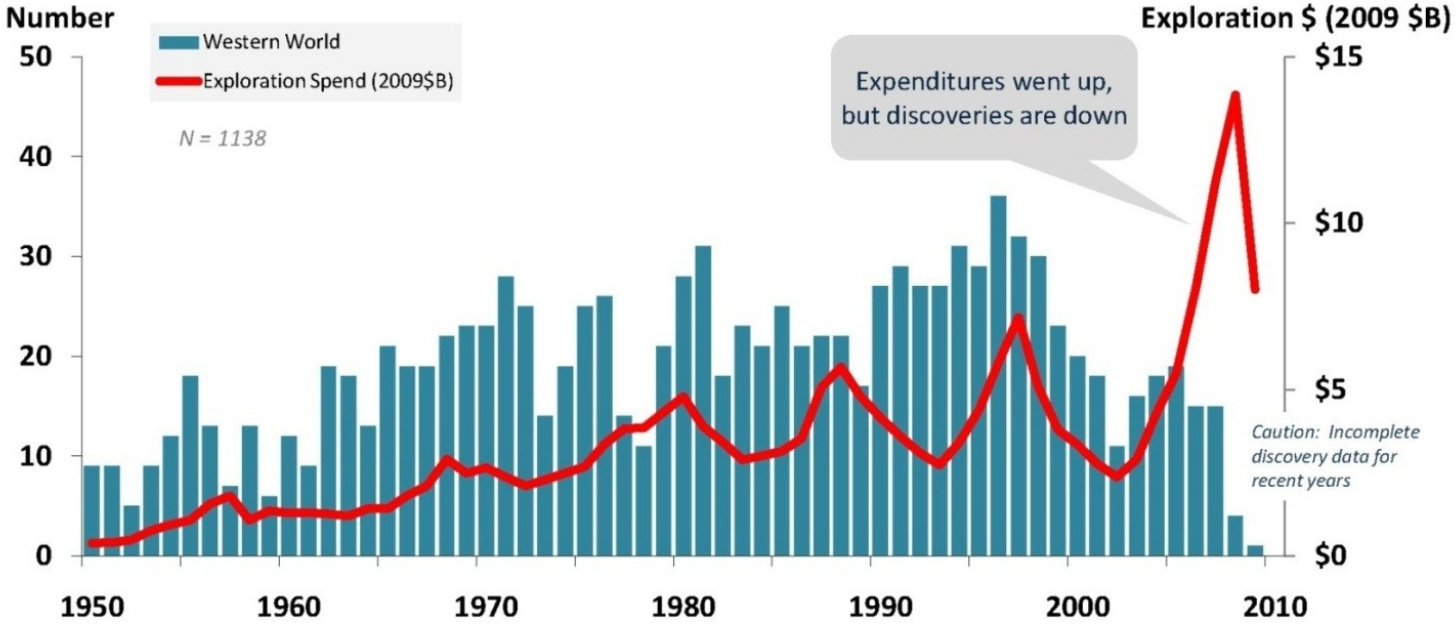
Quo Vadis Exploration?

We are spending more on exploration … but have less to show for it

Exploration expenditures and Major discoveries in the Western World: 1950-2009



Sources: MinEx Consulting, and exploration data from 1993 onwards from MEG

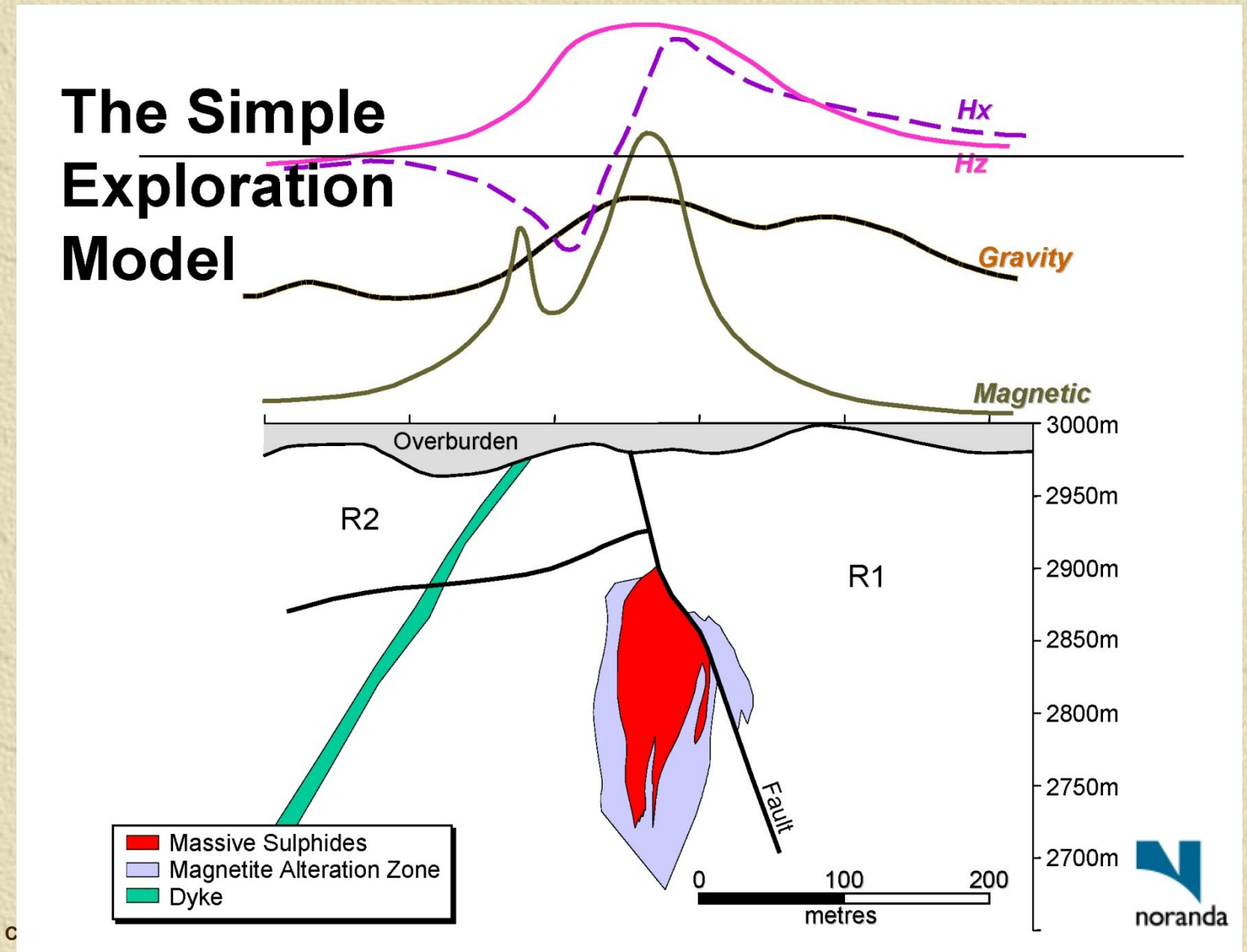
Note: "Major" defined as >1 mt Cu-equiv, > 1 Moz Au-equiv, > 100 kt Ni, > 10 m carats >25 kt U_3O_8

Excludes bulk and industrial mineral discoveries

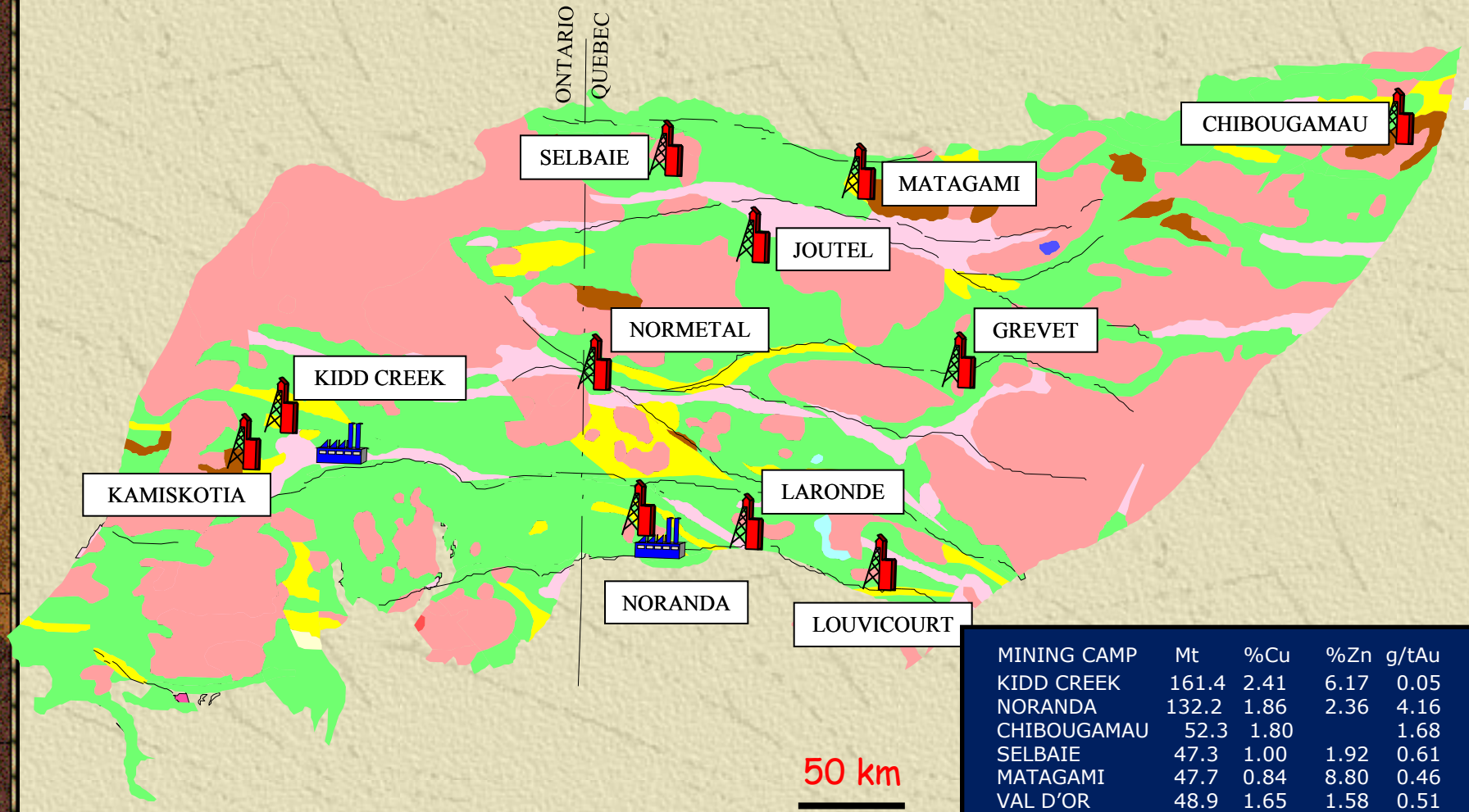
The evolution of the use of geophysics in the search for blind VHMS deposits in the Abitibi greenstone belt, Ontario-Québec Canada

Ken Witherly
Condor Consulting, Inc.
Michel Allard
Xstrata Zinc Canada

The Target

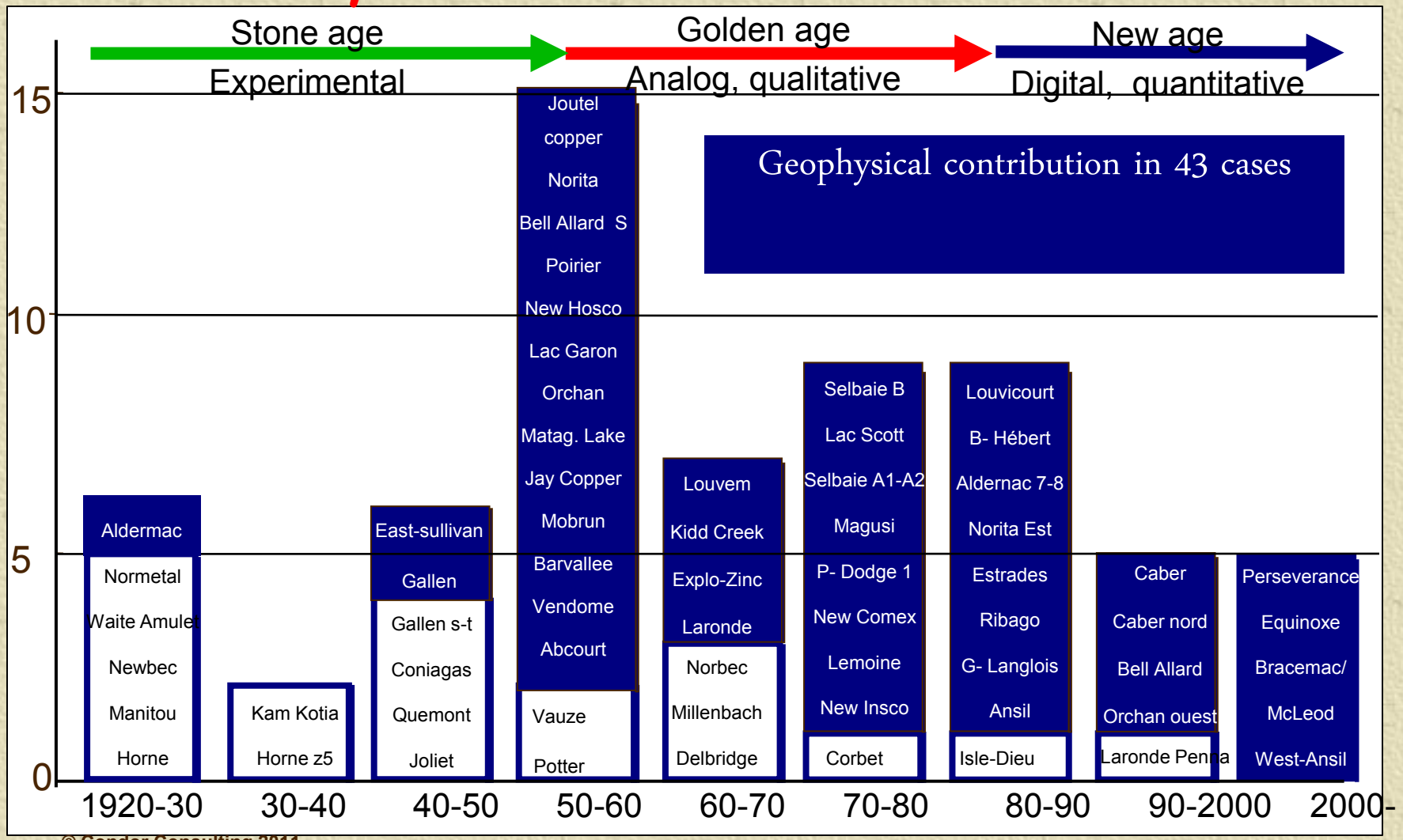

The Simple Exploration Model
Hx
Hz
Gravity
Magnetic
Overburden
R2
R1
Fault
3000m
2950m
2900m
2850m
2800m
2750m
2700m
0
100
200
metres
Massive Sulphides
Magnetite Alteration Zone
Dyke
noranda

Abitibi Subprovince of the Superior Province (Archean)

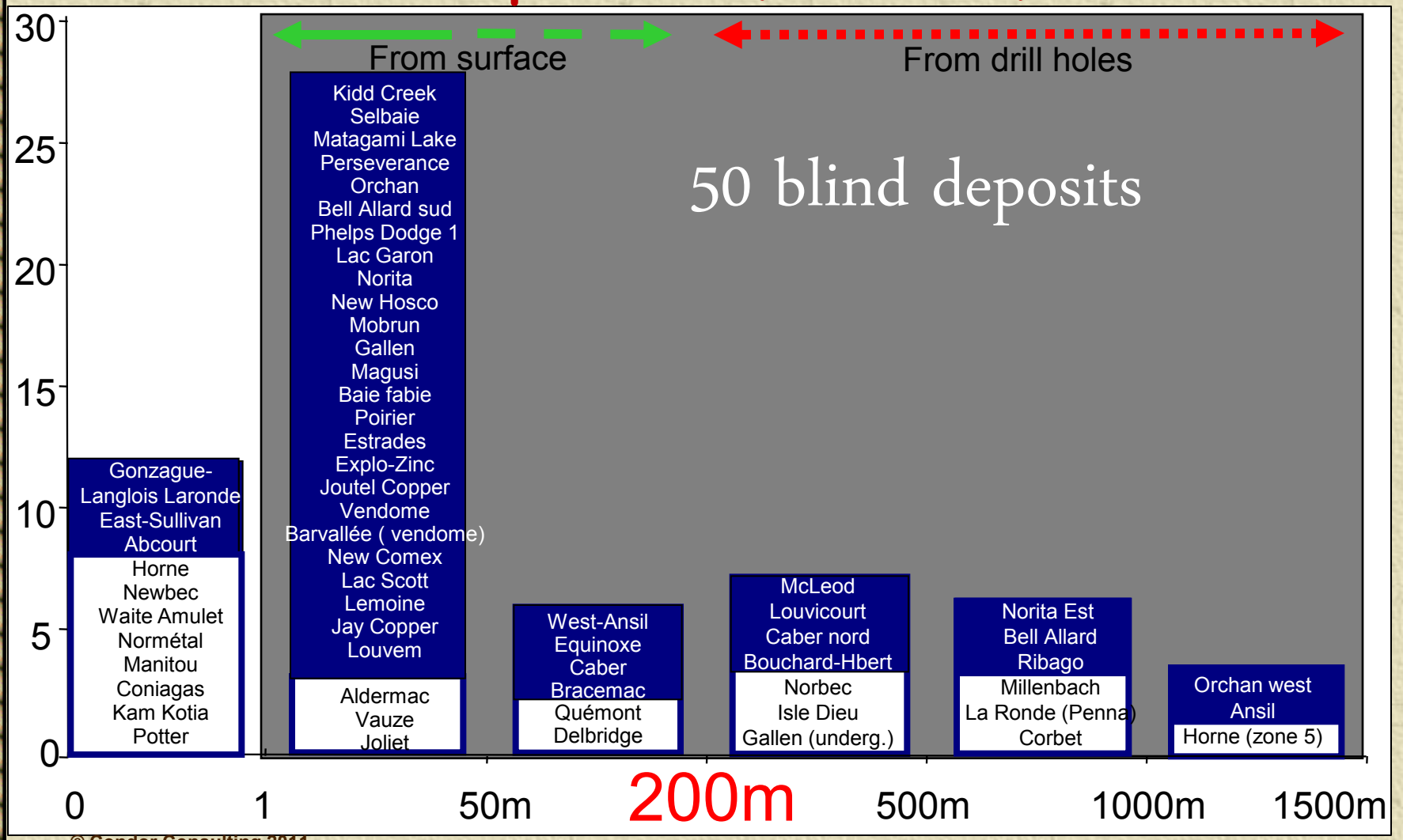


MINING CAMP	Mt	%Cu	%Zn	g/tAu
KIDD CREEK	161.4	2.41	6.17	0.05
NORANDA	132.2	1.86	2.36	4.16
CHIBOUGAMAU	52.3	1.80		1.68
SELBAIE	47.3	1.00	1.92	0.61
MATAGAMI	47.7	0.84	8.80	0.46
VAL D'OR	48.9	1.65	1.58	0.51
LA RONDE	59.3	0.44	2.31	4.10
GREVET	10.7	0.46	8.41	0.10
NORMETAL	10.2	2.17	5.40	0.85
KAMISKOTIA	7.9	1.23	1.47	0.05
JOUTEL	9.6	1.60	2.95	0.33

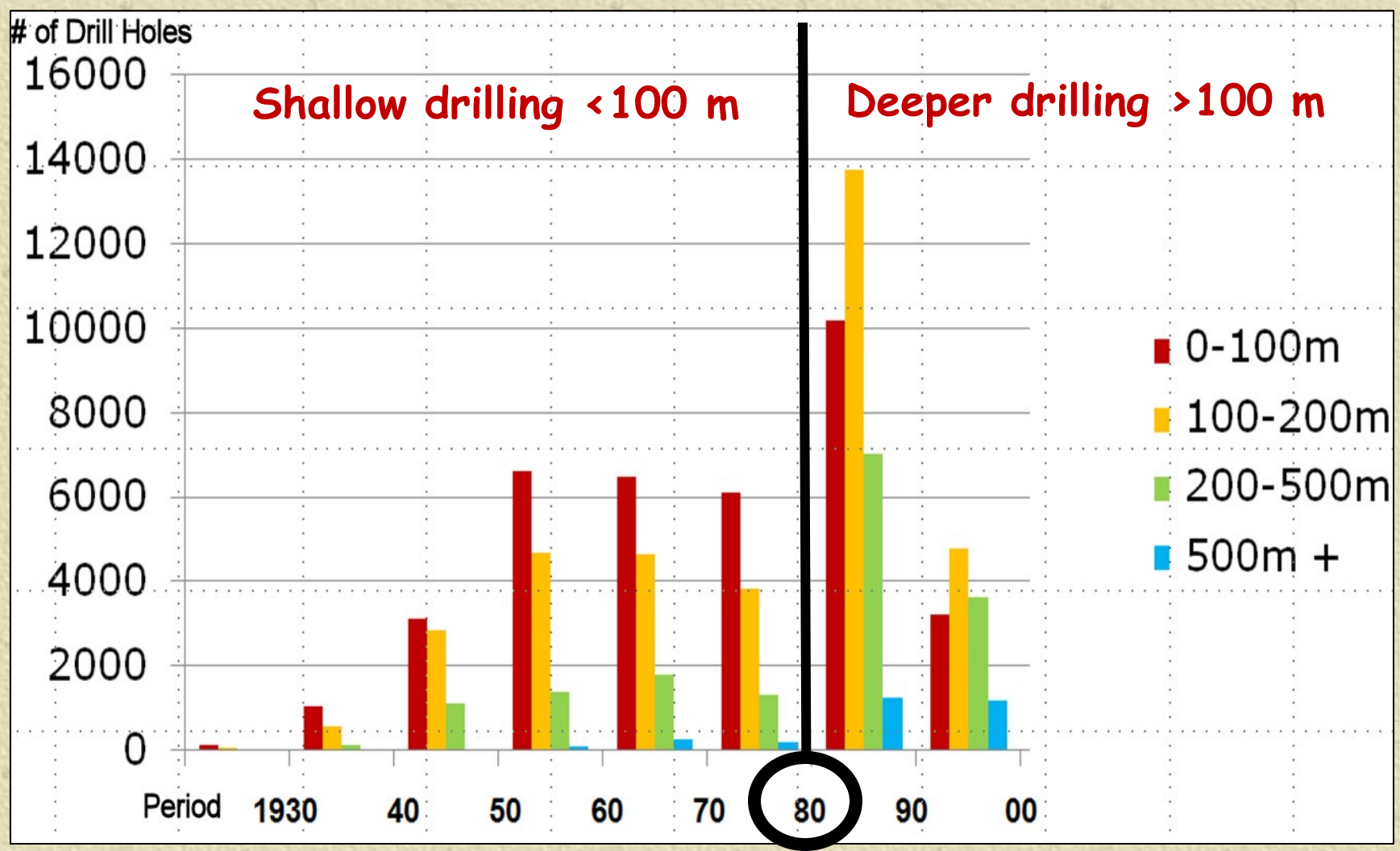
62 VHMS Deposits (>0,2Mt) Discovery vs time



Depth to the top
62 VHMS Deposits (>0,2Mt)



Depth of drilling vs time
Abitibi Subprovince



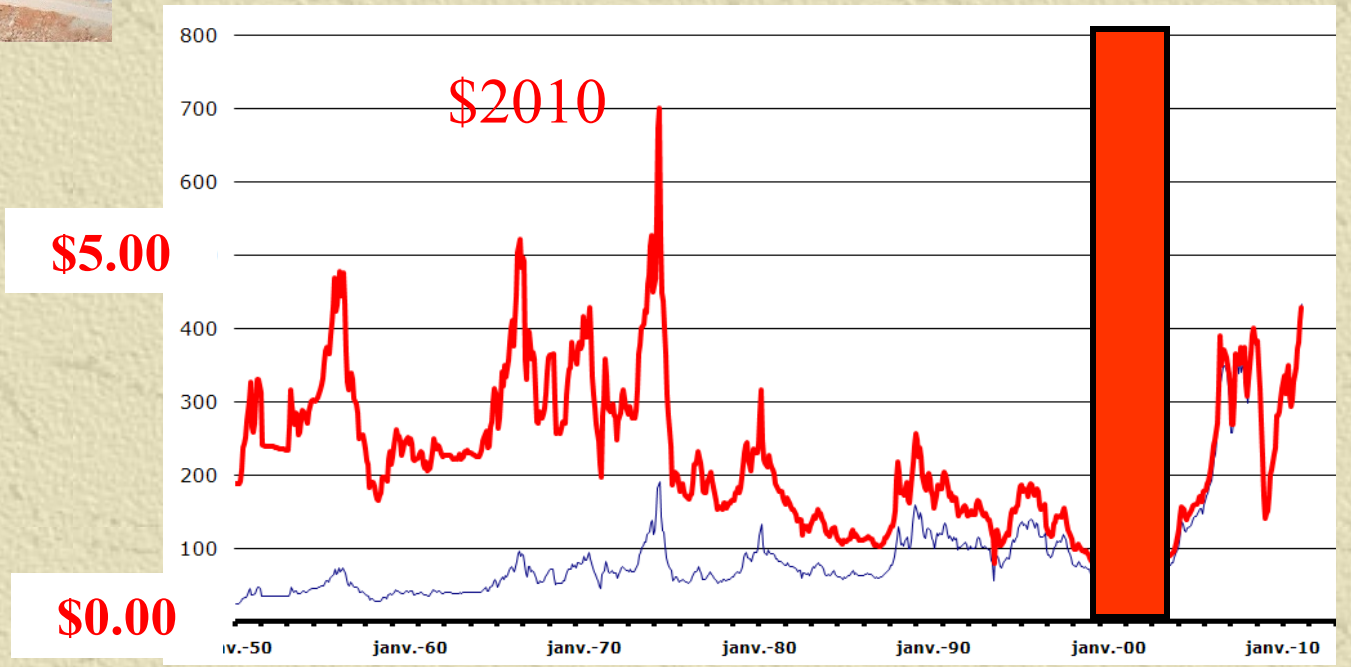
Fewer new VHMS discoveries?

Hypotheses explaining the relative decrease in new discoveries.

- All the big deposits have been found. The undiscovered ones are typically too small, too deep and therefore uneconomic.
- Since the Abitibi has been intensively explored in the past, the chance of finding is decreasing; this results in less exploration effort which in turn leads to fewer discoveries and so on.
- Intrinsic limits of detection technologies and geological knowledge

1999 : Difficult time for Noranda and the industry

- October 1999: Closing of Mine Gaspé, Murdochville. 300 lay off
- November 2001: Noranda annonces temporary closure of its smelting infrastructures
- April 2002: Definitive closure of the smelter. 300 more lay off.



"ask not what your country can do for you - ask what you can do for your country."

Quebec government asked the industry:

- *"what your country can do for you?"*
- to prevent more infrastructure closings.

- The industry (Noranda) suggested tax credits on exploration work!
  - Solution : an incentive plan

  40% refundable tax credit for non-producing companies

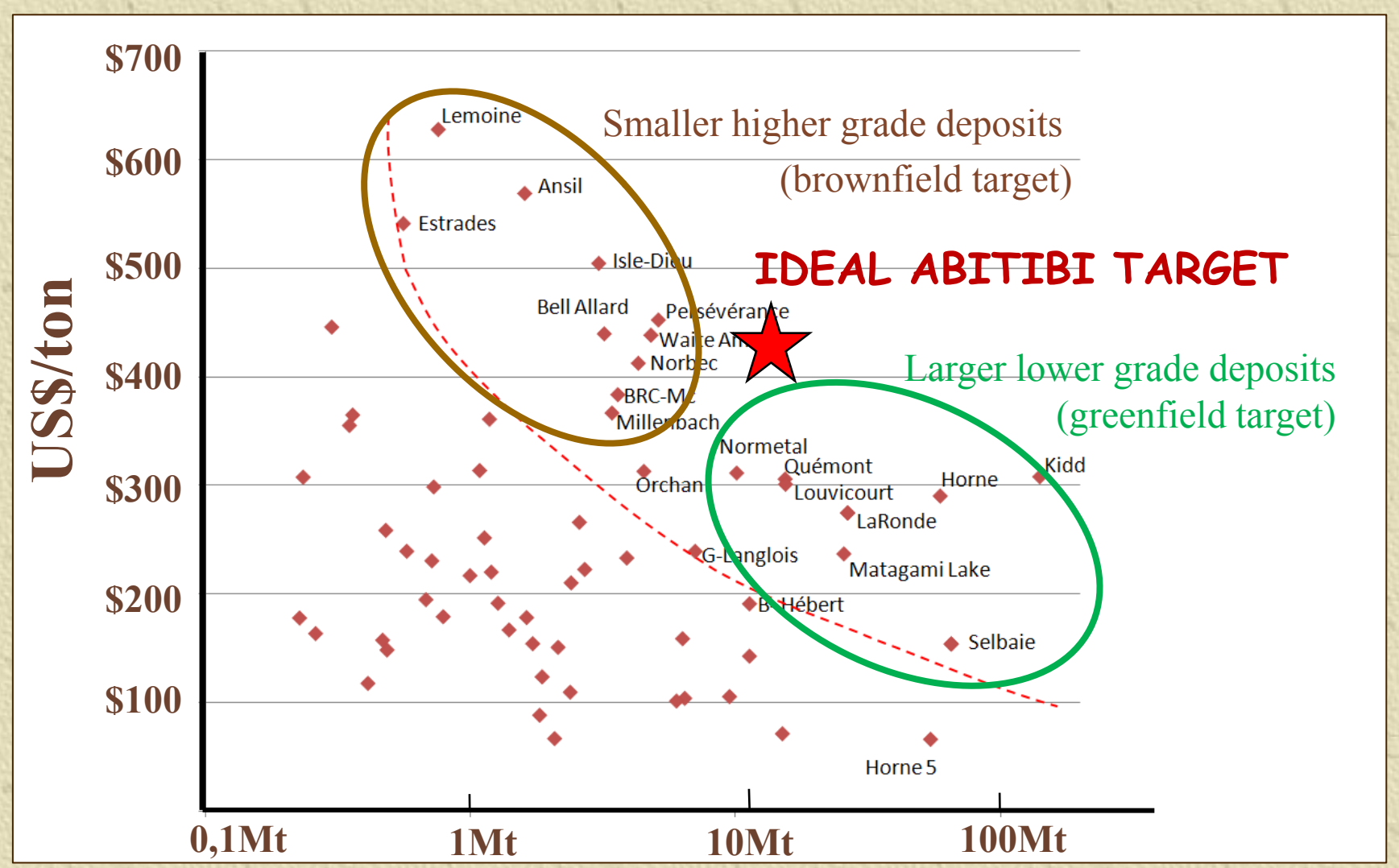
  20% for producers + 40% non-refundable tax credit applicable on capital tax for all exploration work .

2001 Exploration Objectives:

[redacted]

- Generate high quality VMS exploration targets in order to discover 5-50 Mt deposit with NSR > 80$/t
- Find new ore to replace 3 years reserves of Louvicourt
- Provide Noranda Horne smelter with polymetallic concentrate having gold credits
- Prevent more closure following the one of Gaspe Smelter in Murdochville in August 2002.

$/ton vs VHMS tonnage Economic model



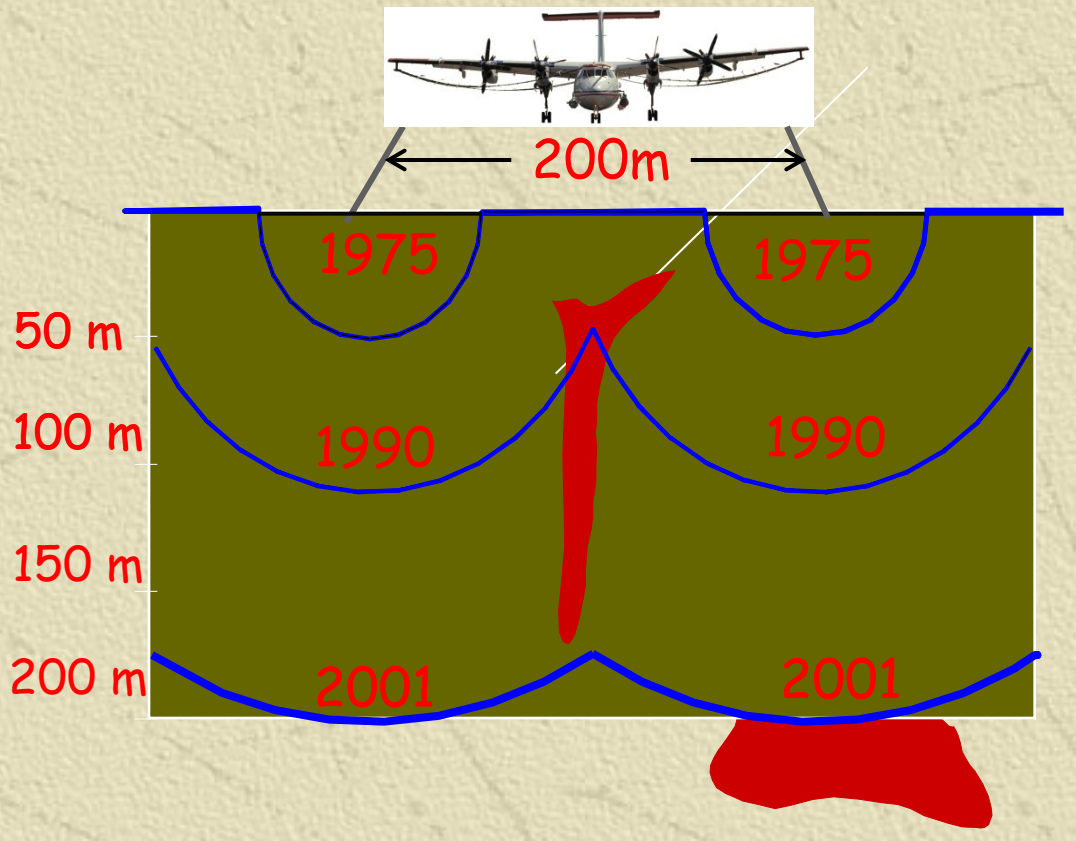
MegaTEM Rational : New Search space

- Relatively few deposits found at a depth below 50 m
- Limited drilling below 100 m
- ***In-house tests had demonstrated that the MEGATEM system could detect typical VHMS at least to a depth of 250 m.***
- Typical VHMS deposit has a high in-situ value (Figure 5). A stand alone 20 Mt deposit shows an in-situ value of 350$US/t (at current prices) is deemed as an attractive target
- Exploration risk could be shared with the government and junior companies.


FUGRO
C-GJPI

The Dream

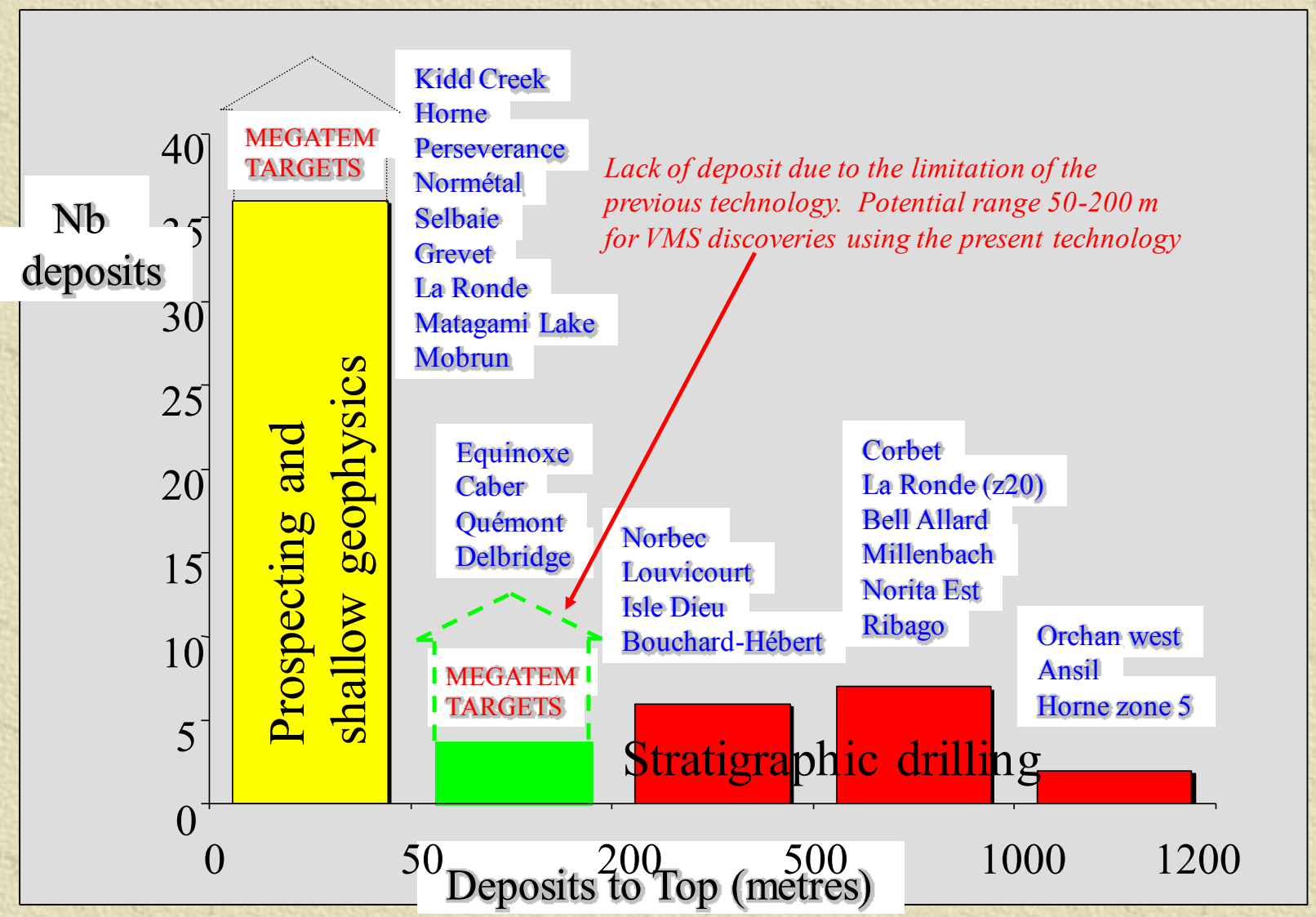
AEM Performance
Best Case
1975 = 10% (Input)
1990 = 46% (GEOTEM)
2001 = 100% (MEGATEM)



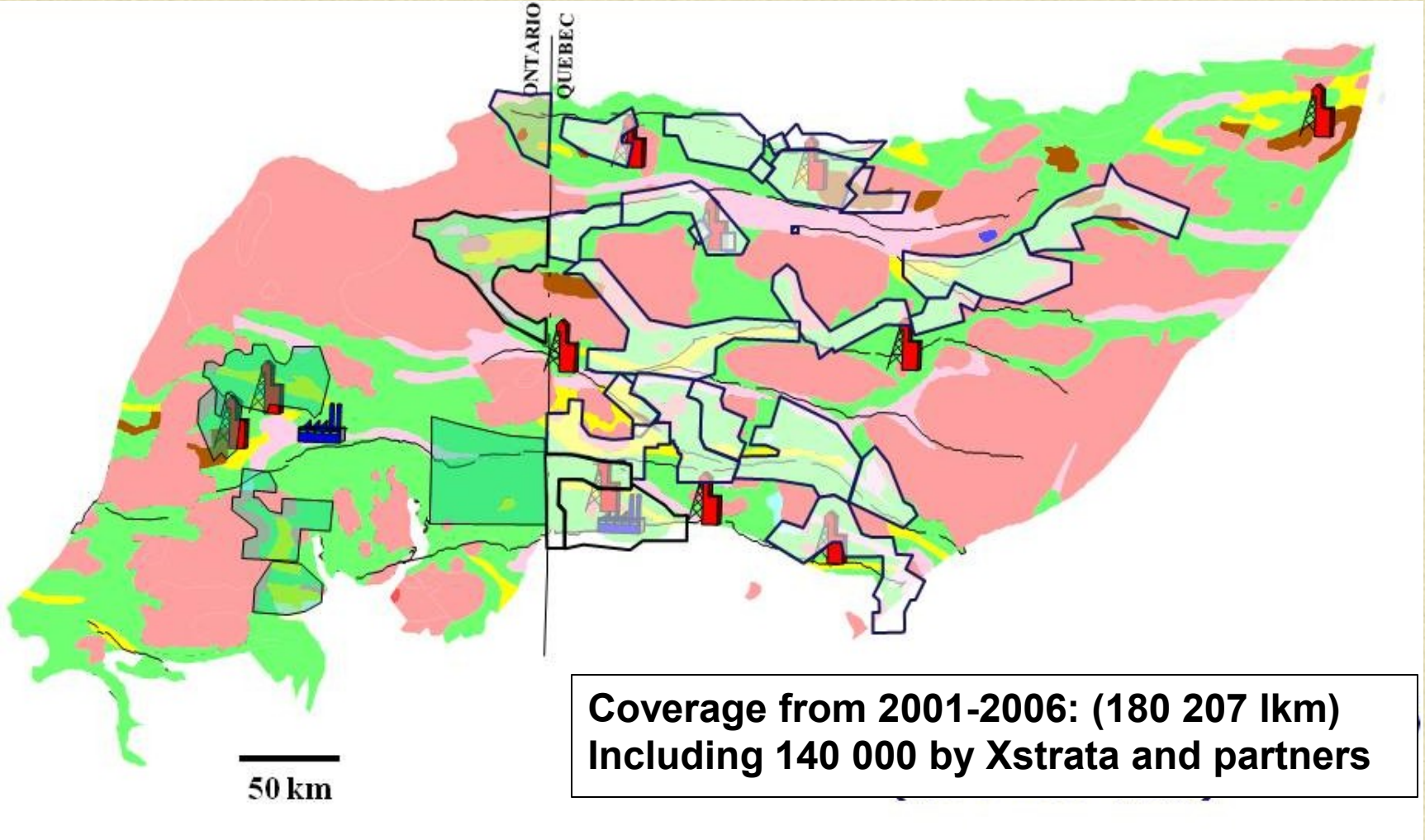
Repeat the sequence of discoveries generated by the first airborne surveys during the late '50s:

Brunswick 12, Mattagami Lake, Kidd Creek…

The Dream

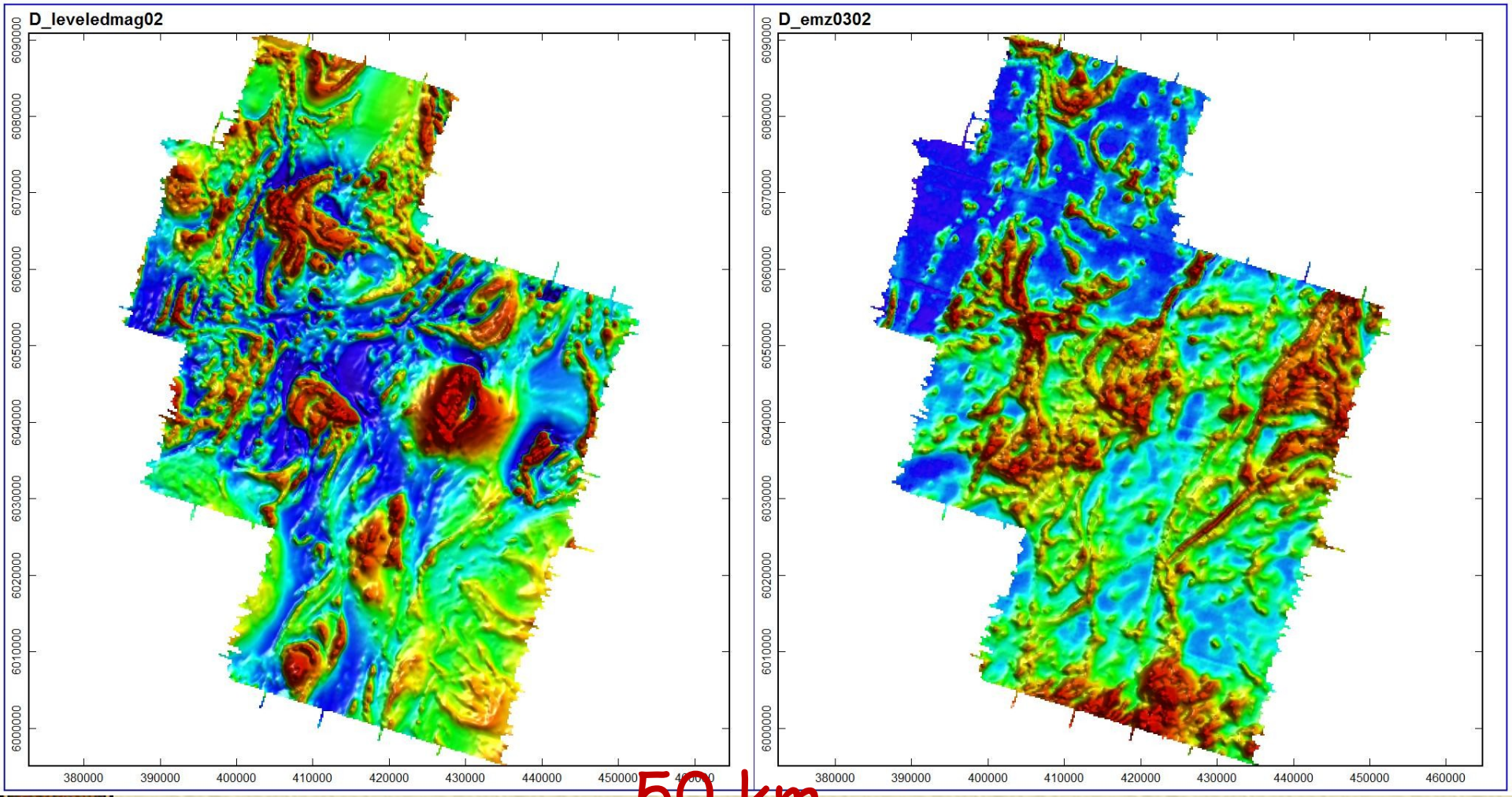


MegaTEM Surveys



Coverage from 2001-2006: (180 207 lkm)
Including 140 000 by Xstrata and partners

Typical VMS Terrain



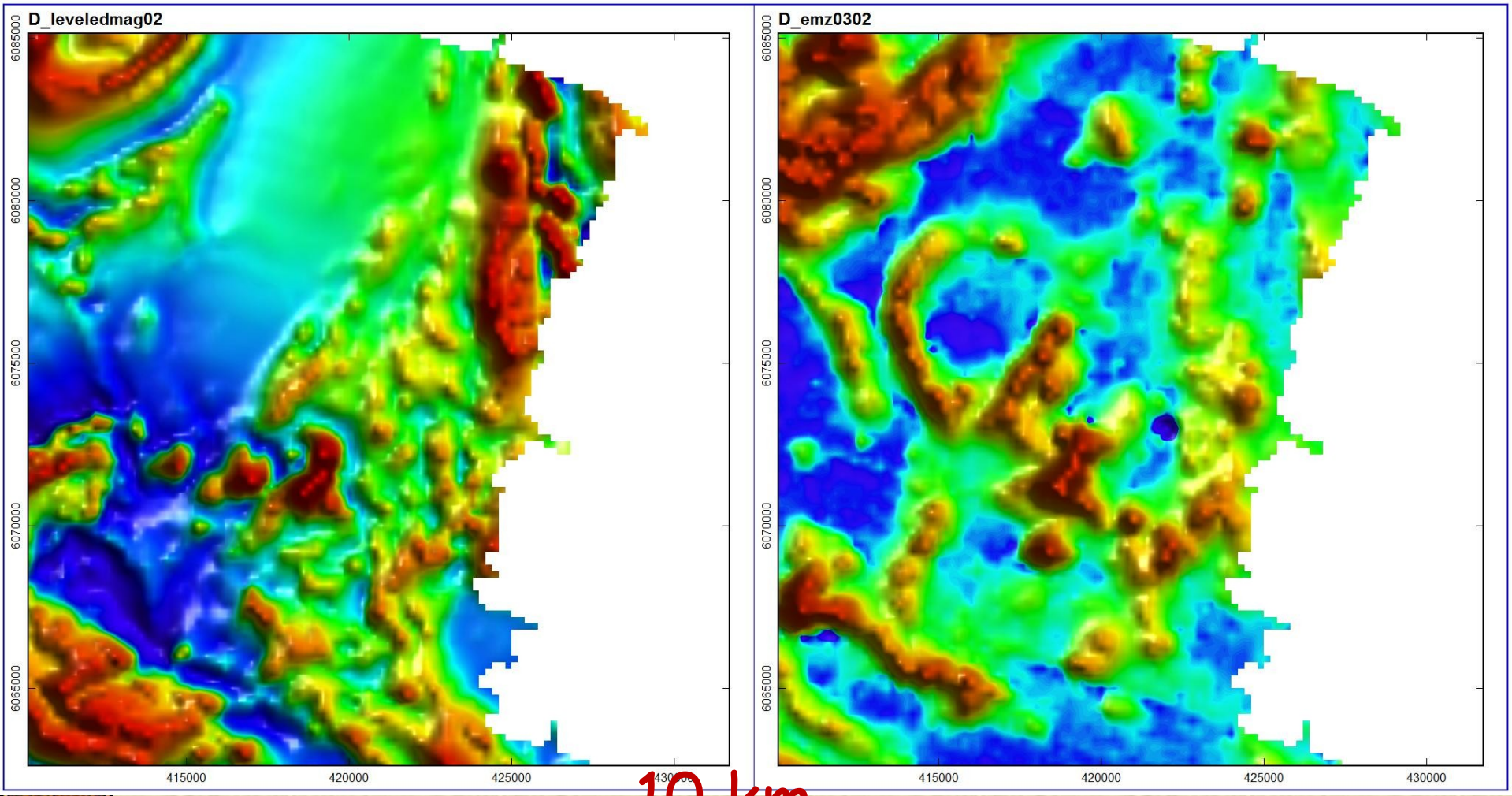
TMI

50 km

EM Ch 3

Typical VMS Terrain

Zoom in…



TMI

10 km

EM Ch 3

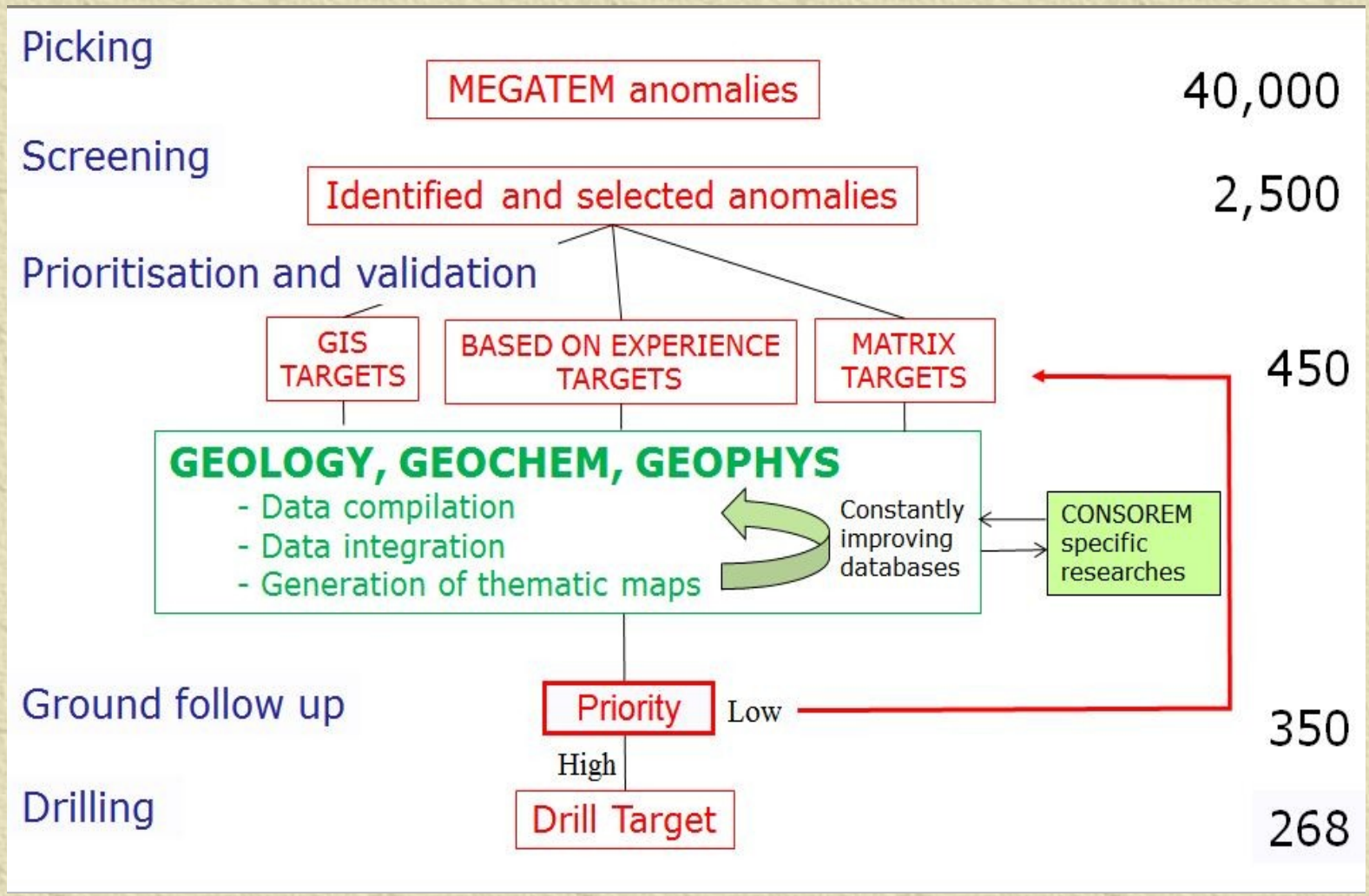
Area and Target Selection

[redacted]

1) "Subjective" priorities based on the following criteria:
   - Favorable geology (Scale 2-3)
   - Coincident MAG-EM anomalies
   - Isolated anomalies (avoid formational)
   - On Xstrata properties or open ground
   - Untested by previous drilling

2) "Objective" priorities based on a large geological-geochemical database was used in parallel to query AEM results using intelligent GIS algorithms.

Area and Target Selection



End Results

On the Québec side

- 40,000 EM picks
- 349 AEM anomalies were followed up
- 203 were drilled tested for a total 267 DDHs.

While discoveries can occur well after the initial generative work, at this stage no new deposits have been attributed to the MEGATEM initiative.

WHY ?

WHY ?

- Geological concepts/models
- Geophysical technology
- Managing "luck"

Scales 1 and 2

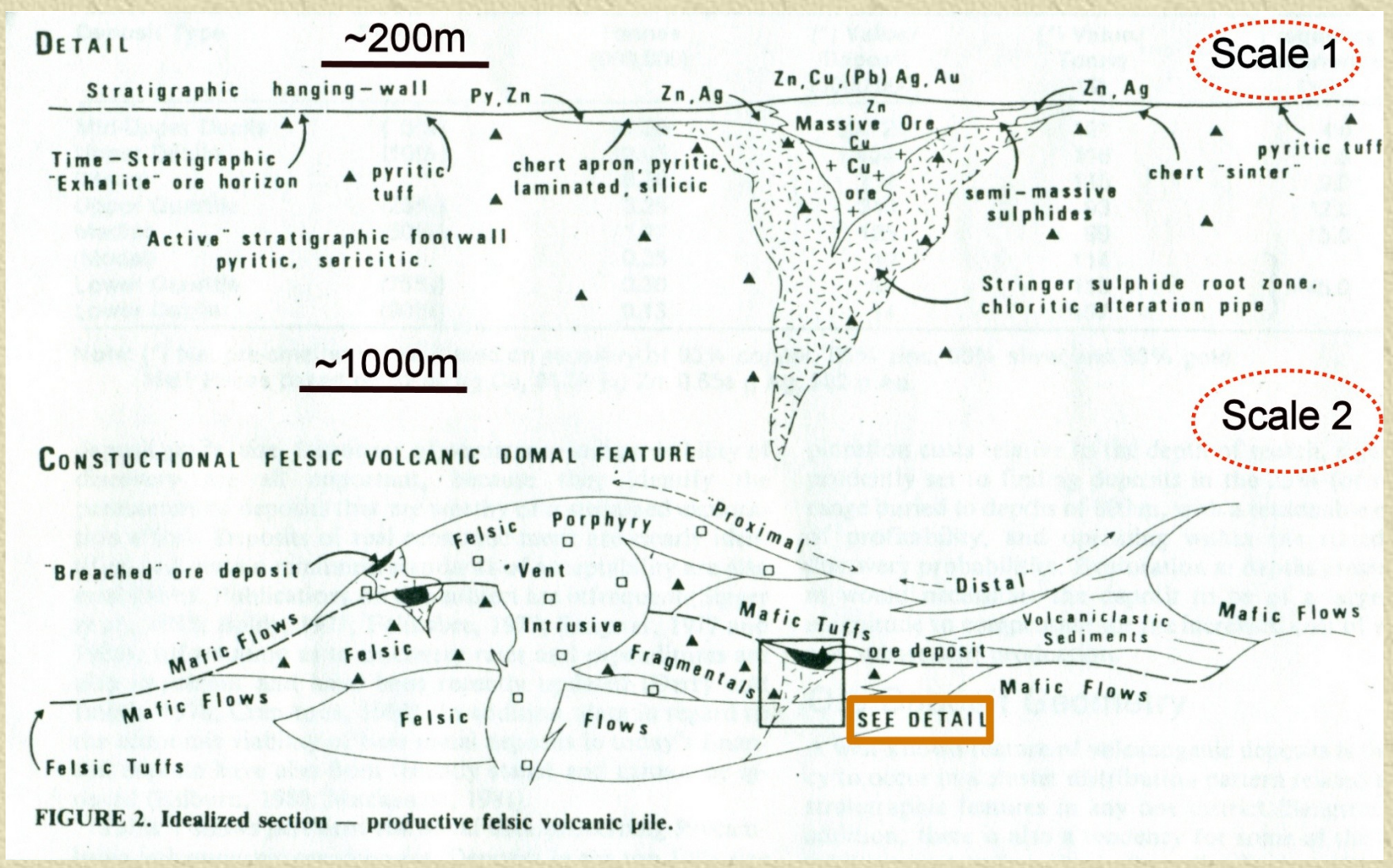
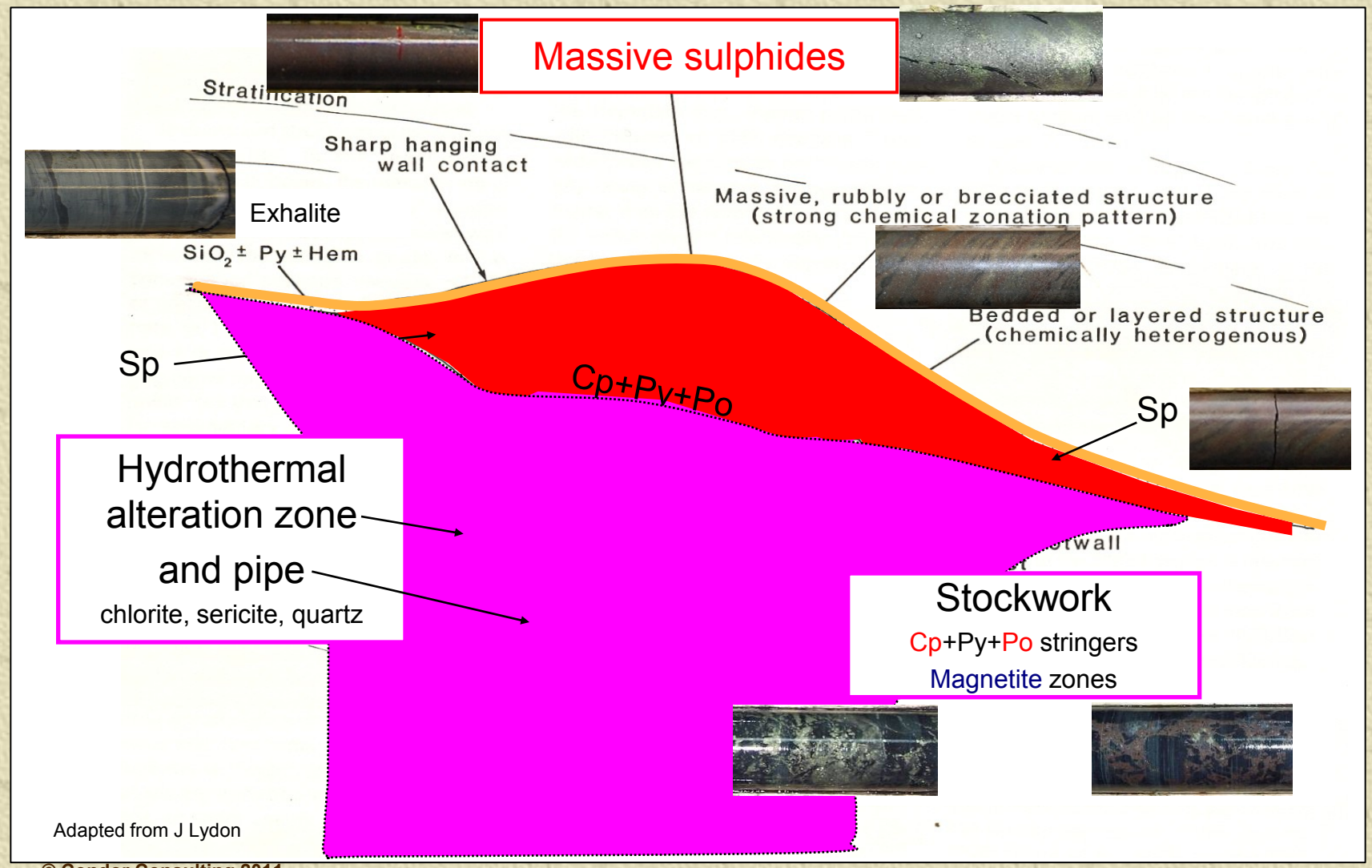
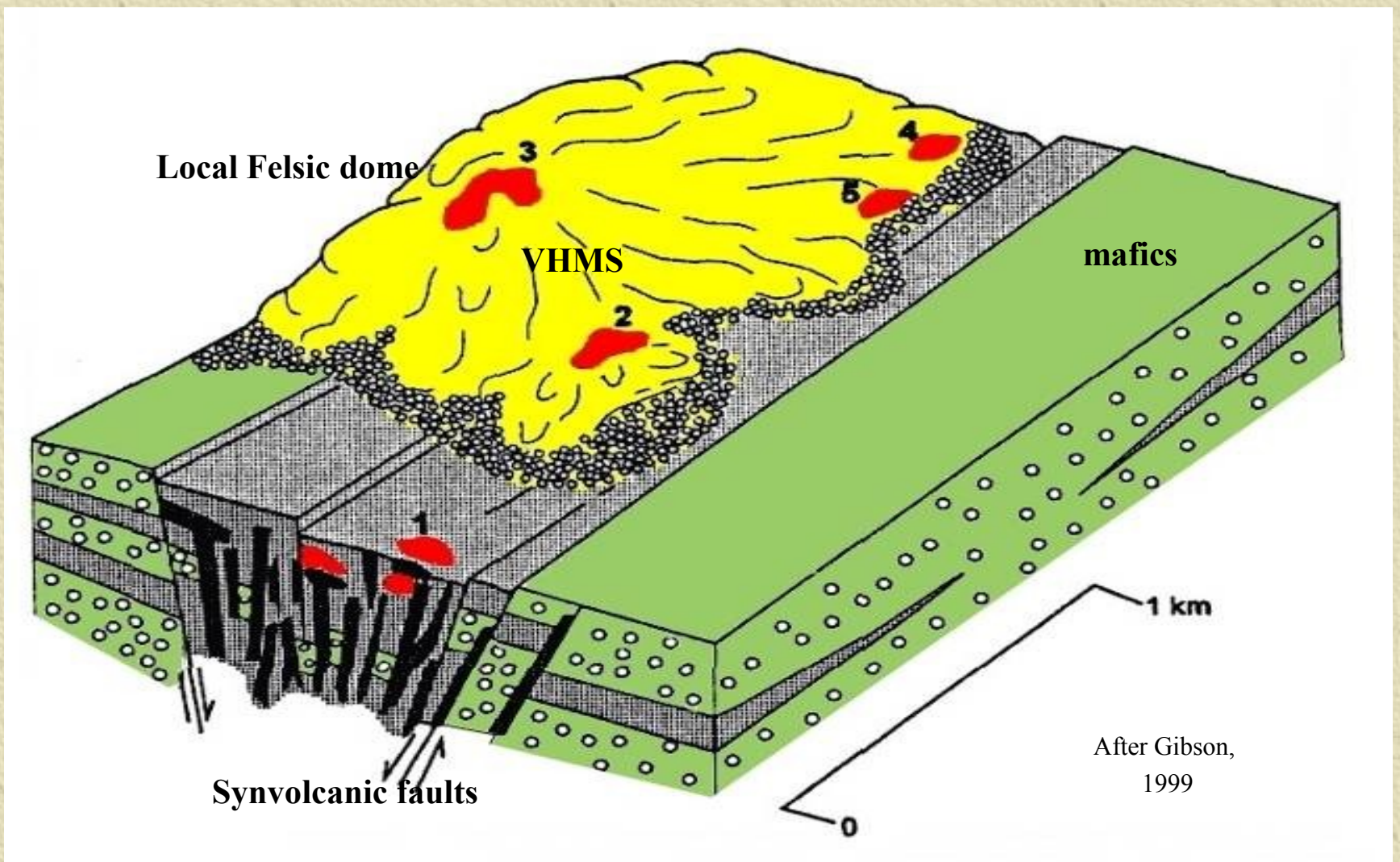


FIGURE 2. Idealized section — productive felsic volcanic pile.

Scale 1 : Deposit Scale
Typical VHMS

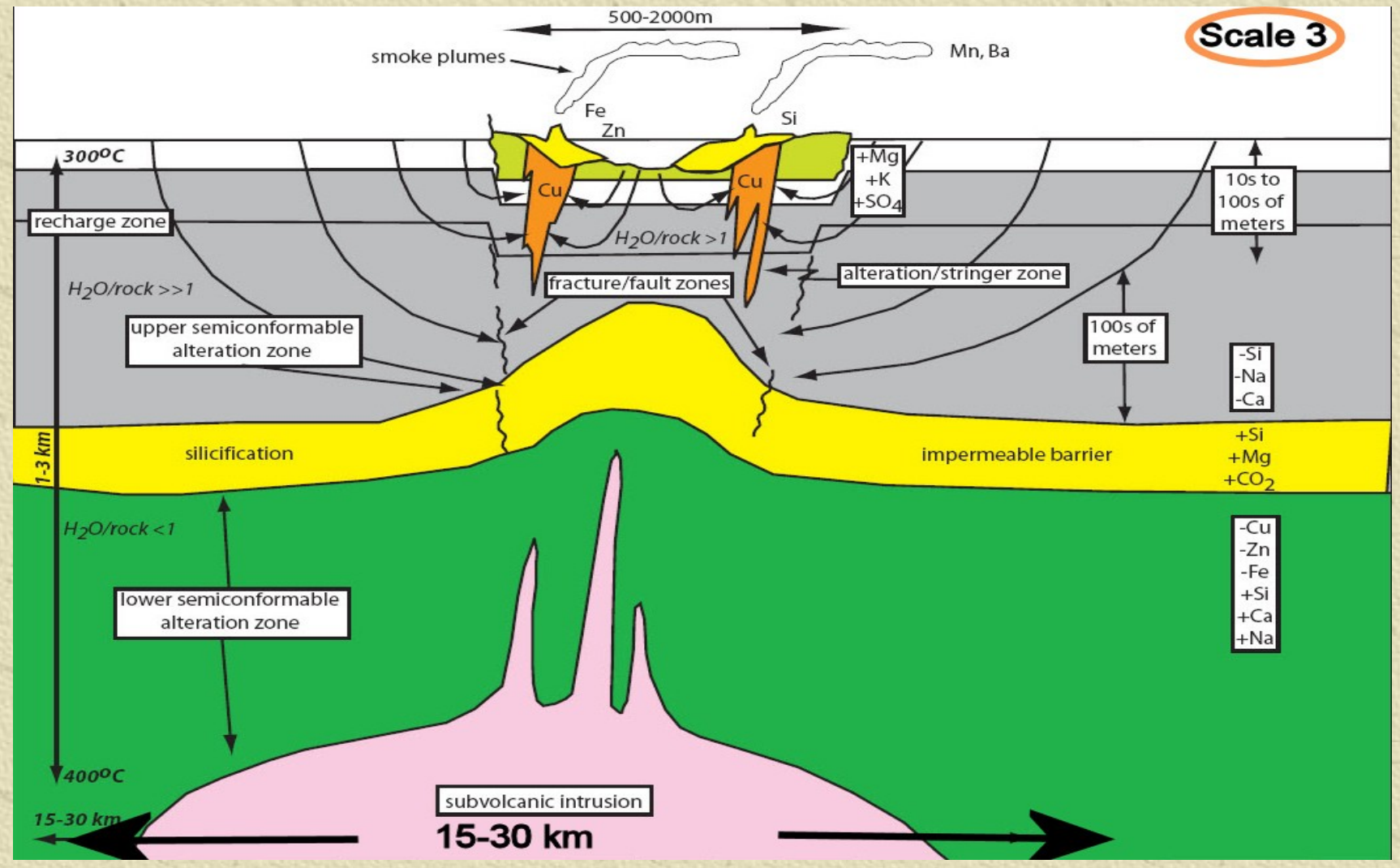


Scale 2 : Property scale ex: Noranda camp

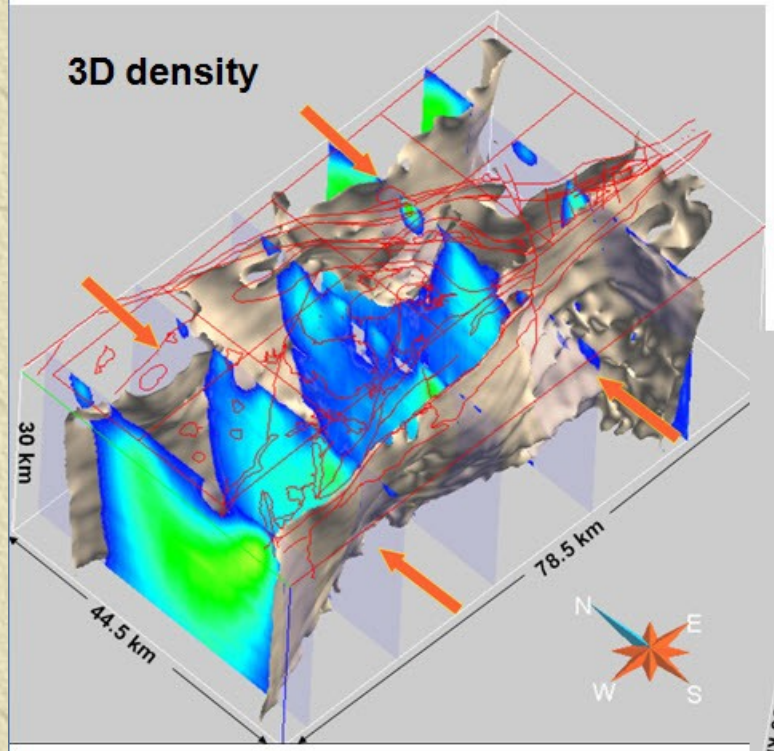


After Gibson, 1999

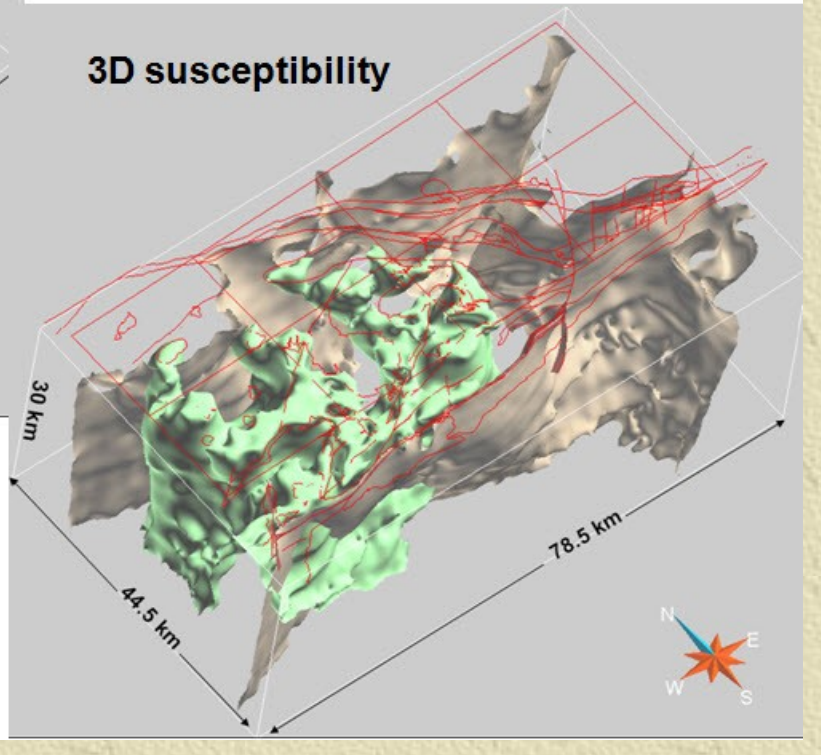
Scale 3: Area selection cartoon



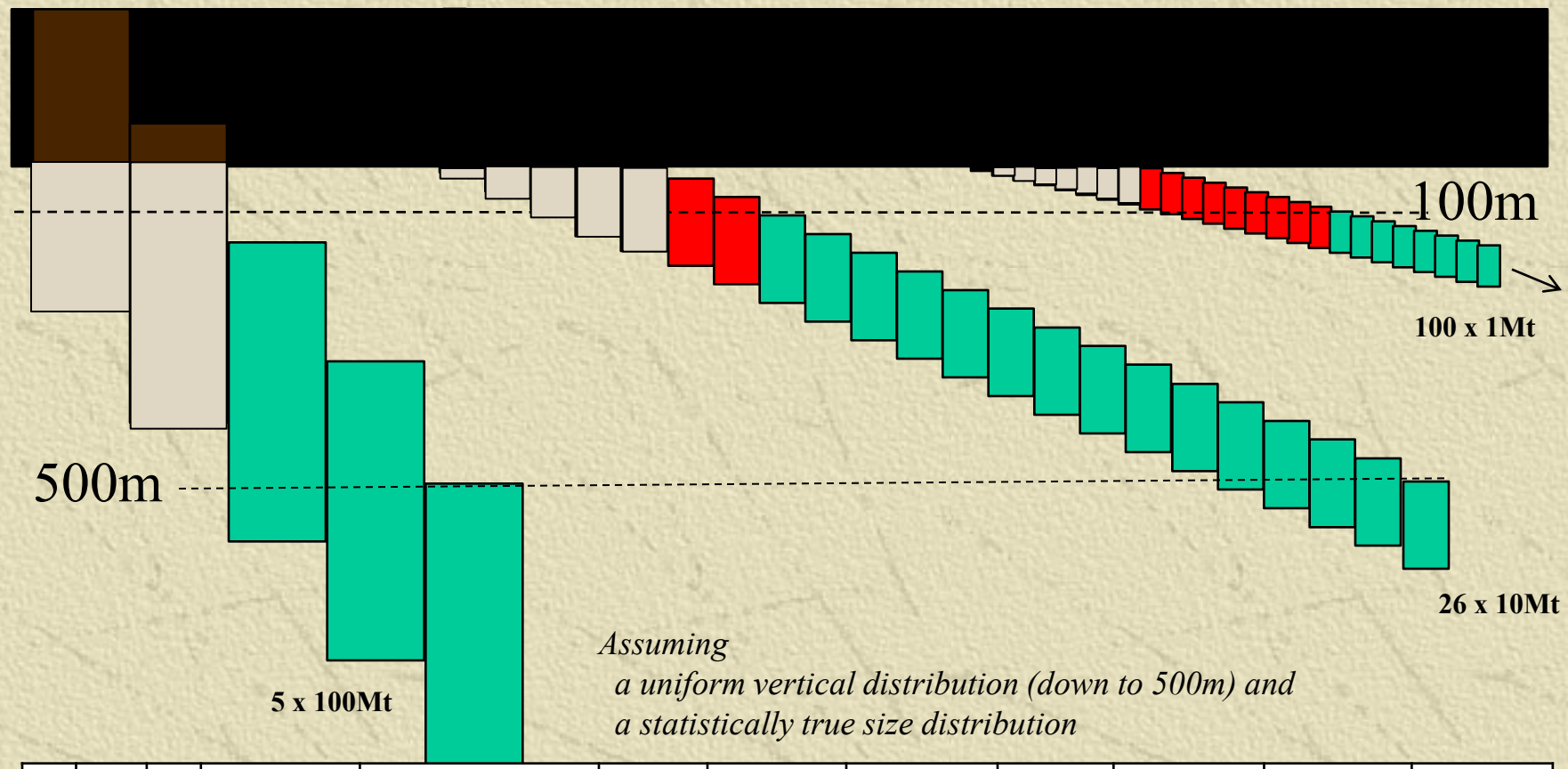
Scale 3: Magnetic and density modeling



Three dimensional density and susceptibility distribution from non constrained inversion



Smaller probability of finding a large barren deposit



Assuming
a uniform vertical distribution (down to 500m) and
a statistically true size distribution

l	L	th		nb	eroded	remaining	outcropping	0-100m	outcropping	blind	0-100m
400	1250	50	100 000 000.00	5 (4%)	0	5	2	0	40%	60%	0%
200	500	25	10 000 000.00	26 (20%)	4	25	5	3	19%	81%	7%
100	175	15	1 050 000.00	100 (76%)	25	75	8	9	11%	89%	12%

False Positives

1. Few good targets **in** the right geological setting.
   - Barren sulfides (mainly Py-Po stringers)

2. Numerous targets that appear like VHMS targets but **are not** in the right geological setting
   - Barren sulfides and graphite

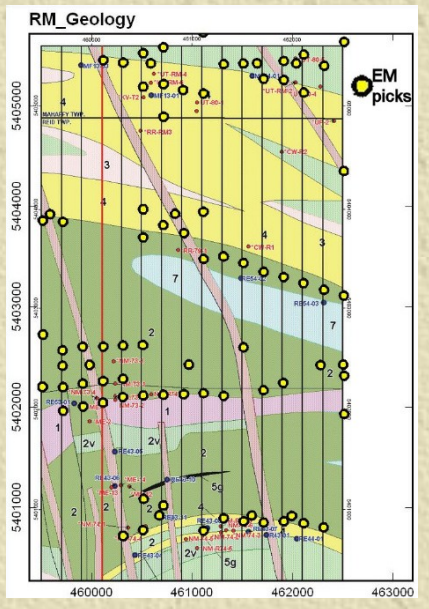
One easy solution : no selection of " formational" conductors

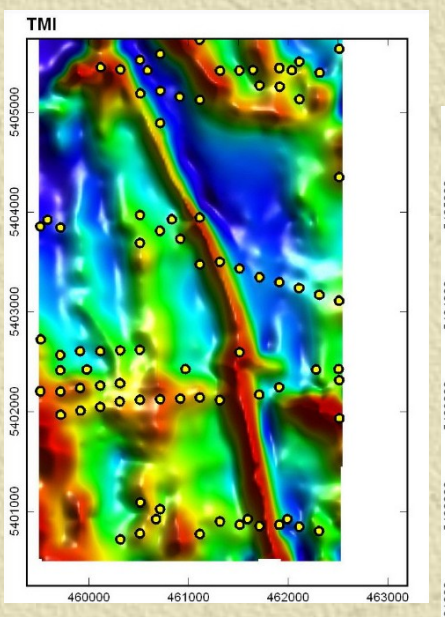
Consequence : Lost opportunity or reduced search space
VHMS have been found in the so-called "formational" settings

THUS : Need for better predictive models

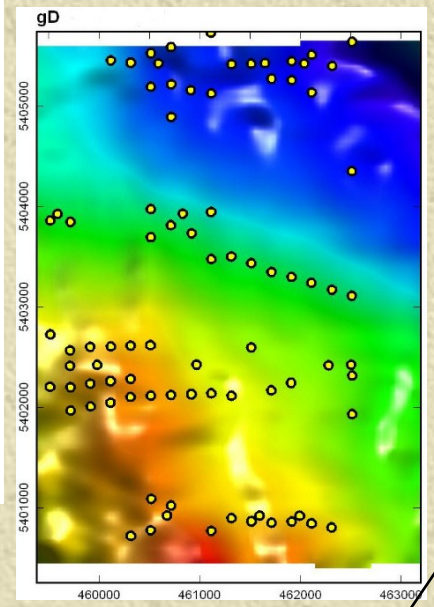
"Only good fishermen are successful,
first by selecting the good lakes and then the good spots"

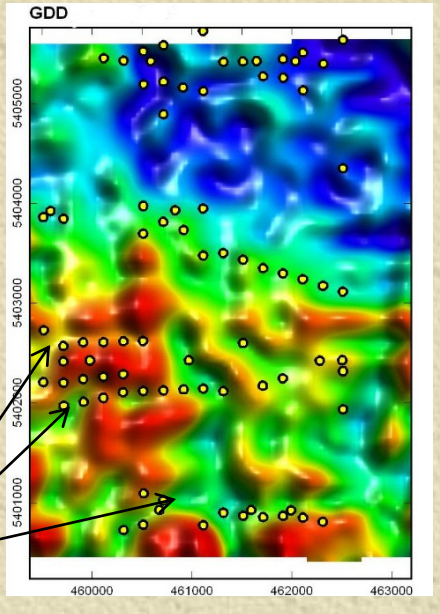
The evolution :
Reid Mahaffy example





Gravity data at this scale can help to constrain and refine





EM conductors in gravity lows

[redacted]

Toronto, 2 June 2011

Xstrata Zinc has entered into a binding agreement with Sabina Gold and Silver Corporation to purchase the Hackett River and Wishbone exploration properties in the Western Kitikmeot region of Nunavut, North Canada. Under the terms of the agreement, Xstrata will pay a cash consideration of ***C$50 million*** and will grant a silver royalty to acquire the properties. Additionally, Xstrata will commit a further ***C$50 million*** in exploration and to complete a bankable feasibility study within four years of the transaction's closing.

Now and into the future

- **Near mine exploration** will remain quite effective.
- **Incremental advances in technology** can be expected and in the right geological circumstances, ex: Lalor Deposit
- The efficacy of geophysical techniques to **search at depth** (2-3 km) will remain **challenging**.
- More integrated **modeling of multiple data sets** is expected to help define areas of interest.
- Specific targeting (i.e. where to drill) will likely require some new definitions of **geoscience infrastructure** such as systematic seismic-MT transects and deep drilling for geological control and to feed-back into modeling.
- Economically the shortest returns could be realized if the means could be developed to target effectively in the areas classified now as **"formational conductors"**

PDAC 2011

Technical Program

Wednesday, March 9

New discoveries and developments

9:00 am – 12:00 noon

Chairs: Bill Mercer, Avalon Rare Metals Inc. & Charles Beaudry, Xmet Inc., Toronto, Canada

The New Serra Pelada (high-grade gold PGE's in Brazil), Vic Wall, Colossus Minerals Inc., Spring Hill, Australia

Building Ontario's largest gold mine, Gerald Panneton, Detour Gold Corporation, Toronto, Canada

Pallas Green project, Normand Dupras, Xstrata Zinc Ireland Ltd., Limerick, Ireland

Visit www.pdac.ca (click on PDAC 2011 Convention) in the coming weeks for a complete list of presenters.

Looking under cover

9:00 am – 12:00 noon

Chairs: Neil Gow, Consultant, & George Cargill, Cargill Consulting Geologists Limited, Toronto, Canada

Geophysical exploration: Challenges for large and small companies, Jim Misener, Paterson, Grant & Watson Limited, Toronto, Canada

Geophysics for blind VMS deposits in the Abitibi greenstone belt: Past, present and future, Michel Allard, Xstrata Zinc, Saint-Laurent, Canada

Geological inferences from pre-competitive geophysical data, Ned Stolz, Geoscience Australia, Symonston, Australia

Exploration geochemistry: An integrated future, Mark Fedikow, Mount Morgan Resources Ltd., Lac du Bonnet, Canada

New advances in geochemical exploration for porphyry deposits in lithocap and green rock environments, David Cooke, CODES, University of Tasmania, Hobart, Australia

Exploration for blind "Irish type" Zn-Pb deposits and the discovery of Pallas Green, Ireland, David Blaney, BRG Ltd., Naas, Ireland

Advances in exploration targeting, Campbell McCuaig, University of Western Australia, Crawley, Australia

Short Courses and Workshops

9. Changes to NI 43-101: How will they affect your company?

Tuesday, March 8 **7:00 – 9:00 am**

Organizer: Ontario Securities Commission

The proposed amendments to NI 43-101 do not alter the core principles which have been in place since 2001. They do however reflect nine years of regulatory experience, broad consultation through focus groups and a public comment process. It is anticipated that the changes will provide cost savings and efficiencies to mining companies without compromising investor protection and the benefits of NI 43-101.

The proposed changes aim to eliminate or reduce the scope of certain requirements, provide more flexibility to mining companies and qualified persons in certain areas and reflect changes that have occurred in the mining industry since NI 43-101 came into effect.

10. DMEC workshop series: Driving exploration success in deep exploration through multi-disciplinary collaboration and data integration

Wednesday, March 9 **1:00 – 5:30 pm**

Organizers: Ken Witherly, Condor Consulting, Inc., Lakewood, USA & Charles Beaudry, Xmet Inc., Toronto, Canada

Decennial Mineral Exploration Conferences (DMEC) is an out-growth of the very successful Exploration 07 symposium held in Toronto (Sept 2007) that drew together over 1,000 delegates to review the state of the art in minerals exploration technology. At PDAC 2011, DMEC will launch what is planned to become an annual workshop event that will focus on the topics identified at Exploration 07 deemed critical to future exploration success.

The first workshop will examine the importance of integrating

Geoscience BC

About Us | News | RFP | Projects | Data | Publications | Outreach

News Releases

July 26, 2011
Exploration Undercover; a practical example using the QUEST study area

Geoscience BC and the **BC Geophysical Society** would like to draw your attention to an upcoming workshop **"Exploration Undercover; a practical example using the QUEST study area"**. The workshop will be held on Oct 12-14th in downtown Vancouver.

This workshop is being organized in response to the highly successful workshop "Exploration in 2020 - Tools and Techniques to Explore Under Cover", which was held on October 6-7, 2010 in Golden, Colorado as part of the Society of Economic Geologists 2010 Conference. The Vancouver workshop will cover much of the same material but will be tailored to a BC audience.

Workshop Description

News

- 2011
- 2010
- 2009
- 2008
- 2007
- 2006
- 2005

Print This Page

ASEG 2009

Minerals Exploration

- Deeper penetration (More power, greater precision, better interpretation software)
- Satellite deposit detection
- Transferring oilfield technologies to mineral exploration
- Technology developments in mineral exploration
- Uranium exploration update
- Case histories of successes and failures of exploration under cover in major Australian mineral exploration domains including the Yilgarn, the Gawler, the Lachlan Fold Belt, etc – could include identifying new mineralised provinces, as well as exploration for gold, base metals, diamonds, iron ore & mineral sands

SEcG-I

PRESIDENTIAL PERSPECTIVE

Reaching Out to the Future

M. Stephen Enders
SEG President
2011

For those of you who were able to attend the Keystone Meeting in October, you'll undoubtedly remember the great engagement from the 170 student members who attended the meeting and the fun you had in forming and renewing relationships with other members in our Society. Having been involved in promoting SEG programs for students during my five-year term with SEG Foundation a few years ago, I find it gratifying to see the growth of the student and

with other student chapters and the broader membership. This is essentially free, but it requires more involvement from our members and fellows, as well as from Student Chapter sponsors and the SEG mentors.

The students recommended, and the SEG Executive Committee supports, the establishment of a committee of students, to consist of one student per region to be elected or selected by the student chapters and, at least initially,

position to represent the region that includes Mexico, Central America, and the Caribbean. In addition, we're considering establishing additional VPs for Africa and other regions of the world not cur-

VIEWS I

Grassroots Exploration: Between a Major Rock and a Junior Hard Place

Richard H. Sillitoe†
(SEG 1976 F)

Peak metal—the time when demand for certain metals exceeds supply, irrespective of how much is spent on exploration and recycling (e.g., Sverdrup et al., 2009)—is nigh according to a growing number of its adherents, but mainly from outside the mining industry. Nonetheless, it is being increasingly

districts are traditionally discovered, can be sustained at something approaching historical levels. Grassroots exploration has made major contributions to the global metal inventory (Table 1) and, arguably, remains a prerequisite if we are to satisfy long-term metal demands.

explorers, although their near-mine (brownfields) exploration efforts have recently been rewarded with a number of outstanding discoveries, perhaps most notably in the porphyry cop-

SEcG-II

VIEWS II

Exploration—People and Discovery

(These columns are the opinion of the authors and do not necessarily reflect the view of the SEG)

JOHN F.H. THOMPSON† (SEG 1983 F)

DOUGLAS J. KIRWIN† (SEG 1997 F)

INTRODUCTION

At the NewGenGold conference held in Perth in late 2009, presenters consistently expressed two major factors critical to the discovery of new ore deposits, "drill—often repeated multiple times

The energized learners

The lifeblood of the industry comes from young, enthusiastic, and educated employees. The problem is that the industry in general does a poor job of attracting these people and typically an

transferable skills. Of course, this is not

Printed in the April 2011 • No 85 issue of the SEG Newsletter

Views columns are the opinions of the authors and do not necessarily reflect the opinions of SEG.

VIEWS II

Exploration—It's All About Turning Rocks into Money

BRENT COOK (SEG 1997)

INTRODUCTION

I've been in the exploration and mining business for 32 years, during which time my professional career has evolved from mapping and sampling rocks into "turning rocks into money." During this

for those young, energized learners just joining our ranks. Thompson and Kirwin (*SEG Newsletter*, April 2010) recommend the perfectly logical (and true) approach, that mining companies should mentor and employ explorationists during the

dollar spent by a junior explorer has to be replaced, which means shareholder dilution at the com-

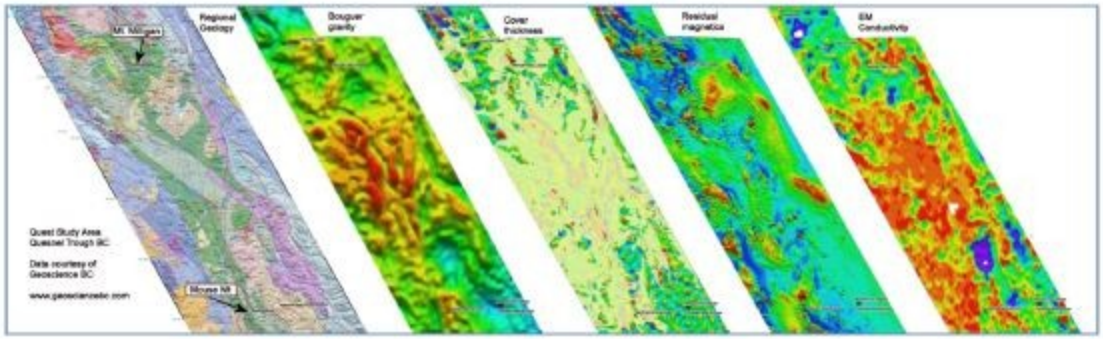
Way Ahead…

Society of Exploration Geophysicists
The international society of applied geophysics

EXPLORATION IN 2020

TOOLS AND TECHNIQUES TO EXPLORE UNDER COVER

Discovery of new mineral resources faces challenges in many parts of the world, with the increased likelihood that new discoveries will be non-outcropping. Moving exploration under cover requires new approaches in the way prospective areas are selected; target models are defined; and geoscience data are acquired, processed and interpreted, with increased emphasis on modeling geology and geophysics in a 3-D GIS environment.



Way Ahead…