Alignment of Resource and Reserve Classification Systems

Russian Federation

and

CRIRSCO

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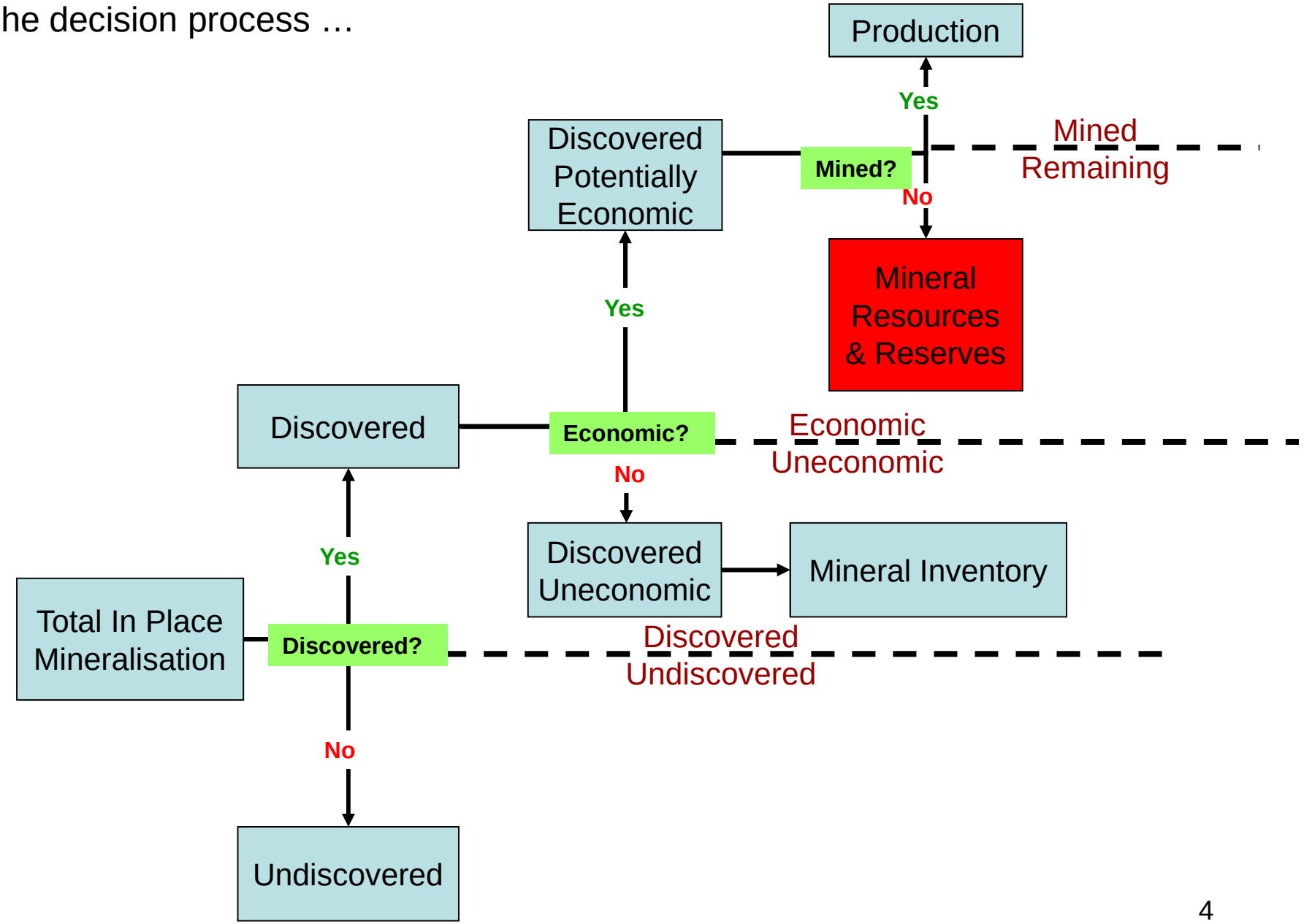
Working group

- Set up in 2006 by CRIRSCO and GKZ. Managed by PERC on behalf of CRIRSCO.
  - Chairman: Mike Armitage
  - Secretary/convenor: Steve Henley
  - Members from GKZ, CRIRSCO, Russian and international mining industry
- Meeting: Moscow, 21-22 October 2008
  - Between GKZ, CRIRSCO, and Russian industry
- Protocol signed 22 October 2008 by Niall Weatherstone (CRIRSCO chairman) and Yuri Podturkin (GKZ chairman) agreeing principles
- Detail to be included in a ‘conversion handbook’ to be prepared during 2009

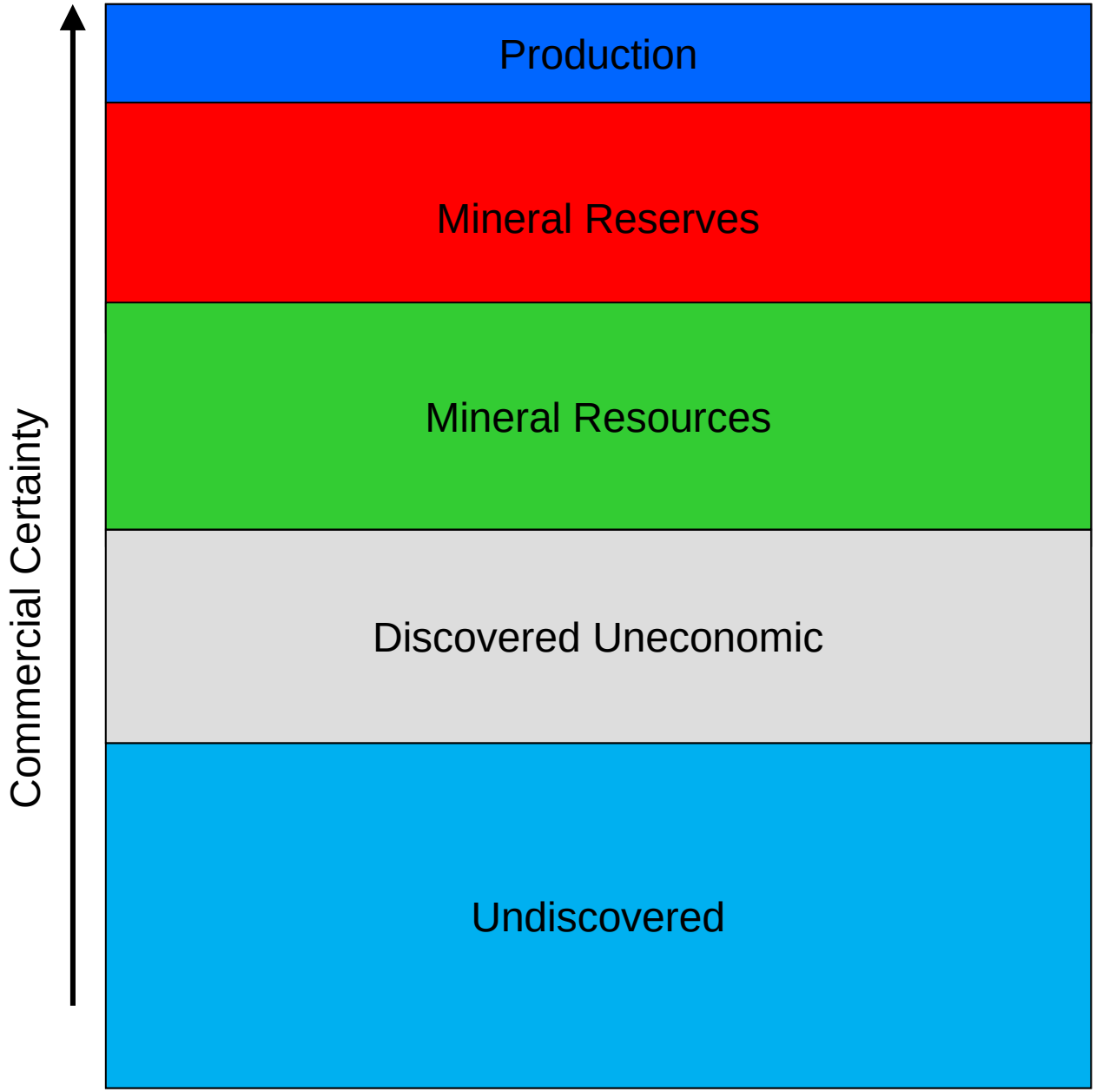
Preliminary Concepts

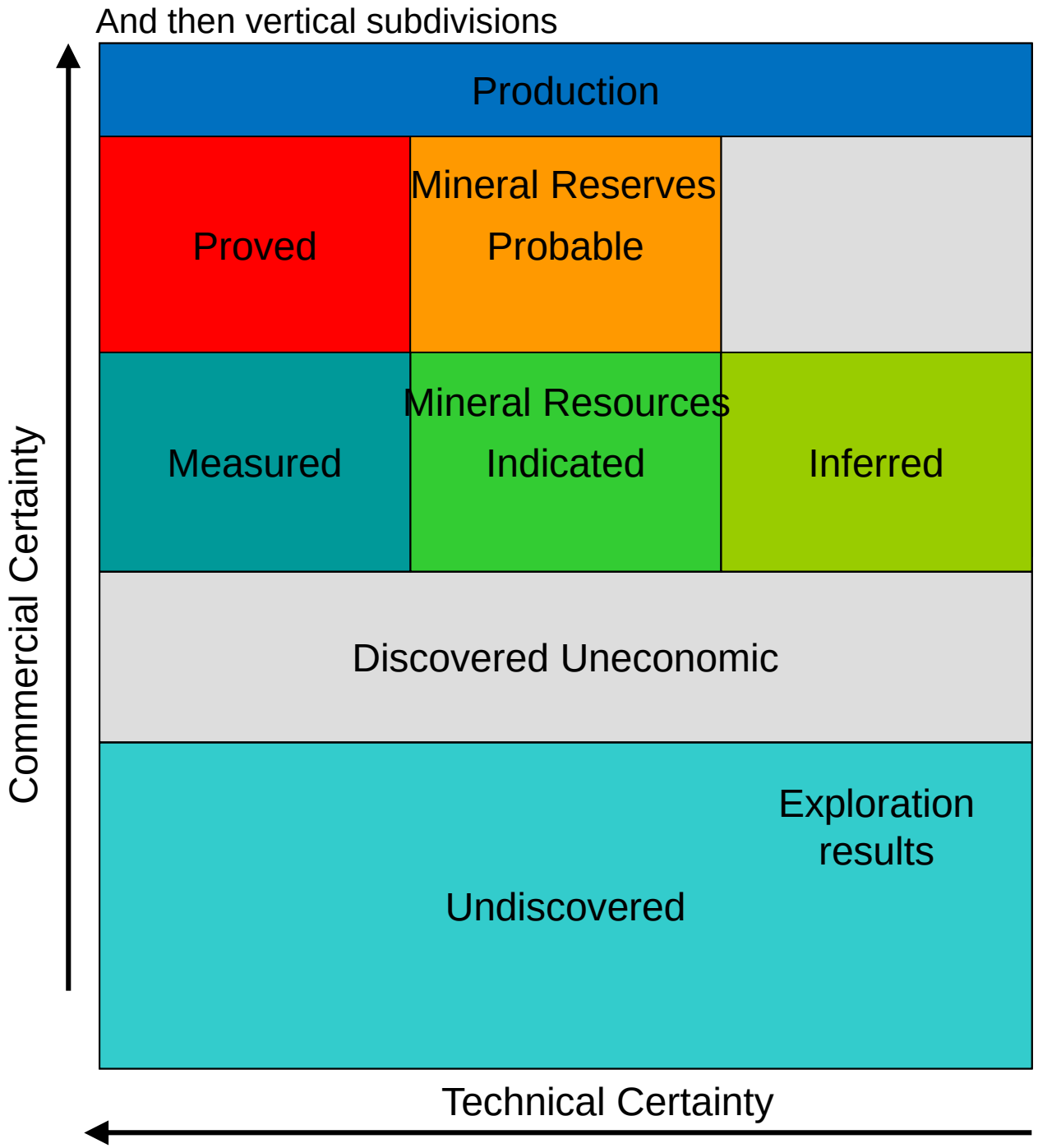
- just the same in Russia as internationally

The decision process …



Leading to horizontal subdivision…




And then vertical subdivisions
Production
Proved
Mineral Reserves
Probable
Measured
Mineral Resources
Indicated
Inferred
Discovered Uneconomic
Exploration
results
Undiscovered
Commercial Certainty
Technical Certainty

Objectives of harmonisation

1. Alignment of Exploration Stages and **Resource** Classification

2. Defining **Reserves** and Resources (as separate terms)

3. Defining Technical & Economic Studies

4. How to allow for complexity of deposit geology

5. Competent Person definitions in Russia and internationally

1
Alignment of Exploration Stages and Resource Classification

Alignment at a Resource Level

- Ignores (for now) the interaction of resource estimation and technical/economic studies

- Ignores the issue of deposit complexity (which does not change the classification: it only applies rules to how it is used)

The starting point – always Geology!

Exploration stages

Russian system :

P3	P2	P1	C2	C1	B	A

International (CRIRSCO) system :

Exploration Results	Inferred	Indicated	Measured

- How can we align the two systems?
- Is it that the exploration principles are different?
- Or are we simply dealing with different terminology?

Exploration steps: the same everywhere

1. Preliminary assessment of a large area: possibly known to be mineral bearing (old mines, historical records etc), application of remote sensing, aerial photography etc: identify areas with good prospects
2. Preliminary ground exploration to identify smaller scale targets as priorities for exploration effort: geochemical sampling, geophysics, develop more detailed exploration plans (eg drilling programmes)
3. Initial drilling programmes: widely spaces points of information seeking a mineralisation discovery. May be difficult to demonstrate continuity of geology/grade
4. Infill drilling: more closely spaced drilling and sampling: sufficient to confirm geology/grade continuity. Sampling for metallurgical tests, environmental impact assessment etc
5. Detailed exploration designed to optimise the mine design eg pit slopes, water modelling, stope design etc. Focus on initial years of mining to reduce uncertainty.

Detailed comparisons of definitions

- The next step is to look at what the two systems (the CRIRSCO template and the Russian code) actually define – and we find that they are not so different !

Preliminary alignment: Resources Only*

Russian Federation System		CRIRSCO Template
A	Reserves of category A are identified in **areas of detailed knowledge of explored and exploited deposits**. The size, form, and formation conditions of the mineral body must be established, the character and nature of variability of their morphology and internal structure studied, any waste or marginal areas within the mineral body identified and outlined, with location and amplitude of fault displacements defined. The outline of the mineral reserves is defined in accordance with the requirements of conditions by **drill hole and mine workings {e.g. trenches, pilot-scale pits}** according to the results of detailed sampling.	A '**Measured Mineral Resource**' is that part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a **high level of confidence.** It is based on detailed and reliable exploration, sampling and testing information gathered through appropriate techniques from locations such as **outcrops, trenches, pits, workings and drill holes**. The locations are spaced closely enough to confirm geological and grade continuity.
B	Reserves of category B are identified **in areas of detailed knowledge of explored and exploited deposits**. the size, basic particularities and variability of form and internal structure, formation conditions of the mineral body, spatial distribution of internal waste or marginal areas are established, with location and amplitude of major fault displacements defined. The outline of the mineral reserves is defined in accordance with the requirements of conditions according to the results of **detailed sampling of drill holes and mine workings.**	

***** In RF system, the terms used to define Reserve and Resource categories are the same. Reserves are distinguished by the completion of technical and economic studies in addition to exploration/geological studies and acceptance by GKZ.

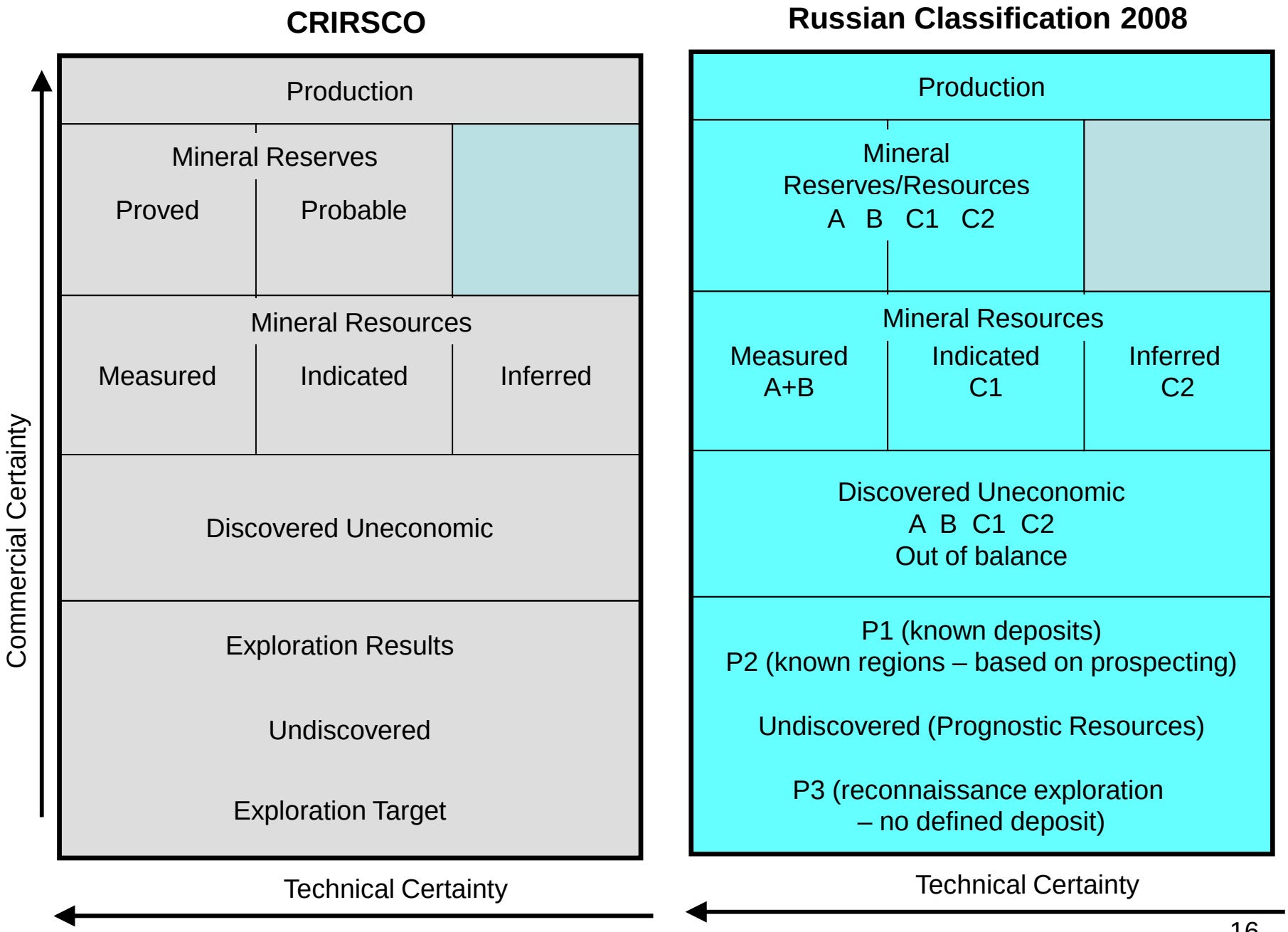
Preliminary alignment: Resources Only

Russian Federation System		CRIRSCO Template
C1	Reserves of category C1 constitute **the main part of reserves of explored and mined deposits of geological structural complexity groups 1, 2, and 3, and also can be identified in areas of detailed study of deposits of complexity group 4**. The size and characteristic form of the mineral body, and main particularities of the conditions of formation and internal structure are explained; variability and possible discontinuity of the mineral body are estimated. The outline of the mineral reserves is defined in accordance with the requirements of conditions according to the results of **sampling of drill holes and mine workings with consideration of data from geophysical and geochemical studies**.	An '**Indicated Mineral Resource**' is that part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a **reasonable level of confidence**. It is based on exploration, sampling and testing information gathered through appropriate techniques from locations such as **outcrops, trenches, pits, workings and drill holes**. The locations are too widely or inappropriately spaced to confirm geological and/or grade continuity but are **spaced closely enough for continuity to be assumed.**
C2	Reserves of category C2 are identified from exploration of deposits of all complexity groups, and in deposits of geological structural complexity group 4 constitute the main part of reserves to be included in mining. **The size, form, and internal structure of the mineral body, and conditions of formation are estimated from geological, geophysical and geochemical data and confirmed by intersection of the mineral by a limited number of drill holes and mine workings.** The outline of the mineral reserves is defined in accordance with the requirements of conditions according to the results of **sampling of a limited number of drill holes, mine workings {e.g. trenches, pilot-scale pits}, natural outcrops** or by their biota {indicator plants ?}, with consideration of data from geophysical and geochemical studies and geological structures	An '**Inferred Mineral Resource**' is that part of a Mineral Resource for which tonnage, grade and mineral content can be estimated with a **low level of confidence. It is inferred** from geological evidence and sampling and assumed **but not verified geological and/or grade continuity**. It is based on information gathered through appropriate techniques from locations such as **outcrops, trenches, pits, workings and drill holes which is limited or of uncertain quality and reliability**.

Preliminary alignment: Resources Only

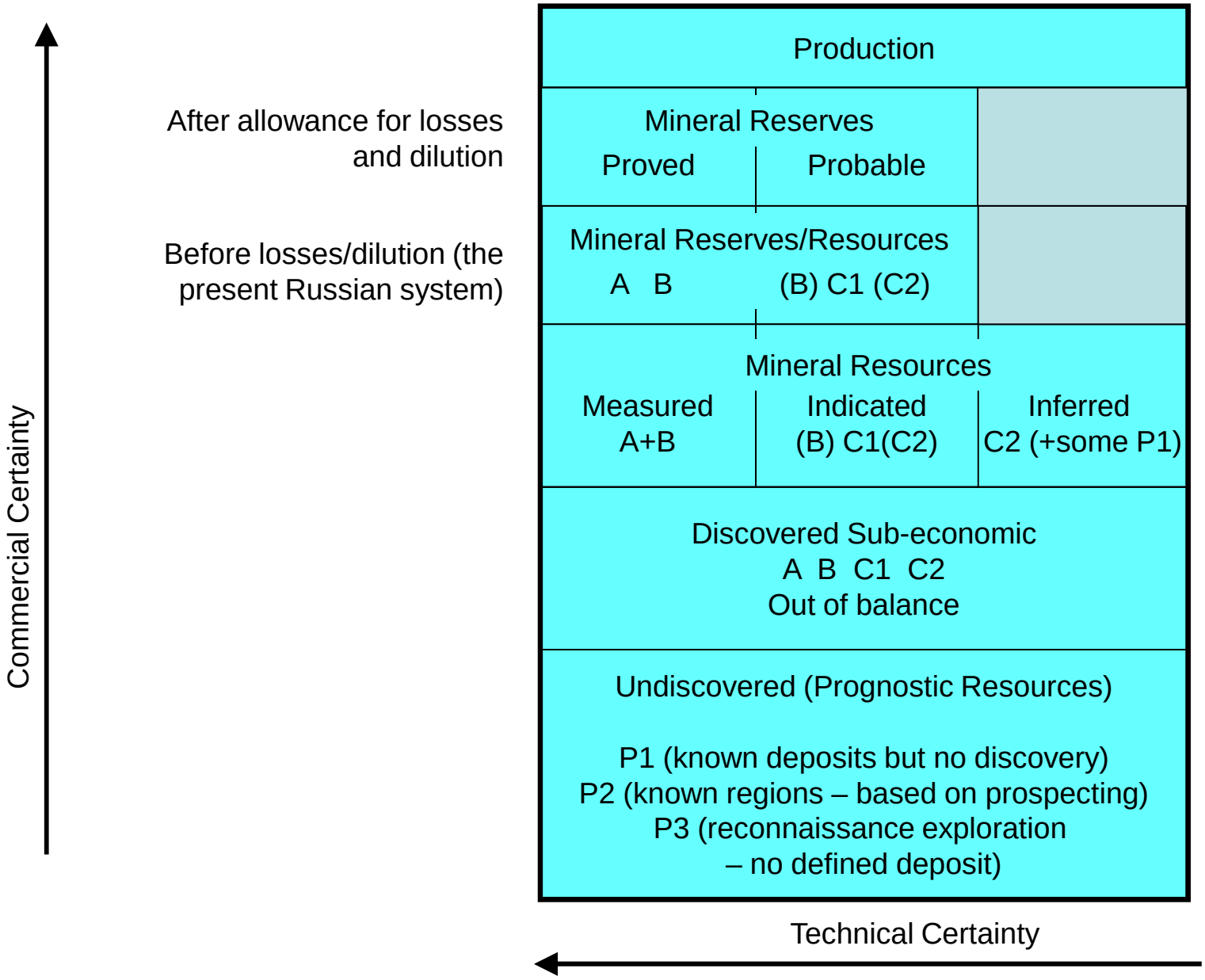
Russian Federation System		CRIRSCO Template*
P1	P1 provides for the possible extension of the mineralisation beyond the boundary of C2 or for the possibility of new deposits in the area being explored. Resource estimates are based on the geological and structural characteristics of known bodies in the area being explored with only limited direct geological evidence.	Essentially extrapolates from known resource areas into unknown areas within the same general geological characteristics. Limited extrapolation is allowable as an Inferred Resource but in general this refers to the exploration stages where **Exploration Results** (eg drill hole intercepts) would be disclosed. The information would generally be too sparse to estimate volume, tonnes and grade.
P2	P2 provides for the possibility of discovery in a **basin, or ore region, a site or field of new mineral deposits,** the proposed existence of which is based upon favourable estimation of occurrence from **large-scale (or in some cases medium-scale) geological survey and exploration work** on the mineral occurrences, and also **geophysical and geochemical anomalies** … Prognostic resources are obtained from **large-scale geological survey, prospecting**. Prognostic resources expressed quantitatively associated with a **local area** form the **basis for formulation of a detailed exploration work programme**	**Exploration target generation** based on regional **geological mapping and structural studies**. Remote sensing, aerial and ground **geophysical and geochemical surveys** to locate preferentially mineralised areas. References to quantitatively estimated prognostic resources associated with a local area in RF system seem to refer to something higher up the chain. CRIRSCO's perspective would be that this stage represents early exploration, often by remote means designed to generate Exploration Targets (not a CRIRSCO term – it occurs in JORC) which form the basis for planning exploration work programmes.
P3	P3 provide for **merely the potential possibility of discovery** of deposits of one or other kind of mineral on the basis of favourable geological and palaeogeographic pre-conditions, discovered in the **region** being estimated, from medium-small scale geological/geophysical and geological survey work **interpretation of satellite imagery**, and also with analysis of results of **geophysical and geochemical studies**. Their **quantitative estimation is done without connection with any concrete locations**.	This is the very earliest stage of target generation prior to any significant exploration. Based only on identifying prospective areas based on mineralisation analogies, literature search, compilations of previous exploration, **satellite imagery** or mining history. Quantification is not allowed at this level of detail (exception would be if CRIRSCO adopted JORC's exploration target)

* Template classes below the level of Inferred are generally regarded as too uncertain to estimate tonnes and grade



Note: Reserves & Resources are not distinguished in Russian system. A resource with a completed Pre-Feasibility or Feasibility study could be a reserve.

New Suggestion - 2008



Note: Reserves & Resources are not distinguished in Russian system. A resource with a completed Pre-Feasibility or Feasibility study could be a reserve.

Agreed simplified basis for resource classification alignment

Russian category	CRIRSCO category
A	MEASURED RESOURCE
B	MEASURED / INDICATED RESOURCE
C1	INDICATED / INFERRED RESOURCE
C2	INDICATED / INFERRED RESOURCE
P1	INFERRED RESOURCE / EXPLORATION RESULTS
P2/3	EXPLORATION RESULTS

Some conclusions

- The RF and CRIRSCO classifications contain significant similarities
- 2-D representation offers the best means of ‘mapping’ different codes
- Differences exist that can be explained by mapping
- Applying the same terminology is fundamental
- Mutual understanding of terminology is critical

2
Defining Reserves and Resources
(as separate terms)

Resources vs. Reserves (CRIRSCO view)

- Mineral Resources are in situ estimates based on geological evidence with preliminary* technical and economic assessments sufficient to show that there are reasonable prospects for eventual economic extraction.

- Mineral Reserves are the economically mineable part of a Mineral Resource. Mining dilution and recovery factors have been applied and technical and economic studies** carried out of sufficient detail to demonstrate at the time of reporting that extraction could reasonably be justified. These studies (pre-feasibility and feasibility) address all of the 'modifying factors': mining, metallurgical, economic, marketing, legal, environmental, social and governmental.

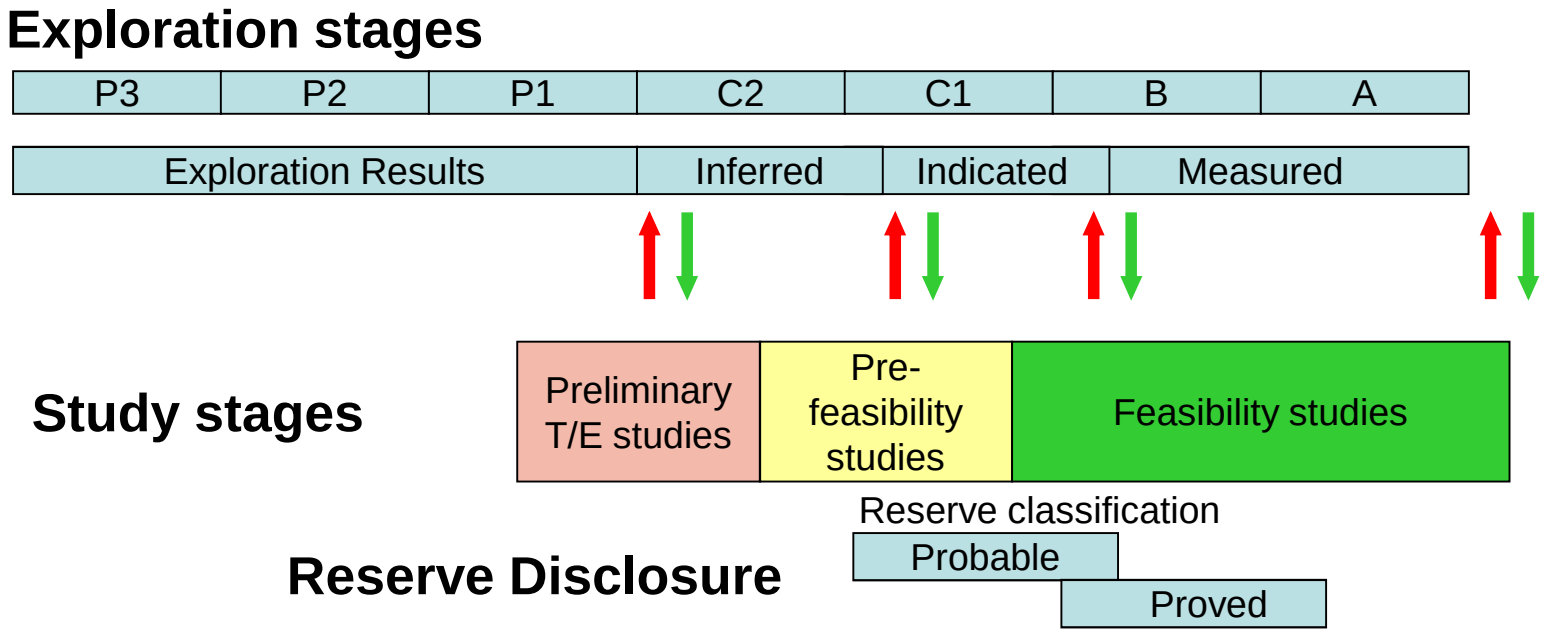
* Preliminary is taken to mean a quick analysis to show that there is reasonable confidence that appropriate mining and processing methods could be found and that there are sufficiently known analogies to say that there are reasons to believe in the reasonable prospects for eventual economic extraction. Simple pit shells, conceptual recovery processes etc, exclusion of fatal environmental flaws etc would be considered.

** Technical and economic studies generally taken to mean pre-feasibility or feasibility studies to address all of the modifying factors

Resources vs. Reserves (RF view)

- Resources out of balance (uneconomic) – below agreed cut-off grade, or metallurgically difficult to process, or inaccessible by current mining methods, etc.
- Resources may be economic on preliminary assessments (but remain out of balance because PFS/FS not completed or not yet submitted for GKZ approval. In this case they may be referred to as “operational resources” or “author’s estimate of resources”.
- Reserves on balance etc: reported only after GKZ approval

Geological and technical/economic studies run in parallel



- Resources are in situ geological estimates:
- Converted to reserves by the application of increasingly detailed technical & economic studies
- The class of the resource is defined by the geological detail and deposit complexity
- The class of reserve is defined by the technical/economic detail
- Progress through the resource stages overlaps with progress through the study stages: but resources and reserves (under CRIRSCO) are always clearly distinguished

3
Defining Technical & Economic Studies

Project Development Stages

- Conceptual
- Order of Magnitude
- Pre-feasibility
- Feasibility
- Detailed Engineering
- Construction
- Production

This sequence is commonly given different names by mining companies but the principles are generally the same

Pre-feasibility Study

- **A Preliminary Feasibility Study is a comprehensive study of the viability of a mineral project that has advanced to a stage where the mining method, in the case of underground mining, or the pit configuration, in the case of an open pit, has been established and an effective method of mineral processing has been determined, and includes a financial analysis based on reasonable assumptions of technical, engineering, legal, operating, economic, social, and environmental factors and the evaluation of other relevant factors which are sufficient for a Qualified Person, acting reasonably, to determine if all or part of the Mineral Resource may be classified as a Mineral Reserve.**

Source: CIM Definition Standards (Canada) 2005

Feasibility Study

- **A Feasibility Study assesses in detail the technical soundness and economic viability of a mining project, and serves as the basis for the investment decision and as a bankable document for project financing. The study constitutes an audit of all geological, engineering, environmental, legal and economic information accumulated on the project. Generally, a separate environmental impact study is required.**

Source: United Nations Framework Classification 2004

4
Deposit Complexity

Deposit Complexity

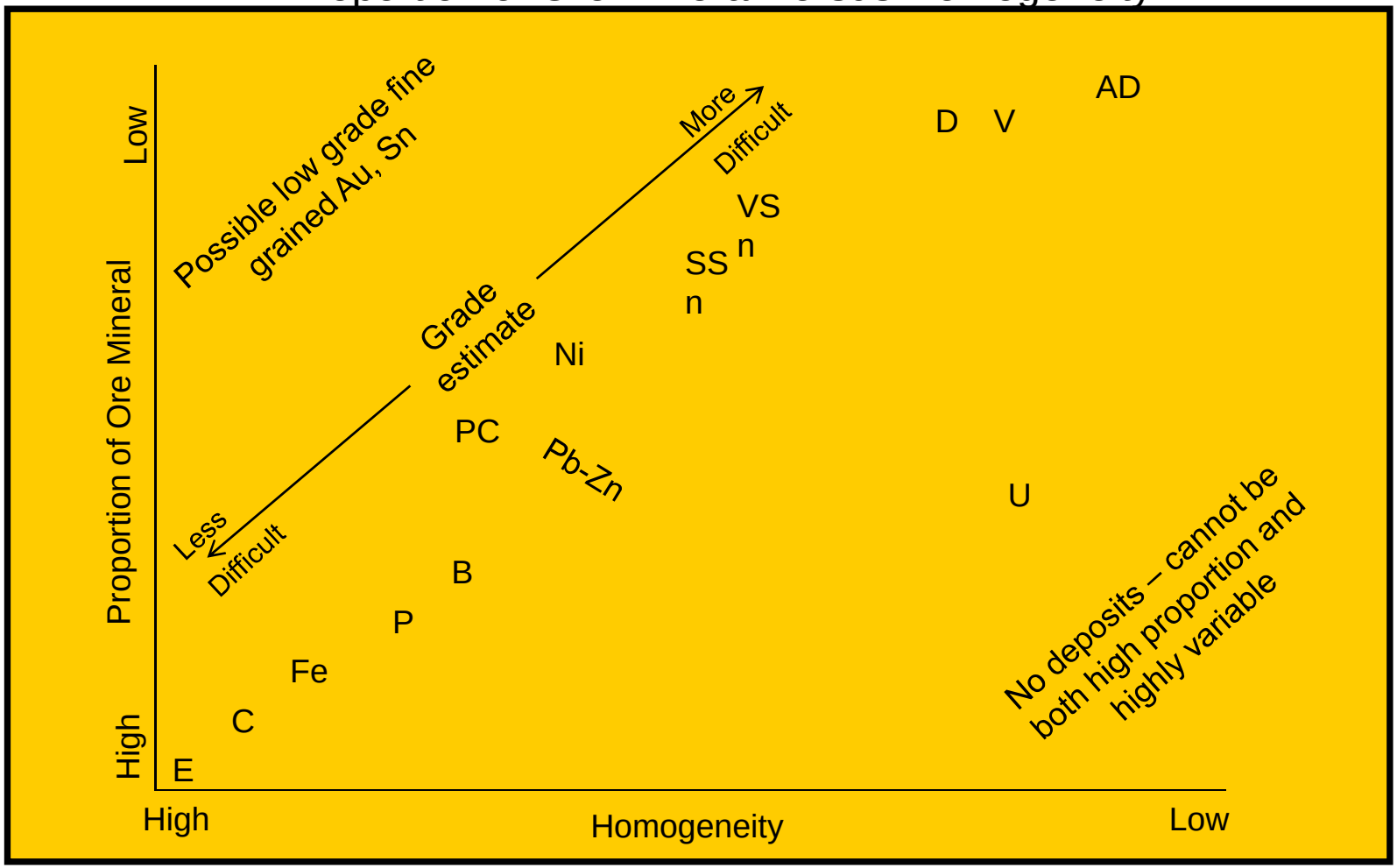
- Recognised formally in Russian Federation system
  - specific exploration rules for each complexity class

Complexity Classes	I	II	III	IV
Highest categories of reserves normally achievable	A	A,B	C1	C2

- Recognised informally in CRIRSCO
  - Competent Person recognises the deposit complexity
  - exploration programme is adjusted to address complexity (drill spacing, extent of sampling etc)

Principle of Deposit Complexity is well understood

Proportion of Ore Mineral versus Homogeneity



E= Evaporite; C= Coal; Fe= Bedded Iron Ore; P=Phosphate; B=Bauxite; PbZn=Stratiform lead-zinc; Ni=Stratiform Ni; SSn=Stratiform tin; PC=Porphyry Copper; VSn=Tin veins; V=Gold, Silver veins; U=Uranium; D=Diamonds; AD=alluvial diamonds (After Haddon King et al 1980)

Source: King, McMahon & Bujtor CRA (Australia) 1980

Deposit complexity

- Recognised by different exploration approaches
- Resource classification reflects uncertainty in grade/geology continuity eg limit diamonds to Indicated Resource at best
- Reserve classification reflects uncertainty in economics eg limit diamonds to Probable Reserves

Deposit Complexity

- Rules (eg the maximum resource class allowable for a given deposit class) can be applied at any point in the estimation/classification process

- CRIRSCO does not specify the level of detail of exploration (eg drill hole spacing)

- Deposits in production may allow the rule to be relaxed based on reconciliation

5
The Competent Person

The Competent Person (CRIRSCO) or Competent Expert (Russia)

- A key component of the CRIRSCO reporting codes. Also for registration of reserves in the Russian system
- Requires qualifications and a minimum of 5 years relevant experience (8 years in the Russian system)
- A CP or CE is responsible for making or approving many experience based decisions during the process of resource and reserve estimation (including deciding the level of exploration needed to address deposit complexity)
- A CP or CE takes individual responsibility* for estimates and can be sanctioned if statements are materially misleading or fraudulent
- Formal estimates of reserves cannot be publicly reported without prior approval by the CP or CE

* Estimates are commonly prepared by teams of people that may contain a number of CPs and signed off by a lead CP

Auditing Process and CPs

International

Company (internal) estimates of resources and reserves

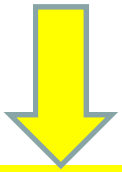
Independent external Consultant* estimates of reserves and resources
CP sign-off

Independent reserves audit required by banks and regulators
CP sign-off

*Independent audit is best practice but not required

Russia

Company (internal) estimates of resources and reserves



Independent external consultant (institute) estimates of reserves and resources
CP sign-off

GKZ submission - Independent technical audit
CP sign-off

Protocol signed 22 October 2008

ФГУ «Государственная комиссия
по запасам полезных ископаемых»
(ГКЗ)

FGU «State Commission
on Mineral Reserves» (GKZ)

Комитет
по международным стандартам
отчетности о запасах твердых
полезных ископаемых
(CRIRSCO)

Committee
for Mineral Reserves International
Reporting Standards
(CRIRSCO)

ПРОТОКОЛ О НАМЕРЕНИЯХ / PROTOCOL OF INTENTIONS

ФГУ «Государственная комиссия по запасам полезных ископаемых» (ГКЗ) и Комитет по международным стандартам отчетности о запасах твердых полезных ископаемых (CRIRSCO):

- исходя из целей и задач своей основной деятельности и долговременных интересов обеих Сторон в развитии мирового горнопромышленного бизнеса с активным включением в него России;
- учитывая роль ГКЗ в обеспечении условий для рационального и наиболее полного использования минерально-сырьевых ресурсов России и ведущую роль CRIRSCO в разработке международных стандартов отчетности по запасам и ресурсам твердых полезных ископаемых (ТПИ);
- отмечая растущую важность международного взаимодействия в области недропользования в условиях глобализации рынков сырья и капитала, и, в частности, укрепления профессиональных контактов между экспертами ГКЗ и CRIRSCO в деле совершенствования и унификации отчетности по запасам и ресурсам ТПИ;

FGU «State Commission on Mineral Reserves» (GKZ) and the Committee for Mineral Reserves International Reporting Standards (CRIRSCO):

- from the aims and purposes of their principal activities and the long-term interests of both sides in the development of the worldwide mining industry with the active participation of Russia;
- in consideration of the role of GKZ in providing the conditions for rational and fullest use of the mineral raw material resources of Russia and the leading role of CRIRSCO in development of international reporting standards for Mineral Resources and Mineral Reserves;
- noting the growing importance of international activity in the field of mineral resource use with globalisation of markets for raw materials and for capital, and in part the strengthening of professional contacts among experts of GKZ and CRIRSCO in the matter of development and unification of reporting standards for solid mineral resources and reserves.

Code Conversion

- Agreed starting point:

Российские категории	Категории CRIRSCO
C1, (A, B)	Измеренные (measured)/исчисленные (indicated) ресурсы
C2	Исчисленные (indicated)/предполагаемые (inferred) ресурсы
P1	Предполагаемые (inferred) ресурсы/результаты геологических исследований (exploration results)
P2, P3	Результаты геологических исследований (exploration results)

Russian category	CRIRSCO category
C1 (A, B)	MEASURED /INDICATED RESOURCE
C2	INDICATED/INFERRED RESOURCE
P1	INFERRED RESOURCE/EXPLORATION RESULTS
P2, P3	EXPLORATION RESULTS

Also agreed

- Principles for mutual recognition of Competent Persons
- Russia to participate in CRIRSCO and in PERC
- Detailed code converson guidelines to be defined in a ‘conversion handbook’ to be written jointly by GKZ and CRIRSCO during 2009