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Development, maintenance and application of the United Nations Framework Classification for Resources: Minerals

Draft proposal on developing specifications and guidelines for classification and subsequent management of mineral inventories

Prepared by the Minerals Working Group of the Expert Group on Resource Classification

Summary

This draft document outlines a high-level proposal to initiate the development of United Nations Framework Classification for Resources (UNFC) specifications and guidelines for mineral resource management. The objective is to promote the use of UNFC as a classification system for the sustainable management of all mineral resources. The mineral specifications and guidelines proposed to be developed are intended to support the attainment of the UN Sustainable Development Goals (SDGs) as relevant to the mineral industry. Through the application of these specifications and guidelines, the collective industry could be directed towards the shared global goals. The ideas included in this document will be developed after taking into consideration the comments received from the Technical Advisory Group of the Expert Group on Resource Classification and suggestions arising out of the ninth session of the Expert Group.

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I. Introduction

1. The United Nations Framework Classification for Resources (UNFC) is a comprehensive system for the classification and management of all natural and anthropogenic resources[1]. Classification is an essential requirement of management and reporting of mineral inventory. Through its classification system and related specifications for specific commodities (e.g. petroleum and solid minerals) the UNFC can be used as the basis for development of management systems and reporting standards that generate information inconsistent formats and with common definitions for international energy and raw material studies and governmental (national and regional) resource management, that is both consistent with and supports company internal resource management, requirements and company public disclosure rules. As the mineral industry embraces new business models such as "raw materials as a service" it will discover clusters of value across the whole network.

2. Leveraging social acceptance of a development project through alignment to the UN Sustainable Development Goals (SDGs) and targeting improved outcomes have become paramount concerns in the minerals sector. Ensuring sufficient, reliable, affordable and environmentally responsible supplies of energy and raw materials for sustainable development is a crucial challenge. In the future, all mining operations will be expected to demonstrate how they are meeting the SDGs. Accordingly, UNFC should ensure that its classification and associated definitions and specifications take into account SDGs to provide appropriate support to users of the UNFC in their development of management and reporting systems and standards.

3. Having a robust set of UNFC specifications and guidelines is essential for stakeholders, including governments, Non-Governmental Organizations and companies managing large portfolios of projects, to deliver the specific functions of the SDGs. Stakeholders using robust principles, specifications and guidelines will consequently have better visibility in the competitive financial landscape.

4. Currently, several public disclosure codes are available in various jurisdictions, notably the Committee for Mineral Reserves International Reporting Standards (CRIRSCO) family of codes and standards (e.g. Joint Ore Reserves Committee (JORC), Pan European Reserves and Resources Reporting Committee (PERC), South African Code for the Reporting of Exploration Results, Mineral Resources and Mineral Reserves (SAMREC)/ South African Code for the Reporting of Mineral Asset Valuation (SAMVAL), Russian Code for Public Reporting of Exploration Results, Reserves and Resources of Solid Minerals (NAEN) etc.). These codes and standards are based on the "CRIRSCO Template", which sets out reporting standards for public disclosure reporting of solid minerals to all major international stock exchanges. The CRIRSCO Template was bridged to UNFC classes in 2013 for reporting of solid mineral Exploration Results, Mineral Resources and Mineral Reserves. In the future, mineral-bearing brines will be incorporated into the CRIRSCO Template. However, the CRIRSCO Template does not provide guidance and standards for national or regional endowment inventory, which fall outside the CRIRSCO definitions. At present, there is no consistent approach or standard relating to the national or regional management of mineral inventory (including obtaining production and reserve/resource data from landowners and mineral operators).

[1] UNFC uses numerical codes to define quantities. The terms "resources" and "inventory" are used in a generic manner in this document and do not correspond to the specific definitions used in any other code or system and must be defined later.

5. Accordingly, the Minerals Working Group should focus on recommending approaches to classification and management of such "upstream" inventory, based on UNFC, such that deposits can be consistently classified and common vocabulary and underpinning principles are applied throughout. The long-term target should be to provide guidance that will facilitate planning of data collection and analysis, offerings of exploration rights, and development of policies and regulations for licensing and permitting in such a manner as to promote mineral opportunities to industry and allow ready conversion from one class to another. This will be especially important to support the transition of deposits classified by governments as having economic potential to classes that are based on confirmation of that potential - usually by industry rather than governments (i.e. those classes related to prospects of economic recovery that are covered by the CRIRSCO Template).

6. A particular issue at the national and regional level will be the development of management systems and reporting standards that support the realization of the SDGs. This is also of importance to the industry in bringing forward sustainable development proposals for mineral recovery, even where this may not be well covered in national legislation (i.e. through proper attention to the "Modifying Factors" in the CRIRSCO system). Accordingly, a collaboration between UNFC and CRIRSCO through the Minerals Working Group will also support the growing interest in potential certification systems relating to the SDGs, and the Working Group should aim to collaborate closely with those groups and bodies responsible for developing such certification systems in future.

7. Hence, the Minerals Working Group, to support the realization of SDGs, proposes to develop a set of documents that will provide:

(a) UNFC specifications that promote the consistent and coherent classification of all mineral resources including mineral brines and deposits suitable for In-Situ Recovery (ISR) techniques;

(b) Additional guidance for specific cases, as needed for the above purpose;

(c) Guidance to generate public reports from comprehensive future UNFC data;

(d) Guidance for social and environmental considerations specifically applicable to mineral resources, either distinctly or as an extension of the high-level guidance developed by and in close collaboration with the Social and Environmental Task Force;

(e) Development of guidance on mineral life-cycles, definitions and certification of mineral recovery chains within an established standard.

8. The above set of specifications and guidelines are expected to provide a comprehensive basis of enhancements to the UNFC that will support the development of an SDG-oriented mineral resource management system under UNFC at all stages in mineral deposit life-cycle.

II. Relevance to Sustainable Development Goals

9. UNFC's mineral management functions should be carried out under the overarching framework of SDGs as shown in Figure 1.

Figure 1
UNFC Mineral Management Framework.

10. UNFC's advantage resides in the fact that it is closely aligned with the Sustainable Development Goals (SDGs). For a future revision and adaption of SDGs into UNFC, some of the goals and specific targets relevant to mineral classification and related management systems include [1]:

SDG1 – No Poverty: *Optimizing the management of national endowments of minerals, with positive implications for local economies, employment, royalties, and tax revenues. Mineral inventory management is relevant to the following specific targets:*

1.4 - By 2030, ensure that all men and women, in particular, the poor and the vulnerable, have equal rights to economic resources, as well as access to essential services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology, and financial services, including microfinance.

1.6 - Ensure significant mobilization of resources from a variety of sources, including through enhanced development cooperation, to provide adequate and predictable means for developing countries, in particular, least developed countries, to implement programs and policies to end poverty in all its dimensions.

1.7 - Create sound policy frameworks at the national, regional and international levels, based on pro-poor and gender-sensitive development strategies, to support accelerated investment in poverty eradication actions.

SDG2 – Zero Hunger: *The management of macro and micro soil nutrients, such as potassium and phosphorous sources, are important for food production, which can be implemented effectively with good resource management practices. The applicable targets are:*

2.4 - By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.

SDG5 – Gender Equality: *Providing women equal access to decent work, and representation in political and economic decision-making processes in the mining industry, especially:*

5.7 - Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws.

SDG6 – Clean Water and Sanitation: *Interconnected tools with other systems to manage impacts on water systems and monitor progress during resource production, in particular:*

6.3 - By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and substantially increasing recycling and safe reuse globally.

SDG7 – Affordable and Clean Energy: *Effective management of national resource endowments and socio-economically efficient development of the energy resources contributing to sustainable development, especially:*

7.1 - By 2030, ensure universal access to affordable, reliable and modern energy services.

SDG8 – Decent Work and Economic Growth: *Promote inclusive and sustainable economic growth, employment and decent work for all in mineral industries:*

8.2 - Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high value-added and labor-intensive sectors

8.3 - Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services.

8.4 - Improve progressively, through 2030, global resource efficiency in consumption and production and endeavor to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programs on sustainable consumption and production, with developed countries taking the lead.

8.8 - Protect labor rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment.

SDG9 – Industry Innovation and Infrastructure: *Contribute to manage resources efficiently during production by promoting cleaner and environmentally sustainable technologies and industrial processes:*

9.4 - By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.

9.5 - Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending.

SDG10 – Reduced inequalities: *Include factors that promote the continued social viability of a project including gender equality and fruitful employment of disadvantaged sections of the local population:*

10.4 - Adopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality.

SDG11 – Sustainable cities and communities: *Effective tools are required for local governments to optimize the management of local and sub-regional endowments of mineral resources:*

11.8 - Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning.

11.9 - By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels.

SDG12 – Responsible Consumption and Production: *Sustainable management of mineral resources for addressing the issues related to environmental impact and mitigation are necessary:*

12.1 - Implement the 10-year framework of programs on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries.

12.2 - By 2030, achieve the sustainable management and efficient use of natural resources.

12.4 - By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.

12.5 - By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.

12.6 - Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle.

SDG13 – Climate Action: *Reducing the carbon footprint of mineral production as well as supplying materials required for clean energy production:*

13.1 - Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries

SDG17 – Partnerships for the Goals: *Management of mineral resources should be effective in the context of the regional and international cooperation:*

17.6 - Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism.

11. The UNFC, mineral management system, will provide specifications and guidelines that will allow the mineral industry to align with the goals and targets mentioned above. Through the application of these specifications and guidelines, the collective industry could be directed towards the shared global goals.

III. Functions in resource management

12. Proposed specifications and guidelines for the UNFC mineral classification system (Figure 2) will include clarifications of the functional areas for application:

(a) International energy and raw material studies

(b) Government (national) mineral inventory management

(c) Internal corporate mineral inventory management

(d) Company financial reporting, where it is not covered by CRIRSCO.

13. Government (National Resource Management) and company business-process management have differing aims and requirements. Specific guidance may be required for each of the functions. In conjunction with the four functional requirements above, the UNFC mineral management system document will clarify the distinct areas of:

(a) Resource classification (UNFC Framework)

(b) Resource management

(c) Socio-economic and commercial assessment

(d) Innovation planning and management

(e) Definition of life-cycle and certification of recovery chains.

IV. Clarification of definitions, terminology and concepts

14. In the current setting of the four functional roles where UNFC application would occur, there exists considerable confusion due to different definitions, terminology, and concepts. This document will endeavour to develop common language that is universally applicable for all functional roles. Together with the alignment of SDGs, the harmonized terminology and concepts will provide a consistent vocabulary for mineral resources management. Otherwise, reserved wording such as ‘inferred’, ‘indicated’, ‘measured’, ‘proven’ and other already allotted expressions will be explicitly avoided to prevent confusion that is caused by variations in terminology used by different systems. Some of the key UNFC definitions are also below.

Mining Project - A defined mining operation, which provides the basis for economic evaluation and decision-making. A project comprises a defined activity or set of activities, which provide the basis for estimating both costs and potential revenues associated with its implementation.

E1F1 Commercial Projects – Current or future recovery by commercially viable mining operations. Commercial Projects have been confirmed to be technically, economically and socially feasible. **In production** is used where the project is producing, and supplying one or more mineral products to market, at the Effective Date of the evaluation. **Approved for Development** requires that all approvals/permits/contracts are in place, and capital funds have been committed. **Justified for development** requires that the project has been demonstrated to be technically feasible and commercially viable, and there must be a reasonable

expectation that all necessary approvals/contracts for the project to proceed to development will be forthcoming.

E2F2 Potentially Commercial Projects - Potential future recovery by mining operations, where development is pending or on-hold. **Development pending** is limited to those projects that are actively subject to project-specific technical activities, such as the acquisition of additional data (e.g. appraisal drilling) or the completion of feasibility studies and associated economic analyses designed to confirm the commerciality including the determination of optimum development scenarios or mine plans. Also, the status may include projects that have non-technical contingencies, provided these contingencies are currently being actively pursued by the developers and are expected to be resolved positively within a reasonable time frame. **Development on-hold** is used where a project is considered to have at least a reasonable chance of achieving commerciality (i.e. there are reasonable prospects for eventual economic recovery), but where there are currently major non-technical contingencies (e.g. environmental or social issues) that need to be resolved before the project can move towards development.

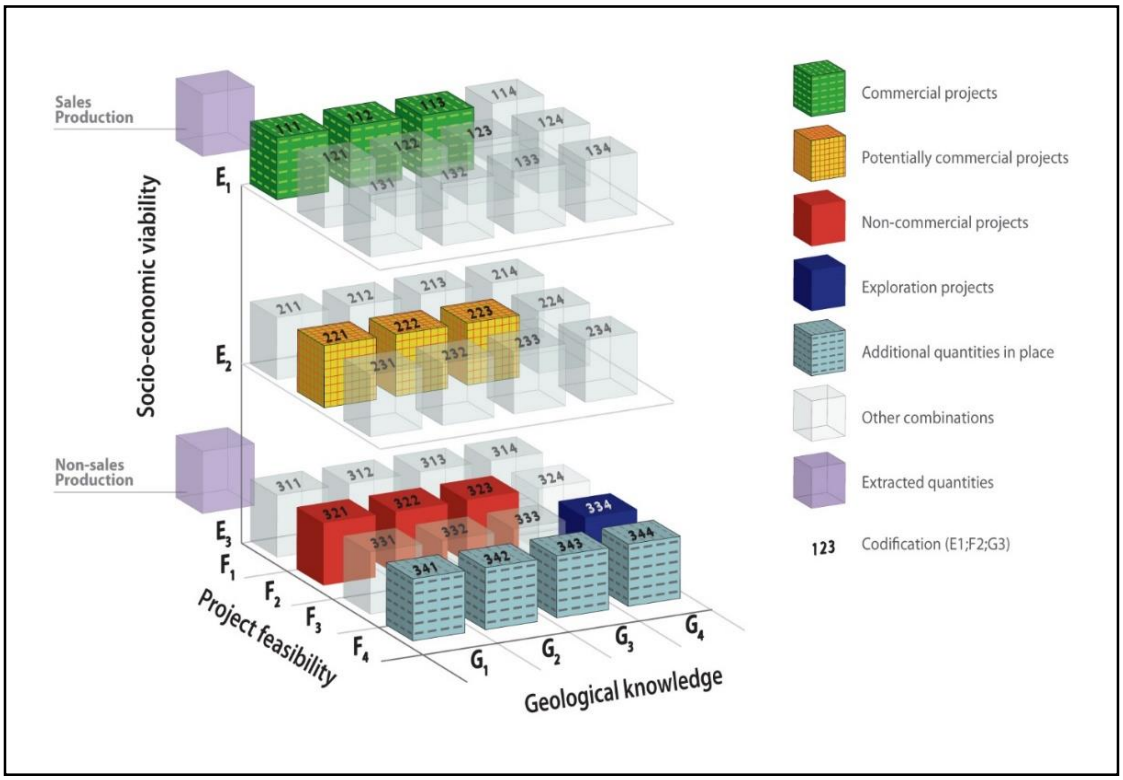
E3F3 Non-Commercial Projects - Potential future recovery by mining operations, but where development is uncertain or development is currently assessed as not viable. **Development unclarified** is appropriate for projects that are in the early stages of technical and commercial evaluation (e.g. a recent new discovery), and/or where significant further data acquisition is required, in order to make a meaningful assessment of the potential for a commercial development (i.e. there is currently insufficient basis for concluding that there are reasonable prospects for eventual economic recovery). **Development not viable** is used where a technically feasible project can be identified, but it has been assessed as having the insufficient potential to warrant any further data acquisition activities or any direct efforts to remove commercial impairments.

G4 Exploration Projects - Potential future recovery by successful exploration activities. An Exploration Project is associated with one or more major occurrences, i.e., a deposit that has not yet been demonstrated to exist by direct evidence (e.g. drilling and/or sampling), but has been assessed primarily on indirect evidence (e.g. surface or airborne geophysical measurements).

F4 Additional quantities in place - Additional quantities in place associated with a known deposit that will not be recovered by any currently defined mining operation. Quantities should only be classified as additional quantities in place where no technically feasible projects have been identified that could lead to the recovery of any of these quantities.

15. Commonly used industry terms such as “extraction”, “exploitation”, “commodities” and other terms often have negative connotations in many other contexts. Their usage has created confusion in the minds of the public and other stakeholders who may not be familiar with mining terminology. As UNFC aims for global communication, the objective should be to use common and well-understood alternatives.

Figure 2
The UNFC Framework



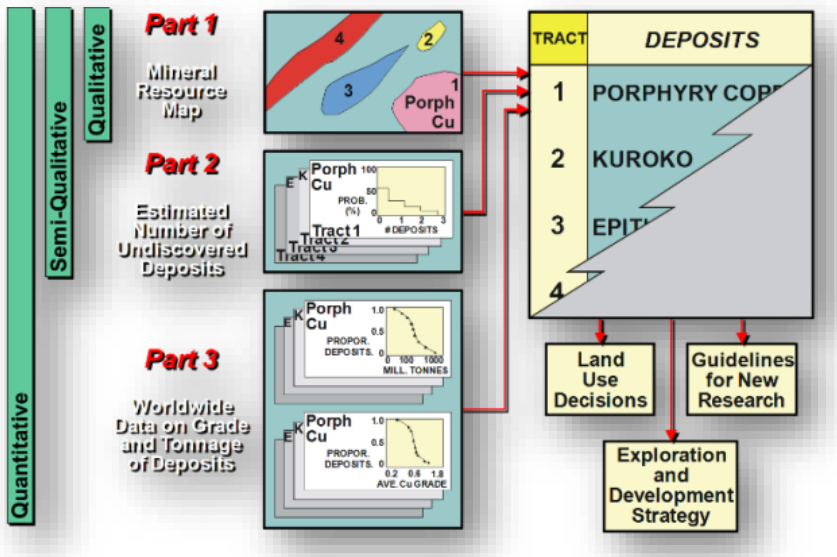
V. Assessment of Exploration Projects (Undiscovered mineral potential)

16. UNFC's Exploration Project Class corresponds to undiscovered mineral potential. The terms "deposit", "resource", and "undiscovered" have specialized and specific meanings when applied to mineral assessment and estimation studies [2, 3 and references therein]. A "deposit" is defined as a mineral (or brine) accumulation or concentration of sufficient quantity, quality and form that, under the most favourable of circumstances, is considered to have the potential for economic development, including deposits under development, actively producing, and past-producers. A "resource" is defined as an already explored mineral accumulation or concentration of sufficient quantity, quality, and form, and in such setting that economic recovery of a mineral from the accumulation or concentration is currently or foreseeably feasible [4]. An "undiscovered mineral potential" is defined as an occurrence or showing postulated to exist by indirect geologic evidence, for which the quantity, quality or form are not known, or some combination thereof is only partially or incompletely known.

17. Assessment of undiscovered mineral potential may be qualitative, specifying the general geographic area and may include some degree of mineral potential and certainty, or quantitative, which includes probabilistic estimates of the number of undiscovered deposits and their contained undiscovered resources. [5,6,7].

Figure 3

Three-part form of mineral resource assessment. It is an intuitive, flexible, and open-framework approach to mineral resources assessment, which can be qualitative, semi-quantitative, or quantitative. Modified from Singer (1993).



18. The three-part form of assessment (Figure 3) works in both data-rich (brownfields) and data-poor (greenfields) settings. It provides internally consistent estimates of undiscovered minerals inventory represented as permissive tract maps and probability frequency distributions of an in-place mineral for a given permissive tract. The resulting probability estimates of undiscovered mineral potential can be evaluated using economic filters and other tools for environmental, land use, and policy analysis [8].

19. Further specifications and guidelines are required to integrate undiscovered mineral quantities and deposit assessments into UNFC.

VI. Defining the factors that control resource progression

20. Controlling Factors (CF) are all social, economic, environmental, technological and geological factors that should be considered when changing a mineral resource project from one class to another. In the early stages of the project, many of the CFs will be vague or unclarified. With the availability of more data, the CFs will acquire more clarity.

21. The Minerals Working Group should control the application and the adjustment of the following CFs and of the geological (technical) factors represented in the G Axis. At a higher level, UNFC can only provide generic principles and specifications, and it is the responsibility of the Working Group to frame UNFC for application to minerals.

22. CFs that should be considered are:

- Policy
- Social
- Economic
- Regulatory

- Treatment of exploration data
- Mining Methods (including solution and brine mining)
- Sorting
- Processing
- Refining
- Metallurgical aspects
- Comprehensive recovery
- Value-addition
- Environment
- Anthropogenic resources /secondary management
- Safety
- Infrastructure
- Marketing
- The legal and contractual framework
- Fiscal design and administration
- Revenue management and distribution
- Site closure
- Remediation
- External cost factors (esp. water treatment)
- Human resources
- Sustainable Development Implementation.

23. These UNFC controlling factors must be resolved to convert:

(a) G4 projects to E3 projects;

(b) E3 projects to E2 projects;

(c) E2F2 projects to E1F1projects.

24. Efforts to advance Controlling Factors (CF) are commonly used to develop mineral potential and raise resources from lower classes (E3, E2) to higher ones, ultimately leading to production (E1). Such a set of defined and scaled factors will allow the harmonization and standardization of the mining business process through its entire value chain. The factors will also include innovation aspects based on Technology Readiness Level (TRL 1-9) as specified by the European Commission. In spite of the critical importance of the CFs related to technology, economics, environmental and social aspects, the measurements of these factors are presently vague and unscaled. The application of the conversion factors may lead to the conversion from “Potentially Commercial Projects” to bankable “Commercial Projects” and is among the most important steps for defining the economics of a mineral resource and obtaining funding.

25. However, many aspects of the CFs are currently unscaled and lack a structured and transparent classification such that any UNFC Evaluator with proven competence could apply these factors to any mineral resource worldwide. A classification of controlling

factors should result in clear, transparent and comparable E1F1 estimates so that they can be applied to any mineral resource anywhere in the world.

26. A meaningful, transparent and measurable classification of controlling factors requires a method to add and determine scaling for each controlling factor. Currently E2F2 to E1F1 conversion is applied by estimating the cost for mining, processing, metallurgical processing and refining, infrastructure, economic considerations, marketing, legal, environmental social and governmental factors, and subtracting the sum of these costs from the mineral resource value as defined by G2 and G1 resources.

27. Alternatively, the CFs could be individually measured. For instance, the Mining Factors could be measured as the cost of the individual technology readiness level applied to mining projects (TRL 1-9). An advanced mining project with TRL 7-9 could be classified (e.g. as F1); such a project would apply industry-tested and confirmed mining, processing and metallurgical refining technologies. The Metallurgical Factors could be scaled according to the environmental sustainability of the metallurgical flowsheet (e.g. if the acids used for processing are being recycled).

VII. Mining Methods

28. There are numerous conventional and unconventional mining methods, which could be utilized to recover mineral resources. Each has its pros and cons depending on situation-specific characteristics like deposit type, ore morphology, mineralization style, mineralization depth, rock mechanics, safety, geopolitical factors, infrastructure, economics etc.

29. The following mining methods are considered as conventional mining technologies:

(a) Surface Mining (Open Pit Mining, Quarrying)

(b) Subsurface Mining (Room & Pillar, Longwall, Slope Mining and others)

(c) Placer Mining (Trenching)

30. Unconventional mining technologies:

(a) In-situ Recovery (ISR) or In-situ Leaching (ISL)

(b) Solution Mining

(c) Brine Mining

(d) Borehole Mining

(e) Seafloor Mining

(f) Tailings Re-mining

(g) Space Mining

31. Quantity/volume estimates vary significantly depending on the deployed mining method. The most significant differences in quantity estimates become evident when comparing conventional open pit to underground production methods. Underground mining is more commonly applied to high-grade, low tonnage deposits whereas open pit mining provides an economically feasible approach for rather a homogenous low- to medium-grade high tonnage deposits with limitations based on the depths and strip ratio. Key parameters defining the quantity estimates for both methods vary significantly since the overburden or strip ratio is crucial for an open pit operation making it amenable only to shallow deposits while underground operations do not consider any overburden thickness and instead require a precise understanding of the ore morphology and have much higher unit costs.

32. Some deposit types like low-grade uranium (also copper or rare-earth elements) resources considered to be uneconomic using conventional mining methods may be economically viable if suitable for ISR. The quantity estimate incorporates additional physical and chemical parameters that are not relevant to open pit and underground mining. These include permeability and hydrologic confinement of the mineralized horizon, the solubility of the uranium minerals by weak alkaline or acidic solutions, and ability to return groundwater within the mined area to its original baseline quality.

33. It is common practice in quantity estimates for ISR projects to use a grade x thickness (GT) contour method. A minimum GT cut-off, used in much the same way that a grade cut-off is established for conventional mining operations, should be reported.

34. Mineral resources for ISR production methods should be reported regarding quantity, quality and anticipated recovery. This can be achieved by reporting, in addition to the contained uranium and anticipated recovery, either: i) deposit area, average thickness and average GT; or ii) tonnage, average grade and average GT. Recovery may be reported either as the quantity of recoverable uranium or a percentage of the estimated contained uranium.

VIII. Definition of Mineral Life Cycles

35. Definition of mineral life cycles from recovery to recycling is important to the classification and sustainable management of mineral inventories. Activities in the recovery and recycling of mineral tailings should in future be implemented into one project because the future demand of mineral resources greatly depends on the recycling and substitution capabilities of primary mineral resources and end-of-life products. This work will be done in close cooperation with the Anthropgenic Resources Working Group.

36. To align the activities of both mineral recovery and recycling, specifications and guidelines will need to be developed to define mineral life cycles with specific life times, e.g. Rare Earth Element products, water footprint, and NORM (Naturally Occurring Radioactive Materials) disposal footprints. This effort will interlink and reference the UNFC Anthropogenic Resources Specifications.

IX. Certification of Mineral Resource Recovery Chains

37. A potential solution for certification of mineral recovery chains is presented by the Certification of raw materials (CERA), a raw materials sustainability certification system, currently under development by a multinational consortium of experts in mining and certification and funded by EIT Raw Materials [9]. The CERA certification system aims to develop holistic certification standards and labels that cover the entirety of raw materials and their respective value chains from exploration to the use phase and through to recycling. Exploration and classification of resources are focal points of the certification scheme development, as the consortium has deemed it essential to provide a more sustainable supply of raw materials for future generations via inclusion of sustainability criteria into the process of resource assessment and conceptual planning of recovery. The CERA standard ensures that the sustainability aspects are objectively and comprehensibly taken into account as modifying factors for the valuation of resources.

38. The standards that will cover classification of resources are set to include all of the aforementioned Controlling Factors, such as legal compliance or environmental and social sustainability. Thus, the CERA certification system provides a scalable and measurable controlling factor classification system for resources, as certification will label resources

with a CERA readiness level, acknowledging the potential for sustainable mining practices and enabling funders to make informed decisions.

39. The aim of the tracking raw materials might imply the certification is to ensure that the assessment already implicitly includes sufficient sustainable use of the deposit and subsequent recovery in the public disclosure. This lays the foundation for future recovery under appropriate sustainability criteria.

X. Social and environmental consideration in mineral resource development

40. The Expert Group on Resource Classification's Social and Environmental Considerations Task Force has developed guidelines for resource development. These guidelines apply to all resources, but additional guidelines will be required for mining projects, especially for unconventional projects.

XI. Preparation and predicting the future of mining

41. Mineral management will not be complete without an insight into the future of the industry. An analysis of the next generation of mineral recovery methods and evolution of the processing chain for classification and sustainable management is therefore required. The factors that will be studied include:

(a) Innovation in the mineral sector (exploration, mining, processing, remediation, mine closure) and understanding of how sustaining, transformational and experiential innovations are going to change discovery of resources in the future;

(b) The mineral potential that will be mined in the future (materials that will be required for the future);

(c) How we foresee mineral industry transformation, especially through the networked development and identifying clusters of value;

(d) Success stories focused on building and nurturing a catalytic environment conducive to innovation in mineral management.

XII. Valuation

42. The assessment of the sustainability of the recovery process (readiness assessment) is based on a staging system with the following three levels (tiers): Basic – Advanced – Excellent. The introduction of tiers for the readiness assessment allows stakeholders (e.g. investors, regulators, the general public) to distinguish between and compare projects regarding potential sustainability performance. Basic means adequate approaches to sustainability and traceability. The "advanced" tier is the transition type between "basic" and "excellence". "Excellence" means comprehensive, fully-covering approaches to sustainability and traceability.

XIII. Sustainability Reporting

43. Sustainability reporting such as Global Reporting Initiative (GRI) reporting, Sustainable Mining Management Standards published by Spanish Standardization Institute (AENOR), Finnish sustainability standards for mining, Canadian Initiative Towards

Sustainable Mining have become very common today. Another example is the CERA certification of resources that was referred above.

44. There is a range on how to optimize especially open-pit mining operations [10]. An optimisation based on the net present value (NPV) optimizes the revenue but frequently sterilizes significant parts of the deposit due to technical reasons. A certain lever factor that is meaningful for the position within this range might provide a valuable tool to rank the sustainability of a specific primary minerals recovery.

XIV. Public (Financial) reporting

45. Public and industrial reporting of mineral resources is a major subject for the industrial standards and should follow the guidelines mandated by the institution to which reporting is done. When a CRIRSCO code is required, the Bridging Document between the CRIRSCO Template and UNFC can be used. Therefore, updating the bridging documents in the minerals sector must be a major task for the Minerals Working Group in cooperation with CRIRSCO.

46. Irrespective of the requirements of financial reporting, the UNFC guidelines could be used as a basis for robust classification, and several aspects of the guidance could be used to produce disclosure reports.

47. Financial reporting should always include the detailed assumptions that were adopted for so-called external costs after mining is finalized (i.e., remediation costs for site rehabilitation, water table management, dump water treatment, ground water protection). History shows that initial decisions, especially regarding mining dump management (surface, in-pit, underground), frequently are mere functions of time and technological progress.

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