

# **INTERNATIONAL STANDARDS FOR RESERVE REPORTING IN GOLD MINING**

**Jean-Michel Rendu**  
**Newmont Mining Corporation**  
**Lincoln Street, Denver,**  
**Colorado 80203, U.S.A.**  
e-mail; [jren5896@corp.newmont.com](mailto:jren5896@corp.newmont.com)

## **1. Introduction**

The mining industry has long recognized the need for international standards for evaluation and reporting of exploration information, mineral resources, and reserves. These standards would improve communications within the mining industry, as well as with other stakeholders that have an interest in the industry, such as investors and governmental and non-governmental agencies. Over the last few years, considerable progress was made towards the development of such standards. The current status is described below. How these standards were reached and plans for further improvements are also discussed. Particular attention is given to the application of such standards to the gold mining industry.

## **2. Historical Developments of International Standards**

A brief review of historical developments will help appreciate the current level of standardization, and determine the steps to be followed to improve these standards.

A systematic effort to develop international standards started in the 1990's (Figure 1). The "Australasian Code for Reporting of Identified Mineral Resources and Ore Reserves" was published in June 1988. The "Guidelines to the Australasian Code for Reporting of Identified Mineral Resources and Ore Reserves" was published in May 1990. In April 1991, the US Society for Mining, Metallurgy and Exploration

(SME) published "A Guide for Reporting Exploration, Information, Resources and Reserves". In September 1994, the Fifteenth Congress of the Council of Mining and Metallurgical Institutions (CMMI), was held in Sun City, South Africa. During this congress, CMMI organized a meeting to discuss international standards. This represented the first meeting of what was later to be called the CMMI International Resources/Reserves Definitions Group (the CMMI Group). The group is composed of representatives from Australia (AusIMM), Canada (CIM), South Africa (SAIMM), the United Kingdom (IMM) and the United States

(SME). The group's primary objective was to develop a set of international definitions for reporting mineral resources and mineral reserves.

Concurrently, and since 1992, a Task Force of the United Nations Economic Commission for Europe (UN-ECE) was developing an international framework classification for resources and reserves. IN November 1996, the United Nations published the "United Nations International Framework Classification for Reserves/Resources – Solid Fuels and Mineral Commodities".

In March 1997, following the Bre-X mining scandal concerning the fictitious Busang gold deposit in Indonesia, the Toronto Stock Exchange and the Ontario Securities Commission formed a Mining Standards Task Force, whose final report, "Setting New Standards, Recommendations for Public Mineral Exploration and Mining Companies", was published in January 1999.

A major breakthrough happened on October 18, 1997 when the CMMI Group met in Denver, Colorado and reached a provisional agreement, the "Denver Accord" on definitions of mineral resources and mineral reserves. A joint meeting was held in Geneva on October 4, 1998 between the CMMI Group and the UN-ECE Task Force. Agreement was reached to incorporate the CMMI standard definitions, with minor modifications, into the UN framework classification.

Following the October 1998 meeting, the United States, Australia and South Africa updated their national guides. A new version of the SME Guide ("A Guide for Reporting Exploration Information, Mineral Resources and Mineral Reserves") was accepted in March 1999. The revised Australian Code (the "Australian Code for Reporting of Mineral Resources on Ore Reserves [the JORC Code]") became effective September 1999. The South African Code (the "South African Code for Reporting of Mineral Resources and Mineral Reserves [the SAMREC Code]") became effective November 1999.

In November 1999, the CMMI Group met again with the UN-ECE Task Force to continue the process of developing international definitions and guidelines. With only minor differences between countries, which are of no material significance, the following terms were accepted, which are defined in the next section (Figure 2).

- Mineral Resources
- Inferred Mineral Resources
- Indicated Mineral Resources
- Measured Mineral Resources
- Mineral Reserves
- Probable Mineral Reserves

- Proved Mineral Reserves

### 3. Standard Definitions of Mineral Resources and Mineral Reserves

A '**Mineral Resource**' is a concentration or occurrence of material of intrinsic economic interest in or on the Earth's crust (a deposit) in such form and quantity that there are reasonable prospects for eventual economic extraction. The location, quantity, grade, geological characteristics and continuity of a Mineral Resource are known, estimated or interpreted from specific geological evidence and knowledge. Mineral Resources are sub-divided, in order of increasing geological confidence, into Inferred, Indicated and Measured categories. Portions of a deposit that do not have reasonable prospects for eventual economic extraction must not be included in a Mineral Resource.

An '**Inferred Mineral Resource**' is that part of a Mineral Resource for which tonnage, grade and mineral content can be estimated with a low level of confidence. It is inferred from geological evidence and assumed but not verified geological and/or grade continuity. It is based on information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes which is limited or of uncertain quality and/or reliability.  
An Inferred

Mineral Resources has a lower level of confidence than that applying to an Indicated Mineral Resource.

An '**Indicated Mineral Resource**' is that part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a reasonable level of confidence. It is based on exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes. The locations are too widely or inappropriately spaced to confirm geological continuity and/or grade continuity but are spaced closely enough for continuity to be assumed. An Indicated Mineral Resource has a lower level of confidence than that applying to a Measured Mineral Resource but has a higher level of confidence than that applying to an Inferred Mineral Resource.

A '**Measured Mineral Resource**' is that part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a high level of confidence. It is based on detailed and reliable exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes. The locations are spaced closely enough to confirm geological and/or grade continuity.

A **‘Mineral Reserve’** is the economically mineable part of a Measured or Indicated Mineral Resource. It includes diluting materials and allowances for losses which may occur when the material is mined. Appropriate assessments which may include feasibility studies, have been carried out and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction is reasonably justified. Mineral Reserves are sub-divided in order of increasing confidence into Probable Mineral Reserves and Proved Mineral Reserves.

A **‘Probable Mineral Reserve’** is the economically mineable part of an Indicated and, in some circumstances, Measured Mineral Resource. It includes diluting materials and allowances for losses which may occur when the material is mined. Appropriate assessments, which may include feasibility studies, have been carried out and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction is reasonably justified. A Probable Mineral Reserve has a lower level of confidence than a Proved Mineral Reserve.

A **‘Proved Mineral Reserve’** is the economically mineable part of a Measured Mineral Resource. It includes diluting materials and allowances for losses which may occur when the material is mined. Appropriate assessments, which may include feasibility studies, have been carried out and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction is reasonably justified.

#### **4. Standardization of Reporting Guidelines**

In addition to the definitions listed above, specific guidelines were developed by Australia, South Africa and the United States, that explain the definitions and how they should be used to report information. These guidelines are nearly identical between countries, but the extent to which they must be followed varies significantly.

The JORC and SAMREC Codes must be followed by all public companies listed on the Australian and South African Stock Exchanges, respectively. The SME Guidelines are not fully consistent with the requirements of the US Securities and Exchange Commission (US-SEC). Specifically the US-SEC does not allow the use of the term “resources”, and the conditions under which the US-SEC allows publication of material not in reserve may differ from those recommended in the SME and other guidelines.

The US-SEC regulations must be followed by all companies listed on stock exchanges of the United States. In Canada, the Mining Standards Task Force made recommendations to the stock exchanges which would result in reporting requirements different from those accepted in other countries. However, the Task Force also recommended that the Canadian Institute for Mining and Metallurgy (CIM) work with other professional societies toward the development of international standards.

All guidelines require that reserves and resources are reported by a '**Competent Person**'. A Competent Person must be a member of a professional society for earth scientists or mineral engineers, or have other appropriate qualifications which differ between countries. In addition, the Competent Person must have a minimum of five years experience which is relevant to the style of mineralization and type of deposit under consideration and to the activity which that person is undertaking. If the Competent Person is estimating, or supervising the estimation of Mineral Resources, the relevant experience must be in the estimation, assessment and evaluation of Mineral Resources. If the Competent Person is estimating, or supervising the estimation of Mineral Reserves, the relevant experience must be in the estimation, assessment, evaluation and economic analysis of Mineral Reserves.

## **5. Future Plans for Standardization**

The current objective of the CMMI Group is to develop international guidelines, as well as an international definition of the Competent Person, including reciprocity conditions for recognition of the Competent Person across national boundaries. The CMMI Group is in the process of preparing the following draft documents to be submitted to member countries for review.

- International Guidelines for Reporting Mineral Resources and Mineral Reserves.
- International Definition of the "Competent Person"
- International Code of Ethics for the Competent Person
- Reciprocity Conditions, or conditions which must be satisfied for a Competent Person to be recognized across national boundaries

Countries other than those which are part of the CMMI Group are invited to comment on this process and the guidelines being developed.

## **6. Application to the Gold Industry**

How definitions and guidelines are used, is best illustrated by examples from the gold mining industry.

In the early stages of exploration, when mostly surface samples are available as well as geochemical, geophysical and other exploration information which may include drill hole information, tonnages and grades must not be reported. Of course, exploration information can, and often must be reported. For example, early drill hole information can be reported in terms of length mineralized, average grade of mineralized samples, depth of mineralization from the surface. For exploration planning, it may be useful to speculate on the size of the geologic target, including on what could be the tonnage mineralized and its gold content. But this information, which is of a speculative nature, must not be published.

At a later stage, sufficient information may be available, from drill holes as well as surface and underground samples, to quantify the tonnage and grade of mineralized material. Provided there are reasonable prospects for economic extraction of the gold contained in this material, it may be possible to publish a Mineral Resource. A resource is expressed in terms of tonnage and grade. Only that part of the deposit which could become a reserve under reasonable assumptions can be published as a resource. Portions of a deposit that do not have reasonable prospects for eventual economic extraction must not be included in a Mineral Resource.

The definition of a Mineral Reserve is probably that which is most uniformly accepted by regulatory agencies and the mining industry worldwide. A Mineral Reserve can only be published once the economic and technical feasibility of mining the deposit has been demonstrated. Mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors must have been taken into account.

It is not necessary that all permits are in hand before a reserve is published, but it is necessary that the assumption that such permits will be granted is reasonable.

A number of examples are given below for illustration:

**Case 1:** Four exploration holes have been drilled in a geological zone which shows significant horizontal continuity over a very large area. The drill holes show a thickness of mineralization varying between 5 and 25 m, with average grade between 0,10 and 0,60 g/tons of gold. Geological and geophysical evidence indicates that the zone may cover up to 10 km<sup>2</sup>, and could contain 5 million oz of gold. According to international guidelines, this information could only be published as “exploration information”. The length of each drill hole intercept, the corresponding average grade, the depth to the top of mineralization, the general property and extent of the geological horizon could

be made public. The potential gold content of the mineralized zones should not be published. Continuity of mineralization has not been established. There is not sufficient information to demonstrate that any part of the deposit could be of economic value, under anything but extremely speculative assumptions.

**Case 2:** The same deposit has been more extensively drilled. A higher grade zone containing approximately six million tons of mineralized material average 0.70 g/ton gold has been delineated. Preliminary bottle roll tests have shown this mineralization to be amenable to cyanide leaching, and recoveries between 45% and 80% have been obtained. The deposit is mostly outcropping. If the deposit is near existing facilities, only minimal capital expenditures are required, and current operating costs are low, it may be possible to declare this higher grade zone a Mineral Resource. Conversely, if the deposit is isolated and requires significant infrastructure, it is not likely that it could be declared as a Mineral Resource. The determination whether or not the zone can be reported a Mineral Resource should be made by a Competent Person, taking into account all geologic, mining, metallurgical and cost information available. Before a Mineral Resource is published, a scoping study may be helpful to demonstrate that there are reasonable prospects for eventual economic extraction.

For example, on the basis of experience with similar deposits, one may estimate mining costs to be at least US\$1,00/ton, processing costs US\$2/ton, other costs US\$0,70/ton, recovery 75%, capital cost US\$36 million or US\$6/ton. The total operating and capital cost per ton would be US\$9,70. Assuming a gold price of US\$350/oz, the value of gold recoverable is  $0,7 \text{ g/ton} \times 0,75 \times \text{US\$350} (31, 1035) = \text{US\$5,91}$ . It is not reasonable to assume that economic feasibility can be demonstrated. A Mineral Resource cannot be declared.

**Case 3:** In another exploration project, a mineralized zone has been delineated, which is estimated to contain two million tons of material averaging 20 g/ton gold. The deposit could be mined by underground method. Given the geologic properties and location of the deposit, mining and processing costs of US\$50/ton are reasonable to assume. Recoveries could be between 70% and 90%. Using this limited information, a simple calculation shows that there is reasonable prospect for eventual economic extraction. This material may be declared a Mineral Resource, and tonnage and grade may be published.

**Case 4:** A detailed study of the economic feasibility of mining the deposit described in Case 3 has been completed. This included sufficient drilling and deposit modeling to estimate a Measured and Indicated Mineral Resource. Geotechnical testing was completed to evaluate mining method and calculate mining costs. Metallurgical tests have been completed to choose a process, estimate gold recoveries, design a processing plant and calculate processing

costs. Overhead costs have been estimated. A detailed study of capital cost was completed, including detailed mine design and underground facilities, processing facilities, tailings dams, access roads, laboratories, offices and other surface facilities. A detailed life of mine plan was developed. Reclamation costs were estimated, cash flow was calculated, taking into account taxes, royalties and other costs. Sensitivity to gold price was analyzed. Review of the plan of operation has shown that the mine can be operated in an environmentally sound fashion. Social, governmental and legal aspects have been taken into account. All permits have not yet been obtained, but there are reasonable expectations of timely approval.

Under these circumstances, if an economically viable project has been demonstrated, a Mineral Reserve may be declared. It is the responsibility of a Competent Person, qualified in the economic evaluation of underground gold mines, to assess the feasibility of the project.

As shown by these examples, there can be significant differences in the information needed, and the expertise required, before exploration information, a Mineral Resource or a Mineral Reserve can be declared. A person who is competent to declare a Mineral Resource may not be competent to declare a Mineral Reserve. In the first case, most of the expertise required is of a geologic nature. In the second case, expertise in managing the economic evaluation of mining projects is required.

## **7. Conclusions**

Standardization has not yet been reached worldwide, but considerable effort is being allocated toward international agreement. Standards will improve the quality and ease of communications within the mining industry, as well as with other stakeholders who have interests in the activities of the industry. These standards may impose a higher level of self-regulation on the industry, which should not be considered a hindrance, but rather as a means toward improved public relations.



**Figure 1: Development of International Standards – Historical Highlights**

<b>Date</b>	<b>Place</b>	<b>Event</b>
September 1994	Sun City, South Africa	First Meeting of the CMMI International Resources/Reserves Definitions Group
November 1996	Geneva, Switzerland	Publication of the “United Nations International Framework Classification for Reserves/Resources – Solid Fuels and Mineral Commodities”.
March 1997	Indonesia and Canada	Bre-X Scandal
October 1997	Denver, Colorado	Second Meeting of the CMMI International Resources/Reserves Definitions Group  “The Denver Accord”
October 1998	Geneva, Switzerland	Third Meeting of the CMMI International Resources/Reserves Definitions Group  First Meeting with the UN-ECE
January 1999	Toronto	“Setting New Standards, Recommendations for Public Mineral Exploration and Mining Companies” published by Toronto Stock Exchange and Ontario Securities Commission
November 1999	Geneva, Switzerland	Fourth Meeting of the CMMI International Resources/Reserves Definitions Group  Second Meeting with the UN-ECE

**Figure 2: Relationship Between Exploration Information, Mineral Resources and Mineral Reserves**

