

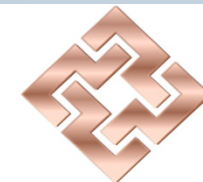
The Geophysical Tool Kit to Map the Upper 3 km



ASEG-PESA 2013

'THE EUREKA MOMENT'
11-14 AUGUST 2013 • MELBOURNE, AUSTRALIA

Ken Witherly-Condor Consulting, Inc.



FIRST QUANTUM
MINERALS LTD.

Undercover Toolkit
The Dilemma



“we can see deep but its blurry...”
Joel Jansen-Teck

Undercover Toolkit The Roster



- **Potential fields**
 - **Magnetics**
 - **Gravity**
- **Electromagnetics**
 - **Active**
 - **Passive**
- **Seismic**
 - **Surface**
 - **VSP**
- **DC resistivity/IP**
- **Radiometrics**
- **Other**

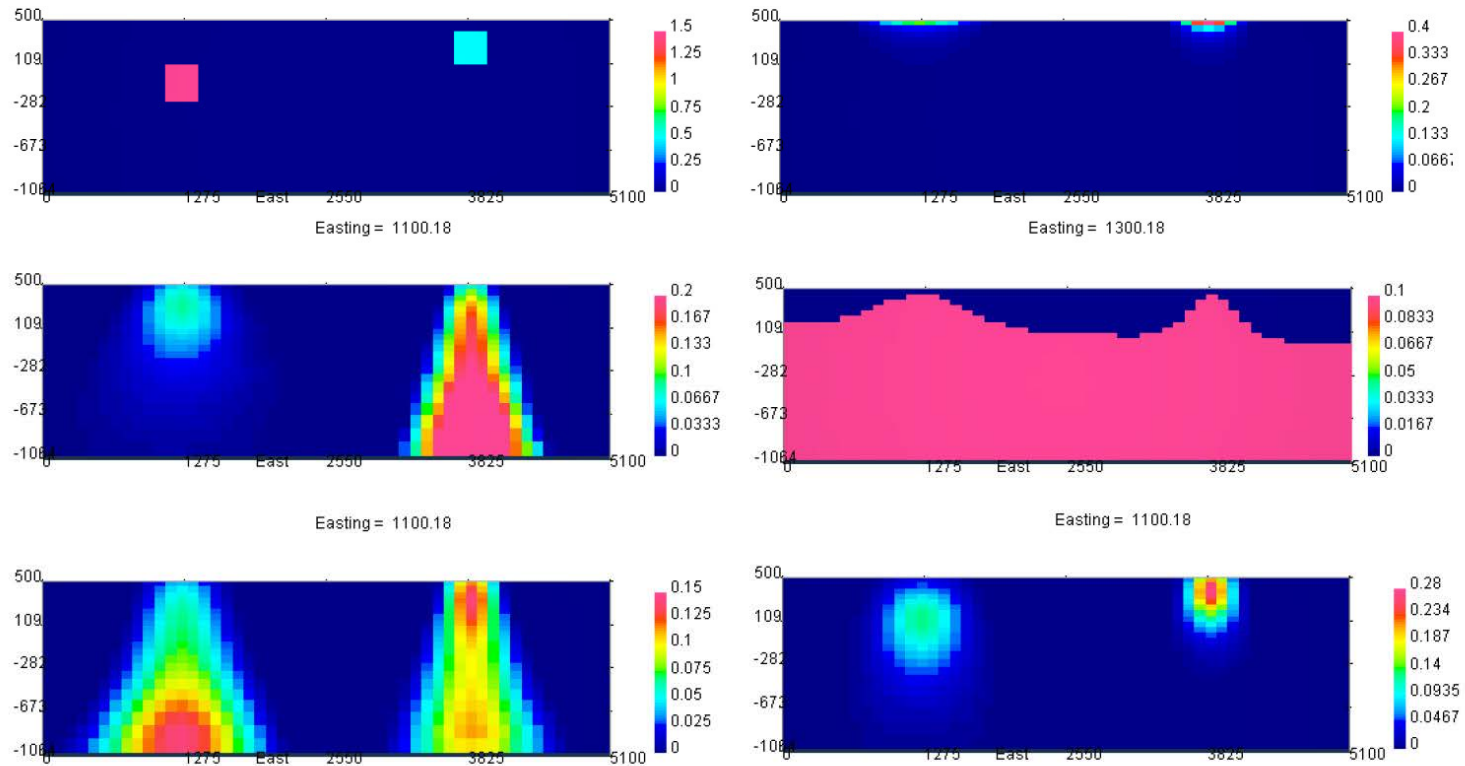
Undercover Toolkit Uncertainty



Understanding Inversion: Non-Uniqueness



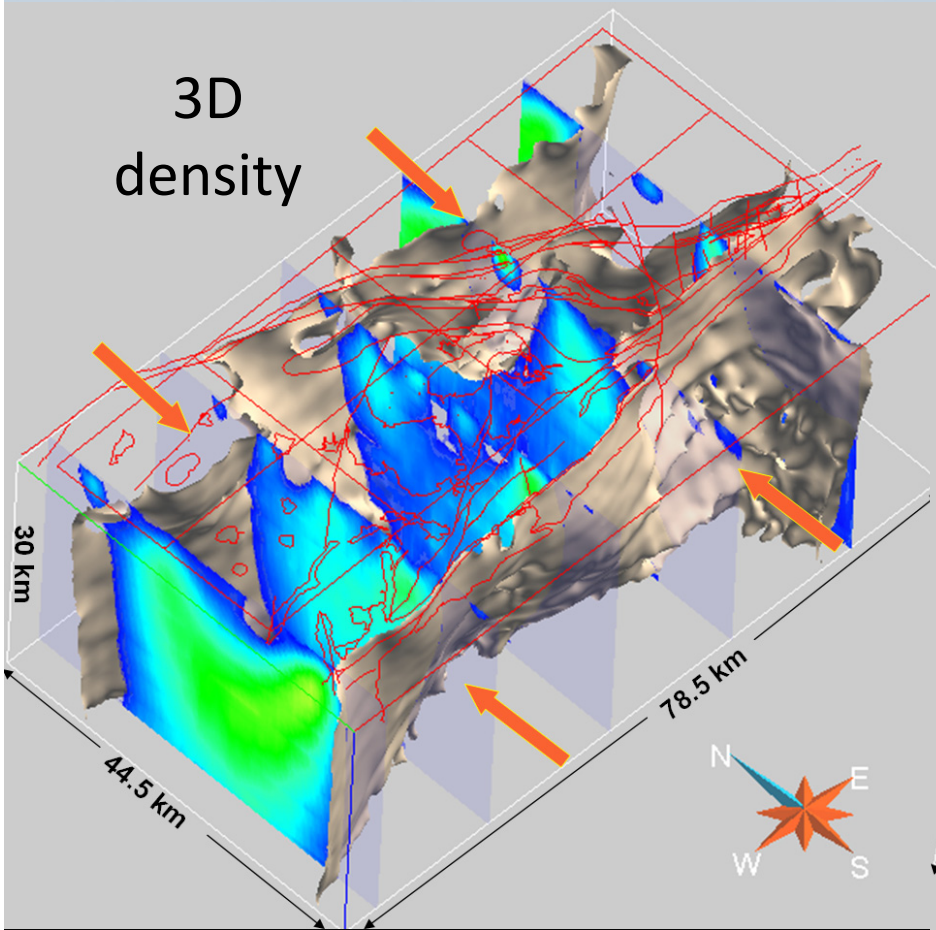
An Infinity of Models have the same Gravity Tensor Response



Undercover Toolkit
Unconstrained inversion

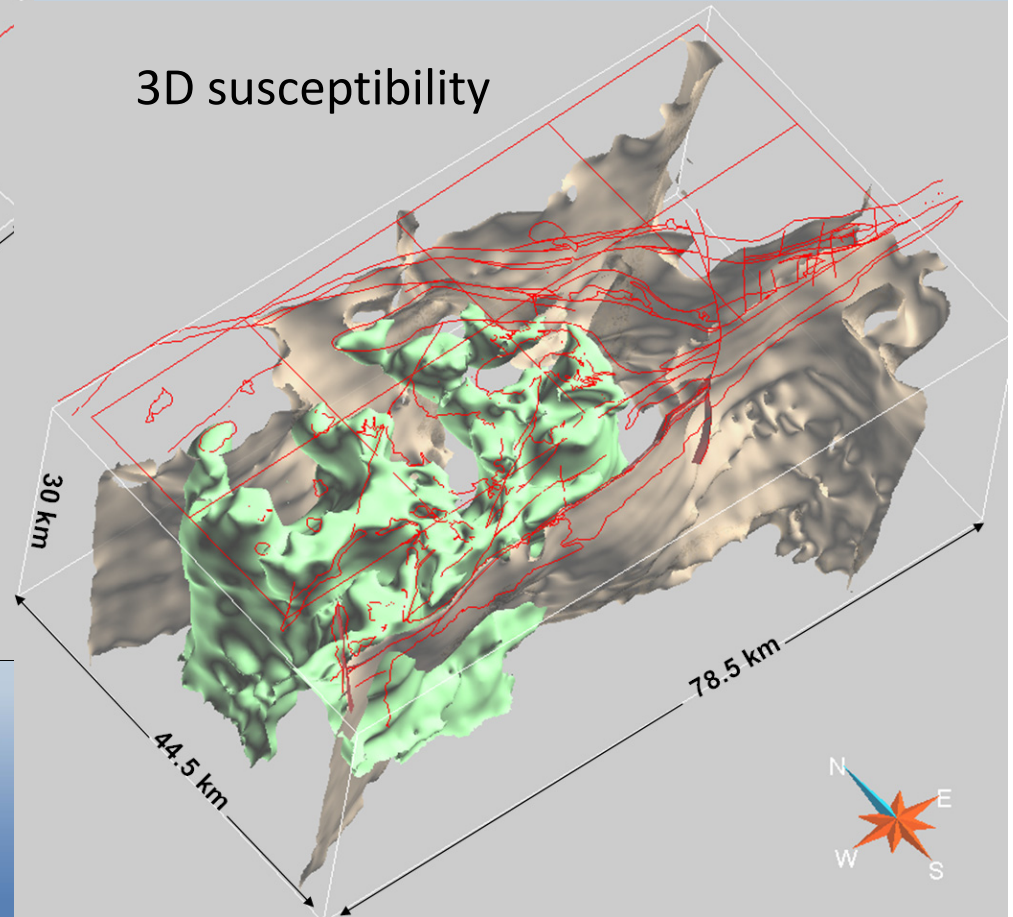


3D
density



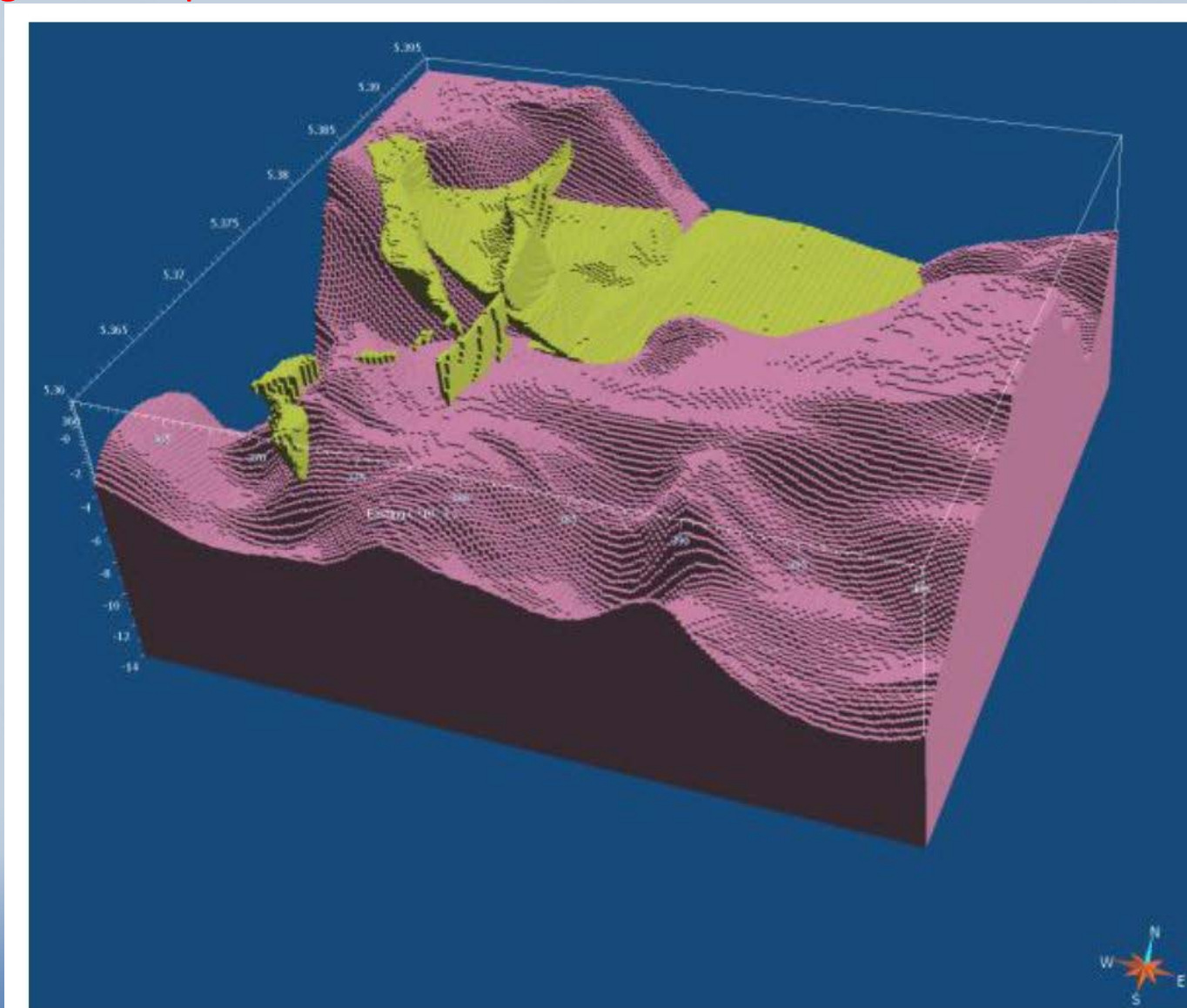
Three dimensional density and
susceptibility distribution from non
constrained inversion

3D susceptibility



Undercover Toolkit

Getting more sophisticated



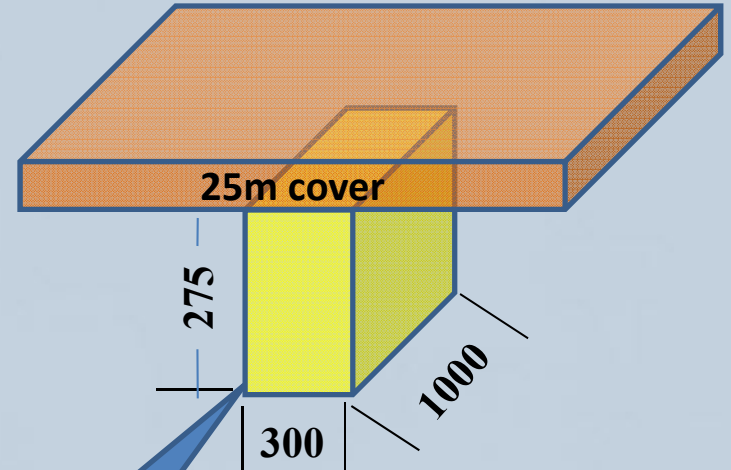
Undercover Toolkit Simulations



How might such alteration systems appear in this data?

In the next slide we consider the effect of adding the response from silicification / or desilicification zones above the unconformity.

The simplistic geometry and the six different density contrasts used are shown below.

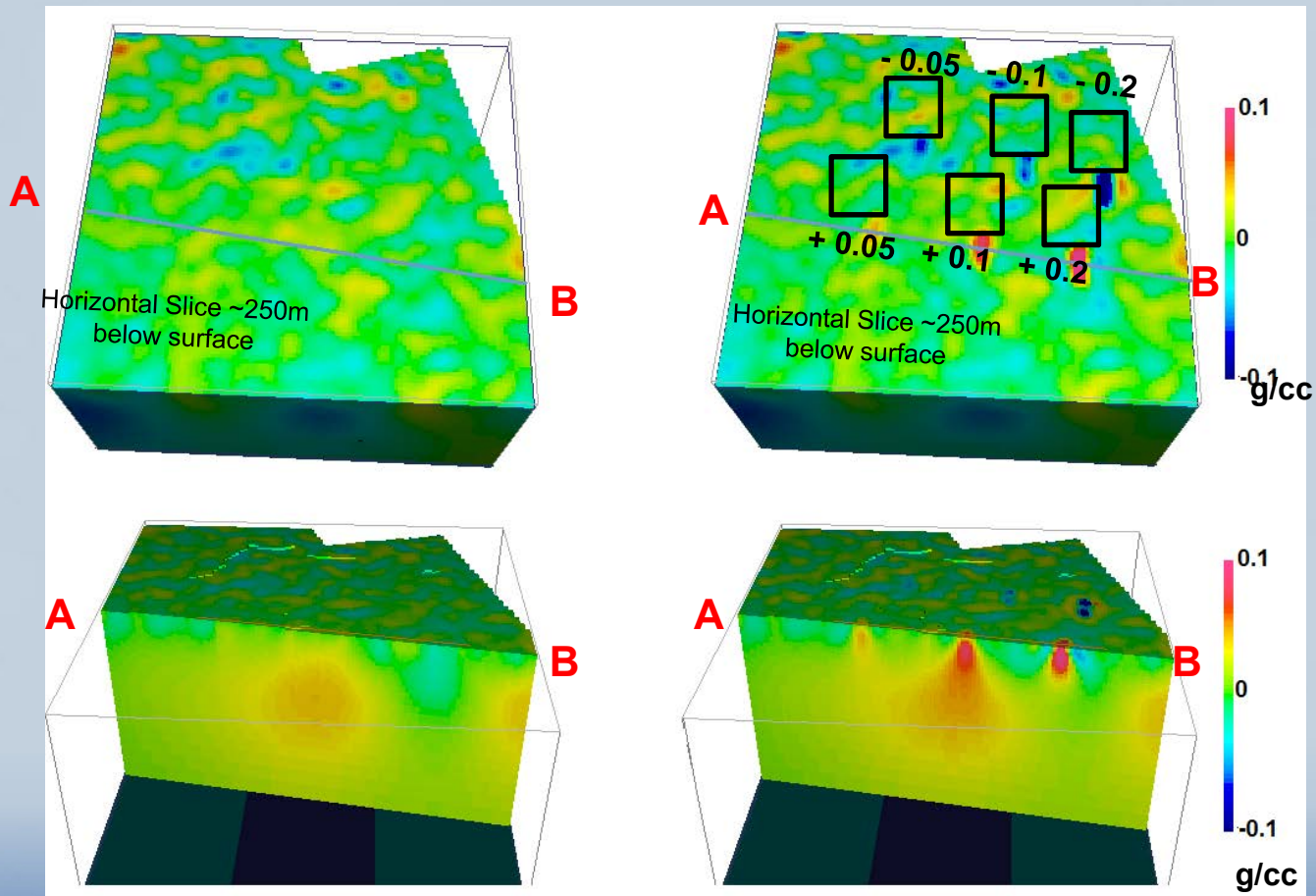


Density Contrasts

-.05, -.10 and -.20 g/cc

.05, .10 and .20 g/cc

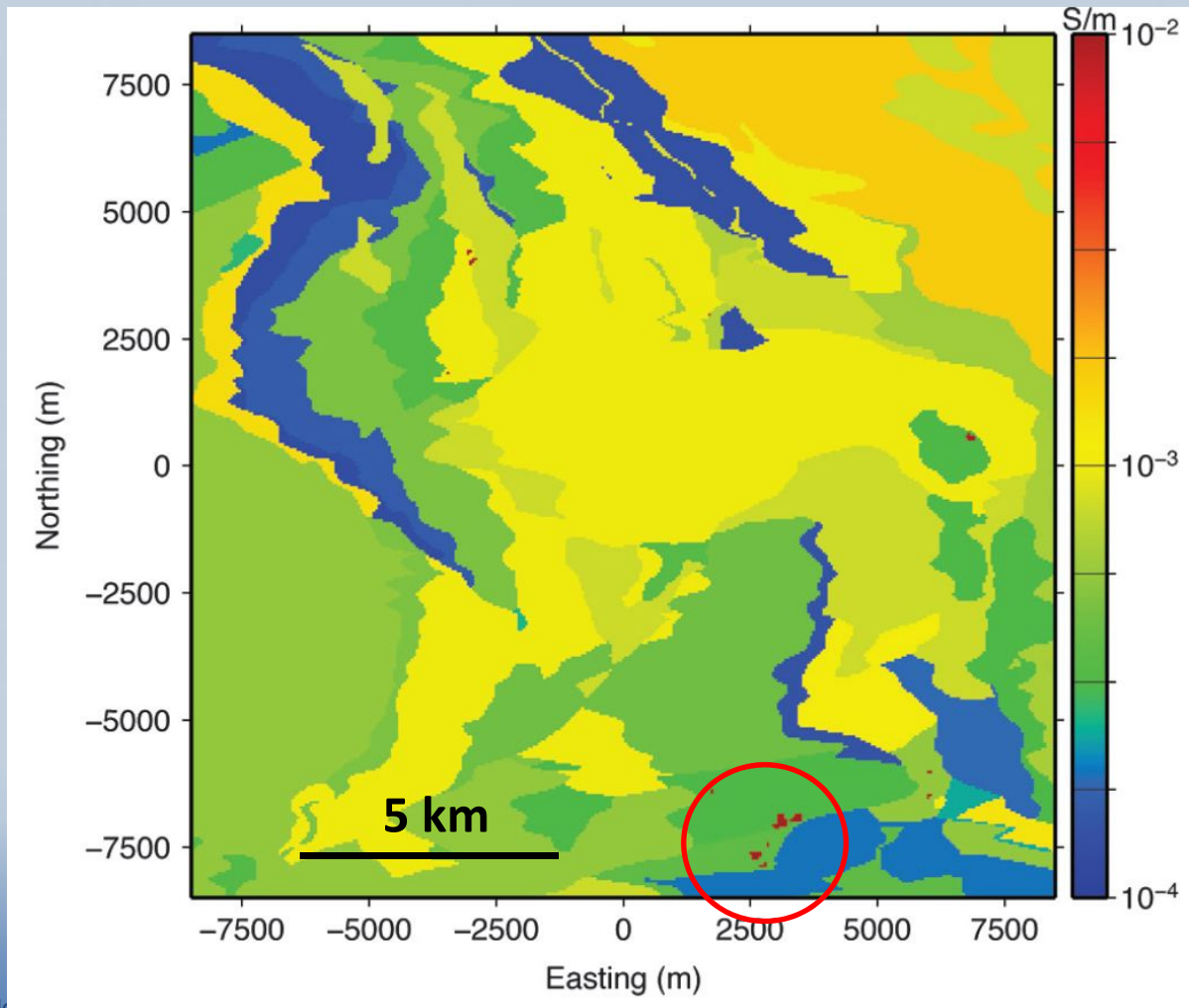
Undercover Toolkit Simulations



Inverted Density
Model

... with "Alteration Chimneys" added
to data before inversion

Undercover Toolkit Simulations

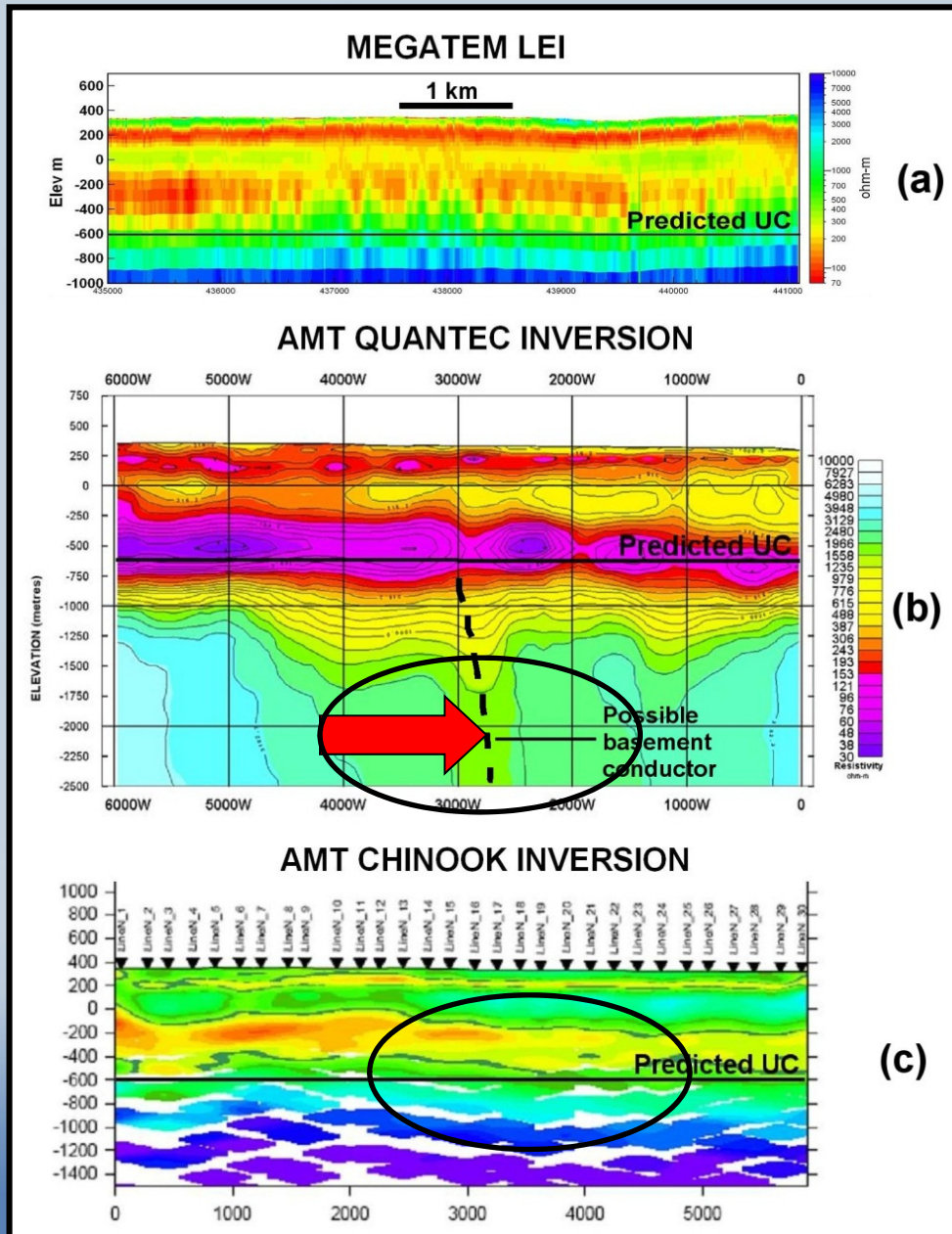


Noranda Camp
Quebec

Undercover Toolkit Limits of certainty



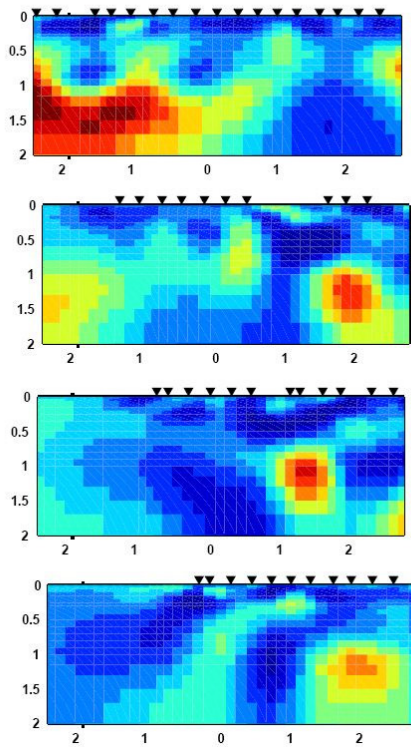
Athabasca Basin
Virgin Trend



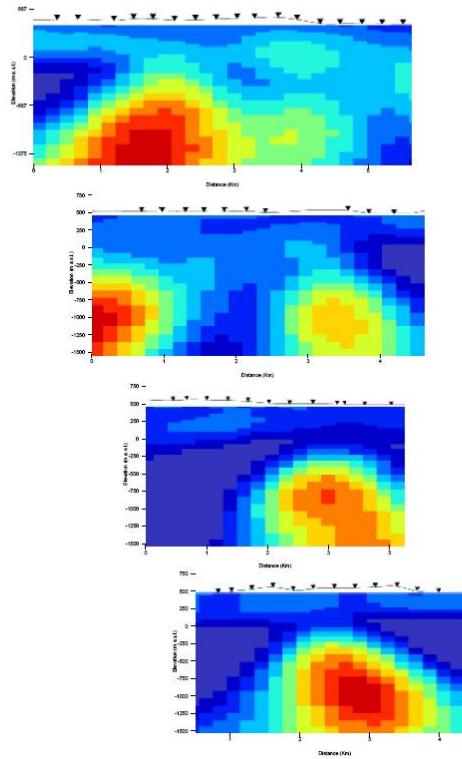
Undercover Toolkit Uncertainty in modeling



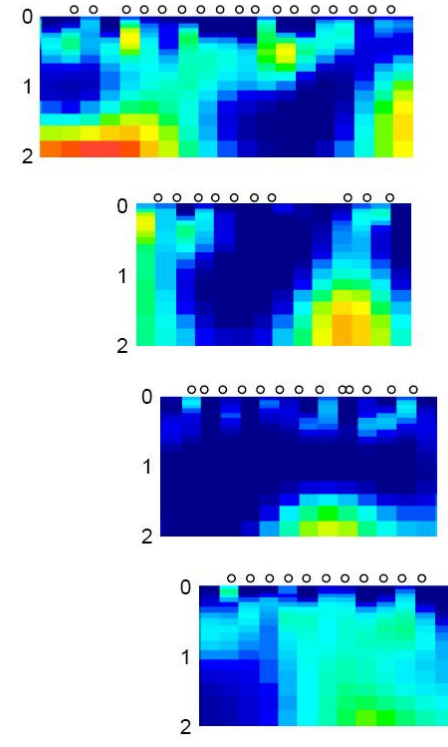
3-D, Siripunvaraporn



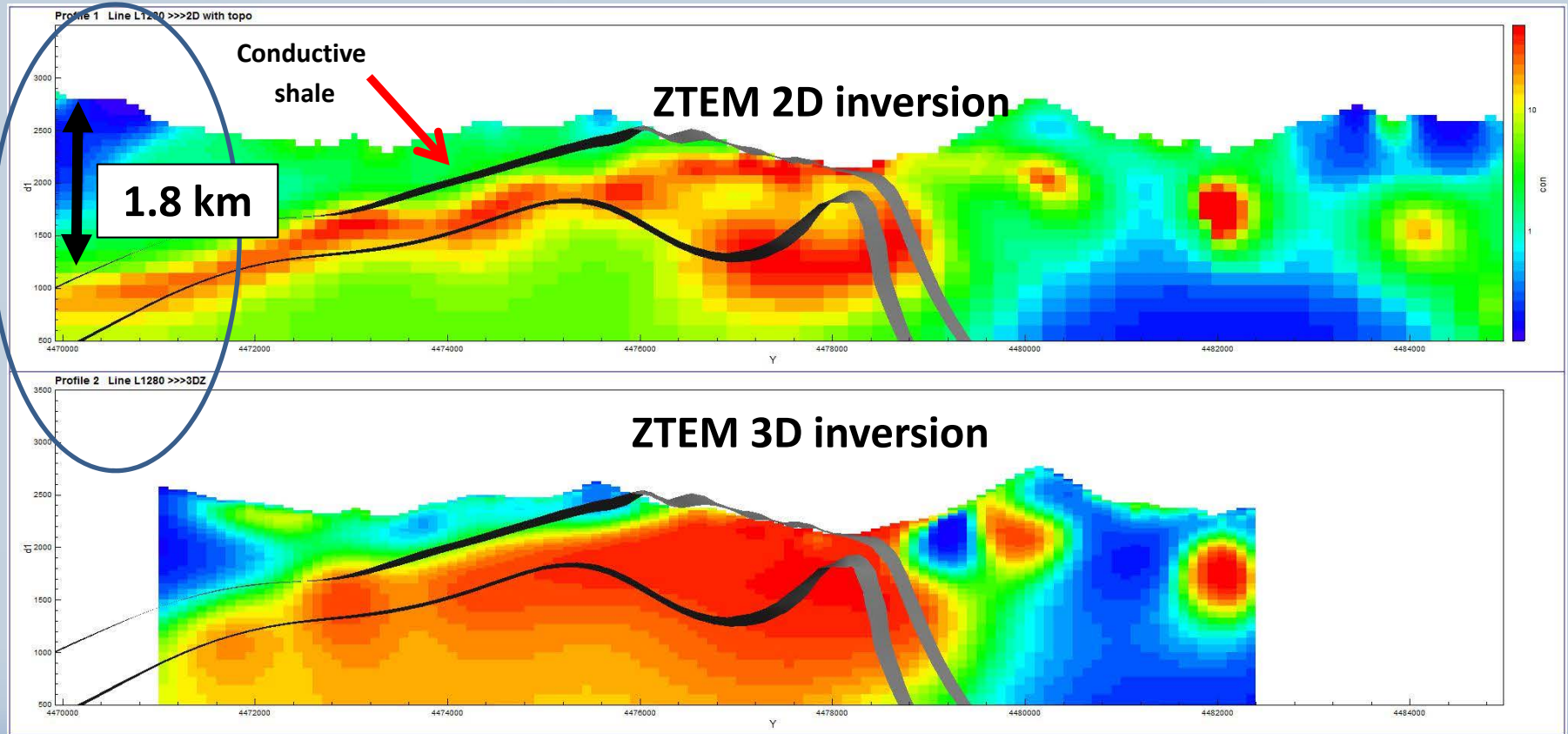
3-D, Mackie



3-D, Farquharson

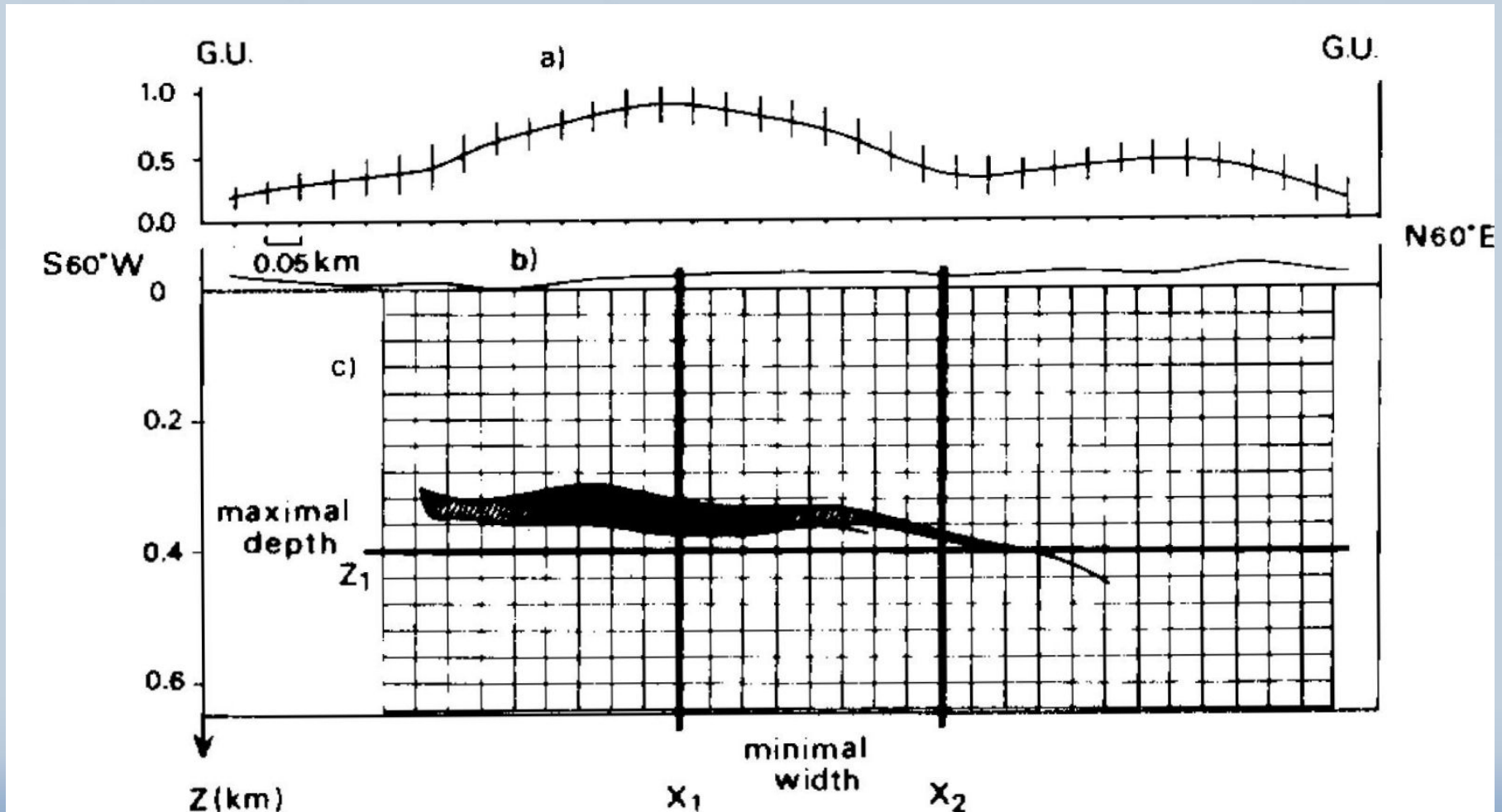


Undercover Toolkit Seeing deep



Undercover Toolkit

Seeing deep



Neves Corvo

Case study – Neves Corvo



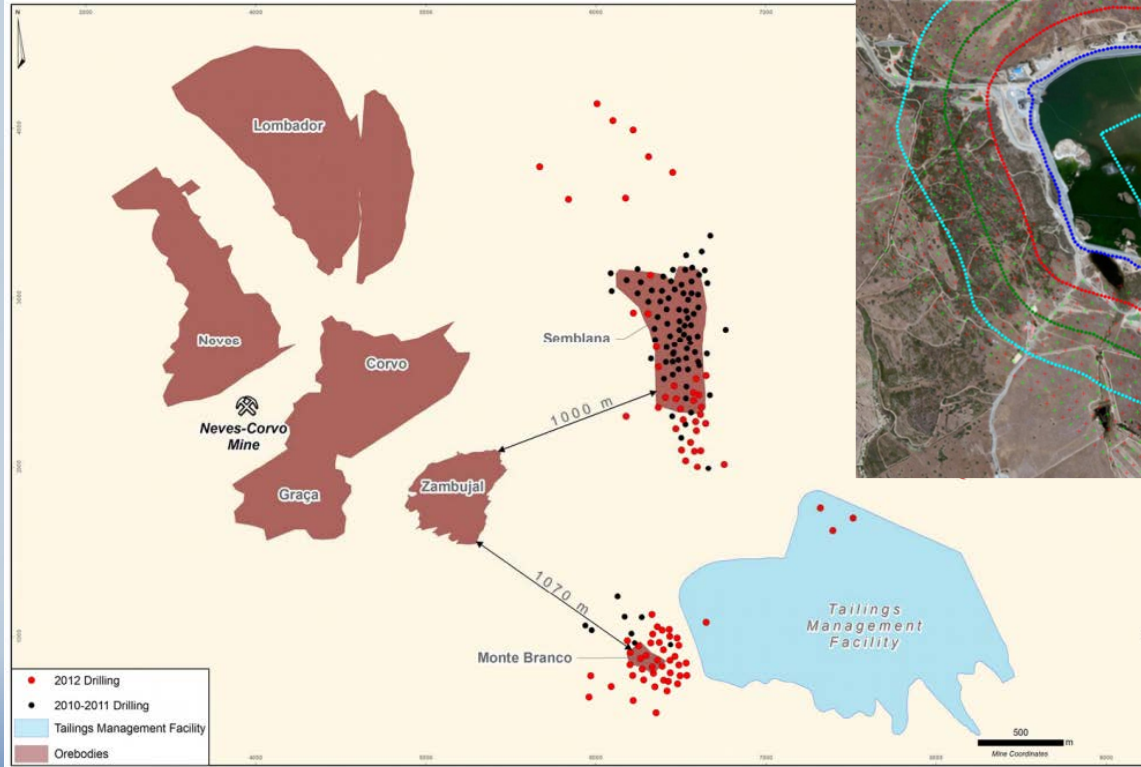
Exploration Challenge in Portuguese Iberian Pyrite Belt

(www.lundinmining.com)

- Complex structural geology with thrusting
 - Surface geology does not always represent subsurface
- Mature terrain = deep targeting >500m
 - 30 years of exploration focused within upper 500m
- Economic mineralization is difficult to target with conventional methods
 - All geophysical and many geochemical surveys tried with limited significant success



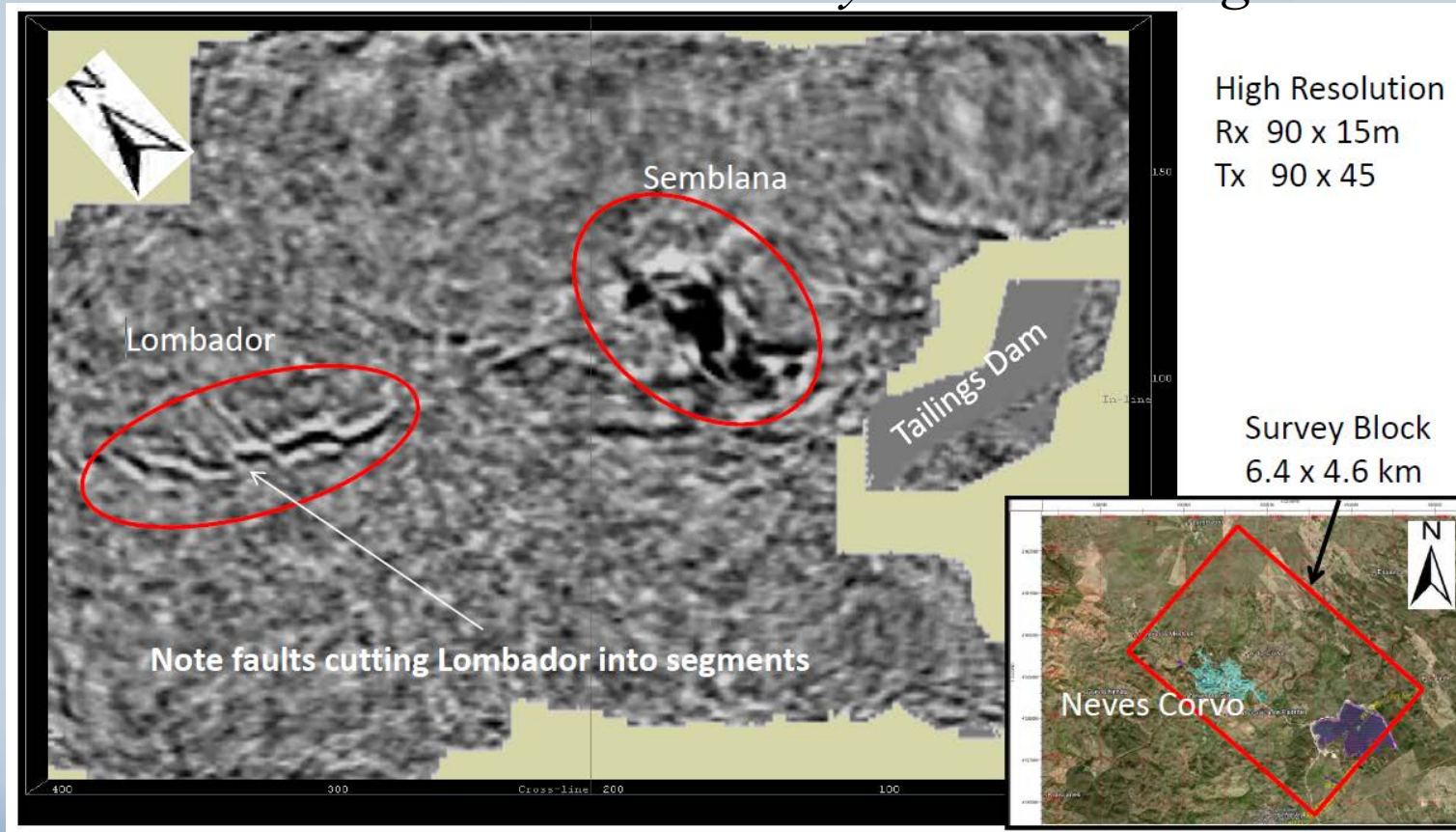
Case study – Neves Corvo



Case study – Neves Corvo



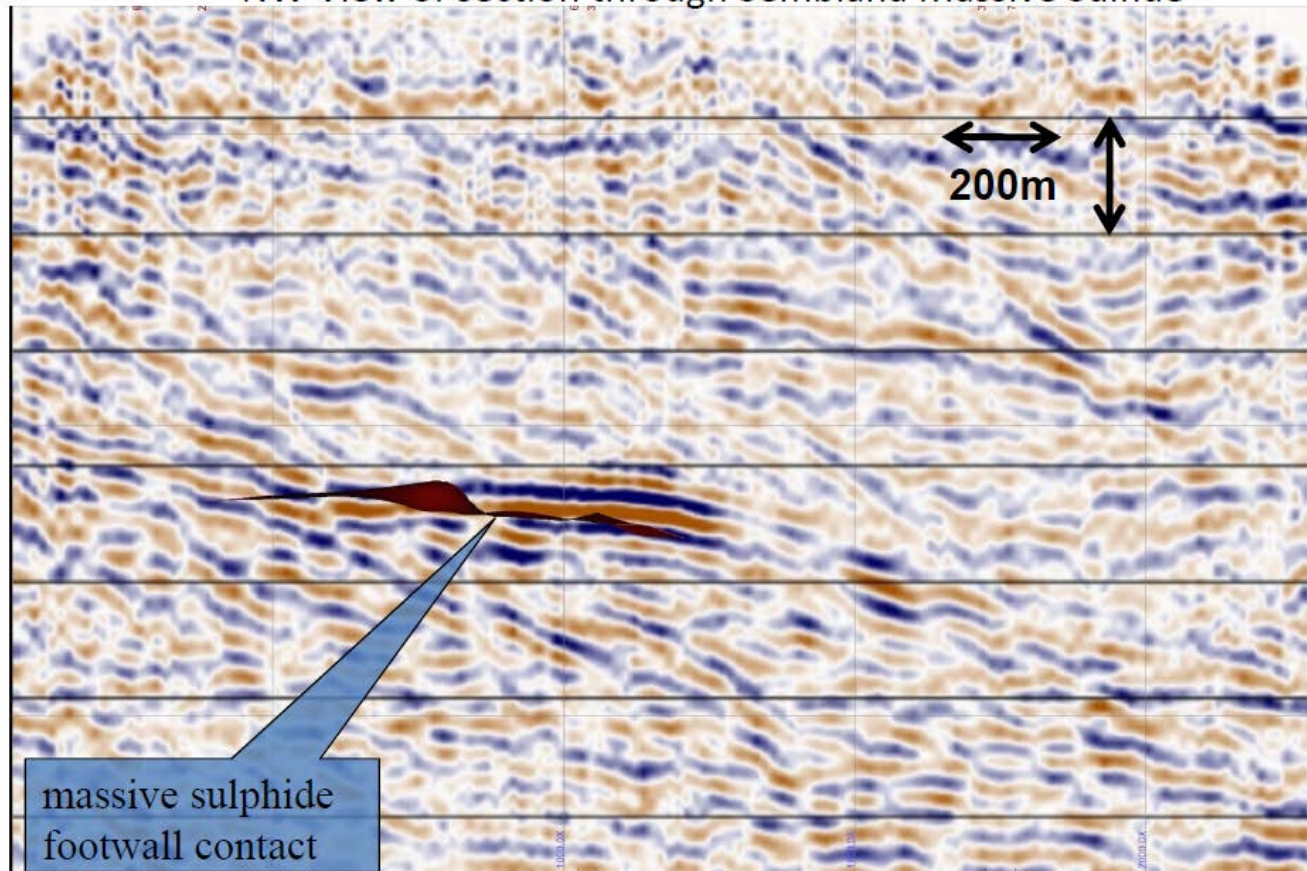
Courtesy Lundin Mining



Case study – Neves Corvo



NW View of section through Semblana Massive Sulfide



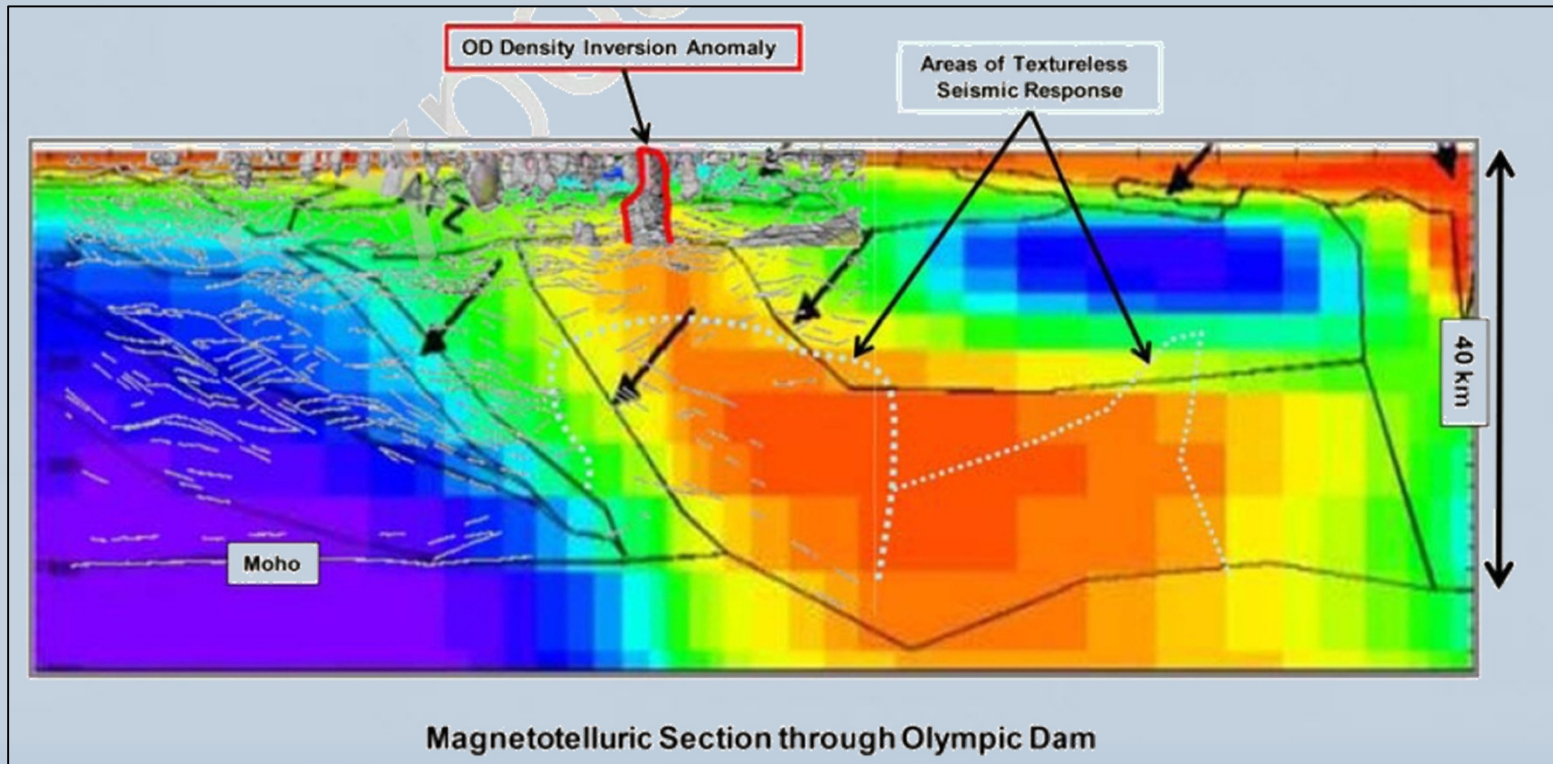
Case study – Neves Corvo



"A high-resolution 3D seismic survey has now been completed over a 21 square kilometer area surrounding the Neves-Corvo mine. Preliminary results have clearly imaged the major Semblana deposit, verifying the effectiveness of this new tool in the search for blind massive sulphide deposits"

[Lundin Mining news release to the Toronto stock exchange. July 21, 2011](#)

Undercover Toolkit The Big Bite

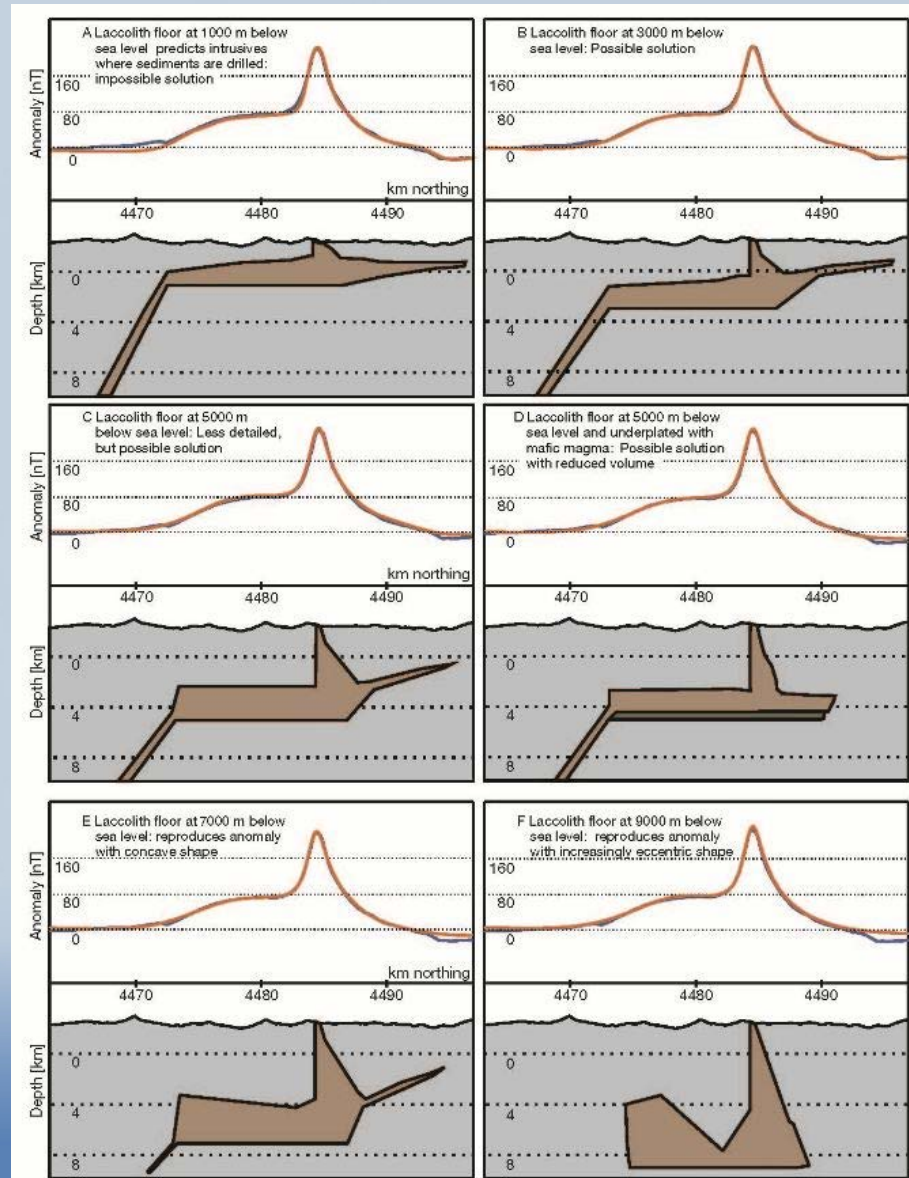


Undercover Toolkit
3D models; primitive but understood



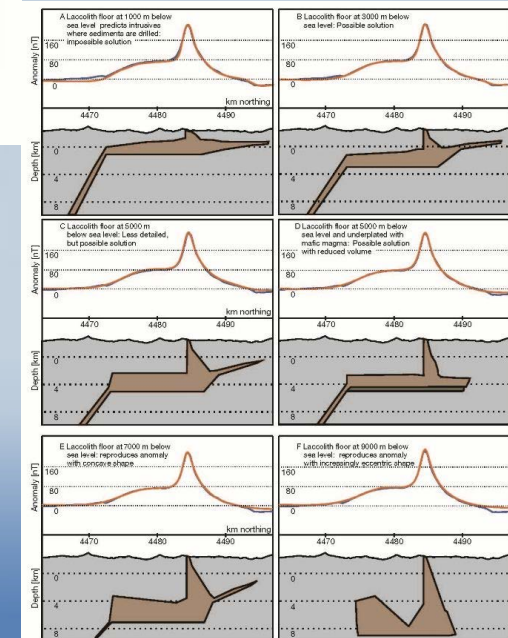
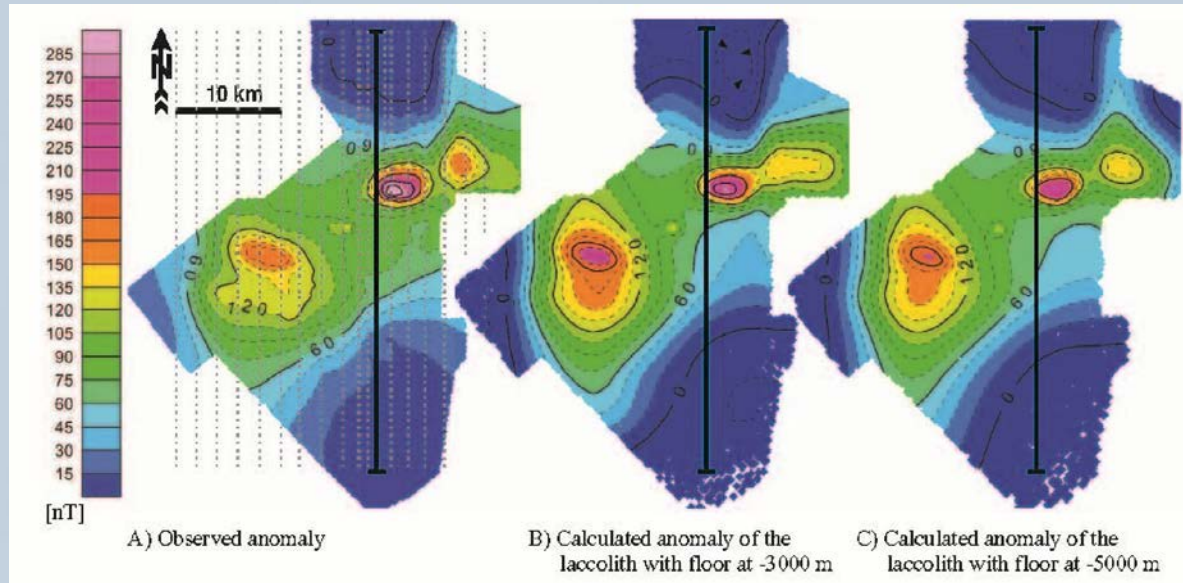
Undercover Toolkit

Merging geology & geophysics-hypothesis testing



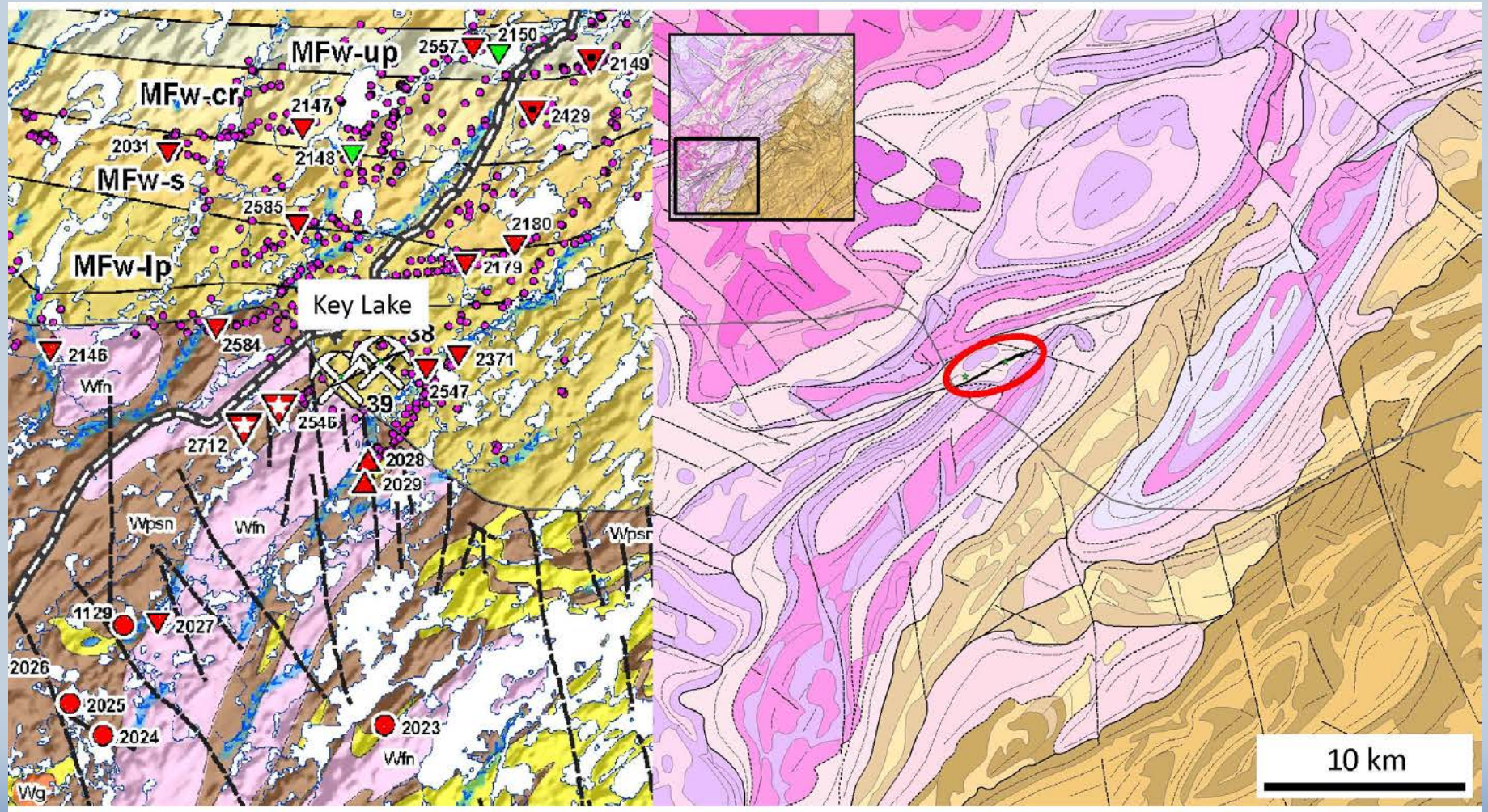
Undercover Toolkit

Merging geology & geophysics-hypothesis testing

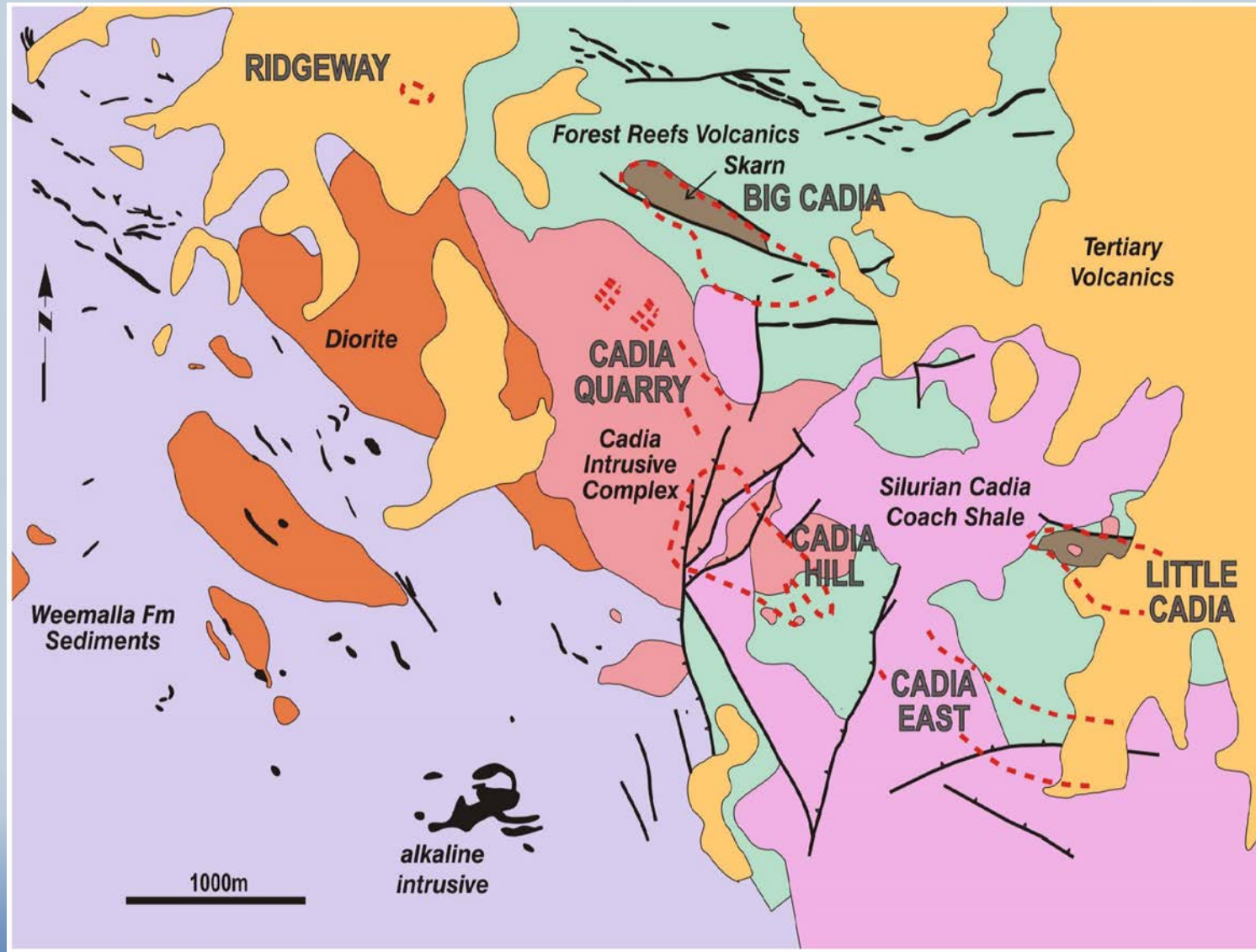


Undercover Toolkit

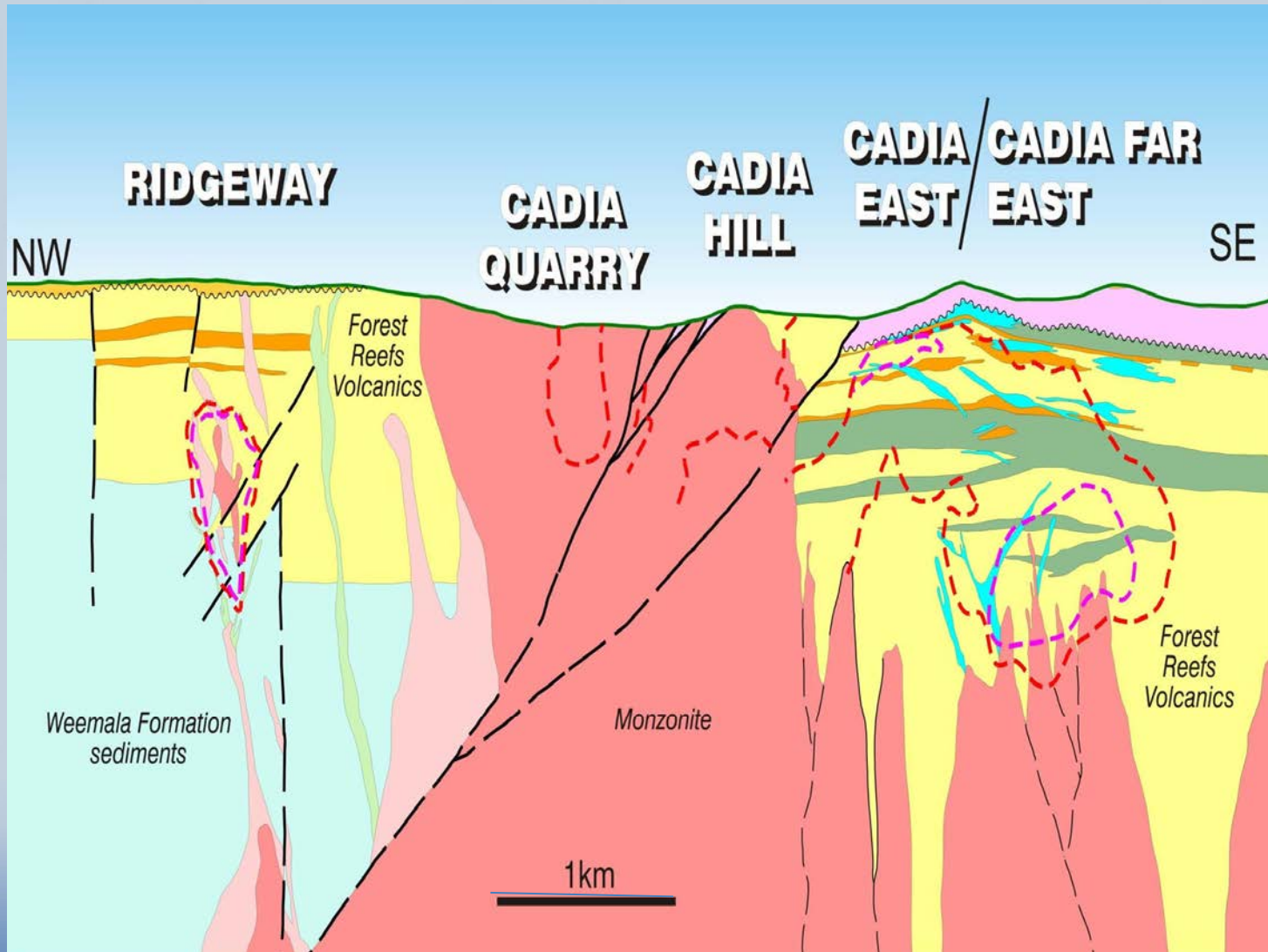
Geological mapping with geophysics



Undercover Toolkit



Undercover Toolkit





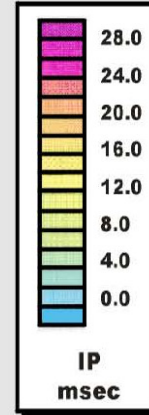
CADIA - RIDGEWAY

LINE 11,000E

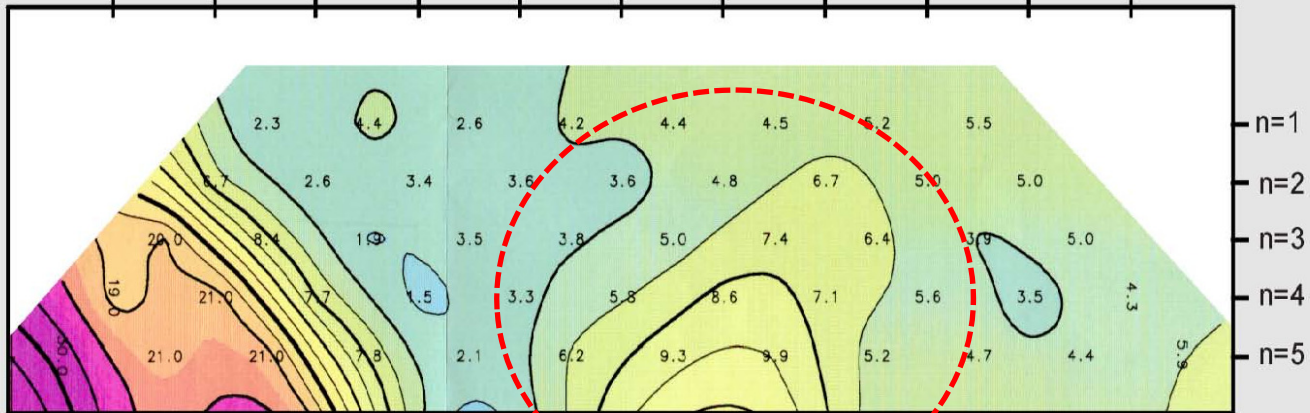
DIPOLE - DIPOLE PSEUDO SECTION

APPARENT CHARGEABILITY
(mSECS)

Ridgeway



21,400 N 21,600 N 21,800 N 22,000 N 22,200 N 22,400 N 22,600 N 22,800 N 23,000 N 23,200 N 23,400 N

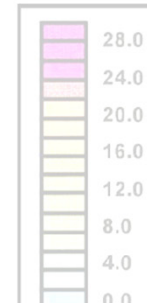


CONTOUR INTERVAL : 2mSECS

400 m



CADIA - RIDGEWAY
LINE 11,000E
DIPOLE - DIPOLE PSEUDO SECTION



**“The IP survey did not find
Ridgeway but Ridgeway was
found because of the IP survey”**

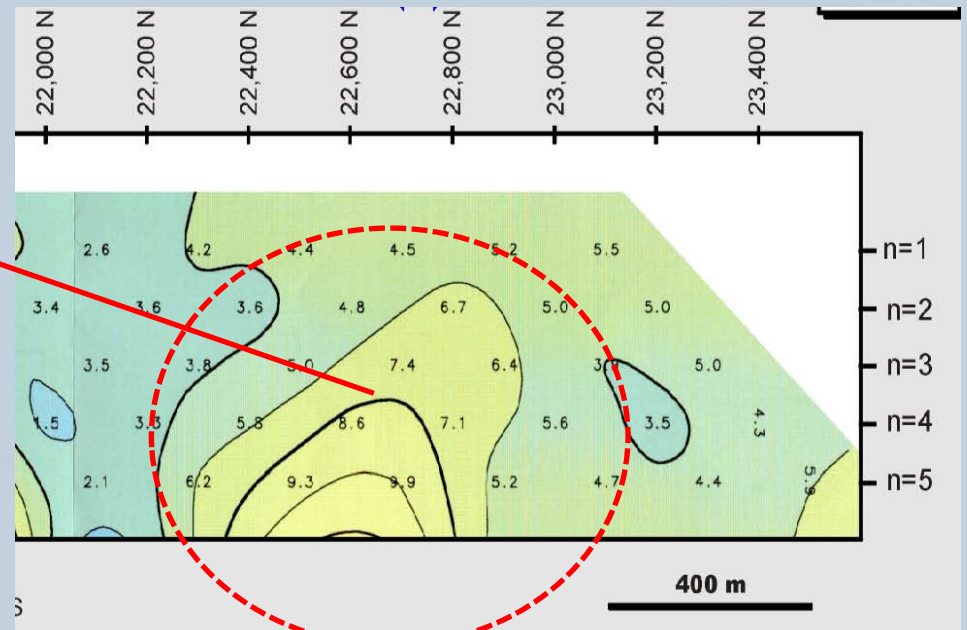
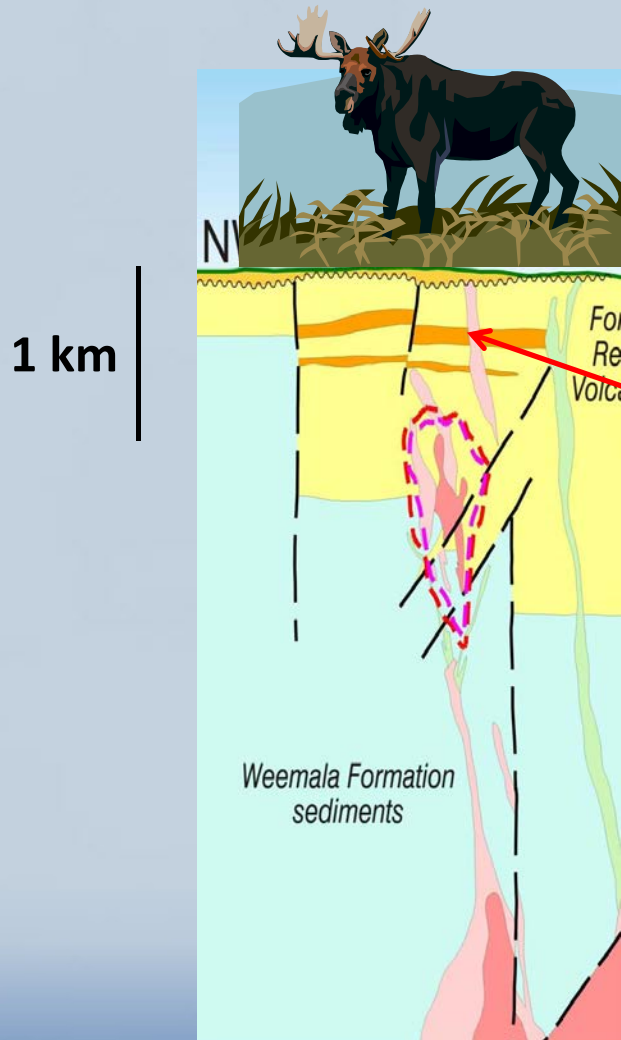
Dan Wood-ASEG Aug 13 2013



CONTOUR INTERVAL : 2mSECS

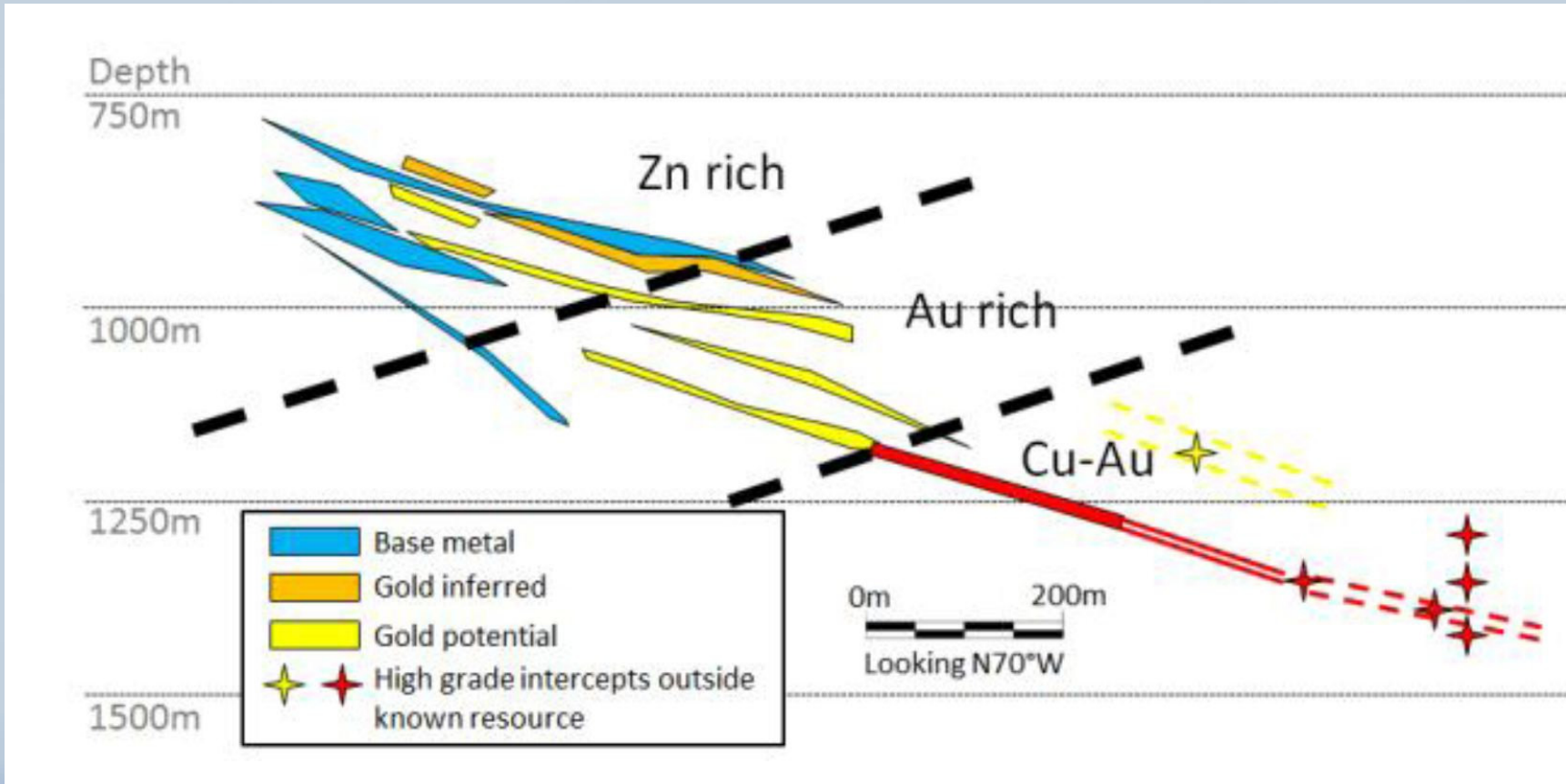
400 m

Undercover Toolkit Is it enough??



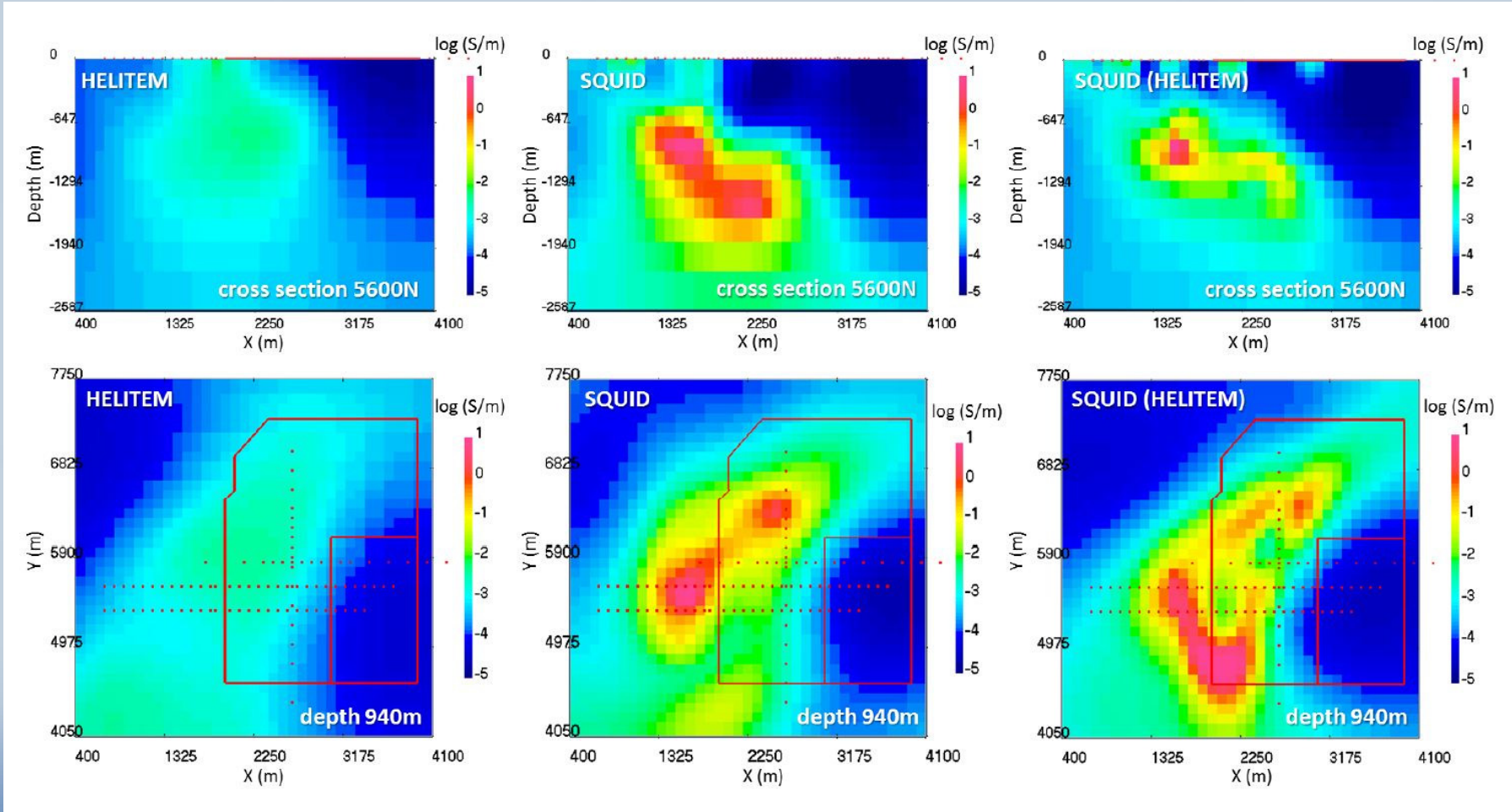
????

Undercover Toolkit
See deep and fuzzy

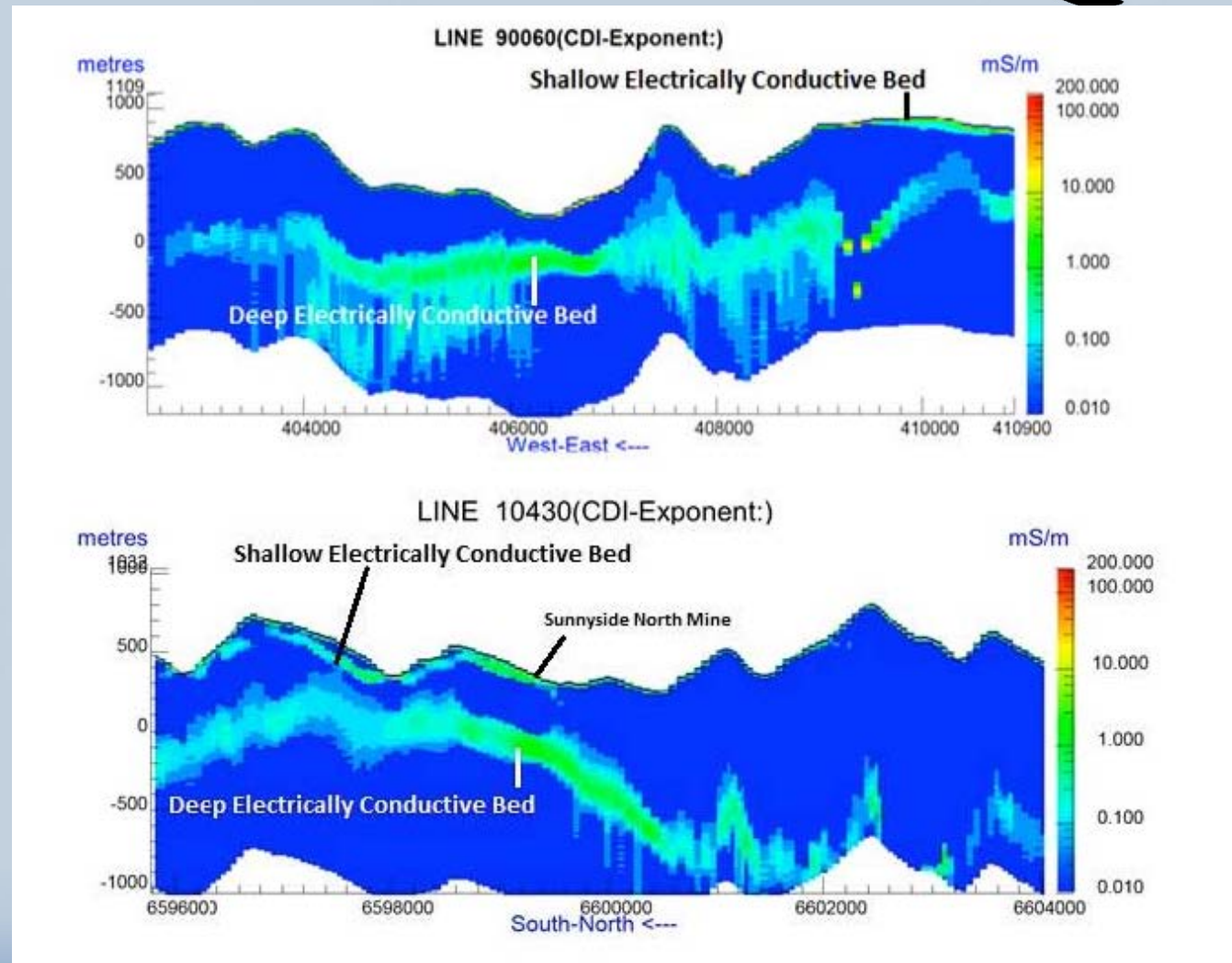


Undercover Toolkit

See deep and fuzzy



Undercover Toolkit



Precious Metal Resources
June 20, 2013
Halls Peak NSW

The reprocessing by CD3D clearly demonstrated two electrically conductive beds with the deep bed, which had previously been mapped by electromagnetic surveys to depths of 400 metres, now interpreted as extending up to 1,500 metres deep.

Undercover Toolkit

A ranking



Task	Potential Fields	EM Active	EM Passive	Seismic	DC Res/IP	Radiometrics	Other
Targeting	M-H	M-H	L-M	L-M	M	L-M	?
Mapping	M-H	M	M-H	M-H	M	M	L?
Cost	L	M-H	M-H	H	M-H	L	??
Rank	H	M	M-H	M	M	L-M	NA

H= high

M= medium

L= low

Undercover Toolkit
A ranking



Terrain	District	Project	Target
100	10	1	0.1

Undercover Toolkit

