



Massive Open Online Course (MOOC)

LECTURE 4 - CLASSIFICATION OF MINERAL RESOURCES

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CIRAN Introduction

- Even though extraction of critical raw materials from mining is a comparatively small part of the EU economy it is important for mining countries and consumption of raw materials is a huge part of the economy. As an example, in Sweden mining represents 1% to 3% of gross domestic product, about 8% of all exports and between 13% to 20% of annual investments. There is e.g., a similar importance in Finland, Poland, Portugal and Spain.
- Investments though are depending upon the economic risk for a project. Therefore, an evaluation of an exploration or mining investment has to consider both intrinsic technical and economic factors, as well as more general short- and long-term benefits versus costs in comparison with other potential land uses.
- Within this lecture we will view two sets of instruments used for evaluating mining projects namely the **CRISCO reporting standard** and the **UNFC classification of natural resources**. CRIRSCO is the instrument that is standard for industry and investors.

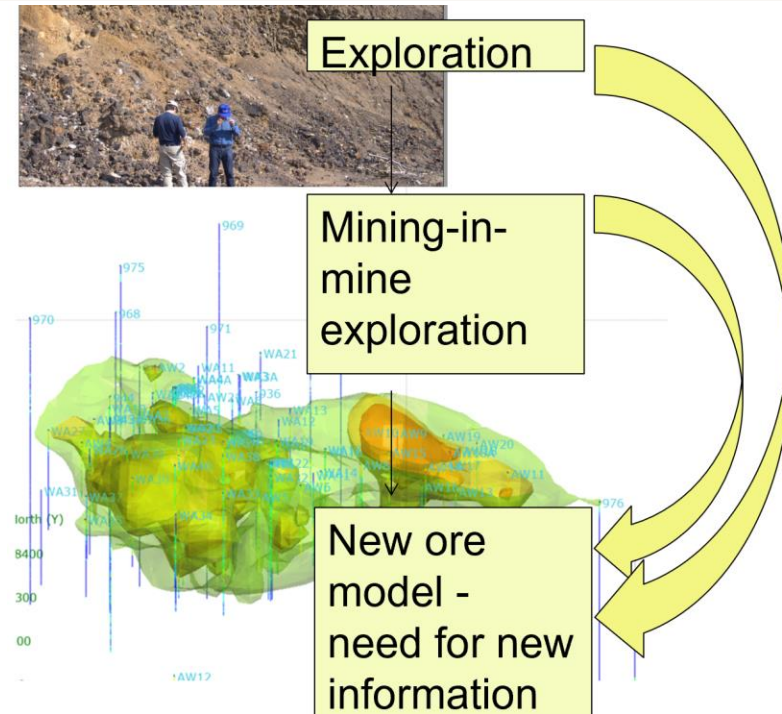


Figure: Resource estimation is an iterative process from observation, drilling to model and new observations. Photo Ronald Arvidsson, figure Bakker and Arvidsson.

CIRAN Introduction

- These internationally recognized standards have been agreed between numerous countries and coordinated through an international committee on reporting standards for mineral reserves or CRIRSCO, in order to provide recommendations and guidelines of effective and well-tested best practices, stringent corporate governance and regulation in the mining and mineral exploration sectors.
- The second part of an economic evaluation, which deals with the short- and long-term costs and benefits, although based on the preceding technical and economic evaluation, takes into account and compares other potential land uses. This part of the evaluation is typically done by the national permitting authority and ultimately includes political and societal considerations.

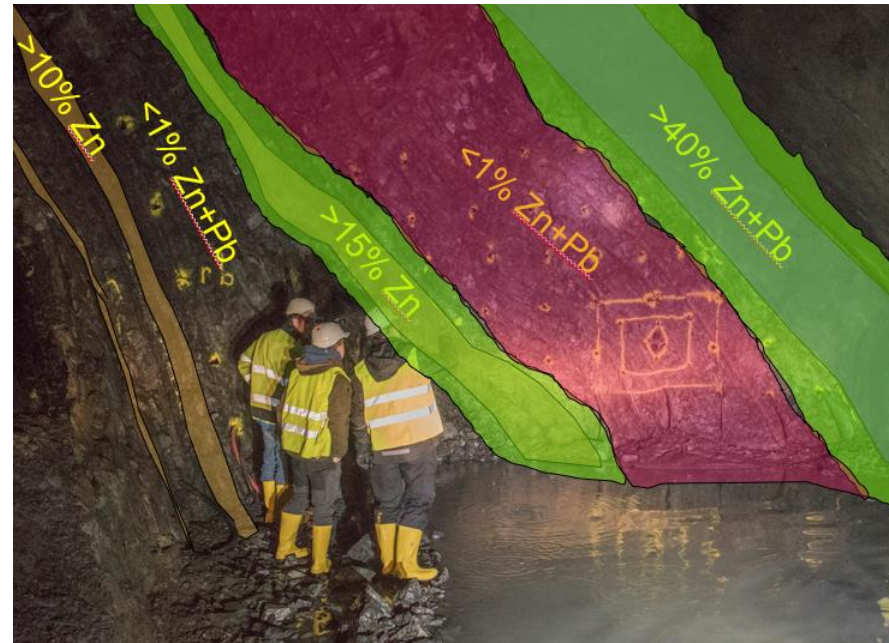
The need for a reliable reporting instrument surfaced due to the BRE-X scandal where a fraud gold deposit in Indonesia was valued many time higher than its value. Investors were fooled and hence a reporting instrument to support investors. Among other things it is driven by transparency of any results that may affect investments.

CIRAN CRISCO simplified concepts

In order to have accountability of a project to meet the investors need of weighting the economic risk of an exploration and mining project international standards have been developed – the CRISCO template.

A set of local codes have been developed and the most used for Europe is the PERC code

In Europe, North America, Australia and large parts of the world these codes or instruments are used. They ensure high standard of transparency and accountability of a mining project. The codes used in Europe account for all aspects in mining including robust resource estimates and environmental standards. They exist to support investors in evaluating a mining project.



In the assessment is also included detailed studies within the mine to determine not only amount (tonnage) but also grade and amount of surrounding rock that needs to be excavated. Picture: Stefan Sädbom.

CRIRSCO members as of April 2024



Figure: Sides, E. and Allington, R (2024): Mineral Reporting Standards: PERC's Role in CRIRSCO and its Relevance to the European Mining Sector; Earth Science, Systems and Society – Open Access article.

CIRAN Competent or qualified person

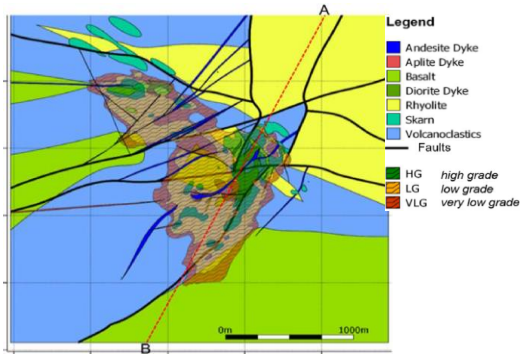


Figure: Aspects of an evaluation of a geological resource, field work and mapping.

Photo: SGU, figure: Joslin et al. (2024): Boliden Summary Report, Resources and Reserves 2024 – Laver project, with permission.

- Competent person (CP) is necessary in evaluating the geological mineral resource in terms of average grade, tonnage and reliability. A CP needs to be:
 - A professional in the minerals industry that has a minimum of five years of relevant experience recognized by a professional organization in the style of mineral deposit being evaluated and in his specific field of expertise.
- Relevant experience:
 - The knowledge and the ability to carry out the tasks and duties needed to evaluate a specific style of type of mineral deposit.
- Mineralization:
 - An anomalous concentration of a mineral in a well delimited area due to geological processes.
- Ore deposit:
 - An anomalous concentration of a mineral due to geological processes that could be potentially extracted economically.

CIRAN Competent or qualified person



Geological mapping data



PERC

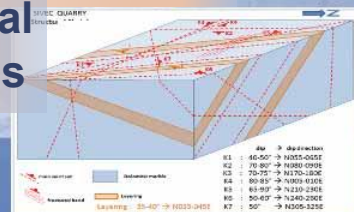


Mining data

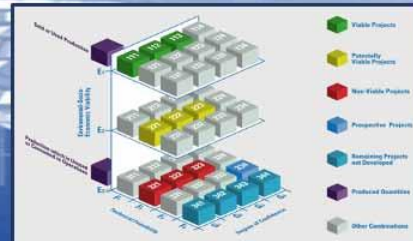
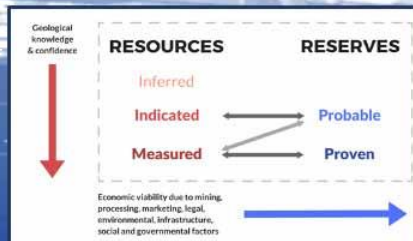


The Role of the "Competent Person" in the Mining Sector Involves Multiple Tasks and Competences Necessary for for the Economic Evaluation of a Mineral Resource Following Industry Standards

Slide taken from a Presentation of the Italian National Council of Geologists and ALPI Consultants



Geological modelling



UNFC



Figure: Elements of an economic evaluation of a mineral resource, a visual summary.
Picture: Così, M. (2021): "Mineral Standard Reporting" e il Ruolo del "Competent Person" nel Settore Minerario; ALPI Consult Stones, CNG - Consiglio Nazionale dei Geologi Italiani, and European Federation of Geologists, with permission.

Exploration target and exploration results

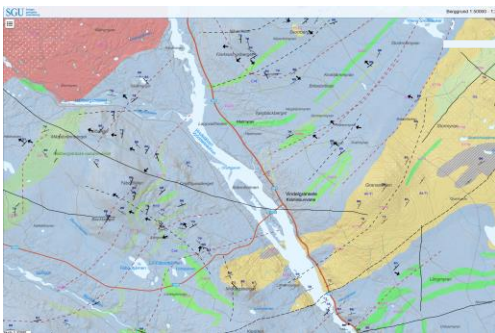
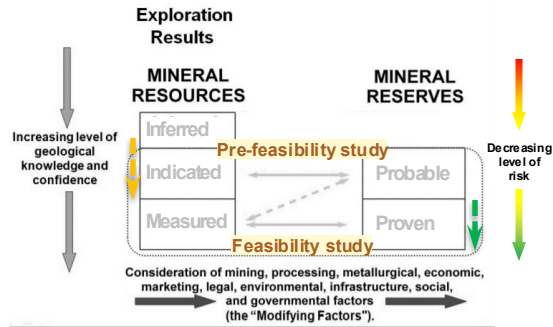


Figure: Elements involved in the definition and evaluation of an exploration target.

Photo: SGU, map figure: SGU Kartvisaren on-line map viewer Berggrund 1:50000 - 1:250000.

- Exploration target:
 - Is an informative estimate of the quantity, content and/or quality of a mineralized area and therefore its exploration potential but for which there has been insufficient work to estimate mineral resources.
- Exploration results:
 - Are the data and information generated by a mineral exploration program that might be useful to investors but can't be considered a formal declaration of mineral resources or reserves.

CIRAN Factors determining risk



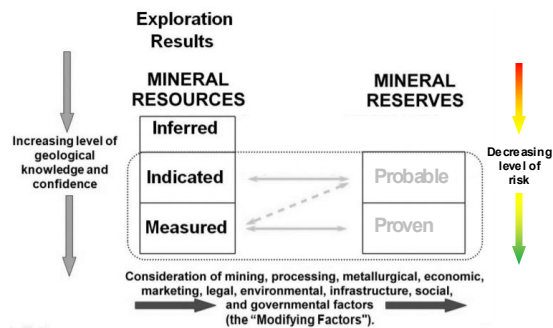
- **Modifying factors:**
 - Are the technical, economical, legal and socio-political considerations used to convert mineral resources to reserves.
- **Pre-feasibility study:**
 - Is a lower confidence level study of the range of options for the technical and economic viability of a mineral project.
- **Feasibility study:**
 - Is a higher confidence level detailed study of the selected technical development options and financial analysis needed to demonstrate that a mineral project is economically viable at the time of reporting.

CIRAN Mineral resource what is that

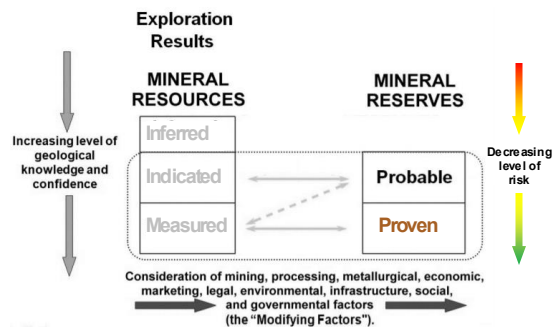
Mineral resource estimation is the determination through sampling at surface and drill holes and use of geochemistry and geophysical modeling to determine the amount and grade to a specific degree of reliability

The mineral resource classes are:

- **Inferred resource:** that part of a mineral resource with which one can imply but not verify its geological continuity, grade or quality due to limited evidence and sampling.
- **Indicated resource:** that part of a mineral resource with adequately detailed and reliable exploration, sampling and testing that is sufficient to assume geological and grade or quality continuity.
- **Measured resource:** that part of a mineral resource with detailed and reliable exploration, sampling and testing sufficient to confirm geological and grade or quality continuity.



Mineral resources, mineral reserves and their levels of risk



- Economic value:
 - **Mineral resource:** mineral in or on the ground that can be eventually extracted economically (when technology allows, demand is high, and price is right).
 - **Mineral reserve:** part of the mineral in or on the ground likely or very likely to be extracted economically under current conditions and available technology, even considering some amount of waste material and some losses, and for which an appraisal has been undertaken.
- Economic risk:
 - **Probable reserves:** a mineral resource with a moderate to high probability of economic recovery and therefore moderate risk.
 - **Proven reserves:** a mineral resource with a high to very high probability of economic recovery, and therefore of low risk.

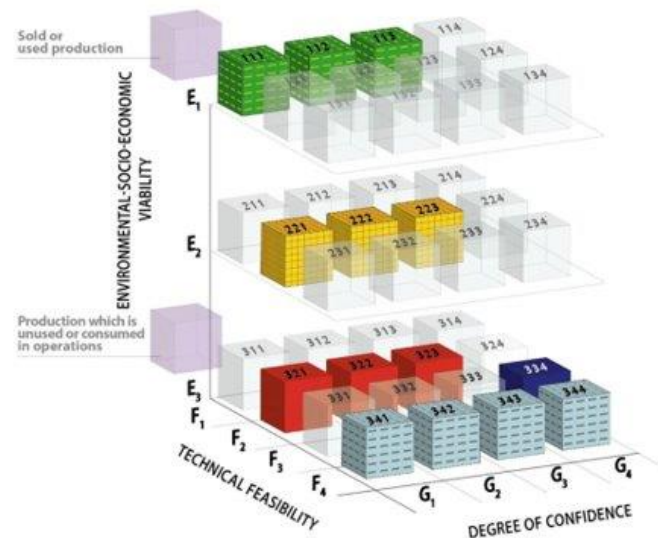
CIRAN Why invest? Mineral deposit quality

- Unified evaluation standards and guidelines of exploration/mining ventures help reassure investors, institutions and society that economic evaluations are clear, reliable and transparent. Due to the complex interplay between natural, technical, economic and social factors, and the intensity of capital outlays, exploration and mining are fairly high economic risk.
- Mineral deposits must meet high standards of quality. Quality is defined as:
 - relative simplicity and predictability of the natural factors,
 - efficiency and reliability of the technical solutions for extraction,
 - Profitability, and favorable economic and social environment.
- Efficiency and reliability of technical solutions must include environmental criteria to reduce potential costs and liabilities.
- Inclusion of land use and social criteria further affect economic and social environment favorably.

CIRAN UNFC

What is UNFC

- Global system for reporting and classify natural resources
- It consists of three axes – lowest number means highest value on the axis
 - G-axis describes the knowledge of the resource. In the case of minerals where from 4 to 1 describes rising levels of confidence
 - F-axis – level of technical maturity best 1 worst 4.
 - E-axis - environmental –socio-economic viability
- It is currently mandatory for reporting in the CRM Act and necessary when applying for a strategic project under the CRM Act

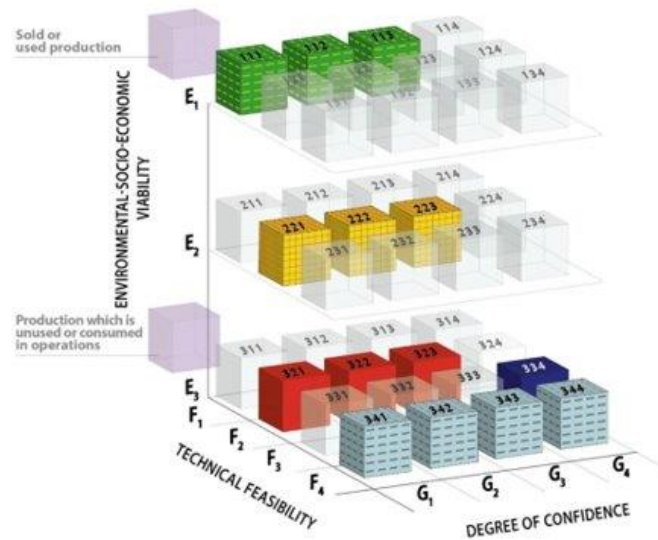


CIRAN UNFC Minerals

UNFC for mining projects

Controlling factors – value and state of controlling factors determine the classification

- Exploration only: When the classification is in the blue box E3,F3,G4 it means the project is in exploration phase only
- Scoping study: When the project has reached scoping study the value of the project raises to E2, F2, G1,2,3 and is the first yellow box.
- Pre-feasibility then E2,F2,G1,2,3
- If economically viable then the project end up in the green boxes. Ready to begin production and all permits on hand E1, F1, G1



CIRAN Further information

CRIRSCO

[Document Library – CrirSCO](#)

[PERC | PAN-EUROPEAN RESERVES & RESOURCES REPORTING COMMITTEE](#)

UNFC

<https://unece.org/sites/default/files/2022-01/UNFC%20Mineral%20Specifications%202021.pdf>

https://www.unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/publ/UNFC_ES61_Update_2019.pdf

https://unece.org/sites/default/files/2024-04/CRIRSCO_Template_UNFC_BD_ECE_ENERGY_GE.3_2024_5_ENG.pdf

[UNFC Documents | UNECE](#)

CIRAN Glossary

Mineral resource an estimate of the amount and grade of a commodity in a mineral deposit

Mineral reserve an estimate of the amount and grade in a mineral deposit that (potential) can be extracted for profit

CRIRSCO – an overbridging template for estimating mineral resources to support investors decisions

PERC – a CRISCO code applied for Europe – Pan-European Reporting Code

UNFC is a global reporting and classification system for natural resources. In use when applying for a strategic project under the CRM Act

CIRAN Quiz

Describe the difference between mineral resource and mineral reserve using one of the expressions below and then motivate: tonnage and grade, economic viability, commodity?

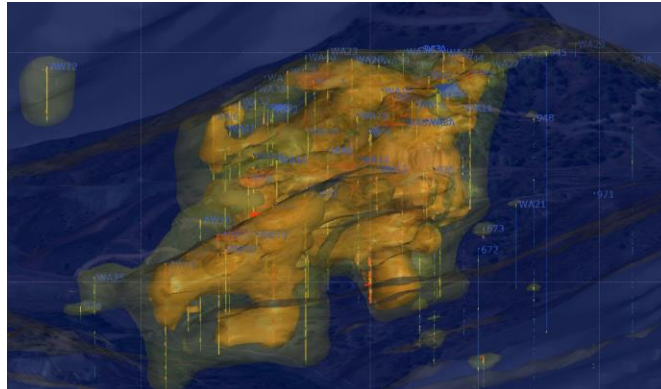
What is PERC?

What defines the UNFC G-axis for a mineral resource?

What defines F-axis when a mineral resource is classified under UNFC?

The levels 1-4 is used for UNFC. What is the highest value number in UNFC?

Thank you





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