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THE RUSSIAN RESERVES & RESOURCES REPORTING SYSTEM
Discussion and Comparison with International Standards

1. Introduction

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 in a region and at a time when computers were a rarity).

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 in the Russian system to broadly equivalent terms in the international codes.

2. Background to the Russian Reporting System

This section is adapted from a presentation given by Nikolai Vlasov, chief geologist, Peter Hambro Mining plc.

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 pre-feasibility study, but it is much more formalised, and its preparation follows a defined set of procedures (Stanchenko et al, 1986). It takes into account factors such as technical options and commercial aspects, as well as the environmental implications of a planned project.

In a Russian mining project, one of the most important controlling factors, and the one which causes most misunderstandings in the west, is the procedure for reporting reserves and resources. 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, which will vary according to the mineral concerned, but each authorised reporting body (formerly one of the state-owned 'design institutes' but now drawn more broadly) 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.

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. herefore GKZ has set up regional sub-committees, the TKZ (Territorial Committees 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 from 7 to 11 'chief specialists' employed directly by GKZ or the TKZ, and 5 to 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 (e.g. "this is a Carlin-type deposit") and in which the exploration programme is informed by the parameters which are expected thereby.

The ultimate quality of the numbers for reserves and resources – regardless of what system has been used – depends on the quantity and quality of the work that has been done, and the know-how and experience of the team that is carrying out the work, 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 150-300 rubles/km^2 at exploration stage 1, or 2000-4000 rubles/km^2 at exploration stage 2 (i.e. after the pre-feasibility study).

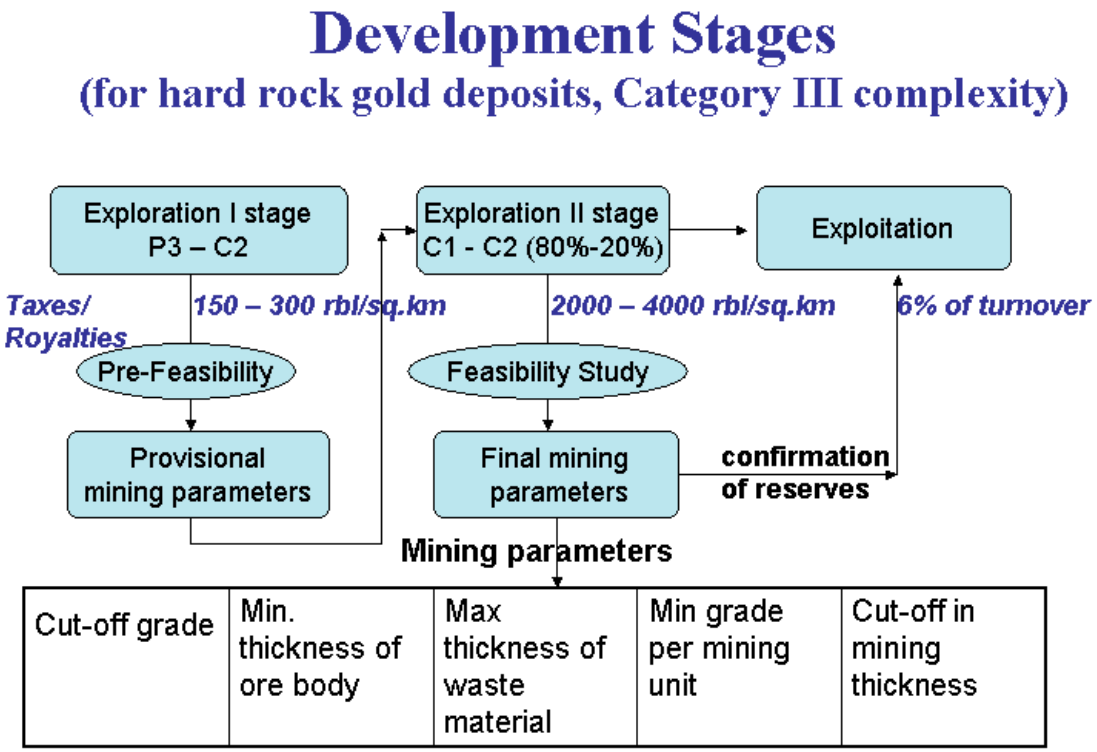


Figure 1 - Project development stages, formal documentation, resource/reserve categories, and taxation for a typical hard-rock gold deposit *(diagram copyright Peter Hambro Mining plc)*

Once a deposit is considered to be ready for mining, an official reserve is calculated that 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 prduction 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 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 of that with 'out-of-balance' ore and so avoid the penalties for failing to meet the terms of the mining licence.

Due 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 over-estimate 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.

3. 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, C_1), evaluated reserves or resources (C_2) and prognostic resources (P_1, P_2, P_3).

In principle, these follow a succession of approximations that are applied to various stages of exploration. This means that reserves or resources are assigned to classes based on the degree of reliability and indicate their comparative importance for the national economy (in other words, the classification is not defined purely by exploration confidence levels but also incorporate 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, they generally work from drillhole 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 drillholes. Although geostatistical methods have been available in Russia for some time (Kaputin et al, 1995), 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 can be matched to the usual international categories are classified into five main classes designated by the symbols A, B, C_1, C_2 and P_1. Capital letters are used to designate ores that are economic. Sometimes, the same group of letters are written in lower case when the mineralization is considered sub-economic. Alternatively, and more commonly, a simple classification into classified (A,B,C_1,C_2) “balansovye” (balance) = commercially exploitable reserves and unclassified “zabalansovye” (out-of-balance) = uneconomic resources is used. Synonyms of “balansovye” and “zabalansovye” which are often met, 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 by 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 only known 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 C_1 The reserves in place have been estimated by a sparse grid of trenches, drillholes or underground workings. This category also includes 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 average thickness of the ore body. Allowance for barren blocks may be made statistically.

Category C_2 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 that are adjoining A, B, and C_1 reserves in the same deposit.

Prognostic Resources are estimated for mineralization 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 P_1 Resources in the P_1 category may extend outside the actual limits of the ore reserves defined in the C_2 category. The outer limits of P_1-type resources are determined indirectly by extrapolating from similar known mineral deposits in the area. P_1 is the main source from which C_2 reserves can be increased.

Category P_2 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 mineralized geologic structures in the area.

Category P_3 Any potential ore-bearing deposits are classified as resources in the P_3 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 (P_1, P_2, and P_3) routinely depend on assumptions and projections regarding the probable dimensions (length, width and depth) and grade of the deposit that are subject to confirmation by more detailed investigations.

In decision-making on a new mining project, the categories that are normally taken into account are A, B, C_1, and C_2. There is, therefore, a broad equivalence between these and the western proved plus probable reserves.

4. Deposit Categories

Deposits are categorised by their complexity and by their size and shape. These two categorisation systems overlap to a significant extent (i.e. they are not orthogonal), in that complexity class I deposits tend also to be in shape/size group 1.

Complexity classes:-

I. no structural complexity, uniform thickness, homogeneous grades
II. more complex, non-uniform thickness, 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 drillholes 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). Only up to B category reserves may be defined with a normal grid of drillholes. 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). Drillholes can only establish C1 reserves. B reserves can be established only with underground workings.
- **Group 4 deposits -** Smaller sized deposits similar to 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.

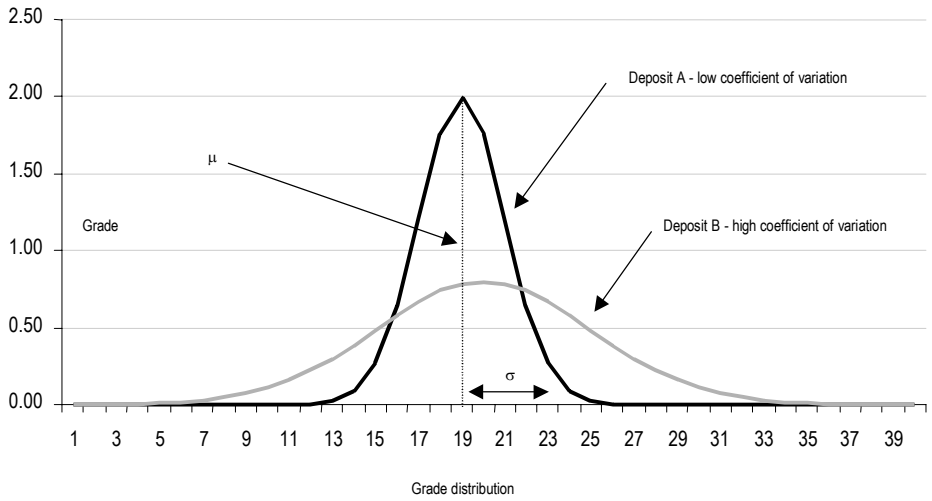
Thus hard-rock gold deposits typically are of complexity classes III and IV, and size/shape groups 3, 4, and 5. The result of this is that reported exploration reserves and resources - even at the stage of making the decision to commence mining - can reach only the C1 classification. Indeed, in many 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 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 Group III deposit is C1. Based on such arguing, the highest category that can be allocated to a Class II deposit is B, whereas only a Class I deposit can be awarded an A reserve category, i.e. 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 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.

The concept is perhaps best explained using the diagram below, which simply shows two normally distributed samples that are representative of the grade distribution in a deposit. Deposit A (black line) clearly has a less variable distribution of the grade. The ratio of the standard deviation and the average grade defines the coefficient of variation. Deposit B (grey line) has a wider grade distribution for the same average grade and therefore has a higher coefficient of variation.



Source: PHM

It is likely that this variability will persist regardless of the amount of drilling that has been completed. As noted, one of the concepts of the Russian system is to define the

variability of the grade in a given mineral deposit and do as much work as possible to reduce the level of uncertainty. In this example, Deposit B would never be allocated a higher reserve category than Deposit A.

5. The Evolving International Standards

In December 1991, the IMM approved new definitions for reserves and resources. These also appeared in a slightly modified form in the London Stock Exchange Listing Rules (Chapter 19 – Mineral Companies).

Since 1994, the Council of Mining and Metallurgical Institutions (CMMI) has been working to create a set of standard international definitions for reporting Mineral Resources and Mineral Reserves, modelled on the existing JORC Code (the Australasian Code for Reporting of Mineral Resources and Ore Reserves). An ad-hoc CMMI Mineral Resources/Reserves International Reporting Standards Committee (CMMI – CRIRSCO) was formed, with representatives from mining and metallurgical institutions from the United States (SME), Australia (AusIMM - JORC), Canada (CIM), the United Kingdom (IMM, now the IMMM) and South Africa (SAIMM).

Concurrently, and since 1992, the United Nations Economic Commission for Europe (UN-ECE) has been developing an International Framework Classification for Reserves/Resources - Solid Fuels and Mineral Commodities (the UNFC).

In 1997, the CMMI - CRIRSCO reached a provisional agreement (the Denver Accord) on definitions of Mineral Resources and Mineral Reserves. At a joint meeting in Geneva in 1998 between the CMMI – CRIRSCO and the UN-ECE Task Force, agreement was reached to incorporate the CMMI – CRIRSCO standard reporting definitions for Mineral Resources and Mineral Reserves into the UNFC, thus giving truly international status to the CMMI – CRIRSCO definitions.

As a consequence of the CMMI initiative, significant developments have taken place towards producing consistent reporting standards for Mineral Resources and Mineral Reserves. These include the release of updated versions of the JORC Code in Australia in 1996 and 1999, followed by publication of similar Codes and Guidelines by the professional bodies in South Africa, the USA, Canada, UK, Ireland and Europe. The similarity of reporting codes and guidelines in those countries represented by the CMMI is now at a point where the development of a generally recognised International Reporting Code is nearly completed.

National codes such as JORC will in future be implementations of subsets of this international code.

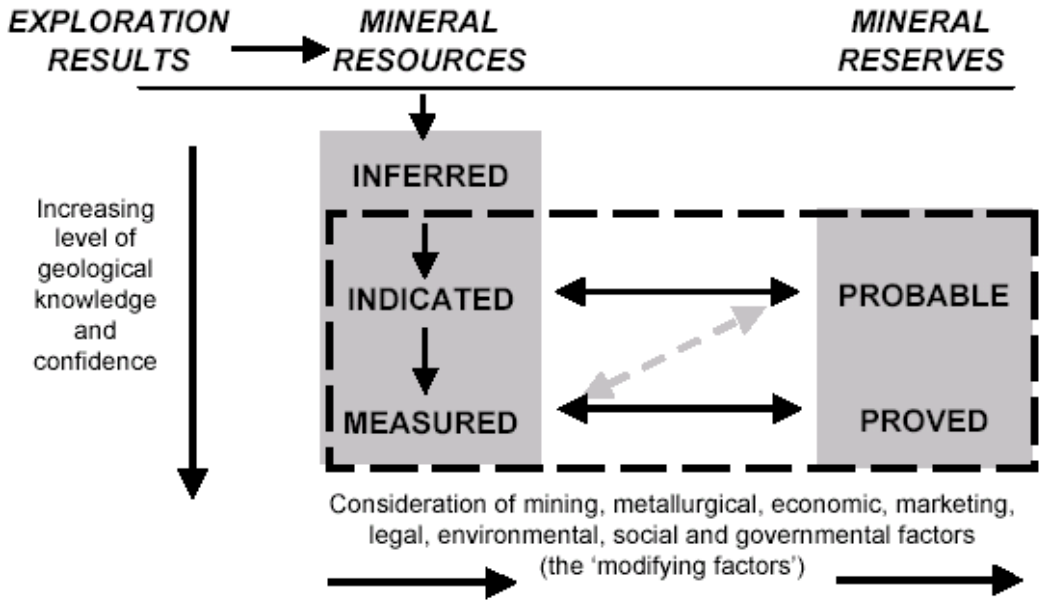
In the United Kingdom, the Financial Services Authority (FSA) is the competent authority, with listing through the UK Listing Authority (UKLA). The UKLA keeps the “Official List” of company stock shares, and creates the “Listing Rules” for the London Stock Exchange. In preparing The Reporting Code, consultations were held

with the UKLA and stock exchanges in London, with relevant comments addressed in the document.

As of November 2003, the UKLA, however, had not yet adopted The Reporting Code and instead relies on its own rules contained in Chapter 19 of the Listing Rules (Chapter 19), which addresses Mineral Companies, though it has agreed in principle to replace chapter 19 by The Reporting Code in the near future. Chapter 19 relies on the older 1991 IMM definitions for reserves and resources. Chapter 19 is not consistent with The Reporting Code, with significant differences, including no allowance for inferred mineral resources. However, UKLA has been accepting reporting in accordance to the Reporting Code, including the allowance for including inferred mineral resources as long as they are tabulated separately from measured and indicated resources.

There are two key aspects of the international and the 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**.



- *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 reliability.*

- *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 and/or grade continuity but are spaced closely enough for continuity to be assumed.*

- *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 grade continuity.*

- *A **'Probable Mineral Reserve'** is the economically mineable part of an Indicated, and in some circumstances, 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 justified.*

- *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 justified.*

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

The UNECE / UNFC contribution to the International Reporting Code (Appendix 1) is potentially very important from the point of view of the Russian system, as it provides an additional resource category of **Reconnaissance Mineral Resource**:

> *A **'Reconnaissance Mineral Resource'** is based on regional geological studies and mapping, airborne and indirect methods, preliminary field inspection, as*

well as geological inference and extrapolation. The aim is to identify areas of enhanced mineral potential worthy of further investigation towards deposit identification. The level of confidence is lower than that applying to an Inferred Mineral Resource and is usually not sufficient to quote tonnage and grade figures. UNFC Code 334.

Estimates of quantity based on limited information and analogies with known deposits of similar geological character may be possible but are inadequate for classification as Inferred Mineral Resources.

This means that there is an internationally recognised category which can be used to express resources that are classified as P_2 in the Russian system.

However, it must be noted that the UNECE categories are included as an appendix to The Reporting Code, and come with a 'health warning': they are *"... for information only and do not form part of the Code or Guidelines", and furthermore, "It is not intended that these categories be used for non-governmental investment and financing decisions."*

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.

6. Reconciliation of Russian and International Reporting Systems

A broad equivalence between the classifications may be presented as:-

Russian	International reporting Code, JORC, etc
A,B	Proved Reserve / Measured Resource
C_1	Proved or Probable Reserve / Indicated Resource
C_2	Probable reserve / Indicated Resource / Inferred Resource
P_1	Inferred Resource
P_2	*Reconnaissance Mineral Resource (or UNFC code 334)*
P_3	*no equivalent*

Reserves (in western classifications such as JORC) will generally contain material of categories A, B, and C_1, but adjacent to existing or planned mining operations (where technical and economic studies have been carried out), C_2 will often also be considered as part of the reserves. In exploration areas (where no mine planning has been done), C_2 might more appropriately be thought of as indicated resource.

For material to be included in A, B, and C_1 categories there has generally been sufficient technical and economic study carried out to interpret them as **reserves.** C_2, 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 C_2 also require a substantial amount of additional work to have been done.

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 Internatonal 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.

7. Acknowledgments

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