



COMMITTEE FOR MINERAL RESERVES
INTERNATIONAL REPORTING STANDARDS

crirSCO

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Application of CRIRSCO (PERC) in
mineral exploration and exploitation:

Commodity expertise and quality
assurance for investment disclosure

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Mineral commodities and occurrences are diverse

Copper (*disseminated, massive veins, porphyry, sediment-hosted, skarns*)

Gold (*disseminated, veins*)

Iron Ore (*sediment-hosted, skarns*)

Diamonds (*pipes, alluvial, marine*)

Nickel (*sulphides, laterites*)

Potash (*bedded salts solution mining versus conventional mining*)

Uranium (*hard-rock, sandstone-hosted in situ leach versus conventional mining*)

Lead-Zinc-Silver (*Volcanogenic massive sulphides, carbonate-hosted*)

Specialties (*Lithium, vanadium, rare earths*)

Coal (*structurally disturbed, flat-bedded*)

Industrial minerals

Construction materials (*cement raw materials, aggregates, brick clays*)

Dimension Stones

Is anyone a specialist in all of deposits?

Stages of development need different skills

Exploration

Delineation

Conceptual study

Scoping study

Pre-feasibility study

Feasibility study

Commissioning

Production

Closure

Requiring:

Geological knowledge

Mining expertise

Processing and metallurgical expertise

Legal understanding

Environmental management

Commercial and economic knowledge

Social/cultural awareness

Is anyone responsible for all of these activities?

Different reports have different audiences

Geological reports

Internal project reports

Management planning reports

Investment and strategy reports

State inventory reports

External statements and reports for investors

Is anyone writing all of these reports?

Requirements for a Competent Person

A minerals industry professional

Often a geologist or mining engineer

Employed to work with mineral deposit occurrences in geological environments

Exchanges & sharing of information with other countries & companies

A member of a Recognised Professional Organization (RPO)

Appropriate membership level

Requires academic qualifications, professional experience & peer scrutiny

Subject to ethics and disciplinary codes

Minimum 5 years relevant experience

Style of mineralization

Type of deposit

Activity or area of technical input which that person is undertaking

"Competent Persons should be clearly satisfied in their own minds that they could face their peers and demonstrate competence in the commodity, type of deposit and situation under consideration. If doubt exists, the person should either seek opinions from appropriately experienced colleagues or should decline to act as a Competent Person."

Those that think experience in a similar but still different deposit type makes them competent, should do so with caution.

Note: These requirements are also subject to any additional restrictions or conditions which may be required by relevant stock exchanges or regulatory authorities.

Preparing Competent Persons Reports

- Issued by owners of mineral assets
- Provide information on Exploration Results, Mineral Resources & Mineral Reserves
- Reports are any public announcement that includes or relies on this information
- Reports are prepared at different stages of project development and operation

Exercising judgement in providing external information

- Ensuring that information available is properly considered and reasonable conclusions are drawn, supported by objective views

Upholding the principles of transparency, materiality, competence and impartiality

- The core principles inherent in the CRIRSCO aligned standards

Enabling balanced and reasoned investment decisions

- Information is provided to enable investors and/or professional advisors to make informed decisions

Reporting

Primary responsibility

- May be annual, or for specific purpose
- Include 'first time' reporting, bond issues, results updates, divestments, privatization, press releases, etc.
- Exploration geologists report exploration results
- Mining (or estimation) geologists estimate and report mineral resources
- Mining engineers estimate and report mineral/ore reserves

Leading a team

Co-ordinating other specialists

- Can include other Competent Persons
- Oversees and directs work on those not Competent Persons in their own right
- Could include metallurgists, environmental engineers, economists, marketing experts, etc.
- Responsibility for the work included in reports done by others

Organizing audits and reviews

Considering all matters in reports

- Legacy information
- Geological confidence
- Modifying factors
- Experience from similar or analogue deposits can be important in making assumptions about poorly drilled deposits or unknown aspects in initial stages, but can also be misleading.

A CP Report should demonstrate the competence of the CP to write that report

SME: *The report should be supported adequately by text, figures, tables, sections, and maps to demonstrate competence by conveying material information in a transparent manner.*

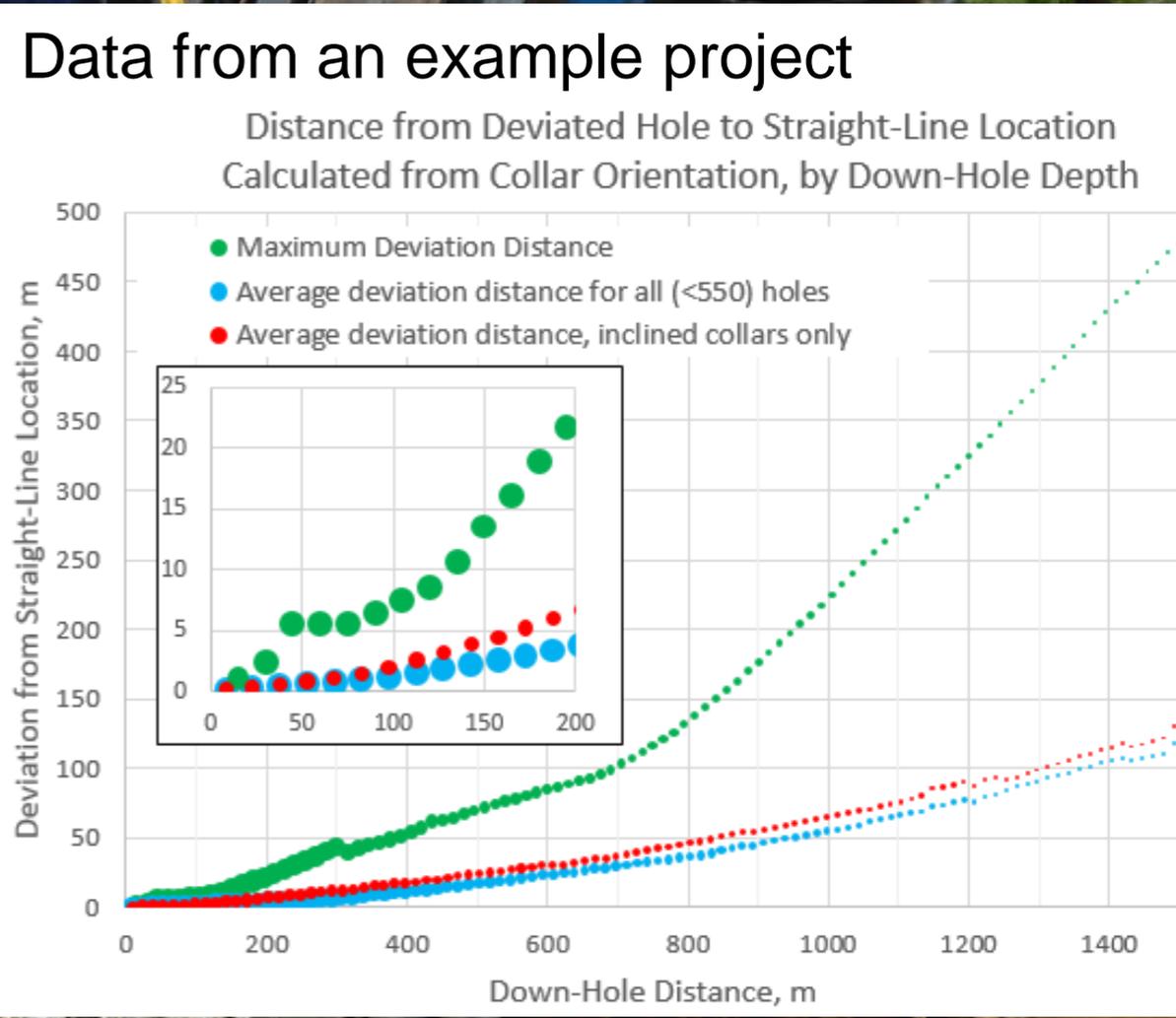
Figures of any type should contain appropriate explanatory information in the form of titles and/or captions.

Areas of Risk	PERC T1 Entries	Examples of aspects where CP Report should assess risks that may affect the outcomes of investment
Context & History	6	Who was the report prepared for and why? Project description outline Previous work and its reliability Previous, existing and/or nearby operations. Location, geography (e.g. in a city?) climate & environment.
Legal Aspects and Tenure	3	Issuer's rights <ul style="list-style-type: none"> • Prospecting, mining, environmental licenses & permits • Land ownership, access, infrastructure rights • Security, present & future & and legal proceedings Cultural, wilderness, parks or other impediments
CP Knowledge of Project	1	Visits made The extent to which CP has personally verified the data
Deposit Sampling & Data	11	Surveying, drilling, trenching, logging, sampling Locating, analysis, assaying, testing, quality control & assurance, data accumulation, verification & storage
Exploration Results	10	Access & ownership rights, geology, mineralogy, geophysics, geochemistry, drilling, environmental liability. Reporting balance to avoid unrealistic expectations
Audits or Reviews	2	Independent technical assessment of data & methods Valuable safeguards for the investor

Areas of Risk	PERC T1 Entries	Examples of aspects where CP Report should assess risks that may affect the outcomes of investment
Geological estimation Mineral Resources	7	Database integrity. geological interpretation (+alternatives) modelling, estimation (+appropriateness), validation, accuracy, values of multiple products - deleterious minerals
Mine Planning Mineral Reserves	4	Cut-off grades, qualities or value. Evidence and/or assumptions of dilution, recovery, access, geotechnical (slopes, stability, support), hydrogeology, equipment, safety
Processing & Metallurgy	1	Flowsheet (new / conventional), recovery & upgrading factors deleterious minerals, environmental impact, health & safety
Economics	1	Land lease / purchase, Royalties, taxes, prices, penalties, transport & treatment, Capital & operating costs, revenues, Financial model & analysis
Market	1	Demand, supply and stocks. Customer & competitor analysis. Price & volume forecasts. If market cannot accommodate max. quantities, adjust Reserves.
Other Modifying Factors	1	Natural risks – earthquakes, flooding, volcanos, climate Infrastructure – transport, power, water, employees Environment – land use, groundwater, discharges, visual Social – local to national employment & economy changes Governmental – local to national mining policy & perceptions
Specialised Minerals	9	Diamonds

Table 1: Location Quality

Down-hole Deviation Survey in progress using a Gyroscopic Tool

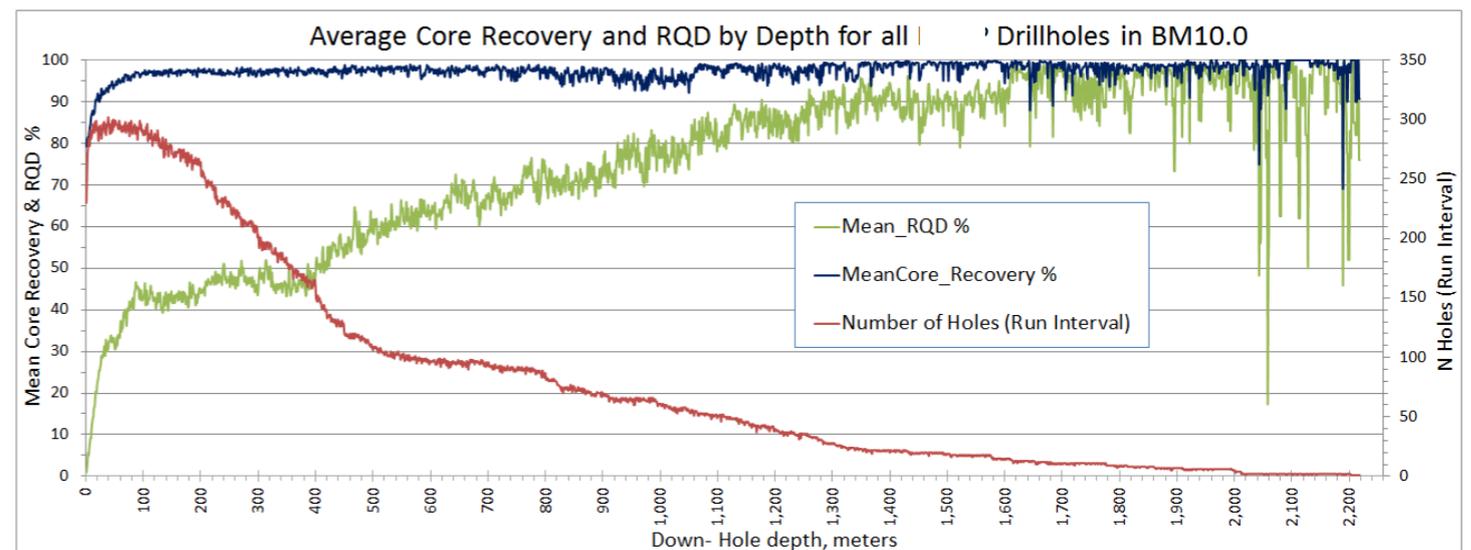


Data location

A statement is required regarding the accuracy and quality of surveys used to locate drill holes (collar and down-hole surveys), trenches, mine workings and other locations. Quality and adequacy of topographic control should be described and locality plans provided.

<i>Drill sample recovery</i>	<ol style="list-style-type: none"> 1 <i>Method of recording and assessing core and chip sample recoveries and results assessed.</i> 2 <i>Measures taken to maximise sample recovery and ensure representative nature of the samples.</i> 3 <i>Whether a relationship exists between sample recovery and grade and whether sample bias may have occurred due to preferential loss/gain of fine/coarse material.</i>
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1. Graph of core recovery vs. depth (right) with other influences, and explanation of significance
2. Might include:
 - Triple-tube wireline drilling
 - For water-soluble minerals, drill fluid is often a saturated solution of that mineral.
 - e.g. KCl solution for Potash
3. Example of core (right) from an evaporite deposit, (could be Trona, Na_2CO_3). Arrows show dissolution of minor mineral (could be Halite NaCl). **Risk of samples negatively biased in this mineral!** Evaluate risk.

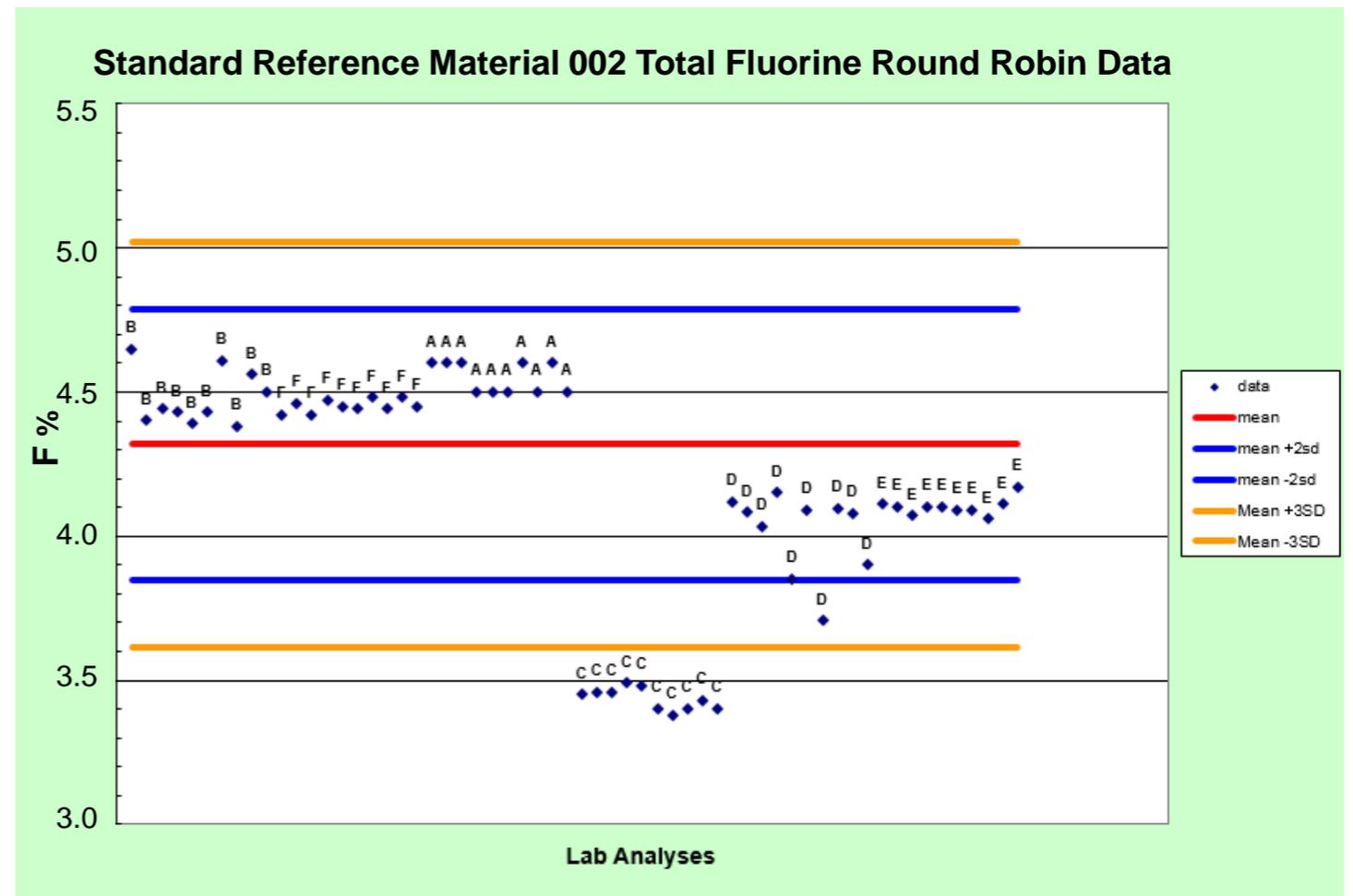


Assaying Quality Example from a Fluorite Project

A quantity of mineralized rock was pulverised and homogenized to provide material for certification as a Certified Reference Material (CRM)

- 10 samples sent to each of 6 reputable commercial laboratories
- Results show great range with highest value 39% higher than the lowest value!
- Certifying consultant discounted Lab C analyses and low outliers of Lab D, then calculated mean and failure thresholds.

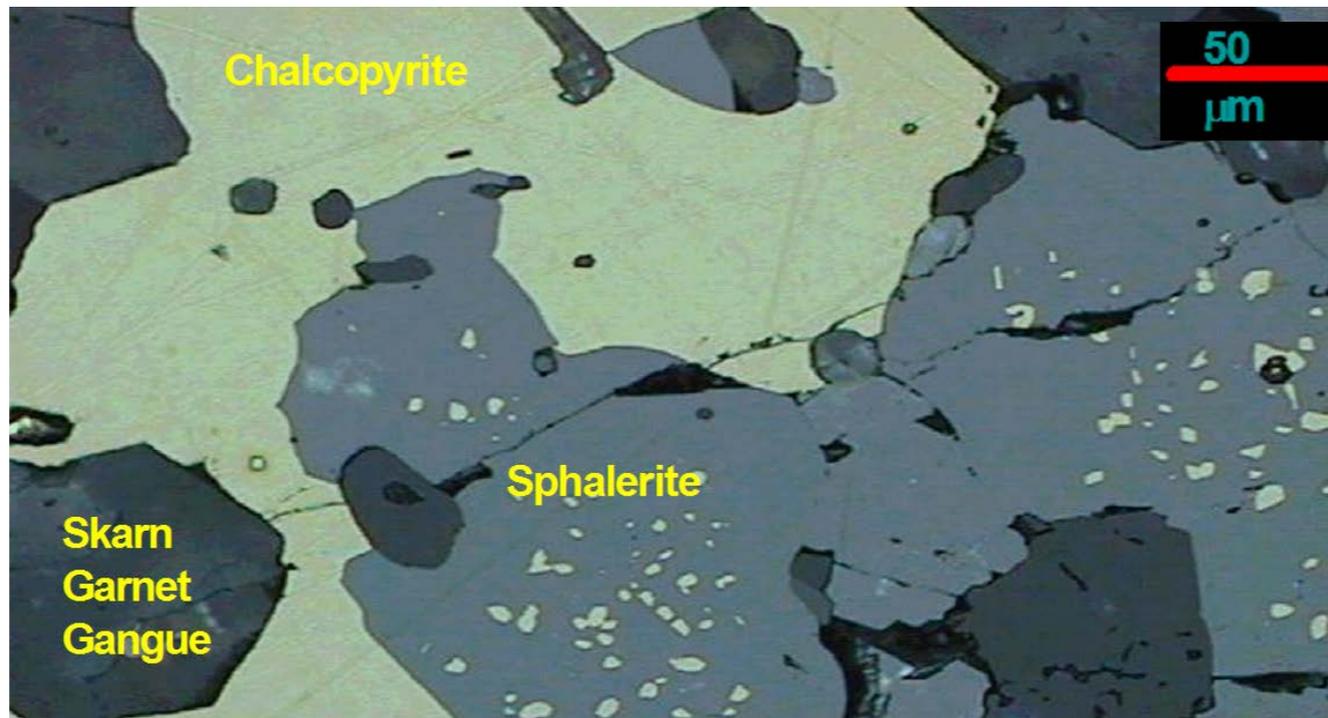
Assay results cannot be assumed to true!
CP must test and support by Quality Assurance / Control procedures (QA/QC)



Assay data and laboratory investigation

... there should be consideration given to ... all stages of sample preparation and analysis, including the use of ... standard samples... In particular, it should be noted whether analyses of samples ... have been replicated independently in other laboratories.

Micrograph of copper & zinc ore: Exsolution Blebs of Chalcopyrite in Sphalerite



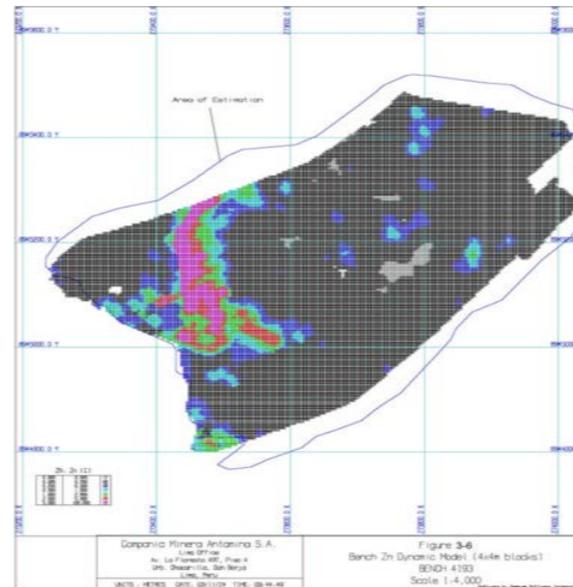
Will there be a penalty for copper in zinc concentrate?

PERC	Metallurgical factors or assumptions	<i>Any assumptions or allowances made for deleterious elements or variability in the ore feed to the process should be stated.</i>
	Cost and Revenue Factors	<i>The assumptions made regarding revenue including ... treatment charges, penalties, etc.</i>

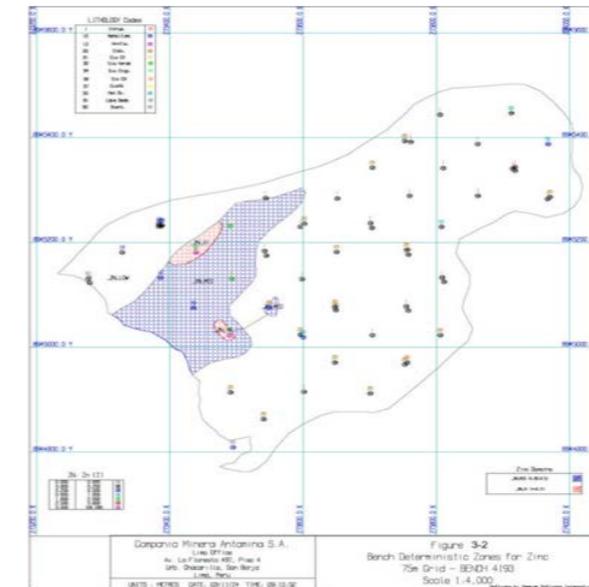
Zinc Open Pit Mine Example (supplied by Dr H Parker)

- The CP must judge what sample spacing is appropriate to classify confidence in Mineral Resources as Inferred, Indicated & Measured
- This must be based on geological & mathematical (geostatistical) reasoning.
- **Before the deposit is mined:** CP may also refer to other comparable operations with same style of mineralization.
- **After mining has started:** CP must reconcile what was estimated with ground truth, and develop estimation procedure so that future estimates are unbiased.

Plans of Example Bench: Blue ≥ 0.25 , Pink $\geq 2.5\%$

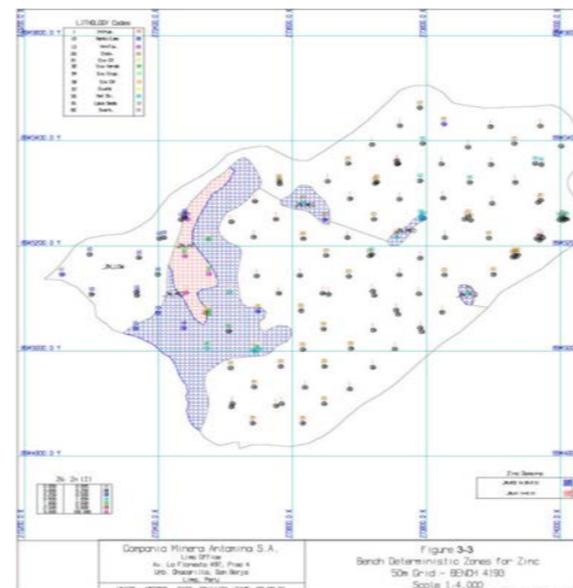


Ground-truth Based on Blast Holes (7 X 7 m Spacing)



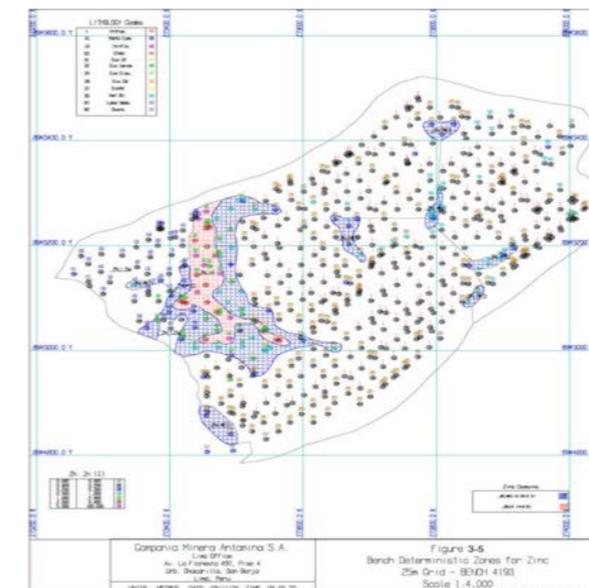
75 X 75 m Spacing; High-grade is under-represented

Inferred



50 X 50 m Spacing; High-grade is still under-represented

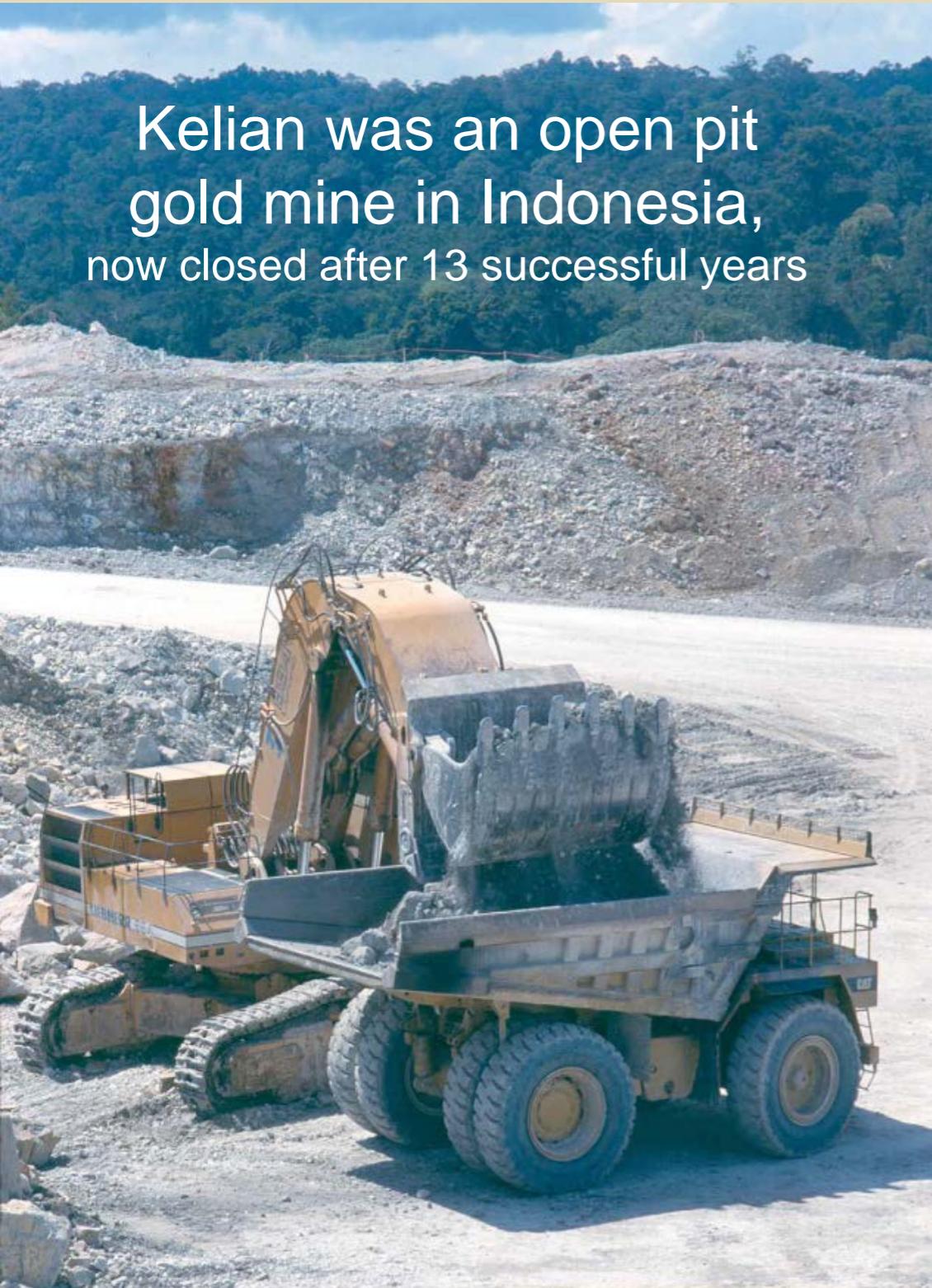
Indicated



25 x 25 m Spacing High-grade is fairly well represented

Measured

Kelian was an open pit
gold mine in Indonesia,
now closed after 13 successful years

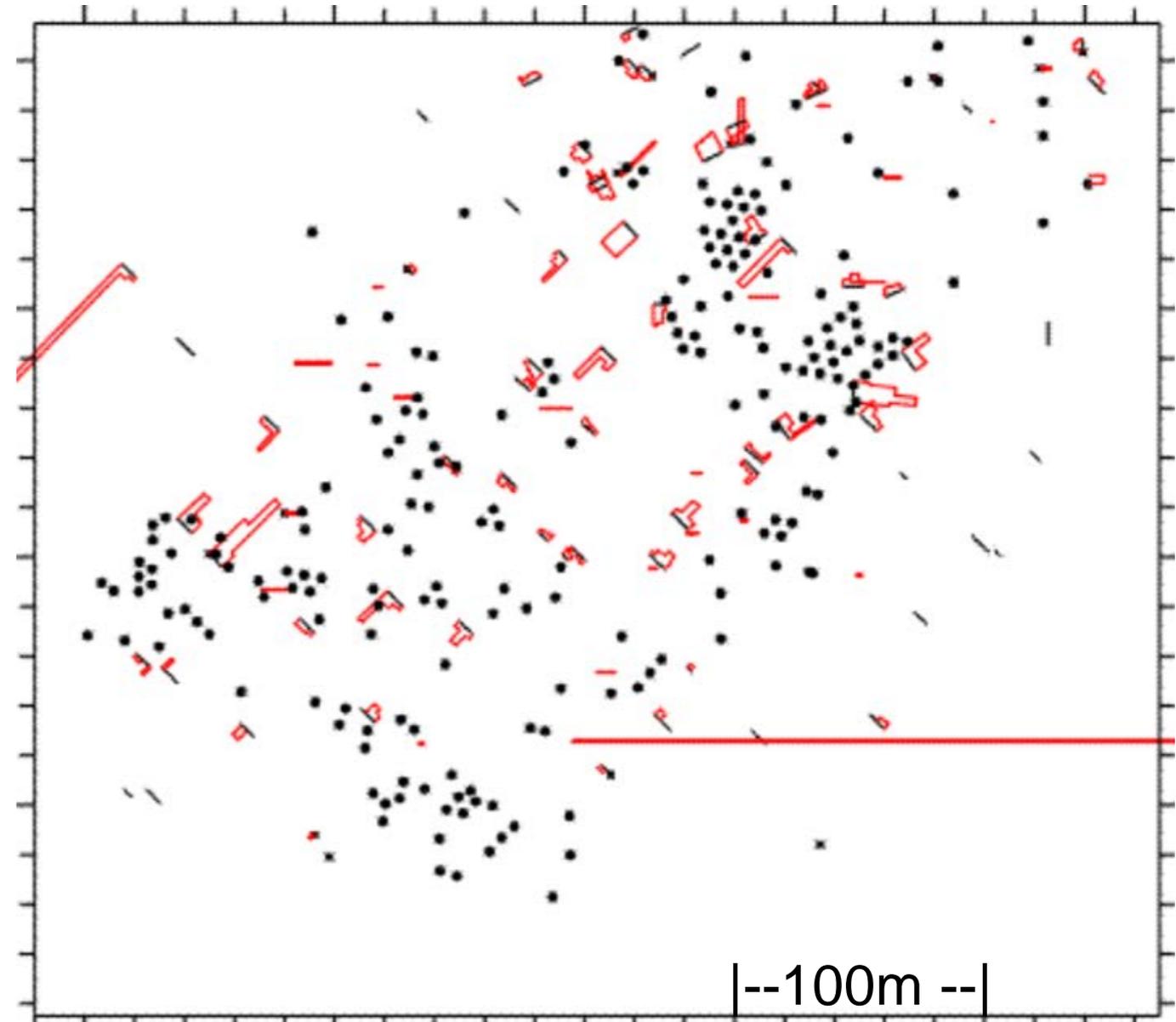


- **1976 – 1988** : Discovery & Exploration by a consortium of:
 - CRA (now part of Rio Tinto)
 - Kalimantan Gold (KMG) - “Junior” mining co.
- **1989** : Feasibility Study – used CRA expertise
 - CRA decide to go ahead with mining
 - KMG shareholders decide to sell up to CRA
- **1992** : Mining Starts
- **1993** : **Gold grades ≈50% higher than forecast!**
- **1994** : ex-KMG shareholders file suit to claim a share of the revenue from extra gold production.
 - CRA defends – it had taken on all risks.
- **1996** : Trial begins (CRA defended by Dr H Parker)
- **1997** : Litigation Case settled in mediation
 - i.e. CRA did not have to pay.
 - Study of lessons learnt – as follows:

An open pit bench plan

- Drillholes drilled for the Feasibility Study through the bench are shown as short black lines.
- Their gold grades are shown as red histogram bars, length proportional to grade
- Blast-holes drilled during production are shown as black dots if their gold grades were high (>4 grams/tonne.)
- **The Feasibility Study drillholes missed most of the high grade locations**
- **There were not enough drillholes to identify that the high-grade gold was present in small localised structures.**

The data spacing was not close enough and the geology was not understood!



- The defence was that the Feasibility Study was of adequate standard for its time.
- The court did not uphold the claimants case.
- It told the two sides to settle in mediation.
- Cases such as this led to development of CRIRSCO standards and codes
- and specifically, the following Table 1 criteria (JORC Code Example)

<i>Data spacing and distribution</i>	<ul style="list-style-type: none"> • <i>Data spacing for reporting of Exploration Results.</i> • <i>Whether the data spacing and distribution is sufficient to establish the degree of geological and grade continuity appropriate for the Mineral Resource and Ore Reserve estimation procedure(s) and classifications applied.</i>
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- **If the CRIRSCO standards and codes had been available in 1989, and a compliant CP Report had been produced, the Kelian Litigation should never have happened.**

Commodity expertise and quality in the acquisition, interpretation and calculation of information are vital for transparency, materiality, competence and impartiality in mineral disclosure.

Thank you!