources, or vice versa, should be applied as a result of changes expected to be of a short-term or temporary nature, or where a contractor's management has made a deliberate decision to operate on a non-economic basis. Examples of such cases include commodity price fluctuations expected to be of short duration, mine emergency of a non-permanent nature and transport strike.

term "economically mineable". However, it is expected that companies will attempt to achieve an acceptable return on the capital invested, and that returns to investors in the project will be competitive with alternative investments of comparable risk.

51. *In order to achieve the required level of confidence in the mineral resources and all the modifying factors, studies of pre-feasibility or feasibility, as appropriate, will have been carried out before determining the mineral reserves. The study will need to determine a mine plan that is technically achievable and economically viable and from which the mineral reserves can be derived.*

52. *The term "mineral reserves" need not necessarily signify that extraction facilities are in place or operative, or that all necessary approvals or sales contracts have been received. It signifies that there are reasonable expectations of such approvals or contracts. The contractor should consider the materiality of any unresolved matter that is dependent on a third party on which extraction is contingent.*

53. *Any adjustment made to the data for the purpose of making the mineral reserve estimate, for example by cut-off or factoring grades, or the factoring of seabed nodule abundance measurements, should be clearly stated and described in the report.*

54. *It should be noted that the reporting standard does not imply that an economic operation should have proved mineral reserves. Cases may arise where probable mineral reserves alone may be sufficient to justify extraction. This is a matter of judgement by the contractor.*

55. A probable mineral reserve is the economically mineable part of an indicated and, in some circumstances, measured mineral resource. The level of confidence in the modifying factors applying to a probable mineral reserve is lower than that applying to a proved mineral reserve.

56. A probable mineral reserve has a lower level of confidence than a proved mineral reserve but is sufficiently reliable to serve as the basis for a decision on the development of the deposit.

57. A proved mineral reserve is the economically mineable part of a measured mineral resource and implies a high degree of confidence in the modifying factors.

58. A proved mineral reserve represents the highest level of confidence for reserve estimates.[15]

59. The choice of the appropriate category of the mineral reserve is determined primarily by the relevant level of confidence in the mineral resource and after considering any uncertainties in the modifying factors. The allocation of the appropriate category must be made by the contractor.

60. The reporting standard provides for a direct relationship between indicated mineral resources and probable mineral reserves, and between measured mineral resources and proved mineral reserves. In other words, the level of geological confidence for probable mineral reserves is similar to that required for the determination of indicated mineral resources. The level of geological confidence for proved mineral reserves is similar to that required for the determination of measured mineral resources. Inferred mineral resources are always in addition to mineral reserves.

Guidance

61. *The reporting standard also provides for a two-way relationship between measured mineral resources and probable mineral reserves. This provision is to cover cases in which uncertainties associated with any of the modifying factors considered when converting mineral resources into mineral reserves may result in there being a lower degree of confidence in the mineral reserves than in the corresponding mineral resources. Such a conversion would not imply a reduction in the level of geological knowledge or confidence.*

[15] The style of mineralization or other factors could mean that the status of proved mineral reserves is not achievable in some deposits. The contractor should be aware of the consequences of declaring material of the highest confidence category before satisfying themselves that all of the relevant resource parameters and modifying factors have been established at a similarly high level of confidence.

62. *A probable mineral reserve derived from a measured mineral resource may be converted into a proved mineral reserve if the uncertainties in the modifying factors are removed. No amount of confidence in the modifying factors for the conversion of a mineral resource into a mineral reserve can override the upper level of confidence that exists in the mineral resource. Under no circumstances can an indicated mineral resource be converted directly into a proved mineral reserve (see the figure in para. 7).*

63. *The application of the category of proved mineral reserves implies the highest degree of confidence in the estimate, with consequent expectations in the minds of the readers of the report. Such expectations should be borne in mind when categorizing a mineral resource as measured.*[16]

64. Mineral reserve estimates are not precise calculations. The reporting of tonnage and grade figures should reflect the relative uncertainty of the estimate by rounding off to significant figures (see also para. 40).[17]

Guidance

65. *The contractors are encouraged, where appropriate, to discuss the relative accuracy or confidence level of the mineral reserve estimates. The statement should specify whether it relates to estimates that are global (whole reserve) or local (a subset of the reserve for which the accuracy or confidence level might differ from that of the whole reserve), and, if local, state the relevant tonnage or volume. Where a statement of the relative accuracy or confidence level is not possible, a qualitative discussion of the uncertainties should be provided (see enclosure 1 and the guidelines in para. 40).*

66. Reports of mineral reserves must specify one or both of the categories of "proved" and "probable". Categories must not be reported in a combined proved and probable mineral reserve unless the relevant figures are provided for each category. Reports must not present metal or mineral content figures unless corresponding tonnage and grade figures are also given. Mineral reserves must not be aggregated with mineral resources.[13]

Guidance

67. *Mineral reserves may incorporate material (dilution) that is not part of the original mineral resource. It is essential that this fundamental difference between mineral resources and mineral reserves be borne in mind and caution exercised if attempting to draw conclusions from a comparison of the two.*

68. *When revised mineral reserve and mineral resource statements are reported, they should be accompanied by a reconciliation with previous statements. A detailed account of differences between figures is not essential, but sufficient comments should be provided to enable significant changes to be understood by the reader.*

69. When figures for both the mineral resources and the mineral reserves are reported, a statement must be included in the report that clearly indicates whether the mineral resources include the mineral reserves or are reported in addition to them.

70. Mineral reserve estimates must not be included in mineral resource estimates under a single combined figure.[18]

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[16] See also the guidelines in paras. 32-34 regarding the classification of mineral resources.

[17] To emphasize the imprecise nature of a mineral reserve, the final result should always be referred to as an estimate and not a calculation.

[18] In some cases, there are reasons for reporting mineral resources inclusive of mineral reserves and, in other cases, for reporting mineral resources in addition to mineral reserves. It must be made clear which form of reporting has been adopted. Appropriate forms of clarifying statements may be reported.

Guidance

71. *The measured and indicated mineral resources are additional to the mineral reserves. In the former case, if any measured and indicated mineral resources have not been modified to produce mineral reserves for economic or other reasons, the relevant details of these unmodified mineral resources should be included in the report. This is to assist the reader of the report in making a judgement on the likelihood of the unmodified measured and indicated mineral resources eventually of being converted into mineral reserves.*

72. *Inferred mineral resources are by definition always in addition to mineral reserves. For reasons stated in paragraph 24 and in the present paragraph, the reported mineral reserve figures must not be included in the reported mineral resource figures. The resulting total is misleading and may be misunderstood or misused to give a false impression of a contractor's prospects.*

VIII. Technical studies

73. A scoping study is an economic study of the potential viability of mineral resources that includes appropriate assessments of realistically assumed modifying factors, together with any other relevant operational factors that are necessary to demonstrate at the time of reporting that progress to a pre-feasibility study can be reasonably justified.

74. A pre-feasibility study is a comprehensive study of a range of options for the technical and economic viability of a mineral project that has advanced to a stage where a preferred mining method is established and an effective method of mineral processing is determined. It includes a financial analysis based on reasonable assumptions with regard to the modifying factors and the evaluation of any other relevant factors that are sufficient for an contractor, acting reasonably, to determine whether all or part of the mineral resource may be converted into a mineral reserve at the time of reporting. A pre-feasibility study is at a lower confidence level than a feasibility study.

75. A feasibility study is a comprehensive technical and economic study of the selected development option for a mineral project that includes appropriately detailed assessments of applicable modifying factors, together with any other relevant operational factors and detailed financial analysis that are necessary to demonstrate at the time of reporting that extraction is reasonably justified (economically mineable). The results of the study may reasonably serve as the basis for a final decision by a proponent or financial institution to proceed with, or finance, the development of the project. The confidence level of the study will be higher than that of a pre-feasibility study.

Guidance

76. *Enclosure 1 provides, in a summary form, a list of the criteria that should be considered when preparing reports on mineral exploration results assessments, mineral resources and mineral reserves. Those criteria need not be discussed in a report unless they materially affect the estimation or the classification of the mineral reserves. Changes in economic or political factors alone may be the basis for significant changes in mineral reserves and should be reported accordingly.*

Enclosure 1

Checklist of assessment and reporting criteria

1. The present table is a checklist that those preparing reports on mineral exploration results assessments, mineral resources and mineral reserves should use as a reference. The checklist is not prescriptive and, as always, relevance and materiality are overriding principles that determine what information should be reported. It is, however, important to report any matters that might materially affect a reader's understanding or interpretation of the results assessments or estimates that are reported. This is particularly important where inadequate or uncertain data affect the reliability of, or confidence in, a statement of mineral exploration results assessments or an estimate of mineral resources or mineral reserves.

2. The order and grouping of the criteria in the table reflect the normal systematic approach to exploration and evaluation. Criteria in the first group (sampling techniques and data) apply to all succeeding groups. In the remainder of the checklist, criteria listed in one group would often apply to succeeding groups and should be considered when estimating and reporting.

Criteria	*Explanation*
	Sampling techniques and data (criteria in this group apply to all succeeding groups)
Sampling techniques	Nature and quality of the sampling (e.g. free-fall grab samplers, box corers, box grab samplers, etc.) and measures taken to ensure sample representativity.
Sample recovery	▪ Indication of whether the recovery of samples has been properly recorded and the results assessed ▪ Measures taken to maximize sample recovery and ensure the representative nature of the samples ▪ Indication of whether a relationship exists between sample recovery and grade and whether sample bias may have occurred owing to the preferential loss or gain of fine and coarse material
Logging and sample description	▪ Indication of whether the samples have been logged or described to a level of detail sufficient to support appropriate mineral resource estimations, mining studies and metallurgical studies ▪ Indication of whether logging is qualitative or quantitative in nature and provision of sample photographs
Subsampling techniques and sample preparation	▪ Nature, quality and appropriateness of the sample preparation technique ▪ Quality control procedures adopted for all subsampling stages to maximize the representativity of samples ▪ Measures taken to ensure that the sampling is representative of the material collected in situ ▪ Indication of whether sample sizes are appropriate for the grain size of the material being sampled ▪ Statement as to the security measures taken to ensure sample integrity is recommended

Criteria	*Explanation*
Quality of assay data and laboratory tests	▪ Nature, quality and appropriateness of the assaying and laboratory procedures used and whether the technique is considered partial or total
	▪ Nature of the quality control procedures adopted (e.g. standards, blanks, duplicates or external laboratory checks) and whether acceptable levels of accuracy (i.e. lack of bias) and precision have been established
Location of data points	▪ Accuracy and quality of surveys used to locate other sample sites used in the mineral resource estimation
	▪ Quality and adequacy of the topographic control (providing locality plans)
Data spacing and distribution	▪ Data spacing for reporting mineral exploration results assessments
	▪ Indication of whether the data spacing and distribution are sufficient to establish the degree of geological and grade continuity appropriate for the mineral resource and mineral reserve estimation procedures and the classifications applied
	▪ Indication of whether sample compositing has been applied
Reporting archives	Documentation of primary data, data entry procedures, data verification, data storage (physical and electronic) for preparing the report
Audits or reviews	Results of any audits or reviews of the sampling techniques and data
	Reporting of mineral exploration results assessments (criteria listed in the preceding group also apply to this group)
Mineral rights and land ownership	▪ Type, reference name or number, location and ownership, including agreements or material issues with third parties, such as joint ventures, partnerships, overriding royalties, environmental setting, etc.
	▪ Security of the tenure held at the time of reporting, along with any known impediments to obtaining a contract to operate in the area
	▪ Location plans of the mineral rights and titles. It is not expected that the description of a mineral title in a technical report should represent a legal opinion but it should be a brief and clear description of such title as understood by the author
Exploration done by other parties	Acknowledgment and appraisal of exploration by other parties
Geology	▪ Type of deposit, geological setting and style of mineralization
	▪ Reliable geological maps should exist to support interpretations
Data reporting methods	▪ When reporting mineral exploration results assessments, maximum and minimum grade truncations (e.g. the cut-off of high grades) and cut-off grades are usually material and should be stated
	▪ The assumptions used for any reporting of metal equivalent values should be clearly stated
Diagrams	Where possible, maps and scaled tabulations of sample results should be included for any material discovery being reported, if such diagrams significantly clarify the report

Criteria	*Explanation*
Balanced reporting	Where the comprehensive reporting of all mineral exploration results assessments is not practicable, the representative reporting of both low and high grades and widths should be applied to avoid the misleading reporting of such assessments
Other substantive exploration data	Other exploration data, if meaningful and material, should be reported, including (but not limited to): geological observations; geophysical survey results; geochemical survey results; seabed photography or sonar results; bulk samples and the size and method of treatment; metallurgical test results; bulk density and the geotechnical and rock characteristics; potential deleterious or contaminating substances
Further work	Nature and scale of planned further work (e.g. tests for lateral extensions)
	Estimation and reporting of mineral resources (criteria listed in the first group and, where relevant, in the second group, also apply to this group)
Database integrity	▪ Measures taken to ensure that the data have not been corrupted by, for example, transcription or keying errors, between its initial collection and its use for mineral resource estimation purposes ▪ Data verification or validation procedures used
Geological interpretation	▪ Confidence in (or, conversely, the uncertainty of) the geological interpretation of the mineral deposit ▪ Nature of the data used and of any assumptions made ▪ Effect, if any, of alternative interpretations on the mineral resource estimation ▪ Use of geology in guiding and controlling the mineral resource estimation ▪ Factors affecting the continuity of both grade and geology
Dimensions	▪ Extent and variability of the mineral resource expressed as length (along strike or otherwise) and width
Estimation and modelling techniques	▪ Nature and appropriateness of the estimation techniques applied and key assumptions, including the treatment of extreme grade values, domaining, interpolation parameters and the maximum distance of extrapolation from data points ▪ Availability of check estimates, previous estimates and mine production records, and indication of whether the mineral resource estimate takes appropriate account of such data ▪ Assumptions made regarding the recovery of by-products ▪ Estimation of deleterious elements or other non-grade variables of economic significance ▪ In the case of a block model interpolation, block size in relation to the average sample spacing and the search employed ▪ Any assumptions behind modelling of selective mining units (e.g. non-linear kriging) ▪ Indicate any assumptions about correlation among variables ▪ Process of validation, checking process used, comparison of model data to sampling data and use of reconciliation data, if available

Criteria	*Explanation*
	▪ Detailed description of the method used and the assumptions made to estimate the tonnage (or abundance) and grades (section, polygon, inverse distance, geostatistical or other method)
	▪ Description of how the geological interpretation was used to control the resource estimates
	▪ Discussion of the basis for using or not using grade cutting or capping. If a computer method was chosen, description of the programmes and parameters used
	▪ Geostatistical methods are extremely varied and should be described in detail. The method chosen should be justified. The geostatistical parameters, including the variogram, and their compatibility with the geological interpretation should be discussed
	▪ Experience gained in applying geo-statistics to similar deposits should be taken into account
Moisture	Indication of whether the tonnage or abundance is estimated on a dry basis or with natural moisture, and the method of determination of the moisture content
Cut-off parameter	Basis of the adopted cut-off grade or grades, or quality or quantity parameters applied, including the basis, if appropriate, of equivalent metal formulae
Mining factors or assumptions	▪ Assumptions made regarding possible mining methods, minimum mining dimensions and internal (or, if applicable, external) mining dilution. It may not always be possible to make assumptions regarding mining methods and parameters when estimating mineral resources. Where no assumptions have been made, this should be reported
	▪ In order to demonstrate realistic prospects for eventual economic extraction, basic assumptions are necessary. Examples include geotechnical parameters, seabed topography, size of seabed mining area, infrastructure requirements and estimated mining costs. All assumptions should be clearly stated
Metallurgical factors or assumptions	▪ Metallurgical process proposed and appropriateness of that process to the type of mineralization. It may not always be possible to make assumptions regarding metallurgical treatment processes and parameters when reporting mineral resources. Where no assumptions have been made, this should be reported
	▪ In order to demonstrate realistic prospects for eventual economic extraction, basic assumptions are necessary. Examples include the extent of metallurgical test work, recovery factors, allowances for by-product credits or deleterious elements, infrastructure requirements and estimated processing costs. All assumptions should be clearly stated
Bulk density	▪ Indication of whether the bulk density is assumed or determined. If assumed, basis for the assumptions. If determined, method used, whether wet or dry, frequency of the measurements and nature, size and representativeness of the samples
Classification	▪ Basis for the classification of the mineral resources into varying confidence categories
	▪ Indication of whether appropriate account has been taken of all relevant factors (i.e. the relative confidence in tonnage or grade computations, the confidence in the continuity of geology and metal values, quality, quantity and the distribution of the data)
	▪ Indication of whether the result appropriately reflects the view that the contractor has of the deposit
Audits or reviews	Results of any audits or reviews of the mineral resource estimates

Criteria	*Explanation*
Discussion of relative accuracy and confidence	▪ Where appropriate, statement of the relative accuracy or confidence level of the mineral resource estimate using an approach or procedure deemed appropriate by the contractor. For example, application of statistical or geostatistical procedures to quantify the relative accuracy of the resource within stated confidence limits or, if such an approach is not deemed appropriate, qualitative discussion of the factors that could affect the relative accuracy and confidence level of the estimate
	▪ The statement should specify whether it relates to global or local estimates, and, if local, state the relevant tonnage or abundance, which should be relevant to the technical and economic evaluation
	▪ The documentation should include the assumptions made and the procedures used
	▪ The statements of relative accuracy and confidence level of the estimate should be compared with production data, where available
	Estimation and reporting of mineral reserves (criteria listed in the first group and, where relevant, in other preceding groups, also apply to this group)
Mineral resource estimate for conversion into mineral reserves	▪ Description of the mineral resource estimate used as a basis for the conversion into a mineral reserve
	▪ Clear statement as to whether the mineral resources are reported in addition to the mineral reserves or include them
Study status	▪ Type and level of the study undertaken to enable the conversion of the mineral resources into mineral reserves
	▪ The reporting standard does not require for a final feasibility study to have been undertaken to convert mineral resources into mineral reserves; however, it requires that studies to at least pre-feasibility level have determined a mine plan that is technically achievable and economically viable, and that all modifying factors have been considered
Cut-off parameter	▪ Basis of the cut-off grade or grades or quality parameters applied, including the basis, if appropriate, of equivalent metal formulae. The cut-off parameter may be an economic value per block rather than a grade
Mining factors or assumptions	▪ Method and assumptions used to convert the mineral resource into a mineral reserve (i.e. either by the application of appropriate factors by optimization or by a preliminary or detailed design)
	▪ Choice, nature and appropriateness of the selected mining method or methods, size of the selected mining unit and other mining parameters, including associated design issues
	▪ Assumptions made regarding geotechnical parameters (e.g. the seabed floor slope and the topographic conditions)
	▪ Mining dilution factors, mining recovery factors and minimum mining widths used
	▪ Infrastructure requirements of the selected mining methods and, where available, historical reliability of the performance parameters
Metallurgical factors or assumptions	▪ Metallurgical process proposed and appropriateness of that process to the style of mineralization

Criteria	*Explanation*
	▪ Indication of whether the metallurgical process is a well-tested technology or novel in nature
	▪ Nature, amount and representativeness of the metallurgical test work undertaken and the metallurgical recovery factors applied
	▪ Any assumptions or allowances made for deleterious elements
	▪ Existence of any bulk sample or pilot-scale test work and degree to which such samples are representative of the orebody as a whole
	▪ The tonnage and grades reported for mineral reserves should state clearly whether they are in respect of material sent to the plant or after recovery
	▪ Comment on the existing plant and equipment, including an indication of their replacement and salvage value
Cost and revenue factors	▪ Derivation of, or assumptions made, regarding the projected capital and the operating costs
	▪ Assumptions made regarding revenue, including head grade, metal or commodity prices, exchange rates, transportation and treatment charges, penalties, etc.
	▪ Allowances made for royalties payable, international benefit sharing, etc.
	▪ Basic cash flow inputs for a stated period
Market assessment	▪ Demand, supply and stock situation for the particular commodity, as well as consumption trends and factors likely to affect supply and demand in future
	▪ Customer and competitor analysis, along with the identification of likely market windows for the product
	▪ Price and volume forecasts and the basis for such forecasts
Other	▪ Effect, if any, of natural risk, infrastructure, environmental, legal, marketing, social or governmental factors on the likely viability of a project and on the estimation and the classification of the mineral reserves
	▪ Status of titles and approvals critical to the viability of the project, such as mining leases, discharge permits and governmental and statutory approvals
	▪ Environmental descriptions of anticipated liabilities
	▪ Location plans of mineral rights and titles
Classification	▪ Basis for the classification of the mineral reserves into varying confidence categories
	▪ Indication of whether the result appropriately reflects the view that the contractor has of the deposit
	▪ Proportion of probable mineral reserves that have been derived from measured mineral resources, if any
Audits or reviews	Results of any audits or reviews of the mineral reserve estimates

Criteria	*Explanation*
Discussion of relative accuracy and confidence	▪ Where appropriate, statement of the relative accuracy or confidence level of the mineral reserve estimate using an approach or procedure deemed appropriate by the contractor. For example, application of statistical or geostatistical procedures to quantify the relative accuracy of the reserve within stated confidence limits or, if such an approach is not deemed appropriate, qualitative discussion of the factors that could affect the relative accuracy and confidence level of the estimate ▪ The statement should specify whether it relates to global or local estimates and, if local, state the relevant tonnage or abundance, which should be relevant to the technical and economic evaluation. The documentation should include the assumptions made and the procedures used ▪ Statements of the relative accuracy or confidence level of the estimate should be compared with production data, where available

Enclosure 2

Generic terms and equivalents, and definitions

The reporting standard of the International Seabed Authority uses in a generic sense certain words that might have a more specific meaning attached to them by particular groups in the industry. In order to avoid duplication or ambiguity, those terms are defined below, together with other terms that may be regarded as synonymous for the purposes of the present guidance.

Generic term	*Synonym or similar term*	*Definition*
Cut-off grade	Product specification	The lowest grade, or quality, of mineralized material that qualifies as economically mineable and available in a given deposit. It may be defined on the basis of economic evaluation or on the physical or chemical attributes that define an acceptable product specification
Feasibility study	–	A comprehensive study of a mineral deposit in which all geological, engineering, legal, operating, economic, social, environmental and other relevant factors are considered in such detail that it may reasonably serve as the basis for a final decision by a financial institution to finance the development of the deposit for mineral production
Grade	Quality; assay; analysis; value	Any physical or chemical measurement of the characteristics of the material of interest in samples or product
Metallurgy	Processing; beneficiation; preparation concentration	Physical or chemical separation of constituents of interest from a larger mass of material; methods employed to prepare a final marketable product from material as mined. Examples include screening, flotation, magnetic separation, leaching, washing and roasting
Mineral reserve	Ore reserve	A deposit that has been classified as a reserve. “Mineral” is the preferred term in the reporting standard of the Authority, but “ore” is in common use and generally acceptable. Other terms can be used to clarify the meaning, for instance “seabed reserves”
Mineralization	Type of deposit; style of mineralization	Any single mineral or combination of minerals occurring in a mass, or deposit of economic interest. The term is intended to cover all forms in which mineralization might occur, whether by type of deposit, mode of occurrence, genesis or composition
Mining	Seabed harvesting	All activities related to the extraction of metals and minerals from the earth, whether on the surface, underground or on the seabed

Generic term	*Synonym or similar term*	*Definition*
Pre-feasibility study	Preliminary feasibility study	A comprehensive study of the viability of a mineral project that: (a) has advanced to a stage where the mining method has been established and where an effective method of mineral processing has been determined; and (b) includes a financial analysis based on reasonable assumptions of technical, engineering, legal, operating and economic factors and the evaluation of other relevant factors sufficient for a suitably qualified and experienced qualified person to determine, within reason, whether all or part of the mineral resource may be classified as a mineral reserve
Recovery	Yield	The percentage of material of initial interest that is extracted during mining or processing; a measure of mining or processing efficiency
Tonnage	Quantity; volume; abundance	An expression of the amount of material of interest irrespective of the units of measurement (which should be stated when figures are reported)

ANNEX 2: Background Document: Workshop on Polymetallic Nodule Resource Classification

Introduction:

1. In January 1994, the Preparatory Commission for the ISA and the International Tribunal for the Law of the Sea convened a meeting of its technical experts to review the state of deep seabed mining and make an assessment of the time when commercial production might be expected to commence.[1] In the 20 years since, along with the establishment of the International Seabed Authority, a number of developments of a legal, structural, economic and technical nature have taken place.

2. Following the adoption of the Regulations on Prospecting and Exploration for polymetallic nodules in the Area, by the International Seabed Authority, it entered into exploration contracts, in 2001 with six entities for these resources; the Interoceanmetal joint Organization (IOM), Yuzhmorgeologiya, the government of the Republic of Korea (KORDI), China Ocean Mineral Resources research and Development Association (COMRA), Deep Ocean Mineral Resources Development Co. Ltd (DORD) and Institut Français de recherché pour l'exploitation de la mer (IFREMER). The Government of India signed an exploration contract with the Authority in 2002 and the Institute for Geosciences and Natural resources of Germany signed an exploration contract in 2006 under the same regulations. Nauru Ocean Resources Inc. entered into an exploration contract in 2011, Tonga Offshore Mining Limited (TOML) in 2012, UK Seabed Resources Ltd in 2013 and G-Tec Sea Mineral Resources NV in 2013. Pending the decision on the applications by the Cook Islands, UK Seabed Resources Ltd and Ocean Mineral Singapore Pty Ltd, the Authority has approved 13 exploration contracts for polymetallic nodules exploration.

3. Under the Regulations, an exploration contract is for fifteen years duration, and is to be executed in three phases of five years each.[2] Six contracts will expire in 2016 and another in 2017. These are the contracts entered into by the IOM and Yuzhmorgeologiya on 28th March 2001; the Republic of Korea on 26 April 2001, the People's Republic of China on 21st May 2001, France and Japan on 19th June 2001. India's contract will expire on 24th March 2017.

4. Each contractor is required to submit an annual report to the Secretary-General covering its programme of activities in the exploration area and containing, as applicable, *inter alia*, information in sufficient detail on: the exploration work carried out during the calendar year, including maps, charts and graphs illustrating the work that has been done and the results obtained; the equipment used to carry out the work, including the results of tests conducted.

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[1] Report of the Group of Technical Experts to the General Committee of the Preparatory Commission for the International Seabed Authority and for the International Tribunal for the Law of the Sea LOS/PCN/BUR/R.32 1 February 1994

[2] Regulations on Prospecting and Exploration for polymetallic nodules in the Area ISBA/6/A/18 proposed mining technologies, but not equipment design data, and the results obtained from environmental monitoring programmes, including observations, measurements, evaluations and analyses of environmental parameters.

5. In addition, Annex IV, Section 11 of the regulations requires that:

11.1 The Contractor shall transfer to the Authority all data and information that are both necessary for and relevant to the effective exercise of the powers and functions of the Authority in respect of the exploration area in accordance with the provisions of this section.

11.2 Upon expiration or termination of this contract the Contractor, if it has not already done so, shall submit the following data and information to the Secretary-General:

(a) Copies of the geological, environmental, geochemical and geophysical data acquired by the Contractor in the course of carrying out the programme of activities that are necessary for and relevant to the effective exercise of the powers and functions of the Authority in respect of the exploration area;
(b) The estimation of mineable areas, when such areas have been identified, which shall include details of the grade and quantity of the proven, probable and possible polymetallic nodule reserves and the anticipated mining conditions;[4]
(c) Copies of geological, technical, financial and economic reports made by or for the Contractor that are necessary for and relevant to the effective exercise of the powers and functions of the Authority in respect of the exploration area.
(d) Information in sufficient detail on the equipment used to carry out the exploration work, including the results of tests conducted of proposed mining technologies, but not equipment design data;
(e) A statement of the quantity of polymetallic nodules recovered as samples or for the purpose of testing; and
(f) A statement on how and where samples are archived and their availability to the Authority.

11.3 The data and information referred to in section 11.2 hereof shall also be submitted to the Secretary-General if, prior to the expiration of this contract, the Contractor applies for approval of a plan of work for exploitation or if the Contractor renounces its rights in the exploration area to the extent that such data and information relates to the renounced area.

[3] The terminology in the regulations reflects the categorization of mineral reserves at the time the regulations were developed, but it does not reflect current international accounting and mineral assessment reporting standards that have developed and been widely accepted since that time. Over the two decades since the Authority came into being, the terminology related to "reserves" has evolved and coalesced around industry-standard definitions that have been incorporated into international accounting standards for the extractive industries and in national mineral assessment and reporting standards maintained by professional societies that are being adopted into international accounting standards.

6. Annex IV, Section 9 of the Regulations on "Book Records", states that: "The Contractor shall keep a complete and proper set of books, accounts and financial records, consistent with internationally accepted accounting principles. Such books, accounts and financial records shall include information which will fully disclose the actual and direct expenditures for exploration and such other information as will facilitate an effective audit of such expenditures."

7. Together therefore, sections 9 and 11, mandate the application of internationally accepted standards and practices applicable to the assessment and reporting of mineral resources of the seabed beyond national jurisdiction. No standards or guidelines were provided to contractors to perform resource assessments and to report on the relevant work that were doing in this regard during exploration. No standards or guidelines exist for undertaking such work for deep seabed minerals. The results of the work undertaken so far by contractors reflect this reality. If this situation is not addressed, upon the expiration of exploration contracts for polymetallic nodules, the data and information made available to the Authority with regard to, *inter alia*, mineable areas will not show whether or not they are financial assets. Applicable standards have been developed for land-based mining. Utilizing these standards, company reports of mineral resources and reserves are not simply a repackaging of the findings of a mineral exploration program. They examine the exploration results through lenses of technology selection and design, commodity markets, estimates of construction, infrastructure and operating costs, legal, regulatory, environmental and social factors. The assessment of mineral resources and reserves provides a comprehensive assessment of the economic viability of a mining operation. It also marks the start of the transition of a mining operation from exploration to exploitation. These standards need to be developed for deep seabed polymetallic nodules of the Area so that the transition from exploration to exploitation within the framework of the international minerals industry can occur.

8. This paper reviews the evolution and current status of the standards that have been established for land-based mineral development. It also provides a summary of the work that has been completed and reported to the Authority with regard to resource assessment of the polymetallic nodules in contract areas for exploration. Since the effective dates of exploration contracts varies among contractors, progress in resource assessment show considerable variation. The paper provides a background for the necessary standardization that has to take place for polymetallic nodules to be commercialized, utilizing the considerable work that has been undertaken by professional organizations within the minerals industry.

Standards applicable to land-based mining

9. For land-based mining, the formalization of international standards for mineral assessment and reporting has been driven by investors and stockholders and implemented by national resource management and financial securities agencies, but the details of the standards for determining reserves and resources and the professional standards for assessment and categorizing mineral deposits have been driven by international standards established by professional organizations in the fields of accounting and mineral economics.

International Mineral Assessment Standards Organizations

10. Professional societies have made significant contributions in clarifying reporting standards, identifying and sharing best practices, and recognizing experts competent to oversee exploration and assessment activities. Both the Authority and the seabed mining industry can benefit from applying practices developed for land-based mineral deposits, and they will also benefit from the development of standards and approval of their use by the same organizations that establish standards for land-

based extractive industries.

11. There are four bodies that will be closely involved in establishing international mineral assessment and reporting standards that will apply to activities in the Area:

- International Accounting Standards Board (IASB)
- International Marine Minerals Society (IMMSOC)
- Society of Petroleum Engineers Oil and Gas Resources Committee (SPE OGRC)
- UN ECE Framework Classification

The International Accounting Standards Board

12. The specific reference to “internationally accepted financial principles” in the regulations for exploration and in contracts with the Authority is directly related to the work of the International Accounting Standards Board. In the years following the Authority’s adoption of exploration regulations in 2000, there have been significant advances in the adoption of international financial standards. Significant work has been undertaken on standards for the extractive industries that will be applicable to financial information, including the estimation of mineral resources and reserves in the contract areas.

International Standards for Mineral Assessment and Reporting

13. The IFRS Foundation is an independent non-profit organization whose goals are to develop a single, globally-accepted and enforceable set of standards governing financial reporting standards, promote the use of those standards, give attention to emerging economies and small to medium-sized entities, and promote and facilitate adoption through convergence with national standards. IFRS promotes the development and adoption of financial reporting standards through the work of its International Accounting Standards Board (IASB). The IFRS and the IASB were founded in 2001; a year after the Authority adopted its rules and regulations for prospecting and exploration for polymetallic nodules.

14. Since the establishment of the IFRS Foundation and its International Accounting Standards Board, application of the standards developed by the IASB have either been required or permitted by 124 countries including 103 members of the Authority and 15 of the 20 current and prospective states sponsoring exploration contracts (the five outstanding state sponsors are small island states of which only Cuba has a significant land based minerals industry). As such, the work of the IASB will be the primary source for internationally accepted accounting standards for contractors with the Authority.

15. In August of 2009 the IASB released a working draft of a discussion paper titled "Extractive Industries." In early 2010 the Discussion Paper was published and distributed for public comment. In addressing the accounting issues related to mineral reserves and resources, the Discussion Paper reached beyond IASB's expertise to identify two professional mineral assessment and reporting organizations to establish the basis for definitions of reserves and resources. For international standards applicable for mineral assessment and reporting, the Discussion Paper turned to the "International Reporting Template for the Public Reporting of Exploration Results, Mineral Resources and Mineral Reserves" prepared by the *Committee for Mineral Reserves International Reporting Standards* (CRIRSCO).

16. The discussion paper went beyond the definition of mineral reserves and resources to discuss financial and legal issues in determining the conditions under which a mineralization may be claimed as a financial asset. This includes the existence of legal rights, including exploration and exploitation rights that are necessary to the exploitation of the mineral deposit. Committee for Mineral Reserves International Reporting Standards (CRIRSCO) was established in 1994, the same year in which the Authority was established. The current membership of CRIRSCO comprises seven national professional organizations from North and South America, Europe, Australia, Africa and Asia (see Table 1).

Table 1 - CRIRSCO Membership

Nation/Region Represented	CRIRSCO Member Organization
Australia	Australasian Joint Ore Reserves Committee (JORC)
Canada	Canadian Institute of Mining, Metallurgy and Petroleum
Chile	(CIM) Chilean Institute of Mining Engineers (IMEC)
Europe	Pan-European Reserves & Resources Reporting Committee
Russia	(PERC) National Association for Subsoil Examination (NAEN)
South Africa	South African Mineral Codes (SAMCODES)
United States	Society for Mining, Metallurgy and Exploration Inc (SME)

17. CRIRSCO's mission statement is:

The mining industry is a vital contributor to national and global economies; never more so than at present with soaring demand for the commodities that it produces. It is a truly international business that depends on the trust and confidence of investors and other stakeholders for its financial and operational well-being. Unlike many other industries, it is based on depleting mineral assets, the knowledge of which is imperfect prior to the commencement of extraction. It is therefore essential that the industry communicates the risks associated with investment effectively and transparently in order to earn the level of trust necessary to underpin its activities. The aim of CRIRSCO (Committee for Mineral Reserves International Reporting Standards) is to contribute to earnings and maintaining that trust by promoting high standards of reporting of mineral deposit estimates (Mineral Resources and Mineral Reserves) and of exploration progress (Exploration Results).

18. CRIRSCO works by consensus. Its recommendations are implemented and enforced at the national level by government agencies, particularly by securities agencies and stock market managers that oversee informational materials published by firms seeking funds through sales of stocks.

19. Membership in CRIRSCO is open to National Reporting Organizations (NROs) that meet the following criteria to be accepted for CRIRSCO Membership:

- Produce and be responsible for maintaining a reporting standard that is compatible with the Template and which is recognized as the standard for Public Reporting, or has the wide support of professional bodies, in the country/region;

- Agree to conduct international consultation with NROs represented on CRIRSCO before making amendments to its National or Regional reporting standard;

- Include credible, self-regulating, professional bodies that provide disciplinary systems and codes of ethics that govern the behaviour of Competent Persons or equivalents as defined in the Template; and

- Commit to engaging in CRIRSCO activities.

Society of Petroleum Engineers Oil and Gas Resources Committee (SPE OGRC)

20. Beginning from the same basic roots as the CRIRSCO taxonomy, the Society of Petroleum Engineers "Oil and Gas Resources Committee" (SPE OGRC) developed a contemporary taxonomy that reflects differences between how the hard mineral and energy sectors have historically approached the identification and assessment of resources and reserves as potential financial assets of an exploration or development company. The SPE OGRC taxonomy includes a wider range of sub-economic or speculative resources in the taxonomy so it is related to, but not directly comparable with, the mineral taxonomy developed by CRIRSCO.

21. Consultation continues between CRIRSCO and SPE to improve the correlation between categories in the two taxonomies. Until that time, both systems will inform the application of internationally accepted accounting standards with regard to their target resources.

UN ECE Framework Classification (UNFC)

22. The UN Economic Commission for Europe began work on a comprehensive Framework Classification for mineral and energy resources in the 1990s, preparing its "Framework Classification for Reserves and Resources of Solid Fuels and Mineral Commodities" in 1997. Continuation of this work led in 2009 to the release of "United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009". Consultations between CRIRSCO and the UNECE led to the incorporation of the CRIRSCO definitions of reserves and resources into the UNFC.

23. The UNFC taxonomy is more complex than either the CRIRSCO or SPE-OGRC taxonomies. One source of complexity is the separation of technical feasibility from economic matters, resulting in a three dimensional system that provides resource managers with greater illumination on the potential for development through policy actions affecting economic factors (including legal and regulatory issues) and technology development.

24. The complexity of the UNFC and its lack of wide acceptance in internationally accepted accounting standards let the IASB to recommend the use of the CRIRSCO and SPE-OGRC systems. However, the UNFC may be more suitable than these two systems in broad resource management applications, including tracking and projecting changes in development potential across different minerals, technologies and legal and economic conditions.

Evolution of Reporting Standards for Exploration Results

25. The importance of publicly reported exploration data has grown radically over the past century. The starting point is illustrated by the recommendation of Herbert Hoover, mining engineer and future president of the United States, that ore in place be divided into three classifications: proved, probable and prospective.

26. Hoover's classifications depended on the division of ore deposits into blocks of uniform characteristics. The classification was intended to replace an older evaluation of "ore in sight" that had been subject to abuse in mineral assessment and reporting. In Hoover's three-part classification, assessment of deposits depended on the uniformity of such blocks and the assurance through sampling and testing of the characteristics of each block. This classification of degree of geological assurance of economically mineable ore provided the foundation upon which modern systems of exploration and assessment of ore deposits are based.

27. Hoover's classification, which reflected the consensus of professionals in mining engineering in the early 20th century, responded to the needs of two categories of stakeholders: mine developers and investors in mining developments.[4] Over the next several decades, and particularly after the lessons learned during and after World War II in critical and strategic materials supply, national resource managers and planners became a third stakeholder in the assessment and measurement of mineral deposits. Improvements in geologic understandings, resource modelling and remote measurement led to a broadening of the inputs affecting the evaluation of the economic viability of potential deposits.

Development of the Taxonomy for Exploration Results

28. As mineral development projects grew in size and expense, as new independent companies focused on discovery and exploration of prospective deposits grew in number, and as the cost of development expanded beyond the scope of individual company resources, it became increasingly more important for developers to assess with increasing assurance the real potential of a deposit for commercial development. Similarly, it became more important for the resource owner, either private or public, to understand the potential value of a deposit in order to set rates for its sale or lease.

29. In the 1970's, a new structure for assessing mineral resources was developed. One of the early new taxonomies was prepared by the US Geological Survey.[5] Known as the "McKelvey Box," for the head of the USGS, Dr Vincent McKelvey, the taxonomy arrays mineral deposits in two dimensions based on assurance of the geological nature of a deposit on the horizontal axis and potential for commercial development on the vertical axis (see Figure 1). The "McKelvey Box" served as the starting point for the more detailed taxonomies of today.

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[4] Herbert Hoover, *Principles of Mining*, (New York, NY: McGraw-Hill Book Company, 1909) page 19. Accessed On-line at <http://www.gutenberg.org/files/26697/26697-h/26697-h.htm#page_19> on July 8, 2013.

[5] SGS, "Principles of the mineral resource classification system for the U.S. Geological Survey," *USGS Bulletin 1450-A*, Washington, DC, 1976.

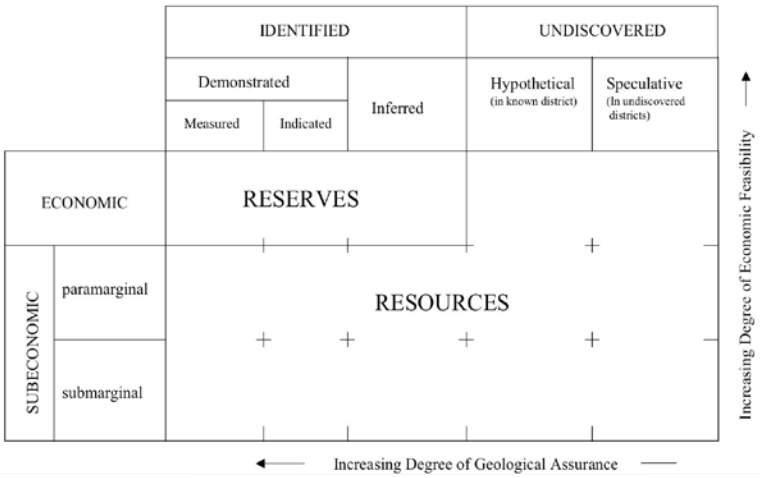

Figure 1 - USGS Taxonomy of Mineral Resources and Reserved: The "McKelvey Box"

In Figure 1: *Reserves* are the part of a mineral resource which could be economically extracted or produced at the time of determination. The term reserves need not signify that extraction facilities are in place and operative. *Demonstrated Reserves* are determined by measurement with "*Measured Reserves*" determined by detailed sampling and "*Indicated Reserves*" computed from more widely spaced sampling. *Inferred Reserves* are estimated based on assumed continuity of more widely spaced samples in which estimates between samples may be based on factors other than direct sampling. "Reserves" in the McKelvey Box corresponds roughly to Hoover's three ore classifications (proven, probable, and possible). What is added are levels of economic viability below current economic conditions and mineral deposits that have yet to be found. Identification of deposits in this broader characterization provides a basis for policy making with regard to future exploration and the development of exploitation technology.

30. The 1990s saw major advances in mineral resource taxonomy and reporting standards. These were prepared to address the needs of three different audiences: the mining industry, the finance and investment sector, and resource owners, managers and planners.

Reporting standards

31. Mineral information and public reports, including measured data, inferred information and theoretical assessments, is of interest to three distinct clients, with each category of clients having its own needs and interests:

- *Developers*, for determining whether and how to develop a site, the development, selection and improvement of technology, and the development of operational plans for exploitation and exploitation operations;
- *Investors, lenders and insurers,* for evaluating the economic prospects for development and for estimating the value of investments and the value of the site as collateral for loans;
- *Owners and managers* of resources who must consider not only issues of development, but the management of the resource to ensure the greatest value to all stakeholders, not just for the value of exploitation, but for protection of other values of the area under consideration, and the maximization of value over time.(category of the International Seabed Authority)

32. While all three sets of stakeholders have interests in the raw data, information and observations of the minerals and the surrounding environment, they have differing needs for level of detail and type of analysis. In many countries, reporting standards for exploration results and mineral resource assessment and reporting are governed by laws under which the dissemination of mineral information to potential investors and to stockholders is regulated. As the mineral industry is international, mineral exploration experts sought to bring order to differing national standards.

33. In order to minimize confusion and incompatibility among national reporting standards regarding mineral resources, professional organizations in key mineral producing nations joined together to help bring national reporting standards into compatibility. Established in 1994 as the "Mineral Definitions Working Group" under the auspices of the Council of Mining and Metallurgical Institutes (CMMI), the body became the Committee for Mineral Reserves International Reporting Standards (CRIRSCO) in 2002.

34. In 2007, CRIRSCO became a task force of the International Council on Mining and Minerals (CIMM) and in 2009 became a "Strategic Partner" of the Council. The Council provides administrative and financial support for CRIRSCO but is not involved in the substantive work of the body.

Professional Societies in Standard Setting for Mineral Assessment and Reporting

35. CRIRSCO's focus is on the public reporting of mineral resource and reserve information. Public reports include:

- Reports prepared for investors or potential investors
- Annual Reports
- Quarterly Reports
- Information Memoranda
- Websites
- Public Presentations
- Stock Exchange Information Systems

36. Information in some or all of these categories of reports may be regulated by national authorities, particularly those that regulate investment markets and stock exchanges. Publication of data in nations with different standards would undermine efforts to make reliable information available to potential investors.

37. CRIRSCO identifies three principles that guide the work of the organization and its members: transparency, materiality, and competence.

- *Transparency* - to inform with a clear and fair description of the mineral assets.
- *Materiality* - to inform with concrete and concise information.
- *Competence* - to inform with knowledge, expertise, and judgment.

38. Underlying these three principles is the essential requirement that the reporting system earns and maintain the public trust.

The CRIRSCO Taxonomy of Mineral Resources and Reserves

39. The CRIRSCO taxonomy of mineral resources (see Figure 2) has its roots in the "McKelvey Box" but it has both a different orientation and increased specificity. In orientation, geological assurance increases toward the lower edge of the diagram and economic prospects increase as one moves toward the right. In specificity, the taxonomy addresses a specified "exploration target" so it excludes hypothetical and speculative resources and minerals from consideration. The taxonomy focuses on known mineral deposits that show serious indication of potential economic value.

40. Progress of mineral classification from Inferred Resources to Proved Reserves is based on exploration of the site, giving increasingly detailed geologic understanding of the site, and research and development to understand and improve the "modifying factors" that affect the economic outlook for commercial development. Modifying factors include mining, processing, metallurgical, economic, marketing, legal, environmental, social, infrastructure and governmental considerations. Details of the resource and reserve categories are provided below in Table 2.

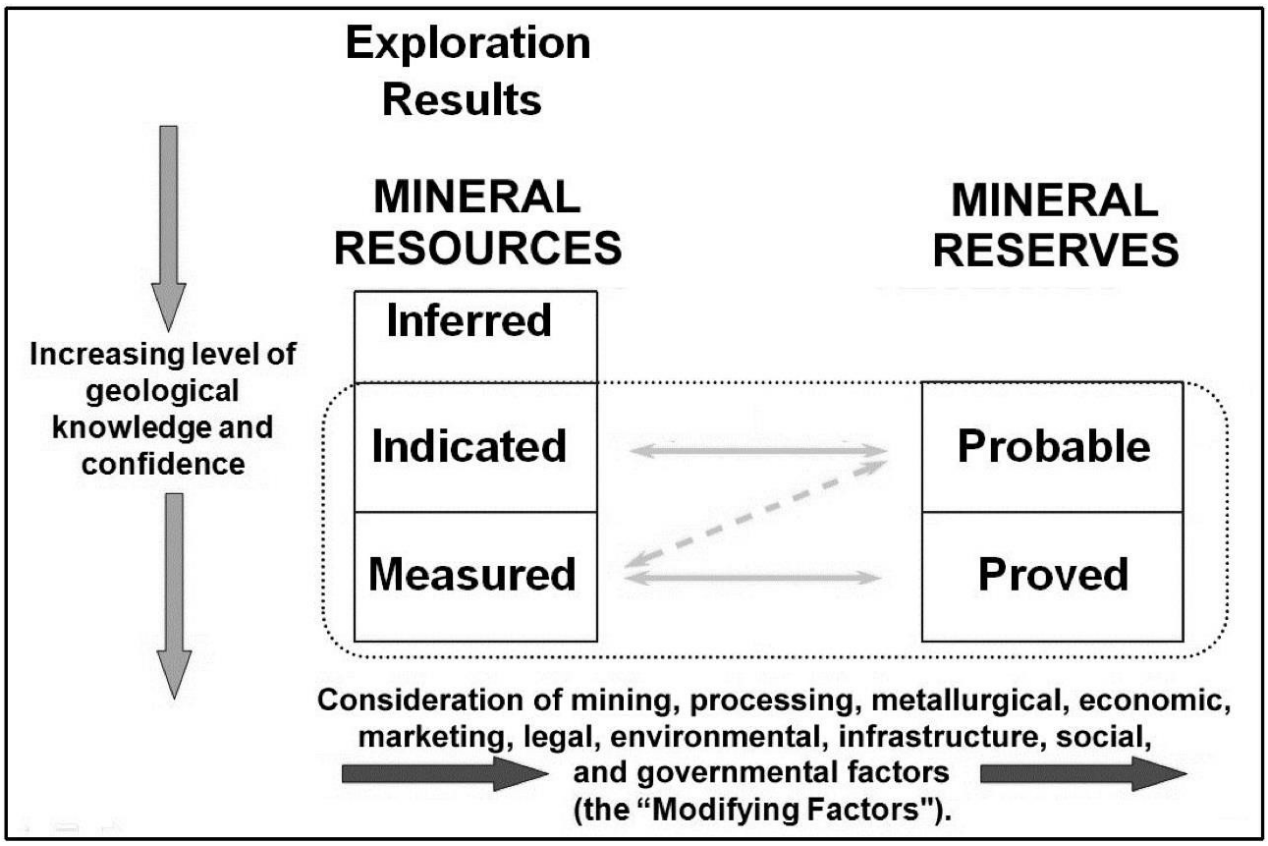

Figure 2 - CRIRSCO Taxonomy for Mineral Reserves and Resources

Table 2: Industry Standard Definitions of Resource and Reserve Categories [6]

Mineral Resource

A Mineral Resource is a concentration or occurrence of solid material of economic interest in or on the Earth's crust in such form, grade or quality and quantity that there are reasonable prospects for eventual economic extraction. The location, quantity, grade or quality, continuity and other geological characteristics of a Mineral Resource are known, estimated or interpreted from specific geological evidence and knowledge, including sampling.

Inferred Mineral Resource

An Inferred Mineral Resource is that part of a Mineral Resource for which quantity and grade or quality are estimated on the basis of limited geological evidence and sampling. Geological evidence is sufficient to imply but not verify geological and grade or quality continuity. An Inferred Resource has a lower level of confidence than that applying to an Indicated Mineral Resource and must not be converted to a Mineral Reserve. It is reasonably expected that the majority of Inferred Mineral Resources could be upgraded to Indicated Mineral Resources with continued exploration.

Indicated Mineral Resource

An Indicated Mineral Resource is that part of a Mineral Resource for which quantity, grade or quality, densities, shape and physical characteristics are estimated with sufficient confidence to allow the application of Modifying Factors in sufficient detail to support mine planning and evaluation of the economic viability of the deposit. Geological evidence is derived from adequately detailed and reliable exploration, sampling and testing and is sufficient to assume geological and grade or quality continuity between points of observation. An Indicated Mineral Resource has a lower level of confidence than that applying to a Measured Mineral Resource and may only be converted to a Probable Mineral Reserve.

Measured Mineral Resource

A Measured Mineral Resource is that part of a Mineral Resource for which quantity, grade or quality, densities, shape, and physical characteristics are estimated with confidence sufficient to allow the application of Modifying Factors to support detailed mine planning and final evaluation of the economic viability of the deposit. Geological evidence is derived from detailed and reliable exploration, sampling and testing and is sufficient to confirm geological and grade or quality continuity between points of observation. A Measured Mineral Resource has a higher level of confidence than that applying to either an Indicated Mineral Resource or an Inferred Mineral Resource. It may be converted to a Proved Mineral Reserve or to a Probable Mineral Reserve.

[6] *Source: CRIRSCO Standard Definitions, October, 2012:* <http://www.crirsco.com/news_items/CRIRSCO_standard_definitions_oct2012.pdf>

41. CRIRSCO has developed and refined a template for the assessment and reporting of mineral deposit information. The template addresses not only the classification of mineral deposits; it establishes a methodology for applying the classifications. The most important elements of the template are the concept of the "Competent Person" and the "Modifying Factors" that are applied to exploration results by the Competent Person(s) to properly categorize the mineralization.

Role of the "Competent Person" in Mineral Classification

42. Classification of minerals into the specified taxonomy is a task that requires trusted professional judgement. This judgement is incorporated in the taxonomy by the specification that public reports be prepared under the direction of a "Competent Person" (equivalent terms in different national systems are "Qualified Person" and "Competent Qualified Person").[7] While it is up to each country to define the qualifications, experience, and responsibilities of this person, CRIRSCO provides a standard definition for this role:

A "Competent Person" is a minerals industry professional who is a member at an appropriate classification of an organization specified by the national authority with enforceable disciplinary processes including the powers to suspend or expel a member.

Such a person must have a minimum of five years relevant experience in the style of mineralisation or type of deposit under consideration and in the activity which that person is undertaking.

43. The "Competent Person" is responsible for directing or overseeing the conduct of exploration and research related to the determination of mineral resources and reserves and may be assisted by other "Competent Persons" in areas that contribute to the assessment. The Competent Person is the critical element of the mineral reporting system. The quality and accuracy of public reports depends upon the work of the Competent Person so CRIRSCO has prepared a Code of Conduct for the Competent Person. The Code is contained in the International Reporting Template. A copy of the Code of Conduct is provided as Appendix 1 of this background paper. Breeches of the code are responded to by the national professional organization of which he or she is a member.

Transforming Geological Information into Mineral Resource and Reserve Assessments

44. Where exploration results address the issue of geological assuredness of mineral endowment, it is the "modifying factors" that determine the economic potential of a specific mineralization.

45. Modifying factors include:

- Commodity Prices
- Mineral Excavation Technology
- Metallurgy of Mineral Recovery
- Transportation

[7] Alternative terms in national regulation include "Qualified person" and "Competent Qualified Person."

- Capital and Operating Expenses of Operation
- Infrastructure
- Fees, Royalties and Taxes
- Assurance of Legal Title and Right to Mine
- Environmental Regulation and Costs of Compliance
- Social Factors
- Training Projects

46. Other than cases of straight-forward expansion of a known exploitation project, the evaluation of modifying factors will draw upon site and industry specific studies and upon the judgement of the "Competent Person." In such cases, the "Competent Person" is required to layout and justify the bases of the assumptions used in his or her evaluation. The overall evaluation and the information and expertise upon which it is based may be presented in a series of increasingly detailed and rigorous assessments that begin with "scoping studies" and extend through "pre- feasibility" and "feasibility studies (see Table 3 for definitions of these studies).

47. The Canadian Institute of Mining, Metallurgy and Petroleum (CIM, a member organization of CRIRSCO) has prepared an extensive set of best practice guidelines for estimation of mineral resources and mineral reserves. The guidelines include 35 pages of generally applicable recommended best practices, and are supplemented by additional commodity specific recommended practices.

Table 3: Categories of Reports Used in Defining "Modifying Factors" and Evaluating Mineral Resources[8]

Scoping Study

A Scoping Study is an order of magnitude technical and economic study of the potential viability of Mineral Resources that includes appropriate assessments of realistically assumed Modifying Factors together with any other relevant operational factors that are necessary to demonstrate at the time of reporting that progress to a Pre-Feasibility Study can be reasonably justified.

Pre-Feasibility Study

A Pre-Feasibility Study is a comprehensive study of a range of options for the technical and economic viability of a mineral project that has advanced to a stage where a preferred mining method, in the case of underground mining, or the pit configuration, in the case of an open pit, is established and an effective method of mineral processing is determined. It includes a financial analysis based on reasonable assumptions on the Modifying Factors and the evaluation of any other relevant factors which are sufficient for a Competent Person, acting reasonably, to determine if all or part of the Mineral Resource may be converted to a Mineral Reserve at the time of reporting. A Pre-Feasibility Study is at a lower confidence level than a Feasibility Study.

Feasibility Study

A Feasibility Study is a comprehensive technical and economic study of the selected development option for a mineral project that includes appropriately detailed assessments of applicable Modifying Factors together with any other relevant operational factors and detailed financial analysis that are necessary to demonstrate at the time of reporting that extraction is reasonably justified (economically mineable). The results of the study may reasonably serve as the basis for a final decision by a proponent or financial institution to proceed with, or finance, the development of the project. The confidence level of the study will be higher than that of a Pre-Feasibility Study.

[8] Source: CRIRSCO, Standard Definitions, October 2012: <http://www.crirsco.com/news_items/CRIRSCO_standard_definitions_oct2012.pdf

Best Practices in Mineral Resource and Reserve Assessment and Reporting

48. The "Competent Person" is also able to draw upon best practices, guidelines and standards established within the profession and within specialized fields related to the "modifying factors." Evaluation of mineral resources may draw upon professional standards and guidelines and upon best practices developed for specific categories of minerals and mineralization.

49. The best practice guidelines laid out by CIM provide guidance in nine categories[9]:

(a) Qualified (Competent) Person

50. A mineral resource/mineral reserve assessment will be directed by a "Qualified/Competent Person," but may require that such person be assisted by individuals qualified/competent in subspecialties of the assessment.

(b) Definitions

51. Strict adherence to the formal definitions of resource and reserve categories and levels of studies ("pre-feasibility, "feasibility") as defined in law and professional best practices must be maintained.

(c) The Resource Database

52. The Resource Database has three components: primary data (observed and measured); interpreted data; and data related to "modifying factors" that include engineering, economic, mining, metallurgical, legal and social data related to the determination of commercial viability.

(d) Geological Interpretation & Modelling

53. Models and interpretations of data must be clearly presented and based on primary data. Models must be selected for their appropriateness to the specific mineralization.

(e) Mineral Resource Estimation

54. Available data must be assessed to determine its adequacy or to identify gaps that must be filled to achieve the appropriate level of confidence. Data must be archived and made available for future reference.

(f) Quantifying Elements to convert a Mineral Resource to a Mineral Reserve

55. Details of references on modifying factors must be met or exceed criteria for preliminary feasibility studies before a mineral resource may be advanced to a mineral reserve.

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[9] CIM Best Practice Guidelines <http://web.cim.org/UserFiles/File/Estimation-Mineral-Resources-Mineral Reserves-11-23-2003.pdf

(g) Mineral Reserve Estimation

56. A Mineral Reserve estimate must be based on a collection of information whose results are based at least on the level of a Preliminary Feasibility Study. The Qualified/Competent Person must understand the significance of each discipline's contribution to the overall reliability of the assessment. Documentation of the evaluation process must be maintained throughout the life of the mine.

(h) Reporting

57. A comprehensive technical report signed by the Qualified/Competent Person(s) should be prepared on completion of a particular phase or stage of work. Public reports of mineral resources and mineral reserves should be based on reports approved by the Competent/Qualified Person(s).

(i) Reconciliation of Mineral Reserves

58. Mineral production during exploitation could be monitored and reconciled with mineral resources and mineral reserve estimates. This provides a cross-check on the estimation process and reconciliation of estimates with actual performance.

International Reporting Template

59. The "International Reporting Template" was developed as a guideline for national implementation of mineral reporting systems. It was initially prepared based on the experiences of experts from Australia, Canada, South Africa, Chile, the UK and Europe and the United States and released in 2005. As a common standard, the International Reporting Template has resulted in revisions of national standards to bring them in compliance with the new international standards.

60. An outline of the contents of the International Reporting Template is provided below. The template includes sections that are specific to five categories of minerals:

(1) mineralized fill, low grade mineralization, stockpiles, dumps and tailings,
(2) Coal,
(3) Diamonds and other gemstones,
(4) Industrial minerals, and
(5) Unconventional energy resources.

61. The International Reporting Template is a check list of assessment and reporting criteria for exploration results, mineral resources and mineral reserves. Having been developed from experience in land-based mineral develop, the template includes some specific examples of techniques for general land based mineral assessment and some techniques specific for one category of minerals (gemstones). It provides general guidance that could be applied to deep seabed minerals, but does not address issues specific to polymetallic nodules.

62. The Template includes in its appendices recommended rules of conduct and guidelines for "Competent Persons" engaged in preparation of reports on exploration results, mineral resources or mineral reserves. A copy of the Code of Conduct is provided as Appendix 2 of this report.

63. CRIRSCO drew upon the national reporting codes to produce a template for developing national codes consistent with the practice of CRIRSCO members. The International Reporting Template (IRT) draws from the codes adopted by the professional organizations representing Australasia, Chile, UK and Western Europe, Canada, South Africa, and the United States. The highly annotated template is intended to serve as a guide that is based on successful national reporting codes and standard that have already been developed and tested. The template includes extensive annotation and guidance. It also includes sections directed at specific categories of mineralization.[10]

64. The main sections of the International Reporting Template are as follows:

- Introduction
- Scope
- Competence and Responsibility
- Reporting Terminology
- Reporting General
- Reporting of Exploration Results
- Reporting of Mineral Resources
- Reporting of Mineral Reserves
- Technical Studies
- Reporting of Mineralized Fill, Pillars, Low Grade Mineralization, Stockpiles, Dumps and Tailings
- Reporting of Coal Exploration Results, Resources and Reserves
- Reporting of Diamond and Other Gemstone Exploration Results, Mineral Resources and Mineral Reserves
- Reporting of Industrial Minerals Exploration Results, Mineral Resources and Mineral Reserves
- Reporting of Unconventional Energy resources

The Template also includes an illustrative checklist of general and mineral-specific practices.

- Sampling Techniques and Data
- Reporting of Exploration Results
- Estimation and Reporting of Mineral Resources
- Estimation and Reporting of Mineral Reserves
- Estimation and Reporting of Diamonds and Other Gemstones

65. While illustrative of the information required to construct /evaluate mineral deposits, the checklist does not address deep seabed minerals. The Template is designed as a starting point for national governments and is open to extension through the specification of mineral and commodity-specific guidelines and best practices.

[10] The November 2013 edition of the International Reporting Template may be downloaded from the CRIRSCO site at <http://www.crirsco.com/templates/crirsco_international_reporting_template_2013.pdf

The Resource Database[11]

66. A Resource Database is established by the collection, verification, recording, storing and processing of the data and forms the foundation necessary for the estimation of mineral resources and mineral reserves. The establishment of a QA/QC program of all data is essential during this process. Components of the Resource Database typically will include geological data (e.g. lithology, mineralization, alteration, and structure), survey data, geophysical data, geochemical data, assay data, rock quality and bulk density information and activity dates.

67. As stated in the CIM Standards and as noted above, a Mineral Resource must have reasonable prospects of economic extraction. Consequently, preliminary data and information concerning a number of factors (e.g. mining, metallurgy, economics and social and environmental sensitivity) will be collected and assessed during the estimation of a Mineral Resource.

General comments (land-based deposits)

- A database consists of two types of data, primary data and interpreted data. Primary data are parameters amenable to direct physical measurement. Examples include assays, survey data, and geological observations. Interpreted data sets are derivations or interpretations of primary information. Examples are geological projections and block models.

- Bulk density is an important parameter that should be measured and recorded at appropriate intervals, and in an appropriate manner, for the deposit. The choice of methods for determining the bulk density of a particular deposit will depend on the physical characteristics of the mineralization and the available sampling medium.

- The QP should be diligent in ensuring that the final database fairly represents the primary information. Data verification is an essential part of finalising the resource database.

- The Resource Database provides a permanent record of all the data collected from the work carried out, the date of the work, observations and comments from the results obtained. It should be readily available for future reference. The database provides all of the information necessary to enable current and future geological interpretations and modelling.

- Although most databases are generally maintained in an electronically-stored digital format, hand-printed tables with well-organized information may also form a database. It is recommended that data be stored digitally, using a documented, standard format and a reliable medium that allows for easy and complete future retrieval of the data.

Primary Data Visualization

- It is essential that the systematic recording of geological observations from mapping and drill hole logging be entered into an organized database.

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[11] May 30, 2003 - Adopted by CIM Council on November 23, 2003

- Data collection and display must foster a good geological understanding of a deposit as a prerequisite for the Mineral Resource estimation process.

- The important primary data must be identified and accurately presented in three dimensions, typically on a set of plans and sections. Examples are lithology, structural measurements, assays, etc.

- Where local mine coordinates are used on geological maps and sections, a mechanism for conversion to universal coordinates must be provided. Maps and sections must include appropriate coordinates, elevation, scale, date, author(s) and appropriate directional information.

- Data positioning information should be relative to a common property co-ordinate system and should include the methodology and accuracy used to obtain that information. Accurate location of data points is essential. If data points are referred to a particular map or grid, those reference data should be included, the map properly identified and the coordinate system clearly stated.

- If primary data have been intentionally omitted from the presentation, they should be identified with an explanatory note for their exclusion.

Interpreted Data Visualization

- The geological interpretation including mineralization and its controls (e.g. structure, alteration, and lithology) is essential for MRMR estimation. The primary data (i.e. from outcrops, trenches and drill holes) should be clearly identifiable and be distinct from the interpreted data so that it may be utilised in subsequent interpretations and Mineral Resource estimates.

- The relevant geophysical/geochemical/topographic data used to support the interpretation of faults or boundaries must be included or referenced appropriately.

- Since the mineralising episode(s) and related features of the geology are critical aspects in the mineral resource/mineral reserve estimations, they must be clearly represented. Examples are controlling features, style(s) and age(s) of mineralization, boundaries of the mineralization, and zonation of the mineralization.

Polymetallic Nodules of the Area

68 Mineable areas are neither defined in the Regulations nor in the Convention. The term is first used in the United States "Deep Seabed Hard Mineral Resources Act" of 1978. In this regard, the Act states that: “The applicant must submit with the application a resource assessment to provide a basis for assessing the area applied for. This assessment must include a discussion of mineable and unmineable areas, taking into account nodule grade, nodule concentration, and other factors such as seafloor topography. These areas may be delineated graphically. The resources in the area must be described in relation to the applicant's production requirements, operating period, and recovery efficiency in order to justify the area applied for”[12]

[12] H.R.2759 (96TH): Deep Seabed Hard Mineral Resources Act (Public law 96-283)

69. Mineable areas comprise three crucial factors; the grade of nodules, the abundance (concentration) of nodules and seafloor characteristics.[13] Thus mineable areas will be defined by each contractor as having a combination of grade and abundance above respective cut-off levels and abundance above respective cut-off levels and acceptable seafloor characteristics (slope, number and size of obstacles and sediment shear strength are the factors upon which the collector system would be designed and its recovery efficiency determined). Mine sites within the exploration area will have to contain a sufficient number of mineable areas capable of supporting an economic mining venture, including its operating period. Grade and abundance are geological factors; seafloor characteristics will determine the design of the collector system and the latter's recovery efficiency.

70. Within two to three years from now, seven Contractors for polymetallic nodules exploration in the Area are coming to the end of their contracts. For this reason, to order to ascertain the work done by the contractors in complying with the Regulations and to provide clarification of the terms contained in paragraph 1(b) of Section 11 (paragraph 2 above), the present workshop for Contractors, mineral classification experts, scientists, engineers and members of the Authority's Legal and Technical Commission has in part been organized.

71. The information and data that have been submitted to the Authority in relation to the process by which mineable areas have been identified by the contractors, including the criteria that have been utilized to identify such areas or the proposed technologies to collect nodules is presented below. Indeed, no information has been provided to the Authority with regard to the size and duration of possible economic mining ventures. This information would indicate the number of mineable areas in a given exploration area that would support the mining venture. Similarly, no information has been provided to the Authority with regard to proposed collectors for mining nodules, the results of tests of these technologies and their recovery efficiencies. In the absence of the requisite resource classification data, the Authority is challenged in its efforts to establish a suitable fiscal regime for polymetallic nodule mining in the Area.

The Resource Assessment work reported by the Contractors to the Authority

INTEROCEANMETAL JOINT ORGANIZATION (IOM)

72. Using the UNFC classification system, IOM has classified the polymetallic nodules deposits in its exploration area as Inferred. Its resource assessment work was accomplished using geo- statistical methods, such as Kriging and the geological blocks methods of interpolation. The contractor had identified 15 ore nodule fields of different sizes with > 10 kg/m^2 wet nodules, for future development. Allocation of ore nodule fields and assessment of resources was carried out on data from 516 sampling stations distributed within an area of 63,075 km^2.

[13] Analysis of exploration and mining technology for manganese nodules (Seabed minerals series; v.2) United Nations. Ocean Economics and Technology Branch, 1984

Part of the criteria used by IOM to identify mineable areas was by excluding areas containing slopes with more than 7° gradient and outcrops with more than 3 meters amplitude. IOM reported that the relative error of nodule resource assessment varied from 13 to 68 per cent [mean 35%] for estimating grid practice at the present stage, whereas the assessment accuracy of average metal was less than 10 per cent.

73. The monetary value of products of mining and processing the commercial ore within the contoured prognostic nodule resources of the IOM exploration area was calculated for different indices of ore-bearing (1.0, 0.7, 0.6, 0.5), dilution (5, 10 and 15%), and losses during mining and transportation (20, 30 and 40%). IOM calculated that the supply of commercial ore for a future mining enterprise processing 3 million tonnes dry nodules per year, as the worst-case scenario of geological and mining conditions should be sufficient to meet required terms of an exploitation license. The Inferred nodule resources estimate that could be economically viable to be mined at the favourable market condition provided a sound basis for future mining activities.

74. IOM continues the selection and delineation of additional ore nodule sites within ore fields and development of more detailed nodule technology, processing technology and environment.

YUZHMORGEOLOGIYA – RUSSIAN FEDERATION

75. Yuzhmorgeologiya, in its 2010 annual report, described a total of 32 ore deposits (industrial ore) with development potential in the Area. In its 2011 report, Yuzhmorgeologiya describes 38 ore deposits being the most prospective, ranging in area from 11 to 310 km^2, length 6-67 km and width 1.0 to 7.5 km. The Contractor has used a sampling grid of 6 to 3km with the distance between stations ranging from 2 to 4 km.

76. Yuzhmorgeologiya plans to continue the demarcation of the deposits and assessment of the resource content (resource computation) of the nodules which could be developed in the future and for identification of sites favourable for development in the area demarcated as containing nodule deposits.

THE GOVERNMENT OF THE REPUBLIC OF KOREA (KORDI)

77. KOREA, in its 2011-15 programmes of activities has indicated that it will outline priority mining areas and carry out a benthic impact experiment in its exploration area in preparation for commercial production. It proposes to use high precision acoustic surveys for assessment of resource potential in the priority mining area; and pre-pilot mining test at 1000 m depth in the East Sea of Korea. However, KORDI provides limited information on its resource assessment and classification work.

CHINA OCEAN MINERAL RESOURCES RESEARCH AND DEVELOPMENT ASSOCIATION (COMRA)

78. COMRA reports that it has set up a data and information management system for mathematical and geological models for evaluating and predicting the mineral resources for economic prospecting. It has used sampling grids of 5.3'x5.3' or 9.8km x 9.8km in selected areas and carried out a resource assessment.

79. The contractor has made an economic analysis of commercial deep sea mining on varieties of production, consumption and market conditions of metals produced from the categories of minerals to be derived from the Area based on the results of general, technical and economic evaluation. It concludes that due to uncertainty of technology, operating costs and environmental protection costs, as well as competition with land based mineral resources, the commercial development prospects for mining polymetallic nodules is not certain in the short term.

DEEP OCEAN RESOURCES DEVELOPMENT CO. LTD (DORD)

80. DORD has used the land based Code of the Australian Joint Reserve Committee (JORC, 2004) to classify the mineral resources in its exploration area as Inferred. DORD collected a significant amount of data on occurrence, density and know-how of exploration during 1975 to 1996. A review and economic appraisal work was conducted in 2010 with respect to the value of ore deposits using the Discounted Cash Flow (DCF) method. DORD reports that though the technological developments for low cost mining and smelting are necessary, because of the stable supply of minerals from land, the advancement of Research and Development related to deep-sea mineral resources has been sluggish.

Therefore, it has taken old methods and cost estimates into consideration. The contractor has assumed that the project would be economically viable.

INSTITUT FRANÇAIS DE RECHERCHE POUR L'EXPLOITATION DE LA MER (IFREMER)

81. IFREMER has compiled and geo-referenced all the data that it collected during 1975 to 1988. In 2012, it undertook a major integrative overview on environment work carried out in its licence blocks and plans biological work with Germany for the period 2011-16 in the Area. No developments on resources and resource classification have been reported by the contractor.

MINISTRY OF EARTH SCIENCES, GOVERNMENT OF INDIA

82. The contractor has identified a first generation mine-site, an area of 7858 km^2, in its exploration area and has divided the mine site into 42 blocks of 0.125°x 0.125° for detailed exploration and comprehensive resource evaluation.[14]

83. The MOES of India plans to identify a test mining site (a block of 12.5km x 12.5km) within the contractor's First Generation Mine-site to carry out a preliminary techno-economic evaluation of the mining complex including processing and recovery of additional metals and value added products. Based on the existing resource evaluation with further refinement relating to block- wise estimation variances and the available sampling grids, the contractor plans to attempt classification of the resources in the Area into measured, indicated and inferred categories, during 2014-15.

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[14] The term "first generation mine site" is to be defined.

FEDERAL INSTITUTE FOR GEOSCIENCES AND NATURAL RESOURCES OF GERMANY (BGR), GERMANY

84. Based on conceptual studies and modelling of limited available data, BGR has identified 'a highly prospective area of approximately 2000 km^2 with a high density of mineable nodule areas of economic interest, which would be sufficient for 7-12 years of mining'. The Contractor reports the coefficient of variation for the main metal content (Mn, Cu, Ni, Mo, V) is a factor 3 lower than the coefficient of variation for nodule abundance (approximately 10% versus 30%). The nodule abundance being the controlling factor for resource estimation, the contractor projected to improve the quantity and quality of nodule abundance data.

85. BGR reports that it has prepared an internal report with the Aker Wirth Company regarding a study on the "Technical development and economic feasibility of mining polymetallic nodules from the deep-sea". This covered:

(a) An evaluation of existing deep-sea mining techniques;

(b) an assessment of these techniques regarding environmental issues, safety, capital expenditure, operating costs, and profitability;

(c) a survey of related technological sectors regarding their transferability and based on the results of these studies, and

(d) The development of a detailed conceptual design for a nodule mining and lifting system, including computer simulations of important sub-systems and components and basic concepts for a production platform and a nodule ore transport system to a land-based metallurgical processing plant.

86. In its 2013 Annual Report, BGR reported its resource calculations for the entire PA1 as "indicated mineral resource" according to the CIM Definitions Standards for mineral resources and mineral reserves (2010).

TONGA OFFSHORE MINING LIMITED (TOML) TONGA

87. Tonga Offshore Mining Limited (TOML), TONGA signed its contract with the ISA in 2012. However, in its first annual report, it has classified the deep sea polymetallic nodule resources as Inferred deposits. This classification follows the Canadian Securities Exchange Standards and is in accordance with the JORC standards (NI43-101 or JORC standards). The resources have been classified based on conceptual costing and revenue modelling and relative metal price assumptions, conceptual production cost per tonne at each stage of the production chain, based almost entirely on proven technology. The resource modelling reviewed the historical data available for the CCZ.

NAURU OCEAN RESOURCES INC., (NORI)

88. Based on the interpretation of geological and geophysical data collected during 2012, NORI has generated a nodule distribution model including correlation with the seafloor topography and sediment characteristics, which was used for its resource estimate and geological model. This model also incorporated historical data. The Inferred mineral resource estimates were prepared in accordance with

the CIM 'Estimation of Mineral Resources and Mineral Reserves Best Practice Guidelines' and the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (JORC Code, 2012).

89. The remaining polymetallic nodule contractors are yet to report on their resource assessment work, as well as the classification of the resources.

Comments on reported work

90. With the limited amount of information and data on the polymetallic nodule resources in exploration areas, in particular for contracts that expire between 2016 and 2017, there is an urgent need to Inform and educate all stakeholders (including staff of the Authority, members of Authority, commissions and committees, sponsoring states and contractors) in the international standards for mineral assessment and reporting through discussions with experts in the establishment and application of such standards. There is also an urgent need to work with the Committee on Mineral Reserve Information Reporting Standards (CRIRSCO) in order to apply the CRIRSCO standards to mineral reserve and mineral resource reporting by all contractors and, through the CRIRSCO standards, maximize consistency with national reporting standards.

91. Of the seven contracts that expire by 2017, only one contractor has provided criteria to define mineable areas, the number of such areas that have been identified in its exploration area and a classification of these resources. Another contractor has provided information on "ore deposits" in its exploration area without reference to the criteria used to define "ore deposits". A third contractor refers to a first generation mine site without and definition of the term. Two others indicate that they have undertaken resource assessment work but provide no data or reports on the work. Only one contractor has indicated the classification system that it has used.

92. As can be gleaned from the above, the comparability of assessments across deposits and development sites is not possible. This will require clear standards, and these standards must reflect the nature of the resource and the technology and economics of their exploitation.

93. In order for such comparability to be possible, there is a need to review the work being undertaken by contractors in this regard, agreement on the utilization of applicable land-based standards and their utilization in the short term for polymetallic nodules, establishment of a continuing relationship with organizations such as CRIRSCO to refine standards, and a determination of the additional work to be performed by contractors and the time required to fulfill. Consideration must also be given to elaborate on the best practices for the "Resource Database" identified in the CIM Best Practices in regard to the 'end of contract' regulation applicable to exploration contractors regarding transfer of exploration and resource data from the contractor to the Authority at the end of the exploration contact.

Objectives of the workshop

(I) Ascertain the work being undertaken by contractors for polymetallic nodule exploration in the Area with a view to the standardization of the exploration and resource data required in Section 11 of the standard clauses of Exploration contracts;
(II) Review of current practice in land-based mineral development on national reporting standards for exploration results and resource classification;

(III) Identification of special aspects of polymetallic nodule deposits that should be addressed in resource reporting standards;

(IV) Identification of any issues arising from differences in national reporting standards to which the Authority should respond;

(V) Assist contractors to identify and implement best practices in polymetallic nodule resource evaluation;

(VI) Identification of the work to be completed by contractors to fulfil item (i);

(VII) Determine the time required to fulfil item (v); and

(VIII) Provide guidance to the ISA regarding relations with mineral information standards organizations, including potential cooperation with CRIRSCO's work.

Appendix 2: Recommended Rules of Conduct Applicable to "Competent Persons" [15]

The following recommended Rules of Conduct apply to Competent Persons engaged in the practice of preparing or contributing to public reports that include statements of Mineral Exploration Results, Mineral Resources or Mineral Reserves. These Rules are in addition to the Professional Codes of Ethics that may apply due to the Competent Person's membership of a recognized professional body.

In the event of a conflict, the rules of the Competent Person's recognized professional body will prevail. The Rules of Conduct are listed under various areas of responsibility, highlighted in bold text.

The Public and Society

Competent Persons must discharge their duties with fidelity to the public, and at all times in their professional or employed capacities carry out their work with integrity and professional responsibility.

In particular:

- Recognize at all times, that the responsibility of Competent Persons towards the Public overrides all other specific responsibilities including responsibility to professional, sectional, or private interests or to other Competent Persons.

- Ensure that public comments on geological, engineering and metallurgical and related matters are made with care and accuracy, without unsubstantiated, exaggerated, or premature statements; they should be made clearly and concisely.

- Base documentation underpinning Public Reports on Mineral Resources and Mineral Reserves on sound and relevant estimation techniques, adequately validated data and unbiased judgement.

- Note that when required to do so, Competent Persons should give evidence, express opinions or make statements in an objective and truthful manner on the basis of adequate knowledge and understanding.

- Recognize that where required to do so, Competent Persons should be prepared to disclose details of qualifications, professional affiliations and relevant experience in all public reports.

15. CRIRSCO, International Reporting Template, November, 2013. Accessed at <http://www.crirsco.com/templates/crirsco_international_reporting_template_2013.pdf> on February 23, 2014.

The Profession, Employers and Clients

Competent Persons must uphold the honour, integrity, reputation and dignity of their profession and maintain the highest level of conduct in all professional matters. In particular they should:

- Act with due skill, care and diligence at all times in conducting their activities.
- Perform work only in their area of competence.
- Never knowingly mislead or deceive others, falsify or fabricate data.
- Respect and safeguard confidential information.
- Acknowledge and avoid wherever possible both real and perceived conflicts of interest.

International Standards for Mineral Assessment and Reporting

- Distinguish between fact and opinion so that it is clearly evident what is interpretation of fact and what is professional judgement. Competent Persons may give a considered professional opinion based on facts, experience, interpretation, extrapolation or a combination of these.
- Ensure the scientific and technological contributions are thorough, accurate and unbiased in design, implementation and presentation.
- Ensure that sound and relevant estimation techniques, adequately validated data and unbiased judgement are applied to the documentation upon which public reports on Mineral Resources and Reserves are based.
- Comply with all laws and regulations relating to the mineral industries and rules, regulations and practices as established and promulgated by the relevant regulatory authorities.
- Use their best endeavours to ensure that their employer or client complies with the rules and regulations and practices of the relevant regulatory authorities.

Professional Bodies, Colleagues and Associates

Competent Persons must at all times conform to the rules of the professional bodies to which they belong and respect and acknowledge the contributions of colleagues and other experts in enabling them to conduct their work.

They should:

- Accept responsibility for their own errors.
- Demonstrate a willingness to be judged by their professional peers.
- Agree to be bound by the disciplinary code of the professional body to which they are affiliated.
- Encourage others to accept the same responsibilities, to join a recognized professional body and to be bound by these Recommended Rules of Conduct.

The Environment, Health and Safety

In performing their work, Competent Persons should strive to protect the natural environment and ensure that the consequences of their work do not adversely affect the safety, health and welfare of themselves, colleagues and members of the Public.

- Ensure that consideration of the modifying factors used to determine Mineral Reserves fully recognizes the need to provide a safe working environment.
- Ensure that Mineral Reserve estimates acknowledge the likely environmental impact of development and ensure that appropriate allowances are made for mitigation and remediation.

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