The September 1994 issue of JASSA included an article explaining the work in progress towards a common terminology among major resource nations. In this article, P.R. STEPHENSON discusses the application of the Australasian Code for Reporting of Identified Mineral Resources and Ore Reserves.

The quality of resource or reserve classification and reporting has been an issue since the early days of mining in Australia.

In 1909, Herbert Hoover (then working in Australia and later to become president of the United States) published his classic Principles of Mining in which he recommended a threefold division of ore reserves into Proved, Probable and Prospective. If the word “prospective” is replaced with the word “possible”, the system is identical to that used by many organisations until the mid-1980s (and not much different from that in use today, 86 years after Hoover’s recommendation).

Unfortunately, the threefold Hoover classification was not universally adopted by Australian mining companies and the period to the early 1970s saw the development and application of a variety of classification and reporting systems, all developed to suit individual mines and companies. Public reporting of ore reserves during this time was generally very poor.

The lack of standards covering classification and reporting finally came to a head in the late 1960s, when dubious (and occasionally downright scurrilous) reporting practices during the so-called “nickel boom” became of great concern to regulatory authorities and to the industry as a whole. This led, in 1971, to the Australasian Institute of Mining and Metallurgy (The AusIMM) and the Australian Mining Industry Council (AMIC) setting up the Joint Ore Reserves Committee (JORC).

Between 1972 and 1988 a number of reports were issued by JORC which made recommendations about public reporting and resource/reserve classification and which gradually developed the principles in use today. These reports had the status of guidelines only and were not binding in a regulatory sense. However, through peer pressure and recognition of their good sense, the principles were adopted by most mining and exploration companies.

In June 1988, the committee issued the first version of the Australasian Code for Reporting of Identified Mineral Resources and Ore Reserves. This document, which was officially released in February 1989, differed from previous reports in that it:

- introduced the concept of Mineral Resources as a precursor to Ore Reserves, the latter being derived from the former by the consideration of economic and production-related factors;
- restricted the term “Ore Reserves” to what had in previous documents been termed “Recoverable Ore Reserves”;
- eliminated the category of “Possible Ore”;
- introduced the concept of “Pre-Resource Mineralisation”;
- became a mandatory minimum standard for companies reporting to the Australian Stock Exchange (ASX) when, in July 1989, it was incorporated into the ASX listing rules.

Guidelines to the code were published in 1990 and the two documents were revised and released in combined form in 1992. In 1993, an appendix was published covering public reporting of diamond exploration results.

WHAT THE CODE DOES AND DOES NOT COVER

It is important to understand what the code is (and is not) intended to regulate. The code does:

- establish and prescribe the minimum standards required for public report-
ing of Mineral Resources and Ore Reserves;
• set out a system for classification of
tonnage (or volume) and grade estimates
as either Mineral Resources or Ore
Reserves and for subdivision of each
into categories which reflect different
levels of certainty or confidence;
• describe the qualifications and experi-
ence required for a “Competent
Person” and set out the responsibili-
ties of the Competent Person with
regard to classification and reporting
of Mineral Resources and Ore
Reserves.

The code does not (inter alia):
• seek to regulate the estimation
of Mineral Resources and Ore
Reserves;
• seek to regulate companies’ internal
classification or reporting systems;
• quantify the minimum amount of data
required for each category of Mineral
Resources and Ore Reserves.

It follows that the phrase, often includ-
ed in public reports, that “the mineral
resources/ore reserves have been esti-
_imated in accordance with the code” is, in
fact, meaningless. Resources and
Reserves may be classified and reported
in accordance with the code but not estimat-
ed.

It should be remembered that the code
provides a minimum set of standards to
be applied in public reporting. Companies
may (and, in fact, are encour-
aged to) provide information beyond what
required by the code. Where there is
doubt about an appropriate course of
action, a company should adopt the prin-
ciple of maximum disclosure of informa-
tion to enable (as the guidelines state) “an
informed layman to make a reasoned and
balanced judgment regarding the mineral-
isation reported”.

**CLASSIFICATION OF
MINERAL RESOURCES**

Before considering aspects of Mineral
Resource classification, it is important to
recognise two key factors.

First, Mineral Resource classification is,
and (I believe) will always remain, basi-
cally subjective. Every mineral deposit is
unique and what are being classified are
estimates of tonnage and grade which are
based on a tiny sample of the deposit and
which are dependent on an interpretation
of the geology of the deposit. This is why
the code gives the responsibility for
resource estimation and classification to a
“Competent Person” and why it is essen-
tial that the Competent Person retains
control over all matters affecting these
important activities.

Second, the main reason for classifying
tonnage/grade estimates is to provide
company executives and others making
mining investment decisions with a basis
for assessing relative risk. It is essential to
bear this in mind when classifying
resources.

Mineral Resources are categorised as
Measured, Indicated or Inferred, depend-
ing on (inter alia ) the amount, quality
and distribution of data, confidence in
geological and grade continuity and,
importantly, the Competent Person’s
confidence in the tonnage/grade esti-
mate. Given that the decisions are largely
subjective, how does a Competent Person
deide between the Measured, Indicated
and Inferred categories? (A good starting
point is to read carefully the code and
guidelines. In the author’s experience,
many examples of confusion over how to
classify resources arise from inadequate
reading of this document.)

**MEASURED VERSUS INDICATED**
The key words in the description of
Measured Mineral Resources in the
guidelines to the code are “... any varia-
tion from the estimate would be such as
not significantly to affect potential eco-
_nomic viability”. In other words, a
resource may be classified as Measured if
confidece in the estimate is such that
additional technical information would
not significantly affect technical or econ-
omic decisions made on the basis of the
estimate.

A useful technique used by the author
in helping to decide between Measured
and Indicated categories is t_o imagine the
effect of infill drilling. If it is felt that infill
drilling would not greatly affect the geo-
ological interpretation and/or confidence
in grade distribution – or, even if it could
affect these factors, would not result in a
significantly different estimate of ton-
nage, grade, shape and location of the
mineralised bodies – then the particular
section of the deposit under question
may reasonably be classified as
Measured.

**INDICATED VERSUS INFERRED**

Again, some key words in the description
of Indicated Mineral Resources are con-
tained in the guidelines: “Confidence in
the estimate would be such as to allow
the application of technical and financial
parameters and to enable an evaluation
of economic viability.” The description
of Inferred Resources, on the other hand,
contains the warning: “Caution should be
exercised if this category is considered in
preliminary economic studies.”

Again it might be useful to consider the
likely effect of further drilling. If it is
thought that additional drilling could sig-
ificantly affect the shape and/or distrib-
ution of the mineralised zones but not
substantially affect the tonnage/grade
estimate, then the portion of the deposit
in question can probably be classified as
Indicated. If, however, it is thought that
the tonnage and grade, as well as the
shape and distribution, of mineralised
zones could be substantially affected by
further drilling, then the relevant portion
of the deposit is probably not defined ade-
quately to allow an evaluation of eco-
omic viability and should probably be
classified as no better than Inferred.

Not all situations are straightforward.
There may be times when the degree of
confidence in a tonnage estimate is greater than the degree of confidence in a grade estimate, to the point where on the basis of the former, the estimate could be classified as, say, Indicated, whereas on the basis of the latter the estimate could be classified as Inferred. How should the situation be handled? (This, by the way, is based on a real industry example.)

In the author’s opinion, the Competent Person should use the same criteria as suggested above. If, taking full account of uncertainty regarding derivation of grade figures, he or she is prepared to support use of the estimate for the purposes of economic evaluation and mine planning, then the resource should probably be classified as Indicated. If the Competent Person is not so prepared, then it should probably be classified as Inferred. The decision has to be made carefully, because the code does not allow Inferred Mineral Resources to be converted to Ore Reserves.

**COMPUTER-BASED CLASSIFICATION SYSTEMS**

Most software packages used in block-modelling resource estimation are able to calculate the number and relative distance of data used to “inform” each block and are therefore able to assign relative mathematical confidence levels to grades estimated for each block.

Often these mathematical confidence levels are translated directly into mineral resource categories; for example, Measured Resources might be defined as “blocks informed by 10 or more data points” and Indicated as “blocks informed by three to nine data points” (within a specified search ellipse). Distances of data from block centroids may also be used.

This type of classification system is more quantitative than qualitative, so is it acceptable? Is it “in accordance with the code”?

Take the second point first. The means by which a Competent Person determines the classification of mineral resources is not the concern of the code. The code provides a classification system and a minimum set of standards for public reporting but deliberately avoids the fields of estimation and classification methodology.

As to whether the system itself is acceptable, it depends on who determines the parameters used for the classification and what information that person uses.

If, for example, the parameters are set by the Competent Person responsible for the deposit, taking full account of all the uncertainties with regard to (inter alia) geological interpretation, quality of data, difficulties of resource estimation, etc., so that the end result reflects his or her overall confidence in the tonnage/grade estimates, then the system should provide an acceptable result.

If, however, (and this unfortunately happens) the parameters are set by a person who knows little about the deposit except the data he or she has been given to work with and who is not the Competent Person responsible for the deposit, then this type of classification system may produce unacceptable results unless it has been vetted and approved by the Competent Person.

There is an additional danger with “mathematical” resource classification: the risk of becoming fixed on the first set of parameters set for defining each resource category.

If the first parameters used result in a resource classification which sits uncomfortably with the Competent Person, then the parameters are obviously not reflecting the Competent Person’s view of the deposit and should be changed.

The Competent Person should not be reluctant to make or to recommend such changes, since the parameters were probably, to some extent, “plucked out of the air” in the first place. There is nothing magic about such figures; they are only a means to an end, not the end itself.

**ORE RESERVE CLASSIFICATION**

So far, no mention has been made in this paper of ore reserve classification. The reasons are twofold:

- A decision whether to classify Ore Reserves as Proved or Probable is made on exactly the same geotechnical bases as a decision on whether to classify Mineral Resources as Measured or Indicated.
- The direct relationship between Measured Mineral Resources and Probable Ore Reserves and between Indicated Mineral Resources and Probable Ore Reserves provided for in the code means that often the decision whether ore reserves should be classified as Proved or Probable is made when the corresponding Mineral Resources are classified as Measured or Indicated.

**PRE-RESOURCE MINERALISATION**

The code provides a classification of Pre-Resource Mineralisation to cover identified mineralisation about which there is...
insufficient knowledge to allow classification as a Mineral Resource. How, in practical terms, should the classification be used?

The intention of the Joint Ore Reserves Committee in providing for Pre-Resource Mineralisation was to assist companies to report discoveries of mineralisation at a very early stage of exploration when drilling and sampling results would be insufficient to allow an estimate of tonnage and grade to be made. It might assist if Pre-Resource Mineralisation is thought of as an "indicated exploration target" or "partially identified mineralisation considered worthy of further exploration". It is emphasised that the classification was not intended to be used as another category of mineral resources.

One way of envisaging the difference between Pre-Resource Mineralisation and Inferred Resources might be to consider the relationship with known mineralisation (defined as Indicated and/or Measured Mineral Resources). Inferred Resources usually cover extensions beyond known mineralisation, so that resources may be inferred to exist, and therefore may be quantified on the basis of little sampling data supported by knowledge of the adjoining defined mineralisation.

Pre-Resource Mineralisation usually encompasses mineralisation at an early stage of exploration which has little sampling data and often no adjoining defined mineralisation which might support a definitive estimate of tonnage and grade. It cannot therefore be quantified except in terms of general potential.

There has been recent discussion in industry journals on the issue of Pre-Resource Mineralisation and the matter was considered at a meeting of the Joint Ore Reserves Committee in November 1994 (see letter from D.S. Tyrwhitt, chairman of JORC, to the editor, AusIMM Bulletin, December 1994). It was decided that both the term itself and the explanatory text in the code and guidelines were not satisfactory and that steps would be taken in the next revision of the documents to clarify the situation. It is likely that the term "Pre-Resource Mineralisation" will be replaced by a term which more appropriately reflects the intent of the committee in providing this classification.

**COMPETENT PERSON**

The concept of a "Competent Person" was introduced in the first report issued by the joint committee in 1972. It has been a central theme ever since and is one of the main reasons why the code and the documents which preceded it have been successfully applied by industry. Rather than attempt to regulate the estimation of mineral resources and ore reserves, a procedure which would have been fraught with difficulty and controversy, the joint committee decided to regulate the estimator and to allow him or her freedom to use his or her experience in deciding appropriate estimation and classification methodology.

The definition of a Competent Person in the code covers both qualifications and experience.

**QUALIFICATIONS**

The code requires that a Competent Person must be a corporate member of either the AusIMM or the AIG. The reason for this is that both organisations have stringent entry requirements and have enforceable codes of ethics. The latter is essential if the code is to have any teeth in terms of controlling those who estimate resources and reserves.

**EXPERIENCE**

The code specifies that the required five years' experience must be "relevant to the style of mineralisation under consideration". In other words, someone with experience only in base metal mineralisation may not report publicly on alluvial gold deposits, since his or her experience is not "relevant" in this context. The main reason for the requirement is that a Competent Person must have sufficient knowledge of the type of mineralisation in question and of appropriate exploration techniques to be fully aware of potential traps and pitfalls in the estimation and classification process.

One of the proposed changes to ASX listing rules is a requirement for the Competent Person to be named in public reports. It is believed that this would do more to eliminate the estimation and reporting of mineral resources and ore reserves by inadequately qualified persons than any fine tuning of definitions.

**COMMON ERRORS IN REPORTING UNDER THE CODE**

The Joint Ore Reserves Committee has, since release of the 1992 edition of the code, been monitoring a selection of mining company reports, selected by the ASX, relating to mineral resources and ore reserves. The number of reports not complying with the code during this period has been relatively small and is decreasing, and is confined mainly to some lodged by exploration companies; however, there are areas of the code which suffer greater incidences of non-compliance than others.

**Lack of categorisation**

The code strongly discourages statements which provide only total figures for mineral resources or ore reserves. In public reports, mineral resource estimates should be allocated to one or more of the defined categories of Measured, Indicated and Inferred and the tonnages/grades allocated should be stated (likewise ore reserves). While this requirement stops short of being mandatory, it is possible that failure to observe the standard could lead to questions from regulatory authorities.

**Use of incorrect terminology**

Terms such as "Probable Resources", "Geological Resources", "In-Situ
Reserves", "Mining Reserves", "Possible Reserves" and so on have no meaning under the code and may not be used in public reports. They may, of course, be used in internal company reports - however, their use should be discouraged since they are inconsistent with code terminology.

Reporting of only contained metal without also reporting tonnages and grades

The guidelines state that such reporting "deprives the public of vital information" and "is not in accordance with the code". It is very relevant to the potential investor to know whether a quoted quantity of contained metal is the product of a large tonnage of low-grade material or a small tonnage of high-grade material. Further, quoting contained metal without also quoting grades can, particularly for mineral resources, result in a potential investor inferring a value for the deposit which is at variance with its true realisable value.

Lack of explanation of the relationship between reported mineral resources and ore reserves

Reports often do not make it clear whether stated mineral resources are inclusive of, or additional to, stated ore reserves. The relationship is important because readers of the report might otherwise add together tonnage/grade figures which are not intended to be added together and so reach incorrect conclusions (of course, mineral resources and ore reserves, being "apples and pears", should not be added together anyway).

The guidelines provide recommended forms of clarifying statements.

Lack of reference, when necessary, to assessment criteria

Any report of Pre-Resource Mineralisation must include details which bear on sampling of the mineralisation, such as drilling/sampling density, drilling/sampling methodology, or sample and assay quality. Reports of mineral resources and/or ore reserves should state the nature of the data on which the estimates are based and mention any assessment criteria for which inadequate or only poor-quality data are available.

Inadequate and/or incorrect statements regarding the competent person

It is often forgotten that the listing rules require that public reports which contain information on mineral resources and ore reserves include a statement to the effect that the requirements of the code with respect to the Competent Person have been met. The guidelines provide a recommended form of statement which covers this requirement and it (or variants of it) should be used in all relevant reports.

Statements to the effect that resource and/or reserve figures have been "estimated" (or, worse, "calculated") in accordance with the code

The code does not regulate estimation methodology. It establishes a system of resource/reserve classification and sets minimum standards for public reporting.

Lack of rounding of resource/reserve figures

If tonnages and grades are not rounded so as to reflect the uncertainty surrounding their estimation, then an unrealistic degree of accuracy is implied. This is not only poor professional practice but is potentially misleading to readers of the report.

THE FUTURE

The code is not a static creation. It is constantly being re-examined to determine its relevance to the mining and investment industries. The Joint Ore Reserves Committee meets regularly to consider matters raised by its own members and by other interested parties.

Major developments are occurring on the international scene, with Australia taking a leading role in the initiative to develop a universal set of reporting standards which would be adopted or acceptable in most countries. At a recent conference of the Council of Mining and Metallurgical Institutions at Sun City, South Africa, Norman Miskelly, a member of the Australasian Joint Ore Reserves Committee, gave presentations designed to stimulate debate and speed the adoption of an international code.

The response from other countries was encouraging and realisation of this aim seems achievable in the short to medium term.

As part of the push towards the adoption of an international code, the Australasian code and guidelines will be revised during 1995. Contributions from individuals and companies to the revision process are welcome.

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