MINLAND: Mineral resources in sustainable land-use planning

A H2020 Project

Topic: SC5-15d - Linking land use planning policies to national mineral policies

Deliverable 4.1: Existing valorisation and classification schemes and valuation methods for mineral land use practices

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Preface

Process of assessing of mineral deposits includes (or can include): their exploration and recognizing, together with appropriate mineral resources (and – sometimes – reserves) reporting; their valuation regarding assessment of their importance for economy (e.g. through various methods of valorisation), but with consideration of social and environmental issues (constraints); finally – their valuation in monetary terms.

EU countries have different legal and procedural approaches to all of three mentioned above issues. In numerous cases they constitute a part of national mineral policy. In each country there is some accepted system of mineral resources reporting. When we look into approaches related to monetary valuation, there is one main guideline here, but for business purposes – VALMIN Code or some of its derivatives. However, when we look into approaches related to valorisation of mineral deposits to assign these which should be safeguarded within land use planning process, though at least 15 EU countries have some kind of national mineral policy, only single solutions regarding to this issue are known (existing valorisation schemes in Austria and Sweden, proposed - in Portugal and Poland), with some general path of the proceedings for all EU countries given in MINATURA2020 project. Even in these cases, in general, it is not a part of a comprehensive concept of the state's mineral policy (maybe except of Sweden and Austria).

Mineral deposits and even mineral potential areas are known (at least – roughly) and limited territorial extent and fixed location in space (mineral deposits location details in EU are also commonly compliant with INSPIRE). Their possible future mining requires exclusion of sometimes vast and valuable land plots. It often provokes conflict of varied possible modes of a given territory utilization. Social opposition against development of deposit – not so rare in Europe nowadays - is motivated often by economic value of ground over the deposit area, e.g. for long term agricultural utilization, residential, industrial or commercial plant building. Lack of widely recognized methodology for mineral resources valorisation and valuation forms a significant obstacle in objective parameterization of land uses in consideration and therefore often leads to a waste of significant mineral wealth through leaving them idle.

This report has concentrated on review of existing mineral resources reporting schemes (chapter 1), mineral resources valorisation approaches (chapter 2), and mineral resources valuation approaches (chapter 3). These issues have been analysed both in context of known mineral deposits and yet unknown (or weakly known) mineral potential areas. The special attention has been paid not only to geological and economic dimension of them, but also to environmental and social dimension, which have to be thoroughly taken into account in land use planning process. These aspects are especially taken into account in chapter 4. Possible mechanisms and tools for solving of conflicting interests in this area have been also analyzed where possible.

1. Mineral resources reporting

Various mineral resources reporting schemes were introducing step by step by various countries and administrations since the beginning of 20th century, being developed separately in various places. First common approach being used in a significant number of countries, was Russian mineral resources classification, which was introduced after the Second World War also in other countries of Soviet Bloc. On the contrary, approaches to these topic in market economy countries were very dispersed until early 1990s, where first attempts to current CRIRSCO template were done. Further specific classification based on CRIRSCO approach were developed later e.g. in Australia, Canada, Chile, South Africa, USA, Russia and finally – also In EU. More less at the same moment, works on more universal mineral resources reporting scheme were started by the United Nations Economic Commission for Europe. Their assumption was to obtain multidimensional classification, being additionally some kind of bridge between Russian and CRIRSCO approach. After a decade or so, United Nationas Framework Classification (UNFC) was proposed in 2004 and revised in 2009.

Current practice of use of various mineral resources reporting schemes is very variable among various EU countries (table 1.1).

Table 1.1. Resources reporting schemes in EU countries

Country	Resources reporting scheme used	Country	Resources reporting scheme used
Austria	CRIRSCO derivatives (companies)	Italy	National (even regional)
Belgium	None	Latvia	National (Russian modified)
Bulgaria	National (Russian modified), also UNFC	Lithuania	National (Russian modified)
Croatia	National (Russian modified)	Luxembourg	None
Cyprus	National	Malta	None
Czech Republic	National (Russian modified)	Netherlands	None
Denmark	None	Poland	National (Russian modified)
Estonia	National (Russian modified)	Portugal	JORC, NI43-101 and others
Finland	JORC, NI43-101 and others (companies), to implement UNFC in future	Romania	National (Russian modified), also UNFC
France	CRIRSCO derivatives (companies)	Slovakia	National (Russian modified)
Germany	CRIRSCO derivatives (companies)	Slovenia	National (Russian modified), also UNFC
Greece	JORC, CIM (companies)	Spain	JORC, NI43-101 and others
Hungary	National (Russian modified), also UNFC	Sweden	CRIRSCO compatible (PERC, JORC, NI43-101 and others)
Ireland	CRIRSCO, JORC or similar	United Kingdom	JORC, NI43-101 and others

Source: Minerals4EU project, Minventory project

Some eastern EU countries still use various modifications of Russian approach (eg. Poland), some other EU countries use – but not as a rule – various derivatives of CRIRSCO approach (eg. JORC, NI 43-101, PERC, NAEN), while only a few is trying to introduce UNFC approach. Moreover, in some countries there is a lack of one general approach in the country, while mineral companies operating there use various modifications of CRIRSCO scheme. Table 1.1 presents this situation in EU countries.

Reported mineral resources (mostly according to CRIRSCO schemes) should have not only adequate geological information, but also adequate geographical (spatial) information, preferably linked to INSPIRE. INSPIRE (Infrastructure for Spatial Information in the European Community) is gradually implemented in all EU Member States. In some EU countries this process is fully implemented, while in others – still in progress or, in some thematic areas, even not yet started. On the basis of information collected in Minland's WP2 and WP3, some examples of INSPIRE implementation and related INSPIRE compliance of minerals information (mineral deposits) data and land use data are summarized in table 1.2.

Table 1.2. INSPIRE compliance of minerals information and land use information data in selected EU countries

Country	INSPIRE compliance of minerals data	INSPIRE compliance of land use data	Country	INSPIRE compliance of minerals data	INSPIRE compliance of land use data
Austria	Yes	In progress	Italy	Yes	Yes
Cyprus	Yes	Yes	Netherlands	Yes	Yes
Czech Rep.	Yes	Yes	Poland	Yes	Yes
Finland	Yes	In progress	Portugal	Yes	Not
Greece	In progress	In progress	Slovenia	Yes	Yes
Hungary	Yes	Yes	Spain	Yes	Yes
Ireland	Yes	Yes	Sweden	Yes	In progress

1.1. CRIRSCO Template and its derivatives

1.1.1. CRIRSCO - International Reporting Template

Full name in English	CRIRSCO - International Reporting Template
Full name in original language	CRIRSCO - International Reporting Template
Acronym	CRIRSCO
Used in Country or Legal Entity	International
Institution(s)	Committee for Mineral Reserves International Reporting Standards, International Council on Mining&Metals
Source	www.crirsco.com
Year	2013
Resources identified	1. Mineral resources; 1.1. Inferred mineral resources; 1.2. Indicated mineral resources; 1.3. Measured mineral resources; 2. Mineral Reserves 2.1. Probable Reserves; 2.2. Proved Reserve

Considering the responsibility of governments, companies, and the community relative to the extraction, processing, and commercialization of minerals and metals, the industry requires the best practices for reporting Mineral Exploration Results, Mineral Resources and Mineral Reserves. **International reporting standards provide a common basis for understanding resources and reserves information worldwide**. Yet reserve and resource estimation and reporting for the minerals industry has had a chequered history and has been at the heart of a number of investment scandals. One of the biggest areas of concern has been exactly what is meant by the terms "reserves" and "resources", how and by whom these have been estimated and obligations to investors using such information to understand risk when determining investment opportunity. A **lack of clear definitions** of terms and the factors relevant to estimation led to an international initiative to standardise market-related reporting definitions for mineral resources and mineral reserves.

This international initiative **had start** at the 15th CMMI Congress at Sun City, South Africa **in 1994**. **The mineral definitions working group** (**later called CRIRSCO**) was formed after a meeting at that Congress, and was made up of representatives from several countries (Australasia, Brazil, Canada, Europe, Indonesia, Kazakhstan, Mongolia, Russia, South Africa, USA), with the primary objective of developing a set of international standard definitions for the reporting of mineral resources and mineral reserves.

In 1997, a working group with representatives drawn from the US, Canada, Australia, South Africa and Europe reached agreement for the definitions of the **two major categories**, **Mineral Resources** and **Mineral Reserves**, and their respective sub-categories **Measured, Indicated and Inferred Mineral Resources, and Proved and Probable Mineral Reserves**. **In 1999**, agreement was reached with the United Nations Economic Commission for Europe (UN-ECE), which had, since 1992, been developing an International Framework Classification for Mineral Reserves and Resources (UNFC), to incorporate into the UNFC the CMMI-CRIRSCO resource / reserve definitions for those categories that were common to both systems. **This agreement gave true international status to the CMMI-CRIRSCO definitions.** These definitions form the core of national and regional reserve and resource reporting codes and standards, which continue to be developed and expanded to address the needs of all mineral industry sectors. The international standards for both publicly listed and privately owned companies are maintained by **CRIRSCO (the Committee for Mineral Reserves International Reporting Standards)**. CRIRSCO provides and maintains a reporting template on which all national and regional reporting standards are based, ensuring compatibility and consistency in reporting practices worldwide. CRIRSCO promotes de best practices for the reporting of Mineral Exploration Results, Mineral Resources and Mineral Reserves. The CRIRSCO standards aim to quantify, qualify, and categorize mineral assets on the basis of the best supported data, models, and criteria. A clear distinction between resources and reserves is mandatory.

The **Committee for Mineral Reserves International Reporting Standards (CRIRSCO)** is an advisory body (without legal authority) set up to promote best practice in the international public reporting of mineral exploration results, mineral resources and mineral reserves. It relies on its constituent members to ensure regulatory and disciplinary oversight at a national or regional level. CRIRSCO members (NROs) include (Figure 1.1.):

- **Australasia** (JORC Code),
- **Canada** (CIM Code),
- **Chile** (Comisión Minera),
- **South Africa** (SAMREC/SAMVAL Code),

- **United States** (SME Guide),
- **Russia** (NAEN Code),
- **Europe** (PERC Reporting Standard).

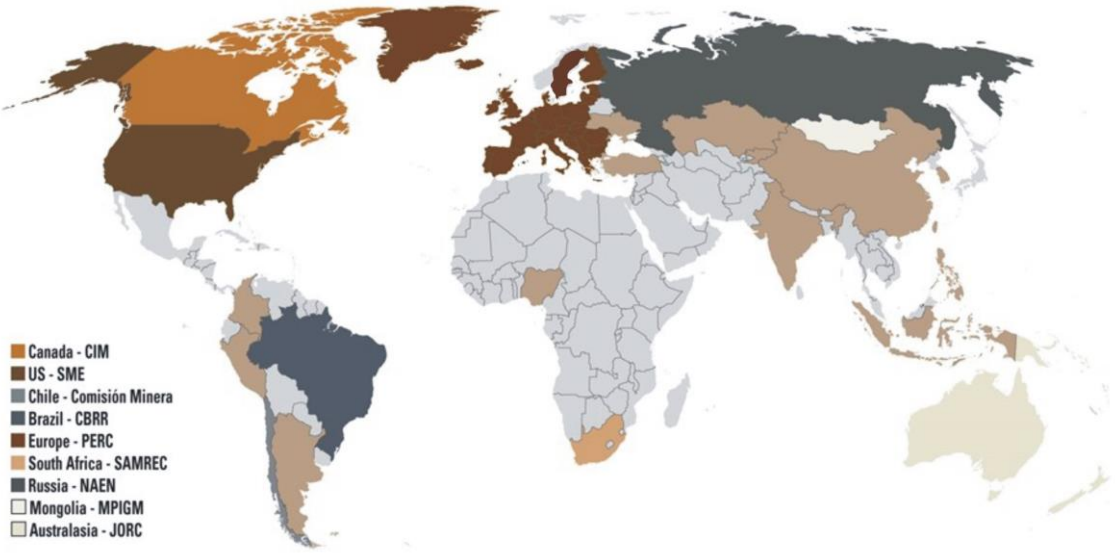


Figure 1.1. Worldwide use of CRIRSCO compliant reporting codes and standards (www.aggbusiness.com, mofidied)

All CRIRSCO Standards follow the same set of principles and use the same classification (table 1.3.). There are only minor differences in the names — Ore Reserves versus Mineral Reserves, Proved Reserves versus Proven Reserves — but the definitions are, or will be, the same.

Table 1.3. Code comparison (Stoker 2014)

	Australia	**Canada**	**Chile**	**Europe**	**Russia**	**South Africa**	**USA**
Adoption of CRIRSCO-type Standard	yes	yes	yes	yes	Yes	yes	yes
Reporting Standard recognized by National	yes	yes	yes	yes	Yes	yes	no
Competent Person Requirement	yes	yes	yes	yes	yes	yes	yes
Reporting of Mineral Resources allowed	yes	yes	yes	yes	yes	yes	yes
Inferred Resources allowed in economic studies	yes	*	yes	yes	yes	yes	yes
Commodity price process specified by management	yes	yes	yes	yes	no	yes	yes
RPO type reciprocal system	yes	yes	yes	yes	yes	yes	yes
Level of study required for Mineral Reserves	PFS	PFS	PFS	PFS (expected)	FS	FS (new)	Study

* allowed under certain restricted circumstances; PFS - Pre-Feasibility Study, FS - Feasibility Study

These codes and standards are mutually recognized, which may be an important consideration for international operators with activities in more than one region. **An International Reporting template (the CRIRSCO Template**) was released in **July 2006** and **an update was published in 2013**. This is advisory and intended to be used as a model for development of new systems of reporting in constituent countries. For this reason the CRIRSCO Template is used to indicate that CRIRSCO is a model for code development and does not constitute a 'Code' or 'Standard' with legal or other regulatory force.

The similarity of the various national reporting codes and guidelines has enabled CRIRSCO to develop an **International Minerals Reporting Code Template**. This can act as a "core code and guidelines" for any country wishing to adopt its own CRIRSCO-style reporting standard, after including provisions for country-specific requirements such as those of a legal and investment regulatory nature. Following discussions over a number of years, **CRIRSCO published Standard Definitions in October 2012**. **These fifteen definitions have been incorporated in International Reporting Template of CRIRSCO dated November 2013 and in the Codes and Standards of most of the CRIRSCO Members in their own updates**.

The Template is applicable to **all solid mineral raw materials** for which Public Reporting of Exploration Results, Mineral Resources and Mineral Reserves is required by the relevant regulatory authorities. Solid raw materials include (but are not limited to): diamonds and other gemstones, metalliferous minerals, industrial minerals, cement feed materials and construction raw materials, other mineral raw materials and coal. The Template applies to the reporting of **all potentially economic mineralised material**. This can include also mineralised fill, remnants, pillars, low grade mineralisation, stockpiles, dumps and tailings (remnant materials) where there are reasonable prospects for eventual economic extraction in the case of Mineral Resources, and where extraction is reasonably justifiable in the case of Mineral Reserves. Unless otherwise stated, all other clauses of the Template (including Figure 1.3.) apply.

The **International Template is advisory only and where national codes already exist, these will take precedence**. The International Template is intended to assist those countries that either do not have a reporting code or whose code is outdated, to produce a new code consistent with international best practice. The word 'Template' is used advisedly to indicate that this document is a **model for code development and does not in itself constitute a 'code'** which implies that it has legal or other regulatory force.

The main principles governing the operation and application of the **Template** are **transparency, materiality** and **competence** (fig. 1.2.). **Transparency** requires that the reader of a Public Report is provided with sufficient information, the presentation of which is clear and unambiguous, so as to understand the report and not to be misled. **Materiality** requires that a Public Report contains all the relevant information which investors and their professional advisers would reasonably require, and reasonably expect to find in a Public Report, for the purpose of making a reasoned and balanced judgement regarding the Exploration Results, Mineral Resources or Mineral Reserves being reported. **Competence** requires that the Public Report be based on work that is the responsibility of suitably qualified and experienced persons who are subject to an enforceable professional code of ethics and rules of conduct.

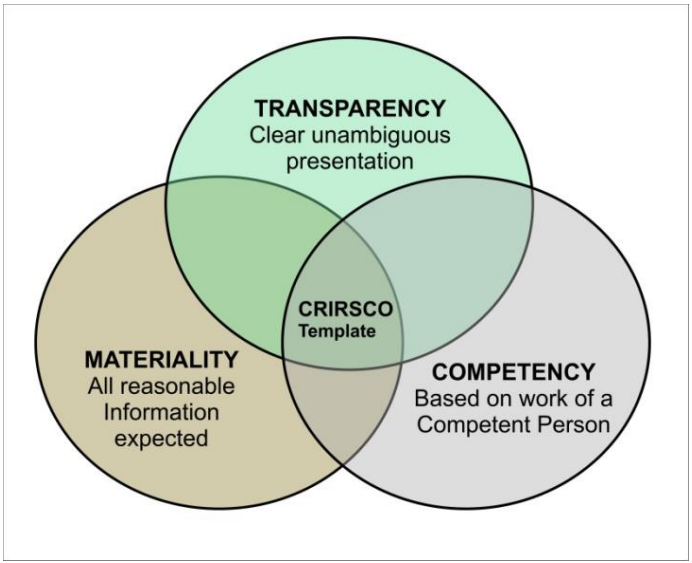


Fig. 1.2. Principles governing the application of JORC Code

In recent years, CRIRSCO has worked towards aligning all the international reporting codes so that the codes used in the extractive industries are globally consistent. This consistency is based on insisting that the fifteen core definitions are commonly applied to all the international Codes (CRIRSCO, 2013). The following are the **core defined terms**:

- Public Reports,
- Measured Resources ,
- Competent Person,
- Mineral Reserves,
- Modifying Factors,
- Probable Reserves
- Exploration Target,
- Proved Reserves,
- Exploration Results,
- Scoping Study ,
- Mineral Resources,
- Pre-Feasibility Study,
- Indicated Resources,
- Feasibility Study,
- Inferred Resources.

Systems of reporting aligned to the CRIRSCO Template have securities exchange recognition (for example ESMA recommends the use of any of the seven CRIRSCO-aligned standards, but no others). Undiscovered mineral resources are expressed in the CRIRSCO Template through the definition of an *exploration target*, now adopted across all CRIRSCO-aligned systems of reporting. CRIRSCO aligned systems of reporting are organized according to the classification in Figure 1.3.

Definitions

Modifying Factors are considerations used to convert **Mineral Resources** to **Mineral Reserves**. These include, but are not restricted to, **mining, processing, metallurgical, infrastructure, economic, marketing, legal, environmental, social and governmental factors**. Mineral Resources can be estimated mainly on the basis of geological information with some input from other disciplines. Mineral Reserves, which are a modified sub-set of the Indicated and Measured Mineral Resources (shown within the dashed outline in Figure 1.3), require consideration of the Modifying Factors affecting extraction, and should in most instances be estimated with input from a range of disciplines. Measured Mineral Resources may convert to either Proved Mineral Reserves or Probable Mineral Reserves. The Competent Person may convert Measured Mineral Resources to Probable Mineral Reserves

because of uncertainties associated with some or all of the Modifying Factors which are taken into account in the conversion from Mineral Resources to Mineral Reserves. This relationship is shown by the broken arrow in Figure 1.3 Although the trend of the broken arrow includes a vertical component, it does not, in this instance, imply a reduction in the level of geological knowledge or confidence. In such a situation these Modifying Factors should be fully explained.

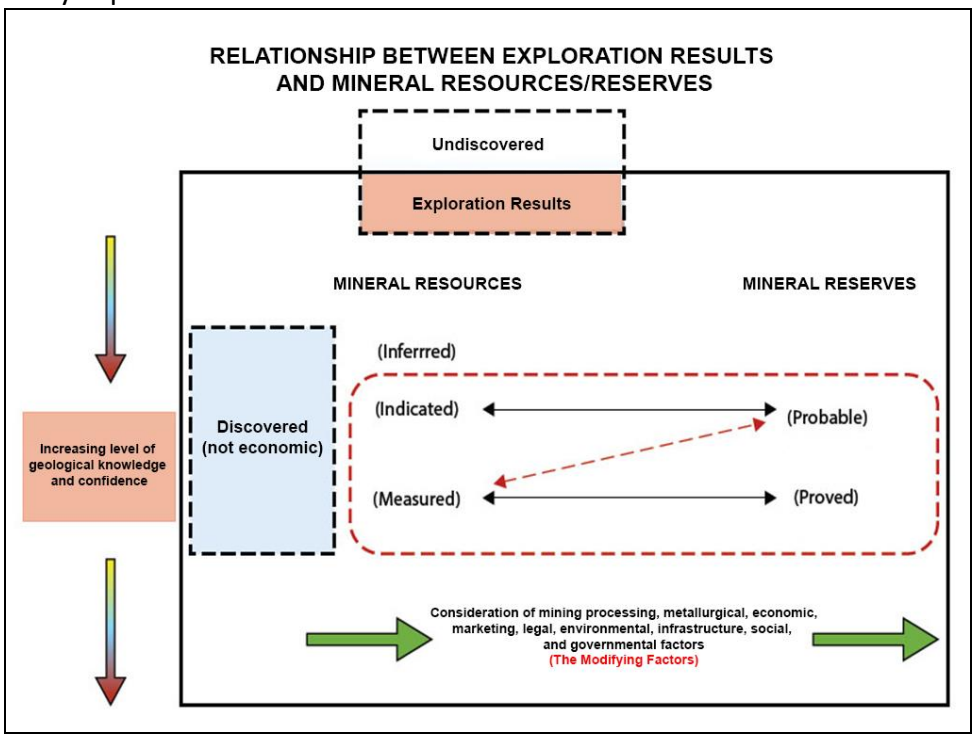


Figure 1.3. General relationship between Exploration Results, Mineral Resources and Mineral Reserves (International Reporting Template 2013, http://www.umrek.com.tr)

Public Reports are reports prepared for the purpose of informing investors or potential investors and their advisers on Exploration Results, Mineral Resources or Mineral Reserves. They include, but are not limited to annual and quarterly company reports, press releases, information memoranda, technical papers, website postings and public presentations. **Public Reports include** but are not limited to: company annual reports, quarterly reports and other reports to regulatory authorities, or as required by law. **Public Reports concerning a company's Exploration Results, Mineral Resources and/or Mineral Reserves must include a description of the style and nature of mineralisation.** A company must disclose any relevant information concerning a mineral deposit that could materially **influence the economic value of that deposit** to the company. A company must promptly report any material changes in its Mineral Resources or Mineral Reserves. Companies must review and publicly report on their Exploration Results, Mineral Resources and/or Mineral Reserves at least annually and the effective date of each Mineral Resource and Mineral Reserve statement must be shown. Companies are encouraged to provide information in their Public Reports, which is as comprehensive as possible. A company's economic interest in the project must be declared.

An **Exploration Target** is a statement or estimate of the exploration potential of a mineral deposit in a defined geological setting where the statement or estimate, quoted as a range of tonnes and a range of grade or quality, relates to mineralisation for which there has been insufficient exploration to estimate Mineral Resources. **Exploration Results** include

data and information generated by mineral exploration programmes that might be of use to investors but which do not form part of a declaration of **Mineral Resources** or **Mineral Reserves.**

A **Mineral Resource** is a concentration or occurrence of solid material of economic interest in or on the Earth's crust in such form, grade or quality and quantity that there are reasonable prospects for eventual economic extraction. **The location, quantity, grade or quality, continuity and other geological characteristics of a Mineral Resource are known**, estimated or interpreted from specific geological evidence and knowledge, including sampling. **Mineral Resources are subdivided, in order of increasing geological confidence into Inferred, Indicated and Measured categories** (fig. 1.4.).

An **Inferred Mineral Resource** is that part of a Mineral Resource for which quantity and grade or quality are estimated on the basis of limited geological evidence and sampling. Geological evidence is sufficient to imply but not verify geological and grade or quality continuity. An Inferred Resource has a lower level of confidence than that applying to an Indicated Mineral Resource and must not be converted to a Mineral Reserve. It is reasonably expected that the majority of Inferred Mineral Resources could be upgraded to Indicated Mineral Resources with continued exploration.

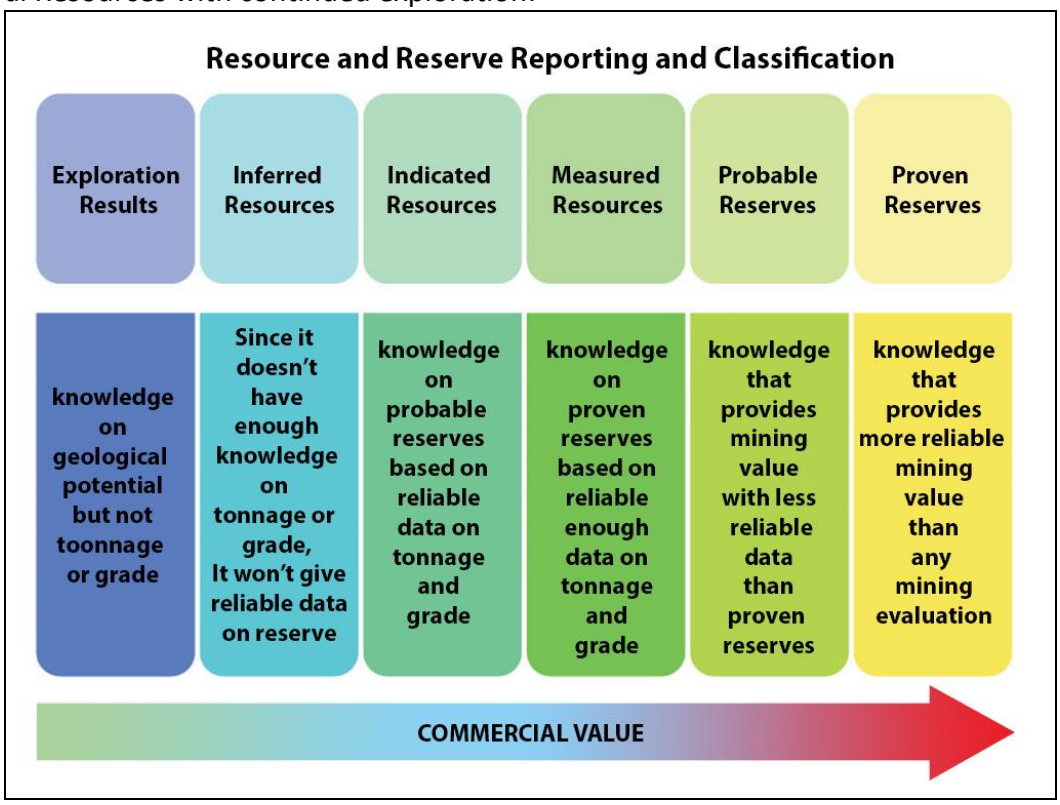


Figure 1.4. Resource and Reserve Reporting and Classification (www.umrek.com.tr)

An **Indicated Mineral Resource** is that part of a Mineral Resource for which quantity, grade or quality, densities, shape and physical characteristics are estimated with sufficient confidence to allow the application of Modifying Factors in sufficient detail to support mine planning and evaluation of the economic viability of the deposit. Geological evidence is derived from adequately detailed and reliable exploration, sampling and testing and is sufficient to assume geological and grade or quality continuity between points of observation**.** An Indicated Mineral Resource has a lower level of confidence than that

applying to a Measured Mineral Resource and may only be converted to a Probable Mineral Reserve.

A **Measured Mineral Resource** is that part of a Mineral Resource for which quantity, grade or quality, densities, shape, and physical characteristics are estimated with confidence sufficient to allow the application of **Modifying Factors** to support detailed mine planning and final evaluation of the economic viability of the deposit. Geological evidence is derived from detailed and reliable exploration, sampling and testing and is sufficient to confirm geological and grade or quality continuity between points of observation. A Measured Mineral Resource has a higher level of confidence than that applying to either an Indicated Mineral Resource or an Inferred Mineral Resource. **It may be converted to a Proved Mineral Reserve or to a Probable Mineral Reserve**.

Mineral Resource estimates are not precise calculations, being dependent on the interpretation of limited information on the location, shape and continuity of the occurrence and on the available sampling results. Reporting of tonnage and grade figures should reflect the relative uncertainty of the estimate by rounding off to appropriately significant figures and, in the case of Inferred Mineral Resources, by qualification with terms such as 'approximately'. Public Reports of Mineral Resources must specify one or more of the categories of 'Inferred', 'Indicated' and 'Measured'. Categories must not be reported in a combined form unless details for the individual categories are also provided. Mineral Resources must not be reported in terms of contained metal or mineral content unless corresponding tonnages and grades are also presented. Mineral Resources must not be aggregated with Mineral Reserves.

A Mineral Reserve is the economically mineable part of a Measured and/or Indicated Mineral Resource. It includes diluting materials and allowances for losses, which may occur when the material is mined or extracted and is defined by studies at Pre-Feasibility or Feasibility level as appropriate that include application of Modifying Factors. Such studies demonstrate that, at the time of reporting, extraction could reasonably be justified. The reference point at which Reserves are defined, usually the point where the ore is delivered to the processing plant, must be stated. It is important that, in all situations where the reference point is different, such as for a saleable product, a clarifying statement is included to ensure that the reader is fully informed as to what is being reported.

A **Probable Mineral Reserve** is the economically mineable part of an Indicated, and in some circumstances, a Measured Mineral Resource. The confidence in the **Modifying Factors** applying to a Probable Mineral Reserve is lower than that applying to a Proved Mineral Reserve. A **Proven Mineral Reserve** is the economically mineable part of a Measured Mineral Resource. A Proved Mineral Reserve implies a high degree of confidence in the **Modifying Factors**.

A **Scoping Study** is an order of magnitude technical and economic study of the potential viability of Mineral Resources that includes appropriate assessments of realistically assumed Modifying Factors together with any other relevant operational factors that are necessary to demonstrate at the time of reporting that progress to a **Pre-Feasibility Study** can be reasonably justified.

A **Pre-Feasibility Study** is a comprehensive study of a range of options for the technical and economic viability of a mineral project that has advanced to a stage where a preferred mining method, in the case of underground mining, or the pit configuration, in the case of an open pit, is established and an effective method of mineral processing is determined. It includes a financial analysis based on reasonable assumptions on the

Modifying Factors and the evaluation of any other relevant factors which are sufficient for a Competent Person, acting reasonably, to determine if all or part of the Mineral Resource may be converted to a Mineral Reserve at the time of reporting. A Pre-Feasibility Study is at a lower confidence level than a **Feasibility Study**.

A **Feasibility Study** is a comprehensive technical and economic study of the selected development option for a mineral project that includes appropriately detailed assessments of applicable Modifying Factors together with any other relevant operational factors and detailed financial analysis that are necessary to demonstrate at the time of reporting that extraction is reasonably justified (economically mineable). The results of the study may reasonably serve as the basis for a final decision by a proponent or financial institution to proceed with, or finance, the development of the project. The confidence level of the study will be higher than that of a Pre-Feasibility Study.

The validity of any estimates (at the operational level, not the public authority level) of mineral resources and mineral reserves comes down to the knowledge, experience and integrity of the **Competent Person(s)** or their equivalent e.g. Canada (Qualified Person) and Chile (Qualified Competent Person) collating the data, undertaking the evaluation and signing off on the statement. In 2003 **The Australian Securities Exchange** (ASX) introduced a procedure for identifying **Recognised Professional Organizations** (table 1.4) as accredited organizations to which Competent Persons must belong for the purpose of preparing reports on Exploration Results, Mineral Resources and Ore Reserves for submission to the ASX (if they are not members of the AusIMM or AIG).

Table 1.4. The list of Professional Organizations (www.jorc.org)

	Professional Organization	Minimum membership class required		Professional Organization	Minimum membership class required
1	Institute of Materials, Minerals and Mining	Member (MIMMM) or Fellow (FIMMM)	14	Association of Professional Engineers and Geoscientists of Manitoba	P.Geo, or P.Eng,
2	Geological Society of London	Chartered Geologist (CGeol), Chartered Scientist (CSci) or European Geologist (EurGeol)	15	Association of Professional Geoscientists of Ontario	P.Geo., P.Geo.(limited), P.Geo.(Temporary)
3	Institute of Geologists of Ireland	Professional Geologist (PGeo)	16	Association of Professional Engineers and Geoscientists of Newfoundland and Labrador	P.Eng., P.Geo.
4	European Federation of Geologists	European Geologist (EurGeol)	17	Association of Professional Engineers, Geologists and Geophysicists of the Northwest Territories	P.Eng, P.Geo (or P.Geol., P.Geoph.)
5	Mining and Metallurgical Society of America	Qualified Professional (QP)	18	Association of Professional Geoscientists of Nova Scotia	P.Geo.
6	American Institute of Professional Geologists	Certified Professional Geologist (CPG)	19	Association of Professional Engineers and Geoscientists of New Brunswick	P.Geo., P.Eng.
7	Society for Mining, Metallurgy & Exploration	SME Registered Member	20	Association of Professional Engineers, Geologists and Geophysicists of Alberta.	P.Eng., P.Geo., P.Geoph.

8	Engineering Council of South Africa	Professional Engineer (Pr Eng)	21	Association of Professional Engineers and Geoscientists of Saskatchewan	P.Geo. or P.Eng.
9	South African Council for Natural Scientific Professions	Professional Natural Scientist (Pr.Sci.Nat.)	22	Ordre des Geologues du Québec	P.Geo., géo.
10	Geological Society of South Africa	Member or Fellow	23	Ordre des Ingénieurs du Québec	P. Eng. or ing.
11	The Southern African Institute of Mining and Metallurgy	Member or Fellow	24	Comisión Calificadora de Competencias en Recursos y Reservas Mineras (Chilean Mining Commission or Comisión Minera)	Registered Member
12	South African Council for Professional and Technical Surveyors	Mine Surveyors and Professional Mine Surveyors	25	Russian Society of Subsoil Use Experts (OERN)	Expert
13	Professional Engineers Ontario	P.Eng.	26	Association of Professional Engineers and Geoscientists of British Columbia	P.Geo, or P.Eng,

A **Competent Person is a minerals industry professiona**l with a minimum of **five years relevant experience in the style of mineralisation or type of deposit under consideration and in the activity which that person is undertaking**. If the Competent Person is preparing a report on Exploration Results, the relevant experience must be in exploration. If the Competent Person is estimating, or supervising the estimation of Mineral Resources, the relevant experience must be in the estimation, assessment and evaluation of Mineral Resources. If the Competent Person is estimating, or supervising the estimation of Mineral Reserves, the relevant experience must be in the estimation, assessment, evaluation and economic extraction of Mineral Reserves**.** The key qualifier in the definition of a Competent Person is 'relevant'. Reporting mineral reserve estimates requires different disciplines to exploration results or mineral resources estimates. Furthermore, it is not always necessary for a Competent Person to have five years' experience in each and every type of deposit if that person has relevant experience in other deposit types. In cases where estimation of mineral resources is a team effort involving several technical disciplines, those participants with clear responsibility for a particular contribution should be identified.

The CRIRSCO Code includes **checklist and guideline** for use to preparing reports on Mineral Exploration Results Mineral Resources and Mineral Reserves. The **checklist is not prescriptive** and, as always, relevance and materiality are overriding principles that determine what information should be publicly reported. It is, however, important to report any matters that might materially affect a reader's understanding or interpretation of the results or estimates being reported. This is particularly important where inadequate or uncertain data affect the reliability of, or confidence in, a statement of Exploration Results or an estimate of Mineral Resources and/or Mineral Reserves. Sections that are prescribed under the CRIRSCO Code include:

- Sampling Techniques and Data;
- Reporting of Exploration Results;
- Estimation and Reporting of Mineral Resources;
- Estimation and Reporting of Mineral Reserves;
- Estimation and Reporting of Diamonds and Other Gemstones.

The order and grouping of criteria reflect the normal systematic approach to exploration and evaluation. Criteria in the first group 'Sampling Techniques and Data' apply to all succeeding groups. In the remainder of the checklist, criteria listed in preceding groups would often apply to succeeding groups and should be considered when estimating and reporting (CRIRSCO 2013).

There may also be other criteria, not included in the checklist, which should also be taken into account. The list should be considered as advisory only, as a guide to facilitate a reasoned and balanced approach to preparing a Public Report. The use of the checklist for every declaration is considered best practice and if completed properly it can provide the Competent Person with assurance that no technical inputs or practices have been omitted. It also provides users with confidence that the declaration is fully compliant and can be relied upon.

Environmental and social aspects in CRIRSCO Code

In performing their work, **Competent Persons should strive to protect the natural environment** and ensure that the consequences of their work do not adversely affect the safety, health and welfare of themselves, colleagues and members of the Public;

- Ensure that consideration of the modifying factors used to determine Mineral Reserves fully recognises the need to provide a safe working environment;
- Ensure that Mineral Reserve estimates acknowledge the likely environmental impact of development and ensure that appropriate allowances are made for mitigation and remediation.

In connection with the above, the report should describe any environmental factors that could have any material effect on the likelihood of eventual economic extraction and discussed possible means of mitigation.

The environmental and social aspects are included in checklist (table 1.5) which should be the reference point for people preparing these reports on Mineral Exploration Results Mineral Resources and Mineral Reserves.

Table 1.5. Environmental and social aspects in CRIRSCO Code (CRIRSCO 2013)

CRITERIA	EXPLANATION
Reporting of Exploration Results	
Mineral rights and land ownership.	-Type, reference name/number, location and ownership including agreements or material issues with third parties such as joint ventures, partnerships, overriding royalties, native title interests, historical sites, wilderness or national park and environmental settings, - The security of the tenure held at the time of reporting along with any known impediments to obtaining a licence to operate in the area, - Location plans of mineral rights and titles. It is not expected that the description of mineral title in a technical report should be a legal opinion
Estimation and Reporting of Mineral Resources	
Other	- The effect, if any, of natural risk, infrastructure, environmental, legal, marketing, social or governmental factors on the likely viability of a project and/or on the estimation and classification of the Mineral Reserves, - The status of titles and approvals critical to the viability of the project, such as mining leases, discharge permits, government and statutory approvals, - Environmental descriptions of anticipated liabilities. Location plans of mineral rights and titles.

1.1.2. JORC Code (Australia)

Full name in English	The Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves
Full name in original language	The Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves
Acronym	JORC Code
Used in Country or Legal Entity	Australia
Institution(s)	Australasian Joint Ore Reserves Committee ('the JORC Committee')
Source	www.jorc.org
Year	2012 - current version
Resources identified	1. Mineral resources; 1.1. Inferred mineral resources; 1.2. Indicated mineral resources; 1.3. Measured mineral resources; 2. Reporting of Ore Reserves 2.1. Probable Ore Reserve 2.2. Proved Ore Reserve

The **Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves** (**'the JORC Code'**) is a professional code of practice that sets minimum standards for Public Reporting of minerals Exploration Results, Mineral Resources and Ore Reserves. The JORC Code provides a mandatory system for the classification of minerals **Exploration Results**, **Mineral Resources** and **Ore Reserves** according to the **levels of confidence in geological knowledge and technical and economic considerations in Public Reports**. Public Reports prepared in accordance with the JORC Code are reports prepared for the purpose of informing investors or potential investors and their advisors. They include, but are not limited to, annual and quarterly company reports, press releases, information memoranda, technical papers, website postings and public presentations of Exploration Results, Mineral Resources and Ore Reserves estimates.

The JORC Code was **first published in 1989**, with the most recent revision being published late in 2012. **Australia** was one of the leading countries in implementing standards and guidelines since 1989 with the first edition of the Joint Ore Reserves Committee Code (www.jorc.org). The Code was adopted the same year by the Australian Securities Exchange (ASX, 2013) and by the **New Zealand Market** (NZX) in 1992. Other jurisdictions that nowadays accept the Code include, **Hong Kong, Papua New Guinea, Singapore, South Africa, UK, UAE** and **Europe**.

The JORC Code is produced by the **Australasian Joint Ore Reserves Committee** ('the JORC Committee'). The JORC Committee was established in 1971 and is sponsored by the Australian mining industry and its professional organisations. The Committee comprises representatives of each of the three parent bodies: **The Minerals Council of Australia** (MCA), **The Australasian Institute of Mining and Metallurgy** (The AusIMM), and the **Australian Institute of Geoscientists** (AIG); as well as representatives of the Australian Securities Exchange (ASX), the Financial Services Institute of Australasia (FinSIA) and the accounting profession.

The current edition of the JORC Code was published in 2012 and after a transition period the 2012 Edition came into mandatory operation from 1 December 2013.

Environmental and social aspects in JORC Code

The environmental and social aspects are include in checklist (table 1.4) which should be the reference point for people preparing reports on Mineral Exploration Results Mineral Resources and Mineral Reserves. The application and description of all Modifying factors connected with environmental and social aspects (table 1.6) should be included in Feasibility Study.

Table 1.6. Environmental and social aspects in JORC Code (JORC CODE 2012)

CRITERIA	EXPLANATION
Reporting of Exploration Results	
Mineral tenement and land tenure status	- Type, reference name/number, location and ownership including agreements or material issues with third parties such as joint ventures, partnerships, overriding royalties, native title interests, historical sites, wilderness or national park and environmental settings, - The security of the tenure held at the time of reporting along with any known impediments to obtaining a licence to operate in the area.
Estimation and Reporting of Mineral Resources	
Environmental factors or assumptions	Assumptions made regarding possible waste and process residue disposal options. It is always necessary as part of the process of determining reasonable prospects for eventual economic extraction to consider the potential environmental impacts of the mining and processing operation. While at this stage the determination of potential environmental impacts, particularly for a greenfields project, may not always be well advanced, the status of early consideration of these potential environmental impacts should be reported. Where these aspects have not been considered this should be reported with an explanation of the environmental assumptions made
Estimation and Reporting of Ore Reserves	
Environmental	The status of studies of potential environmental impacts of the mining and processing operation. Details of waste rock characterisation and the consideration of potential sites, status of design options considered and, where applicable, the status of approvals for process residue storage and waste dumps should be reported.
Social	The status of agreements with key stakeholders and matters leading to social licence to operate.

1.1.3. CIM Code (Canada)

Full name in English	Canadian Reporting Standards for Mineral Resources and Mineral Reserves
Full name in original language	Canadian Reporting Standards for Mineral Resources and Mineral Reserves
Acronym	CIM CODE
Used in Country or Legal Entity	Canada
Institution(s)	Canadian Institute of Mining Metallurgy and Petroleum (CIM)
Source	https://mrmr.cim.org/; www.crirsco.com/national.asp
Year	adopted 2001, current edition 2014
Resources identified	1. Mineral resources; 1.1. Inferred mineral resources; 1.2. Indicated mineral resources; 1.3. Measured mineral resources; 2. Mineral Reserves 2.1. Probable Mineral Reserves 2.2. Proved Mineral Reserves

The **CIM Definition Standards on Mineral Resources and Reserves** introduced definitions and guidance for the public disclosure of mineral resources and mineral reserves and mining studies used in **Canada** by Canadian public reporting mining companies, whether their deposits are in Canada or elsewhere in the world. They were adopted by the Canadian Securities Administrators in 2001 and incorporated into **National Instrument 43-101 – Standards of Disclosure for Mineral Projects (NI 43-101)** (Qualified Persons (Competent Person) preparing public Mineral Resource and Mineral Reserve reports in Canada must follow the requirements in Form 43-101F1 of National Instrument 43-101). The latest update in 2014 aligned the CIM Definition Standards for all public disclosure of geological and technical information for mineral exploration and mining projects with the **principles and definitions of the CRIRSCO template**. The category to which a Mineral Resource (Measured, Indicated and Inferred) or Mineral Reserve (Proven and Probable) is assigned depends on the level of confidence in the geological information available on the mineral deposit; the quality and quantity of data available on the deposit; the level of detail of the technical and economic information which has been generated about the deposit, and the interpretation of the data and information.

Environmental and social aspects in CIM Code

The environmental and social aspects are include in checklist (table 1.7) which should be the reference point for people those preparing reports on Mineral Exploration Results, Mineral Resources and Mineral Reserves. The application and description of all Modifying factors connected with environmental and social aspects (table 1.7) should be included in Feasibility Study.

Table 1.7. Environmental and social aspects in CIM Code

CRITERIA	EXPLANATION
Estimation of mineral reserves	
Others	The effect, if any, of natural risk, infrastructure, environmental, legal, marketing, social or governmental factors on the likely viability of a project and/or on the estimation and classification of the Mineral Reserves. The status of titles and approvals critical to the viability of the project, such as mining leases, discharge permits, government and statutory approvals.
Reporting of Exploration Results	
Mineral tenement and land tenure status	Type, reference name/number, location and ownership including agreements or material issues with third parties such as joint ventures, partnerships, overriding royalties, native title interests, historical sites, wilderness or national park and environmental settings. In particular the security of the tenure held at the time of reporting along with any known impediments to obtaining a licence to operate in the area.

1.1.4. National Instrument NI 43-101

Full name in English	National Instrument (NI) 43-101 Standards of Disclosure for Mineral Projects
Full name in original language	National Instrument (NI) 43-101 Standards of Disclosure for Mineral Projects
Acronym	NI 43-101
Used in Country or Legal Entity	Canada
Institution(s)	Canadian Securities Administration
Source	http://www.osc.gov.on.ca/en/15019.htm
Year	2005 – first version, 2011 – last version
Resources identified	1. Mineral resources; 1.1. Inferred mineral resources; 1.2. Indicated mineral resources; 1.3. Measured mineral resources; 2. Mineral Reserves 2.1. Probable Mineral Reserves 2.2. Proved Mineral Reserves

National Instrument (NI) 43-101 Standards of Disclosure for Mineral Projects is a **Canadian mineral resource classification scheme** used to disclose information about mineral properties. Foreign and domestic companies listing on stock exchanges overseen by the Canadian Securities Administration (CSA) are required to abide by the NI 43-101 rules and guidelines for displaying information related to mineral properties. Disclosures covered by the NI 43-101 code include press releases of mineral exploration reports, reporting of resources and reserves, presentations, oral comments, and websites. The NI 43-101 covers **metalliferous, precious metals** and **solid energy commodities** as well as **bulk minerals, dimension stone, precious stones** and **mineral sands commodities**.

The National Instrument 43-101 is broadly **comparable to the Joint Ore Reserves Committee Code (JORC Code)** which regulates the publication of mineral exploration reports on the Australian Stock Exchange (ASX). It is also **broadly comparable with the South African Code for the Reporting of Mineral Resources and Mineral Reserves (SAMREC)**. The reporting codes are, however, not entirely congruent in practice, in that NI 43-101 is more prescriptive in terms of the manner in which mineral exploration reporting is presented, although the content of the technical reports, and the scientific rigors to which the mineral resource classifications within them are put, are often very similar.

The purpose of National Instrument 43-101 is to ensure that misleading, erroneous or fraudulent information relating to mineral properties is not published and promoted to investors on the stock exchanges overseen by the Canadian Securities Authority. NI 43-101 was created after the Bre-X scandal to protect investors from unsubstantiated mineral project disclosures.

In this Instrument, the terms: **mineral resource**, **inferred mineral resource, indicated mineral resource**, **measured mineral resource** and **mineral reserves** have the meanings ascribed to those terms by the Canadian Institute of Mining, Metallurgy and Petroleum, as the CIM Definition Standards on Mineral Resources and Mineral Reserves adopted by CIM Council, as amended. Moreover, the terms **preliminary feasibility study**, **pre-feasibility study** and **feasibility study** have the meanings ascribed to those terms by the Canadian Institute of Mining, Metallurgy and Petroleum, as the CIM Definition Standards on Mineral Resources and Mineral Reserves adopted by CIM Council, as amended. Preliminary economic

assessments, pre-feasibility studies, and feasibility studies generally analyze and assess the same geological, engineering, and economic factors with increasing detail and precision.

NI 43-101 reports have a number of core requirements designed to protect investors. The most basic requirement is a "qualified person" that must vouch for the report. But other requirements include standardized feasibility studies and sample preparation and analysis. And finally, the technical report itself and any data referenced from it must be used in proper ways. According to industry guidelines, a "qualified person" is an individual who is an engineer or geoscientist with at least five years of experience in mineral exploration, relevant experience to the subject matter, and a member in good standing of a professional association. The "qualified person" must sign-off on the report and is ultimately liable for any errors or omissions. Feasibility studies must also be conducted to analyze the viability of a mineral project that has advanced to a stage where the mining method or pit configuration has been established and an effective method of mineral processing has been determined. These studies include financial analysis, and economic, social and other relevant factors.

The NI 43-101 report itself usually contains several key sections:

- **Executive Summary** - A summary of the entire report from a high level.
- **Introduction** - The purpose, source of information, qualified persons, terms of reference, units of measure and other related information.
- **Property Description** - The location, legal agreements, environmental liability and operational permits for the mineral property.
- **Exploration & Drilling** - Data from rock samples, surface geochemistry, geophysical surveys, and other reports, as well as drilling procedures and results.
- **Sample Preparation & Analysis** - Review of drilling campaigns, sample chains of custody, preparation and assay procedures, and the actual sampling study results.
- **Mineral Resource & Reserve Estimates** - Grade estimates, resource optimization, mineral resource classifications, and other data.
- **Market Studies & Economic Analysis** - Data that supports the economic feasibility of the development and production of mining, including any relevant models.
- **Conclusions & Recommendations** - Overview of the data and conclusions that can be made from it, along with a recommendation of how to proceed.

Environmental and social aspects in NI 43-101

Among the requirements for all technical reports, the Instrument mentions: **environmental studies, permitting, and social or community**. It discusses reasonably available information on environmental, permitting, and social or community factors related to the project. It considers and, where relevant, include (National Instruments 2011):

- a summary of the results of any environmental studies and a discussion of any known environmental issues that could materially impact the issuer’s ability to extract the mineral resources or mineral reserves;
- requirements and plans for waste and tailings disposal, site monitoring, and water management both during operations and post mine closure;
- project permitting requirements, the status of any permit applications, and any known requirements to post performance or reclamation bonds;
- a discussion of any potential social or community related requirements and plans for the project and the status of any negotiations or agreements with local communities; and
- a discussion of mine closure (remediation and reclamation) requirements and costs.

1.1.5. Comisión Minera Code (Chile)

Full name in English	Code for Certification of Exploration Prospects, Mineral Resources and Ore Reserves
Full name in original language	Código para Informar sobre los Resultados de Exploración, Recursos Minerales y Reservas Minerales
Acronym	-
Used in Country	Chile
Institution(s)	Mineral Resources Committee of the Institution of Mining Engineers of Chile (IIMCh)
Source	www.crirsco.com/national.asp
Year	2004
Resources identified	1. Mineral resources; 1.1. Inferred mineral resources; 1.2. Indicated mineral resources; 1.3. Measured mineral resources; 2. Reporting of Ore Reserves 2.1. Probable Ore Reserve 2.2. Proved Ore Reserve

The **Code for the Certification of Exploration Prospects, Mineral Resources and Ore Reserves** is the result of a Collaboration Agreement between the **Mineral Resources Committee of the Institution of Mining Engineers of Chile** (IIMCh) and the Ministry of Mining established in December, 2002. The exchange of ideas concerned the establishment of a code that would rule and regulate public information disseminated in the country about Mineral Prospects, Resources and Reserves. The purpose of this was to prepare a technical, legal, financial, accounting, and entrepreneurial platform that would serve as a basis for the reforms propitiated by the Government oriented to push a vigorous capital market in the country. These initiatives should incorporate the global character of the mining operations and include the new factors that impact the mining sector such as the technical, economic, environmental and financial sustainability. Additionally, these initiatives should emphasize the professional ethics of those Qualified Competent Persons that must have the necessary specialization in order to certify public reports to be presented to the financial and stock-exchange institutions.

This Code synthetizes the **present practice of the mining industry in regard to standards and procedures applied to exploration prospects, mineral resources, and reserves with the purpose of reporting publicly on financial instruments based on these mine assets in the capital markets**. These standards follow general criteria already adopted and applied by capital markets in those countries characterized by a very dynamic and well developed mining sector such as Australia, Canada, South Africa, United Kingdom, and others. The work done by the Mineral Resources Committee of the IIMCh has had the recognition of the Combined Reserves International Reporting Standards Committee (CRIRSCO) that leads the establishment of an international code in these matters (Code 2004).

Environmental and social aspects in Chilean Code

The environmental and social aspects are include in checklist (table 1.8) which should be the reference point for people those preparing reports on Mineral Exploration Results Mineral Resources and Mineral Reserves. The application and description of all Modifying

factors connected with environmental and social aspects (table 1.8) should be included in Feasibility Study.

Table 1.8. Environmental and social aspects in Code for Certification of Exploration Prospects, Mineral Resources and Ore Reserves (Chile)

CRITERIA	EXPLANATION
Information on exploration prospects	
Mineral rights and land ownership	Data on: - Type, reference name/number, location and ownership including agreements or material issues with third parties such as joint ventures, partnerships, overriding royalties, native title interests, historical sites, wilderness or national park and environmental settings, - The security of the tenure held at the time of reporting along with any known impediments to obtaining a licence to operate in the area. Location plans of mineral rights and titles.
Information on reserve estimation	
Environmental factors or assumptions	Assumptions made regarding possible waste and process residue disposal options. It is always necessary as part of the process of determining reasonable prospects for eventual economic extraction to consider the potential environmental impacts of the mining and processing operation. While at this stage the determination of potential environmental impacts, particularly for a greenfield project, may not always be well advanced, the status of early consideration of these potential environmental impacts should be reported. Where these aspects have not been considered this should be reported with an explanation of the environmental assumptions made
Estimation and Reporting of Ore Reserves	
Others	Data on the effect, if any, of natural risk, infrastructure, environmental, legal, marketing, social or governmental factors on the likely viability of a project and/or on the estimation and classification of the Mineral Reserves. status of titles and approvals critical to the viability of the project, such as mining leases, discharge permits, government and statutory approvals. Environmental descriptions of anticipated liabilities. Location plans of mineral rights and titles.

1.1.6. SAMREC/SAMVAL Code (South Africa)

Full name in English	The South African Code for the Reporting of Exploration Results, Mineral Resources and Mineral Reserves
Full name in original language	The South African Code for the Reporting of Exploration Results, Mineral Resources and Mineral Reserves
Acronym	SAMREC/SAMVAL
Used in Country or Legal Entity	South Africa
Institution(s)	SSC Committee (The SAMREC/SAMVAL Committee)
Source	www.samcode.co.za; www.crirsco.com/national.asp
Year	1992 - first edition, 2016 - current edition
Resources identified	1. Mineral resources; 1.1. Inferred mineral resources; 1.2. Indicated mineral resources; 1.3. Measured mineral resources; 2. Mineral Reserves 2.1. Probable Mineral Reserves 2.2. Proved Mineral Reserves

The **SAMREC Code** was first issued in March 2000 and adopted by the JSE in their Listings Requirements later that same year. The Code has been adopted by the Southern African Institute of Mining and Metallurgy (SAIMM), the Geological Society of South Africa (GSSA), the South African Council for Natural Scientific Professions (SACNASP), the Engineering Council of South Africa (ECSA), then South African Geomatics Council (SAGC) (formerly PLATO, the *S*outh African Council for Professional and Technical Surveyors) and the Institute of Mine Surveyors of South Africa (IMSSA). The Code is binding on all members of these organisations (SAMREC 2016). A second edition of the SAMREC code was issued in 2007 with an amendment being issued in 2009. **The 2016 edition supersedes the previous editions of the Code (Lomberg, Rupprecht 2017).** The South African Code for the Reporting of Exploration Results, Mineral Resources and Mineral Reserves (The SAMREC Code) contributes to promoting the minimum requirements of Public Reporting (Rupprecht 2015).

The definitions in this edition of the SAMREC Code **are either identical to, or not materially different from, those existing standard definitions published in the CRIRSCO Reporting Template 2013** (SAMREC Code 2016).

The Code is applicable to the reporting of all styles of solid mineralisation or economic deposit. Certain commodities, namely coal, diamonds/gemstones and industrial minerals, have specific additional reporting requirements.

Environmental and social aspects in SAMREC Code

The environmental and social aspects are include in checklist (table 1.9) which should be the reference point for people those preparing reports on Mineral Exploration Results, Mineral Resources and Mineral Reserves. In the context of complying with the principles of the Code, comment on the relevant sections of Table 1.9 must be provided on 'if not, why not' basis within the Competent Person's Report and must be provided where required. This is to ensure that it is clear to the reader whether items have been considered and deemed to be of low consequence or have yet to be addressed or resolved.

Table 1.9. Environmental and social aspects in SAMREC Code (SAMREC Code 2016)

CRITERIA	**EXPLANATION**		
	Exploration results	**Mineral resources**	**Mineral Reserves**
Project outline			
Legal Aspects and Permitting	- Discuss the nature of the issuer's rights (e.g. prospecting and/or mining) and the right to use the surface of the properties to which these rights relate. Disclose the date of expiry and other relevant details, - Present the principal terms and conditions of all existing agreements, and details of those still to be obtained, (such as, but not limited to, concessions, partnerships, joint ventures, access rights, leases, historical and cultural sites, wilderness or national park and environmental settings, royalties, consents, permission, permits or authorisations), - Present the security of the tenure held at the time of reporting or that is reasonably expected to be granted in the future along with any known impediments to obtaining the right to operate in the area. State details of applications that have been made, - Provide a statement of any legal proceedings for example; land claims, that may have an influence on the rights to prospect or mine for minerals, or an appropriate negative statement, - Provide a statement relating to governmental/statutory requirements and permits as may be required, have been applied for, approved or can be reasonably be expected to be obtained,		

Technical studies		
Environmental and Social	Technical Studies are not applicable to Exploration Results	- Confirm that the company holding the tenement has addressed the host country environmental legal compliance requirements and any mandatory and/or voluntary standards or guidelines to which it subscribes, - Identify the necessary permits that will be required and their status and where not yet obtained, confirm that there is a reasonable basis to believe that all permits required for the project will be obtained, - Identify and discuss any sensitive areas that may affect the project as well as any other environmental factors including I&AP and/or studies that could have a material effect on the likelihood of eventual economic extraction. Discuss possible means of mitigation, - Identify any legislated social management programmes that may be required and discuss the content and status of these, - Outline and quantify the material socio-economic and cultural impacts that need to be mitigated, and their mitigation measures and where appropriate the associated costs.

1.1.7. SME Code (USA)

Full name in English	SME Guide for Reporting Exploration Results, Mineral Resources, and Mineral Reserves
Full name in original language	SME Guide for Reporting Exploration Results, Mineral Resources, and Mineral Reserves
Acronym	SME Guide
Used in Country or Legal Entity	USA
Institution(s)	Resources and Reserves Committee of Society for Mining, Metallurgy and Exploration, Inc (SME)
Source	www.crirsco.com/usa_sme_guide_2007.pdf; www.crirsco.com/national.asp
Year	2016 - current edition
Resources identified	1. Mineral resources; 1.1. Inferred mineral resources; 1.2. Indicated mineral resources; 1.3. Measured mineral resources; 2. Mineral Reserves 2.1. Probable Mineral Reserves 2.2. Proved Mineral Reserves

The **SME Guide for Reporting Exploration Results, Mineral Resources, and Mineral Reserves** has been adopted by **the Society for Mining, Metallurgy, and Exploration, Inc. (SME) in the USA** and is used by members of this organization. The SME Guide is recommended as a minimum standard for any individual, sole proprietorship, partnership, limited liability company, corporation, or other legal entity (Company) reporting Exploration Information and estimates of Mineral Resources and Mineral Reserves to outside parties for public or private purposes (SME Guide 2017).

The U.S. Securities and Exchange Commission (SEC) regulates the reporting of Exploration Information, Mineral Resources, and Mineral Reserves by companies subject to the filing and disclosure requirements of the U.S. SEC as promulgated in its **Regulation S-K, Industry Guide 7**, and staff communications. Decisions as to whether information should be filed with the SEC or reported publicly are the sole responsibility of the person or Company making the filing or public disclosures, and the contents of such filings and public disclosures are prescribed by SEC rules, regulations, and interpretations, including but not limited to Industry Guide 7 and other staff communications. The reporting of Exploration Information, Mineral Resources, and Mineral Reserves may also be subject to other national and international rules and regulations. These rules and regulations vary from time to time, and at any given time may not be consistent with the guidance given by the SME Guide. The advice of securities counsel should be sought in preparing filings for the SEC or other securities regulatory authorities, and in preparing other public disclosures (SME Guide 2017).

Environmental and social aspects in SME Code

The environmental and social aspects are include in checklist (table 1.10) which should be the reference point for people those preparing reports on Mineral Exploration Results Mineral Resources and Mineral Reserves. The application and description of all Modifying factors connected with environmental and social aspects (table 1.10) should be included in Feasibility Study.

Table 1.10. Environmental and social aspects in SME Code

CRITERIA	**EXPLANATION**		
	Exploration results	**Mineral resources**	**Mineral Reserves**
Property Ownership	Description of ownership of surface rights, mineral rights, access rights, leases, concessions, royalties, and other		
Environmental Compliance and Reclamation	Description of obvious environmental factors likely to stop the project.	Description of any environmental factors that could have a significant impact on the project feasibility. Discussion of possible means of mitigation.	The necessary permits have been obtained, or there is reasonable basis to believe that all permits required for the project can be obtained in a timely manner. Description of yearly environmental compliance methods and costs, including reclamation.

1.1.8. NAEN Code (Russia)

Full name in English	The NAEN Russian Code for the Public Reporting of Exploration Results, Mineral Resources, Mineral Reserves.
Full name in original language	Российский Кодекс публичной отчетности о результатах геологоразведочных работ, ресурсах и запасах твердых полезных ископаемых (Кодекс НАЭН)
Acronim	NAEN Code
Used in Country or Legal Entity	Russia
Institution(s)	NAEN and Russian Society of Subsoil Experts

Source	http://www.crirsco.com/national.asp
Year	2011 - current editions
Resources identified	1. Mineral resources; 1.1. Inferred mineral resources; 1.2. Indicated mineral resources; 1.3. Measured mineral resources; 2. Mineral Reserves 2.1. Probable Mineral Reserves 2.2. Proved Mineral Reserves

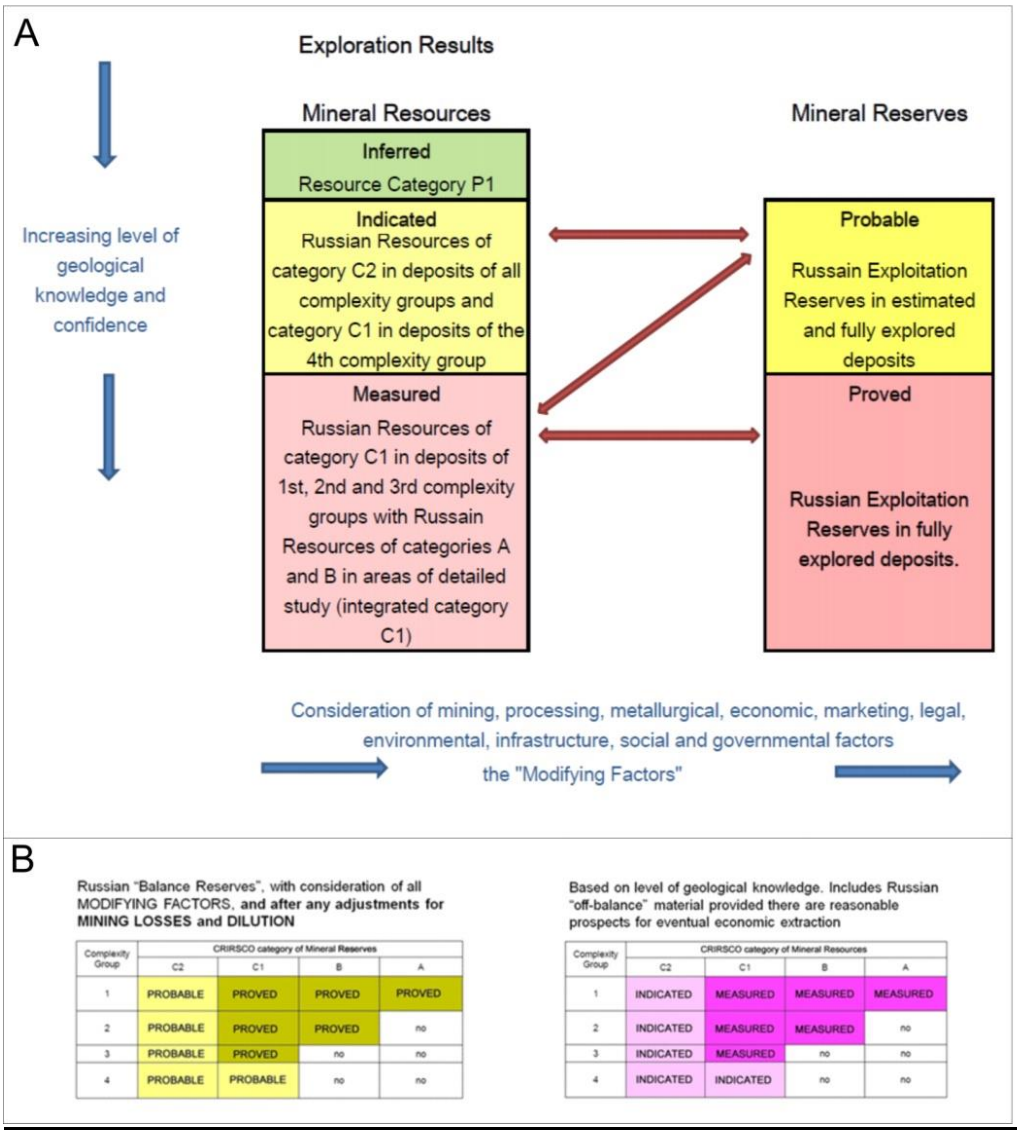
The **Russian Code for the Public Reporting of Exploration Results, Mineral Resources and Mineral Reserves** (**NAEN Code**) has been prepared **in 2011** (and updated in 2013) by **Non-Commercial Partnership "Self-Regulating Organization "National Association for Subsoil Examination" (NAEN**), 57 members of which represent leading mining companies, industry research centers and regional centers for subsoil survey of Russia, as well as the **Society of Russian Experts on Subsoil Use (OERN**), with participation of the Committee for Mineral Reserves International Reporting Standards (**CRIRSCO**) and the Pan-Europea Reserves and Resources Reporting Committee (**PERC**). The NAEN Code is based on the CRIRSCO Template (2013) and the Guidelines on Alignment of Russian Minerals Reporting Standards, agreed by FGU "GKZ" (Russian State Commission of Reserves) and CRIRSCO on 28th September 2010 (Moscow). As a result The NAEN Code sets minimal requirements for Public Reporting by Russian mining and exploration companies The NAEN Code has been developed in accordance with general criteria adopted by the world mining community (Australia, Canada, South Africa, Chile, Great Britain and others), taking into account the **Russian State system of subsoil (subsurface) use management, classification and accounting of solid minerals** (NAEN 2011).

Today the NAEN Code is recognized by European Securities of Markets Authority (ESMA) and The Canadian Securities Commission accepted code for reporting under NI 43-101, subject to the restrictions and provisions of Part 7.

The NAEN Cod currently provides the Guidelines on the Alignment of Russian Minerals Reporting Standards and a mapping of the Russian and the CRIRSCO categorization of mineral resources and mineral reserves. It is recommended that the Competent Person (CP) for the project use the proposed alignment guidelines to report exploration and mining results in public disclosures. The proposed "mapping" facilitates the conversion of the Russian classification categories of Resources and Reserves, used for state and corporate reporting in the GKZ (**Categories A, B, C1, C2**) to CRIRSCO categories (Figure 1.5), commonly used for public disclosure, which is simple and understandable for the investor community. Categories A, B, C1 and C2 were widely used for resource classifications in Mongolia, the Kirgiz Republic, Armenia and other countries in Eastern Europe and Central Asia. The NAEN Guidelines can be used for conversion of the resources from historical geological reports from those countries and also from China.

The Code is designed for use in international markets, in parallel with the Russian classification used for State purposes. One of the **main differences between the CRIRSCO Reporting Standards and the classification systems for State Regulatory purposes is that CRIRSCO standards are non-prescriptive**. The Competent or Qualified Person (CP or QP) for the project can design and implement exploration programs, following the best exploration practices, but having the freedom to choose appropriate exploration techniques, field activities and analyses. The Resource/Reserve estimation parameters and procedures are selected by the CP or QP in regards to the implementation of appropriate exploration programmes. The code does not recommend observation point density, drill hole spacing or

any other metrics. The resource categories depend on the CP's or QP's experience, technical skills, and professional judgement.



Complexity Group	CRIRSCO category of Mineral Reserves			
	C2	C1	B	A
1	PROBABLE	PROVED	PROVED	PROVED
2	PROBABLE	PROVED	PROVED	no
3	PROBABLE	PROVED	no	no
4	PROBABLE	PROBABLE	no	no

Complexity Group	CRIRSCO category of Mineral Resources			
	C2	C1	B	A
1	INDICATED	MEASURED	MEASURED	MEASURED
2	INDICATED	MEASURED	MEASURED	no
3	INDICATED	MEASURED	no	no
4	INDICATED	INDICATED	no	no

Figure 1.5. Recommended conversion of the Russian GKZ System to CRIRSCO Exploration Results, Mineral Resources and Mineral Reserves (A - www.micon-international.com, NAEN Code (2011), B - Hanley 2010)

Environmental and social aspects in NAEN Code

The environmental and social aspects are include in checklist (table 1.11) which should be the reference point for people those preparing reports on Mineral Exploration Results Mineral Resources and Mineral Reserves. It is the responsibility of the Competent Person to consider all the criteria listed below and which additional criteria should apply to the study of a particular project or operation. The relative importance of the criteria will vary with the particular project and the legal and economic conditions pertaining at the time of determination. The application and description of all Modifying factors connected with environmental and social aspects (table 1.11) should be contain in Feasibility Study.

Table 1.11. Environmental and social aspects in NAEN Code (NAEN Code 2011)

CRITERIA	EXPLANATION
Reporting of Exploration Results	
Geotechnical, Mining and geological, hydrogeological, technological and environmental surveys	Significant sources of environmental impact in production and social infrastructure of the planned enterprise. Types and nature of their impact on atmosphere, water bodies, soils, plant and animal life, ecosystems, micro-climate, landscapes, natural protected and recreation zones, historical and cultural sites.
Reporting of Mineral Reserves	
Modifying Factors	Other factors (environmental, social, administrative, legal, etc.). The effect, if any, of natural risk, infrastructure, environmental, legal, marketing, social or governmental (administrative legal) factors on the likely viability of a project and/or on the estimate and classification of Mineral Reserves. The status of titles and approvals critical to the viability of the project, such as subsurface use license and the license period, mining leases (permit-PAF) justification documents, State Registration Certificate, discharge permits, government and statutory approvals.

1.1.9. PERC Reporting Standard (EU)

Full name in English	Pan-European Standard For Reporting of Exploration Results, Mineral Resources and Reserves
Full name in original language	Pan-European Standard For Reporting of Exploration Results, Mineral Resources and Reserves
Acronim	PERC Reporting Standard
Used in Country or Legal Entity	Europe
Institution(s)	The Pan-European Reserves and Resources Reporting Committee
Source	www.percstandard.eu
Year	2017 - current edition
Resources identified	1. Mineral resources; 1.1. Inferred mineral resources; 1.2. Indicated mineral resources; 1.3. Measured mineral resources; 2. Mineral Reserves 2.1. Probable Mineral Reserves 2.2. Proved Mineral Reserves

PERC is the **European equivalent** of JORC in Australasia, SAMREC in South Africa, and similar reserves standards bodies elsewhere, and is a constituent member of the Committee For Mineral Reserves International Reporting Standards (CRIRSCO). **Representation on PERC** (currently 21 members) covers major and junior mining sectors, industrial minerals, aggregates, coal, the investment and financial community and the professional accreditation organisations including (www.percstandard.eu):

- Institute of Materials, Minerals, and Mining (IOM3),
- European Federation of Geologists,
- Geological Society of London,
- Institute of Geologists of Ireland.

PERC is **organization responsible for setting standards for public reporting of exploration results, mineral resources, and mineral reserves** (Bailey 2013). The **PERC**

Reporting Standard is fully aligned with the CRIRSCO Reporting Template, hence with other international reporting standards. Currently **2017 edition** of the PERC Reporting Standard supersedes all previous editions and standards (including The Reporting Code, the IMM Reporting Code, the PERC Code, the PERC Standard 2013, and the Recommended Rules for Public Reporting of Exploration Results, Surveys, Feasibility Studies and Estimates of Mineral Resources and Mineral Reserves in Sweden, Finland and Norway) (PERC 2017). The PERC Standard has been adopted by the Participating Organisations that comprise PERC (and as defined in the PERC Statutes), to be applied within the respective member countries of these organisations. The Standard is binding on the individual members of the Participating Organisations. These rules are subject to national laws and regulations and to laws and regulations of the European Union as and when appropriate.

Like other national codes, the PERC standard **sets minimum standards** for **public reporting** of Exploration Results, Mineral Resources and Mineral Reserves, provides a **mandatory system for classification** of tonnage/grade estimates according to geological confidence and technical/economic considerations, **provides definitions** for mineral resource and ore reserve classes that are compatible with international agreements and **provides extensive guidelines** on the criteria to be considered when preparing reports on Exploration Results, Mineral Resources and Mineral Reserves.

The **main principles** governing the operation and application of the **PERC Standard** are **transparency, materiality**, **competence** and **impartiality** (figure 1.6.)**,** which is a new element compared to CRIRCSO Template. **Impartiality** requires that the author of the Public Report is satisfied and able to state without any qualifications that his work has not been unduly influenced by the organisation, company or person commissioning a Public Report or a report that may become a Public Report; that all assumptions are documented; and that adequate disclosure is made of all material aspects, including any relevant direct or indirect relationship (such as employment or ownership of shares) between the Competent Person and the owners of the project on which he or she is reporting, that the informed reader may require to make a reasonable and balanced judgement thereof (PERC 2017).

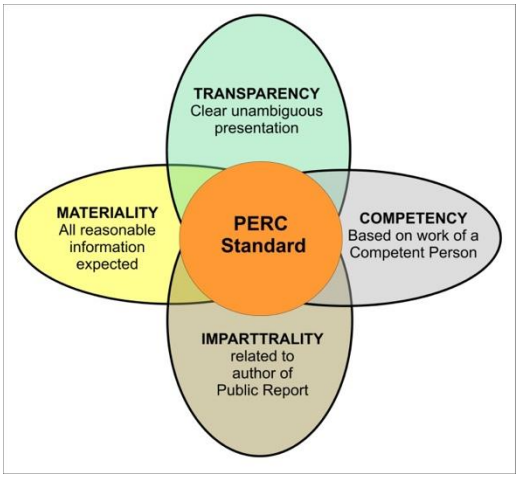


Figure 1.6. Principles governing the application of PERC Standard (based on PERC 2017)

Environmental and social aspects in PERC Standard

The environmental and social aspects are include in checklist (table 1.12) which should be the reference point for people those preparing reports on Mineral Exploration Results Mineral Resources and Mineral Reserves. The checklist is not prescriptive and, as always,

relevance and materiality are the overriding principles that determine what information should be publicly reported. It is strongly recommended that an 'If not-why not' approach is adopted.

Table 1.12. Environmental and social aspects in PERC Standard (PERC 2017)

CRITERIA	EXPLANATION		
	Exploration results	**Mineral resources**	**Mineral Reserves**
Mineral rights and land ownership	Type, reference name/number, location and ownership including agreements or material issues with third parties such as joint ventures, partnerships, historical sites, wilderness or national park and environmental settings. In particular the security of the tenure held at the time of reporting along with any known impediments to obtaining a licence to operate in the area. Location plans of mineral rights and titles. It is not expected that the description of mineral title in a technical report should be a legal opinion, but should be a brief and clear description of such title as understood by the author.		
Others		Any potential impediments to mining such as land access, environmental or legal permitting. Location plans of mineral rights and titles.	The effect, if any, of natural risk, infrastructure, environmental, legal, marketing, social or governmental factors on the likely viability of a project and/or on the estimation and classification of the Mineral Reserves. The status of titles and approvals critical to the viability of the project, such as mining leases, discharge permits, government and statutory approvals. Environmental descriptions of anticipated liabilities. Location plans of mineral rights and titles.

1.2. UNFC - United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009)

Full name in English	United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009
Full name in original language	United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009
Acronym	UNFC-2009
Used in Country or Legal Entity	international
Institution(s)	United Nations Economic Commission for Europe (UNECE)
Source	www.unece.org
Year	2009
Resources identified	1. Mineral resources; 1.1. Inferred mineral resources; 1.2. Indicated mineral resources; 1.3. Measured mineral resources; 2. Mineral Reserves 2.1. Probable Mineral Reserves 2.2. Proved Mineral Reserves

The **United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009)** is a universally acceptable and internationally applicable scheme for the classification and reporting of fossil energy and mineral reserves and resources and is currently the only classification in the world to do so. It was elaborated by the **United Nations Economic Commission for Europe (UNECE)** and is recommended by **the United Nations Economic and Social Council (ECOSOC)** in Decision No. 2004/33 issued on 18 July 2004. The **specifications for its application** make UNFC-2009 operational (UNFC 2009). The **UNECE** region covers more than 47 million square kilometres. **Its member States include** the countries of Europe, but also countries in North America (Canada and United States), Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) and Western Asia (Israel) (a total of 56 countries) (figure 1.7).

Figure 1.7. The members of Economic Commission for Europe (UNECE) (www.regionalcommissions.org)

UNFC-2009 applies to fossil energy and mineral reserves and resources located on or below the Earth's surface. It has been designed to meet, to the extent possible, the needs of applications pertaining to energy and mineral studies, resources management functions, corporate business processes and financial reporting standards.

The principal objective of UNFC-2009 is to enhance international communication by providing a generic classification framework for the reporting of fossil energy and mineral reserves and resources, even though such estimates may have been generated using classification or reporting systems that: (i) may use different terminology for comparable estimates, or the same terminology with different meanings; (ii) incorporate application guidelines that are commodity specific; and, (iii) may reflect the extraction of solids by mining or the production of fluids through wells. UNFC-2009 has been developed to meet, to the extent possible, the needs of applications pertaining to international energy and mineral studies, government resource management functions, corporate business processes and financial reporting standards.

UNFC-2009 is a generic principle-based system in which quantities are classified on the basis of the **three fundamental criteria of economic and social viability (E), field project status and feasibility (F), and geological knowledge (G**), using a numerical and language independent coding scheme (figure 1.8). Combinations of these criteria create **a three-dimensional system**. The categories (e.g. E1,E2, E3) are defined for each of the three criteria. The definitions of the UNFC-2009 categories and subcategories have been simplified and the most commonly-used classes are defined using plain language, providing harmonized generic terminology at a level suitable for global communications.

These basic criteria are (UNFC 2009):

- **economic and social viability (E)** – it designates the degree of favourability of social and economic conditions in establishing commercial viability of a project, including consideration of market prices and relevant legal, regulatory, environmental and contractual conditions;
- **field project status and feasibility (F)** – it designates the maturity of studies and commitments necessary to implement mining plans or development projects. These extend from early exploration efforts before a deposit or accumulation has been confirmed to exist through to a project that is extracting and selling a commodity;
- **geological knowledge (G)** – it designates the level of confidence in geological knowledge and potential recoverability of quantities.

On the basis of this criteria, resource categories are distinguished, defined and indicated by numbers. Therefore, each resource class can be presented as a 3-digit number (figure 1.9) where digits are designated to the E, F, G criteria (figure 1.8). Theoretically, there can be 48 resource classes, but only some of them used in practice.

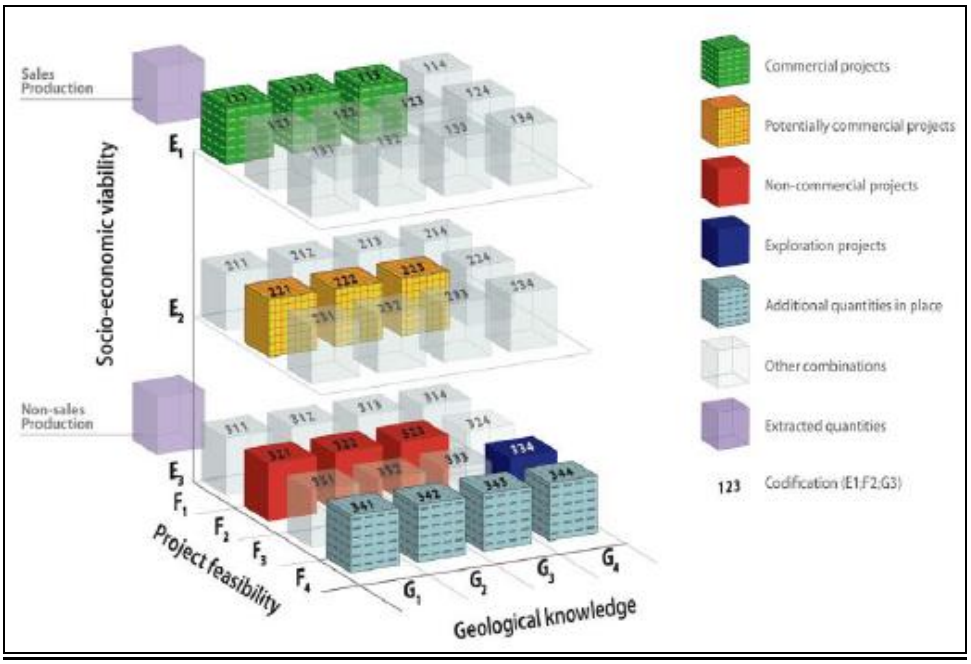


Figure 1.8. UNFC-2009 Categories and Examples of Classes (UNFC 2009; Tulsidas et al. 2015)

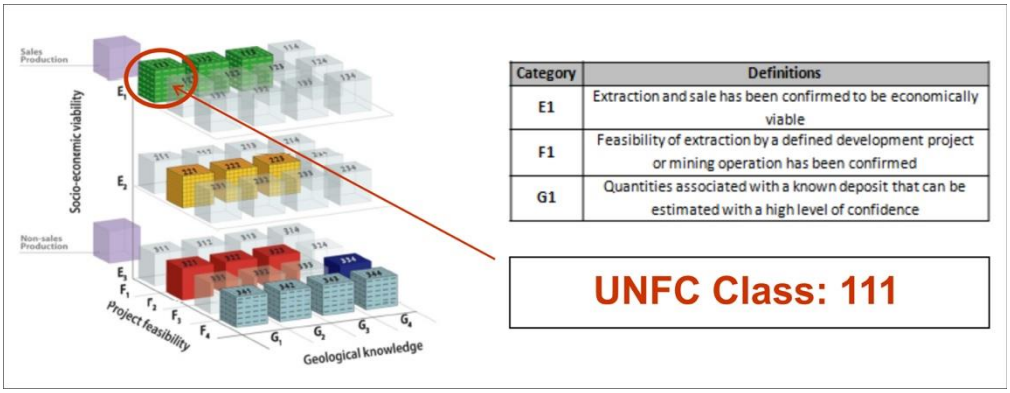


Figure 1.9. UNFC Classification rules

Categories and sub-categories, classes and sub-classes

The **first set of categories (the E axis**) designates the degree of favourability of social and economic conditions in establishing the commercial viability of the project, including consideration of market prices and relevant legal, regulatory, environmental and contractual conditions. **The second set (the F axis)** designates the maturity of studies and commitments necessary to implement mining plans or development projects. These extend from early exploration efforts before a deposit or accumulation has been confirmed to exist through to a project that is extracting and selling a commodity, and reflect standard value chain management principles. **The third set of categories (the G axis)** designates the level of confidence in the geological knowledge and potential recoverability of the quantities (table 1.13). The categories and sub-categories are the building blocks of the system, and are combined in the form of "classes". UNFC-2009 can be visualized in three dimensions, as shown in Figure 1.8 and figure 1.9, or represented in a practical two-dimensional abbreviated version as shown in Figure 1.10.

Table 1.13. Category definitions in UNFC classification (Griffiths, MacDonald 2014)

Category	Definitions
E AXIS	
E1	Extraction and sale has been confirmed to be economically viable
E2	Extraction and sale is expected to become economically viable in the foreseeable future
E3	Extraction and sale is not expected to become economically viable in the foreseeable future or evaluation is at too early a stage to determine economic viability.
F AXIS	
F1	Feasibility of extraction by a defined development project or mining operation has been confirmed
F2	Feasibility of extraction by a defined development project or mining operation is subject to further evaluation
F3	Feasibility of extraction by a defined development project or mining operation cannot be evaluated due to limited technical data.
F4	No development project or mining operation has been identified.
G AXIS	
G1	Quantities associated with a known deposit that can be estimated with a high level of confidence
G2	Quantities associated with a known deposit that can be estimated with a moderate level of confidence
G3	Quantities associated with a known deposit that can be estimated with a low level of confidence.
G4	Estimated quantities associated with a potential deposit, based primarily on indirect evidence

A **class is uniquely defined** by selecting from each of the three criteria a particular combination of a category or a sub-category (or groups of categories/sub-categories). Since the codes are always quoted in the same sequence (i.e. E; F; G), the letters may be dropped and just the numbers retained. The numerical code defining a class is then identical in all languages using Arabic numerals (Figure 1.10).

While there are no explicit restrictions on the possible combinations of E, F and G categories or sub-categories, only a limited number will generally be applicable. For the more important combinations (classes and sub-classes), specific labels are provided as a support to the numerical code, as illustrated in Figure 1.10. For further clarity in global communications, additional generic UNFC-2009 sub-classes. These are illustrated in Figure 1.11.

Total Commodity Initially in Place	Extracted	Sales Production / Non-Sales Production[a]			
		Class	Categories		
			E	F	G[b]
	Future recovery by commercial development projects or mining operations	Commercial Projects[c]	1	1	1, 2, 3
	Potential future recovery by contingent development projects or mining operations	Potentially Commercial Projects[d]	2[e]	2	1, 2, 3
		Non-Commercial Projects[f]	3	2	1, 2, 3
	Additional quantities in place associated with known deposits[g]		3	4	1, 2, 3
	Potential future recovery by successful exploration activities	Exploration Projects	3	3	4
	Additional quantities in place associated with potential deposits[g]		3	4	4

Figure 1.10. Abbreviated Version of UNFC-2009, showing Primary Classes (UNFC 2009)

[a] Future non-sales production is categorized as E3.1. Resources that will be extracted but not sold can exist for all classes of recoverable quantities. They are not shown in the figure; [b] G categories may be used discretely, particularly when classifying solid minerals and quantities in place, or in cumulative form (e.g. G1+G2), as is commonly applied for recoverable fluids, [c] Commercial Projects have been confirmed to be technically, economically and socially feasible. Recoverable quantities associated with Commercial Projects are defined in many classification systems as Reserves, but there are some material differences between the specific definitions that are applied within the extractive industries and hence the term is not used here; [d] Potentially Commercial Projects are expected to be developed in the foreseeable future, in that the quantities are assessed to have reasonable prospects for eventual economic extraction, but technical and/or commercial feasibility has not yet been confirmed. Consequently, not all Potentially Commercial Projects may be developed, [e] Potentially Commercial Projects may satisfy the requirements for E1; [f] Non-Commercial Projects include those that are at an early stage of evaluation in addition to those that are considered unlikely to become commercially feasible developments within the foreseeable future, [g] A portion of these quantities may become recoverable in the future as technological developments occur. Depending on the commodity type and recovery technology (if any) that has already been applied, some or all of these quantities may never be recovered due to physical and/or chemical constraints.

UNFC Classes Defined by Categories and Sub-categories						
Total Commodity Initially in Place	Extracted	Sales Production				
		Non-sales Production				
		Class		Sub-class	Categories	
					E	F	G
	Known Deposit	Commercial Projects		On Production	1	1.1	1, 2, 3
				Approved for Development	1	1.2	1, 2, 3
				Justified for Development	1	1.3	1, 2, 3
		Potentially Commercial Projects		Development Pending	2[b]	2.1	1, 2, 3
				Development On Hold	2	2.2	1, 2, 3
		Non-Commercial Projects		Development Unclarified	3.2	2.2	1, 2, 3
				Development Not Viable	3.3	2.3	1, 2, 3
		Additional Quantities in Place			3.3	4	1, 2, 3
	Potential Deposit	Exploration Projects		[No sub-classes defined][c]	3.2	3	4
		Additional Quantities in Place			3.3	4	4

Figure 1.11. UNFC-2009 Classes and Sub-classes defined by Sub-categories (UNFC 2009)

Specifications for the Application of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009)

UNFC-2009 is designed **to take account of the importance of environmental and social issues** in the context of resource extraction. In classifying estimated quantities that may be extracted in the future from a development project or mining operation, the E-axis Categories are explicitly defined to include both environmental and social issues that may be relevant to the commercial viability of such a venture, in addition to economic, legal and other non-technical factors. In particular, the identification and consideration at the time of the estimate of all known environmental or social impediments or barriers to the project during its entire life cycle is recognized as an integral part of the project assessment. The presence of environmental or social impediments can prevent a project from proceeding or it can lead to the suspension or termination of activities in an existing operation.

UNFC-2009 has been aligned with two other classification systems, which facilitates the reporting of the same resource quantities under either UNFC-2009 or the aligned system. The two systems are the **CRIRSCO Template of 2006** developed by the Committee for Mineral Reserves International Reporting Standards (CRIRSCO) (Figure 1.12), and the **reporting codes and standards that are based on it**, and the Society of Petroleum Engineers (SPE)/World Petroleum Council (WPC)/American Association of Petroleum Geologists (AAPG)/Society of Petroleum Evaluation Engineers (SPEE) **Petroleum Resources Management System of 2007 (PRMS).**

<table>
<tr><td rowspan="2">CRIRSCO (JORC/CIM/ PERC/ NAEN)</td><td colspan="3">Resource</td><td>Measured</td><td colspan="3">Indicated</td><td colspan="2">Inferred</td><td>Exploration Potential or Exploration Target</td></tr>
<tr><td colspan="3">Reserve</td><td>Proven</td><td colspan="3">Probable</td><td colspan="2"></td><td></td></tr>
<tr><td>Russian State Classification</td><td colspan="3">Reserve</td><td>A, B and C1</td><td colspan="3">B, C1 and C2</td><td colspan="2">C2 and P1</td><td>P2 and P3</td></tr>
<tr><td rowspan="6">UNFC-2009 (Chinese and Indian Classification)</td><td rowspan="4">"E"</td><td rowspan="2">Economic Evaluation (100)</td><td>Designed Mining with loss</td><td>Recoverable Reserve (111)</td><td>Probable Recoverable Reserve (121)</td><td></td><td>Probable Recoverable Reserve (122)</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Designed Mining without loss</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Marginal Economic (2M00)</td><td>Basic Reserve (2M11)</td><td>Basic Reserve (2M21)</td><td></td><td>Basic Reserve (122b)</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Sub-Economic (2S00)</td><td>Resource (2S11)</td><td>Resource (2S11)</td><td></td><td>Resource (2S22)</td><td></td><td></td><td></td></tr>
<tr><td>"F"</td><td colspan="2">Intrinsically Economic (300)</td><td></td><td></td><td>Resource (331)</td><td></td><td>Resource (332)</td><td>Resource (333)</td><td>Resource (334)</td></tr>
<tr><td>"F"</td><td colspan="2">Feasibility Evaluation</td><td>Feasibility (101)</td><td>Pre-Feasibility (020)</td><td>Scoping (030)</td><td>Pre-Feasibility (020)</td><td>Scoping (030)</td><td>Scoping (030)</td><td>Scoping (030)</td></tr>
<tr><td>"G"</td><td colspan="2">Geological Evaluation</td><td colspan="3">Measured (001)</td><td colspan="2">Indicated (002)</td><td>Inferred (003)</td><td>Predicted (004)</td></tr>
</table>

Figure 1.12**.** Comparisons between CRIRSCO and Other Resource and Reserve Classifications (www.micon-international.com)

UNFC and Environmental and Social Considerations

Until recently, social and environmental factors have rarely been considered in the classification of natural resources. Their importance has grown considerably in the last few years.

The various factors involved in resource classification do not exist in isolation, and the distinction between them is rarely black and white. The related issues of ownership, contract terms, legal, regulatory issues, and in some cases, financial conditions may be affected by social and environmental issues. A delay due to the resolution of these as a result of socio-environmental issues can have a significant impact on the economics of projects, even making them no longer economically viable. Socio-environmental issues, typically described as a requirement for "social licence" or "social licence to operate" (SLO), have attracted a significant amount of interest and attention in recent years. A project cannot proceed unless the important social and environmental contingencies are resolved, typically described as obtaining a "social licence to operate" (SLO).

UNFC is a tool for effective management of national resource endowments needed for realizing the Sustainable Development Goals (SDGs). UNFC applies to energy and mineral resources; injection projects for the geological storage of CO2; and the anthropogenic resources such as secondary resources recycled from residues and wastes. UNFC aims to provide necessary specifications and guidelines for optimizing the management and development of resources, with positive impacts on the society, environment, local economies and employment.

Guidelines on socio-environmental considerations are under preparation. The Expert Group on Resource Classification (Expert Group) E-axis Sub-group was established to examine the social and environmental aspects of classification using UNFC-2009. The draft guideline documents under development include:

- **Guidance on accommodating social and environmental considerations,**
- **Clarification of terms related to socio-environmental factors.**

Neither social nor environmental factors are defined in UNFC-2009, nor any of the resource specific guidelines, and the difference between them is not always clear. A formal definition may not be necessary, but it should be understood what these terms mean**. The following is suggested** (Draft guidance 2017a)**:**

- **Environmental,** as the physical or biological impact on, or changes to, the pre-existing environment due to a project (e.g. heavy metals contamination). It is often measurable (for example, CO2 emissions, the amount of waste moved, changes in surface geochemistry, etc.),
- **Social, as the impact on humans, from a project, such as:**
  - **Environmental** changes (e.g. health issues due to heavy metal contamination). Some aspects may be measurable, but many others are qualitative, or
  - **Changes in social systems and structures** (e.g. ownership claims, traditional land usage, land, and other values changes, etc.).

The UNFC-2009 E axis combines two aspects of resource classification that are not directly related, the economics and the socio-environmental aspects of a project. A project may meet all the feasibility requirements of the F and G axes and the economic component of the E axis, but unless it is also socially and environmentally acceptable, it often cannot proceed. Suggested revisions of E-axis Sub-categories are shown in table 1.14 and include (Draft guidance 2017b):

a. Changing “economic” to “commercial”,
b. Adding sub-categories E2.1 and E2.2 to differentiate the level of project activity devoted towards the resolution of socio-environmental contingencies situations and the probability that they will be resolved in the foreseeable future,
c. Projects that are unable to proceed until the resolution of social or environmental issues, but for which there is no attempt to resolve them or expectation of their resolution in the foreseeable future would be classified as E3.3.

Table 1.14. Suggested revised Categories and Sub-categories of UNFC-2009 (Draft guidance 2017b)

Category	Category definition	Sub-Category	Sub-Category definition
E1	Extraction and sale has been confirmed to be ~~economically~~ ***commercially*** viable	E 1.1	Extraction and sale is ~~economic~~ ***commercially viable*** on the basis of current market conditions and realistic assumptions of future market conditions.
		E 1.2	Extraction and sale is not ~~economic~~ ***commercially viable*** on the basis of current market conditions and realistic assumptions of future market conditions, but is made viable through government subsidies and/or other considerations.
E2	Extraction and sale is expected to become ~~economically~~ ***commercially*** viable in the foreseeable future.	***E2.1***	***Issues are yet to be resolved, but there is high probability of their resolution evidenced by an active attempt to resolve all impediments (contingencies) with a high probability of success, based on the characteristics of the project, previous history of similar projects in the area, or other strong indications of success, within the foreseeable future***
		E2.2	***Issues are yet to be resolved, but:*** ***There is an active attempt to resolve all impediments (contingencies) but with no more than a medium probability of success, or,*** ***There is no active effort to resolve impediments, but based on the characteristics of the project and previous history of similar projects in the area, success is likely within the foreseeable future***
E3	Extraction and sale is not expected to become ~~economically~~ ***commercially*** viable in the foreseeable future or evaluation is at too early a stage to determine ~~economic~~ ***commercial*** viability.	E 3.1	Quantities that are forecast to be extracted, but which will not be available for sale.
		E 3.2	~~Economic~~ ***Commercial viability*** of extraction cannot yet be determined due to insufficient information (e.g. during the exploration phase). ***Or*** ***Whether or not there is an active effort to obtain approval, the outcome is unknown or unclarified.***
		E 3.3	~~On the basis of realistic assumptions of future market conditions~~ It is currently considered that there are not reasonable prospects for ~~economic~~ ***commerciality*** extraction and sale in the foreseeable future ***Whether or not there is an active effort to obtain approval, the probability of receiving approval is less than medium and may be zero.***

~~Example –~~ changing, ***example*** – new proposition

1.3. Specific national codes (examples)

1.3.1. Russian classification

Full name in English	Reserve Classification Systems of Russian Federation
Acronym	-
Used in Country or Legal Entity	Russia
Institution(s)	State Committee on Mineral Reserves/Resources (GKZ)
Source	
Year	2008- latest version
Resources identified	fully explored reserves or resources (A, B, C1), evaluated reserves or resources (C2) and prognostic resources (P1, P2, P3)

In pre-revolutionary period and until the 1930s of the last century, Russia/Soviet Union used a system of reserve classification based on explicit verbal expression of the categories broken down into actual, probable and potential classes. Division into these categories was not accompanied by clear-cut criteria for classification of reserves, which brought about arbitrary interpretation of available reserves. For this reason in the early 1920s, a special commission at the USSR Geological Committee started work aimed at development of criteria describing the deposits more clearly, both in terms of precise geological information and their economic significance. As a result of discussions in 1928, the Geological Committee adopted a reserve evaluation system based on using letters. In this system, the reserves were classified into letter categories on the basis of geological knowledge and their economic use: **A1, A2, B, C1, C2** (Arden, Tverdov 2013).

Later the Russian system of classification was repeatedly revised with a view to improve reference to geological knowledge and economic significance of deposits. Alongside with refining and improving the system of reserve classification, the work was undertaken to develop regulatory and legal documents, instructions and guidelines for estimation of reserves for deposits of various types and complexities.

As a result of these revisions, the basic principles of the reserve classification system currently in operation in Russia had been formed by 1981. The latest revision of the classification took place in 2008.

Essentially, it divides mineral concentrations into seven categories, in three major groups, based on the **level of exploration performed (analysis of geological attributes)**: fully explored reserves or resources (A, B, C1), evaluated reserves or resources (C2) and prognostic resources (P1, P2, P3). Reserves and resources that can be matched to the usual international categories are classified into five main classes designated by the symbols: A, B, C1, C2, P1.

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 subeconomic. A simple classification into classified (A, B, C1, C2) **“balansovye” (balance) = commercially exploitable reserves** and **unclassified “zabalansovye” (out-of-balance) = uneconomic resources** is used (fig. 1.13). Synonyms of “balansovye” and “zabalansovye” which are often met, and used descriptively, are “konditsionniye” (conditioned) and “nekonditsionniye” (unconditioned). The resources are calculated and recognized as balance

or out-of-balance in keeping **with economically justified cut-off parameters** (Denisov, Kavun 2003).

Characteristic of seven categories (Guidelines 2010)***:***

- **Category A** - Deposit is known in detail, boundaries of the deposit have been outlined by trenching, drilling, or underground workings. Quality and properties of the mineral are known in sufficient detail to ensure the reliability of the projected exploitation;
- **Category B** - Deposit has been explored but is only known in fair detail, boundaries of the deposit have been outlined by trenching, drilling, or underground workings. Quality and properties of the mineral are known in sufficient detail to ensure the basic reliability of the projected exploitation;
- **Category C1** - Deposit has been estimated by a sparse grid of trenches, boreholes or underground workings. The quality and properties of the deposit are known tentatively by analogy with known deposits of the same type and the general conditions for exploitation are known tentatively. This category includes resources peripheral to the boundaries of the A and B category and also reserves allocated in complex deposits in which the mineral distribution cannot be reliably determined even by a very dense grid;
- **Category C2** - Extent of the deposit has been extrapolated from limited data. This category includes resources adjoining areas designated as A, B, and C1 in the same deposit;
- **Category P1** - Resources in the P1 category may extend outside the actual limits of the mineral 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. They are estimated based on geophysical and geochemical data. Morphology, mineral composition and size of the mineralisation is estimated by analogy with similar mineralised geological structures in the area;
- **Category P3** - Potential for discovery of a deposit of any type of mineral on the basis of favourable geological and indicative pre-conditions found in the prospective area by undertaking medium to small scale geological and geophysical surveying, satellite image interpretation and analysis of geophysical and geochemical survey results.

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 that are subject to confirmation by more detailed investigations.

Upgrade to C classes from P requires additional data (typical “modifying factors” such as geotechnical, economic, pit design, etc.) whilst C1, B, and A classes require completion of a prefeasibility/feasibility study which is generally called the **TEO of “conditions**” (**t**echnico-**e**conomicheskoye **o**bosnovaniye kondicy **= technical-economic justification of minimum parameters (cut off parameters)**). The publication of data in the above classes requires audit and registration by an independent organisation i.e. GKZ (Gosudarstvenaya Komisiya po Zapasam) = State Commission on Reserves at national level or TKZ (Teritotorialnaya Komosiya po Zapasam) = Territorial Commission on Reserves at regional level.

The TEO document is a very comprehensive and detailed one and covers not only the geological and technical/technological assessment and economical evaluation of the deposit in question for different cut-off parameters, but also checking the suitability of the various aspects of the chosen mining methodology for the current health and safety legislations and

procedures in place. Economic assessment typically investigates the different cut-off parameter options defined from the geological and technological perspectives under the headings of: analysis of market and economic environment and taxation issues, operational cost and production cost and product sales, capital costs, floating capital investments, profitability, discount rate, net cash flow and net present value, internal rate of return as well as indicators of the commercial effectiveness of the project (Arden, Tverdov 2013).

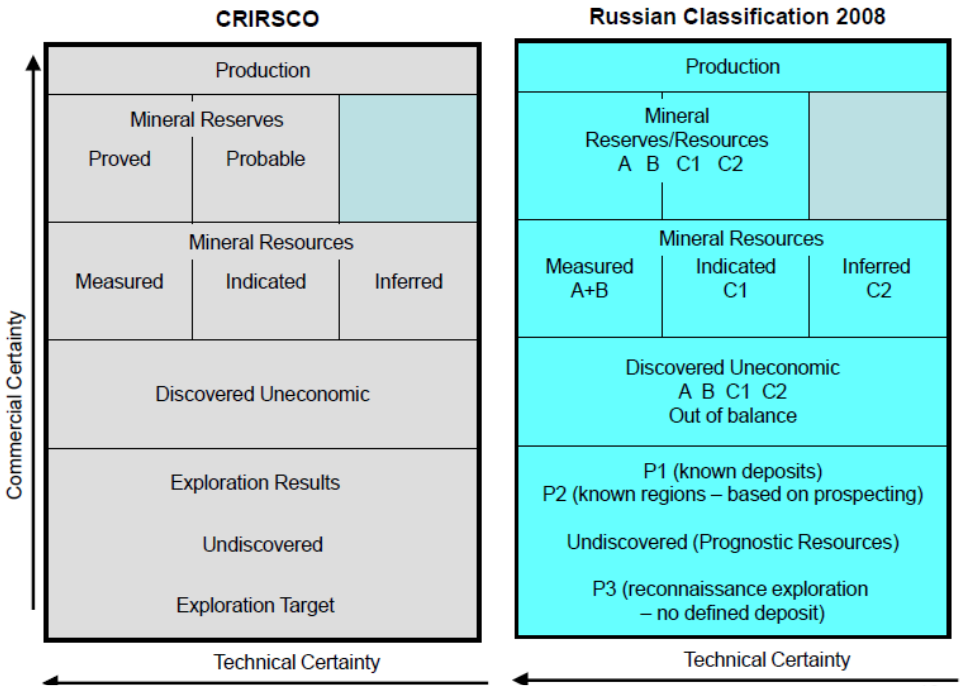


Figure 1.13. Alignment of Resource and Reserve Classification Systems Russian Federation and CRIRSCO (Henley S.)

Environmental and social conditions in Russian classification

The Russian classification of resources is based on the level of exploration performed (analysis of geological attributes). The environmental and social conditions (values) are not considered.

1.3.2. Poland

Full name in English	Polish Resources Classification
Full name in original language	Polska Klasyfikacja Zasobów
Acronym	-
Used in Country or Legal Entity	Poland
Institution(s)	Ministry of the Environment
Source	Act of 9 June 2011, Geological and Mining Law Dz.U. 2011.163. 981; Regulation of the Minister of the Environment of 1 July 2015 on the geological documentation of the mineral deposit, excluding the hydrocarbon deposits Dz.U.2015.987
Year	2015 - current definitions
Resources identified	Resources categories D, C2, C1, B, A

Polish system of reporting exploration results and resources classification was established at the beginning o second half of XX-th century for the needs of central planned economy. It was modified and improved in following years. In the countries of market economy the necessity of commonly accepted formalized rules of reporting resources data was noticed about 30 years later and the JORC Code was compiled. The backgrounds and the mode of reporting exploration results and resources according to JORC Code and polish system are comparable (Nieć 2016). The general rules of classification of resources and reserves in Poland are concordant also with the United Nations Framework Classification (figure 1.14).

Polish classification		JORC Code CRIRSCO	UNFC 2008		
			Geological report		Feasibility study
			Deposits licensed for mining	Deposits not licensed for mining	
prognostic resources D		Prospecting results	234, 334		
Anticipated economic („balance") resources	C_2 C_1 A+B	Resources Inferred Indicated Measured	223 222 221	233 232 231	
Anticipated subeconomic („subbalance") resources	C_2 C_1 A+B		323 322 321	333 332 331	313 312 311
„Not industrial" subeconomic resources	C_2 C_1 A+B				313 312 311
„Industrial" economic resources	C_2 C_1 A+B				213 212 211
Extractable resources	C_2 C_1 A+B				113 112 111
Mineable reserves C_2 C_1 A+B		Reserves Probable Proved			

Figure 1.14. Comparison on Polish classification system with JORC Code (CRIRSCO) and UNFC 2008 classification (Nieć 2010)

Definitions used in Polish classification system according to Regulation of the Minister of the Environment on geological documentation of mineral deposits, excluding hydrocarbons (dated 1 July 2015 – Official Journal of 2015 Item 987), Regulation of the Minister of the Environment on geological-investment documentation of a hydrocarbon field (dated 1 July 2015 – Official Journal of 2015 Item 968) and Regulation of the Minister of the Environment on detailed requirements of a mineral deposit development plan (dated 24 April 2012 – Official Journal of 2012 Item 511):

- **Deposit resources ("geological resources" – anticipated economic resources and anticipated sub-economic resources)** – total resources of mineral commodity/commodities within deposit boundaries;
- **Limit values of parameters that define a deposit** – values of deposit parameters delineating mineral deposit geological boundaries (**cut-of-parameters**);
- **Anticipated economic resources ("balance resources")** – mineral deposit resources (or part of a deposit) meeting limit values of parameters that define a deposit;
- **Anticipated sub-economic resources ("sub-balance resources")** – mineral deposit resources (or part of a deposit) not meeting limit values of parameters that define a deposit;

- **Economic resources in place ("industrial resources")** – part of anticipated economic mineral resources or anticipated sub-economic resources or – in the case of brines, curative and thermal water – exploitable resources within a designated mining area or detached part of a deposit designed for exploitation, which can be designated for mining according to detailed technical and economic analysis taking legal requirements into account, including environmental restraints;
- **Sub-economic (marginal) resources ("not-industrial resources")** – part of anticipated economic mineral resources not-classified as economic resources within an area designated for exploitation, which can be designated for mining as a result of technical or economical or legal requirement changes, including environmental restraints;
- **Extractable resources** – part of economic mineral resources in place which are obtained when reducing economic resources by technical losses;
- **Exploitable resources** – crude oil or natural gas resources, which should be extracted by applying current exploitation technology.

The **mineral resources categorization system** applied **in Poland** is based upon the **two criteria**: **economic pertinence of given raw material** and the **degree of deposit recognition** represented by categories and corresponding, maximum (permissible) values of relative estimation errors of mean deposit parameters and resources: D (>40%), C2 (40%), C1 (30%), B (20%) and A (10%) (Nieć et al. 2012).

Resources categories definition (for solid mineral commodities) according to a **Regulation of the Minister of the Environment on geological documentation of mineral deposits, excluding hydrocarbons** (dated 1 July 2015 – Official Journal of 2015 Item 987)**:**

- **D (inferred resources)** – mineral deposit boundaries, geological feature and anticipated resources are evaluated on the basis of available geological data, in particular, from isolated excavations or natural outcrops, geological interpretation of geophysical measurements. **The admissible error of average deposit parameters and deposit resources estimation may exceed 40%;**
- **C2 (inferred resources)** – mineral deposit boundaries are evaluated on the basis of available data from isolated excavations, natural outcrops, interpolation or extrapolation of geophysical measurements; main structural and geological features and tectonics are recognized; geological-mining conditions of exploitation are initially evaluated; quality of mineral commodity is evaluated on the basis of regular sampling in the full range of commodity usage. **The admissible error of average deposit parameters and deposit resources estimation cannot exceed 40%;**
- **C1 (indicated resources)** – mineral deposit boundaries are evaluated on the basis of available data from exploratory excavations, natural outcrops or interpolation or extrapolation of geophysical measurements; the grade of deposit exploration allows a prefeasibility study of economic mining, including detailed delineation of structural and geological features, tectonics and quality of mineral commodity in a deposit, as well as geological-mining conditions of exploitation, and allows evaluation of the influence of intended exploitation on the environment. **The admissible error of average deposit parameters and deposit resources estimation cannot exceed 30%;**
- **B (measured resources)** – mineral deposit boundaries are delineated in details on the basis of specially carried out exploratory excavations or geophysical measurements, whereby the delineation of structural and geological features, correlation of strata, and main tectonics features have to be unambiguous and the quality and

technological properties of a mineral commodity should be confirmed by sampling results in pilot-scale tests or on a commercial scale. The degree of deposit exploration is sufficient enough to elaborate a mine management plan. **The admissible error of average deposit parameters and deposit resources estimation cannot exceed 20%;**

- **A (measured resources)** – a mineral deposit is explored to an extent allowing current planning and exploitation with a maximum possible rate of resource absorption; delineation of structural and geological features, tectonics, resources on the basis of opening-out, preparation and mining excavations, as well as type, quality and technological properties of mineral commodity on the basis of regular excavations sampling and data from current production are required. The degree of deposit exploration is sufficient enough to elaborate a mine management plan. **The admissible error of average deposit parameters and deposit resources estimation in particular blocks cannot exceed 10%.**

Environmental and social conditions in the Polish Resources Classification

The mineral resources categorization system applied in Poland is based upon the two criteria: economic pertinence of given raw material and the degree of deposit recognition. During determining each categories, environmental and social factors are not taken into account. However, the geological documentation prepared for each documented deposit, must include chapter described: location of deposit, direction of land development, state of environment and its protection (Regulation of the Minister of the Environment on geological documentation of mineral deposits, excluding hydrocarbons (dated 1 July 2015 – Official Journal of 2015 Item 987)**. The documentation does not describe social conditions.**

2. Mineral resources valorisation (multicriterial assessment) approaches (examples)

Multicriterial assessment (valorisation) of mineral resources is not so common, also in EU countries. Only some countries have introduced (Austria, Sweden) or are trying to introduce (Poland, Portugal) such approaches, with the main aim to distinguish the most important mineral deposits, which should be safeguarded, though legal instruments of such safeguarding are various and often limited. Environmental and social dimensions are (or should be) important parts of such assessments.

In this chapter, the most important, coherent and concise examples of such multicritrial assessments of mineral resources in EU countries are presented and analysed, starting from the most mature approach – Austrian Mineral Resources Plan. It does not mean that should analyses are not undertaken in other EU countries, but – if so – are only in preliminary phase of preparation. A step forward for such purpose was MINATURA2020 project, which proposed general framework for such assessments in various EU countries.

2.1. Mineral Resources Plan (Austria)

Full name in English	Mineral Resources Plan
Full name in original language	Der Österreichische Rohstoffplan
Acronym	-
Used in Country or Legal Entity	Austria
Institution(s)	Federal Ministry of Economy
Source	https://opac.geologie.ac.at/wwwopacx/wwwopac.ashx?command=getcontent&server=images&value=AL0026_001_A.pdf
Year	2012
Resources identified	Perspective areas without identified mineral resources; Mineral resources; Mineral Reserves

The Austrian Minister of Economy prepared the **Austrian Mineral Resources Plan (2012)** on request of the National Council as a national master plan to secure supply of mineral resources and to serve as a planning basis for future mining activities with the federal states and municipalities in relation to their specific needs (Republik Österreich 2002). Developing the Austrian Minerals Resources Plan systematic identification and evaluation of mineral deposits with regard to their protection-worthiness was carried out (**Phase 1**) followed by a second phase (**Phase 2**) "conflict-elimination" with limited collaboration of the federal states to eliminate any protection conflicts caused by the mineral zones which had been objectively identified using systematic analysis methods in particular.

The safe and sufficient minerals supply is a core task of the extractive industry. However, the public sector is responsible for providing basic spatial data such as general geo-scientific data and information that allows an economic evaluation of the raw materials. The purpose of the Austrian Mineral Resources Plan was therefore to perform the groundwork required in preparation for activities by private enterprises (Weber 2012). This involved systematically identifying potential raw material zones and then after weighing up competing land use interests in a mineral planning process designed to avoid conflicts with

raw material extraction, enshrining these zones in regional planning to ensure their conflict-free future use. This requires the protection of deposits by the federal government and provinces by means of measures to safeguard raw materials.

As knowledge of occurrences of natural resources is increasing constantly, it should be necessary to update the evaluation at regular intervals. Just as regional development plans have to be continuously adapted to keep up with current developments, the Austrian Mineral Resources Plan should also be understood as a work in continupus progress. As regional planning laws in the provinces contain no uniform definition of raw material areas worthy of safeguarding, they were defined as follows:
For the purposes of the Austrian Mineral Resources Plan, raw material areas are defined as all areas which have been identified using objective and systematic analytical methods and which contain mineral raw materials. In view of expected technological advances and bearing in mind ecological and social aspects it is assumed that it will be possible to use such materials commercially in the medium to long term. Mineral areas worthy of safeguarding as defined by the Austrian Mineral Resources Plan are mineral areas, which have no or minimal conflicts with other land use plans. They follow a traceable mineral planning process designed to avoid conflicts with raw material extraction. They should be kept for the extraction of raw materials, but there should be no mandatory requirement to actually use the occurrences for mineral extraction (Weber 2012). Work was carried out in two phases so that the positive and negative experiences of the federal and provincial administrative authorities, companies, interest groups and the scientific community could be taken into account.

The main purpose of **Phase 1** was to draw up a baseline survey. This involved surveying, documenting and evaluating all occurrences of raw materials in Austria and also carrying out a thorough analysis of the potential supply risks. An effort was also made to find innovative approaches to the exploitation of typical alpine deposits. The work of **Phase 1** was carried out in four working groups (Galos et al., 2016):

- **Working Group 1** - *Geology and Resources:* The evaluation of raw material areas with surface-near construction materials or deeper seated deposits such as metal ores, industrial minerals and coals required problem-specific solutions. Occurrences of soft and hard rock throughout Austria were surveyed by the Geological Survey of Austria (GBA) and their quality and quantity evaluated using systematic analytical methods. The Expert Committee for Mineral Deposit Research of the Mining Society of Austria also developed a special method to evaluate occurrences of metal ores, industrial minerals and coal and to determine the area needed.
- **Working Group 2** - *Mineral Economics*: In cooperation with the Ministry of Economy, Family and Youth, the University of Leoben prepared a number of important parallel studies which evaluated raw materials in economic terms (“modules”). This work included, for example, Austria‘s supply situation and the probable development of prices and demand, the Austrian raw materials industry, the international situation and trends, possible supply risks, and improving Austria’s ability to meet demand from domestic resources e.g. improved mining methods, increasing the value added of mineral raw materials, improving mineral processing techniques. These studies provided important scientific and technical grounds for classifying mineral areas as being worthy of safeguarding. During work on the individual modules several possibilities were identified for using mineral raw materials more efficiently or using previously unutilised resources. This is also an important contribution to the protection of mineral deposits

and the sustainable use of mineral raw materials. Together with the Commission for Mineral Resources Research of the Austrian Academy of Sciences, the working group also sought possibilities to develop new mineral processing techniques, which would enable raw materials, which in the past could not be processed at all or only with great difficulties, to be used for high quality products.

- **Working Group 3** - *GIS Implementation*: Under the auspices of the Federal Ministry of Economy, Family and Youth, the possibilities for depicting the results of the survey on a map were explored and elaborated. The digital working maps were not intended for publication and formed the basis for the following Phase 2.
- **Working Group 4** - *Supply Security*: This working group analysed how vulnerable the economy would be if the supply chain of mineral raw materials were to be interrupted. An attempt was made to identify those raw materials which are of greatest importance for the economy. Recent developments on the international commodity markets have shown that mineral raw materials are becoming increasingly scarce and expensive largely as a result of enormous demand from China. In Phase 2 of the Austrian Mineral Resources Plan, the raw material areas identified and mapped in Phase 1 were digitally merged with those regional development plans which prohibit or hinder the extraction of raw material (conflict elimination). In the case of surface-near raw materials, the areas were chosen on the basis of need. An effort was made to minimise the distance from the producer to the consumer. Furthermore, an effort was made to ensure reserves for at least 50 years for each planning region. Based on the demographic trend and economic forecasts, the current specific regional consumption of sand and gravels and potential infrastructure projects requiring raw materials, an effort was made to estimate the volume that would be required in each planning region (e.g. political district) over the next 50 years. In the case of solid rocks, efforts were directed toward identifying suitably large occurrences with reserves for at least 100 years, as state-of-the-art, environmentally-compatible mining (e.g. glory hole with production shaft and tunnels) requires large investments. The results were validated by the interest groups and handed over to the regional planning authorities. The much scarcer occurrences of metal ores, industrial minerals and coals were evaluated on the basis of supply.

The task of **Phase 2** was to identify **conflict free "mineral zones"** (with other properties protected by law e.g. residential areas, national parks, water management priority zones, landscape protection areas, forests, Natura 2000 areas). Proven conflict-free zones were delivered to the provincial governments as the land use management authorities. Distinguished mineral zones were expected to be declared by provinces as “mineral protection zones” for land use planning purposes. In defining mineral protection zones, special attention will be given ensuring an adequate regional supply of raw building materials found close to the surface for several generations. Due to the individual groups of raw materials (i.e. sands, gravels, solid rock varieties, high-quality carbonates, clays, industrial minerals, ores and energy raw materials) specific methods of evaluation were developed.

Methodology for the Identification of Raw Material Areas and Defining Mineral Safeguarding Zones

Mineral deposits may be only safeguarded if sufficient information on their type, quantity and quality are available. Together with the Geological Survey, type-specific, innovative methods of evaluation were prepared for surface-near mineral deposits. The

Technical Committee for Deposit Research of the Austrian Mining Association developed an own method of evaluation for (deeply situated) deposits of ores, industrial minerals and energy resources (with the exception of crude oil and natural gas).

Example of Construction Resources (Loose Rocks - sand and gravel)

The Geological Survey **compiled geological information** on loose rock in a special map (**lithological map**) as an essential basis for decision-making. In contrast to a classical geological map representing the individual units according to their age in such a lithological map, the usability of the different lithological units is of immediate importance. Already the preparation of such a lithological map as a basis for evaluation is an innovative approach to an objective identification of areas of mineral resources (Weber et al. 2009). In a further step, the loose rock deposits were arranged always in five classes according to their **quality and quantity** and based on a **matrix a geological potential** was determined from them (fig. 2.1) The assessment of the quality of the raw materials was based upon two factors: (1) the lithological description of the material taken from the map of unconsolidated sediments and (2) the information in the database of aggregate mining sites about the use of the raw material, whereby if multiple uses were indicated, the highest-quality use was recorded. The highest quality (Class 1) covers material comprising well-rounded and sorted gravel and sand, of the type used as concrete aggregate or as sand for plasterwork for example. Inhomogeneous sand and gravels with a higher proportion of fine grains or interbedding and which are used as road construction material have a slightly lower quality (Class 2). Unsorted fine to coarse grained gravel with a high proportion of brittle grain which is used as gravel on forest tracks is categorised as medium to low-quality material (talus: Classes 3–4; till: Class 5) (Galos et al. 2016).

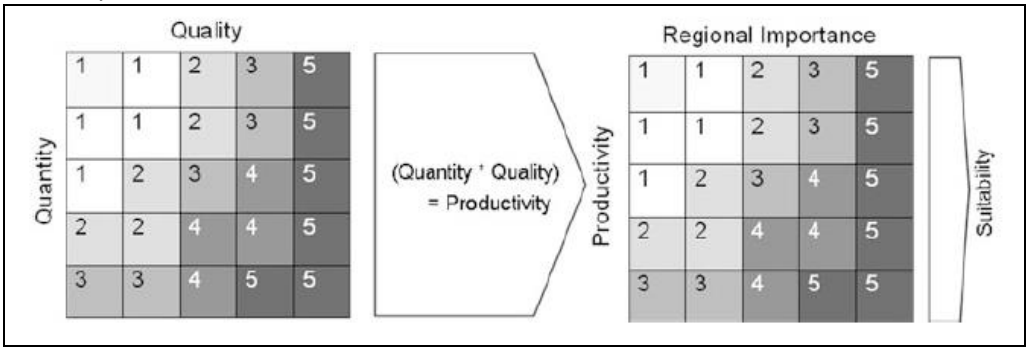


Figure 2.1. Evaluation matrices for the determination of suitable zones (Weber 2013)

Parallel to this operation, the regional importance of the deposits for the supply of the surrounding areas was classified because a large gravel deposit in the plain around a large city has the same importance as a small deposit for the local supply of distant valley inhabitants. Finally, five suitable classes represented as a basis for further processing in digital maps result from the further matrix based cutting of the **geological potential** according to the **regional importance** of the deposits (fig. 2.2).

To calculate the **geological potential** of a body of sediment, the quality and quantity (productivity) of the material were combined in a first matrix. The quantity was graded in five classes on the basis of the area of the polygon and the thickness of the layer, although in **Phase** 1 only two classes were distinguished which were based on the area. Different matrices were used to calculate potential in the **foreland** and in **alpine areas** (fig. 2.2.) so that specific regional geological features could be taken into account, especially as small

occurrences in alpine valleys can be just as important for local supplies as large occurrences in areas close to major towns. For example, the potential of a valley fill in alpine terrain cannot be compared with the potential of a broad fluvial terrace in the foreland and must be considered separately. The resulting five stage quantification of the geological potential describes the relative capacity of the sediment bodies to supply sand and gravel as a construction material. While the quality and quantity of sand and gravels can be assessed by geologists, assessing importance involves evaluating regional economic factors such as transport distances, population density or regional planning and this in turn requires more than purely geological expertise. For this reason, occurrence importance was only graded according to the frequency, size and supply range of the mining operations in this occurrence. Lithological units which are extracted by numerous large-scale mining operations with significance for the regional and supra-regional supply of raw materials were classified as important. In contrast, occurrences of sand and gravels where extraction has practically ceased or where mining operations only serve the local market or meet the operator's own needs were categorised as being of only minor importance. Once again, different standards were applied to assess importance in foreland and mountainous terrain. Thus a low quality occurrence, such as an alluvial fan or talus deposit in mountainous terrain can be upgraded on the grounds of its importance for local supplies if there is no better material available in the surrounding area.

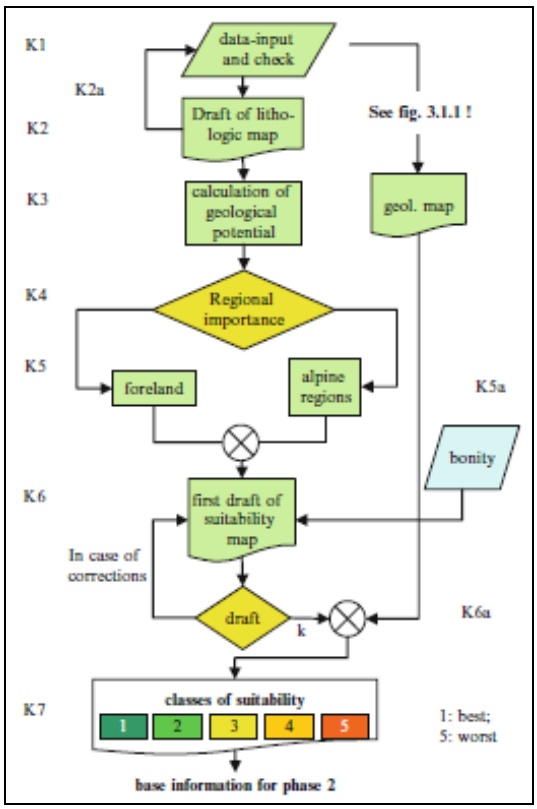


Figure 2.2. Flow diagram for the assessment of sand and gravel, Phase 1 (Weber 2013)

The best suitable areas (suitable zones 1-3) were used for further processing (Phase 2, fig. 2.3). Areas where already now extraction is legally prohibited (e.g. settlement areas, transport routes and national parks) have been digitally cut out (scenario 1). In a further step also, areas where an extraction of mineral resources is only possible under specific conditions (e.g. natural parks, Natura 2,000 areas, preferential zones of water management

and areas 1,600 m above sea level) have been cut out. The remaining areas of mineral resources were represented in digital maps (scenario 2). (Weber 2013). These remaining areas are basically raw material areas where conflicts have been eliminated from a national perspective, but which still required detailed revision, particularly as a number of residual areas are either too small to allow economically viable extraction or there are other reasons which militate against future extraction (e.g. wind parks, electric power lines, gas pipes, etc.).

Once the residual areas from both scenarios had been consolidated in this fine-tuning process, a **volumetric analysis** was carried out. To verify that supply suffices to meet regional demand, the volume of sand and gravel located below the residual areas remaining after the elimination of planning conflicts was calculated. There were two suitable calculation methods for this purpose: (1) the integration of thickness distributions over the area. This required regional sand and gravel thickness models and produced relatively precise total figures; (2) the assumption of a constant average thickness under each individual residual area and the adding up of sub volumes.

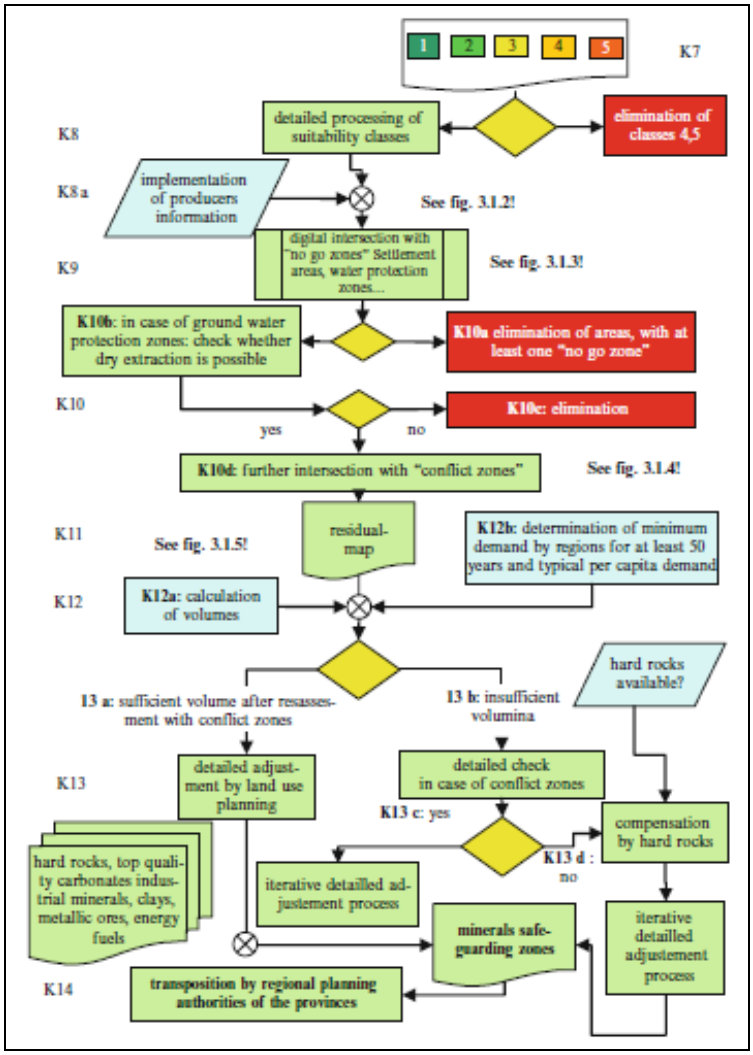


Figure 2.3. Flow diagram for the elimination of conflicts in sand and gravel, **Phase 2** (Weber 2013).

Example of Construction Resources (Solid Rocks)

Solid rocks are raw materials which are mainly used in the construction industry and civil engineering. They include crushed products (crushed stone, stone chippings, high quality chippings, crushed sand) which are processed into mineral aggregates or rock powder as well as dimension stones which are used as building stones or processed to facing and tiles, pavement stones, grave stones, monuments and sculptures. The solid rocks were broken down into (1) magmatic rocks, (2) sedimentary rocks and (3) metamorphic rocks. For each of these raw material occurrences, there is evidence of indicated or explored occurrences (raw material areas in the broad sense) or of use in the form of extraction sites (usually quarries, rarely underground mining). Unless the study team was explicitly aware that materials were being used exclusively for another purpose (e.g. marble for filler materials and dolomite for refractory products), it was assumed that the rock was or is being used as a construction material.

In Phase 1 the geological classification of the occurrences and deposits was carried out on the basis of the geological maps of the Republic of Austria on a scale of 1:200,000 and, where available, the geological maps of the Republic of Austria on a scale of 1:50,000. The source for the survey of the mining sites was the GBA archive on quarries, and the accompanying digital catalogue and search system, the database of mining sites, which is regularly updated. The subsequent evaluation was carried out using the following evaluation schema.

Suitability Class 1

- Occurrences (deposits) in active use (mining operations).
- Occurrences (deposits) which are periodically used and with known suitability for use as dimension stones, retaining wall armour stones or as stone for river training works.
- Explored occurrences and raw material areas (the latter only Lower Austria, Salzburg, Tyrol) and raw material areas with a prospectivity classification of R (Styria, R: reserves, occurrences with a economic importance).

Suitability Class 2

- Occurrences (deposits) which are periodically used for crushed stone products, road and path construction, concrete aggregates.
- Indicated occurrences and raw material areas (Salzburg) as well as raw material areas with a prospectivity classification of 0 (Styria, 0: occurrences)

Suitability Class 3

- Abandoned occurrences where resources have a known suitability for use as dimension stone, retaining wall armour stone and stone for river training works.

No further consideration was given to extraction sites which have already been recultivated. Thus the prime criteria used to classify suitability was status as an expression of current economic relevance and evidence of application, with preference accorded to suitability for use as dimension stones, retaining wall armour stone and stone for river training work due to the relative scarcity and resulting greater value-added of this material as compared to raw materials used for crushed stone. With regard to the lithology of the raw materials (hard rocks, solid rocks) no distinction was made for evaluation purposes; only in the case of stones containing asbestos (serpentinite) did grading diverge from the above schema.

As the time and financial framework meant there would be little chance of producing a proper geological map for all selected occurrences of solid rocks in suitability classes 1 to 3, unless these were already available (for example for Styria, and in some cases for Lower Austria), a highly pragmatic approach was adopted:

- Artificial contours in a radius of 700 m around the points (with colour coding for the lithology) and colour coding of the circles according to suitability class 1 or 2;
- Suitable colour coding of delineated areas, i.e. evaluated or legally defined mineral planning zones in Lower Austria and Styria, which were available in digital form, according to suitability class 1 or 2;
- Suitability Class 3: Centred symbols only (with colour coding of the lithology). Only selected geological;
- units in Lower Austria with occurrences that were previously used for dimension stones, retaining blocks
- and rock armour, are no longer actively mined and have a limited distribution, were delineated on the basis of the geological map of Lower Austria on a scale of 1:200,000.

The results formed the basis for the planning process to avoid conflicts with raw material extraction in **Phase 2.** The raw material areas for solid rocks, defined in Phase 1 were overlayed on the regional planning requirements of the provinces in the same way as the sand and gravels. After the overlay process, the residual area was compared with the local geological situation and provided that no conflicts with other regional development plans were identified, the dimensions were adjusted to the actual geological environment. One of the main aims was to optimise the situation at the extraction site in order minimise emission levels (dust, noise) and ensure that the site remains secluded from public view (e.g. quarry behind the curtain). This made it necessary to deal with each occurrence individually. Those mineral safeguarding areas where planning conflicts had been eliminated and which contained sufficient material (target > 100 years) were finally handed over to the regional planning authorities in the provinces for appropriate implementation. In the case of high quality carbonate rocks and marlstones, occurrences with less material were also included.

Example of High-Quality Carbonate Rocks and Marlstones

The raw material category high-quality carbonate rocks and marlstones comprises limestone, dolomite and marl, which due to their rock properties are suitable for certain high quality uses. The demands made on these raw materials are based primarily on their chemical composition, as well as on structural characteristics such as sub-grain coarsening in the case of marbles. Where necessary, brightness properties were also included. The minimum demands made on high quality carbonate rocks and marlstones by the Austrian Mineral Resources Plan are as follows:

- Dolomite: suitability for use in the production of refractory products;
- Limestone: suitable for use in the production of quicklime, as an aggregate for metallurgical purposes and as a raw material in cement production;
- Marl: suitability for use in the production of cements.

The most important basis for the **evaluation of high quality carbonate rocks and marlstones** was provided by a GBA database containing a large number of **chemical analyses** (whole rock analyses of the main elements). Most of the chemical analyses were taken from carbonate rock raw material projects. Furthermore, historic archive material from the

Austrian Geological Survey raw material archive and published literature on whole rock analyses were perused in order to cover as many geological formations of carbonate rocks and marlstones as possible. Before the analyses contained in the database were sorter on the basis of their methodology (analytical accuracy and the comprehensiveness of the analytical chemistry) and their informative value / representative nature, the criteria for the evaluation schema were calculated. Another database, which mostly uses the results of a raw material project, supplied the brightness value. All analyses were assigned to a suitability class or at least a suitability grade depending on the evaluation option.

The suitability classification was expressed by the colour of the point, the status by the symbol. The latter provides the economic relevance and is differentiated in:

- Status 1: Mine in operation or in operation if needed;
- Status 2: Mine out of operation or reclaimed;
- Status 3: Untouched or unused occurrence (=indication or explored occurrence).

The evaluated data sets from the chemical and brightness analyses were depicted as a point symbol map. This shows the suitability class / quality, status, density and distribution of the locations via their analyses. Each province was processed separately and a point symbol map was prepared in conjunction with a database which holds the tabular information. This created one of the two necessary source maps for the Lithological Map of High-Quality Carbonate Rocks and Marlstones (gross area map). On the basis of the analyses, both the sampled occurrences and the geological formations from which these rock samples were taken were classified. Suitability classes were assigned to formations distributed throughout the individual province and not merely in the immediate locality. Special categories that were necessary due to individual or generalised conditions were usually given an overlaid fill symbol. The geological maps on scales of 1:50,000, 1:100,000 or 1:200,000 were used as geological source material. The result of this work, the Lithological Map of High Quality Carbonate Rocks and Marlstones with the database and additional verbal information for individual provinces, is greatly influenced by the geological maps that were available during the period in which the work was carried out and bear this time stamp. The quality of the map depends on the geological source map and the density of the analyses. In this regard, it is open for corrections, differentiation of geological formations and detailed geological processing.

The depth structures were not included in **Phase 1**. Depending on the tectonic structure, however, surface distribution and the thickness or the volume of a geological layer may differ significantly. The results formed the basis for the further work on developing a mineral planning process to avoid conflicts with raw material extraction in **Phase 2**.

The evaluation for raw material areas for high-quality carbonate rocks and marlstones, defined in Phase 1 was handled in similar manner as discussed for solid rocks. After the overlay process, the residual area was compared with the local geological situation and provided that no conflicts with other regional development plans were identified, the dimensions were adjusted to the actual geological environment.

Example of Clays

The economically important clay raw materials are extremely varied and widely distributed. In terms of age, they range from Paleogene and Neogene to late Holocene. The genetic classification shows marine, brackish, limnic or aeolian sediments in all stages of weathering.

In **Phase 1** the identification of promising clay resources in Austria was based upon the geological maps of the provinces on a scale of 1:200,000 and 1:100,000, and the compiled map of unconsolidated sediments in Austria. In addition, the geological maps of the Republic of Austria on a scale of 1:25,000 and 1:50,000 were also available, although not for all areas. The data on clay deposits that are both in and out of operation was another important source. This data is found in the clay archive, a sub-index of the Austrian Geological Survey's database of mining sites, and is administered electronically with a digital catalogue and search system. Priority was given to those clay deposits which are currently in operation. Contact was made with the companies concerned and wherever possible information regarding planned expansion areas was taken into account. Proposals for mineral safeguarding areas that had been put forward in a number of raw materials studies, and unpublished material on reserves of clay raw materials from the clay archive were included and revised using the latest information regarding clay extraction sites. The analysis database linked to the clay archive was used to classify the clay raw materials in the categories brick, clinker brick and refractory. The mineralogical, and in some cases chemical composition, and above all the distribution of particle sizes in the clay raw materials were compared with the data for brick, clinker brick and refractory products available in the literature and categorised. Finally, comparisons were made with the actual purposes for which the material is used, after which the material was assigned to a final category.

The results formed the basis for a mineral planning process to avoid conflicts with raw material extraction in **Phase 2.** The evaluation for raw material areas for Clay, defined in Phase 1 was handled in similar manner as discussed for solid rocks. After the overlay process, the residual area was compared with the local geological situation and provided that no conflicts with other regional development plans were identified, the dimensions were adjusted to the actual geological environment.

Example of Ores, Industrial Minerals and Energy Resources

Due to the very different levels of information available about the individual occurrences of metal ores, industrial minerals and coals, a distinction was made between occurrences that are worthy of safeguarding and those that have a provisory **worth for safeguarding**. Occurrences considered to be worthy of safeguarding are occurrences, which, due to their quality, quantity and yield, for example, are, could be or have been mined. Past mining activity proves that there are still residual (geological) reserves and that given their quality, quantity and yield it is highly likely that it would be possible to extract them again in future. Mineral areas considered to have provisory worth for safeguarding are deposits, which for economic reasons or due to mining or mineral processing difficulties cannot currently be utilised, but where there is a reasonable likelihood that the development of commodity prices and/or the development of new techniques means that the occurrences could possibly be mined in the future.

After carrying out further investigations, it will be always possible in both cases to classify the deposit higher in the category **worth being safeguarded**. The assessment of partly worth being safeguarded was made by an **expert judgement** by members of the Technical Committee for Deposit Research of the scientific-technical association *Austrian Mining Association* covering the special fields in science of mining (mining and mine economics), science of processing and science of geosciences.

Determination of the Area Required for Safeguarding Areas of Ore and Industrial Mineral Deposits

The **area required for a resource safeguarding area** depends on the type of the mineral deposit. The area required for deep-lying mineral deposits extractable by underground mining may be possibly restricted to the area required only for open-pit mining. The contours of the mineral deposits are taken as basis for surface-near mineral deposits (e.g. building resources). Finally, the resource area was drawn in outline and its worthiness of being safeguarded (worth of being safeguarded/provisory safeguarded) was explained as basis for the elimination of conflicts in **Phase 2**. Similarly, as in the case of loose rock by means of GIS cutting in connection with all possible conflict potentials (water, building land, traffic routes, nature conservation, forest etc.) was carried out (methods: see Fig. 2.4 and 2.5).

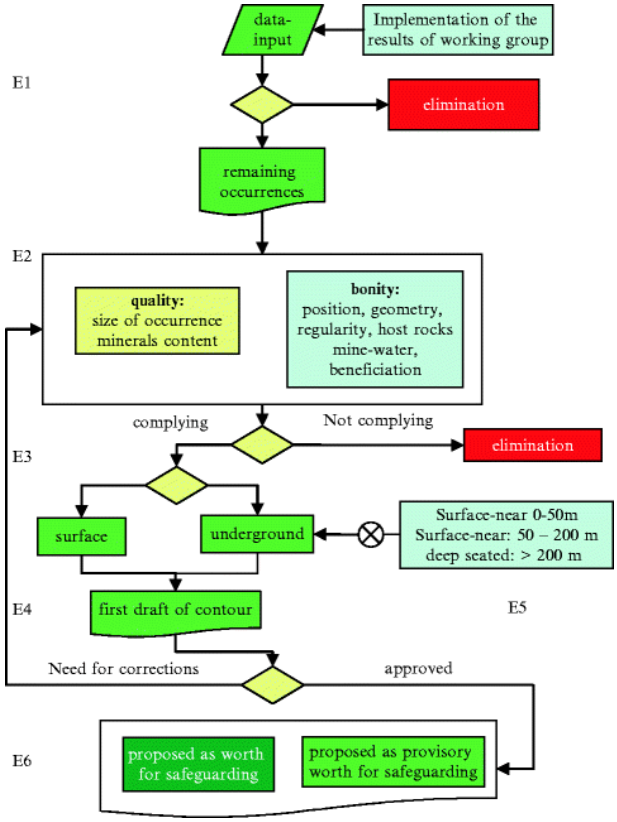


Figure. 2.4. Flow diagram for the assessment of ores, industrial minerals and energy resources; Phase 1 (Weber 2013)

Deposits for Extraction in Open-Pit Mining

The area to be safeguarded at deposits on the surface comprises basically the whole area where in all probability extractions will be made considering open-pit mine slopes and the respective infrastructure including stockpiling, dumps and tailing ponds. Typical values for the general inclination of open-pit mine slopes in loose rock are approx. 30–45° and in solid rock 45–60°.

Deposits for Extraction in Underground Mining

Depending on depth, mining engineers make a distinction between surface-near deposits (up to 50 m depth), low depth deposits (50 m–200 m) and deep seated deposits (> 200 m) (fig. 2.5.).

In the case of **shallow-lying deposits (0–50 m),** it shall be proceeded on the fact that the influenced zone extends to the surface and as a result besides subsidence, in particular, goaf phenomena may appear on the surface. The safeguarding area for shallow-lying deposits comprises, in particular, such areas of the surface where in all probability according to the present and foreseeable state of the art, bigger harmful impacts (e.g. goafs, surface subsidence) may occur if the deposit will be extracted. This impact area forms part of the safeguarding area and results from the projection of the boundaries of the whole prospective extraction area on the surface given a preliminarily assumed critical angle of approx. 60–70° in solid rock and of approx. 45° in loose rock. The deposit shape is irrelevant for fixing the safeguarding area. In the case of **surface-near deposits (50–200 m)**, it shall be proceeded on the fact that the influenced zone may extend to the surface and as a result besides subsidences, in particular, break phenomena may appear on the surface. The safeguarding area for surface-near deposits comprises, in particular, such areas of the surface where in all probability according to the present and foreseeable state of the art, bigger impacts may not be completely excluded if the deposit will be extracted. This impact area forms part of the safeguarding area and results from the projection of the boundaries of the whole prospective extraction area on the surface given a critical angle of approx. 60–70°. The deposit shape is irrelevant for fixing the safeguarding area. In deposits in the **deeper underground (>200)**, it shall be proceeded on the fact that depending on rock conditions and the extraction technology, extensive subsidence phenomena will appear on the surface which, however, may as a rule be tolerated. That is why the safeguarding area for deposits lying deeper than 200 m comprises only the infrastructure belonging to mining including stockpiling, dumps and tailings ponds and areas required for the access and future extraction (Weber 2007).

Occurrences of metal ores, industrial minerals and coals were only overlayed on the prohibition zones. If an occurrence of such higher or high quality minerals is actually utilised and the area coincides with a conflict zone, a decision should be made on a case to case basis as to which use is accorded priority (**Phase 2**, Fig. 2.5).

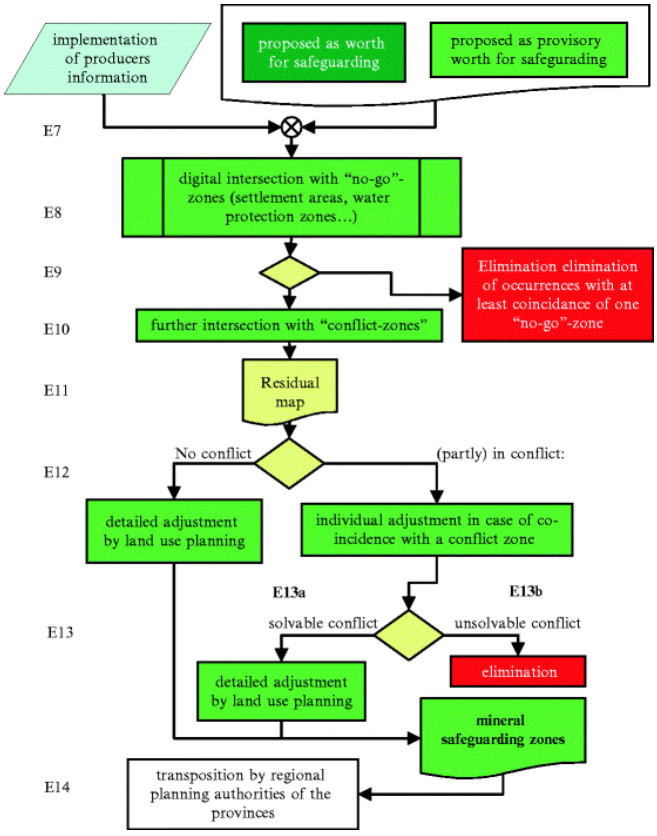


Figure 2.5. Flow diagram for the elimination of conflict in deposits of ores, industrial minerals and energy resources, **Phase 2** (Weber 2013)

RESULTS:

- **Sand and Gravel -** approximately 48 % of the territory of the Republic of Austria is covered by unconsolidated sediments. Of these, approximately 18 % fall into suitability class 1, and 8 % into suitability class 2. The remainder is divided between suitability classes 3 to 5. It is remarkable that the land use requirement for the quantities of sand and gravels in suitability classes 1 and 2 and reserves > 50 years, is only 1.47 % of the total surface area of the Republic of Austria;
- **Solid Rocks** - approximately 2,900 occurrences distributed throughout the entire Republic of Austria were dealt with. 346 of these occurrences proved to be worthy of safeguarding;
- **High-Quality Carbonate Rocks and Marlstones - m**ore than 650 occurrences distributed throughout the entire Republic of Austria were dealt with. 171 of these occurrences proved to be worthy of safeguarding;
- **Clays -** total of 108 raw material zones in the category brick were identified in Austria, 85 zones were identified as being worthy of safeguarding or of provisory worth for safeguarding;
- **Metal Ores, Industrial Minerals and Coals** -a total of 245 mineral occurrences were identified in Austria which are either worthy of safeguarding or of provisory worth for safeguarding. 28 of these fall into the group of iron ores and steel alloys, 14 into the group of non-iron metals and 17 into the group of precious metals. Moreover, 89 occurrences of industrial minerals and 97 occurrences of coals were identified as being worthy of safeguarding or of provisory worth for safeguarding (Der Österreichische Rohstoffplan 2012).

2.2. Deposits of National Interest (Sweden)

Full name in English	Deposits of National Interest
Full name in original language	Riksintresse för värdefulla ämnen eller material
Acronym	-
Used in Country or Legal Entity	Sweden
Institution(s)	Swedish Geological Survey (SGU)
Source	Swedish Environmental Code
Year	1999
Resources identified	Mineral resources; Mineral Reserves

In Sweden the term **'national interest'** originates from the physical planning process first presented in the Governmental report 'Land and Water' (SOU 1971: 75). The background for the development of National Interests was that between 1950 and 1970 economic growth in Sweden was exceptionally strong, which led to a major urbanization process. This development increased claims on the domestic natural resources, and there was an increased pressure to consider different areas of National Interests in Sweden. The purpose of the national planning process was to get a better understanding and knowledge about Sweden's natural resources. The Natural Resources Law, which entered into force in 1987, was strongly linked to spatial planning. Alongside this development the Planning and Building Act was introduced in the same year, in which the municipalities were mainly responsible for the planning of land and water areas. When the **Environmental Code came into force in 1999** all provisions related to National Interests were transferred there (fifteen previous environmental acts) (Swedish Report 2017). The purpose of the Code is to promote sustainable development. Its provisions concern, amongst other things, the management of land and water, nature conservation, protection of flora and fauna, environmentally hazardous activities, water operations, genetic engineering, chemical products and waste management.

Nowadays, the Environmental Code and the Planning and Building Act form the legal basis of physical planning in Sweden and constitute the major legal framework for the definition and regulation of mineral deposits of national interest (Wårell 2015). The Environmental Code constitutes an 'umbrella' for the Planning and Building Act as well as other special laws that have an impact on the physical environment.

The National Interests are the state's ability to intervene in municipal planning and protect national interests in Sweden. The purpose of the National Interests are to assure that land and water areas shall be used for the purpose or purposes for which the areas are most suited, considering the nature and location as well as present societal needs. Preference shall be given to land uses that, from a public interest, ensure good housekeeping of resources. **There are eleven different National Interests defined in Sweden** and responsibilities of these are directed towards twelve different authorities (see further in Sveriges Rigsdag 1998b) on the management of land and water areas, etc. :

1. Reindeer herding – Sami Parliament,
2. Commercial fishing – Marine and Water Authority,
3. Nature conservation – Environmental Protection Agency,
4. Heritage – National Heritage Board,

5. Deposits of substances or materials (Geological Survey of Sweden),
6. Industrial production – Swedish Agency for Economic and Regional Growth,
7. Energy production and plants – Swedish Energy Agency,
8. Plants for final disposal of nuclear waste – Radiation Safety,
9. Communication plants – Transport Administration and the Swedish Post and Telecom Agency,
10. Plants for water supply or waste –Environmental Protection Agency,
11. Defence facilities – Armed Forces and the Swedish Civil Contingencies Agency.

Chapter 3 (Resources and Land Use Management), Section 7, second paragraph of the **Swedish Environmental Code** (Swedish Code 1999) states that **areas containing deposits of valuable substances or materials that are of national interest shall be protected against measures that may be prejudicial to their extraction**. Within such areas, municipalities and central government agencies may not plan for or authorise activities that might prevent or be prejudicial to the exploitation of mineral resources. Consequently, it can be concluded that spatial planning is a strong characteristic in Sweden and it legally prevents unnecessary sterilization of mineral deposits of national interest.

Identification of Deposits of National Interests

Swedish Geological Survey (SGU) is responsible for the deposits of national interests and they identifies deposits for: **Ores, Industrial minerals, Aggregates and Natural stones.** These are identified and appointed after consultation with the National Board of Housing, Building and Planning and the county administrative board.

In Sweden, mineral deposit is considered to be of national interest if it satisfies:
1. The substance or material is relevant to the needs of society - on a national level, or of particular regional importance, in terms of employment, economic development and resource supply in the long term
and
2. The substance or material has particularly valuable properties - as regards e.g. purity, composition, quality, appearance, technical features or volume.
and
3. The area containing the discovery of the substance or the material is well defined, examined and documented (Wårell & Häggquist, 2016).

Criterion 1 - The substance or material is relevant to the needs of society

In the foreword of the Swedish Environmental Code it is recognised that our natural resources should be managed efficiently from an ecological, social and economic point of view. In the preparatory work is discussed in detail what generally constitutes “good management” of land and water areas, and it is stated that "in the management of land, water and the physical environment in general it is required that the interests and claims associated with e.g. industrial raw materials and the expanding society must be taken into account". It is further noted that in case of a conflict between different interests an economic assessment of the different activities should be performed. Furthermore, the impact on employment and economic growth should be given great significance, since it is important that a long term expansion of production, investment and employment is safeguarded. The implications for regional balance and the distribution of living standards in the country must be considered in the assessments.

The first criterion that is of guidance for the definition of Deposits of National Interest focuses on community building and long term raw material supply. SGU indicates that the substance or the material have to be important from an economic perspective (for the needs of the community). Knowledge of where the deposits are located is important in the municipal planning processes, in order to avoid planning activities that will hinder a future exploration of the substance or material. Regarding raw material supply – i.e., aggregates, rock (crushed or natural stone) and gravel – the above means that the needs of the society, including employment and economic development, are in focus. The region's population structure and growth rate, e.g., construction of housing and infrastructure, need to be accompanied with a secure supply of aggregates. Furthermore, infrastructure and housing in a metropolitan region is of importance for the entire country, which means that raw material supply in this region is of national interest. Infrastructure investments, construction projects, or industries are often strategically valuable both for the region and the nation. The conditions for such projects are a good material supply. National interest in this context is an important tool for the planning of material supply.

Criterion 2 - The substance or material has particularly valuable properties

The preparatory work discusses which substances or materials that may be considered to be of National Interest. The deposit in question must be of a certain volume and/or quality in order to be able to support the country, or part of the country, in the long run. Included in the concept "valuable substances or materials" are those substances and materials that are valuable from an economic point of view. The deposit should thus be "economically recoverable" mineral raw materials, which are needed in industry, energy supply and construction works. It can therefore, as stated in the preparatory works, besides ores, include industrial minerals, mineral raw materials on the seabed, and sand and gravel that are available in urban areas.

Regarding raw materials supply, valuable properties of the materials that is necessary for the intended use is considered, such as its:

1. Homogeneity (rock, gravel, natural stone);
2. The mineral composition (rock, gravel, natural stone);
3. Particle size distribution (gravel);
4. Technical features (rock, gravel, natural stone);
5. Appearance, colour (natural stone);
6. Fractures (natural stone);
7. Structure (natural stone);
8. Volume (rock, gravel, natural stone).

Criterion 3 - The area containing the discovery of the substance or the material is well defined, examined and documented

The delineation of the areas are determined by geological conditions, i.e., how a deposit are estimated spatially. This is, as for other national interests, an important parameter of the national interest. It is clear from the legislative history that it is only natural resources that are well documented that should be given protection. SGU produces documentation of cases through systematic work in which they combine geological knowledge of the deposit, with the information that companies reports from prospecting

and extraction of mineral substances. However, it is always SGU that is responsible for the documentation that form the basis of a national interest declaration.

There are a total of 141 deposits of National Interest already defined in Sweden (figure 2.6), and the majority of these are in the categories Ores and Industrial minerals (SGU 2018).

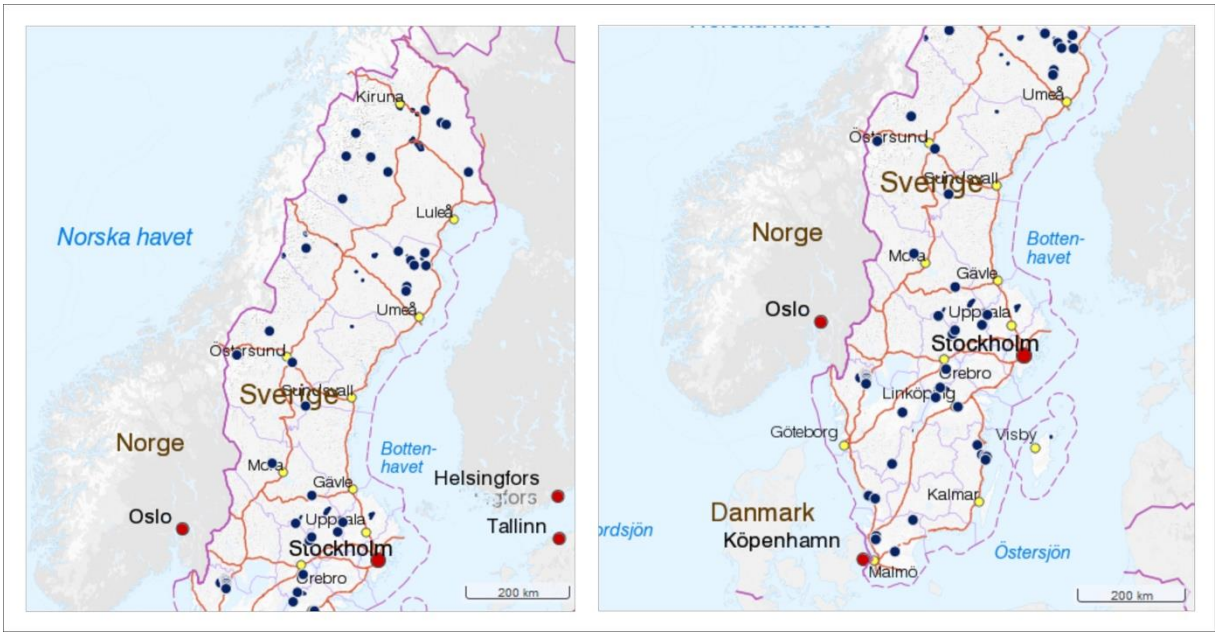


Figure 2.6. Location of Deposits of National Interest in Sweden (SGU, https://apps.sgu.se/kartvisare/kartvisare-riksintressen.html)

2.3. Valorisation of undeveloped mineral deposits (Poland)

Full name in English	Valorisation of undeveloped mineral deposits
Full name in original language	Waloryzacja niezagospodarowanych złóż kopalin
Acronym	-
Used in Country or Legal Entity	Poland
Institution(s)	Ministry of the Environment
Source	Proposal of Mineral Deposits Protection Act
Year	2011
Resources identified	Mineral resources

In 2011, proposal of Mineral Deposits Protection Act was prepared by the Mineral and Energy Economy Research Institute of the Polish Academy of Sciences and the Polish Geological Institute, on request of the Ministry of the Environment (Nieć, Radwanek-Bąk 2014). According to that, the basis for such protection should be complex valorisation and hierarchy of the whole set of recognized, but undeveloped mineral deposits, broken down into deposits of various minerals.

The proposed valorisation system of **industrial mineral and rock deposits** in Poland is based on **4 main groups of criteria** (Nieć [ed.] 2013):

- **geological features (mineral quantity and quality)** – identified separately for each mineral type (table 2.1);
- **mining attractiveness** – taking into account **mining conditions** (overburden thickness, overburden/deposit ratio, complexity of deposit setting, hydrogeological conditions) and **mineral transportation issues** (table 2.2);
- **environmental limitations** – due to environmental protection areas, landscape protection areas, protection of aquifers, protection of forests and high quality soils (table 2.3-2.4);
- **housing and industrial land use limitations** – mostly due to current land development (permanent buildings, linear structures).

This valorisation does not include social conditions.

Table 2.1.Geological features criterion (mineral quality and quantity, examples) (Nieć [ed.] 2013)

Crushed stone			
Quantity	Quality		
	>50% of rock suitable for first class aggregates	Rock suitable mostly for medium class aggregates	Other
>20 million t	M	M	C
5-20 million t	M	C	C
<5 million t	C	C	C
Dimension stone			
Quantity	Quality		
	The possibility of obtaining medium, large and very large blocks (>1.0 m^3) with polishing or decorative properties	The possibility of obtaining medium and small blocks, lack of polishing properties	The possibility of obtaining small blocks (<0.5m^3)
>10 million t	H	M	M
10-2 million t	H	M	M
<2 million t	M	M	M

Natural aggregate (gravel and sand)			
Quantity	Quality		
	Sand (below 2.0 mm grain size) content below 50%)	Sand (below 2.0 mm grain size) content 50-75%)	Sand (< 2.0 mm grain size) content>75%
>20 million t	M	M	sand
20-5 million t	M	C	
<5 million t	C	C	
Feldspar raw materials			
Quantity	Quality		
	Na_2O+K_2O>8.0%, $Fe_2O_3+TiO_2$≤0.5%	Na_2O+K_2O≥ 6.0-8.0%, $Fe_2O_3+TiO_2$ 0.5-1.0%	Other
>5 million t			Valorized as a crushed stone
1-5 million t			
Kaolin			
Quantity	Quality		
	< 1.2% Fe_2O_3, whiteness after firing at 1350°C >75%		
>5 million t	H		
1-5 million t	H		
< 1 million t	M		
Glass sand			
Quantity	Quality		
	> 95% SiO_2, < 0.1% Fe_2O_3		
>10 million t	H		
10-1 million t	M		
< 1 million t	C		

H - high value - nationally important deposits, M - medium value - regionally important deposits, C - common - locally important deposits

Table 2.2. Mining attractiveness criterion (Nieć [ed.] 2013)

Stripping ratio (O/D)	**Overburden thickness**		
	<2 m	2-8 m	>8 m
<0.5	1	2	3
0.5-1.0	2	2	3
>1.0	3	3	3
Geological setting	**Water ingress**		
	Dry pit or underground	Deep pit with only rain water flooding	Deep pit with flooding from aquifers
Simple (class I)	1	2	3
Complex (class II)	2	2	3
Very complex (class III)	3	3	3
Transport conditions – distance to major road	**Distance to end-user**		
	close to deposit (i.e. <50 km)	far from deposit (i.e. 50-100 km)	very far (i.e. >100 km)
Favourable <10 km	1	2	3
Limited >10 km	2	2	3
Lack of local roads	3	3	3

Summary of mining criteria evaluation

Scoring system	
Total sum of points (table 2.2)	**Deposit rating**
3-4	H - best
5-6	M - fair
7-8	C - low
9	X - unsatisfactory

Table 2.3. Nature Protection and Underground Water Protection (Nieć [ed.] 2013)

Underground water protection	Nature and landscape protection		
	Non	Areas of landscape protection or bordering NATURA 2000 areas	Landscape Parks and/or NATURA 2000 areas
Non	1	2	3
Utility aquifer	2	2	3
Main Underground Water Reservoir	3	3	3

Table 2.4 Forest Protection and Soil Protection (Nieć [ed.] 2013)

Forests protection	Soil protection		
	Low quality soils only (class IV-VI)	Up to 30% of high quality soils (class I-III)	Over 30% of high quality soils (class I-III)
Lack of forest	1	2	3
Up to 30% of deposit area covered by forest	2	2	3
30-90% of deposit area covered by forest	3	3	3
Over 90% of deposit area covered by forest	6	-	-

Summary valorisation of environmental criteria

Scoring system	
Total sum of points (table 3 and 4)	**Deposit rating**
2-3	H - highest
4-5	M - conditional
> 6	C - restricted

In the case of **land-use**, the only simple criterion was the degree of built-up development on the ground overlying the deposit. Four classes of accessibility to the deposits are distinguished:

1. High accessibility (H) if terrain built-up to 10%;
2. Medium accessibility (M) if terrain built-up from 11 to 30%;
3. Restricted accessibility (C) if terrain built-up from 31 to 90%;
4. And no accessibility (X) if terrain built-up in over 90%.

Taking into account the incomparability of evaluation of particular factors which stand behind the value of the deposits, the authors of methods proposed independent valorisation and ranking for each of the criteria groups indicated above (Nieć, Radwanek-Bąk 2014) based on a 3-grade rating designed by respective letters: high, very good, the best (H), medium, good, fair of conditional (M) and mediocre, common (C). In view of such valorisation, each deposit can be described using 4 symbols successively which represent evaluation of the deposit value based on the 4 groups of criteria discussed above: **For example: HHMC designates the deposit as being of the highest value in respect to its resources and mineral quality, favourable for mining, without oppressive environmental restraints but with some limitations imposed by existing land utilization**.

Proposed range of mineral deposits safeguarding (protection) depends on its general category:

- **H class deposits – the highest safeguarding:**
    - For such deposits absolute priority of mining land use should be the rule. Each other land use should take into account requirements related to future possible extraction of the deposit, especially regarding other temporary land uses (e.g.

conditional temporary building or industrial or infrastructure land use, but with exact time framework of such investment),
    - H class deposits should be included in land use and strategic document at country level, especially in Mineral policy of Poland (not yet prepared), Energy policy of Poland (current policy requires changes) and Domestic Spatial Development Concept, as well as in land use plans at province and commune levels, with appropriate provisions regarding priority of their safeguarding,
    - Other than mining land use of areas of such deposits, or exclusion of such deposit from safeguarding should require the consent of the Minister of the Environment, on the basis of opinion of the Polish Geological Survey;
- **M class deposits – medium safeguarding:**
    - For such deposits, mining land use should be the main land use,
    - M class deposits should be included in land use plans at province and commune levels, with appropriate provisions regarding priority of their safeguarding,
    - Other than mining land use of areas of such deposits, or exclusion of such deposit from safeguarding should require the consent of the Marshal of Province, on the basis of detailed geo-environmental, land use and socio-economic analyses, aimed at finding the optimum compromise; in case of such non-mining land usewhich excludes future mining land use, opinion of the Polish Geological Survey and approval of the Minister of the Environment would be required.
- **C class deposits** – common safeguarding:
    - For such deposits, mining land use should be the recommended land use, taking into account needs of the nearby communes,
    - C class deposits should be included in land use plans at commune level,
    - Other than mining land use of areas of such deposits should be consulted with the Marshal of Province, on the basis of socio-economic analyses and opinion of the Polish Geological Survey.

Realized valorisation of explored but as of yet undeveloped deposits of industrial minerals and rocks in Poland has demonstrated that deposits characterized by valuable resources and mineral (rock) quality (H and M classes) make up only a small percentage of the total of all deposits analysed. Out of the total of 7378, only 126 were ranked as of the highest (H) and 512 as high (M) value. It is 1.75 and 6.9% of all yet undeveloped deposits, respectively. These 2 classes of deposits should be protected in land-use planning as future objects of mining activity (Radwanek-Bąk, Nieć 2015).

2.4. Plan to increase the capacity and effectiveness of land use planning (with participation of mineral resources component) (Portugal)

Full name in English	Plan to increase the capacity and effectiveness of land use planning (with participation of mineral resources component)
Full name in original language	-
Acronym	-
Used in Country or Legal Entity	Portugal
Institution(s)	Portuguese Mining Authority
Source	Proposal
Year	2012
Resources identified	Potential mineral areas, Mineral resources

The recent political awareness of the economic potential and social relevance of the Portuguese mining sector nurtured the approval of the **National Strategy of Geological Resources - Mineral Resources in 2012** (Strategy 2012). The Strategy for Geological Resources presented aims to promote a mining sector that is:

- dynamic, ensuring the uptake and holding of investment and proper exploitation of resources;
- sustainable at economic, social, environmental and territorial levels;
- promotes the growth of the national economy, by ensuring supply of essential raw materials and reinforces its importance in the national Gross Domestic Product and exports; and
- that promotes regional development, guaranteed return and employment for local people and ensures the development of the communities where it operates.

According to the Portuguese legislation, mineral resources (as other geological natural capitals) can be safeguarded by administrative easements of public utility on the basis of their local, regional or national importance. Presently, all municipal land use plans identify and include geological resource areas and the **Portuguese Mining Authority** (DGEG) participates in each stage of their completion. In addition, an inventory of the national mineral resources is maintained by the **Portuguese Geological Survey** (LNEG). Geological resources are intrinsically natural capitals, so their inclusion is unavoidable in any effective management and planning of land and associated resources for sustained uses. Mineral resources do not configure an exception to this framework and represent a *natural geological capital* whose use must be responsible and optimised while minimising unacceptable environmental impacts. Accordingly, the Portuguese regulatory body concerned with land use management and planning consider geological resources as a whole, specifying details for each type of resource whenever necessary. One of the crucial and higher impact strategic reforms accomplished recently in Portugal is **the National Programme for the Land Use Planning Policy** (Republica Portuguesa 2007). It considers the inevitability of the integration of geological resources in land use management and planning strategies, from local to national scales. The evaluation of land use, and the need of revision of 10-year **old Municipal (PDMs) and Regional (PROTs) Land Use Management Plans**, an

adequate approach was designed by the Portuguese Mining Authority to assist that revision and to ensure the access to mineral resources by the extractive industry.

"Plan to increase the capacity and effectiveness of land use planning" is an initiative of the Portuguese Mining Authority developed under the national strategy for geological resources (Strategy 2012). It establishes a land use planning management system organised at 3 levels: national, regional and municipal. The objective of the intervention has been to develop land use plans which will clearly demarcate areas allocated to geological resources, to facilitate and expedite the mineral licenses process and to help avoid or mitigate land use conflicts. This is an example of a structured approach that improves the land use regime and ensures access to raw materials. It provides a consistent framework for demarcating existing deposits and areas of potential geological interest across the whole country while taking into account other land uses. It also ensures co-ordination among the different levels of land use planning - national, regional and local – integrating the most recent information from geological surveys. In parallel, it contributes towards a more transparent, predictable and effective permit regime.

An important problem for the mining industry in Portugal has been the problematic access to territory for exploration and extractive activity. There are often conflicts with other economic activities, inappropriate demarcations of the different land uses and often inconsistencies between the land use plans of neighbouring municipalities (e.g. areas demarcated for mining use under one plan that extend over multiple municipalities are not recognised as such in the land use plans of the neighbouring municipalities). Such inconsistencies create uncertainty and lead to important delays to the approval of applications for mining activity but also an inability to implement an effective strategy for the exploitation of mineral resources. Thus, the objective of the specific intervention by the Portuguese Mining Authority (DGEG) has been to ensure that exploration and exploitation permit areas and areas with a potential mineral resources interest are clearly demarcated in land use plans and that mining and quarrying activities are always considered in land use planning policies. This should be done in accordance with the overall land use planning strategy determined at the national level and taking into account the most recent geological surveys. The application of the national plan at the regional and local level started in 2007 with the gradual adaptation and update of the regional and municipal land use plans. There are 5 different regional plans for each of the regions.

The land use planning system includes three levels: national, regional and municipal:

- the national level the main principles and policies concerning access and use of mineral resources and the development of mining and quarrying activity are defined,
- at the regional level the principles and policies are implemented taking into account the geological knowledge and the potential of each region,
- at a municipal level, land use plans demarcate areas allocated to geological resources (Spaces of Geological Resources) for exploration and exploitation indicating areas where the mining activity is the main land use and others where the development of other activities does not compromise the access to mineral resources.

The new land use plans also ensure that a consistent terminology is used to characterise land uses related to raw materials including:

- Potential Areas (areas for which there is no sufficient knowledge but for which there are sufficient indications of the presence of raw material deposits. Such areas can be used for research and exploration contracts),

- Conservation Areas (areas for which there is already recognised geological potential that can be used in the future when this is considered appropriate),
- Areas for Exploration (areas for which there is recognised geological potential which are available for exploration and exploitation).

Exploitation permit areas are demarcated in the land use plans as restricted areas where mining activity is the main land use. Furthermore, overlaps with other land uses, to the extent that they do not compromise the current and future access to the minerals, are also possible in the case of areas identified as potential or actual conservation areas.

The Mining Authority is responsible for overseeing the implementation of the policy and ensuring the implementation of land use plans at the municipal level – which eventually take the form of regulations. It ensures that the plans properly cover mining and quarrying activities and that areas dedicated to geological resources exploration and exploitation are included. It has a key role to ensure that the information available from geological surveys – included in geo-referenced maps - is properly integrated and that existing and potential raw materials deposits and mining activities are considered and demarcated.

Experiences gained allowed for preparation of proposal "***Towards a criteria densification to support a "safeguarding decision" on the future access to Mineral Deposits of Public Importance (MDoPI)***" in 2016. Proposed concept assumes that it does not depend on a specific economic value or any other type of advantage, because it deals with the present and future access to mineral resources and not with their (current or foreseen) regional, national or international economic relevance which relies on natural attributes (tonnage, grade, physical and/or chemical characteristics, *etc*.) and on the "market behaviour" (particularly, the demand/supply trends – historical, current and projected – safe provision, prices stability, etc.). Furthermore, the proposed concept does not need to list temporal or particular restrictions related to legal or environmental specificities, because the access to mineral deposits should be viewed in parity with other natural resources.

The Portuguese proposal for dimensions of further valorization, that are taken into account, is as follows:

- *LGK* - level of geological knowledge (geological dimension), i.e. available geological information of each specific area/tract (e.g. from outcrops, regional setting, etc.)
- *Ec* – economic dimension
- *Ev* – environmental dimension
- *SDA* – social dimension

The level of geological knowledge (LGK), as well as the economic (Ec), environmental (Ev) and social (SDA) dimensions for each specific area/tract, would be assessed by means of a set of independent, but complementary criteria.

LGK is critical dimension which would discriminate distinct levels of geological data, information and knowledge at different scales (from regional to local). Four complementary criteria were proposed: 1. Availability and quality of the background geological information and knowledge; 2. Regional exploration information and knowledge about mining/quarrying districts; 3. Existent past exploitation information and knowledge; 4. Comprehensive, up-to-date information and knowledge existent for a single specific mineral area.

For the economic dimension Ec five complementary criteria were proposed: 1. Intrinsic value of a specific area according to the natural attributes presented by identified resource and *considering results of (pre-)feasibility studies*, which should include information that justify its advantageous exploitation in a given time-window; 2. Mining/quarrying lifetime active within a specific area; 3. Appraisal of the contribution given by active

operation within a specific area to the added-value chain of mineral product(s); 4. Relevance of active operation within a specific area to domestic market, contributing to the reduction of the dependence in mineral imports; 5. Significance of active operation within a specific area to exports.

For environmental dimension Ev seven complementary criteria, which should be grounded by independent studies already accomplished in each specific area where active operation exists or is being planned, namely those commonly known as "*Environmental Impact Assessments*": 1. Compatibility of mining/quarrying operations in a specific area with other natural values; 2. Impact of past exploitation activities in a specific area; 3. Impact of mining/quarrying in a specific area in comparison with other (existent and projected) land uses or economic activities; 4. Impact or the foreseen disturbances in natural flows caused by mining/quarrying activities in a specific area, e.g. to soil damage/removing, acid drainage, changes in fluvial charges (dissolved and in suspension components), dust and gas emissions, etc.; 5. On-going or proposed mitigation and rehabilitation measures related to mining/quarrying operations in a specific area; 6. Type of land use for mining and processing in a specific area; 7. Amount of mining wastes/residues produced by an active operation within a specific area.

For social dimension SDA five complementary criteria were proposed: 1. Public acceptance in relation to mining/quarrying operations in a specific area; 2. Compatibility of mining/quarrying operations in a specific area with other land uses by the community; 3. Impact in the population settlement and growth caused by mining/quarrying operations in a specific area; 4. Impact in direct/indirect jobs creation a welfare rise produced by mining/quarrying operations in a specific area; 5. Wealth improvement associated with the mining/quarrying activity in a specific area with other complementary economic sectors.

It should be emphasised that the proposed approach was to categorize specific areas hosting mineral resources, whose access and use must be safeguarded. Therefore, the available geological knowledge at a given time would be the decisive factor, allowing by itself an evaluation of all kinds of potential specific areas. Complementary appraisals regarding the remaining dimensions (economic, environmental and social development and acceptance) would focus only in those areas that enclose active mining/quarrying operations or promising prospects for which the compulsory environmental impact assessments, (pre-) feasibility studies and feedbacks on the public acquiescence already exist.

Given the criteria involved in the general assessment of Ec, Ev and SDA dimensions, with their consideration together with LGK allow to define a three-level priority scheme:

- Specific areas to be safeguarded in first priority, therefore justifying the primacy of mining/quarrying activities or detailed exploration surveys in that area over any other kind of land use;
- Specific areas to be safeguarded in second priority and the land access/use should be preferentially, but not exclusively, assigned to exploration and/or exploitation works; alternative land uses are thus possible provided that they do not lead to partial or total sterilisation of the identified resources.
- Specific areas to be safeguarded of third priority and the land access/use with different purposes should be planned and managed carefully, favouring the progression of exploration surveys whenever needed and avoiding circumstantial or long-lasting alternative land uses that can jeopardise further endeavours that may guide to viable mining/quarrying operations.

2.5. MINATURA2020 proposal

Full name in English	Harmonised Mapping Framework to Protect Mineral Deposits of Public Importance
Full name in original language	Harmonised Mapping Framework to Protect Mineral Deposits of Public Importance
Acronym	-
Used in Country or Legal Entity	Proposal to European Commission
Institution(s)	MINATURA2020 Consortium
Source	MINATURA2020 Project
Year	2018
Resources identified	Potential mineral areas, Mineral resources, Mineral reserves

As stressed by the European Commission (European Commission 2011) and a report of the Ad Hoc Working Group (Ad-Hoc Working Group of the RMSG 2010) a comprehensive land-use planning policy that enables the safeguarding of MDoPI needs to be based on the following elements:

- a digital geological knowledge base;
- a transparent methodology for identification of mineral resources (quality, quantity, local importance);
- long-term estimates for regional and local minimum demand (especially for construction materials, such as sand, gravel, crushed rock), taking account of other sources of materials (e.g. recycled), based on sustainable development principles as a monitoring tool;
- identifying and safeguarding mineral resources to meet minimum demand, taking account other land uses;

those four elements comprise the basis for a common harmonised mapping framework (HMF) that allows the effective safeguarding of MDoPI. The objectives and the methods underlying these common elements need to be standardised, i.e. the same method is employed and takes into account site-specific differences.

Harmonised Mapping Framework to protect MDOPI

The objective of the HMF is to present a common comprehensive approach and methodology to create a coherent European network of MDOPI (similar to the Natura2000 network). Such a European MDoPI network will be constructed based on the input by national and regional members of the network, i.e. the public authorities in charge of identifying and designating MDoPIs and the mineral safeguarding areas which safeguards the access to those tracts hosting the mineral deposits.

It has been suggested that, in order to create a flexible HMF that can be implemented by all countries and that can address and accommodate the heterogeneities previously described, any HMF should:

- be at high level;
- be simple and understandable by a wide range of professionals;
- not require new data (requiring financial resources that may not be available);

- not demand large efforts nor means to be a significant burden for the implementing public authorities;
- be capable of adoption in all countries (recognising the wide regulatory and socio-cultural diversity across the European Union) without significant changes in legislation or procedures.

A simple **Harmonised Mapping Framework** that allows the of MDoPIs and the delineation of mineral safeguarding areas in each jurisdiction should subsequently (not in parallel) follow **these 6 steps** (Tiess et al. 2018):

1. Analysis of mineral policy, mineral demand forecasts and economic context;
2. Identification and classification of potential MDOPIs;
3. Analysis of competing land uses;
4. Proposing and delineating MSAs for each MDoPI;
5. Validation of MDoPIs and MSAs and communication to the MDoPI network management body;
6. Inclusion of MSAs in local spatial planning documents.

The HMF should be applied by each jurisdiction (country/region) and report it to the centralised organisation in charge of maintaining the European MDoPI network. As a hypothesis, it could accepted that the European Commission (via a body of it) runs the European MDOPI network, i.e. maintains a centralised digital network (with an online viewer) of the MDOPIs and the MSA holding them based on the inputs by the national contact points (or national coordinating committee, these are just draft names for the body that will coordinate all steps within each jurisdiction). The latter are the authority regularly monitoring and reporting to the European Commission on the changes at the national level on those mineral deposits considered MDoPI and their spatial extension on the surface.

Step 1: **Analysis of the mineral policy, mineral demand forecasts and economic context**

Each jurisdiction (EU, national or regional) should prepare first a concise description of the mineral policy and of the economic context of the jurisdiction, including current and future mineral demand forecasts (at least for aggregates). The mineral policy description can be based either on a central written document or on different policies applied by regulatory authorities to ensure the minerals industry can remain competitive. The economic context description should allow understanding the importance of the different minerals to the economy of the jurisdiction, e.g. of aggregates for the local building/construction industry. The mineral demand forecasts should also reflect whether estimations foresee an increasing or stable demand in the coming years, which also adds another dimension to understand the need for minerals in the local, regional or national economies.

Step 2: Identification and classification of MDOPIs

In each jurisdiction, the society, respectively experts (interdisciplinary groups) and the National Contact Point should first discuss and agree which mineral deposits (within the national or regional mineral inventory) **have the potential to be eligible to qualify as MDOPI.**

Once a preliminary number of mineral deposits are classified as “eligible”, the stakeholders should execute a multi-criteria methodology to identify which deposits are considered MDOPI. As previously mentioned, an attempt to find a common multi-criteria methodology is being pursued in the Consortium, but were this not to be the case, the MINATURA2020

will only provide recommendations and each jurisdiction needs to apply the most suitable methodology to identify and classify MDOPI.

Even though each jurisdiction may use its own methodology to designate MDOPIs it should be done in a standard way using the same categories for the classification. All MDOPIs should be classified as **MDOPI-EU, MDOPI-CL or MDOPI-RL**. When classifying MDoPI the classification at different levels should be **non-exclusive**, i.e. an MDoPI could be classified as a European and National MDoPI at the same time if the minerals are of importance at both levels (e.g. tungsten in Portugal).

When classifying MDOPIs, each mineral deposit should contain information as to which of the following categories it belongs to:

- **Mineral potential areas** (perspective areas with only hypothetical resources or promising exploration results);
- **Mineral deposits with resources only**;
- **Mineral deposits with reserves** ;
- **Mining wastes** (areas of inactive mines with waste potentially recoverable);
- **Mineral deposits with mining rights/licence** (being exploited as quarries/mines) and areas adjacent to them (extension of the activity).

Step 3: Analysis of alternative land uses (current and future)

An analysis of the current access to land hosting tracts of minerals (either as primary or secondary mineral deposits) should be done (or a pre-existing analysis should be used) The analysis of other land uses allows identifying which MDOPIs will likely be conflict-free and which others might face constraints from other land uses, requiring the finding of compromises or trade-offs. MINTAURA Consortium also recommend (as optional) conducting an analysis of future potential changes in the land uses which was done in the MINATURA2020 project using the iCLUE model. The main advantage of such an exercise is that it refines even more (into the future) the level of potential conflict that may arise against a potentially designated MDOPI. A level playing field for the other land uses should be considered, as well as different options/mechanisms to reconcile alternative interests (e.g. prior extraction).

Step 4: Create a proposal for MSAs for each MDoPI

Based on the list created in Step 2 the stakeholders participating in the Council should define, for each the mineral deposits classified as MDoPI, a spatial extension (physical extent), i.e. a polygon demarcating their extension on the surface. To define such areas the recommendations in the following chapter should be considered.

Step 5: Validation of MDoPIs and MSAs

An iterative deliberation process of validation with further stakeholders (e.g. the wider public) should be implemented by the Council of Stakeholders of each jurisdiction (national or regional) to find common grounds on the MDOPIs selected and their spatial extension, as well as for their regularly update. The Council of Stakeholders needs to define the MSA taking into account current and future competing land uses around the area which holds the MDOPI. This step may be skipped if sufficient multi-stakeholder participation was ensured during the Steps 2 and 4.

Step 6: Inclusion of MSAs in local spatial planning documents

The Council of Stakeholders should advocate and push for the integration of MSAs in local spatial planning documents. However, without a legal piece, this should be voluntary, or at least each country should see if it can make it compulsory that MDOPIs are legally recognised.

MDoPI safeguarding practices need to be included into the MS´s regulatory frameworks. However, based on the feedback from external stakeholders and internal Consortium discussions, it seems that requesting the authorities of Member States to go through all six steps may represent a too high administrative burden which compromises the feasibility of such an approach. The implementation could be problematic and it depends on the internal conditions of a given country. This is because the authorities of each Member State have different levels of information, capacities, staff and budgets available which makes the situation heterogeneous. Therefore, discussions of the HMF point to the result that such six steps will be offered only as a guidance to Member States, but it will not be requested to be implemented. The steps that will be requested to Member States will be only **steps 2 and 4**, i.e. identifying MDoPIs according to basic common criteria and the implementation of safeguarding procedures. This is based on the idea that as long as MDoPI are identified and effectively safeguarded in a transparent and clear way that satisfies the objective of the project.

3. Mineral resources valuation approaches

Works on methodology of mineral resources valuation were very common from – at leats – 1930s years, however they were very dispersed, being scientifically or business grounded. The necessity of trial of some harmonisation of these attpempts started to be clear in the late 1980s, when process of intrenationalization and globalization of mineral industry started very quickly. This is why first such successful approach was prepared and introduced in Australia, due to needs of Sydney Exchange, where a large number of junior mineral companies started to be listed. For years, such valuation methods and approached were developed for business purposes only, with Australian (VALMIN), Canadian (CIMVAL), and South African (SAMVAL) Codes as the most common and used worldwide, also in EU countries (see: point 3.1). In EU countries, the only original mineral resources valuation code was prepared in Poland (POLVAL Code), but it is very similar to VALMIN and CIMVAL codes. Very similar approach is presented in IMVAL Template prepared recently by the International Valuation Standards Committee for use by professional valuers, also in EU countries (see: point 3.2). All these approached are concentrated on business side and made for business purposes, so social and environmental issues are important in them only to some limited extent (if they are important or necessary, they are taken into account).

Other approach is presented in proposal of UN Integrated Environmental and Economic Accounting, where mineral deposits are treated as part of environment and part of national wealth, so they should be valued with such general assumption. However, though works on this methodology started in early 1990s, final version of methodology is still not ready and not introduced into use, though it is still potential to do so. This Is why it was also characterised in point 3.3.

3.1. Code for the Technical Assessment and Valuation of Mineral and Petroleum Assets and Securities for Independent Expert Reports – VALMIN Code (Australia), and codes related to VALMIN

3.1.1. VALMIN Code (Australia, 2015 Edition)

Full name in English	Code for the Technical Assessment and Valuation of Mineral and Petroleum Assets and Securities for Independent Expert Reports – VALMIN Code
Full name in original language	Code for the Technical Assessment and Valuation of Mineral and Petroleum Assets and Securities for Independent Expert Reports – VALMIN Code
Acronym	VALMIN
Used in Country or Legal Entity	Australia (also other countries)
Institution(s)	VALMIN Committee - a joint committee of AusIMM, AIG and MCA
Source	http://www.valmin.org/code2015.asp
Year	2015 (1995)
Resources identified	Potential mineral areas, Mineral resources, Mineral reserves

The Australasian Code for the Public Reporting of Technical Assessments and Valuations of Mineral Assets (VALMIN Code) has been prepared by the VALMIN Committee, a joint committee of The Australasian Institute of Mining and Metallurgy (AusIMM) and the Australian Institute of Geoscientists (AIG), with the participation of the Minerals Council of Australia (MCA) and other key stakeholder representatives.

There have been three previous versions of the VALMIN Code, the first applicable from 1 July, 1995, the second applicable from 1 April, 1998 and the third applicable from 29 April 2005. The Minerals Industry Consultants Association (MICA) was a member of the joint committee and a major contributor to earlier Codes.

The VALMIN Code provides a set of fundamental principles (Competence, Materiality and Transparency), mandatory requirements and supporting recommendations accepted as representing good professional practice to assist in the preparation of relevant Public Reports on any Technical Assessment or Valuation of Mineral Assets. It is a companion to the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (JORC Code). The VALMIN Code provides guidance on matters that may be subject to Australian regulations, other provisions of law and the published policies and guidance of the Australian Securities and Investments Commission (ASIC) and the Listing Rules of the Australian Securities Exchange (ASX) or of other relevant securities exchanges.

The VALMIN Code is written from a Minerals perspective and uses terminology consistent with the JORC Code.

The purpose of the Australasian Code for the Public Reporting of Technical Assessments and Valuations of Mineral Assets (VALMIN Code) is to provide a set of fundamental principles, minimum requirements and supporting recommendations to assist in the preparation of relevant Public Reports on Mineral Assets. The VALMIN Code is based on international good practice as currently employed in the Mineral industry, but allows for professional judgement in certain instances.

The resulting Public Reports must be reliable and should be clear, concise, effective and include all the Material information required by investors and their advisers when making investment decisions.

AIG and AusIMM Members must adhere to the VALMIN Code regardless of where or for whom the Public Reports are prepared or the location of the Mineral Assets under consideration.

The VALMIN Code is designed to fit within the Australian regulatory framework comprising the Corporations Act, and various ASIC Regulatory Guidelines and ASX Listing Rules. It is a companion to the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (JORC Code).

The VALMIN Code is considered to be broadly consistent in terms of fundamental principles and general approach with relevant international codes, templates, standards and guidelines (eg SAMVAL – South African Code for the Reporting of Mineral Asset Valuation, CIMVal – Standards and Guidelines for Valuation of Mineral Properties, CRIRSCO – Committee for Mineral Reserves International Reporting Standards template and the IMVAL Template – International Mineral Valuation Standards template). VALMIN Practitioners preparing Public Reports in jurisdictions other than Australia should be aware of and take note of the specific content of relevant codes, templates, standards and guidelines other than VALMIN.

VALMIN Practitioners

A Practitioner is an Expert as defined in the Corporations Act, who prepares a Public Report on a Technical Assessment or Valuation Report for Mineral Assets or Securities. This collective term includes Specialists and Securities Experts.

The following categories of Expert are recognised and are broadly aligned with ASIC Regulatory Guide 112:

a) Specialists are persons whose profession, reputation and relevant industry experience in a technical discipline (such as geology, mine engineering or metallurgy) provides them with the authority to assess or value Mineral Assets, and who prepare and accept responsibility for a Public Report.
b) Securities Experts are persons whose profession, reputation or experience provides them with the authority to assess or value Securities, and who prepare and accept responsibility for a Public Report.

A Specialist must:

a) be Competent in, and have had at least five years of recent and relevant industry experience in relation to, the specific Mineral Asset to be reported upon;
b) have at least five years of recent and relevant experience in Technical Assessment, and where a Valuation is being prepared, have at least an additional five years (totalling a minimum of ten years) of recent and relevant experience in the valuation of Mineral Assets;
c) be a member of a Professional Organisation with an enforceable professional Code of Ethics and understand that a violation of the VALMIN Code may result in an investigation in accordance with the rules of the Professional Organisation; and
d) be familiar with the VALMIN Code, the JORC Code, the relevant requirements of the Corporations Act, the public policies of ASIC, the ASX or other recognised Securities exchanges, and court decisions that may be relevant to the Public Report being prepared.

Code Principles

The fundamental Principles of the VALMIN Code are Competence, Materiality and Transparency.

Competence or being Competent requires that the Public Report is based on work that is the responsibility of a suitably qualified and experienced person who is subject to an enforceable professional Code of Ethics.

Materiality or being Material requires that a Public Report contains all the relevant information that investors and their professional advisors would reasonably require, and reasonably expect to find in the report, for the purpose of making a reasoned and balanced judgement regarding the Technical Assessment or Mineral Asset Valuation being reported.

Transparency or being Transparent requires that the reader of a Public Report is provided with sufficient information, the presentation of which is clear and unambiguous, to understand the report and not be misled by this information or by omission of Material information.

Additional requirements

Further to the Code Principles, additional requirements are Reasonableness and Independence.

Reasonableness requires that an assessment that is impartial, rational, realistic and logical in its treatment of the inputs to a Valuation or Technical Assessment has been used, to the extent that another Practitioner with the same information would make a similar Technical Assessment or Valuation.

Independence or being Independent requires that there is no present or contingent interest in the Mineral Asset(s), nor is there any association with the Commissioning Entity or related parties that is likely to lead to bias.

Where the legal definition of Independence or Independent differs from the above, the legal definition takes precedence.

Public Report

The intent of a Public Report is to gather, summarise and interpret the Material information related to the Mineral Assets under consideration along with the opinions of the Practitioner, which are to be presented clearly, concisely and accurately.

The Practitioner must state in the Public Report its specific purpose (and that of any subsidiary reports), its terms of reference and if there are any limitations on its use for other purposes.

Public Reports include, but are not limited to: (a) Technical Assessment Report, (b) Valuation Report, (c) Independent Expert Report, (d) corporate presentations, and (e) news releases.

Public Reports should be worded and presented in a clear, concise and effective manner. This applies to both the wording of information (for example, choice of language) and the presentation (for example, choice of communication tools) of a Public Report.

A Public Report must contain all the information that the Commissioning Entity (and others, including investors and their professional advisors) would reasonably require and expect to find to make an informed decision about the subject of the Public Report.

A Public Report should contain: (i) an executive summary setting out the key data, important assumptions made and conclusions drawn by the Practitioner, (ii) a summary of contributing authors to the report and areas of responsibility within the report, which should outline the names, qualifications and relevant experience of the Practitioner, (iii) the effective date of the Public Report, (iv) a statement specifying the relevant currency used in any Valuation, (v) a description of the relevant Mineral Assets, including their location, plant, equipment, infrastructure and ownership, (vi) an account of the Material history of the Mineral Assets, (vii) a balanced, impartial statement of the Practitioner's review and conclusions so that an informed person can have a clear understanding of the merit of the Mineral Assets, their value (if applicable) and associated risks, (viii) information regarding the sources of data used, (ix) sufficient information to convey how the Public Report was prepared, including details of the approaches and methods employed, and sufficient information so that another Practitioner can understand and replicate the outcome, (x) a review of any other matters that are Material to the Public Report, (xi) advice on reliance on third party personnel and/or disclaimers, and (xii) an outline of any areas within a report where there is non-conformance with the VALMIN Code and the impact of this on Materiality.

The Practitioner must state the sources of all Material information and data used in preparing a Public Report. Subject to any confidentiality, regulatory requirements and consents, references to the relevant published and unpublished reports and records must be provided. It may also be necessary to cite reports, data and records that were either

available or known to the Practitioner that were possibly Material but not used, and the reasons why they were not used.

The Specialist must accept responsibility for assessing the technical data and information, interpretations, discussions and conclusions, forecasts and parameters used in a Technical Assessment or Valuation of a Mineral Asset. For Mineral Asset Valuations undertaken by the Specialist, the Specialist must also accept responsibility for the Valuation Approach, Valuation Methods and Public Report conclusion.

A Public Report should include appropriate photographs, plans, diagrams, graphs and maps, including one showing the geographical location of the Mineral Asset in relation to a capital city or major town. Maps, plans or other graphic information should be sufficient to illustrate the geology and other pertinent features. In particular, a map should show local landmarks and boundaries, dimensions and location relative to nearby projects that may have a significant bearing on the Mineral Asset. Maps and graphics in a Public Report should: (i) be of a suitable scale and with a recognised co-ordinate system; (ii) show a bar scale and a direction arrow pointing north, designated as either magnetic, true or grid north; (iii) show key area infrastructure where appropriate (eg ports, roads, power and water supply); (iv) be readable and prepared so that no data is lost or obscured if it has been reduced in size for printing; (v) if showing Exploration Results, be of such a scale so as to assist in the assessment of sampling and other exploration procedures; and (vi) use standard industry symbols.

Technical Assessment Report

A Technical Assessment Report involves the Technical Assessment of elements that may affect the economic benefit of a Mineral Asset.

A Valuation Report expresses an opinion as to monetary Value of a Mineral Asset but specifically excludes commentary on the value of any related corporate Securities.

An Independent Expert Report is a type of Public Report which may be required by the Corporations Act, the Listing Rules of the ASX or other security exchanges. A report will only be an Independent Expert Report when the Practitioners are Independent of the Commissioning Entity and are perceived and acknowledged to be so by the Commissioning Entity.

A Technical Assessment is an evaluation prepared by a Specialist of the technical aspects of a Mineral Asset. Depending on the development status of the Mineral Asset, a Technical Assessment may include any or all of: (a) Tenure, (b) regional and local geology, (c) mineralisation, hosting potential and prospectivity, (d) exploration and production history, (e) Mineral Resources, Ore Reserves, Exploration Results and Exploration Targets, (f) extraction methods and design, (g) processing methods, flowsheets and recoveries, (h) infrastructure availability and requirements, (i) estimated capital and operating costs, (j) actual and projected, or forward estimate, production, (k) environmental, social and heritage impacts, (l) JORC Code Modifying Factors and other aspects that could reasonably be expected to impact on the economic potential, and (m) product pricing and revenue factors.

Any existing or proposed operating, environmental and social practices must be reviewed to establish the technical, economic, environmental and social feasibility of the operation. Matters to be reviewed for Mineral Assets may include, but are not limited to: (i) mining and processing methods, (ii) grade control, mining loss and dilution, (iii) geotechnical, hydrological and climatic conditions, (iv) mineralogical and metallurgical factors likely to

affect process recovery, (v) flow sheet design, (vi) variability of the mineralised body's physical and chemical properties, (vii) metallurgical recoveries and performance, (viii) tailings and waste disposal, (ix) quantity and quality of final and intermediate products and waste, (x) labour sources, requirements and productivity, (xi) operating practices and technologies employed or to be employed; (xii) equipment availability, utilisation and performance, (xiii) energy and water sources, (xiv) recent trial mining and treatment data (for proposed operations), (xv) construction and commissioning schedules, (xvi) marketability of products, revenue factors, commodity prices and exchange rates, (xvii) product transport and realisation issues, (xviii) environmental, legal, statutory and social constraints and commitments, and (xix) closure and post-closure activities and schedules.

A Public Report should outline the range or assessed order of accuracy of forecast capital and operating cost estimates that have been adopted, together with supporting data and date reference.

The Specialist should review and describe the actual and forecast capital and operating costs for the estimated productive life of the Mineral Assets subject to the Public Report.

Estimates of capital costs are likely to include, but are not be limited to: (i) feasibility and associated studies costs, (ii) acquisition cost, (iii) construction, implementation and commissioning costs, (iv) working capital, (v) owner's cost, (vi) sustaining capital, (vii) decommissioning, rehabilitation and site restoration costs, (viii) contingency allowance, and (ix) a stated level of accuracy of cost estimates.

Estimates of operating costs are likely to include but are not limited to: (i) workforce employment, (ii) consumables and spare parts, (iii) power, water and other services, (iv) contract services, (v) equipment lease and hire, (vi) on-site and off-site administration, (vii) environmental protection and monitoring, and non-capitalised rehabilitation, (viii) transport and accommodation of workforce, (ix) social and community programs, (x) product marketing, transport and realisation, (xi) taxes, royalties and other governmental charges, (xii) contingency allowance, and (xiii) a stated level of accuracy of cost estimates.

Services and infrastructure to be considered include power, water supply, transport, communications, security, workforce accommodation, housing, medical services and waste and tailings treatment and/or disposal facilities. The Public Report should also review any access and terrain conditions that may affect the logistics of exploration and development.

A Public Report should assess the Mineral Asset's potential revenue stream over an appropriate period.

Where a Public Report includes information relating to forecast revenue, it must set out a reasonable basis for price-related assumptions applying to any product(s) derived from the Mineral Asset.

The price-related assumptions may include, but are not limited to: (i) forecast product prices, smelter treatment and refinery charges, current and forecast market conditions and the likely quantity and quality of product, (ii) penalty and premium components of the product, (iii) variation in product price and basis and source of forecast product prices used, (iv) size, nature and location of markets, (v) commodity market imbalances and pricing discounts or premiums, (vi) sales volumes, (vii) price escalation, (viii) exchange rates, (ix) hedging or forward sales contracts, and (x) residual value.

Valuation

A Public Report must disclose the basis of value. The basis of value is a statement of the fundamental measurement assumptions of a valuation. The VALMIN Code primarily uses the terms Market Value and Technical Value, although circumstance may require the use of alternative definitions.

Technical Value is an assessment of a Mineral Asset's future net economic benefit at the Valuation Date under a set of assumptions deemed most appropriate by a Practitioner, excluding any premium or discount to account for market considerations.

Market Value is the estimated amount (or the cash equivalent of some other consideration) for which the Mineral Asset should exchange on the date of Valuation between a willing buyer and a willing seller in an arm's length transaction after appropriate marketing where the parties had each acted knowledgeably, prudently and without compulsion.

Market Value may be higher or lower than Technical Value. A Public Report should take such factors into account, stating the results of the principal Valuation Method(s) used and disclosing the amount of and reasons for the difference between the Market Value and Technical Value.

The selection of the Valuation Approach and underlying Valuation Method used is the responsibility of a Practitioner and must not be influenced by the Commissioning Entity or other parties.

Within each Valuation Approach, there are Valuation Methods that share a common rationale or basis but differ in how they are calculated.

Three widely accepted Valuation Approaches are:

a) Market-based, which is based primarily on the notion of substitution. In this Valuation Approach the Mineral Asset being valued is compared with the transaction value of similar Mineral Assets under similar time and circumstance on an open market.
b) Income-based, which is based on the notion of cashflow generation. In this Valuation Approach the anticipated benefits of the potential income or cash flow of a Mineral Asset are analysed.
c) Cost-based, which is based on the notion of cost contribution to Value. In this Valuation Approach the costs incurred on the Mineral Asset are the basis of analysis.

Use of Ore Reserves and Mineral Resources

All Ore Reserves and Mineral Resources must be considered in a Technical Assessment or Valuation. When the Reasonable Grounds Requirement has been met for a Valuation, it is generally acceptable to use all Proved and Probable Ore Reserves in the Income Approach. It may sometimes be appropriate to include other classifications, but these must, subject to the Reasonableness Test:

a) meet the minimum reporting requirements of the ASX Listing Rules and guidance, the ASIC Regulatory Guidelines and guidance, and the JORC Code;
b) not include Exploration Targets that have not been converted to Production Targets;
c) be scheduled for extraction behind Proved and Probable Ore Reserves, where practical to do so;
d) include a statement by the Specialist that confirms the appropriateness of the Modifying Factors along with a description of their level of certainty relative to those of a Feasibility Study or Pre-Feasibility Study; and
e) be discounted in a manner that is commensurate with the increased uncertainty.

Financial Modelling

The basis for using income tax and other taxes, royalties, cost escalation, inflation and exchange rates in a cash flow model for Valuation purposes must be stated in the Public Report.

The conclusions of a Public Report may be affected by the nature of the financing arrangements for a project. A Practitioner should therefore review any such commitments made and the likelihood and form of financing.

Depending upon the scope of the Public Report, the Practitioner should report upon liabilities, commitments and financial exposures.

Risks and opportunities

A Public Report should include an evaluation of the risks likely to apply to the Mineral Assets under consideration. A risk evaluation includes an analysis of the uncertainties inherent in the assumptions made and the effects they may have on the outcome.

Risks may arise with respect to the availability, uncertainty and quality of data and other information, including, but not limited to: (a) geological prospectivity and the possibility that further exploration may fail to demonstrate economic mineralisation (in the case of projects without defined Ore Reserves), (b) geology of the mineral deposits, (c) estimation of Mineral Resources or Ore Reserves, (d) operational aspects including the mining/extraction method, dilution and mining losses, equipment sizing and efficiencies, use of selective mining assumptions, waste management, meeting regulatory requirements and mine closure, (e) mineral processing and the variability of metallurgical parameters and wellfield extraction such as recovery rates, process plant availability and the ability of new processes to be financed and perform as forecast, (f) construction, including unforeseen physical conditions or weather or industrial disputes, which may affect both capital costs and completion date, (g) provision and adequacy of infrastructure, (h) commodity price, inflation and exchange rate forecasts, (i) production of marketable commodities in terms of quality, price and cost of production, (j) sovereign risk involving social, political, environmental, cultural and security factors that cannot be controlled by project operators, and (k) project funding.

Site inspection

Where inspection of a Mineral Asset or Tenure is likely to reveal information or data that is Material to a Public Report, the Specialist should inspect it.

If an inspection is not made, the Specialist must be satisfied that there is sufficient current information available to allow an informed evaluation to be made without an inspection and must declare the reasons for not undertaking a site visit.

Any decision not to conduct an inspection must be made by the Specialist and not by the Commissioning Entity and the reason must be disclosed in the Public Report.

3.1.2. Standards and Guidelines for Valuation of Mineral Properties – CIMVAL Standards and Guidelines (Canada, 2003 Edition)

Full name in English	Standards and Guidelines for Valuation of Mineral Properties – CIMVAL Standards and Guidelines
Full name in original language	Standards and Guidelines for Valuation of Mineral Properties – CIMVAL Standards and Guidelines
Acronym	CIMVAL
Used in Country or Legal Entity	Canada
Institution(s)	Special Committee on Valuation of Mineral Properties (CIMVal) at CIM Council
Source	https://mrmr.cim.org/media/1020/cimval-standards-guidelines.pdf
Year	2003
Resources identified	Potential mineral areas, Mineral resources, Mineral reserves

The VALMIN Code, firstly introduced in 1995, has withstood the test of time, being respected internationally. Many non-Australian valuators attempt to follow the VALMIN Code. Accordingly it provided an extremely useful model for Canada, and is already accepted by many Canadian valuators. Although the situation was Canada is somewhat different from that in Australia, the VALMIN Code has provided much useful material and many key concepts for the CIMVal Standards and Guidelines.

On May 5, 1999 at the Calgary Annual General Meeting, CIM Council approved the formation of a Special Committee on Valuation of Mineral Properties (CIMVal). The members of CIMVal represent of a mix of professional disciplines and experience in the field of Mineral Property valuation. A “Draft Discussion Paper” was released at the CIM Annual General Meeting in Quebec in May 2001. Again, comments and submissions were requested from all interested parties. On March 9, 2002, CIM Council adopted and approved the Draft Standards and Guidelines for Valuation of Mineral Properties, subject to any material changes in the final document being brought back to CIM Council for adoption and approval. CIM Council adopted and approved final document on March 9, 2003. The full name of this document is Standards and Guidelines for Valuation of Mineral Properties. It is also known as “CIMVal Standards and Guidelines”.

Simultaneously, NI 43-101 Standards of Disclosure for Mineral Projects, came into effect on February 1, 2001. NI 43-101 was formulated by the Canadian Securities Administrators (CSA), an umbrella association of Provincial Securities Commissions across Canada. The Instrument includes Form 43-101F1 (Technical Report) and Companion Policy 43-101CP, and is now the principal regulatory document in Canada for disclosure of information on mining projects. NI 43-101 contains a number of items with relevance to issues in mineral valuation, as noted in several places in these Standards and Guidelines. Some of the definitions in the Standards are consistent with those used in NI 43-101 (e.g. “Qualified Person”). Part 4, Section 4.2(1) of NI 43-101 states that an issuer shall file a current Technical Report where a valuation is required to be prepared and filed under securities legislation. Section 4.2(1) does not refer to the contents of a valuation report to be prepared and filed in such circumstances. The CIMVal Standards and Guidelines recommend

contents for a “Valuation Report”, and its relationship to a Technical Report. The CIMVal Standards and Guidelines are intended to augment NI 43-101, with respect to the valuation of Mineral Properties.

Valuation in the CIMVal Standards and Guidelines is concerned with the value or worth of a Mineral Property as opposed to “evaluation” where the key objective is an economic assessment or determination of the economic merit of a property.

The CIMVal Standards and Guidelines are organized into two parts. The first part consists of Standards which are general rules that are mandatory in the Valuation of Mineral Properties. The second part contains Guidelines which elaborate on the Standards and, while not mandatory, provide guidance and best practices which are highly recommended to be followed in the Valuation of Mineral Properties. Definitions are given at the beginning of the Standards for terms used. Where practical, terms are defined in a manner consistent with National Instrument 43-101.

CIMVal has accepted the view that the valuator is responsible for choosing approaches and methods. Valuation approaches and methods should be chosen by the valuator. Certain approaches and methods appear to be currently accepted as standard practice, although they could change over time. The Guidelines provide guidance and commentary on the use and application of various approaches and methods.

Mineral Property Valuations are carried out for a variety of reasons, such as mergers and acquisitions, non arm’s length transactions, a component of pricing of initial public offering of stock, listing support, support of audited financial statements, support for property agreements, determination of vendor considerations, litigation, expropriation compensation, income tax matters, insurance claims, and as components of corporate valuations and fairness opinions, among others.

Standards

In CIMVal, the Standards are mandatory in the Valuation of Mineral Properties. It the beginning, it gives definitions of: Commissioning Entity, Competence, Current, Data Verification, Development Property, Exploration Property, Fair Market Value, Feasibility Study, Guideline, Independence, Materiality, Mineral Property, Mineral Reserves and Mineral Resources, Mineral Resource Property, Prefeasibility Study, Preliminary Assessment, Production Property, Professional Association, Qualified Person, Qualified Valuator, Reasonableness, Report Date, Self-Regulatory Professional Organisation, Standard, Technical Report, Transparency, Valuation, Valuation Date, Valuation Report.

The Standards are limited to Valuation of Mineral Properties (including any interests therein), and do not cover valuation of corporations or other entities that hold Mineral Properties as assets. However, it is recommended that the Standards govern the Valuation of Mineral Properties which are included as assets in the valuation of corporations and as assets in valuations related to fairness opinions.

The Standards cover Valuation of metallic and non-metallic Mineral Properties, which also include bedrock, alluvium, placers, industrial minerals, dimension stone, aggregates, and energy fuels that could be produced by mining such as coal, uranium, oil sands and oil shales. Mining includes solution mining of such materials as uranium, potash and other salts. The Standards do not cover oil and gas properties.

Value in the Standards and Guidelines refers primarily to Fair Market Value. If some other type of value is utilized, a clear definition must be provided by the Qualified Valuator and highlighted in the Valuation Report.

The following basic tenets must be followed in the Valuation process and in the preparation of a Valuation Report. General principles of Valuation are discussed in the Guidelines: Materiality, Transparency, Independence, Competence and Reasonableness.

A Qualified Valuator is responsible for the overall Valuation of a Mineral Property and the preparation of the Valuation Report. The Qualified Valuator may be assisted in, or rely on, various aspects of the Valuation and the Valuation Report by one or more Qualified Persons. In situations where a Qualified Valuator is not a Qualified Person as defined in NI 43-101, all technical data relating to the Mineral Property being valued is subject to Data Verification by one or more Qualified Persons.

The Qualified Valuator must be Independent. The Qualified Valuator must certify in the Valuation Report that he or she meets all of the attributes of the definition of "Qualified Valuator". The Qualified Valuator is responsible for adhering to the tenets of Materiality, Transparency and Reasonableness in the Valuation of the subject Mineral Property and in the Valuation Report.

Valuation

The Qualified Valuator has the responsibility to decide which Valuation approaches and methods to use. The choice of the specific approaches and methods used, or excluded, must be justified and explained by the Qualified Valuator. The limitations of each method must be explained.

The three generally accepted Valuation approaches of Income, Market and Cost must be considered and discussed in the Valuation Report. More than one approach should be used in the Valuation of each Mineral Property.

A Valuation under these Standards and Guidelines must be reported in a Valuation Report. Instructions for the preparation of a Valuation Report and a recommended table of contents are set out in the Guidelines.

NI 43-101 (Part 4, Section 4.2(1)) states "an issuer shall file a current Technical Report where a Valuation is required to be prepared and filed under securities legislation". For such Valuations that require a Technical Report to be filed, the Technical Report may be: (i) appended to the Valuation Report, or (ii) incorporated therein by reference, if the Technical Report is already publicly available.

All Current estimates of Mineral Resources and Mineral Reserves (as well as any reserves and resources that do not comply with or pre-date the CIM categories and definitions of Mineral Resources and Mineral Reserves) for the Mineral Property being valued must be disclosed and discussed in the Valuation Report, unless disclosed and discussed in an appended Technical Report.

The Valuation Report must specify the Valuation Date and refer to all previous Valuations of the subject Mineral Property within the last twenty-four months and explain any Material differences between them and the present Valuation.

The Valuation Report must specify the key risks, assumptions and limitations in the Valuation and explain why the assumptions used are reasonable and appropriate in the circumstances.

A Valuation Report must be signed by the Qualified Valuator who is responsible for the Valuation Report.

The Valuation Report must contain a statement that the Valuation complies with these Standards in their entirety. The Valuation Report must contain a statement regarding the extent to which the Valuation is consistent with the Guidelines.

The Qualified Valuator or a Qualified Person relied upon by the Qualified Valuator should undertake a site visit to the Mineral Property being valued.

Valuation Report shall address, if applicable, each of the following topics: Summary, Introduction and Terms of Reference, Scope of the Valuation, Compliance with the CIMVal Standards, Property Location, Access and Infrastructure, Property Ownership, Status and Agreements, History of Exploration and Production, Geology and Mineralization, Exploration Results and Potential, Sampling and Assaying, Mineral Resources and Mineral Reserves, Metallurgy, Environmental Considerations, Mining and Processing Operations, Key Assumptions, Risk and Limitations, Valuation Approaches and Methods, Valuation, Valuation Conclusions, References, Certificate of Qualifications.

Guidelines

The Guidelines, while not mandatory, provide guidance and best practices which are highly recommended to be followed in the Valuation of Mineral Properties. There are related to the following issues: Professional Associations for Qualified Valuator, Valuation Principles, Valuation Approaches and Methods, Use of Mineral Reserves and Mineral Resources, Valuation Reports – Recommended Table of Contents.

The three generally accepted Valuation approaches are:

- Income Approach
- Market Approach
- Cost Approach

The *Income Approach* is based on the principle of anticipation of benefits and includes all methods that are based on the income or cash flow generation potential of the Mineral Property.

The *Market Approach* is based primarily on the principle of substitution and is also called the Sales Comparison Approach. The Mineral Property being valued is compared with the transaction value of similar Mineral Properties, transacted in an open market. Methods include comparable transactions and option or farm-in agreement terms analysis.

The *Cost Approach* is based on the principle of contribution to value. The appraised value method, is one commonly used method where exploration expenditures are analyzed for their contribution to the exploration potential of the Mineral Property.

Mineral Properties can be categorized as four types. It should be noted that there are no clear-cut boundaries between these types, and it may be difficult to classify some Mineral Properties as to one specific category:

- Exploration Properties
- Mineral Resource Properties
- Development Properties
- Production Properties

Within Income Valuation Approach, the following valuation methods can be used: Discounted Cash Flow, Monte Carlo Analysis, Option Pricing, Probabilistic Methods. Within Market Valuation Approach, the following valuation methods can be used: Comparable Transactions, Option Agreement Terms, Gross In Situ Market Value, Net Metal Value, Value per Unit Area, Market Capitalization. Within Cost Valuation Approach, the following valuation methods can be used: Appraised Value, Multiple of Exploration Expenditure, Geoscience Factor.

All Mineral Reserves and Mineral Resources on a Mineral Property should be considered in its Valuation. Depending on the circumstances, the Income Approach, the

Market Approach or the Cost Approach may be more appropriate for the Valuation of a Mineral Property containing Mineral Reserves and Mineral Resources.

For the Income Approach methods, it is generally acceptable to use all Proven Mineral Reserves and Probable Mineral Reserves, and to use Measured Mineral Resources and Indicated Mineral Resources in the circumstances described below.

Inferred Mineral Resources should be used in the Income Approach with great care, and should not be used if the Inferred Mineral Resources account for all or are a dominant part of total Mineral Resources.

It is not acceptable to use, in the Income Approach, "potential resources", "hypothetical resources" and other such categories that do not conform to the definitions of Mineral Reserves and Mineral Resources.

The Valuation Report should consist of technical information and Valuation analyses. Depending on the status of the property, the level of detail needed will vary, but recommended content of Valuation Report should be as follows: Summary, Introduction and Terms of Reference, Scope of the Valuation, Compliance with the CIMVal Standards, Property Location, Access and Infrastructure, Property Ownership, Status and Agreements, History of Exploration and Production, Geology and Mineralization, Exploration Results and Potential, Sampling and Assaying, Mineral Resources and Mineral Reserves, Metallurgy, Environmental Considerations, Mining and Processing Operations, Key Assumptions, Risks and Limitations, Valuation Approaches and Methods, Valuation, Valuation Conclusions, References, Certificate of Qualifications.

3.1.3. South African Code for the Valuation of Mineral Assets – SAMVAL Code (Republic of South Africa, 2016 Edition)

Full name in English	South African Code for the Valuation of Mineral Assets – SAMVAL Code
Full name in original language	South African Code for the Valuation of Mineral Assets – SAMVAL Code
Acronym	SAMVAL
Used in Country or Legal Entity	Republic of South Africa
Institution(s)	South African Mineral Asset Valuation Committee (SAMVAL) Working Group
Source	https://www.samcode.co.za/samcode-ssc/samval
Year	2016 (2008)
Resources identified	Potential mineral areas, Mineral resources, Mineral reserves

Introduction

The SOUTH AFRICAN CODE FOR THE REPORTING OF MINERAL ASSET VALUATION (the SAMVAL Code or 'the Code') sets out minimum standards and guidelines for Reporting of Mineral Asset Valuation in South Africa.

The SAMVAL Code forms a part of the SAMCODE document, and as such relies upon the requirements of the SAMREC Code (The South African Code for the Reporting of Exploration Results, Mineral Resources and Mineral Reserves) for the reporting of Mineral Resources and Mineral Reserves, where necessary, and it draws on, and cross-references to,

definitions and principles embodied within the SAMREC Code as well as the South African Code for the Reporting of Oil and Gas Resources (the SAMOG Code) for the estimation and valuation of petroleum assets.

The SAMVAL Code was prepared by the South African Mineral Asset Valuation Committee (SAMVAL) Working Group under the auspices of the Southern African Institute of Mining and Metallurgy and the Geological Society of South Africa, through the SAMCODES Standards Committee (SSC).

First edition was finally accepted in April 2008. Second edition with amendments was approved in October 2016.

The Code is applicable to the preparation and reporting of valuations conducted on all styles of solid mineralisation. Valuations conducted on oil and gas (petroleum) assets are to be conducted under the auspices of the SAMOG Code.

The guiding philosophy and intent of the SAMVAL Code is that Mineral Asset Valuations should be performed by Competent Mineral Asset Valuators (CVs), and all relevant information fully disclosed. The SAMVAL Code is based on best practice and Generally Accepted Valuation Standards in the minerals industries and allows for professional judgement.

Valuation is the estimation of the Value of a Mineral Asset in money or monetary equivalent. The word ”valuation” can be used to refer to the estimated value (the Valuation conclusion) or to the preparation of the estimated Value (the act of valuing)’ (IVS Framework, para 9, p.13). The word ‘valuation’ is synonymous with the word ‘appraisal’ as used in certain countries. In contrast, the word ‘appraisal’ is used in Australia for the broader activity of evaluation, including the preparation of Resource and Reserve estimates (IMVAL, 2015).

An evaluation of a Mineral Asset, as defined in this Code, is a broad physical, legal, economic, and other assessment, generally sought for an investment decision. Evaluations include Feasibility Studies, Prefeasibility Studies, and Scoping Studies. For clarity, evaluation is distinct from valuation.

The Code sets out a required minimum standard for the Reporting of Mineral Asset Valuations. This applies to both Public Reports, required for listings, financing, *etc*., and to other reports for various purposes.

The Code is divided into Introduction, Principles and Definitions, Standards and Guidance sections, as well as the minimum disclosure requirements for Mineral Asset Valuation Reporting and Assessment criteria (Table 1 in Appendix A), the competencies of a CV (Appendix B), a glossary of terms (Appendix C), and a list of abbreviations (Appendix D).
This format has been derived from extensive research of other Mineral Asset Valuation Codes. As far as possible, principles have been aligned to other international Valuation Codes, and definitions have been chosen/developed based on further extensive research of globally common definitions.

Standards represent the minimum mandatory standards that CVs ’shall’ adopt and be governed by, whereas Guidance provides best-practice guidelines on various aspects of Mineral Asset Valuation.

What is important, the SAMVAL Code includes the valuation of all types of solid mineral commodities and styles of mineralisation.

The SAMVAL Code applies to the valuation of mineral assets for any report intended for public release and issued for a purpose regulated by the Companies Act, other provisions

of South African law, or by the listing requirements of the JSE and other recognized stock exchanges.

Other purposes for which the SAMVAL Code, in whole or in part, could be followed are valuations involved with, including but not limited to:

- The justification for raising debt or equity finance;
- Facilitating negotiations between parties;
- The assessment of Government charges and taxes;
- Estate settlements;
- Internal corporate reports;
- Reports and expert witness statements provided for the purposes of litigation;
- Acquisitions and disposals;
- Impairment calculations; and
- Accounting and financial reporting.

SAMVAL-compliant valuations shall be based on Resources and Reserves prepared in accordance with the SAMREC or any other CRIRSCO-affiliated Mineral Resource and Mineral Reserve Reporting Code as required by the Commissioning Entity and the respective area of jurisdiction. The Valuation Report shall therefore refer to the Code(s) upon which the valuation is reliant, as well as the reason for using this Code.

Fundamental Principles

The Code is a principles-based code, whereby certain fundamental principles should be followed, upon which CVs base their professional judgement and are able to justify their valuation to their peers.

The Code differentiates between fundamental principles, which shall be adhered to by the CV, and guiding principles (described later), which are more ethics-based.

The following fundamental principles shall be considered in the application of the Code:

- **Materiality:** A Public Report contains all the relevant information that investors, their professional advisors and/or Commissioning Entity would reasonably require, and expect to find, for the purpose of making a reasoned and balanced judgement regarding the Mineral Asset Valuation.
- **Transparency:** The reader of a Public Report shall be provided with sufficient and relevant information, the presentation of which is clear and unambiguous, to understand the report and not be misled. The process or methodology should be aligned with the purpose for which the valuation is intended and should be readily auditable in all material respects.
- **Competency:** A CV is a person who possesses the necessary qualifications, ability, and sufficient relevant experience in valuing minerals assets. A person being called upon to sign as a CV shall be clearly satisfied in their own mind that they are able to pass the scrutiny of their peers and demonstrate competence in the valuation undertaken.
- **Reasonableness:** Reasonableness means that other appropriately qualified and experienced CVs with access to the same information, as of the same Effective Date, would arrive at a broadly comparable range of value using the same Basis of Value and the same Scope of Work.

Basis of Valuation

The basis of valuation is the monetary value of the Mineral Asset being valued. This may vary depending on the value type that is being assessed.

In the extractive industries, value is usually derived from an assessment of the **Intrinsic Value**, which is based on the unique technical characteristics of the asset being valued. If some other type of value is utilized or required, a clear definition shall be provided by the CV and highlighted in the Valuation Report. This is especially the case where a Market Value or Fair Value is required. In order for the Intrinsic Value to be converted to a Market Value, appropriate and justifiable market factors are applied.

Valuation Approaches

The CV shall apply at least two valuation approaches to assess the value of a Mineral Asset. Where it is not possible to use more than one approach, the CV shall clearly justify why this is not possible. The three approaches are:

- **Income Approach -** relies on the 'value-in-use' principle and requires determination of the present value of future cash flows over the useful life of the Mineral Asset.
- **Market Approach -** relies on the 'willing buyer, willing seller' principle and requires that the monetary value obtainable from the sale of the Mineral Asset is determined as if in an arm's-length transaction. The application of certain logic in Mineral Asset Valuation, such as 'gross *in-situ* value' simply determined from the product of the estimate of mineral content and commodity price(s), is considered unacceptable and inappropriate.
- **Cost Approach -** relies on historic and/or future amounts spent on the Mineral Asset, and is a valuation approach based on the economic principle that a buyer will pay no more for an asset than the cost to obtain an asset of equal utility, whether by purchase or by construction.

Other Standards

The CV is responsible for adhering to the principles of materiality, transparency, reasonableness, and competency in the valuation of the mineral asset. The CV is responsible for assessing the technical data and information, technical interpretations, technical conclusions, forecasts, and parameters used in the Mineral Asset Valuation, valuation approach, and valuation methods, and applying judgement to the relevance, reliability, and quality of these inputs. The CV has the responsibility to decide which valuation approaches and methods to use. The choice of the specific approaches and methods used, or excluded, shall be explained and justified by the CV. The applications and limitations of each method shall be explained. Mineral Asset Valuation may require a team effort. Where there is a clear division of responsibilities within a team, each Competent Person or Technical Expert shall accept responsibility for his or her own contribution.

The CV shall ascertain the ownership status the Mineral Asset. In particular, the property is held as a right or freehold, and whether restrictions on rights and agreements influence the valuation. This includes issues such as security of tenure, access, servitudes, royalty payments, and joint ventures, *etc*. Assessment should also be made of the land value, if relevant to the valuation, and whether this attaches to the asset, or requires rentals to be paid.

A site visit to the mineral property being valued shall be undertaken by the CV. If a site visit is not undertaken, the reasons should be given, which may include non-materiality.

Valuation Reports

A Public Report concerning a company's Mineral Asset Valuation is the responsibility of the company acting through its Board of Directors. Any such report shall be based on and fairly reflect the Mineral Asset Valuation report(s) and supporting documentation prepared by a CV. A Public Report shall disclose the name of the CV and his or her qualifications, professional affiliations and relevant experience, and his/her registration with the appropriate Statutory Body, Professional Body, or RPO. Table 1 in Appendix A is a high-level checklist of reporting and assessment criteria to be used as a reference by those preparing reports on Mineral Asset Valuations. The checklist is to be considered in terms of the "if not, why not" principle and, as always, relevance and materiality are the overriding principles that determine what information should be publicly reported.

Where any specific valuation documentation is referred to in a Public Report, the written approval of the CV shall be obtained as to the form, content, and context in which that documentation is to be included in the Public Report.

Guidance

A detailed Guidance is also a part of SAMVAL Code. It describes in details such item like Independence, Valuation Process, Valuation Report, Valuation Methods, Use of Mineral Resources and Mineral Reserves, Valuation of Inferred Resources, Exploration Properties and Exploration Targets, Scoping Study, Highest and Best Use, Dealing with Risk in Valuations, Behaviour of CV.

Appendices

In Appendix A high-level checklist of reporting and assessment criteria and a minimum level of disclosure to be used as a reference by those preparing reports on Mineral Asset Valuations (the Valuation Report'). The checklist is to be considered in terms of the "if not, why not" principle and, as always, relevance and materiality are the overriding principles that determine what information should be publicly reported. The basic items to be pointed out there should be: Illustrations, Synopsis, Introduction and Scope, Compliance, Identity, Tenure and Infrastructure, History, Geological Setting, Exploration Results and Exploration Targets, Mineral Resources and Mineral Reserves, Modifying Factors and Key Assumptions, Previous Valuations, Valuation Approaches and Methods, Valuation Date, Valuation Results, Valuation Summary and Conclusions, Identifiable Component Asset Values, Historic Verification, Market Assessment, Sources of Information.

In Appendix B specific competencies of the Competent Mineral Asset Valuator (CV) are discussed, as well as his tasks during Valuation.

In Appendix C long list of terms and definitions used in SAMVAL Code are given. Over 80 definitions are given there, which are related to Principles and Guidance, Value Types, Study Types, Property Types, Stages of Development, Valuation Approaches, Technical Experts and Professional Organizations, Technical Terms, and Risks.

In Appendix D, all abbreviations use in SAMVAL Code are given.

3.1.4. Polish Code for Mineral Deposits Valuation – POLVAL Code (Poland)

Full name in English	Polish Code for Mineral Deposits Valuation – POLVAL Code
Full name in original language	Polski Kodeks Wyceny Złóż Kopalin POLVAL
Acronym	POLVAL
Used in Country or Legal Entity	Poland
Institution(s)	Polish Association of Mineral Asset Valuators (PAMAV)
Source	http://polval.org.pl/wycena-zloz-kopalin/
Year	2008
Resources identified	Potential mineral areas, Mineral resources, Mineral reserves

Polish Code for Mineral Deposits Valuation – POLVAL Code was prepared by Special Commission of the Polish Association of Mineral Asset Valuators. Until 2008, regulations on mineral deposits valuation and qualifications related to it, were not present. POLVAL Code was prepared to carry on mineral deposits valuation properly, by competent persons with good qualifications, and to prepare reliable, precise and concise Valuation Reports, with all necessary information on mineral deposits, to give possibility for e.g. mining investment decisions.

The main aim of the POLVAL Code was to collect in one document all basic Standards and Guidelines, along with the best world practices, to be helpful for Mineral Deposits Valuators in professional Mineral Deposits Valuations. Works on POLVAL Code started in October 2006 and were finalized in May 2008. Until now, it is the only known mineral deposits valuation code within Europe, though its application is still limited.

During preparation of POLVAL Code, foreign and international mineral deposits valuation codes were analysed, as well as specific legal basis in Poland.

POLVAL Code consists of four parts:

1) Basic definitions,
2) Standards, i.e. general rules, which are obligatory during valuation process,
3) Guidelines, more detailed than Standards, giving recommendations and procedures, which are not obligatory, but highly recommended; use of them by Mineral Deposits Valuator guarantee good quality of Valuation,
4) Rules of Ethics of Mineral Deposits Valuator.

The POLVAL Code is based mostly on VALMIN Code regulations, with some parts based also on CIMVal Code and SAMVAL Code.

In Definitions part, 53 definitions are given. They are mostly related to definitions presented in VALMIN Code, some of them – taken from SAMVAL Code, while there are also some definitions related to Polish specifics.

Next part is related to Standards, i.e. obligatory rules of Code. They are related to Value, Rules of Valuation Process, Qualifications and Responsibility of Mineral Deposit Valuator, Approaches of Valuation, Types of Resources and Reserves used in Valuation, Valuation Report.

Valuation Report should contain Introduction and Summary. It should possess the following chapters:

1) Abstract
2) Introduction. Aim and subject of Valuation

3) Valuation Scope
4) Conformity with POLVAL Standards and Guidelines
5) Location of mineral assets, access do deposit and infrastructure
6) Legal status of mineral assets
7) Review and analysis of Geological Documentation of Mineral Deposit
8) Analysis and review of Project of Deposit Development
9) Mineral Resources and Mineral Reserves
10) Characteristics of mining and processing (in case of metal ore deposits – also metallurgy) of Active Mine
11) State of environment and environmental impact
12) Issues of mine liquidation (technical, environmental, financial)
13) Key assumptions, sources of uncertainty and types of risk
14) Valuation Approaches and Methods
15) Valuation Process
16) Conclusions from Valuation
17) Referenced sources
18) Necessary statements and documents confirming Qualification and Competences of Mineral Deposits Valuators and Experts

Third part, Guidelines – there are recommended rules. They are related to e.g. Valuation Approaches and Methods, and – mostly – to Recommended Content of Valuation Report.

The last part is related to Ethics of Mineral Deposit Valuator.

3.2. International Mineral Property Valuation Standards Template (IMVAL Template, 2016 Edition) – International Valuation Standards Committee (IVSC) approach

Introduction

The IMVAL Template is a standards and guidelines template created for the harmonisation of International Mineral Valuation Codes and Standards.

Prior to the development of IMVAL Template, there was no common template or standard for mineral property valuation. Instead, three national codes or standards existed, being CIMVal (Canada), SAMVAL (South Africa), and VALMIN (Australasia). Although these codes have many similarities, they have differences in structure, definitions, scope, and jurisdictional requirements. In addition, minerals while in the ground are specified as a part of Real Estate in the *International Valuation Standards (IVSs).* The IVSs and the USA's *Uniform Standards of Professional Appraisal Practice (USPAP)* also contain valuation standards of general application non-specific to mineral property valuation.

The International Valuation Standards Council (IVSC) convened an Extractive Industries Task Force of international mining and petroleum industry valuation experts in early 2001.

The IVSC's Guidance Note 14 (GN 14), *Valuation of Properties in the Extractive Industries*, was first published in January 2005, in the IVSs Seventh Edition. It was republished in 2007 in the Eighth Edition.

The IVSC Standards Board withdrew GN 14 in February 2010 pending the outcome of its Extractive Industries Project. Development of a revision based on that outcome has been indefinitely postponed.

Discussions were held in Brisbane in April 2012 to establish a harmonisation project for the mineral valuation codes, VALMIN, SAMVAL, and CIMVal, and when and where appropriate, USPAP, the IVSs, and the *International Financial Reporting Standards (IFRSs)*.

The International Mineral Valuation Committee (IMVAL) was formed in July 2012, with the goal of developing a mineral asset valuation template along the lines of the *International Reporting Template* of the Committee for Mineral Reserves International Reporting Standards (CRIRSCO).

The USA-based Society for Mining, Metallurgy, and Exploration, Inc. (SME) published its first edition of the *SME Valuation Standards* in January 2016 and the USA-based International Institute of Mineral Appraisers (IIMA) has approved the adoption of a set of valuation standards based on the Template.

IMVAL, which has developed IMVAL Template, is an international committee comprised of representatives of SAMVAL (South Africa), CIMVal (Canada), VALMIN (Australasia), the SME Valuation Standards Committee (USA), and IIMA (USA). Representatives of the Royal Institute of Chartered Surveyors (RICS, UK), were also involved in the early deliberations of IMVAL.

The IMVAL Template is intended as a principles-based template to be recognised as a common set of minimum requirements for national codes or standards concerning the valuation of Real Property mineral assets (Mineral Property). The Template represents a consensus of current good practices and is expected to be updated from time to time. The Template is not intended to be a stand-alone reporting code, and does not supersede existing national reporting standards.

The IMVAL Template outlines principles, requirements, guidelines, and definitions broadly consistent with those adopted in the regulatory jurisdictions represented by IMVAL members.

Mineral Property is defined in the Template to include petroleum properties, which may be excluded at the option of individual countries as specified in their respective national codes or standards.

The IMVAL Template deals with Valuation, which is distinct from Evaluation. The distinction inherent in these defined terms is that Valuation addresses the estimation of value of a Mineral Property, whereas Evaluation addresses the broader assessment of a Mineral Property for an investment decision.

Principles

As in VALMIN Code, the three fundamental principles that must be followed in undertaking Valuations and Valuation Reports under IMVAL Template are Competence, Materiality, and Transparency. In addition to these fundamental principles, Objectivity, Independence, and Reasonableness may also apply under national codes or standards.

A Valuer must be able to demonstrate to the Commissioning Entity and those entitled to rely on a Valuation Report that the Valuer is sufficiently Competent to prepare or contribute to the Valuation Report. A Valuation must address all material information. All Material information must be included or adequately referenced in the Valuation Report.

The Valuation process and Valuation Report must be Transparent, such that it must be clear and unambiguous and therefore understandable. For certain Valuations, Independence may be required by law, a national code or standards, or by the circumstances of the Valuation.

The Valuer should approach a Valuation with Objectivity. This is promoted by an environment that is supported by data and minimizes the influence of subjective factors, such as the Valuer's personal bias, on the Valuation process. The Valuer must ensure the Reasonableness of the Valuation. Any Valuation, assumptions applied and any method relied upon, should be reasonable within the context of the purpose of the Valuation and the Basis of Value.

Mineral Resources and Mineral Reserves

When resources or reserves of the subject Mineral Property are used or referred to in a Valuation or Valuation Report, they should use the Mineral Resource and Mineral Reserve definitions of either codes based on CRIRSCO, an associated institute’s definitions, or, in the case of petroleum, the Petroleum Resource and Petroleum Reserve definitions of the *Petroleum Resources Management System (PRMS)*. If the CRIRSCO or PRMS systems are not used, the Valuation Report must explain why not and should provide, to the extent possible, a reconciliation of the resources and reserves with CRIRSCO or PRMS.

Valuation Approaches

More than one Valuation Approach must be applied in the Valuation of the subject Mineral Property, if it is reasonably possible and appropriate to apply them, unless constrained by the Scope of Work agreed to with the Commissioning Entity. The resulting Valuation estimates should be reconciled. If only one Approach is used, the Valuation Report must provide an explanation for why more than one is not used.

The three generally accepted Valuation Approaches are:

- Market Approach
- Income Approach
- Cost Approach

Valuation Report

The Valuation Report must contain, at a minimum, the following information:

a) Mineral Property Identification.
b) Intended use and intended users of the Valuation, and any restrictions on the use or distribution of the Valuation.
c) Purpose of the Valuation.
d) Basis of Value.
e) Report Date and Valuation Date (also called Effective Date), preferably stated together to mitigate confusion.
f) Determination of the highest and best use as of the Valuation Date, where applicable.
g) Scope of Work.
h) Geological Description of the Mineral Property being valued, and details of the status of its exploration, development, or production at the Valuation Date.
i) Assumptions, risks, and limitations.
j) Valuation Approaches and Methods used and the Value estimates derived from each.
k) Reconciliation of the Value estimates derived.
l) Value opinion.
m) Disclosure of Values from any prior Valuations for the same Mineral Property with Valuation Dates within the prior three years, if available to the Valuer, and explanation of Material differences. Valuations with Valuation Dates prior to three years may be included at the Valuer's discretion.
n) Sources of information, including of data, and a statement as to whether or not the information has been accepted as reliable without further verification.
o) Statement of whether or not a site visit to the Mineral Property has been undertaken.
p) Statement that the Valuation complies with the current edition of the relevant national Mineral Property Valuation code or standard, or if applicable, specification of the instructions from which it deviates.
q) Identity, qualifications, and experience of Valuer and any Experts, and the areas of the Valuation Report for which each is responsible.
r) Statement of Independence or non-Independence of the Valuer and any Experts.
s) Declaration of Valuer's Competence, including disclosure of any personal interest or potential interest in the subject Mineral Property, and the on-site inspection date.

Definitions

IMVAL Template gives the following definitions: Appraisal, Basis of Value, Commissioning Entity, Competence, Cost Approach, Effective Date, Evaluation, Expert, Fair Market Value, Fair Value, Income Approach, Independence, Inputs, Investment Value, Market Approach, Market Value, Materiality, Mineral Property, Mineral Resources and Mineral Reserves, Minerals Industry, Objectivity, Petroleum Resources and Petroleum Reserves, Professional Organisation, Public Report, Real Estate, Real Property, Reasonableness, Report Date, Special Assumption, Special Purchaser, Special Value, Synergistic Value, Transparency, Valuation, Valuation Approach, Valuation Date, Valuation Method, Valuation Report, Value, Valuer.

3.3. UN Integrated Environmental and Economic Accounting (UN)

The mineral deposit is an unique object of the work that varies with basic financial, economic and technical parameters and, accordingly, with a range of uncertainties. The act of estimating reserve/resource volumes is of great importance and responsibility – that's because all data on a mineral deposit are simultaneously analyzed in detail and, in consequence, conclusions drawn decide of desirability and economic viability of the mining activity and determine the development of the mining projects and their feasibility.

The values of and changes in the stocks of mineral assets (i.e. changes in mineral resources volumes) are actually in most countries omitted from the national accounts. The current treatment of these resources leads to major anomalies and inaccuracies in the accounts. For example, both exploration and development stages "generate" new mineral assets just as investment creates new produced capital assets. Similarly, the extraction of mineral deposits results in the depletion of mineral assets just as use and time cause depreciation of produced capital assets. The national accounts include the accumulation and depreciation of capital assets, but they do not consider the generation and depletion of mineral ones. The omission is troubling. Mineral resources, like labor, capital, and intermediate goods, are basic inputs in the production of many goods and services. The detection and quantification of mineral resources is not different from the production of consumer goods and capital goods. Therefore, economic accounts that fail to include mineral assets may seriously misrepresent trends in national income and wealth over time. This is particularly evident as production from mineral assets is already included in the nation's gross domestic product (GDP).

Growing awareness of limits set by exhaustibility of natural resources has led to a conclusion that only through their valuation one may assess a comprehensive economic impact of their use. Amongst several others – e.g. forests, fisheries, agricultural lands – mineral resources have been included to almost all studies regarding natural resources assessments.

Valuation of mineral reserves has been a topic of various researches, some of them resulting with adoption of widely recognized valuation methods to their distinctive constrictions, a few resulted with a completely unique prepositions. Subsequently they served as a methodological base for various standardization efforts either in field of mineral assets valuation as separate discipline or as a part of broader attempts regulating valuation of assets in general or accounting principles and practices. The resources valuation of undeveloped deposits remains unsolved.

The first attempt of codifying mineral reserves valuation methodology for the purpose of environment related national accounts came in the 1993 edition of the Handbook of National Accounting: Integrated Environmental and Economic Accounting (UN-EC 1993) which was created following requests made by the 1992 United Nations Conference on Environment and Development (Earth Summit) in Rio de Janeiro. One of the key outcomes of these works was a conclusion that measuring value of mineral resources alongside with physical flows of materials, environment related transactions and measuring impact of the economy on the environment should make pillars of this newly designed system, later named as the System of Integrated Environmental and Economic Accounts (SEEA) (UN-EC 2003). SEEA was meant as a framework to compile statistics linking environmental statistics to economic statistics. This means that the definitions, guidelines and practical approaches of the System of National Accounts (SNA) can be applied to the

SEEA. One of its aims was to show the economic consequences of not only the extraction of mineral resources but also of their depletion. Simultaneously, a so-called London Group was created in 1993 to allow stakeholders to share their experience in developing and implementing environmental accounts linked to the SNA. The London Group is an informal gathering of experts providing them with a forum for review, comparison and discussion of work underway by participants towards development of environmental accounts and become influential stage for methodological discussion on mineral assets valuation. Implementation of SEEA is still in a primary stage and many methodological issues remain unsolved.

The problem of economic evaluation of mineral assets (under SEEA referred to as "subsoil assets") as a part of environment is complex and involves addressing – among others – the below listed challenges:

- The knowledge of deposit is being varied according to the geological assurance of the mode of its occurrence, resource volume, quality, geological and technical accessibility for mining; such knowledge is gained through geological exploration and development and resulted in degree of geological assurance expressed by mineral resource categorization;
- The estimation of geological assurance presents some unsolved problems; it is composed of: confidence to the interpreted geological deposit model (mode and area of occurrence, shape, tectonic features, continuity etc.) and uncertainty of measurable deposit parameters such as thickness, mineral quality, bulk density, etc.; due to natural variation of the value of such parameters their true value distribution and average is known with limited accuracy; such accuracy – if enough data exist – is evaluated by different approaches – most often by geostatistical methods; the confidence of geological model is not exactly measurable; it often depends on knowledge and experience of a geologist presenting it and may be biased by his subjective approach;
- The cost of exploration increases exponentially with assurance gained; it may make deposit value higher due to demonstration of additional resources, but contradictory decrease this value as it itself is a costly activity; the problem presents the reasonable extent of exploration, balancing its cost, deposit value, and risk of imperfect knowledge of demonstrated resources (Nieć 1991, UN-ECE 2003).

Mining industry is the significant segment of the nation's output, though the extraction of subsoil minerals is commonly linked to many serious environmental problems. Moreover, while the value of mineral assets may be a small fraction of the nation's total assets, mineral assets can account for a large proportion of the assets of certain regions of the country.

The explored mineral deposits have known and limited territorial extent and fixed location in space. Mining requires then exclusion of sometimes vast and valuable land plots; it often provokes conflict of varied possible modes of a given territory utilization. Mineral deposits are visualized in land use planning. However, violent opposition against development of deposit is often present. Such opposition is motivated often by economic value of ground over the deposit area, e.g. for long term agricultural utilization, residential, industrial or commercial plant building. Lack of widely recognized methodology for valuation of mineral assets forms a significant obstacle in objective parameterization of uses in consideration and therefore leads to a waste of significant national wealth through leaving idle valuable assets.

In numerous countries, at least some mineral deposits are the property of the State Treasury. Therefore they have to be considered as a part of a common property of Nation. Their exploration and development should be considered as the source of national wealth through generating labor sites, state monetary income and general economic development of the country. As such, known mineral deposits have economic value which should be evaluated.

The prevailing treatment of mineral assets in the national economic accounts has three major limitations. First, there is no entry for additions to the stock of mineral assets under production or asset accounts. This omission is anomalous because businesses expend significant amounts of financial resources on discovering or proving resources for future use. Second, there is no entry for the depletion of the stock of mineral assets under production accounts or asset accounts. When the stock of a valuable resource declines over time through intensive extraction, this trend should be recognized in the economic accounts: if it is becoming increasingly expensive to extract the minerals necessary for profitable output, the nation's sustainable production will be lowered. Third, there is no entry for the contribution of mineral assets to current exploitation in the production accounts. Their contribution is currently recorded as a return to other assets, primarily as a return to capital. The major difficulty for the national accounts has been very limited availability of data on transaction prices of mineral resources. Unlike man made capital goods such as houses or cars, additions to mineral resources and/or reserves are not generally reflected in market transactions, but are determined from internal and often proprietary data on mineral assets. Moreover, there are insufficient data on the transactions of mineral resources, and because these resources are quite heterogeneous, extrapolating from existing transactions to the universe of resources and/or reserves is questionable.

The growing worldwide awareness of inter-linkage between environmental issues and economic development caused that United Nations Environment Program (UNEP) requested in 1982 that methodological guidelines for developing countries on environmental accounting were created to be applied for development planning and policy. A series of five workshops was subsequently held with results summarized seven years later in form of a World Bank publication, where it was clearly stated that accounting had to recognize misleading of so called "free lunch" approach to use of natural resources and *"learn to distinguish between true income generation and drawing down of capital assets by resources depletion or degradation"*. Consequently, United Nations Conference on Environment and Development (Earth Summit) in Rio de Janeiro in 1992 passed the Resolution 1, which in Annex II , par. 40.6 and 40.7 requested preparation of comprehensive indicators reflecting contribution of use of natural resources to GDP formation. As a result of this resolution, based on previous researches, the first edition of the *"Handbook of national accounting: Integrated environmental and economic accounting"* (UN-EC 1993) turned out. As it was indicated above the handbook pioneered the notion of System of integrated Environmental and Economic Accounts (SEEA) which then became a widely recognized expression describing part of national accounts devoted to natural resources. From the very beginning mineral assets, defined under the notion of subsoil assets, were considered within its framework.

The handbook was subsequently supplemented by publication of an operational manual in 2000 as well as by its new editions in 2003 (UN-EC 2003) and 2012 (UN-EC 2014), then with cooperation of the World Bank, IMF, OE CD and European Commission. The last 2014 edition represents certain change of approach. Instead of one comprehensive

handbook it offers fundaments (SEEA Central Framework) to be complemented by specific publications on selected areas. It is also planned that the SEEA Central Framework will be supported by related publications which further elaborate the conceptual framework of the SEEA for specific sectors, including, for example, the SEEA-Water and the SEEA-Energy. These specific publications may also be supported by international recommendations that provide guidance on data items, data sources and methods for developing the basic statistics that can be used, among others, to populate the accounting tables.

Simultaneously, as it was indicated above, the London Group was created in 1993. The name was derived from the place of its first meeting in March 1994. The London Group is an informal gathering of experts, primarily from national statistical agencies but also international organizations. It's meetings provide a forum for review, comparison and discussion of work underway by participants towards development of environmental accounts and become influential stage for methodological discussion on mineral assets valuation.

Another development in the international environmental-economic accounting was the creation of the United Nations Committee of Experts on Environmental-Economic Accounting (UNCEEA) in March 2005 in order to elevate the System of integrated Environmental and Economic Accounting (SEEA 2003) to a globally recognized international statistical standard what could be achieved only via advancements in swift methodological fields. The London Group was requested of the UNCEEA to participate as a key player in research agenda for the revision of the SEEA-2003 as part of its work program.

Natural resources are to be included into the accounts to make it possible to describe stocks and changes in stocks in monetary terms. Therefore issue of the valuation of this natural capital, the physical quantities and qualitative aspects that tend not to have market monetary value, yet, becomes essential. Facing this challenge, in course of work on SEEA several key issues regarding valuation of mineral deposits had been identified and addressed:

- inclusion or exclusion certain items from the scope;
- relation between exploration expenses and value of mineral resources/reserves;
- relation between developed mineral reserves and associated investment in fixed assets;
- recognition of decommissioning extractive structures as well as recovery of land.

Issue of scope has two dimensions. The first one refers to minerals flows recognized in national statistics. Generally countries tend to report flows of hydrocarbons, coal and metallic raw materials, although even in these cases important differences occur. Secondly the discussion relates to geological systematics of mineral assets. Unfortunately, as already indicated above, despite numerous efforts, no universally recognized system regarding classification of mineral deposits has been developed yet.

The special cases of valuation of mineral assets refer to the relationship between exploration costs and valuation of new discoveries "in situ". In commercial accounts these exploration expenditures are usually treated as a form of capital formation and recognized in form of "capitalized expenses". In recognition of the fact that the benefits of exploration efforts are usually substantially delayed, SNA – from 1993 – introduced mineral exploration as a new, separate category of intangible fixed capital. Expenditures in consideration shall include pre-license costs, license and acquisition costs, appraisal costs and the costs of actual test drilling as well as the costs of aerial and other surveys, transportation costs, etc., incurred to make it possible to carry out the tests. Such solution posts a danger of double counting. Should a market exist in parallel for geological information and deposits

themselves, the market price would be possible to get identified easily. Regretfully such situation rarely occurs. Therefore special methods had to be adopted to assure both credible appropriation of value between exploration and deposits *per se.*

Mineral exploration costs question relates to another one that often has to be solved within the framework of national accounts – the ownership issue. In many cases an ultimate title to natural resources belongs to a state regardless specific arrangements enabling various entities to perform activities like exploration, development, extraction. Leaving apart the issue of mineral exploration assets presented above and assuming that a given mineral deposit has entered any further stage of development, SEEA offers two options with the choice depending primary on terms of relevant agreement (UN-EC 2003):

- in case they give to the extractor the right to retain some of the resource rent of the asset, it considers as appropriate to record the value of the mineral deposit as a sum of values belonging to the owner and the extractor according to the proportions each is expected to receive;
- in case the extractor in effect obtains ownership rights by ceasing all important decisions, especially about extraction times and volumes in return for a financial consideration then the owner will disclose a financial claim instead of the deposit while the extractor will recognize the deposit as an asset but also will be obliged to record the financial liability offsetting it.

Valuation of mineral resources is often additionally complicated as a recording of associated investment in produced assets has to occur simultaneously. From a purely theoretical point of view value of fixed assets employed in extracting activities shall be differentiated from the value of deposits themselves. SEEA seems to fully support this preposition focusing instead on practical calculation problems. Admitting extreme difficulties in using market or cost based approaches it gives in depth consideration to recognition of this issue in income based approach (UN-EC 2003).

Giving aims and scope of SEEA an understandably extensive deliberation is given to the problem of decommissioning of mines and well rigs. It recognizes that in case of mining and exploration sites most of environmental protection costs are actually incurred at the end of their useful life. It points out that the major difficulty here is derived from the fact that as oppose to disposals of majority of other assets in the case of mining decommissioning costs are incurred at the end or after the life of the owning enterprise when there is no income against which to set these costs. They must not be neglected though. It is clearly stated that at the end of a produced asset's life, the residual value in the balance sheet should be exactly zero.

Consequently residual items must no longer present any risk of damage in future and land used in extraction should have been reclaimed. The value of the terminal costs represents the cost of improving components of environment to their desired states.

Despite noticeable achievements resulting from works framed by SEEA at present there is no one generally accepted methodology of economic evaluation of undeveloped deposits which may be mined in not determined future. The problem is even more complex in the case of undiscovered but suspected deposits in prospective areas which should also be protected against such land use which may preclude their future development. A helpful tool may be here real options analysis (ROA), that delivers means enabling valuation of delay and flexibility.

In addition to the above presented developments some independent works partially related to valuation of mineral deposits for environmental valuation has been published.

However, none of such research works demonstrated a comprehensive evaluation of available methods with clear recommendations as to principles and methods to be used in linking this area of environmental accounts into the System of National Accounts, taking into account peculiar character of such a methodology, distinct from methodologies applied for other purposes.

Dissemination of SEEA still remains limited. It was admitted in 2003 that very few countries had developed a broad range of accounts, and no country has yet developed the full set of such accounts. Surprisingly, there is also a very limited number of presentations regarding implementation of SEEA in particular countries. However one can indicate Norway, Canada, Australia, the Netherlands and several others as clearly committed to this task (UN-EC 2014).

The explored mineral deposits have known and limited territorial extent and fixed location in space. It provokes conflict of various possible modes of this territory utilization. It is visualized in land use planning and presented in violent opposition against mineral deposits development. Such opposition is motivated often by economic value of ground over the territory of deposit occurrence e.g. for long term agricultural utilization, residential, industrial or commercial plant construction.

At present there is no one accepted general methodology of economic valuation of mineral assets which may be mined in not determined future. The problem is still more composed in the case of undiscovered but suspected deposits in prospective areas which should be protected against such land use which may preclude their exploration and future development.

The analyses performed identified that the challenge of creating such methodology should be decomposed into two tasks:

- creation of an universally accepted geological resources classification,
- development of a set of valuation methodologies strictly linked to such classification.

The special issue is limited confidence to resources estimation and accuracy of data. Moreover, if development of mineral resources is not planned in predictable future, estimation of their value is additionally complicated. The problem of economic evaluation of undeveloped deposits is composed and several questions should be answered. The knowledge of deposit is varied according to the geological assurance of deposit resources, as well as its geological and technical accessibility for mining. The estimation of geological assurance of reported resources volume presents some unsolved problems. It is composed of: confidence to the interpreted geological deposit model (mode and area of occurrence, shape, tectonic features, continuity etc.) and uncertainty (accuracy of estimation i.e. possible error) of measurable deposit parameters such as thickness, mineral quality, bulk density. Due to natural variation of such parameters value, their true distribution and average is known with limited accuracy. Such accuracy is evaluated by different approaches, most often, if exist enough data, by geostatistical methods. The confidence of geological model is not exactly measurable. It often depends of knowledge, experience of geologist presenting it and may be biased by his subjective approach (and sometimes unreasonable fantasy).

At present there is a lack of generally accepted methodology for assessment of geological assurance of resources. The proposed internationally accepted resources classification systems as e.g. JOR C Code, UNFC, define the degree of assurance (and various resources classes respectively) in descriptive mode, without clear comparable criteria. The PRMS classification of hydrocarbon resources divide them into classes according to their probability, however it lacks criteria for estimation of geological assurance.

The above indicated gap posts almost unsolvable challenge to a development of valuation methodologies per se. Since the object of valuation is not universally categorized, efforts to create meaningful valuation rules will always lead either to set only some very general standards or an almost infinite set of particular variations reflecting differences in geological classification.

4. Environmental and social dimensions in existing classification and valorisation schemes and valuation methods of mineral resources

4.1. Mineral resources classification and reporting schemes

Until recently, social and environmental factors have rarely been considered in the classification of natural resources. Their importance has grown considerably in the last decades. Social and environmental issues in mineral projects become to be more and more important, and in some cases they can influence on delay or cancellation, even when they are very attractive from economic point of view. So-called "social licence to operate" (SLO) started to be important and necessary component of each mineral project. Mining project cannot also proceed unless the important environmental contingencies are resolved. The approach to these issues in CRIRSCO-derivate codes differs significantly from the one proposed in UNFC code.

4.1.1. CRIRSCO and CRIRSCO-derivate codes

In CRIRSCO and CRIRSCO-derivate codes environmental issues play an important role, while social dimension are considered, but to a limited extent.

First important area is related to environmental factors which commonly strongly influence on viability of potential mineral project on the basis of studied mineral resources. It is always necessary - as part of the process of determining reasonable prospects for eventual economic extraction - to consider the potential environmental impacts of the mining and processing operation. While at initial stage the determination of potential environmental impacts, particularly for a greenfield project, may not always be well advanced, these potential environmental impacts even at early stage of mineral resources reporting should be reported. So, mineral resources report based on CRIRSCO template should describe any environmental factors that could have any material effect on the likelihood of eventual economic extraction of mineral resources. As a result, environmental factors can have a significant impact on the mineral project feasibility, as e.g. mineral reserves estimates have to acknowledge the likely environmental impact of development and ensure that appropriate allowances are made for environmental impact mitigation and appropriate remediation after extraction. This is also related to assumptions made regarding possible waste and process residue disposal options, which in some cases are even of critical importance. In this area, details of waste rock characterisation and the consideration of potential disposal sites, status of design options considered and, where applicable, the status of approvals for process residue storage and waste dumps, are the most important issues. So, all environmental impacts of projected mining activity should be thoroughly analyzed, also with description of anticipated liabilities.

It is obvious that future mineral project development must comply with country environmental legal requirements and any mandatory standards or even voluntary guidelines related to them. This is why studies of potential environmental impacts of the mining and processing operations (Environmental Impact Assessments) are commonly the necessary component of mining licencing process. As a result, in some cases, environmental issues can completely prevent future mining activity in some areas.

Importance of social component in mining licencing process is still increasing. First of all, it is related to access to land necessary for future mining, as so-called mineral rights are

mostly closely related to land ownership. In numerous cases, during licencing process, also other agreements can be necessary, related to e.g. historical and cultural sites, wilderness or national park and environmental settings, etc. It can be critical to the viability of the project. The whole set of such agreements with key stakeholders leads to Social Licence to Operate (SLO). It is often strongly related to solutions related to land use decisions at local level, depending also on chosen direction of community developement. The right solution of these problems can also strongly influence on viability of potential mineral project, and sometimes even the inability to implement such a project.

In CRIRSCO and CRIRSCO-derivate codes all the above issues should be taken into account during analysis of project feasibility and viability. It is well summarized in Canadian NI 43-101 Instrument, which points out that the following issues should be required in all mineral resources and reserves reports:

- a summary of the results of any environmental studies and a discussion of any known environmental issues that could materially impact the issuer's ability to extract the mineral resources or mineral reserves;
- requirements and plans for waste and tailings disposal, site monitoring, and water management both during operations and post mine closure;
- project permitting requirements, the status of any permit applications, and any known requirements to post performance or reclamation bonds;
- a discussion of mine closure (remediation and reclamation) requirements and costs,
- a discussion of any potential social or community related requirements and plans for the project and the status of any negotiations or agreements with local communities.

However, in some CRIRSCO-derivate codes the additional requirements or guidelines are listed. For example, in South African SAMREC Code it is required to identify any legislated social management programmes that may be required, with discussion of their content and status, as well as to outline and quantify the material socio-economic and cultural impacts that need to be mitigated, their mitigation measures and - where appropriate - the associated costs. In turn, in Russian NAEN Code, the following topics should be analysed in detail: significant sources of environmental impact in production and social infrastructure of the planned enterprise; types and nature of their impact on atmosphere, water bodies, soils, plant and animal life, ecosystems, micro-climate, landscapes, natural protected and recreation zones, historical and cultural sites.

4.1.2. UNFC

UNFC aims to provide necessary specifications and guidelines for optimizing the management and development of resources, with positive impacts on the society, environment, local economies and employment.

Guidelines on socio-environmental considerations in UNFC are still under preparation. The Expert Group on Resource Classification (Expert Group) E-axis Sub-group was established to examine the social and environmental aspects of classification using UNFC-2009. The draft guideline documents under development include:

- Guidance on accommodating social and environmental considerations,
- Clarification of terms related to socio-environmental factors.

Neither social nor environmental factors have been not yet defined in UNFC-2009, nor any of the resource specific guidelines. The following is suggested:

- Environmental, as the physical or biological impact on, or changes to, the pre-existing environment due to a project (e.g. heavy metals contamination),
- Social, as the impact on humans, from a project, such as:
  - Environmental changes (e.g. health issues due to heavy metal contamination); some aspects may be measurable, but many others are qualitative;
  - Changes in social systems and structures (e.g. ownership claims, traditional land usage, land, and other values changes, etc.).

The UNFC-2009 E axis combines two aspects of resource classification that are not directly related, the economics and the socio-environmental aspects of a project. A project may meet all the feasibility requirements of the F and G axes and the economic component of the E axis, but unless it is also socially and environmentally acceptable, it often cannot proceed. Suggested UNFC revisions, related to socio-environmental aspects of a project, include e.g.:

- New sub-categories E2.1 and E2.2 to differentiate the level of project activity devoted towards the resolution of socio-environmental contingencies situations and the probability that they will be resolved in the foreseeable future,
- Classification of projects that are unable to proceed until the resolution of social or environmental issues, but for which there is no attempt to resolve them or expectation of their resolution in the foreseeable future, in category E3.3.

4.1.3. Selected national resources classifications

From among analysed national resources classifications, in the Russian classification of resources, only the level of exploration performed is important (analysis of geological attributes), while the environmental and social conditions (values) are not considered.

In Polish Resources Classification, during determining of each categories, environmental and social factors are not taken into account. However, the geological documentation prepared for each documented deposit, must include chapter described: location of deposit, direction of land development, state of environment and its protection. The documentation does not describe social conditions.

4.2. Mineral resources valorisation approaches

Methods of valorisation of mineral deposits and mineral potential areas are aimed at separating these mineral objects, which should be subject to safeguarding in the first place to secure the state's mineral raw materials needs in a near and far distant future. So far there are no uniform rules in this regard within the European Union, though recently MINATURA2020 project proposed 6 steps Harmonised Mapping Framework for delineation of mineral safeguarding areas. In some European countries there were proposed (e.g. Poland, Portugal) or even introduced (e.g. Austria, Sweden) more detailed valorization approaches to distinguish mineral deposits which should be safeguarded in the first place. However, this is not always combined with a proper assessment of the competition of individual possible land use directions for a given area.

4.2.1. Austrian Minerals Resources Plan

Mineral areas worthy of safeguarding as defined by the Austrian Mineral Resources Plan are mineral areas, which have no or minimal conflicts with other land use plans. Especially important with regard to social and environmental issues was Phase 2, where identification of conflict free "mineral zones" (without conflict with other properties protected by law e.g. residential areas, national parks, water management priority zones, landscape protection areas, forests, Natura 2000 areas) was performed, with collaboration of the federal states to eliminate any protection conflicts caused by the mineral zones which had been objectively identified using systematic analysis methods.

In the Austrian Mineral Resources Plan, such analysis was focused mostly on construction and industrial minerals, with assumption of designation of “conflict-free” zones (also from environmental point of view and with regard to general “social licence to operate” in the area). So, in such cases priority of the majority of land uses other than mining was given, while in the distinguished “conflict-free” zones with mineral accumulations - areas that should be protected in the long term in terms of ensuring the supply of construction and industrial minerals, were indicated.

4.2.2. Swedish mineral deposits of national interest

In Sweden, the Environmental Code and the Planning and Building Act form the legal basis of physical planning in Sweden and constitute the major legal framework for the definition and regulation of mineral deposits of national interest. The Swedish Environmental Code states that areas containing deposits of valuable substances or materials that are of national interest shall be protected against measures that may be prejudicial to their extraction. Within such areas, municipalities and central government agencies may not plan for or authorise activities that might prevent or be prejudicial to the exploitation of mineral resources. Institution responsible for identification of the deposits of national interests is Swedish Geological Survey (SGU). These can be deposits of ores, industrial minerals, aggregates or natural stones. They are identified and appointed after consultation with the National Board of Housing, Building and Planning and the county administrative board. One of criteria used for identification of mineral deposits of public interest is the assessment if the substance or material is relevant to the needs of society. Within this, the impact on employment and economic growth should be given great significance, since it is important that a long term expansion of production, investment and employment is safeguarded. The implications for regional balance and the distribution of living standards in the country must be considered in the assessments.

Swedish approach is different from Austrian one. It is not limited in principle to “conflict-free” zones. In some cases, priority of mining land use is assigned, if there is recognized that mineral from such deposit is of great significance for society needs, and it is agreed with the county administrative board.

4.2.3. Polish mineral deposits valorisation approach

In proposal of Mineral Deposits Protection Act, the basis for such protection should be complex valorisation and hierarchy of the whole set of recognized, but undeveloped mineral deposits, broken down into deposits of various minerals. Proposed – on such assumption -

valorisation system of industrial mineral and rock deposits in Poland is based on 4 main groups of criteria:

- geological features (mineral quantity and quality) – identified separately for each mineral type;
- mining attractiveness – taking into account mining conditions and mineral transportation issues;
- environmental limitations – due to environmental protection areas, landscape protection areas, protection of aquifers, protection of forests and high quality soils;
- housing and industrial land use limitations – mostly due to current land development (permanent buildings, linear structures).

This valorisation does not include social conditions.

According to this methodology, for deposits assigned for the highest protection, absolute priority of mining land use is proposed to be the rule. Each other land use should take into account requirements related to future possible extraction of the deposit, especially regarding other temporary land uses (e.g. conditional temporary building or industrial or infrastructure land use, but with exact time framework of such investment),

Until now, further steps to introduce valorisation mechanisms, as well as further steps of mineral deposits safeguarding, have not yet been introduced in Poland.

4.2.4. Portuguese mineral deposits valorisation approach

The Portuguese proposal of mineral deposits valorisation recognizes four dimensions of valorisation:

- *LGK* - level of geological knowledge (geological dimension)
- *Ec* – economic dimension
- *Ev* – environmental dimension
- *SDA* – social dimension

For environmental dimension Ev seven complementary criteria are proposed, which should be grounded by independent studies already accomplished in each specific area where active operation exists or is being planned (e.g. *Environmental Impact Assessments)*: 1. Compatibility of mining/quarrying operations in a specific area with other natural values; 2. Impact of past exploitation activities in a specific area; 3. Impact of mining/quarrying in a specific area in comparison with other (existent and projected) land uses or economic activities; 4. Impact or the foreseen disturbances in natural flows caused by mining/quarrying activities in a specific area, e.g. to soil damage/removing, acid drainage, changes in fluvial charges (dissolved and in suspension components), dust and gas emissions, etc.; 5. On-going or proposed mitigation and rehabilitation measures related to mining/quarrying operations in a specific area; 6. Type of land use for mining and processing in a specific area; 7. Amount of mining wastes/residues produced by an active operation within a specific area.

For social dimension SDA five complementary criteria were proposed: 1. Public acceptance in relation to mining/quarrying operations in a specific area; 2. Compatibility of mining/quarrying operations in a specific area with other land uses by the community; 3. Impact in the population settlement and growth caused by mining/quarrying operations in a specific area; 4. Impact in direct/indirect jobs creation a welfare rise produced by mining/quarrying operations in a specific area; 5. Wealth improvement associated with the mining/quarrying activity in a specific area with other complementary economic sectors.

The Portuguese approach is the most detailed regarding environmental and – especially – social dimension of mineral deposits valorisation, from among analysed above. It is a good step to include various aspects of these dimensions in the process of identification of mineral deposits worth safeguarding. However, social dimension issues proposed there – as they are very detailed - are possible to be assessed not earlier than at mineral deposit development stage. Portuguese approach is not yet implemented, but such implementation is likely in the near future.

4.2.5. MINATURA2020 proposal

In MINATURA2020 project, finalised in the beginning of 2018, simple Harmonised Mapping Framework (HMF) was proposed as one of final results. It allows the identification of mineral deposits of public importance (MDoPIs) and the delineation of mineral safeguarding areas (MSAs) in each jurisdiction, subsequently (not in parallel) following six steps:

1. Analysis of mineral policy, mineral demand forecasts and economic context;
2. Identification and classification of potential MDOPIs;
3. Analysis of competing land uses;
4. Proposing and delineating MSAs for each MDoPI;
5. Validation of MDoPIs and MSAs and communication to the MDoPI network management body;
6. Inclusion of MSAs in local spatial planning documents.

One of the proposed steps is analysis of alternative land uses (current and future). It should be done (or a pre-existing analysis should be used) of the current (other land uses) to access to land hosting mineral deposits or mineral potential areas (either as primary or secondary mineral deposits). The analysis of other land uses allows identifying which MDOPIs will likely be conflict-free and which others might face constraints from other land uses, requiring the finding of compromises or trade-offs. It was recommended (as optional) conducting an analysis of future potential changes in the land uses. It refines the level of potential conflict that may arise against a potentially designated MDOPI. A level playing field for the other land uses should be considered, as well as different options/mechanisms to reconcile alternative interests.

Discussions of the HMF point to the result that such six steps will be offered only as a guidance to EU Member States, but it will not be requested to be implemented. The steps that will be requested to EU Member States will be only steps 2 and 4, i.e. identifying MDoPIs according to basic common criteria and the implementation of safeguarding procedures.

It is noteworthy that MINATURA2020 project offers a broad approach that can be implemented in various ways in different countries. It should also be stressed that it proposes (optionally) analysis of alternative land uses, as well as future potential changes in the land uses, with introduction of mechanisms of reconciliation of alternative interests.

4.3. Mineral resources valuation approaches

Two basic approaches to mineral resources valuations are known. The most important is VALMIN Code approach (and related and very close to VALMIN other Valuation Codes, e.g. CIMVAL, SAMVAL, POLVAL, IMVAL). Another, totally different approach is

presented at early stage in proposal of UN Integrated Environmental and Economic Accounting, where mineral resources (and also their value) are regarded as integral component of environment.

4.3.1. VALMIN Code and codes related to VALMIN

In reports made according to VALMIN Code or any other mineral valuation code related to VALMIN, and also according to International Mineral Property Valuation Standards Template (IMVAL Template), any existing or proposed operating, environmental and social practices must be reviewed to establish the technical, economic, environmental and social feasibility of the operation. Matters to be reviewed should include – among others – the following environmental issues: tailings and waste disposal, energy and water sources, closure and post-closure activities and schedules, as well as environmental and legal constraints and commitments. Moreover, the following social issues should be considered: labour sources and requirements, and any social constraints and commitments. Within project costs, the following are related to environmental issues: costs of power, water and other services, costs of environmental protection and monitoring, and costs of land reclamation. There can be also costs related to social issues, especially costs of social and community programs.

Within the valuation process, there must be assessed and taken into account various risks, including any environmental and social risks, which can only be mitigated to some extent by project operators.

4.3.2. UN Integrated Environmental and Economic Accounting

The growing worldwide awareness of inter-linkage between environmental issues and economic development caused that United Nations Environment Program (UNEP) requested in 1982 that methodological guidelines for developing countries on environmental accounting were created to be applied for development planning and policy. United Nations Conference on Environment and Development (Earth Summit) in Rio de Janeiro in 1992 passed the Resolution which requested preparation of comprehensive indicators reflecting contribution of use of natural resources to GDP formation. As a result, the first edition of the *"Handbook of national accounting: Integrated environmental and economic accounting"* was proposed. This handbook pioneered the notion of System of integrated Environmental and Economic Accounts (SEEA) which then became a widely recognized expression describing part of national accounts devoted to natural resources. From the very beginning mineral assets, defined under the notion of subsoil assets, were considered within its framework.

Further development in the international environmental-economic accounting was the creation of the United Nations Committee of Experts on Environmental-Economic Accounting (UNCEEA) in March 2005 in order to elevate the System of integrated Environmental and Economic Accounting to a globally recognized international statistical standard what could be achieved only via advancements in swift methodological fields. Natural resources are to be included into the accounts to make it possible to describe stocks and changes in stocks in monetary terms. Therefore issue of the valuation of this natural capital, the physical quantities and qualitative aspects that tend not to have market monetary value, yet, becomes essential.

Despite noticeable achievements resulting from works framed by SEEA at present there is no one generally accepted methodology of economic evaluation of undeveloped deposits which may be mined in not determined future, within the System of integrated Environmental and Economic Accounting. The problem is even more complex in the case of undiscovered but suspected deposits in prospective areas which should also be protected against such land use which may preclude their future development. Moreover, some independent works partially related to valuation of mineral deposits for environmental valuation has been published. However, none of such research works demonstrated a comprehensive evaluation of available methods with clear recommendations as to principles and methods to be used in linking this area of environmental accounts into the System of National Accounts, taking into account peculiar character of such a methodology, distinct from methodologies applied for other purposes.

5. Conclusions

From among various approaches of mineral resources reporting, CRIRSCO - International Reporting Template is and – due to its popularity, also in mineral companies and financial institutions – will probably remain the most important scheme of such reporting both worldwide, as well as in Europe. Its derivatives were introduced step by step in various countries in all continents. CRIRSCO is also (or should be) used within EU, through the PERC Code. However, many countries still apply their own mineral resources reporting schemes, though for business purposes various derivatives of CRIRSCO Template (mostly JORC Code or PERC Code) are used. CRIRSCO Template takes into account mostly technical issues and economic issues. Some basic environmental issues are there regarded as important, while social issues are in practice not taken into account at all or regarded to a limited extent. On the contrary, UNFC - United Nations Framework Classification is very universal approach to mineral resources reporting. Complementary approach not only to technical and economic issues, but also to environmental and social issues is proposed there. However, this scheme is used worldwide only to a very limited extent, though – if it would be introduced – due to its wide, mulitidimensional approach it could be a good tool for proper equilibrium between technical-economic aspects and environmental-social aspects of possible mineral deposits development through their proper safeguarding.

Schemes of mineral resources valorisation for their further safeguarding are not very common worldwide, and in EU too. The most advanced implementations are known in Austria and Sweden, while some trials and proposals, without final implementation – e.g. in Poland and Portugal. It should be underlined that all discussed proposed schemes of mineral resources valorisation take into account numerous technical, economic, environmental and land use aspects of possible mineral deposits development, while social factor is regarded in some cases, to a limited extent.

However, recently MINATURA2020 project proposed a 6 steps Harmonised Mapping Framework for delineation of mineral safeguarding areas, where one of the proposed steps is the analysis of alternative land uses (current and future), taking into account economic, environmental and social factors.

Regarding schemes of mineral resources valuations, two basic approaches are known. The most important – also in EU - is VALMIN Code approach (other Valuation Codes, e.g. CIMVAL, SAMVAL, POLVAL, IMVAL, are very close to VALMIN approach). However, it is mostly business approach, where other aspects of mineral deposits development except of economic ones (e.g. technical, environmental, social) are taken into account only to such extent as it is absolutely necessary, with dominance of economic issues. Totally different approach is presented in proposal of UN Integrated Environmental and Economic Accounting. Mineral resources are regarded there as integral component of environment, also their value. This seems to be very wide and universal approach, which should be steered not by business processes only, but from the point of view of interests of the whole society. However, this proposal is still in very initial phase and its implementation in short-term perspective is unfortunately unlikely, though it should be strongly recommended as an important part of mineral policy of each country.

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