Industrial Minerals

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Preamble

An Industrial Mineral is any rock, mineral or other naturally occurring substance of economic value, exclusive of metallic ores, mineral fuels and gemstones; that is, one of the non-metallic minerals. The General Guidelines and main elements of the current CIM Best Practice draft are for the most part, readily applicable to industrial minerals deposits. However, in estimating either a Mineral Resource or a Mineral Reserve for an industrial mineral deposit, the QP should give priority to: (i) the value of the intended mineral product; (ii) market factors; and (iii) applicability of the market criteria to the mineral deposit being assessed. Estimation of MRMR for industrial minerals requires special care. The classification of an industrial minerals deposit as a MRMR is affected to a significant degree by a number of factors that are less applicable to metallic mineral deposits, including: particular physical and chemical characteristics; mineral quality issues; market size; the level of the producer's technical applications knowledge; market concentration; and transportation costs.

The CIM Standards on Mineral Resources and Mineral Reserves, Definitions and Guidelines, dated August 20, 2000 (the "CIM Standards", NI 43-101 and Companion Policy 43-101CP) state that: *"When reporting Mineral Resource and Mineral Reserve estimates relating to an industrial mineral site, the Qualified Person(s) must make the reader aware of certain special properties of these commodities"*. Best Practice in the estimation of MRMR of industrial minerals centres on determination of components of the Market, Value, and Costs. Market considerations incorporate not only the requirement for detailed market analyses and/or contracts of sale, but also recognition that markets for many industrial minerals are relatively small, may have a high degree of producer concentration, or may have very high technical barriers to entry, thus imposing limits or constraints on achievable market volumes. Value is a function of (*i*) product quality in relation to consuming industry or customer specification, (*ii*) product price, and (*iii*) project robustness. Costs are comprised of (*i*) mining costs, (*ii*) processing costs, and (*iii*) transportation and special handling costs. The key to estimation of MRMR, in particular for industrial mineral deposits, is the recognition by the Qualified Person(s) of the inter-relationship that exists between (*i*) markets, (*ii*) product evaluation, and (*iii*) product development. Dialogue between seller and buyer must start early in the exploration program and continue right through to production.

The estimation of MRMR is likely to be an iterative process where increasingly rigorous assessment is applied in order to attain greater confidence and higher rank in the Mineral Resource/Mineral Reserve classification. An estimate need not attain or incorporate a rigorous and complete understanding of all factors and inter-relations at an early stage in the life of a project. The classification of the mineral deposit as Inferred, Indicated or Measured Mineral Resources, or Probable/ Proven Mineral Reserves should always reflect the level of understanding of the project, which is a function of the stage of exploration/development.

In addition to the General Guidelines, and in particular with respect to industrial minerals deposits, the assessment of the various characteristics of the deposit as well as quality and market factors should be taken into account with respect to the following: Mineral Resource Estimation Critical elements to the Mineral Resource estimate for industrial minerals are: (i) the consideration of the physical and chemical properties of the subject mineral; (ii) the spatial relationship of these properties within the mineral occurrence; and (iii) the relationship of the physical and chemical properties of the mineral to the available market(s).

The QP should also recognize that optimization of the Mineral Resource estimate in consideration of applicable economic parameters is an iterative process and that resource estimates should be adjusted to reflect new market information. In addition to the parameters included in the General Guidelines, it should be emphasized that in completing a MRMR estimate for an industrial mineral deposit, the application of *reasonably developed* economic parameters is crucial to the *reasonable expectation* and/or *demonstration of economic viability* of the deposit.

As stated in the General Guidelines, consideration of economic parameters is an iterative process based on generally accepted industry practice and experience. The judgment of the individual QP will also be a factor in evaluating the economic parameters applicable to industrial mineral deposits. It is recognized that the rigorousness of the estimate, particularly with respect to market factors, shall take into account an appropriate level of detail in consideration of: (i) the stage of the project; (ii) availability of appropriate information; (iii) the level of investment required to place the project into production; and (iv) financial ability of the entity to conduct research. Given the above, an entity or QP shall none the less prepare the estimate to the best of its practical ability, clearly stating where additional information is required in order to increase confidence in the estimate of the MRMR.

In general, estimation methods used for industrial mineral deposits are the same as the methods used for metallic mineral deposits, and the reader is referred to the appropriate section of the ‘General Guidelines’ with respect to considerations of:
Data Density Integration of Geological Information
Listing/Recording of Data Set
Data Analysis
Sample Support
Economic Parameters
Mineral resource Model
Interpolation Method
Mineral Resource Validation

However, the QP should take note of the following considerations when developing a Mineral Resource estimate for an industrial minerals deposit:

- Industrial mineral deposits differ significantly from other, more typical metallic mineral deposits and even amongst themselves. These differences may be reflected in the data density required for certain confidence intervals. For example, the sampling points (e.g. drill holes) required for an industrial mineral deposit that exhibits strong structural and grade continuity (e.g. a bed of homogeneous limestone) may be more widely spaced than they would be for a typical volcanogenic massive sulfide (VMS) deposit where either structure and/or grade are less uniform. In other cases, the converse may apply. The QP

shall use reasonable judgment in the context of the deposit type, style and formation of the particular mineral deposit being assessed, and the objective of the estimation process (i.e. Inferred, Indicated or Measured Mineral Resource/Probable or Proven Mineral Reserve).

- Customer specifications for industrial mineral products are frequently based solely on physical properties rather than, or in addition to, chemical characteristics. Sample testing should include those tests that will provide the physical characteristics and chemical analyses that relate to the specifications of the end product.
- An industrial mineral may have multiple market applications or it may be included in multiple end-products. It is essential to determine the physical and chemical characteristics of the industrial mineral in sufficient detail that its appropriateness for *each* intended market can be assessed.
- Determination of the chemical and physical characteristics of an industrial mineral often involves procedures and tests that are not part of the normal activity of an analytical laboratory. The QP should ensure that the physical and chemical analytical work conducted on the industrial mineral is appropriate and relevant to the identification of the properties of interest in the intended application(s), and that the laboratory has the requisite experience and necessary equipment to conduct the required tests.
- The properties of an industrial mineral occurrence can vary markedly from location to location and even within the same deposit. In particular, many industrial minerals deposits are subject to a nugget effect. The nugget effect may be caused by grain size (e.g. large crystals in pegmatites may distort sample results). Within the context of a particular deposit or deposit type, a sufficient and appropriate number of samples may be required to ensure that: meaningful average sample results are obtained; impurities or other detrimental factors are identified and delineated (impurities may be localized and the sampling density and estimation method employed should recognize this fact); and using appropriate statements reflecting analytical precision (mineral quantification and some other analytical techniques are less precise than standard chemical analyses, thus necessitating the use of averages over a large number of samples).
- Multiple factors may be used in evaluating the quality or value of an industrial mineral during the MRMR estimation process. The QP should be aware of the methods available to estimate the “value” of each block of a resource, and justify the selection of the method employed. Among the techniques available for combining values are the following:

    1. Estimate the main variable (e.g. mineral percent) and use the other variables as indicators. The reason for this is that the potential for error may be greater when the estimation method used is conditionally biased for one or all of the quality parameters. The resource will then include only those blocks that exceed the minimum specifications for all parameters. While this approach may lead to the exclusion of marginal blocks from the resource, these marginal blocks could be mined and blended with other material to provide a product that meets the required specifications.
    2. Estimate each factor separately. Each block is then accepted or rejected (with or without blending with another block or blocks). Adequate data is

required, and an appropriate estimation method is needed, for each factor.

3. Use co-kriging or other geostatistical methods which take into account the correlation between factors. This method is useful where one factor is better known than others. Applied sensibly, it effectively maximizes all of the available data.
4. Use categorical variables. This approach is particularly applicable in cases where value is affected by a number of co-variables, some of which are semi-qualitative. By treating each variable as a categorical variable and then combining those into an "index" which can estimated by geostatistical or other means, subjective evaluation is avoided. This method may be especially useful in estimation of resources/reserves in stone quarries and other working deposits.

- Published specifications and standards for industrial minerals should be used primarily as a screening mechanism to establish the marketability of an industrial mineral. The suitability of an industrial mineral for use in specific applications can only be determined through detailed market investigations and discussions with potential consumers.
- The QP should be aware that test results for industrial minerals, especially those related to the results of beneficiation tests, could be subject to significant scale-up effects. The QP should ensure that laboratory test procedures adequately duplicate the proposed production process. In many cases, bulk samples as large as 500 tonnes may be required. This may necessitate start-up of production prior to finalization of sales contracts.
- Identification of the market and the factors that influence market demand and the potential for success in the market are critical to determining 'value' for an industrial mineral and therefore the classification of the mineral deposit as either a Mineral Resource or Mineral Reserve. The QP should take careful note of the following considerations when evaluating the market potential for an industrial mineral deposit:

    1. The market for an industrial mineral resource is not usually a single entity, but typically consists of a number of distinct segments. It is important to recognize the differing requirements of each market segment and to relate these requirements to the physical and chemical properties of: (i) the industrial mineral in the particular deposit being assessed; (ii) the proposed production and processing technology for the mineral product; (iii) the applications knowledge of the mineral producer; (iv) the market size available in each segment; and (v) the price available for each market segment.

    2. Markets for industrial mineral resources are significantly affected by location and transportation factors. The QP should recognize that the existence of an industrial mineral deposit does not imply that it comprises a Mineral Resource as defined by the CIM Standards and NI 43-101. . Under the definitions of the CIM Standards, a mineral occurrence must have "reasonable prospects of economic exploitation" to be classified as a Mineral Resource; or it must be "demonstrated as being capable of profitable exploitation" to be classified as a Mineral Reserve. If the mineral deposit is in a remote location, distant from transportation infrastructure and customers, so that there may be no realistic market or

development potential for the mineral, the mineral deposit **cannot** be classified as a MRMR.

3. Some industrial minerals are produced in small quantity and/or have specialized, low volume applications. The QP should understand the limits to market size for an industrial mineral and develop estimates of a Mineral Resource or Mineral Reserve that are consistent with the appropriate market size for that particular mineral product.

4. Many industrial minerals are produced by only a small number of companies. In these cases, there may be high barriers to market entry by a new producer. These barriers can include proprietary processing knowledge and/or equipment, knowledge of mineral end use applications, long term contractual producer/customer relationships, or captive consumption. Before estimating either a MRMR in such circumstances, the QP should conduct sufficient investigation**s** to ascertain that an identifiable market can be developed, that the intended product can indeed be sold, and that there is a reasonable expectation that the mineral deposit could be placed into commercial production.

5. Many applications for industrial minerals can be satisfied by several competing minerals offering similar functional properties, and often at similar costs. The QP should therefore be aware of the potential for product substitution when evaluating the market potential of an industrial mineral. Estimates of a MRMR should incorporate provision for product substitution when establishing the anticipated level of market demand and/or market price for the subject mineral.

6. Many industrial minerals consumers are reluctant to change sources of supply. Even when consumers are willing to change sources of supply, the time frame in which this occurs may be quite lengthy. The QP, in developing estimates of MRMR, should therefore incorporate provision for an extended period of customer applications trials and/or the requirement for large –scale bulk sampling.

7. Published prices for industrial minerals may be used as indicators of value in the estimation of MRMR, but should be supplemented by additional pricing research to determine the potential value of the subject commodity. Published prices and actual transaction prices for a particular grade of an industrial mineral may vary substantially. As far as possible, the QP should ensure that price estimates used in estimation of a Mineral Resource, and especially those used in estimation of a Mineral Reserve, can be confirmed by discussion with potential customers and/or commitments of sale.

8. The QP should recognize that specifications for industrial minerals in many applications are flexible. Consumers may be able to incorporate minerals with a wide variety of physical and/or chemical properties into their product either by adjusting the mixture of ingredients used in the manufacturing process, or by making modifications to the process. In

many cases, consistency or predictability of characteristics of the industrial mineral is more important than a specific quality characteristic.

9. Prices and specifications for industrial minerals are usually established by negotiation between producer and consumer. Slight differences in specifications may result in very large differences in price and/or volume, and contracts are sometimes written for large tonnages of a product at a special confidential price. The QP should recognize such considerations when developing the MRMR estimate.

Mineral Reserve Estimation

In addition to the General Guidelines, it is intended that estimation of a Mineral Reserve for an industrial mineral deposit should incorporate more rigorous research and assessment of the criteria than that outlined for estimation of a Mineral Resource in the previous section. Some industrial mineral ventures are relatively simple operations with low levels of investment and risk, where the operating entity has determined that a formal prefeasibility or feasibility study in conformance with NI 43-101 and 43-101 CP is not required for a production decision. The demonstration of the economic viability of an industrial minerals deposit, as required under the General Guidelines, may be satisfied by actual profitable production. Alternatively, where production has not ye t commenced, there should be evidence of market and economic analyses consistent with sound judgment reflecting the spirit and intent of the requirements of NI 43-101 and 43-101 CP. However, the lack of a formal pre-feasibility or feasibility study with respect to a venture should be clearly communicated to current and potential stakeholders as this may be considered a risk factor.

As stated in the General Guidelines, the QP should recognize that the time from discovery to development of a mineral deposit could be measured in years. The QP should be aware of the impact of changing conditions in the industrial minerals commodities, as outlined above, on Mineral Reserve estimates. The parameters that are used as a basis for the estimates should be updated at appropriate intervals to take into account significant changes that may affect the economic viability of a project. Changes in market factors are particularly important.