



EESTI
GEOLOOGIAATEENISTUS

Terms and guidelines for geological exploration

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Conference „Best practice guidelines for mineral exploration and mining perspectives in Estonia”

Tallinn, 16 May 2019

MINERAL EXPLORATION STAGES

CONCEPTUAL /
SCOPING
PEA

PRE-
FEASIBILITY

FEASIBILITY



magnetite quartzite
(Fe, Cu, Ni)



metalliferous black shale
(V, U)



shelly phosphorite
(P for fertilizers, REEs)

MINERAL EXPLORATION STAGES

Criteria

Technical & Economic Studies

 Study	Preliminary Economic Assessment (PEA)	Prefeasibility Study (PFS)	Feasibility Study (FS)
 Concept	“What it could be”	“What it should be”	“What it will be”
 Objective	<u>Early stage conceptual assessment</u> of the <i>potential economic viability</i> of mineral resources	<u>Realistic economic and engineering studies</u> sufficient to <i>demonstrate economic viability</i> and <u>establish mineral reserves</u>	<u>Detailed study of how the mine will be built</u> , used as the basis for a <i>production decision</i>
 Cost Accuracy	+/- 50%	+/- 25%	+/- 15%
 Engineering	<1%	1–5%	5–25%
 Mineral Estimate Inputs	Inferred/Indicated/Measured Resources Oletatavad/Hinnatavad/Määratletud ressursid	Hinnatavad ja Määratletud ressursid Indicated & measured resources	
 Mineral Estimate Outputs	Inferred/Indicated/Measured Resources Määratletud ressursid	Probable & Proven Reserves Tõenäolised ja Tõestatud vaud	

Adapted from a March 2015 PDAC presentation by the Ontario Securities Commission and the TSX.

<http://www.mining.com/web/much-will-cost>

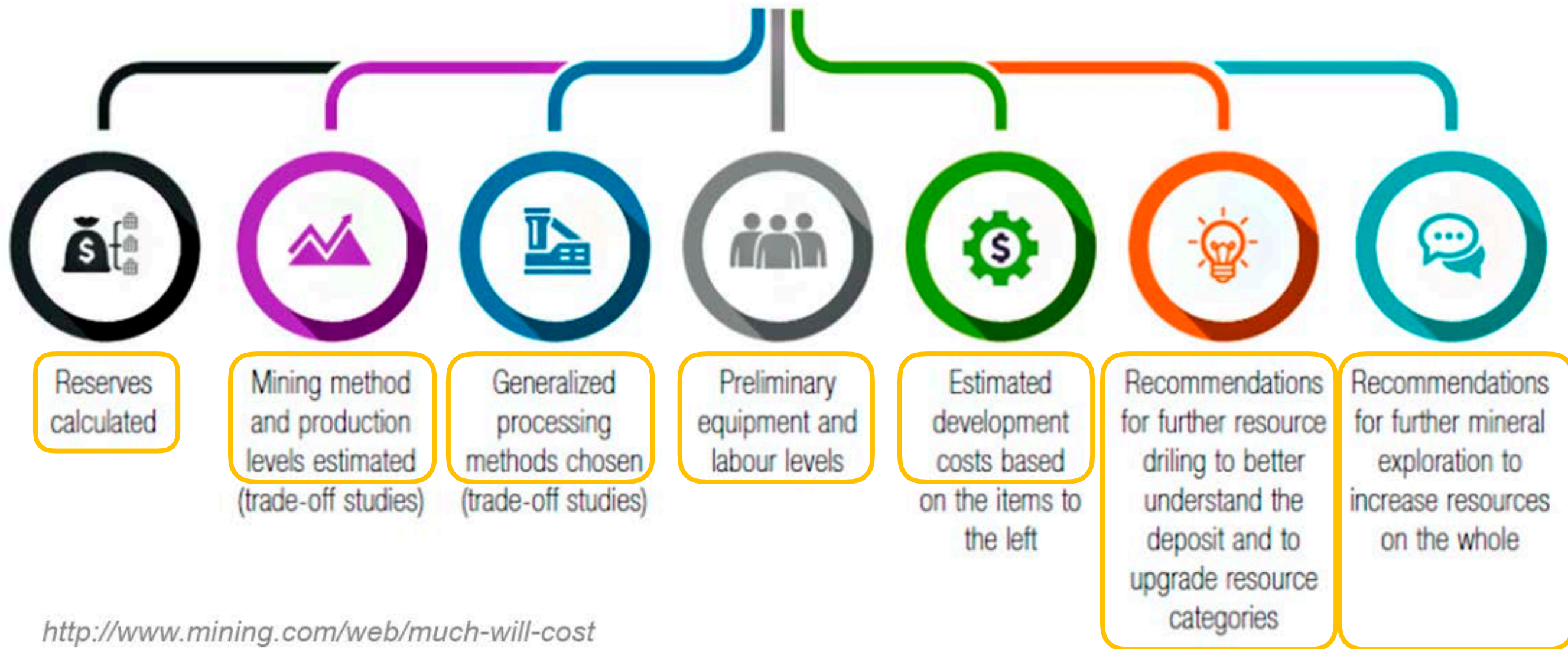
Purpose:

- to determine if the project has the potential to become a viable project
- to present a broad range of project development options
- to assess project issues and concerns
- to identify areas of further studies

Involves:

- **Preliminary ground exploration** – to identify smaller scale exploration targets (geochemical sampling, geophysics, development of further exploration plans)
- **Initial drilling programmes** – to confirm the mineralisation extent using widely spaced points and to obtain data on the target mineralisation quality and grade

PRE-FEASIBILITY STUDY OUTPUTS



- assessing reserves and saleable product
- envisioning mine design
- assessing mining and processing methods
- determining capital and operating costs
- evaluating marketability of the commodity

includes infill drilling

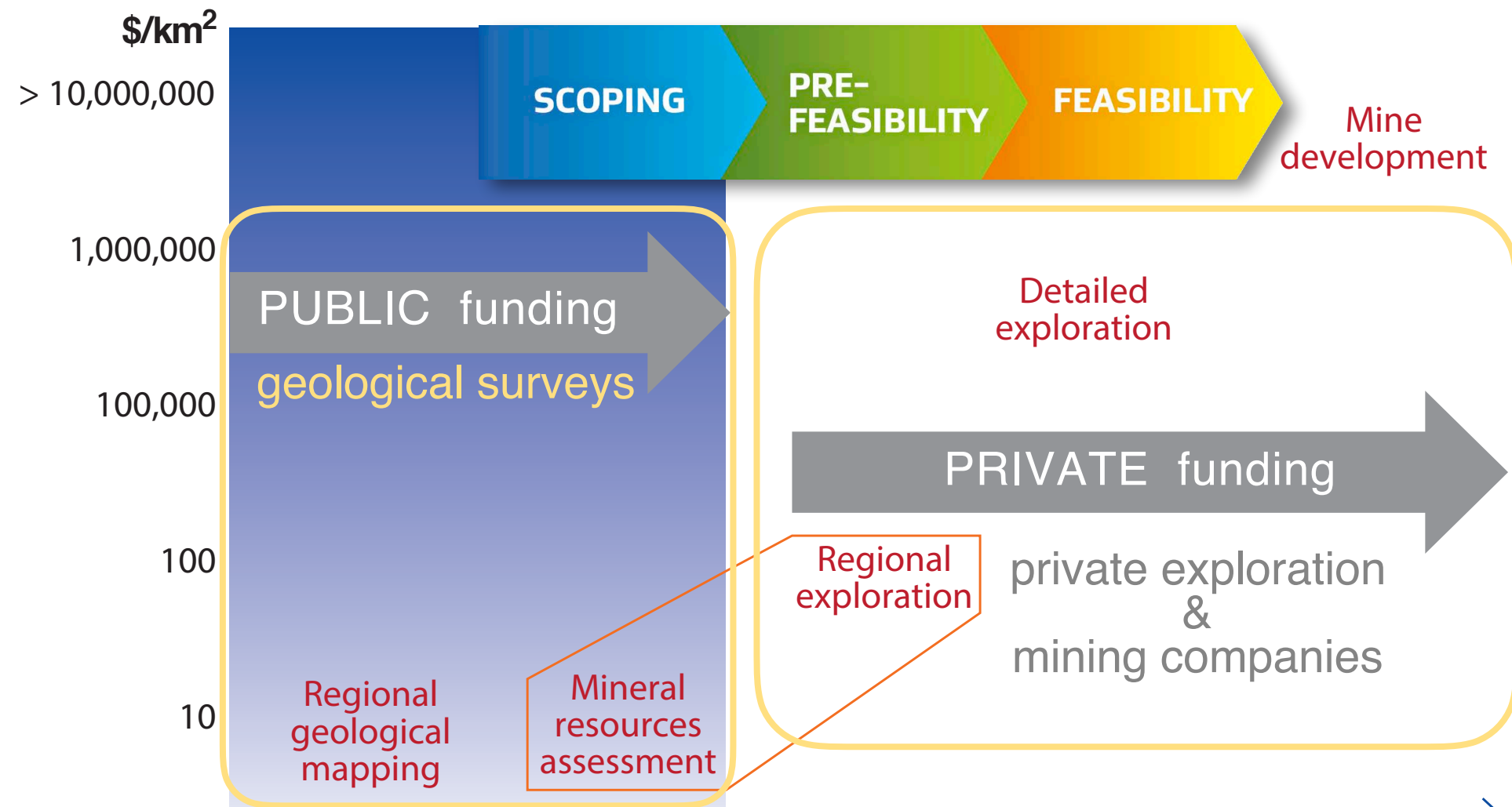
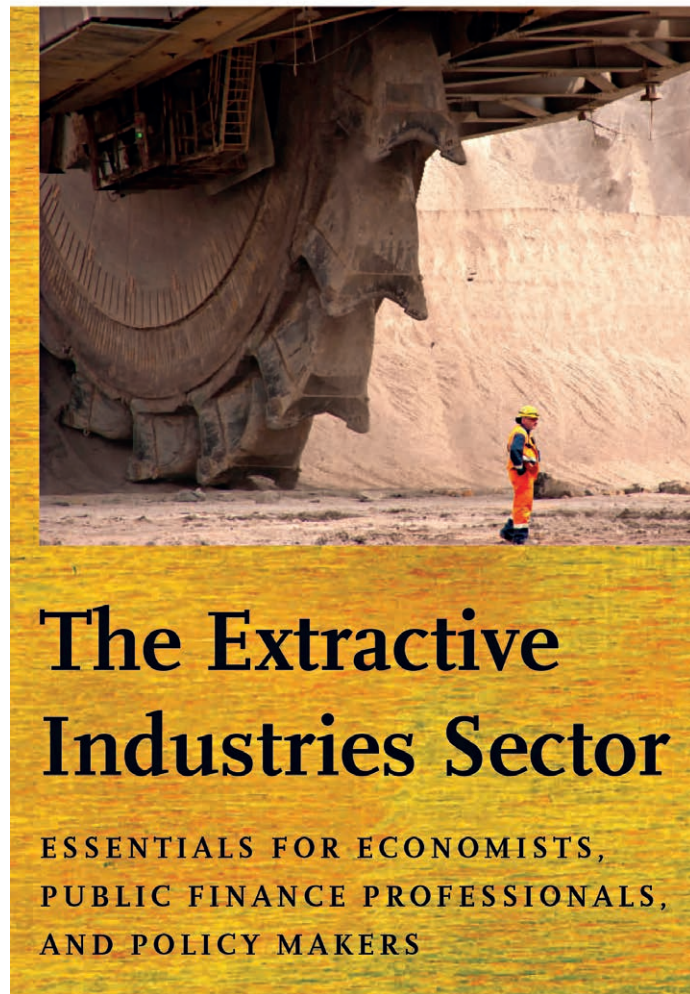
FEASIBILITY STUDY / BANKABLE FEASIBILITY STUDY

(= detailed business plan)

- **compiles the results of all previous feasibility studies**
- **adds** information on required permits, environmental impact studies, negotiated contracts, etc
- **proves** the technical viability of the mine and extraction methods
- **identifies** the market for the commodity
- **assesses** project risk areas, incl. economic sensitivity
- **develops** financial models
- **sets** a timely framework for the implementation of the capital investment in the mine
- **includes** a plan for closing the mine and reclaiming the ground

Sharing Costs of Geodata between the Private and Public Sectors

A WORLD BANK STUDY



<http://dx.doi.org/10.1596/978-1-4648-0492-2>

- **Geological surveys** provide the basic information to attract the interest of investors and interested companies
- **Companies** develop more detailed surveys at their own cost
- **Costs** will increase with the level of detail [= increase in drilling density]

What are

Mineral Resources vs Reserves?

STRATIFORM vs LENSOIDAL deposit types

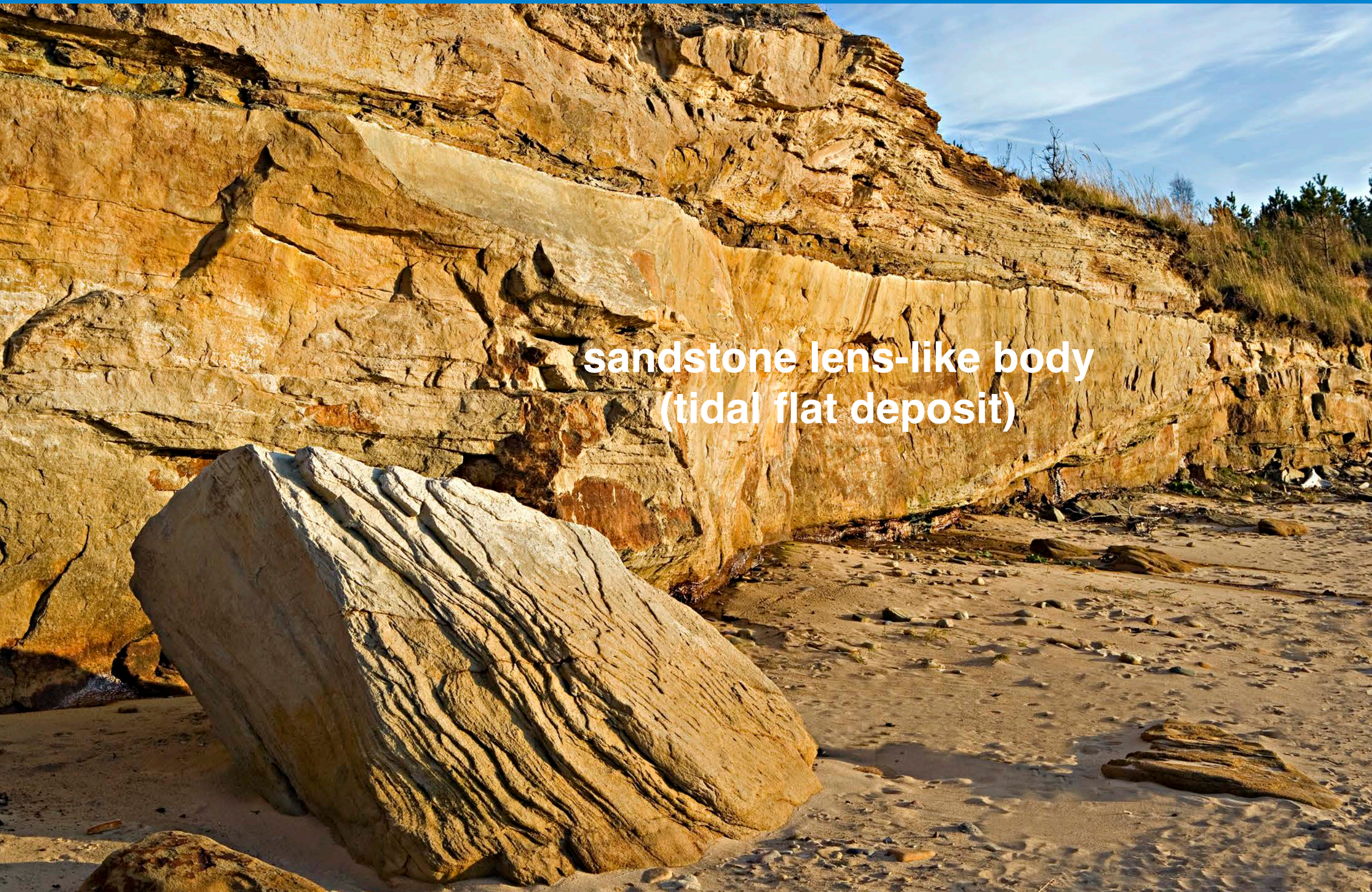


stratiform deposit of
kukersite oil shale

bed D-F₂

bed C/D

STRATIFORM vs LENSOIDAL deposit types



sandstone lens-like body
(tidal flat deposit)

CRIRSCO template: Code for reporting to investors



COMMITTEE FOR MINERAL RESERVES INTERNATIONAL REPORTING STANDARDS

INTERNATIONAL REPORTING TEMPLATE

for the public reporting of

**EXPLORATION RESULTS, MINERAL
RESOURCES AND MINERAL RESERVES**

November 2013

CRIRSCO template: Code for reporting to investors

Purpose: the CRIRSCO family of codes has been designed specifically for reporting exploration results transparently to stock exchanges, shareholders and to potential investors

Exploration result = bankable document

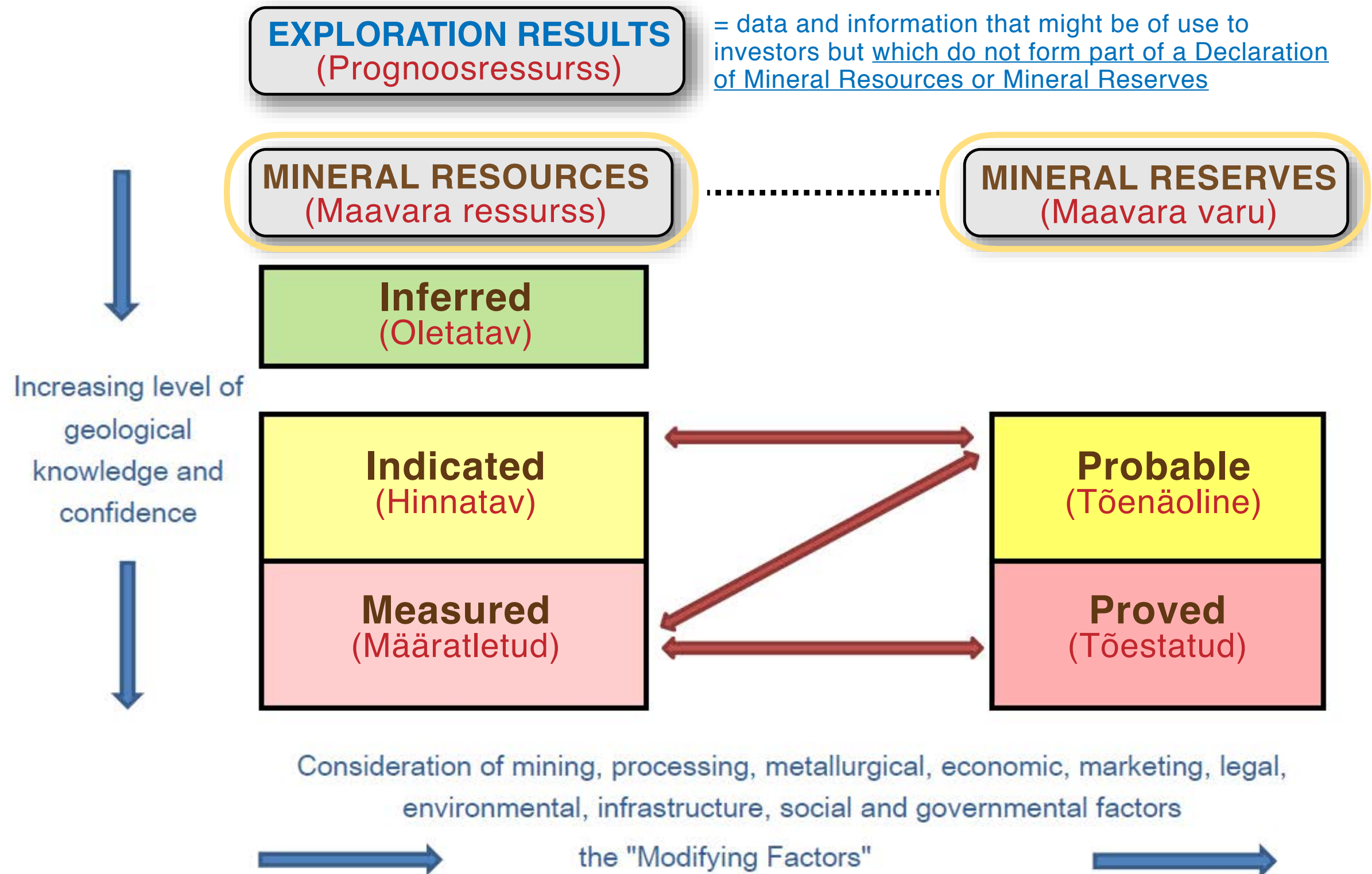


CRIRSCO MEMBERS

JORC (Australasia)
CBRR (Brazil)
CIM (Canada)
Comision Minera (Chile)
CCRR (Colombia)
PERC (Europe)
KCMi (Indonesia)
KAZRC (Kazakhstan)
MPIGM (Mongolia)
OERN (Russia)
SAMCODES (South Africa)
UMREK (Turkey)
SME (United States of America)

<http://www.crirSCO.com/members.asp>

CRIRSCO code: general relationship between Exploration Results, Mineral Resources and Mineral Reserves



CRIRSCO code: general relationship between Exploration Results, Mineral Resources and Mineral Reserves

MINERAL RESERVES
(Maavara varu)

MINERAL RESOURCES
(Maavara ressurss)

POTENTIAL RESOURCE*
(Exploration Results)
(Prognosressurss)

“**Mineral Reserves** are those portions of Mineral Resources which:

- after the application of all mining factors, result in an estimated tonnage and grade
- in the opinion of the **Competent Person** making the estimates, can be the basis of a viable project, after taking account of all relevant **Modifying Factors**”

MODIFYING FACTORS: Reserves vs Resources

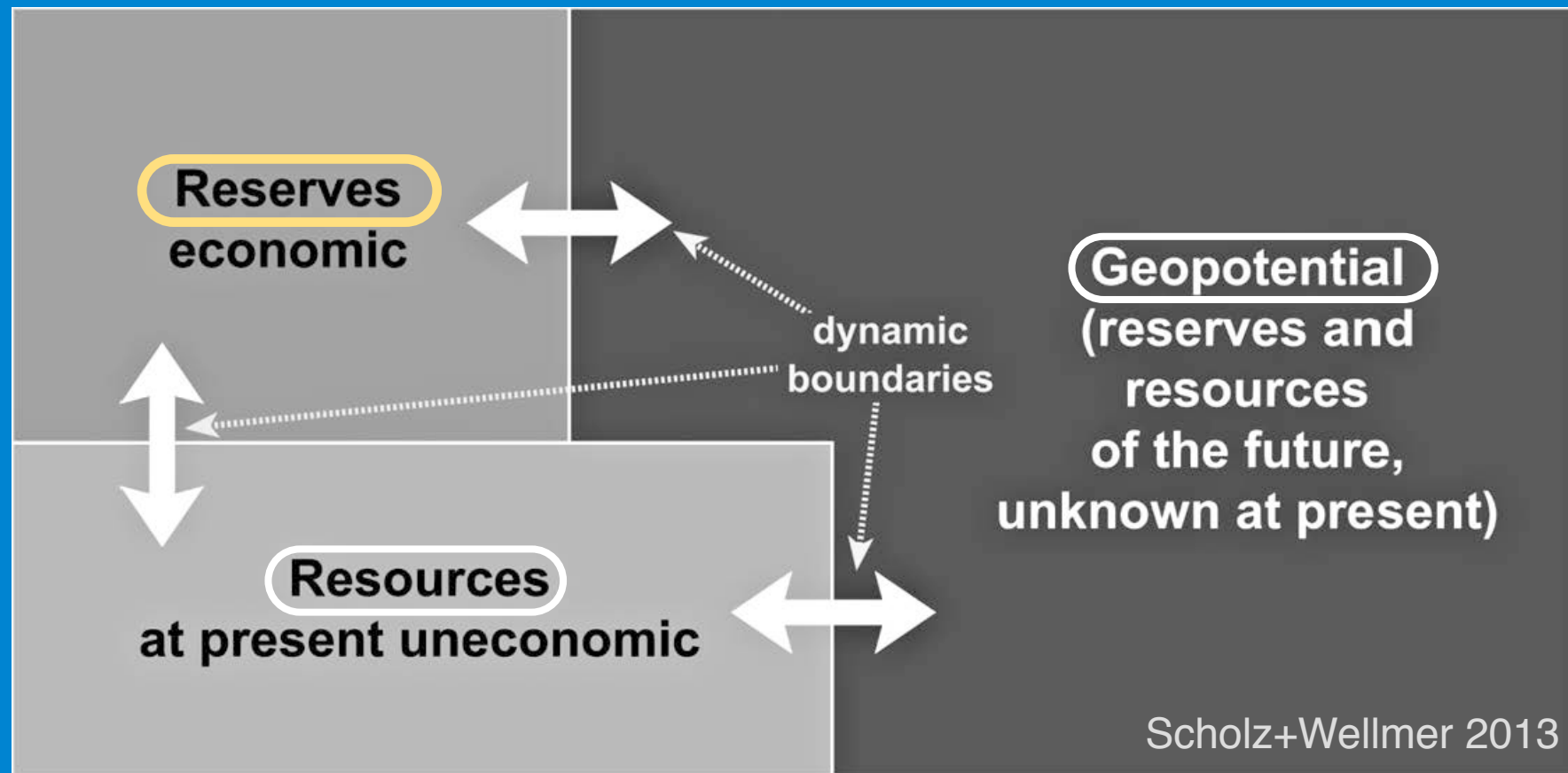
p. 8: CRIRSCO International Reporting Template, Nov. 2013

“ Modifying Factors are considerations
used to convert
Mineral Resources to Mineral Reserves”

The Modifying Factors include, but are not restricted to:

- mining
- processing
- metallurgical
- infrastructure
- economic
- marketing
- legal
- environmental
- social
- governmental factors

Categories: RESERVES, Resources & Geopotential

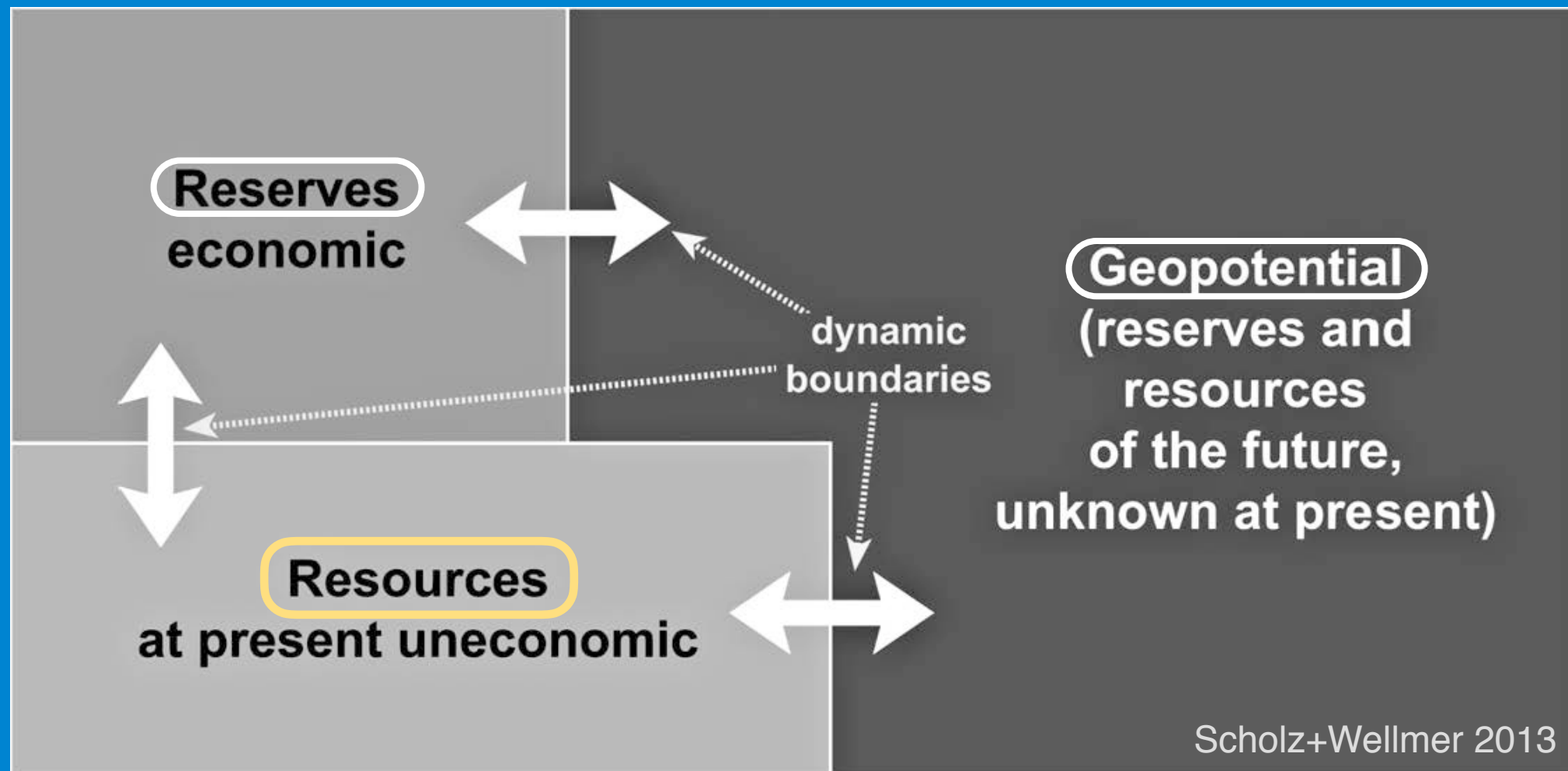


RESERVES are the share of the total resources that can be economically extracted with available technology and energy under environmentally and socio-economically acceptable conditions

RESERVES are part of an identified resource that can be economically extracted at the time of assessment [= working inventory]

RESERVES are dependant on commodity prices [if prices increase, the cutoff grade can be lowered, and lower grades can be mined economically]

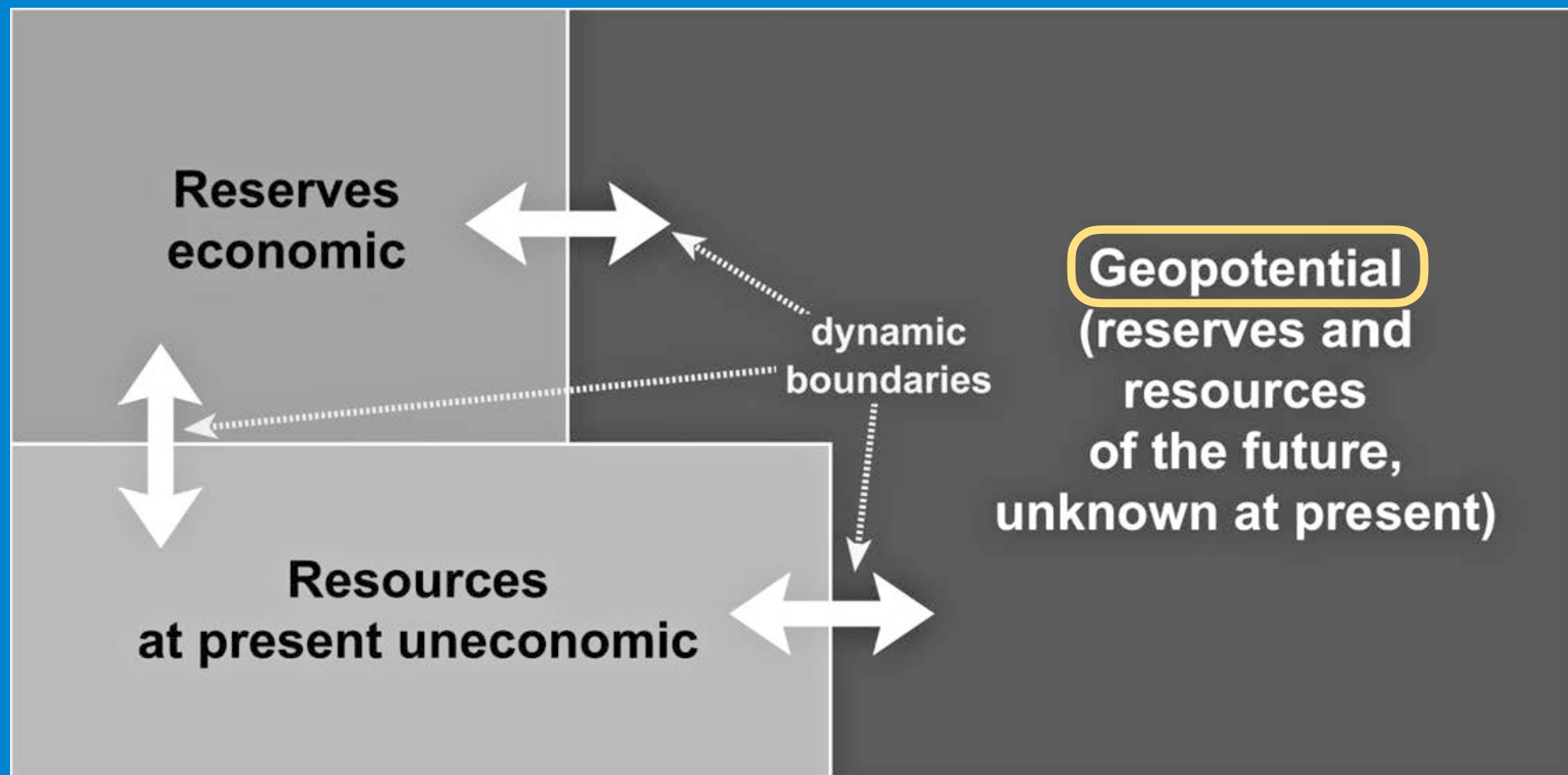
Categories: Reserves, RESOURCES & Geopotential



A MINERAL RESOURCE is defined as a natural concentration of material in such form and quantity that economic extraction of a commodity is potentially feasible (CRIRSCO, 2016)

[**mineral resource** = in situ estimate based on geological evidence with preliminary technical and economic assessments but not economically viable at present; **resources** = **future possible reserves**]

Categories: Reserves, Resources & Geopotential

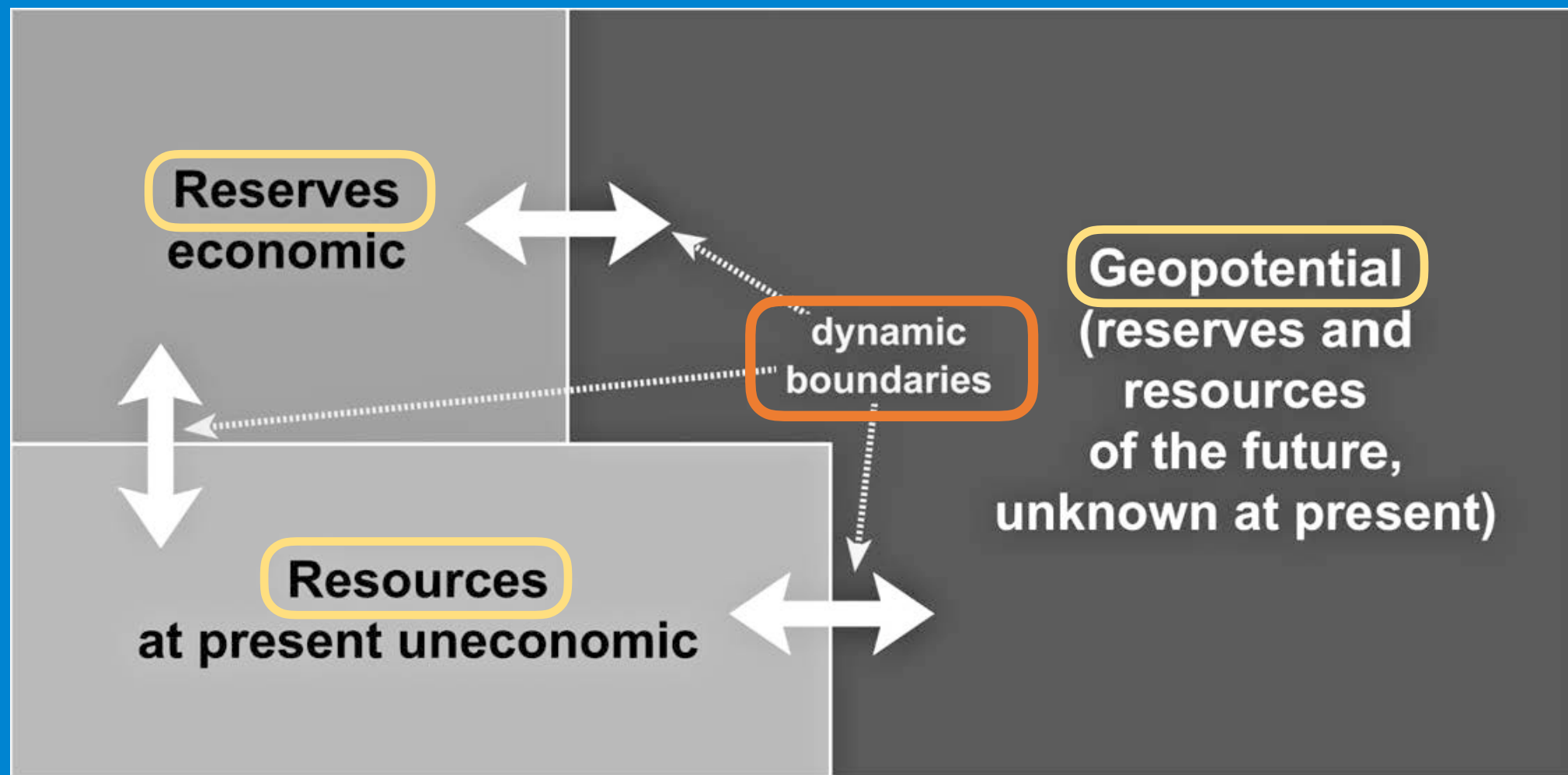


Scholz+Wellmer 2013

GEOPOTENTIAL (potential resources) is not yet known resource.

But by geologic reasoning, it can be expected to contain deposits that will be discovered by modern exploration technologies in the future

Dynamics of Reserves, Resources & Geopotential



Scholz+Wellmer 2013

The BOUNDARIES are always dynamic, influenced by new technologies and/or price developments

[boundaries = timely snapshots; **resources of today can be reserves tomorrow and vice versa**; geopotential can become either resources or reserves]

COMPETENT PERSON

- a minerals industry professional
- must have 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 Ore Reserves**, the relevant experience must be in the estimation, assessment, evaluation and economic extraction of Ore Reserves



Earth's Crust Act

[Translation](#)[Authentic text](#)[Content](#)

Issuer: Riigikogu

Type: act

In force from: 01.01.2019

In force until: 30.09.2019

Translation published: 07.01.2019

Select wordings:

[Previous](#)[In force](#)[Compare wordings](#)[Parallel texts](#)

Earth's Crust Act¹

Passed 27.10.2016

⊕ Amended by the following legal instruments (show)

Chapter 1 General Provisions

§ 23. Categories of mineral reserves

§ 23. Maavaravaru kategooriad

1

(1) The quantity of the **registered mineral resources** (hereinafter **mineral reserves**) is divided, based on the detail of exploration, into **proved reserves and probable reserves**.

Reconnaissance resources may be designated in areas bordered by a mineral deposit.

(1) **Arvele võetud maavara** kogus (edaspidi **maavaravaru**) jaguneb olenevalt uurituse detailsusest **tarbevaruks ja reservvaruks**.

Maardlaga piirneval alal võidakse määrata **prognoosvaru**.

* * * * *

PROVED RESERVES = TARBEVARU

PROBABLE RESERVES = RESERVVARU

RECONNAISSANCE RESOURCES = PROGNOOSVARU

§ 23. Categories of mineral reserves

§ 23. Maavaravaru kategooriad

2

(2) **Proved reserves** are mineral reserves the detail of the geological exploration of which allows the receipt of the information necessary for the extraction and use of mineral reserve.

(2) **Tarbevaru** on maavaravaru, mille geoloogilise uurituse detailsus võimaldab saada maavaravaru kaevandamiseks ja kasutamiseks vajalikud andmed.

(3) **Probable reserves** are mineral reserves the detail of the geological exploration of which allows the receipt of the information necessary to assess the perspectives of the mineral reserves and to direct the further geological explorations.

(3) **Reservvaru** on maavaravaru, mille geoloogilise uurituse detailsus võimaldab saada vajalikud andmed maavaravaru perspektiivi hindamiseks ja edasise geoloogilise uuringu suunamiseks.

§ 23. Categories of mineral reserves

§ 23. Maavaravaru kategooriad

3

(5) **The proved reserves** and **probable reserves** are divided as economic and potentially economic on the basis of their possibilities of use.

(5) **Tarbevaru** ja **reservvaru** jagunevad nende kasutamisevõimalikkuse alusel **aktiivseks** ja **passiivseks**

(6) **Mineral reserves are deemed to be potentially economic** if the mining and use of the reserves is prohibited under legislation or not possible from the standpoint of environmental protection. In other cases, mineral reserves are economic.

6) **Maavaravaru on passiivne** juhul, kui selle kaevandamine ja kasutamine on õigusaktide kohaselt keelatud või ei ole selle kaevandamine ja kasutamine keskkonnakaitse vajadust arvestades võimalik. Muul juhul on maavaravaru aktiivne

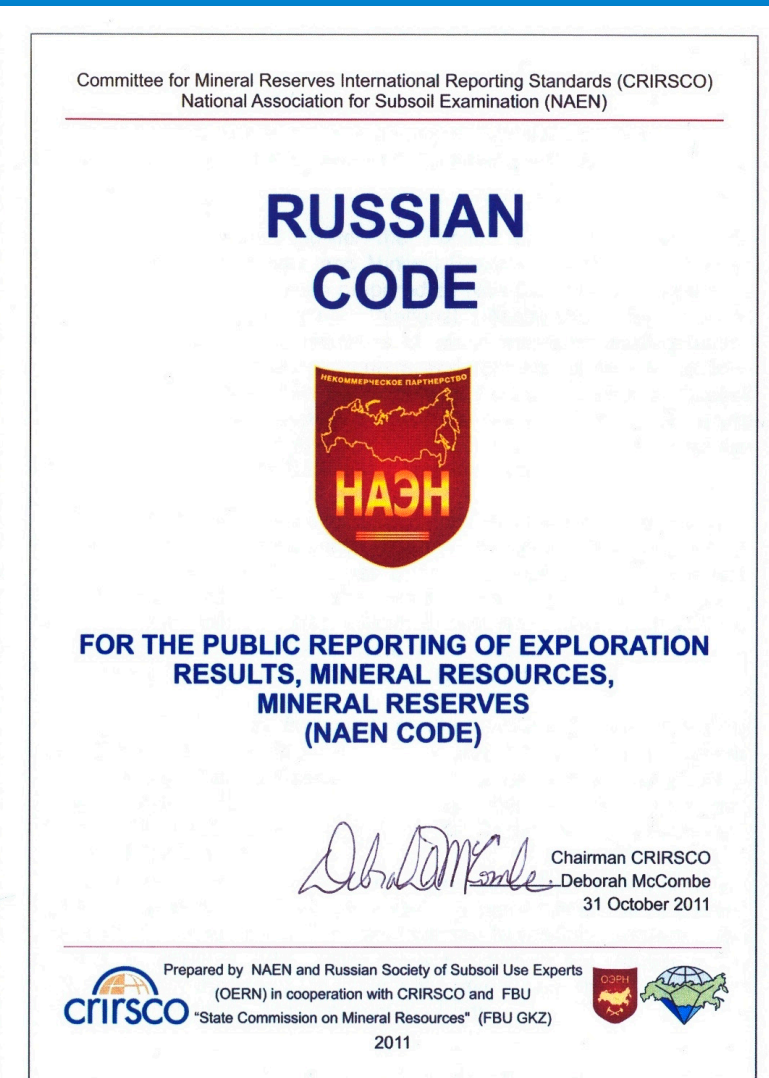
COMPETENT PERSON in Estonia



(7) The dividing of proved reserves and probable reserves as **economic or potentially economic** shall be decided by the person deciding on making the entry in the environmental register

(7) Tarbevaru ja reservvaru eristamise aktiivseks ja passiivseks otsustab keskkonnaregistri kande tegemise otsustaja, tuginedes üldgeoloogilise uurimistöö või geoloogilise uuringu tulemustele ja muule keskkonnaregistri kande tegemise ajal saada olevale teabele

Bridging CRIRSCO codes & Russian NAEN code



Comparisons between CRIRSCO and Russian NAEN Resource and Reserve Classifications

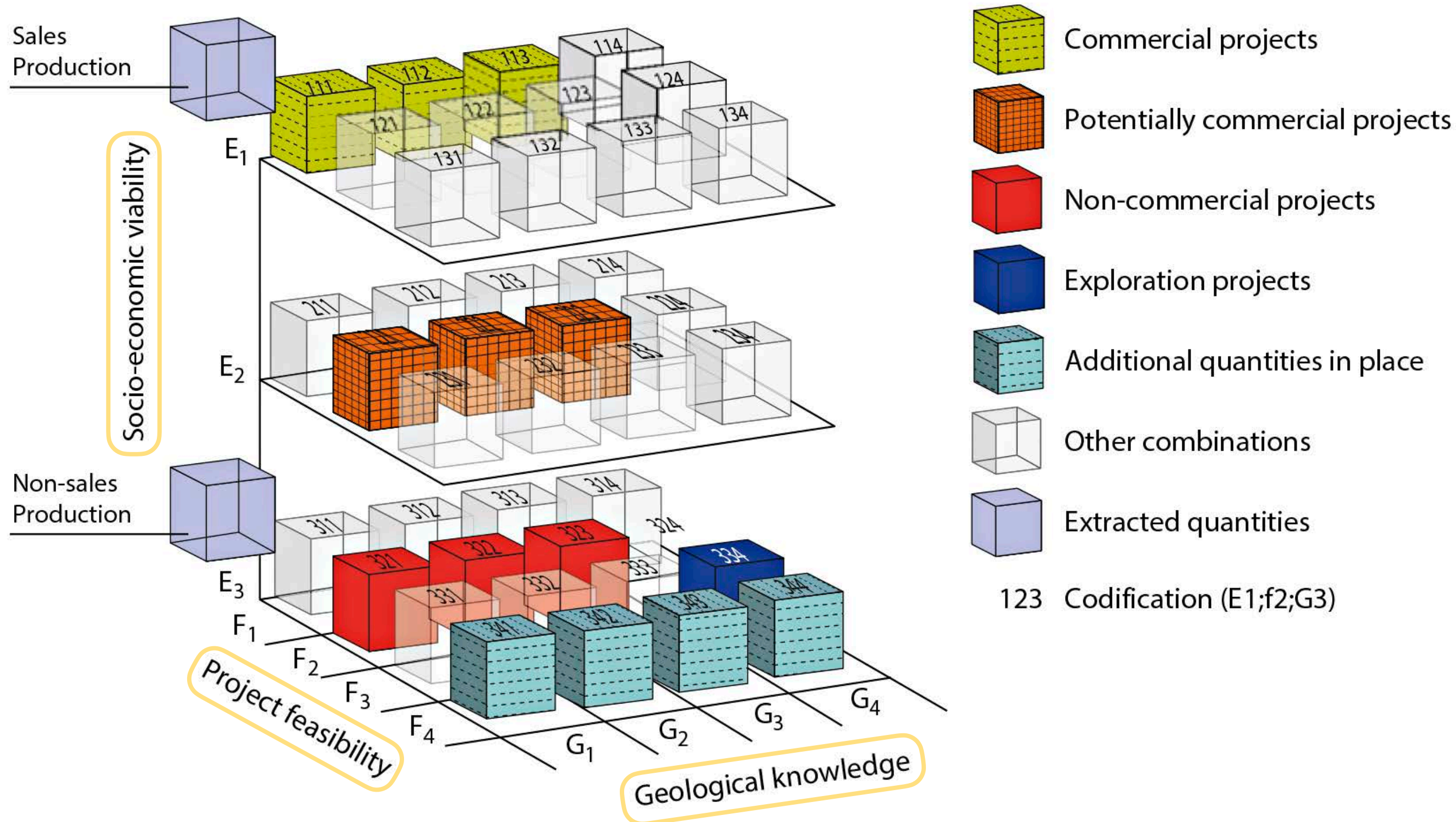
CRIRSCO (JORC/CIM/ PERC/ NAEN)	Resource Ressurss	Measured Määratletud	Indicated Hinnatav	Inferred Oletatav	Exploration Potential or Exploration Target
	Reserve Varu	Proven Tõestatud	Probable Tõenäoline		
Russian State Classification	Reserve	A, B and C1	B, C1 and C2	C2 and P1	P2 and P3

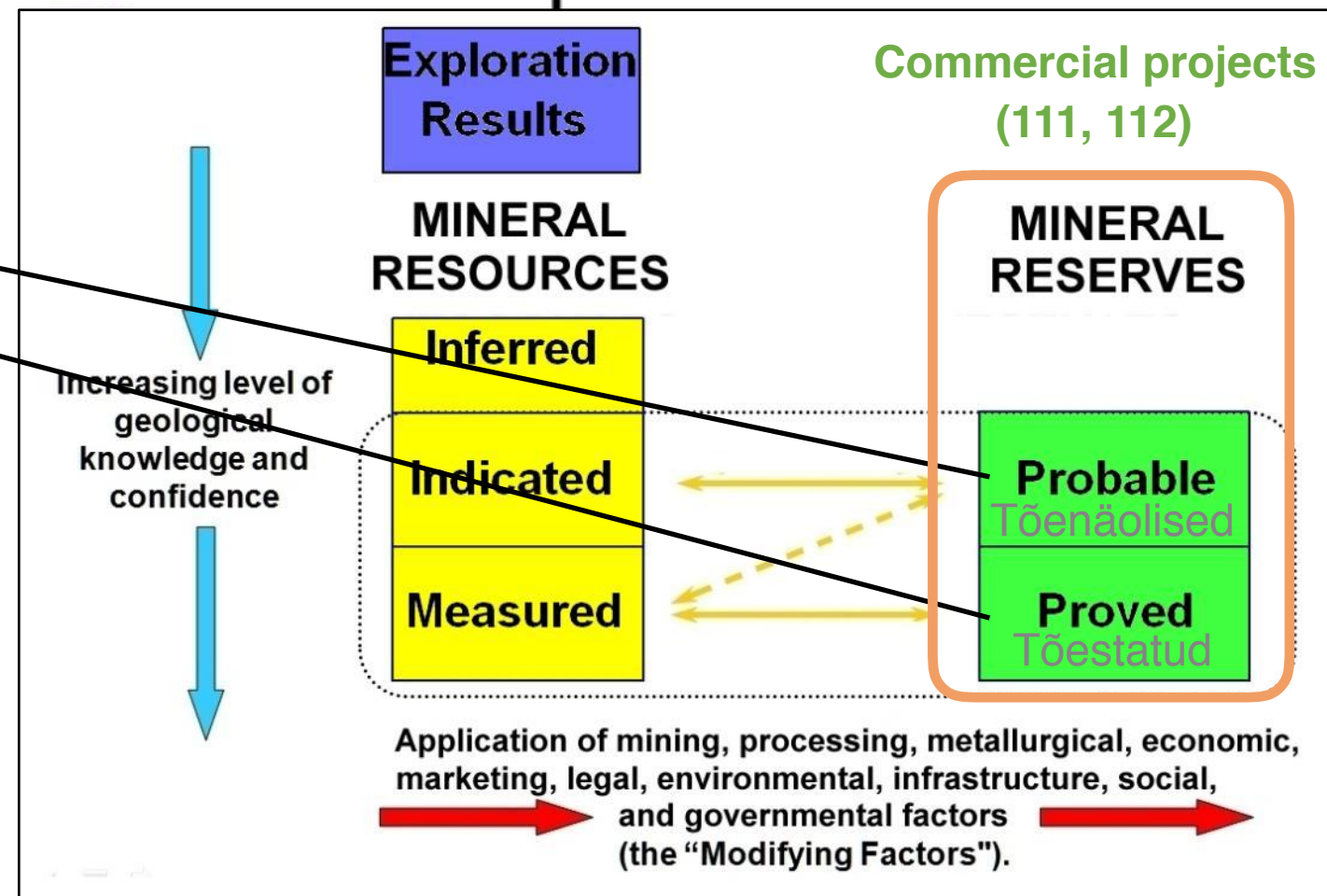
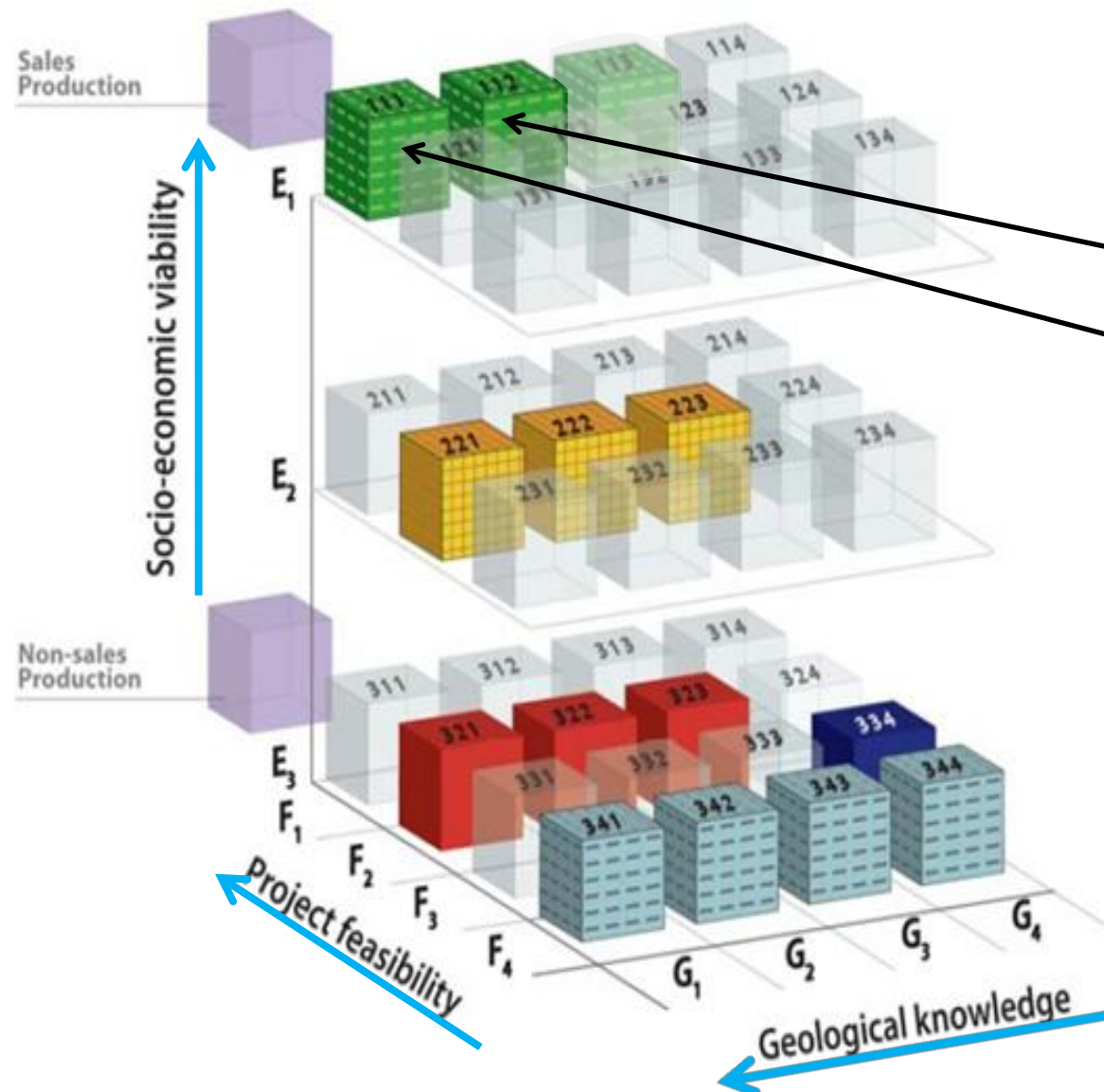
UN Framework Classification (UNFC-2009)

(UNFC-2009 – code for reporting to governments)

UNFC-2009 System: Key Principles

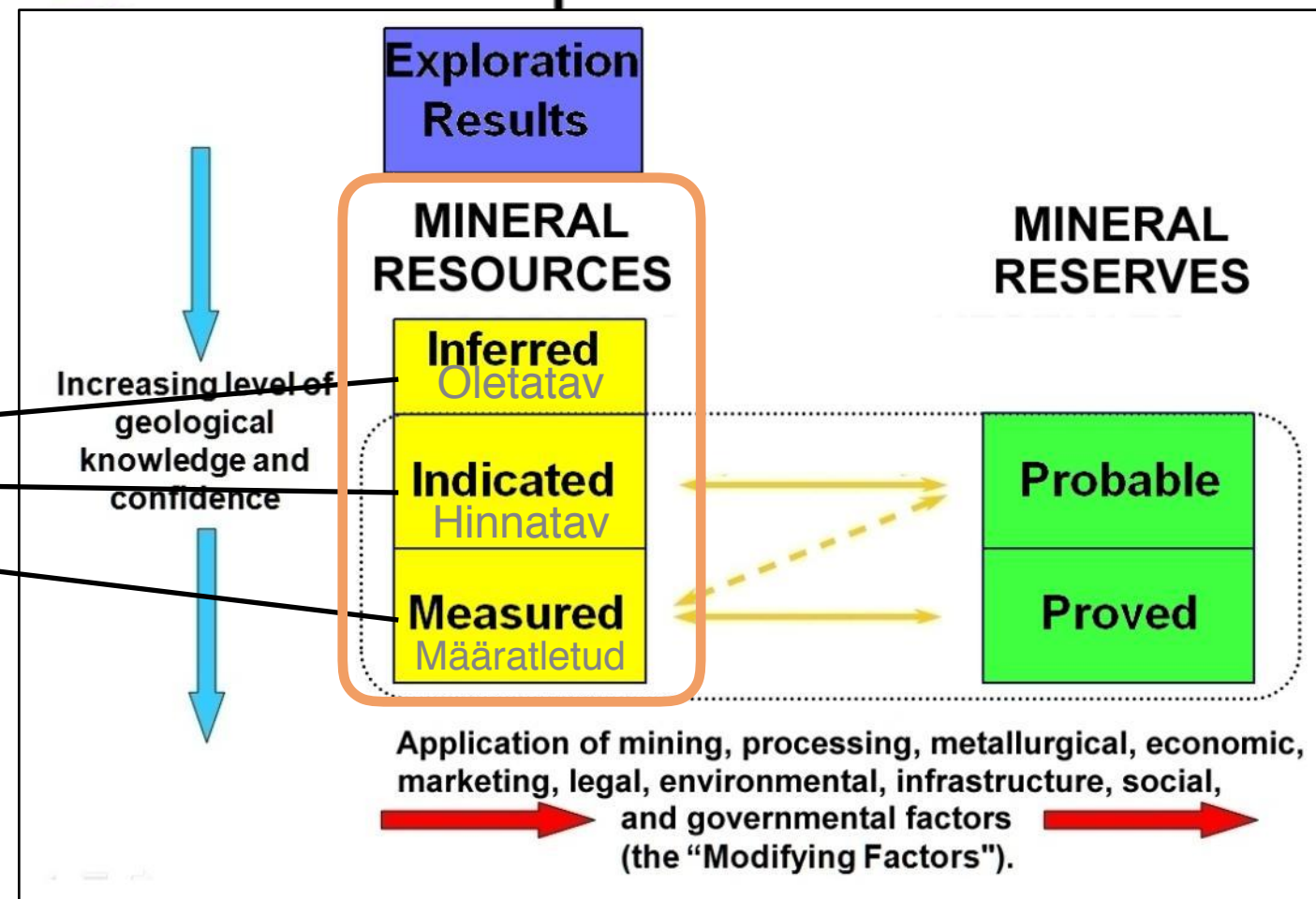
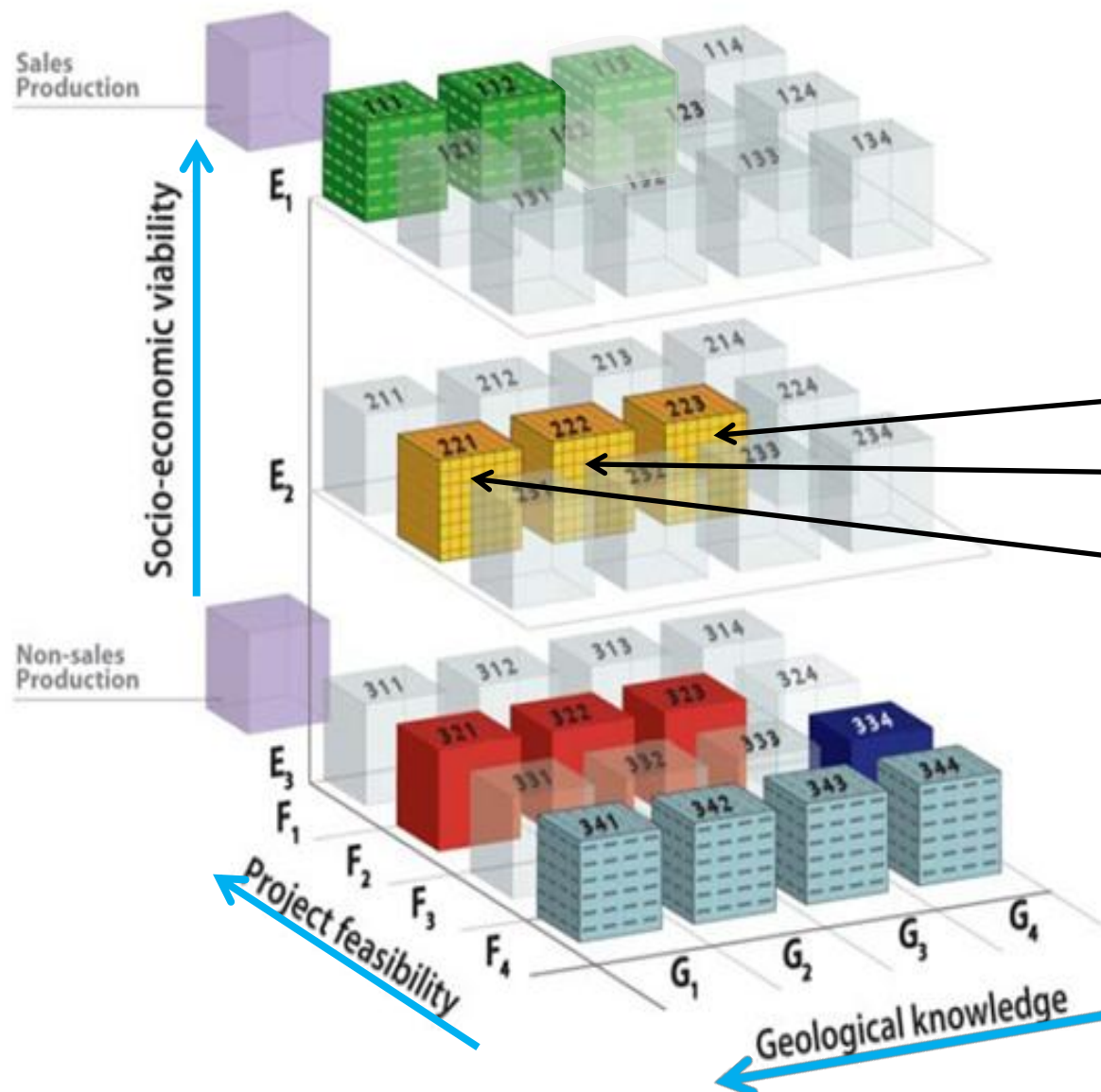
Purpose: to establish a framework for a national mineral resources inventory



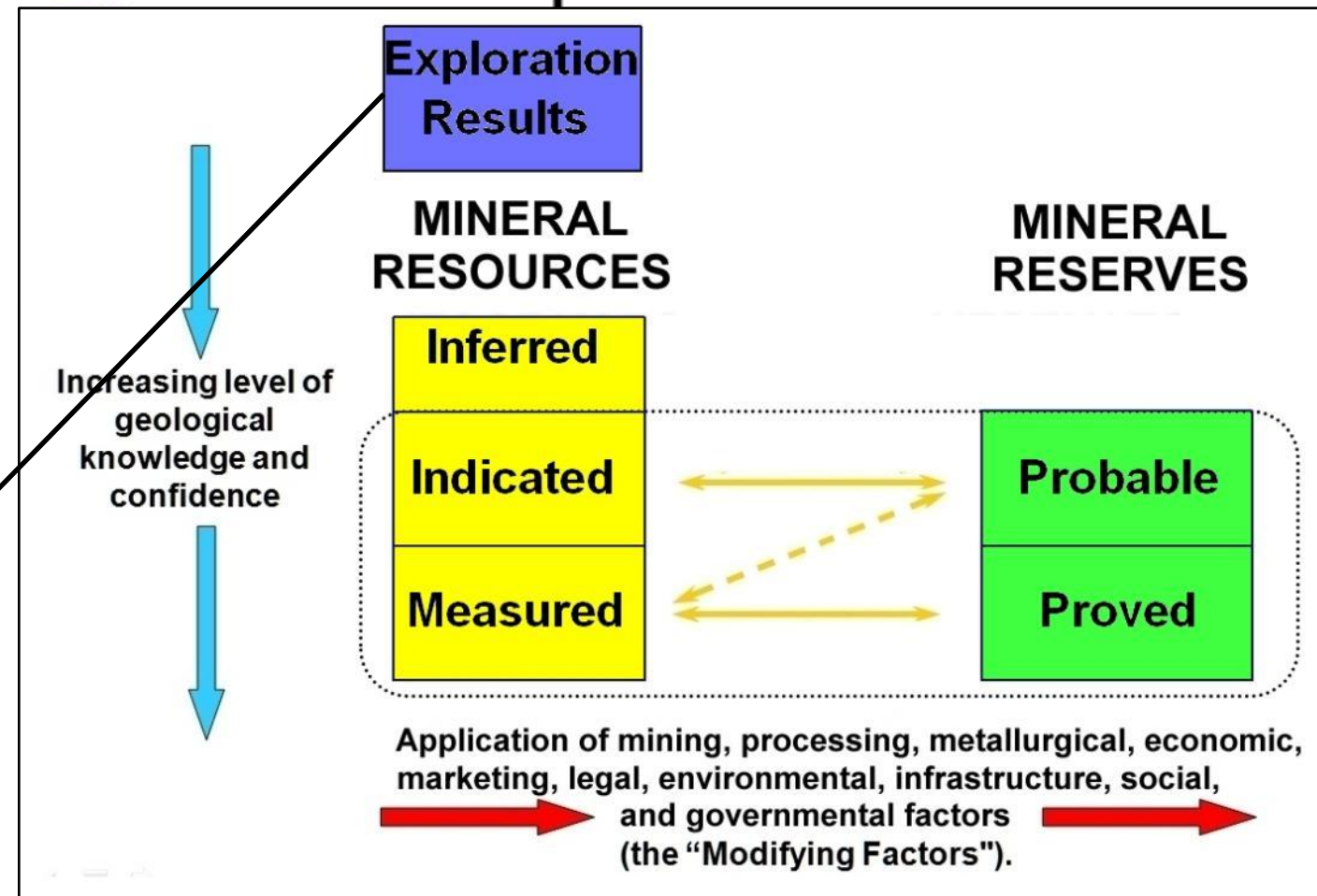
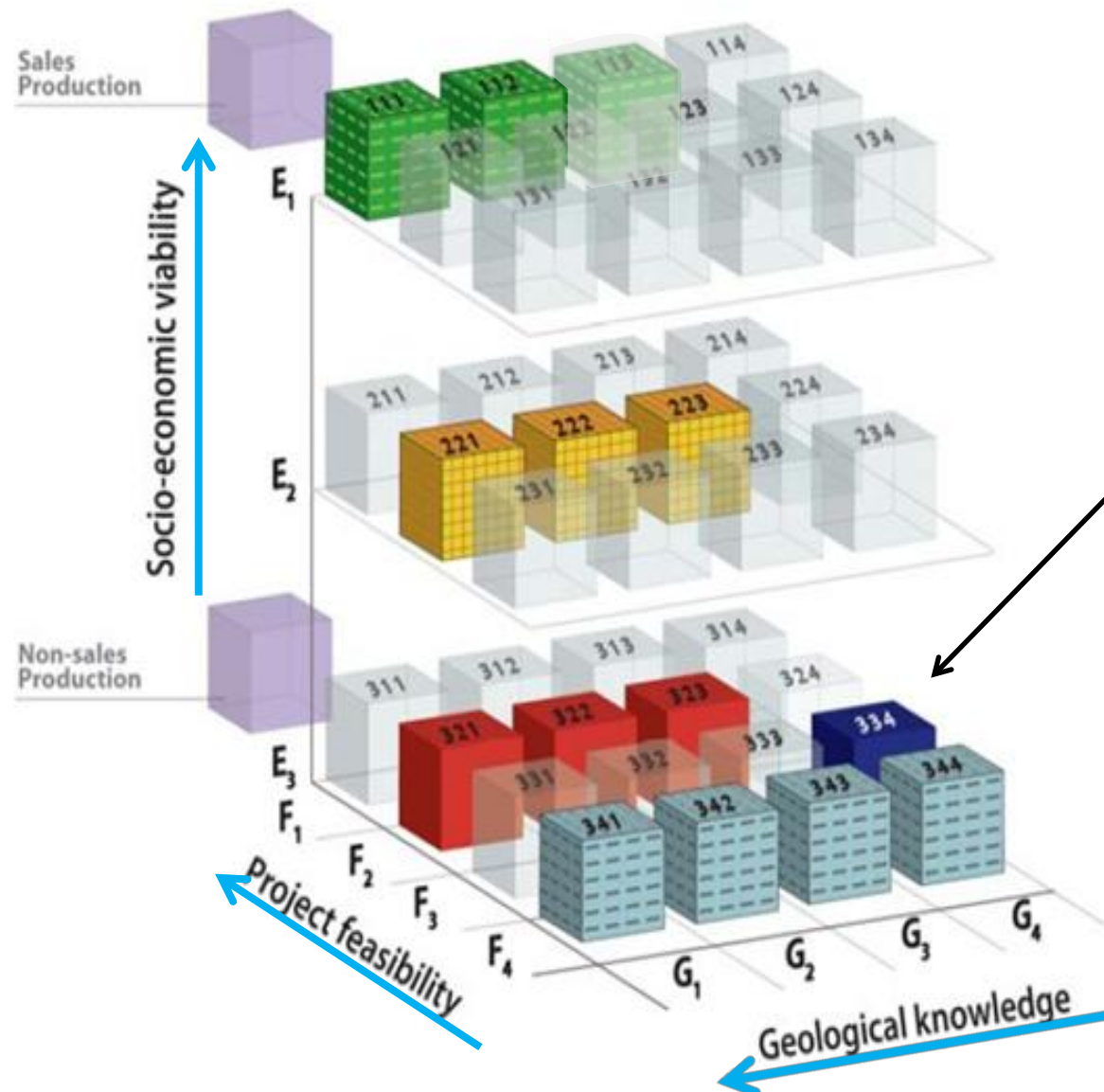


source: Stephen Henley, 2013

Potentially commercial projects (221, 222, 223)



source: Stephen Henley, 2013



source: Stephen Henley, 2013



COMMITTEE FOR MINERAL RESERVES INTERNATIONAL REPORTING STANDARDS

INTERNATIONAL REPORTING TEMPLATE

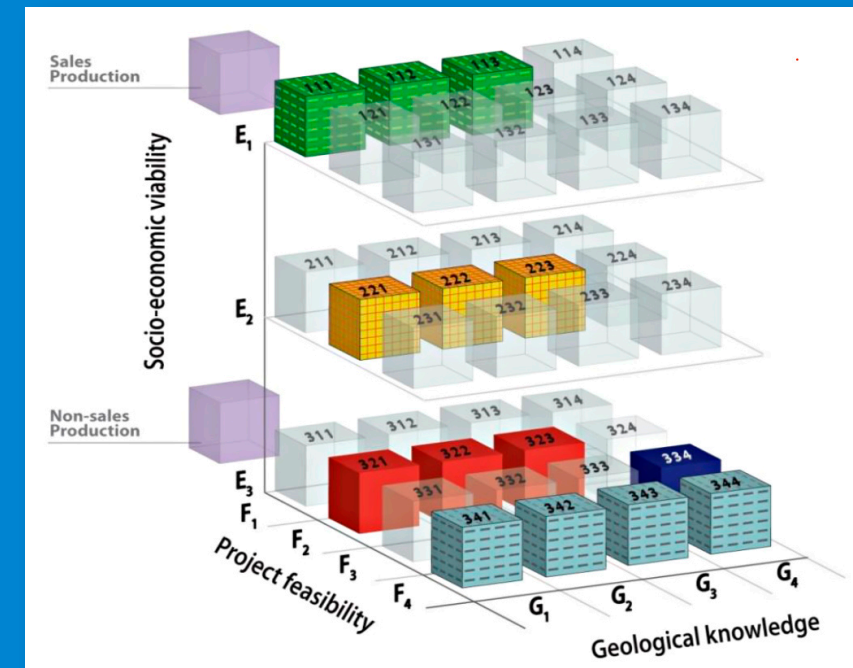
for the public reporting of

EXPLORATION RESULTS, MINERAL
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November 2013

ICMM
International Council
on Mining & Metals

SUMMARY



- geological exploration for potential future raw materials (e.g. phosphate rock, metalliferous black shale, metals in crystalline basement rocks) in Estonia should comply with **CRIRSCO international reporting template**
- such exploration as well as related resource calculations should be led and authorized by **Competent persons**
- reporting for currently extractable raw materials (e.g. construction aggregates) in Estonia needs to be harmonized with **UN Framework Classification**
- **updating legal framework** for geological exploration in Estonia



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Thank You!

Heikki Bauert, Geological Survey of Estonia