Russian mineral

The increasing attention given by Western mining companies to Russia, particularly in gold, means that mining executives, analysts and investors must understand the Russian system for quantifying mineral deposits. This is vital not only for realising the opportunities presented by deposits already explored by Russian geologists, but also because Western entrants must comply with Russian regulations

BY STEPHEN HENLEY

THE Russian resource/reserve reporting system is very different, both in principle and in detail, from the principal reporting codes used internationally (JORC, SAMREC, Canadian NI43-101, USA SEC, and the IMM code).

The basis of all of the international codes is a recognition of the diversity of mineral deposits, the types of data available, and the economic factors which are to be applied. They place ultimate responsibility for reports on a competent person or qualified person, whose professional judgment in applying the codes is the principal determinant in the figures which are presented. The reporting codes themselves do no more than provide a consistent framework within which reports are prepared.

In contrast, the Russian system, developed initially in the USSR in the 1960s, aims to achieve total objectivity by prescribing the entire process of exploration, resource computation, and reporting. There is little or no space in the system – as originally designed, at least – for application of professional judgment. The prescribed computational methods are simple (they can be completed manually – important at a time when computers were a rarity in the region).

At first sight, the two systems appear completely incompatible. However, from the early 1990s onwards there have been significant changes in the way in which the Russian system has been applied – especially in the role played by economic modelling.

In parallel there has also been rapid convergence among the various Western national standards and emergence of a harmonised international reporting code. The result is that it is realistic now to use both systems and to translate reports prepared under the Russian system to broadly equivalent terms in the international codes.

BACKGROUND TO RUSSIAN REPORTING

The Soviet approach was centred on a document called the TEO (*technico-economicheskiye obosnovaniye* = technical-economic characterisation) and the TER (*technico-economicheskiye raschoti* = technical-economic calculations).

The TEO is broadly equivalent to the Western prefeasibility study, but is much more formalised, and its preparation follows a defined set of procedures. It takes into account factors such as technical options and commercial aspects, as well as the environmental implications of a planned project.

Formerly, the Soviet TEO was a precisely defined document written according to a set of detailed specifications – a style manual. Now there is less central control over the structure and content of a TEO, which will vary according to the mineral concerned, but each authorised reporting body follows its own internal guidelines for projects on which it is reporting, and requires consultants to follow such rules in their own reports on projects for which the institute is official adviser to the central GKZ.

(In Soviet times the authorised reporting body was one of the state-owned mine design institutes, but nowadays they are drawn more broadly and in many cases the body is the mining company holding the licence.)

The legislative framework within which the Russian system now works is all centred on GKZ, the State Commission on Mineral Reserves. This is a standing committee whose chairman is appointed by the Russian president. Clearly a single committee would be overwhelmed if it had to approve the reserves and resources for every mining project in such a large country. Therefore GKZ has set up regional sub-committees, the TKZ (Territorial Commission on Mineral Reserves) who actually do most of the work. The TKZ chairmen are appointed by GKZ; membership of the TKZ committees consists typically of 7-11 'chief specialists' employed directly by GKZ or the TKZ, and 5-7 'independent specialists' drawn from research institutes and other organisations within each region. Decisions on approval of resource/reserve estimates are reached by vote of the TKZ committee or, for larger-scale deposits, by a vote at GKZ level.

Because all mineral rights are owned by the state, one of the concepts in Russia which continues to the present day is the idea of the 'national raw materials base' as a 'balance' of reserves of all kinds of minerals, which can be used in computing the national net worth. Any mining operation will necessarily reduce this 'balance' and there is a presumed burden on the mining company to take action to restore the 'raw materials balance'.

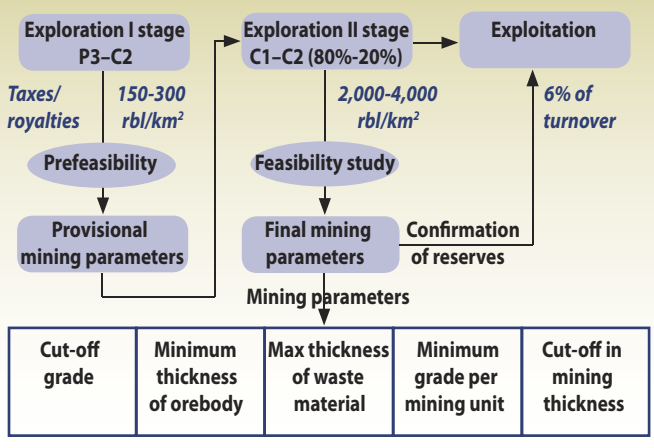
Mineral exploration in Russia follows a series of formal stages which represent progressively increasing detail of knowledge of a mineral deposit and are reflected directly in the resource classification system. Depending on the type of deposit (how complex it is, and its overall shape), drilling must be carried out on grids of prescribed density at each stage.

Clearly most coal deposits require less-dense drilling than most gold deposits. This is reflected in the rules. However, no account is taken of the detailed differences which make each mineral deposit unique.

Although this system is prescriptive, in practice it is little different from the Western approach which establishes analogies with known deposits (eg 'a Carlin-type deposit') and in which the exploration programme is informed by the parameters that are thereby expected.

The ultimate quality of the numbers for reserves and resources – regardless of the system used – depends on the quantity and quality of the work

FIGURE 1: DEVELOPMENT STAGES
(for hard-rock gold deposits, category III complexity



Project development stages, formal documentation, resource/reserve categories and taxation for a typical hard-rock gold deposit

reporting

that has been done, and the know-how and experience of the team responsible, in Russia just as in the West.

At the exploration stage, taxation is based purely on the area of the exploration licence, and currently is in the range of Rb150-300/km^2 at exploration stage 1, or Rb2,000-4,000/km^2 at exploration stage 2 – ie after the prefeasibility study (figure 1).

Once a deposit is considered to be ready for mining, an official reserve is calculated which becomes part of the mining licence. Under the terms of the licence, the official reserve is classed as 'balance ore' and is reduced each year according to the annual production from the mine. The company will be charged royalties (generally 6% of production revenue) based on the official reserves.

In principle these must be fully extracted, and the full royalties therefore paid, over the life of the mine. If this target is not met for some reason, penalties may be payable, though in practice there are generally mitigating circumstances which can be argued to waive the penalties.

There is also provision for the mining of 'out-of-balance' ore, which is generally low-grade ore that can be mined and which thus boosts production. A lower rate of royalty is usually paid on out-of-balance ore and if there is a shortfall on the balance ore it may be possible to offset some or all with out-of-balance ore and so avoid the penalties for failing to meet the terms of the mining licence.

Owing to the linking of the estimated ore reserves to actual payments of royalties over a mine's life, there is a natural tendency for Russian geologists to be conservative in their estimations. Not only would an overestimate lead to paying higher-than-necessary royalties, in past times the geologist was likely to find himself in trouble. Better, therefore, to err on the side of caution.

RESOURCE/RESERVE CLASSIFICATION

The former Soviet system for classification of reserves and resources, developed in 1960 and revised in 1981, is still used today in Russia and other CIS republics. Essentially, it divides mineral concentrations into seven categories, in three major groups, based on the level of exploration performed: fully-explored reserves or resources (A, B, C1), evaluated reserves or resources (C2) and prognostic resources (P1, P2, P3).

In principle, these follow a succession of approximations which are applied to various stages of exploration. This means that reserves or resources are assigned to classes based on the degree of their reliability and on their comparative importance to the national economy – in other words, the classification is not defined purely by exploration confidence levels but also incorporates some economic criteria.

Computation of reserves and resources follows a prescribed set of manual procedures (though these days they may be implemented in computer programs). The precise procedure used depends on the type of deposit being evaluated, but for hard-rock gold or polymetallic deposits, the procedures generally work from drill-hole intersections on parallel section lines.

The computation is effectively a simple linear interpolation – computing volumes of prisms and pyramids, and computing weighted averages of grades in the bounding drill holes. Although geostatistical methods have been available in Russia for some time, it requires special justification, and approval by the TKZ or GKZ, to use these for formal reporting, and they are not yet widely used.

Reserves and resources that could be matched to the usual international categories are those classified into five main classes designated by the symbols A, B, C1, C2 and P1. Capital letters are used to designate ores that are economic. Sometimes, the same group of letters are written in lower case when the mineralisation is considered sub-economic.

Alternatively, and more commonly, a simple classification is used, into classified (A, B, C1, C2) *balansovye* (balance) = commercially exploitable reserves, and unclassified *zabalansovye* (out-of-balance) = uneconomic resources.

Synonyms of *balansovye* and *zabalansovye* that are often encountered, and used descriptively, are *konditsionniye* (conditioned) and *nekonditsionniye* (unconditioned).

The resource/reserve categories are defined below (please note that the terms 'reserves' and 'resources' are to a large extent interchangeable here, and do not have the very distinct meanings that are placed on them in the international reporting codes).

Category A – The reserves in place are known in detail. The boundaries of the deposit have been outlined by trenching, drilling or underground workings. The quality and properties of the ore are known in sufficient detail to ensure the reliability of the projected exploitation.

Category B – The reserves in place have been explored but are known only in fair detail. The boundaries of the deposit have been outlined by trenching, drilling or underground workings. The quality and properties of the ore are known in sufficient detail to ensure the basic reliability of the projected exploitation.

Category C1 – The reserves in place have been estimated by a sparse grid of trenches, drill holes or underground workings. This category also includes

Continued on page 20

Continued from page 19

reserves adjoining the boundaries of A and B reserves, as well as reserves of very complex deposits in which the distribution cannot be determined even by a very dense grid. The quality and properties of the deposit are known tentatively by analyses and by analogy with known deposits of the same type. The general conditions for exploitation are known. The ore tonnage is derived from estimates of strike length, dip length and the average thickness of the orebody. Allowance for barren blocks may be made statistically.

Category C2 – These reserves are based on an extremely loose exploration grid, with little data. The limits of the orebody are defined mainly by extrapolation within known geological structures, and from comparison with other similar deposits in the vicinity. The grade and mineral properties of the orebody are determined from core samples and comparison with similar mineral deposits in the area. The reserves have been extrapolated from limited data, sometimes only a single hole. This category includes reserves adjoining A, B, and C1 reserves in the same deposit.

'Prognostic' resources (P) are estimated for mineralisation outside the limits of areas that have been explored in detail, and are often based on data from trenches and from geochemical and geophysical surveys.

Category P1 – Resources in the P1 category may extend outside the actual limits of the ore reserves defined in the C2 category. The outer limits of P1-type resources are determined indirectly by extrapolating from similar known mineral deposits in the area. P1 is the main source from which C2 reserves can be increased.

Category P2 – These resources represent possible mineral structures in known mineral deposits or ore-bearing regions. They are estimated based on geophysical and geochemical data. Morphology, mineral composition and size of the orebody are estimated by analogy with similar mineralised geological structures in the area.

Category P3 – Any potential ore-bearing deposits are classified as resources in the P3 category. The presence of these resources relies on the theoretical definition of a 'favourable geological environment'. Resource figures are derived from figures of similar deposits in the region.

Estimates of prognostic resources (P1, P2, and P3) routinely depend on assumptions and projections regarding the probable dimensions (length, width and depth) and grade of the deposit, which are subject to confirmation by more detailed investigations.

In decision-making on a new mining project, the categories normally taken into account are A, B, C1, and C2. There is, therefore, a broad equivalence between these and the Western proved and probable reserves.

DEPOSIT CATEGORIES

Deposits are categorised by their complexity (figure 2) and by their size and shape. These two categorisation systems overlap to a significant extent, in that complexity-class I deposits tend also to be in shape/size group 1.

COMPLEXITY CLASSES

I – No structural complexity, uniform thickness and homogeneous grades

II – More complex, non-uniform thickness and significant grade variability

III – Highly complex structure, significant variations in thickness and very uneven grade distribution

IV – Extremely complex structure, extreme variations in thickness and in grade distribution

SIZE/SHAPE GROUPS

Group 1 deposits – Large deposits, simple in form, with uniform distribution of minerals (examples: coal, some iron and disseminated copper deposits). A normal density of drill holes allows the definition of a high level of A and B reserves.

Group 2 deposits – Large deposits with different and sometimes complicated forms and uneven distribution of minerals (examples: some iron and sedimentary copper deposits). Up to only B category reserves may be defined with a normal grid of drill holes. A combination of drilling and underground workings may be necessary to define the reserves. Category A reserves can be established only by close-spaced drilling and underground workings.

Group 3 deposits – Smaller-sized deposits with uneven distribution of minerals (examples: some veins, skarns, dykes, and pegmatite deposits). Drill holes can establish only C1 reserves. B reserves can be established only with underground workings.

Group 4 deposits – Smaller-sized deposits similar to shape/size-group 3 deposits or with even more complex shapes (examples: some veins, skarns, dykes, pegmatite deposits and gold placers). Category A reserves cannot be established with drilling or a normal grid of underground workings. Drilling in combination with underground workings is necessary to establish category B reserves.

Group 5 deposits – Small pocket deposits. Category A and B reserves cannot be established. Only category C reserves can be established, by systematic prospecting.

Thus, hard-rock gold deposits typically are of complexity classes III and IV, and size/shape groups 3, 4 and 5. The result of this is that reported exploration reserves and resources – even at the stage of making the decision to commence mining – can reach only the C1 classification. Indeed, in many projects, even during mining, there will be no reserves classified as A or B.

To expand on this: the maximum level of confidence that can be achieved depends on the type of deposit. Thus, the 'highest' two reserve categories – A and B – do not necessarily require more work than a C1 category. The reason for this thought process is that there is a limit to the amount of certainty that can be achieved. Therefore, a complexity-class III-type deposit will continue to have a high degree of uncertainty even if additional work (such as a tighter drilling pattern) were done. So, the highest reserve category that could normally be awarded under the Russian system to a complexity-class III deposit is C1.

Based on this argument, the highest category that can normally be allocated to a complexity-class II deposit is B, and only a complexity-class I deposit can be awarded an A reserve category, ie highest quality and a large degree of confidence. Obviously, the drilling requirements (though not necessarily the other engineering and economic studies) are less onerous for a simpler type of deposit. Thus, a complexity-class I deposit could achieve an 'A' reserve category even if the drilling is fairly wide-spaced.

In addition to considerations about deposit type, the Russian system is also concerned with progressive elimination of as much uncertainty as possible. So, the Russian approach also takes into account the coefficient of variation of the ore grade. The coefficient of variation is the ratio of the amount of variability (standard deviation) relative to the value of the mean.

Thus an A-type reserve would be one where the grade of the deposit might be known to a confidence level of 90%, a B reserve to a confidence level of 75%, and a C1 reserve to a confidence level of 50%. Even though the C1 reserve might be drilled on a closer spacing, the variability of the grade distribution would be such that a higher reserve category would not be warranted.

INTERNATIONAL CONTEXT

There are two key aspects of the international and the

FIGURE 2: COMPLEXITY CLASSES

	I	II	III	IV
Highest categories of reserves normally achievable	**A**	**A,B**	**C1**	**C2**

FIGURE 3: BASIC WESTERN APPROACH

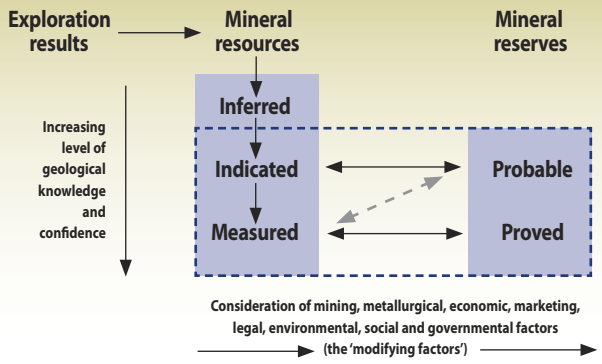
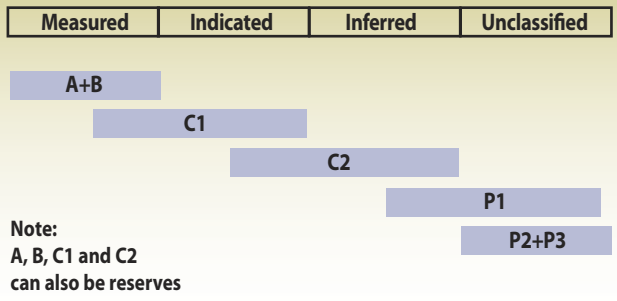


FIGURE 4: RECONCILIATION OF RUSSIAN AND INTERNATIONAL REPORTING SYSTEMS



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various Western national codes:

- Their reliance upon the professional judgment of 'competent persons' who are qualified, experienced, and are members of relevant recognised professional bodies with enforceable rules of conduct
- Their use of a set of common concepts to define reserves and resources according to a standardised nomenclature.

Like the Russian system, there is classification according to increasing levels of confidence derived from progressively more detailed exploration data (figure 3).

Unlike the Russian system, there is an explicit separation between this and the economic and technical factors – which are reflected in a transfer from resources to reserves. (In the Russian system, the transition from P categories to C2 and above is taken as being also the transition from resources to reserves.)

It must be noted that the quoted numbers for resources or reserves are not exact. Although reserves and resources may be stated as quite precise numbers, in terms of tonnage and grade, they are based on best estimates, and as such cannot be exact.

In the international reporting codes, the boundaries between ore classes are flexible. Particularly for resources, it is the responsibility of a qualified competent person to decide when sufficient data are available to move ore resources from inferred to indicated, and from indicated to measured. This contrasts with the Russian system, where the transfer between categories is decided on much more objective criteria.

RECONCILIATION OF RUSSIAN AND INTERNATIONAL SYSTEMS

A broad equivalence between the classifications may be presented as follows.

Russian	International reporting code, JORC etc
A, B	Proved reserve/measured resource
C1	Proved or probable reserve/indicated resource
C2	Probable reserve/indicated resource/inferred resource
P1	Inferred resource
P2	Reconnaissance mineral resource (as found under UN Framework Classification for Reserves/Resources, code 334)
P3	No equivalent

(See also figure 4)

Reserves (in Western classifications such as JORC) will generally contain material of categories A, B, and C1, but adjacent to existing or planned mining operations (where technical and economic studies have been carried out), C2 will often also be considered as part of the reserves. In exploration areas (where no mine planning has been done), C2 might more appropriately be thought of as indicated resource.

For material to be included in A, B, and C1 categories there has generally been sufficient technical and economic study carried out to interpret them as reserves. C2, as noted above, depending on the circumstances, may correspond to inferred or indicated resources or to a probable reserve, though the Russian rules for acceptance of C2 also require a substantial amount of additional work to have been done beyond that which would be needed simply to establish a resource.

The Russian classification allows for something known as a 'sub-economic reserve' (often material that is classified as *zabalansoviye* resources). This is material that has been intensely drilled and analysed (including economics, engineering, etc) but which is not economic under current conditions.

This material would not be considered a reserve according to the SEC standard, but could well fit within the measured and indicated category under the International Code. Moreover, the intent of the classification is the same. This is material that has been the subject of a full feasibility, but which does not fall into an economic reserve at present.

When expressing Russian classified reserves and resources in terms of one of the Western codes, it is important that a competent person (in the sense of the International Reporting Code definition) who understands both systems should carry out the conversion.

It is important to note that in the Western codes, the methods of analysis are not defined. For example, the JORC definitions use words such as 'appropriate' and 'estimation'.

Much reliance is placed on the experience of the competent person supervising the analysis. However, the exact methodology of the analysis is not defined – and is deliberately left open to allow for developments in exploration, mining and geostatistics.

ACKNOWLEDGMENTS

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