

Evergreens in Exploration and Green Skills

for
finding Green Minerals

examples from
Tenke-Fungurme,
DR Congo

Wolf Schuh
08 2023



Kwatebala, DR Congo

Cautionary Statement



This presentation contains forward-looking statements in which FCX discusses its potential future performance. Forward-looking statements are all statements other than statements of historical facts, such as plans, projections, or expectations relating to business outlook, strategy, goals or targets; global market conditions; ore grades and milling rates; production and sales volumes; unit net cash costs and operating costs; capital expenditures; operating plans; cash flows; liquidity; PT-FI's financing, construction and completion of additional domestic smelting capacity in Indonesia in accordance with the terms of its special mining license (IUPK); extension of PT-FI's IUPK beyond 2041 and export licenses; PT-FI's timely resumption of exports; payment of export duties; export volumes; FCX's commitment to deliver responsibly produced copper and molybdenum, including plans to implement, validate and maintain validation of its operating sites under specific frameworks; execution of FCX's energy and climate strategies and the underlying assumptions and estimated impacts on FCX's business related thereto; achievement of 2030 climate targets and 2050 net zero aspiration; improvements in operating procedures and technology innovations and applications; exploration efforts and results; development and production activities, rates and costs; future organic growth opportunities; tax rates; the impact of copper, gold and molybdenum price changes; the impact of deferred intercompany profits on earnings; mineral reserve and mineral resource estimates; final resolution of settlements associated with ongoing legal proceedings; debt repurchases; and the ongoing implementation of FCX's financial policy and future returns to shareholders, including dividend payments (base or variable) and share repurchases. The words "anticipates," "may," "can," "plans," "believes," "estimates," "expects," "projects," "targets," "intends," "likely," "will," "should," "could," "to be," "potential," "assumptions," "guidance," "aspirations," "future," "commitments," "pursues," "initiatives," "objectives," "opportunities," "strategy" and any similar expressions are intended to identify those assertions as forward-looking statements. The declaration and payment of dividends (base or variable), and timing and amount of any share repurchases are at the discretion of the Board of Directors (Board) and management, respectively, and are subject to a number of factors, including maintaining FCX's net debt target, capital availability, FCX's financial results, cash requirements, global economic conditions, changes in laws, contractual restrictions and other factors deemed relevant by the Board or management, as applicable. The share repurchase program may be modified, increased, suspended or terminated at any time at the Board's discretion.

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Estimates of mineral reserves and mineral resources are subject to considerable uncertainty. Such estimates are, to a large extent, based on metal prices for the commodities we produce and interpretations of geologic data, which may not necessarily be indicative of future results or quantities ultimately recovered. This presentation includes forward-looking statements regarding mineral resources not included in proven and probable mineral reserves. A mineral resource, which includes measured, indicated and inferred mineral resources, is a concentration or occurrence of material of economic interest in or on the Earth's crust in such form, grade or quality, and quantity that there are reasonable prospects for economic extraction. Such a deposit cannot qualify as recoverable proven and probable mineral reserves until legal and economic feasibility are confirmed based upon a comprehensive evaluation of development and operating costs, grades, recoveries and other material modifying factors. This presentation also includes forward-looking statements regarding mineral potential, which includes exploration targets and mineral resources but will not qualify as mineral reserves until comprehensive engineering studies establish legal and economic feasibility. Significant additional evaluation is required and no assurance can be given that the potential quantities of metal will be produced. Accordingly, no assurances can be given that estimated mineral resources or estimated mineral potential not included in mineral reserves will become proven and probable mineral reserves.

This presentation also contains measures such as unit net cash costs per pound of copper and molybdenum, net debt and adjusted EBITDA (earnings before interest, taxes, depreciation and amortization), which are not recognized under U.S. generally accepted accounting principles (GAAP). FCX's calculation and reconciliation of unit net cash costs per pound of copper and net debt to amounts reported in FCX's consolidated financial statements are in the supplemental schedules of FCX's 2Q23 press release, which is available on FCX's website, fcx.com. A reconciliation of amounts reported in FCX's consolidated financial statements to adjusted EBITDA is included on slide 27.

For forward-looking non-GAAP measures FCX is unable to provide a reconciliation to the most comparable GAAP measure because the information needed to reconcile these measures is dependent upon future events, many of which are outside of management's control as described above. Additionally, estimating such GAAP measures and providing a meaningful reconciliation consistent with FCX's accounting policies for future periods is extremely difficult and requires a level of precision that is unavailable for these future periods and cannot be accomplished without unreasonable effort. Forward-looking non-GAAP measures are estimated consistent with the relevant definitions and assumptions.

Evergreens and Green Skills



- Business
- Exploration Model
- Mapping
- Targeting
- **Drilling**
- **People**

A look beyond the comfort zone of engineering and science.

- **Environmental**
- **Social**

Mining is a Business

- Stock exchange regulations require definition of an **ore body**, based on **drill data**.
- Drilling requires **drill targets**
- Targeting is based on different **exploration methods**. AMIRA
- The choice of methods is driven by the **exploration model** you use. AMIRA
- The exploration model is based on
 - a) **ore deposit type** AMIRA
 - b) the **local** variation of that type
 - c) local geography (climate, topo, soils)
- Regional **metallogenic trends** get you into an area in first place AMIRA



Definition of Ore

Ore is a rock that can be mined for a profit.

0.8 % Cu, 0.02 Mo
99.2 % Waste
Phyllic Alteration
Quartz Eyes
Multiple sets of veins



Discovery of a Mine

- **Mines are found in the field, not in the office**
 - A day in the office is not a day in the field (*Confucius*)
- Office work is a necessity to prepare for field work, i.e. to make it more efficient



- a day in the field is a day not spent in meetings.

The Job of a Company Geologist



Find a mine:

Discover an ore body

Define an ore body



What is an Ore Body?

- Non-geologists seem to have an unspoken notion of some blob-shaped ‘ore body’ inside the earth. Apparently a lot of people think that the explorer with his donkey suddenly recognizes the ore body and exclaims ‘Eureka!’



From this Eureka moment on,
the ore body is thought of
some sort of
fixed 3D shape

The Ore Body in Reality

An Ore Body is a mass of rock that can be mined for a profit.

In exploration, there is no 'instantly' appearing ore body.

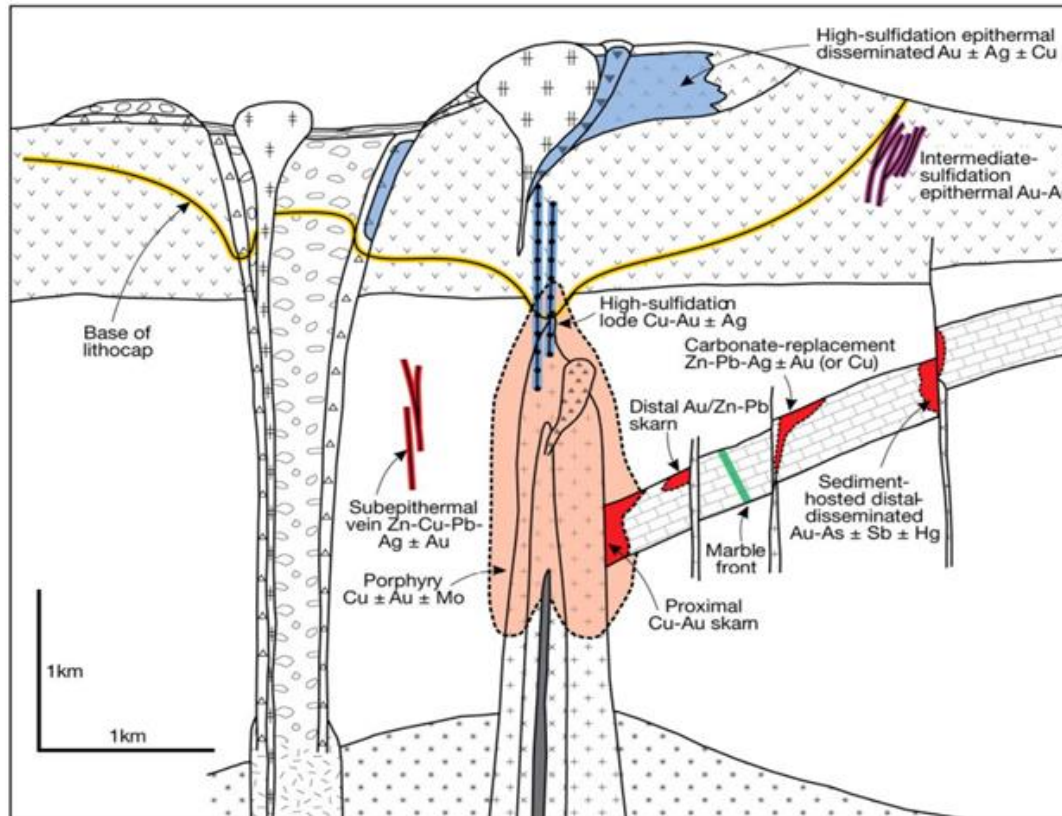
Finding and defining an ore body is a **slow, organic process**.

During a multi-year exploration program, the ore body grows, then later shrinks again, sometimes morphs.

.....if commodity prices fall low enough, your ore body can shrink a lot.



Exploration Model

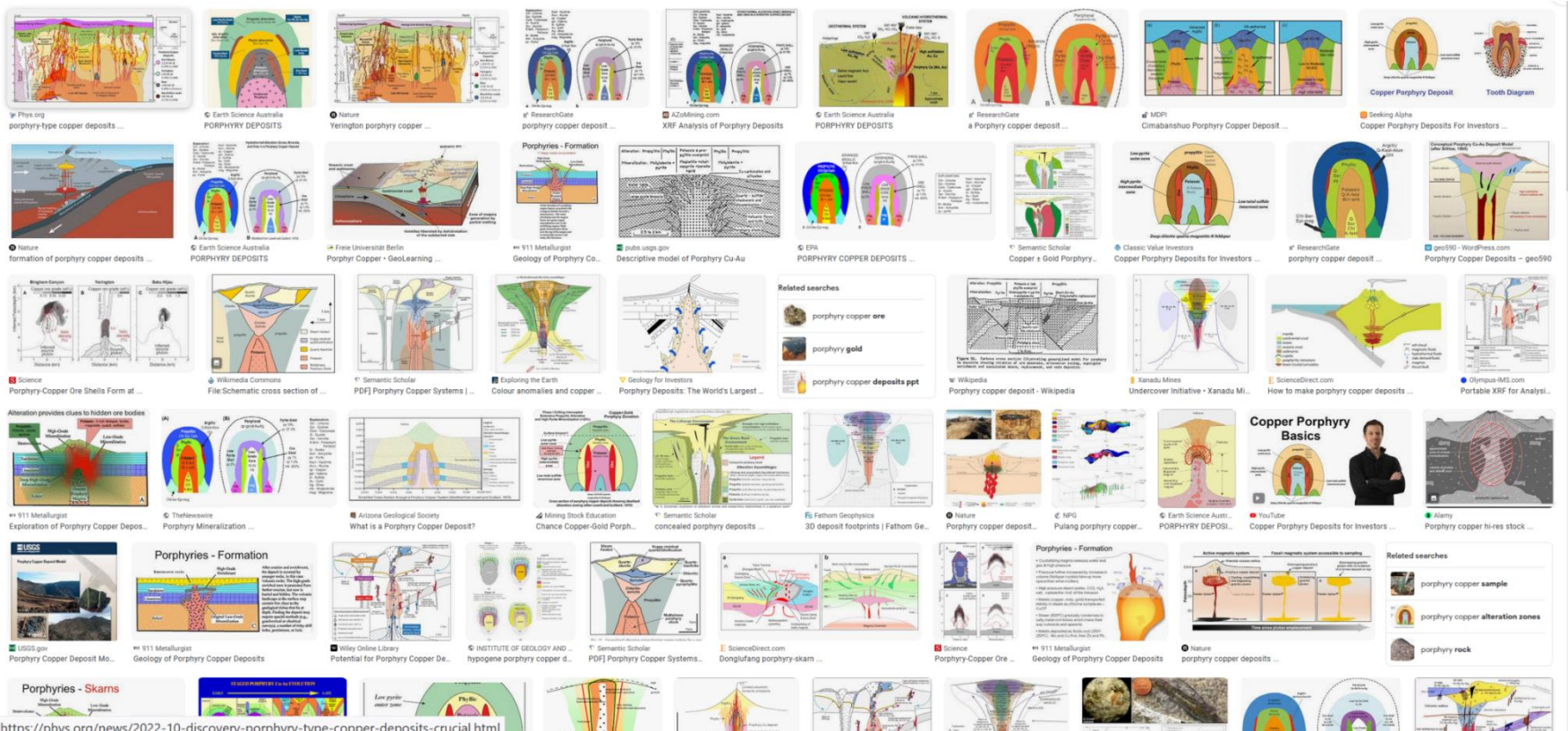


Modified from Sillitoe (1995b, 1999b, 2000)

Sillitoe, Richard H., "Porphyry Copper Systems." *Economic Geology* v. 105 no. 1 (2010): pp. 3-41

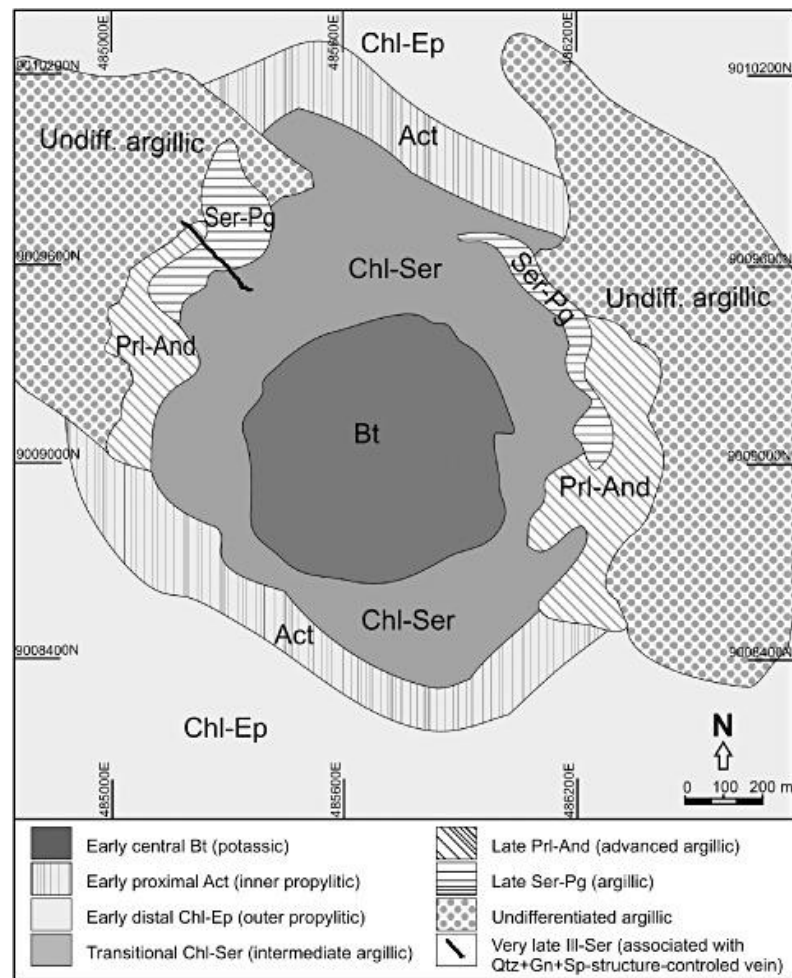
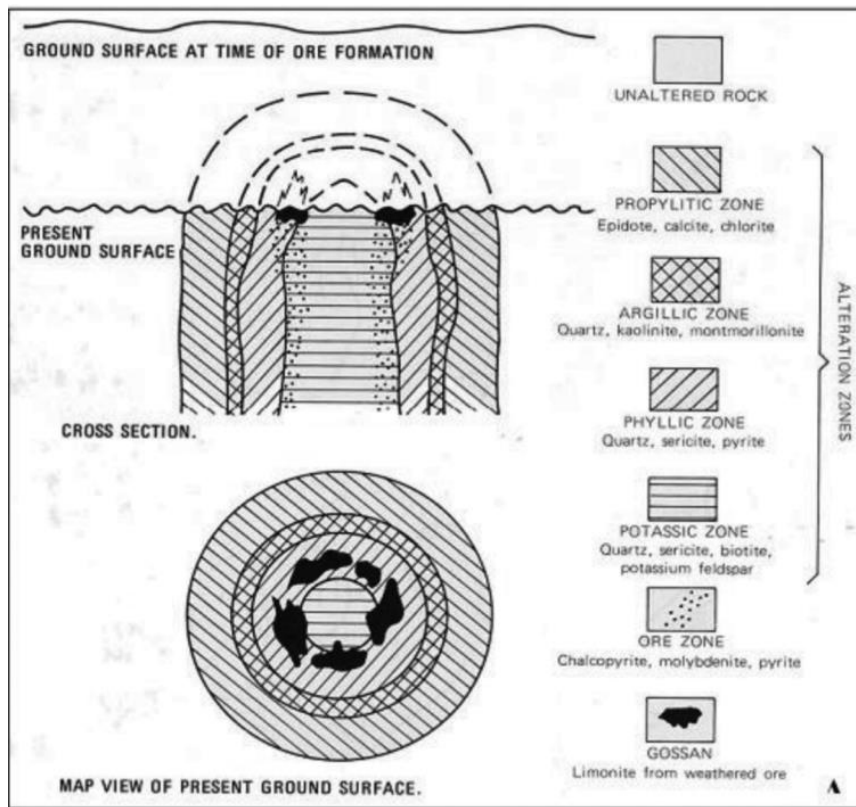
Ore deposit models are not scientific dogma but working hypotheses

A Google search produces 100s of zoning models as cross sections, but rarely in planar view



<https://ohvs.ora/news/2022-10-discovery-porphvrv-tvce-copper-deposits-crucial.html>

Exploration reality: planar view



Bring in the Experts - early

Expert advice can
provide a huge
shortcut on the
wastage curve

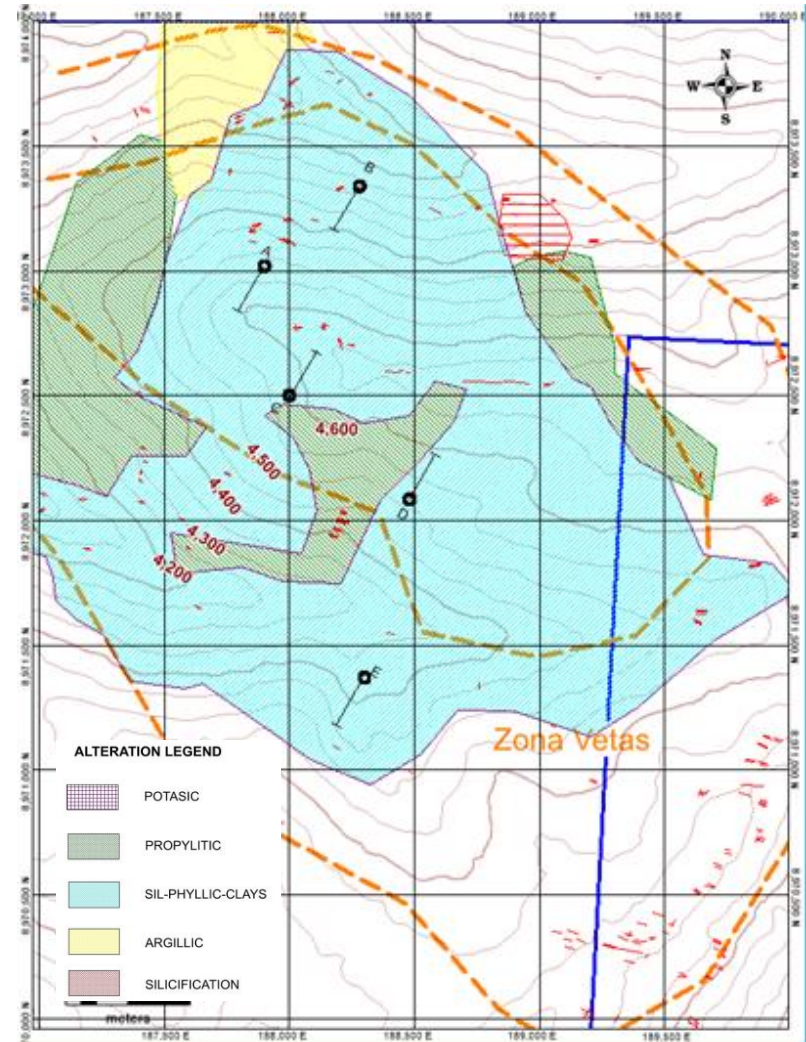
**AI will not replace
expert knowledge
in exploration in a
very long time**



Murray Hitzman, Congo, 2004

Why make a Map if I have a Computer ?

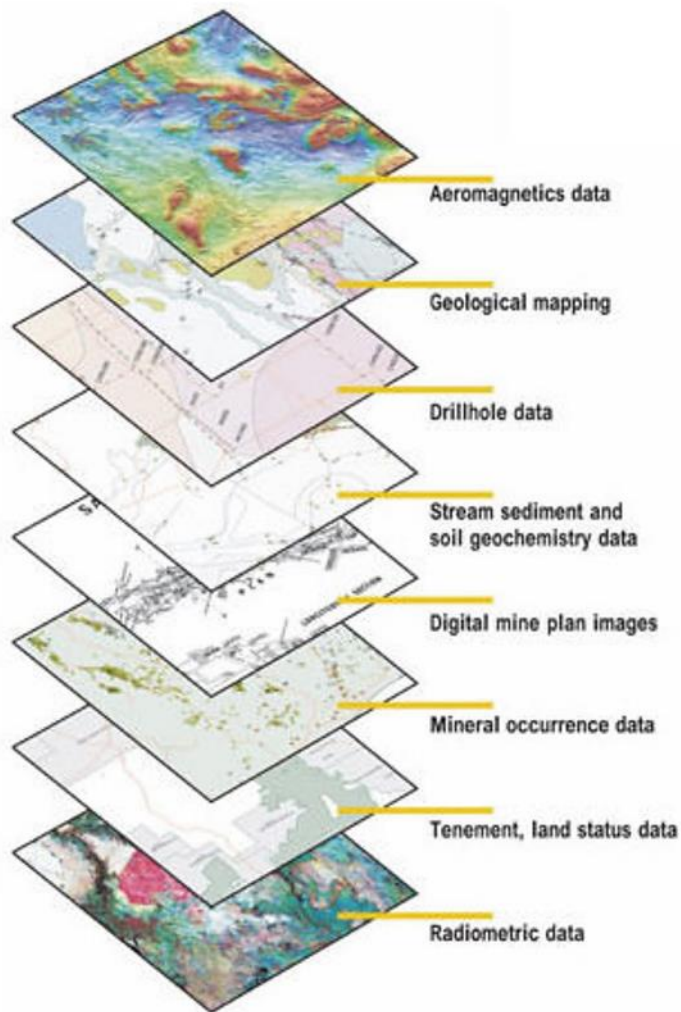
- **Geological mapping is a method of recording and organizing of observations.** (*John Proffett, 2004*)
- Intelligent vs Systematic Mapping
- **Targeting tool**, ideally in combination with other exploration methods
- *Nothing replaces walking the ground, hitting hundreds of rocks, listening to the sound they make when you hit them, their different hardness, different textures, even the different smell they give off, the way they are weathering.*



Maps – Communication Tool



Target Generation

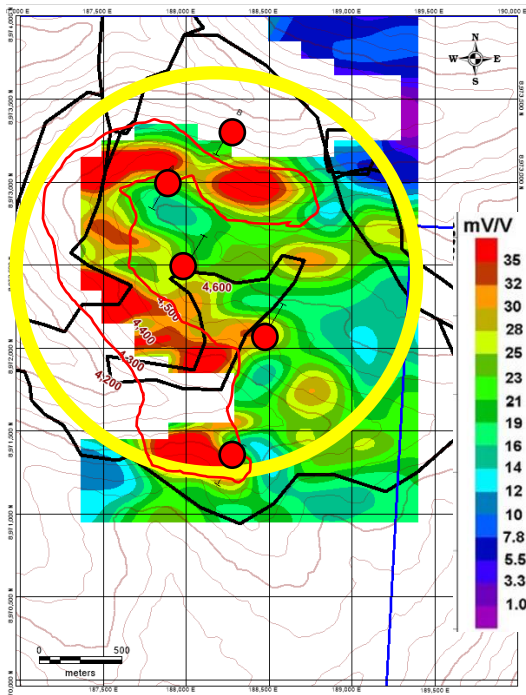


- **Targets are needed for drilling.**
- For targeting, use a **combination** of favorable factors that match well with your exploration model.
- In **GIS**, 90% of the time is compilation work.
- The fun is in the 10% of the time.

Map View of a Drill Target

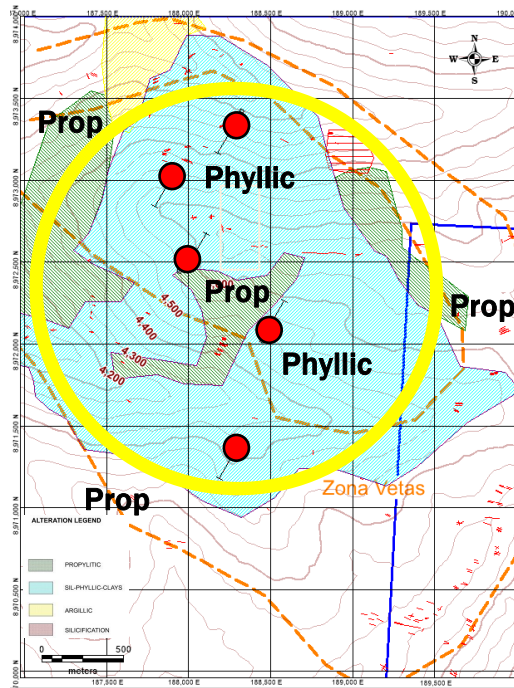
Geophysics

Distinct electric anomaly = red horseshoe zone marking the outside and upper side of a porphyry copper deposit



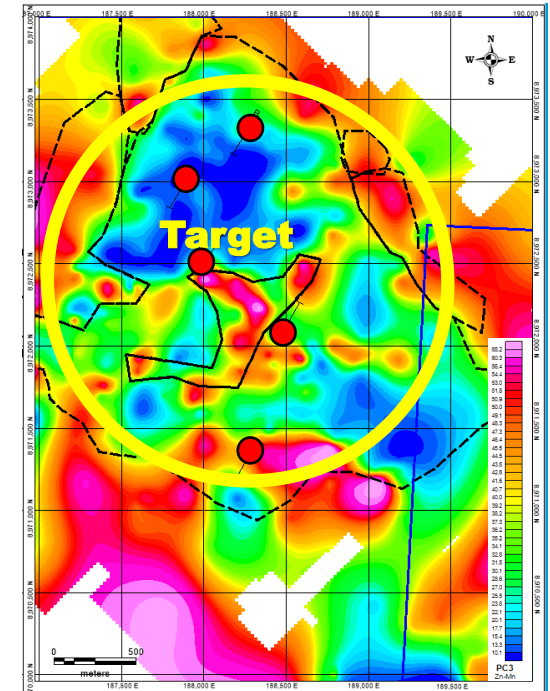
Alteration

Outer propylitic zone (green) & inner phyllic zone (blue) = top of a porphyry copper deposit. Central green patch is atop the blue phyllic below.



Geochemistry

Principal Component Analysis: distinct Zn-Mn removal (= blue, low area) indicates the top of a porphyry copper deposit

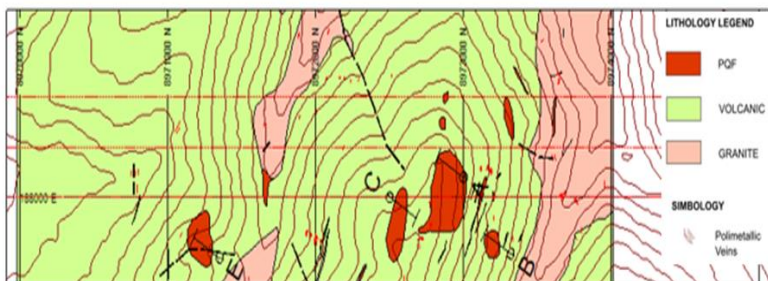


● red circles = proposed drill sites ● yellow circle = target area

Un-drilled target with classic indicators of a porphyry copper deposit

Section View of a Drill Target

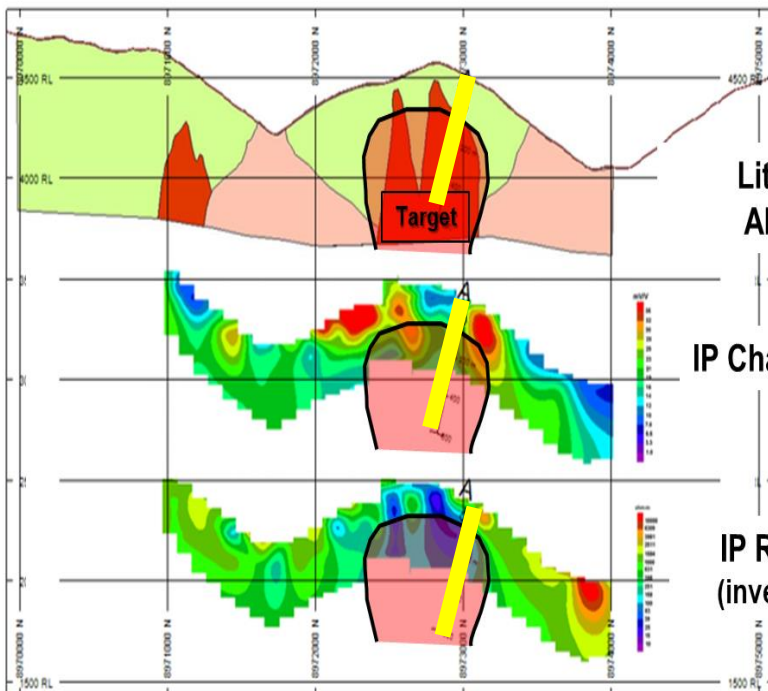
S LITHOLOGY



N S

ALTERATION

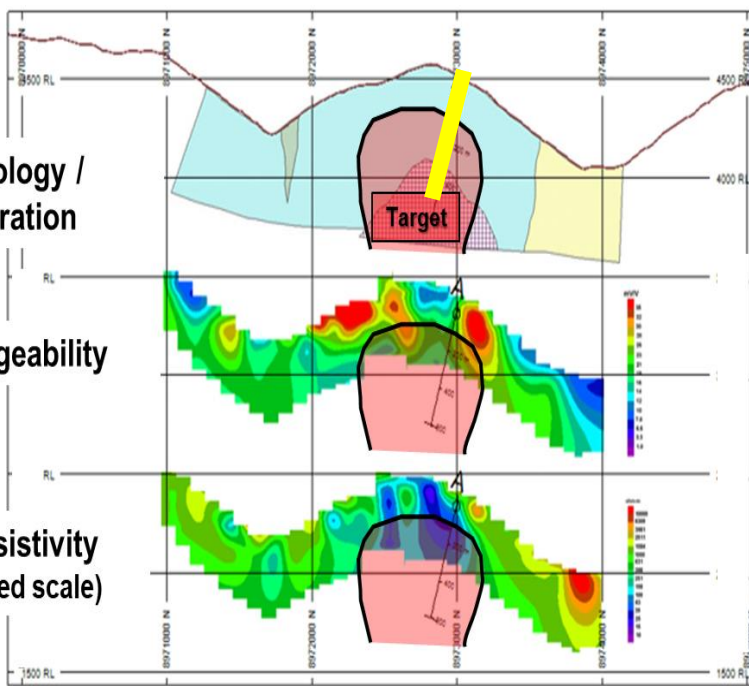
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Lithology /
Alteration

IP Chargeability

IP Resistivity
(inverted scale)



Lithology /
Alteration

IP Chargeability

IP Resistivity
(inverted scale)

Gorilla in the Room: Drilling

- Mines are almost always discovered by drilling.
- In an exploration program without a drilling component, your chances of success are very small.
- Drill cost should be the gorilla-sized line item in most exploration budgets (>50%).



Drill Method

- For the initial discovery, diamond core is overrated.
- **Rotary drilling ('RC') is often good enough. Initially, all you want is find the metal you are looking for. Diamond drilling effectively cuts your chances of success in half.**
 - *Escondida would not have been found using diamond drilling, because the drill budget would have been exhausted before getting there.*

Good ESG: man-portable
core rigs in mountains

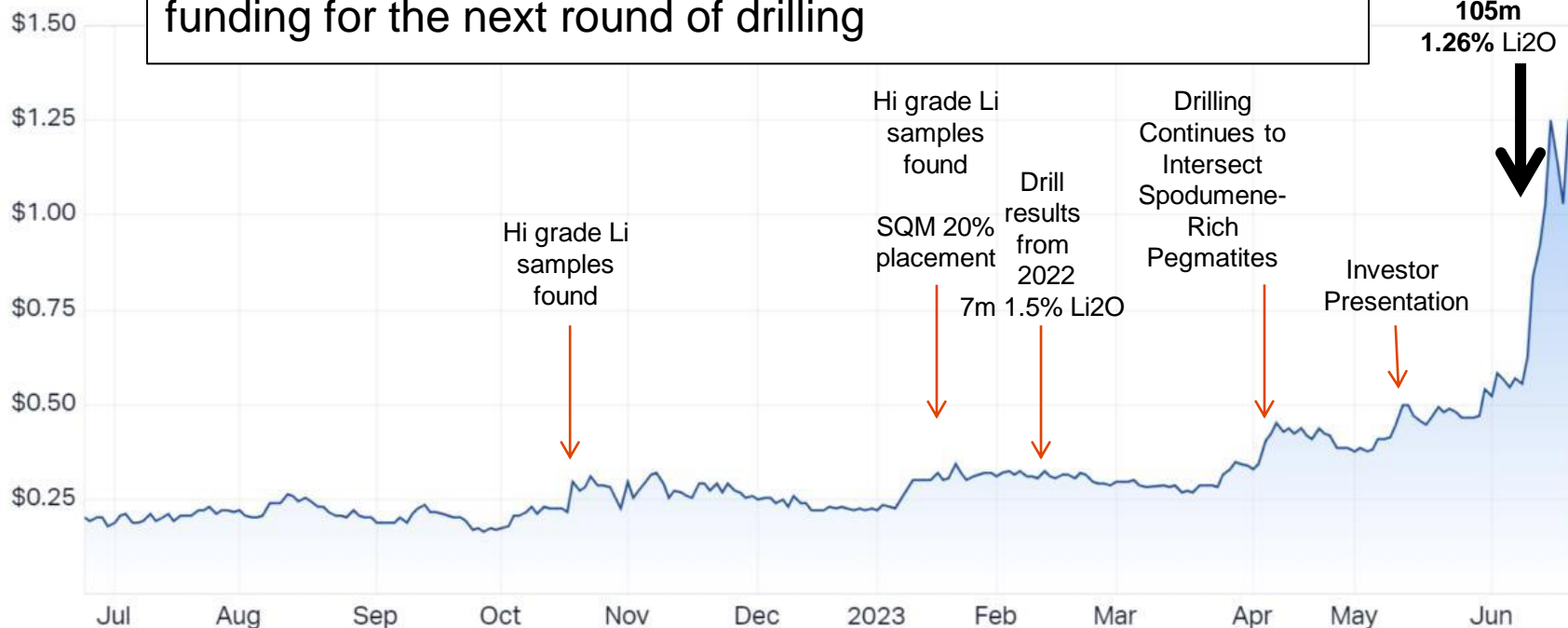


A long, high-grade drill intercept

Good and long drill intercepts are the *most important*

driver of stock price changes of junior companies

In major companies, a good intercept usually gets you new funding for the next round of drilling



The 1: 5,000 Pyramid

1 World-Class mine

Knowledge \$\$

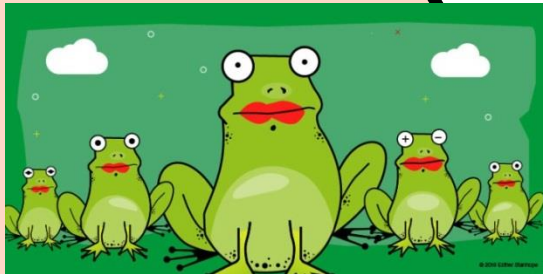
Risks



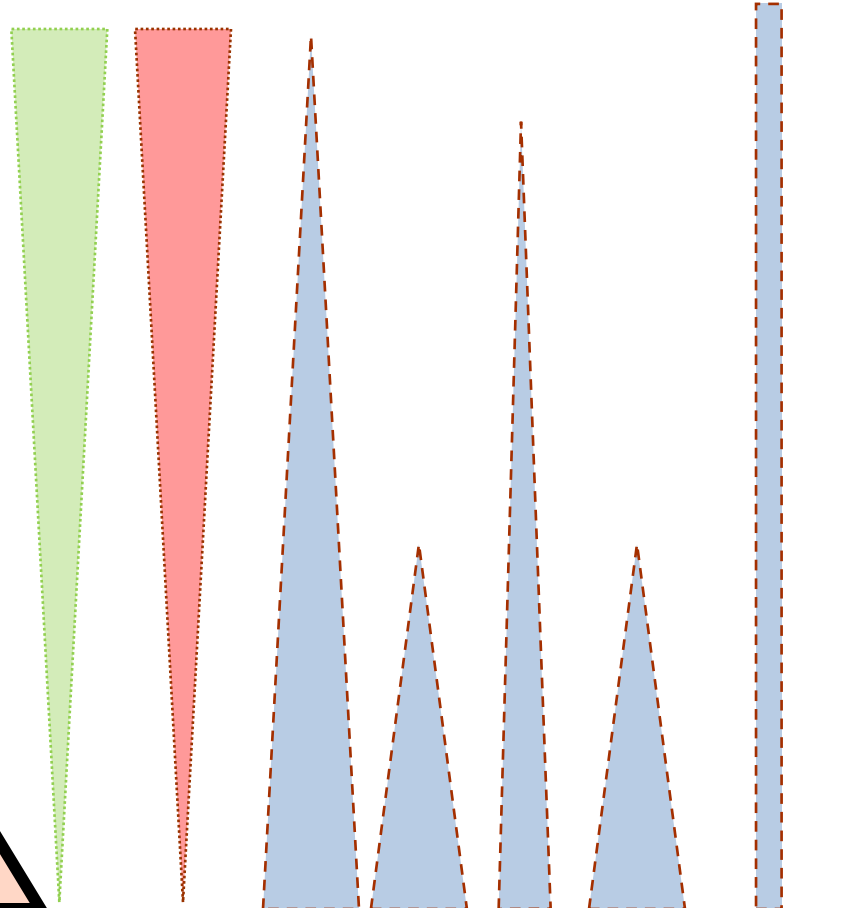
Promotors



Red Herring



5,000 prospects



ESG

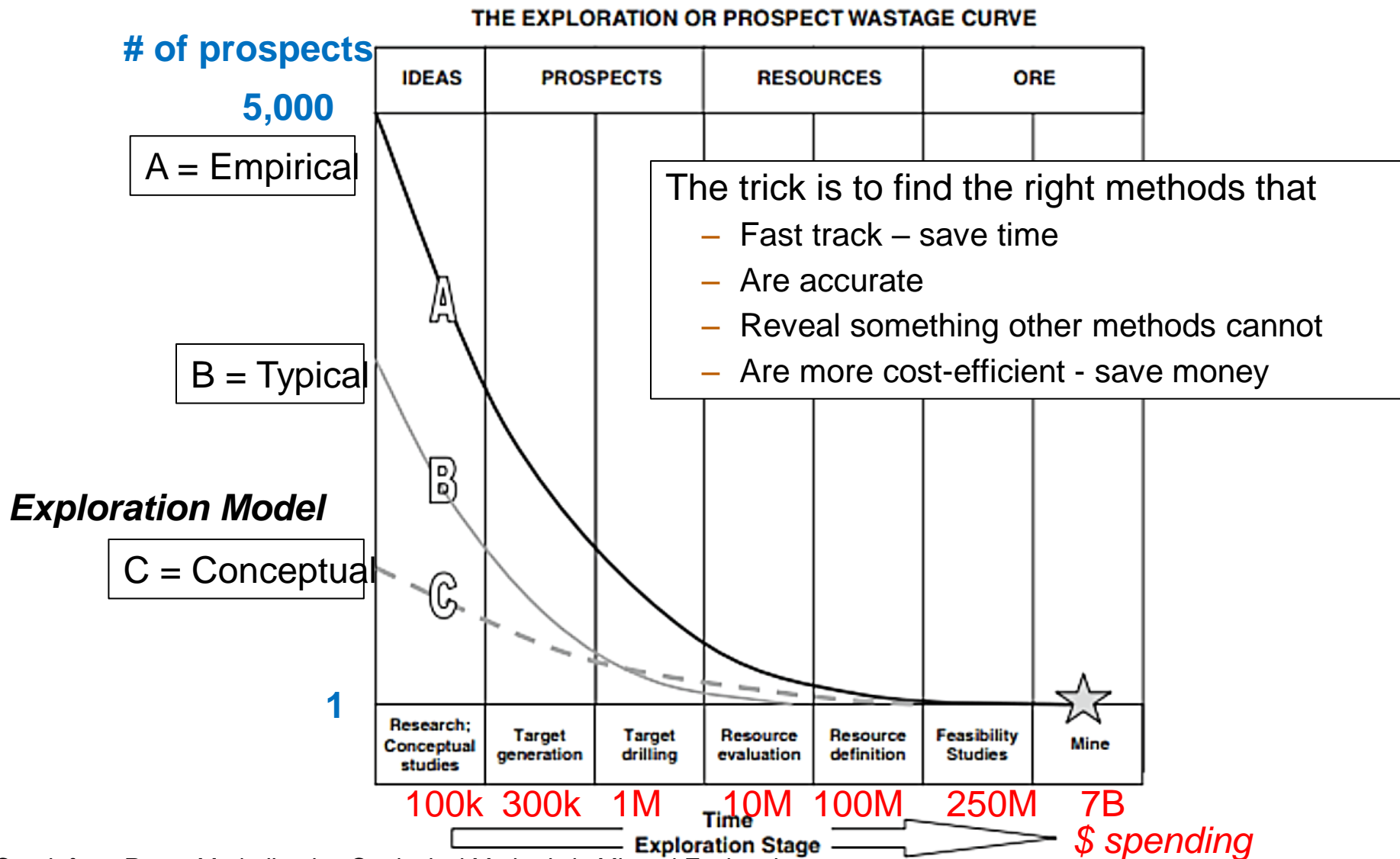
Land Economics

Geology

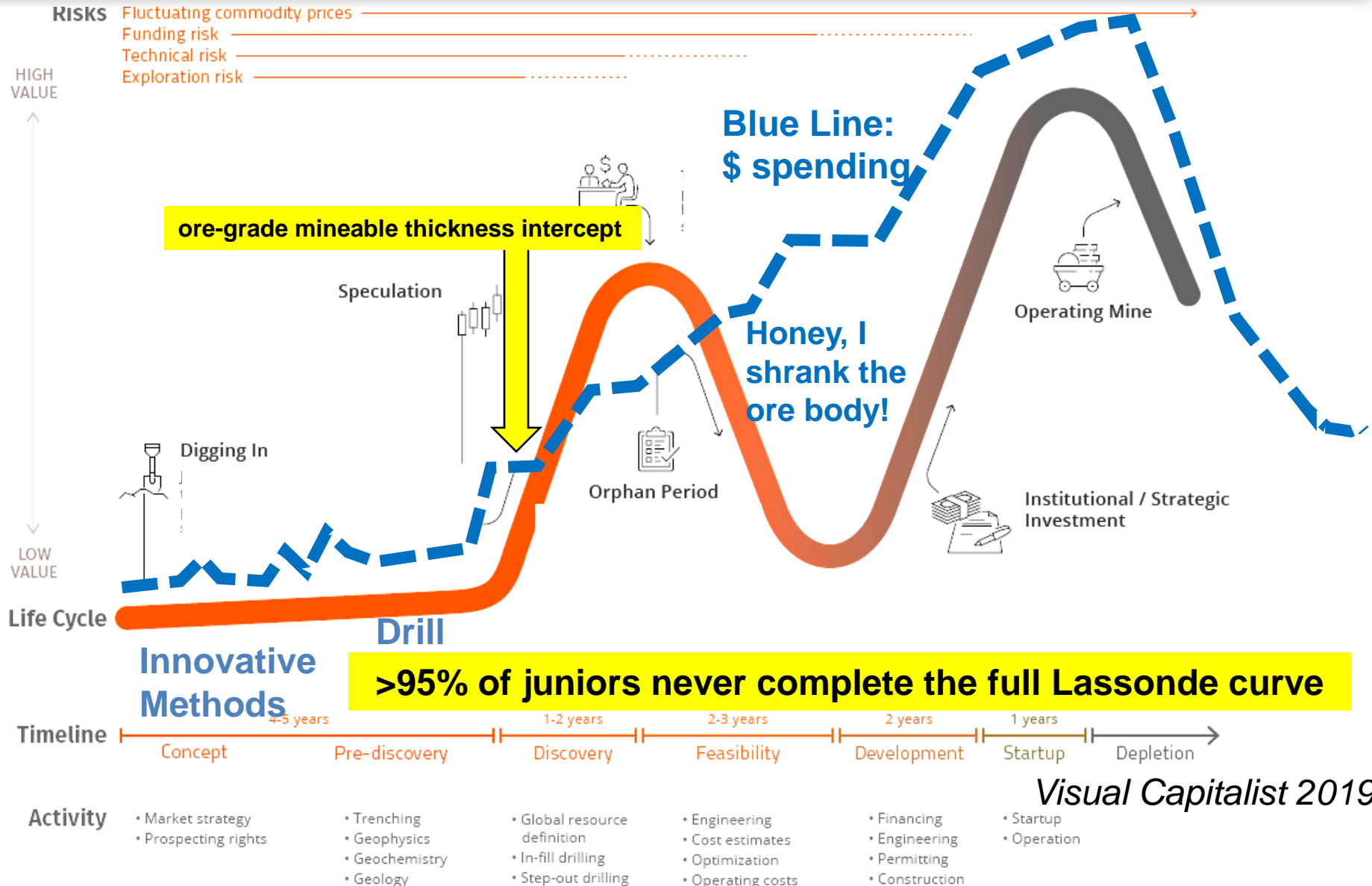
Country

Risk

Wastage Curve



The Lassoonde Curve – a great marketing tool



Sanity Check – Famous Explorers



- **Ore bodies are found in the field, not in the office** (*David Lowell, Escondida, Toromocho*).
- **Exploration is a business, not a science** (*Sig Muessig*)
- **Drills find ore bodies, geologists don't. Drill rigs are truth machines** (*Sig Muessig, Getty*)
- **The better geologists are the ones who have seen the most rocks.** (*Doug Kirwin, Oyu Tolgoi*)
- **Boots and Hammer. Overreliance on computer work at the expense of field observation** (*Doug Kirwin*)
- **Sure, 'prospectivity' is important. But access is also important.** (*Jim Lalor, Nevada gold*)
- **Too many people think you can discover ore bodies with laptop computers, but all you can do with those is become a very qualified draftsman** (*Dan Wood, Cadia*)
- **In a lot of bigger organizations, exploration becomes about process, and that has nothing to do with discovery. It becomes about managing rather than leading.** (*Graham Brown, Anglo*)

People – The Exploration Geologist

GEOLOGY



What I think I do



What society thinks
I do



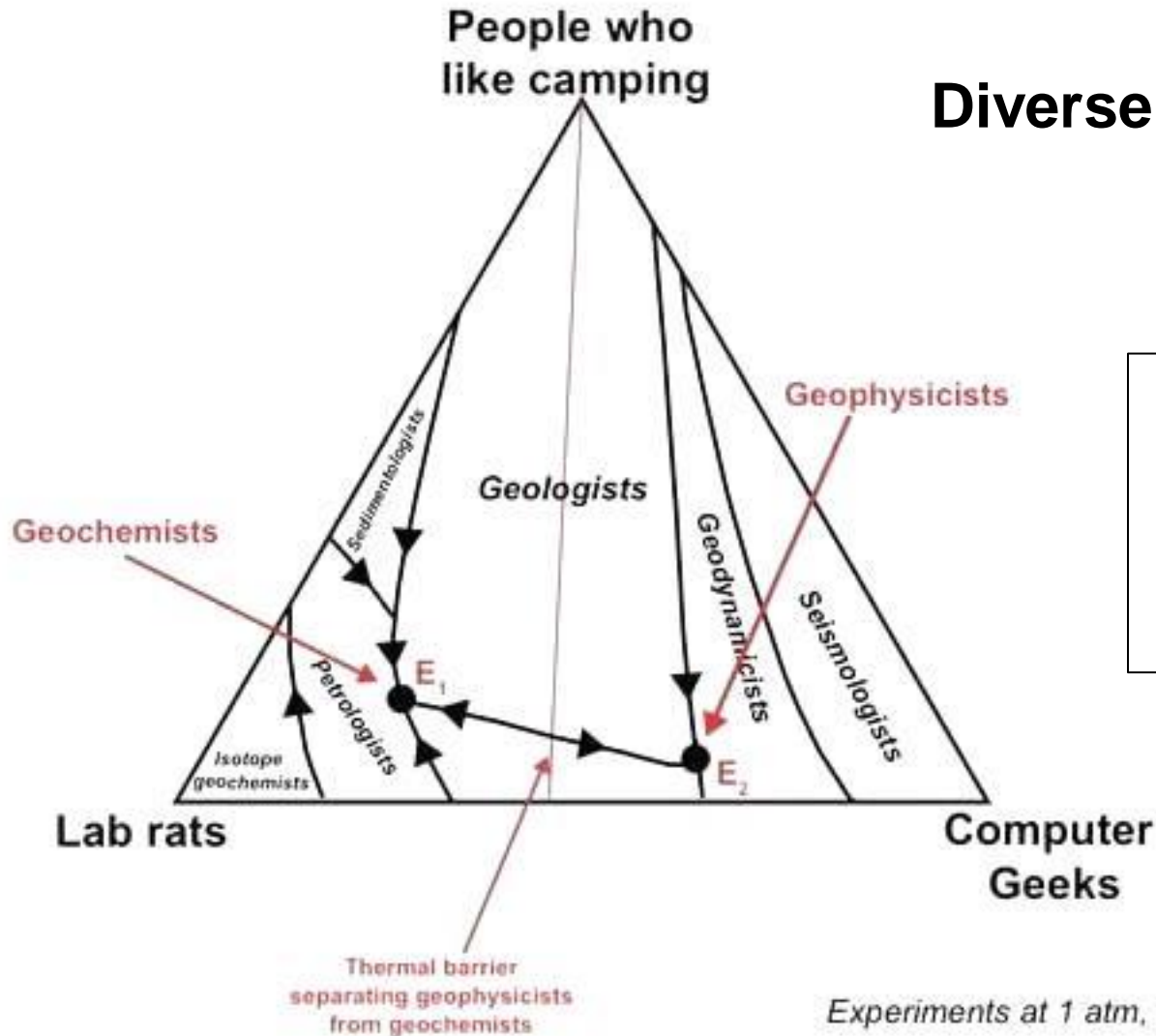
What my friends
think I do



What I actually do

Recognize Strengths of Each Team Member

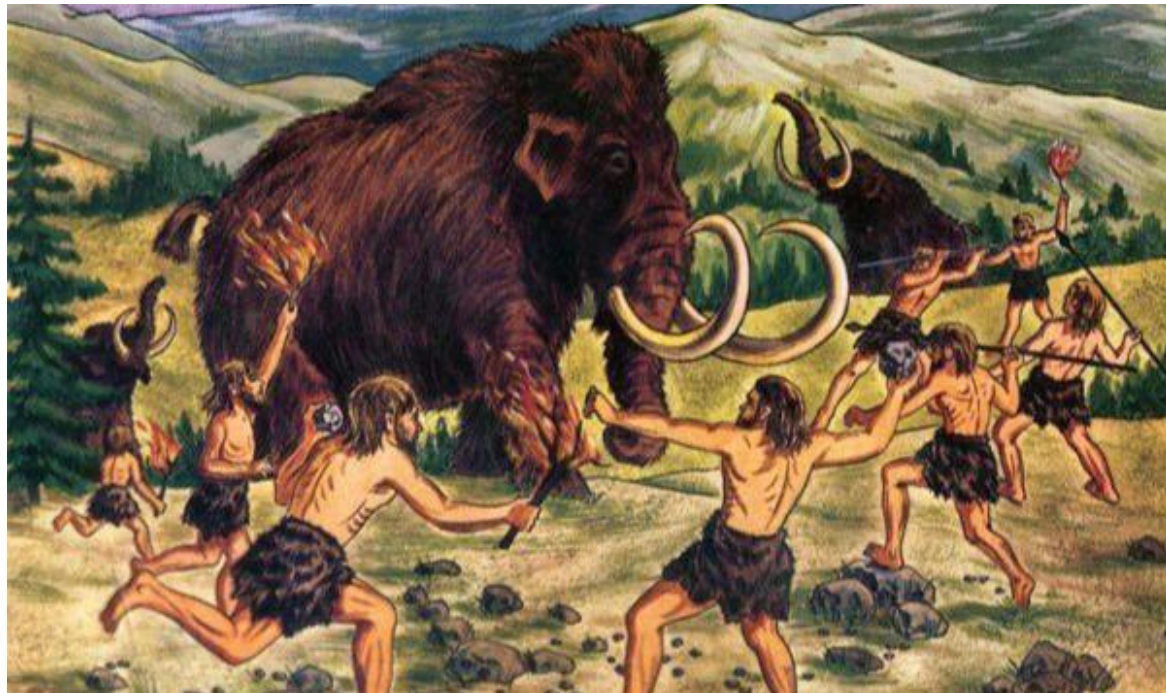
Diverse Teams are better



In which field are you?

Hunt in small packs of 4-8 people

- ‘.....The undesirability of a groupthink environment in exploration is not a new revelation, and underpins the hunting pack size of a **group of around 4-8 people** and the need **for diversity** amongst that team (e.g. Snow and MacKenzie, 1981; Woodall, 1994; White, 1997). *(Neil Philips)*



Why Groupthink is bad:

- silences opposing viewpoints
- Illusion of agreement.
- Lack of Creativity.
- Lack of outside perspectives

The Corporate Geologist and his 10 Managers



Beware of bureaucracy and top-heavy admin creep, increasing over time.

In large companies, you can view this also as an opportunity.

lots of free services, free information, free in-house knowledge, in-depth knowledge, that small companies do not have.

In small companies, having too many managers can be fatal



It's People ! Summary

- **Ore Finders**
- **Misfits & Mavericks have a 20% higher chance of finding ore.**
- **Attitude before aptitude**
- **Diversity is better**
- Form smaller teams of 4-8 people each. Avoid groupthink.
- **Foster creativity**, ideas, thinking outside the box
- Give back geologists time to be geologists
- Project Management, Leadership, Talent Development
- Communicate effectively 360 degrees
- Support your team

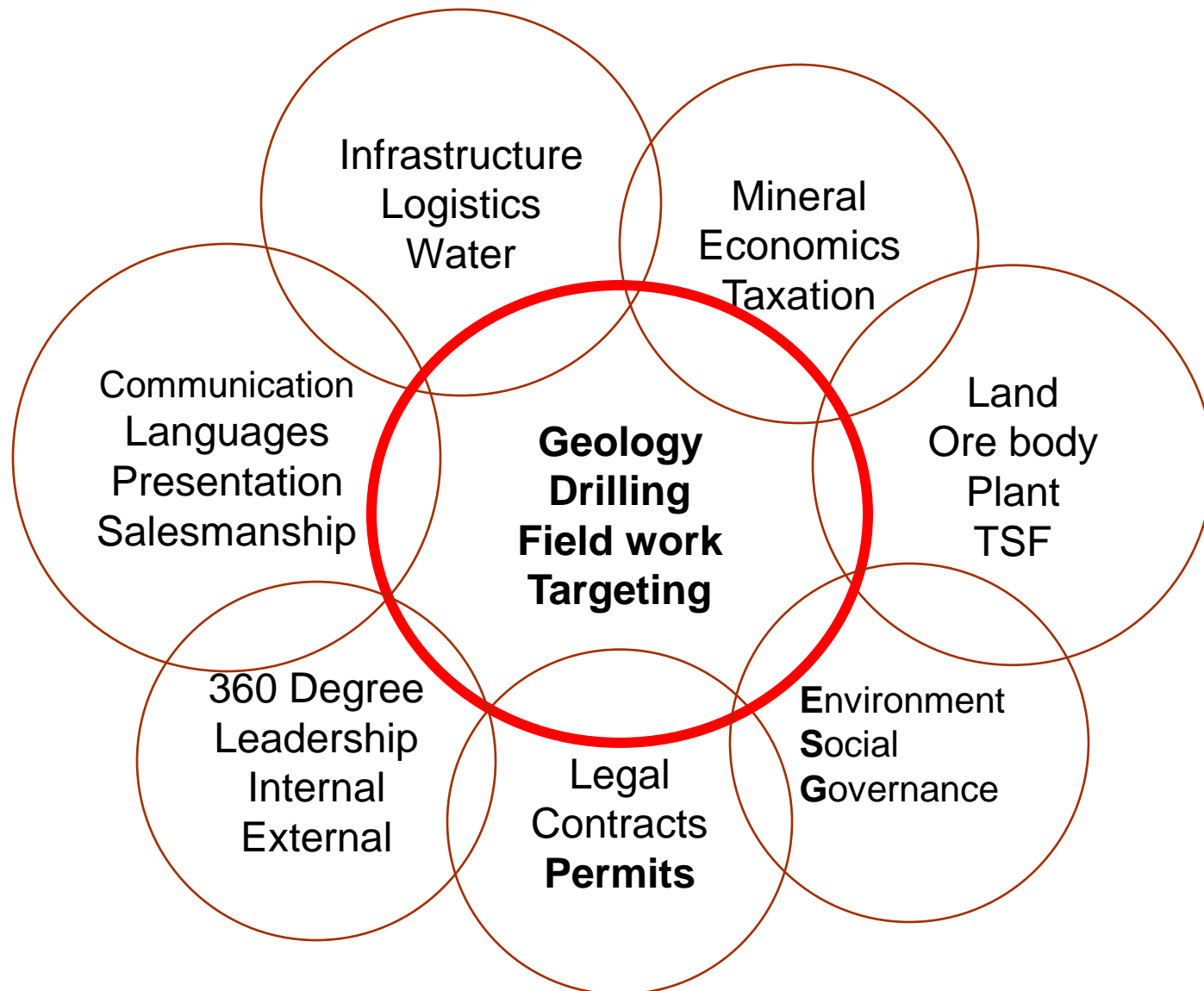
Useful Skills

50-75% of your time will be spent with doing non-geological things

We are all trained in sciences, engineering, economics, accounting, i.e. solving material problems, we are not trained in solving people problems.

- **Language**
- **Training in ESG matters**
- **Communication**
- **Transparency**, Equator Principles, Human Rights
- Learn about local culture
- Presentation skills: powerpoint, budgets, fundraising, Keep it Simple,
- Attitude: respect, polite.
- Negotiation Skills: Contracts, regulatory matters,
- Economic Valuation; red flag concept

Look outside your sandbox



ESG - Geologists are Ambassadors of their company.

First Encounters



Local community

- Local people have time; totally different priorities. They have not been waiting for you.
- A mine development is a huge change in their lives.
- Huge material improvement
- Huge change of their lives.

- **99% of the projects are *not* going to happen.**
- It is a challenge to explain the concept of probability, i.e. that most likely there will never be a mine. 1: 5,000 pyramid.

Only in-kind help during drill projects



- The local village is best off with mid-term opportunities from the 1-3 year exploration project:
 - **Bulldozer to repair roads, make new ones.**
 - **Use drill rig to drill a water well**
 - **Repair, paint school**
 - **Install water piping to bring potable water to village**
 - **Set up medical post**
 - **Backpacks for school children**
- **Decision is up to the village**
- Company to provide in-kind, **never** give cash
- *In communities used to receive cash (from prior companies), this is concept is a challenge.*

Communication, form a Strong Exploration Team



Explain to the community what exploration is doing: **Transparency**



Drill Technician Jobs for Locals
Local Exploration Team

ESG - First Questions



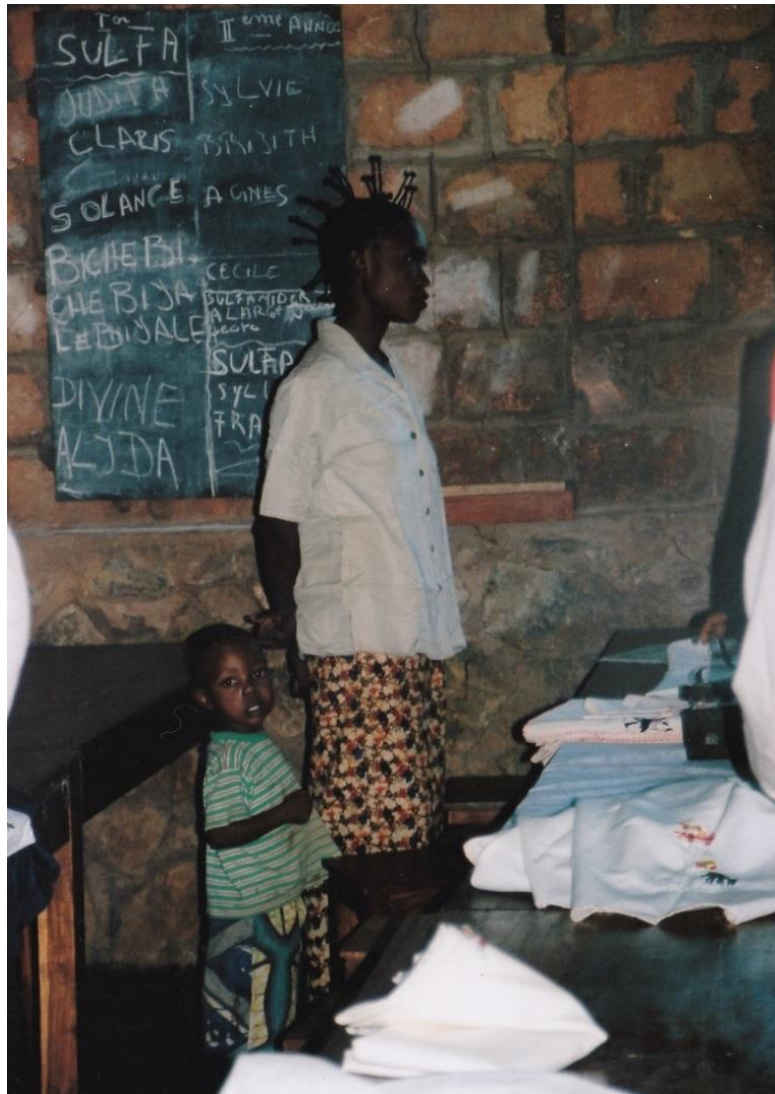
. The major company buying the junior's project will ask, often in that order:

1. **What is your ESG record?**
2. Can I operate a mine there?
3. Do you have an ore-grade, mineable intercept?
4. Do you have the land?

ESG - Football is a global sport



ESG - Making Sample Bags



15 Local women got jobs for several years making cloth sample bags for Exploration and Mine Site Geology.

Most remarkable, they had for the first time in their lives their own source of income.

ESG – Lukutola collaboration with a Church mission



Furniture making –
carpentry apprenticeship

Salad & Legumes
Growing



ESG - Schools



Micro Business for Making Bricks

Straw
Huts



Brick
Press

Kiln



Model
Home

For

New
Village

Drinking the Magic Potion

- Lots of ceremonies in the Congo



Village Chiefs at Mine Opening Ceremony

THE POWER OF
COPPER



ESG- Relocating Copper Clearing Vegetation



Cobalt Flower

Soils are 5000ppm Cu



- Study by Expert Botanist
- Kept all top soils
- Created new copper clearing on un-mineralized hill



ESG - Most wanted: jobs in the mine



Tenke was Built in 3 Years – 2,500 jobs

THE POWER OF
COPPER



16 Jan 2006

View from Kwatebala towards future **Plant Site**, which is outlined as **red dotted line**. View is towards north



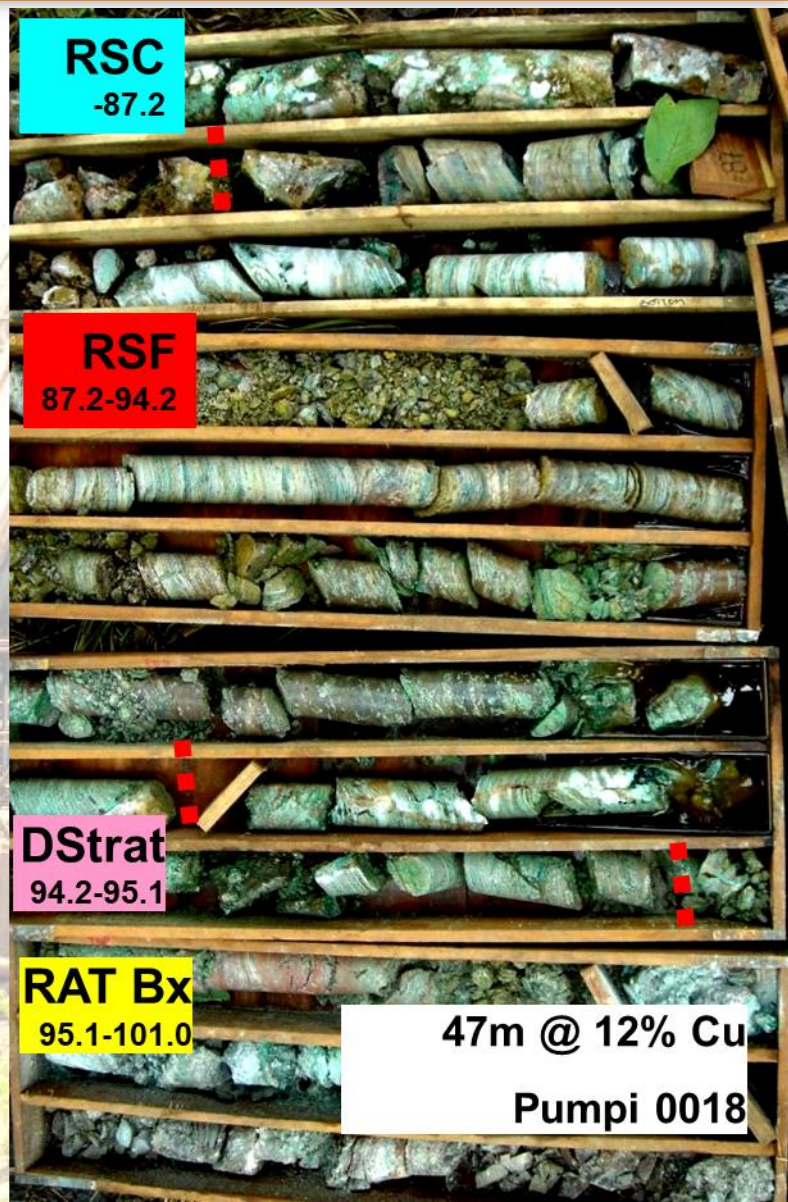
18 Mar 2009

Summary

- New technologies & methods : should be tested by all means
- Can divert attention, cost time & money, and reduce budget for later drilling.
- Old Methods = Evergreens: **Drilling** most important and will stay so for a long time
 - Use RC where applicable, shift to diamond after discovery, drill out with both.
 - have to get that sample from 3D space in order to:
 - Discover
 - Delineate an ore body
 - Create an economic resource/reserve, as per stock exchange regulations. Incremental improvements.
- Ore bodies are found in the field. Boots *and* Robots.
- Mapping, sampling, site visits, logging.
- Successful Discoveries are based on a **combination** of methods and data.
- Look laterally and vertically, beyond technical skills and exploration methods
- **Green skills** are critical. Geologists are the first ones in a project, ambassadors for your company. First impression counts.
- Useful skills: language, negotiation, presentation
- Relocate if possible; avoid group think; work in small teams;

Discover Ore?

Drill, Drill, Drill



Supplementary Slides

References

- Credit goes to publications, presentations, comments from these explorationists:

Dave Lowell, Doug Kirwin, Murray Hitzman, Dan Wood, Neil Philips, Erik Ronald, Andy White, Sig Muessig, John Proffett, Roger Marjoribanks, Dick Sillitoe, Boston Consulting Group, and many more fellow geologists .

- +30 years in exploration

Corruption

- **Short-cut, proxy for gaining trust**
 - Trust takes a long time to build. You have no time for trust-building exercises. You want to advance your project rapidly, e.g. get a drill permit ASAP.
 - E.g. local official understands you are in a hurry, and intentionally stalls progress; he does that in order to extract ‘facilitation payments’ in exchange for expedited progress.



Community Ceremonies even for smaller milestone in the project

