

Emerging Deep penetrating geophysical technologies for exploring under cover.

Porphyry and Skarn Examples

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Y EDUCACIÓN

MINING, SCIENCE, INNOVATION
TECHNOLOGY, AND EDUCATION



Overview

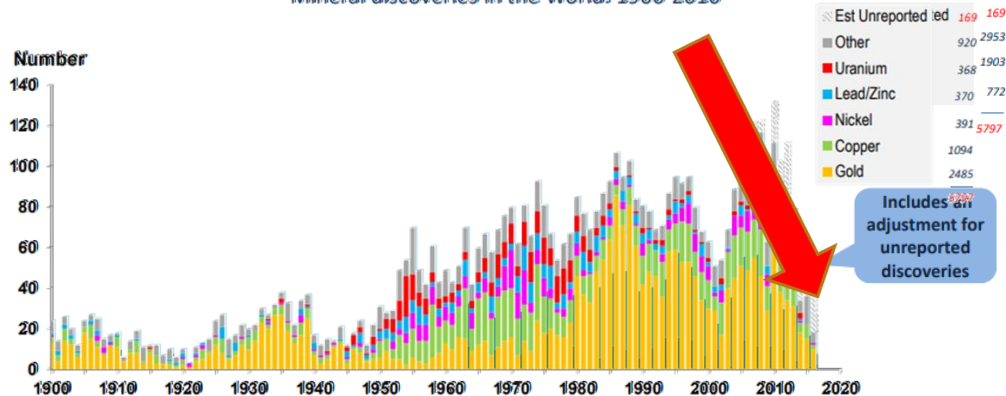
- **Intro to deep penetrating geophysical technologies**
- **Case Examples**
 - Bolivar Skarn Mineralisation
 - Deposit delineation and Exploration at Santa Cecilia
 - Charcas 3D Exploration
- **Conclusions**



Drivers for deep innovation

Number of discoveries by commodity type

Mineral discoveries in the World: 1900-2016



Note: Excludes Bulk Mineral discoveries (i.e. bauxite, potash, phosphate, coal and iron ore)

"Moderate" >100koz Au, >10kt Ni, >100kt Cu equiv, 250kt Zn+Pb, >5kt U₃O₈

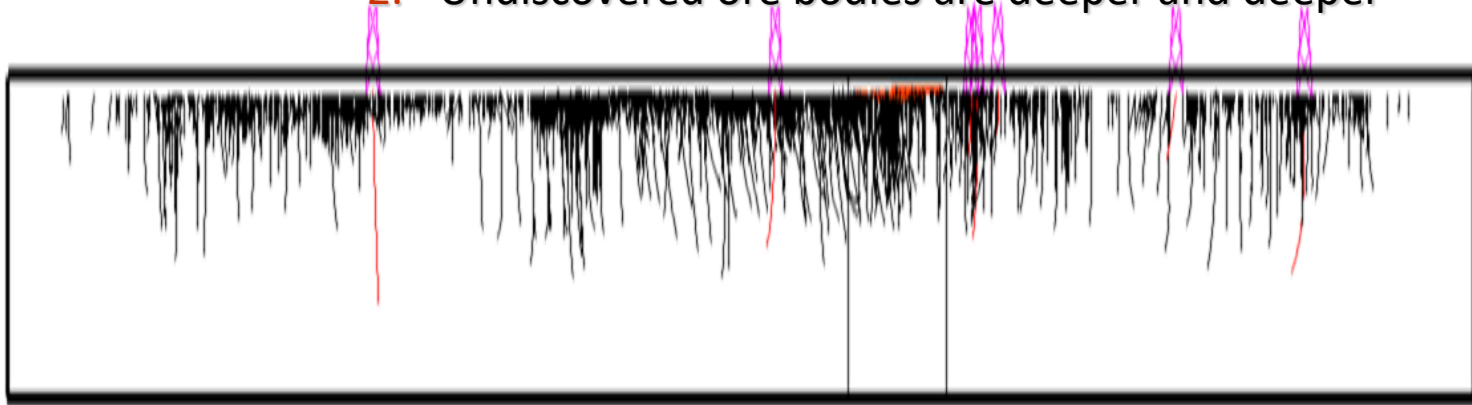
Note: Excludes Bulk Mineral discoveries (i.e. bauxite, potash, phosphate, coal and iron ore)

"Giant" >6Moz Au, >1Mt Ni, >5Mt Cu equiv, 12Mt Zn+Pb, >125kt U₃O₈

Source: MinEx Consulting © October 2017

Discovery Rates are probably falling because ...

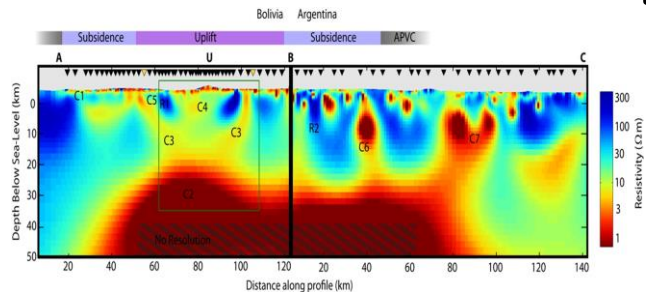
1. The earth is complicated
2. Undiscovered ore bodies are deeper and deeper



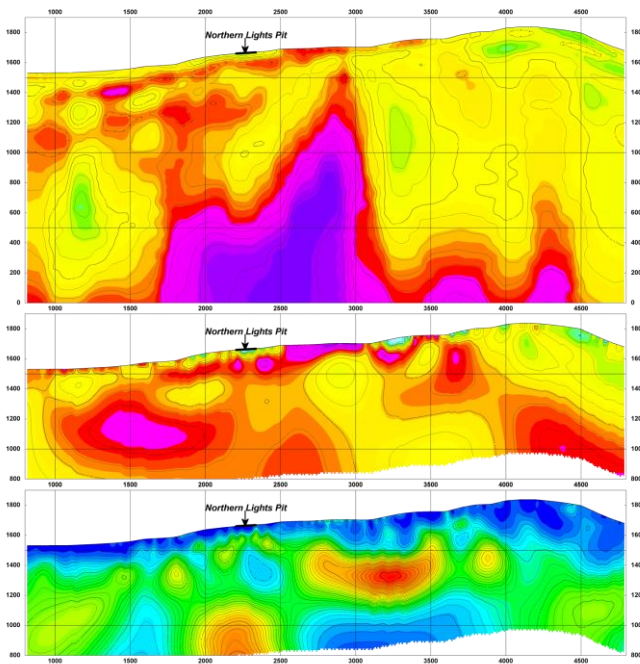
10 years of drilling One OrebodyGuess where??



Geophysical Imaging started to Advance significantly in 2000



**MT Resistivity –
Regional Transect
across the Andes**



Top panel: MT Resistivity

PW 2D inversion;

Typically 1500 metres

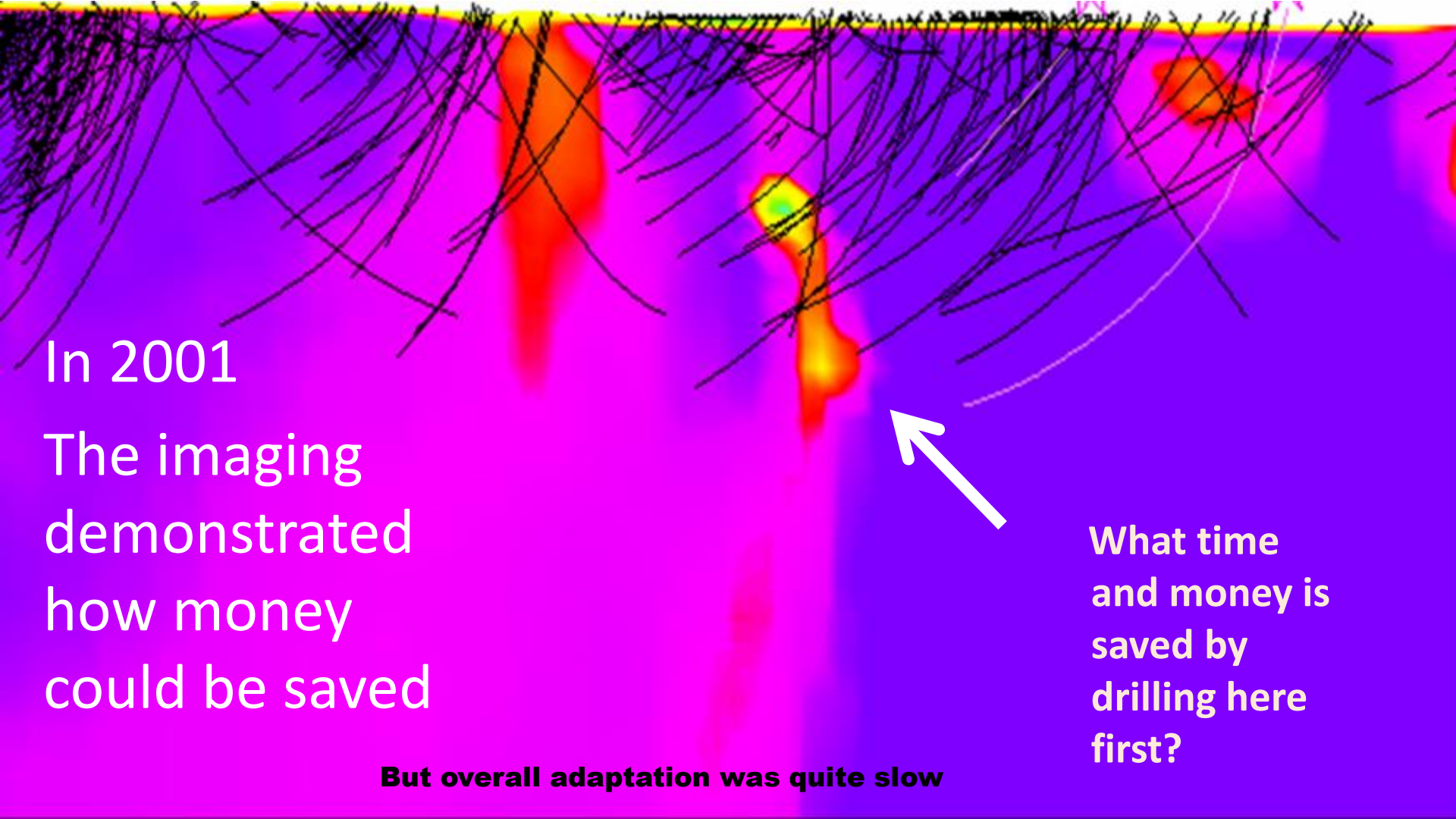
Middle panel: DC Resistivity

UBC smooth inversion;

Typically 500-750 metres

Bottom panel: Chargeability

UBC smooth inversion.



In 2001

The imaging
demonstrated
how money
could be saved

What time
and money is
saved by
drilling here
first?

But overall adaptation was quite slow

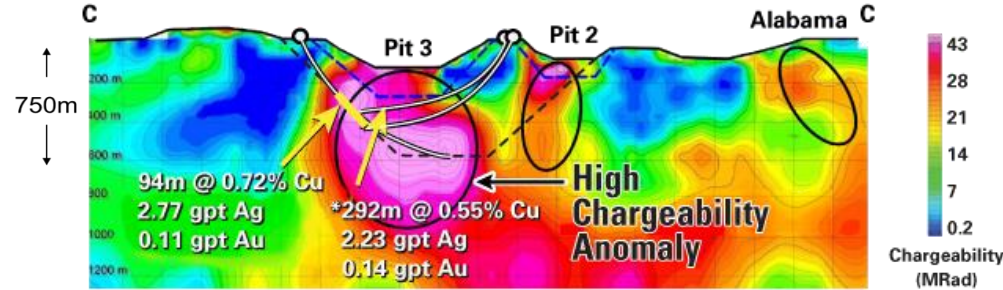


Early adapters had immediate success

- This image helped the company raise

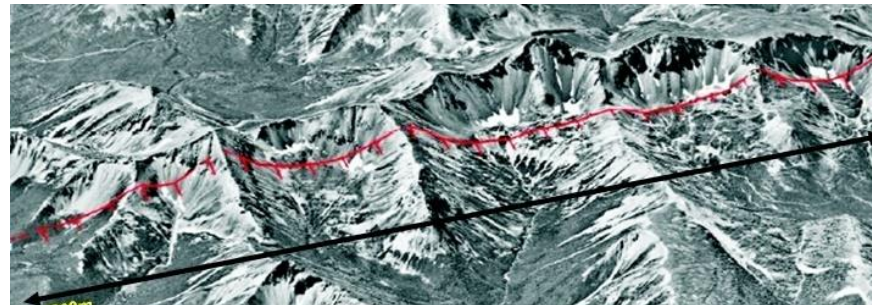
50 MILLION dollars !

- Changed mine design

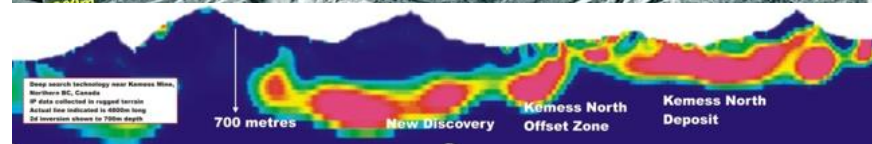


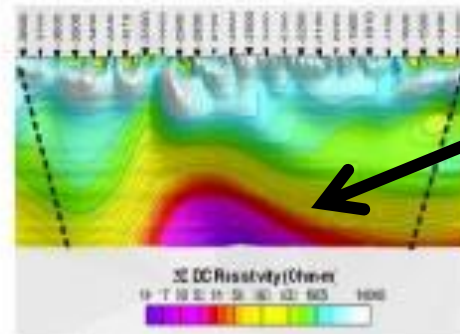
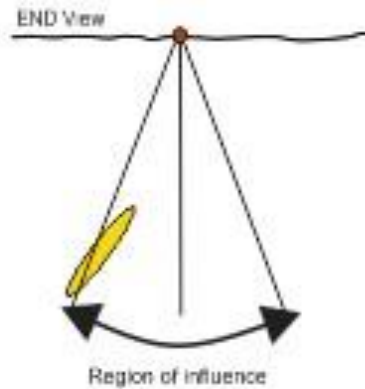
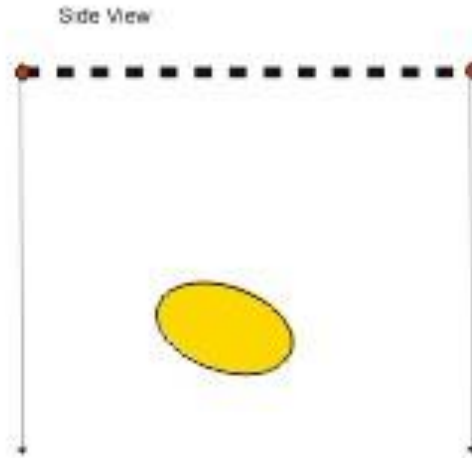
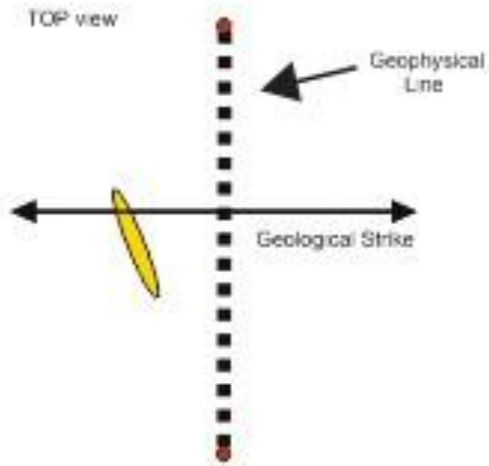
Copper Mountain

- This image helped Geological team vector to **New Discovery**



Kemess





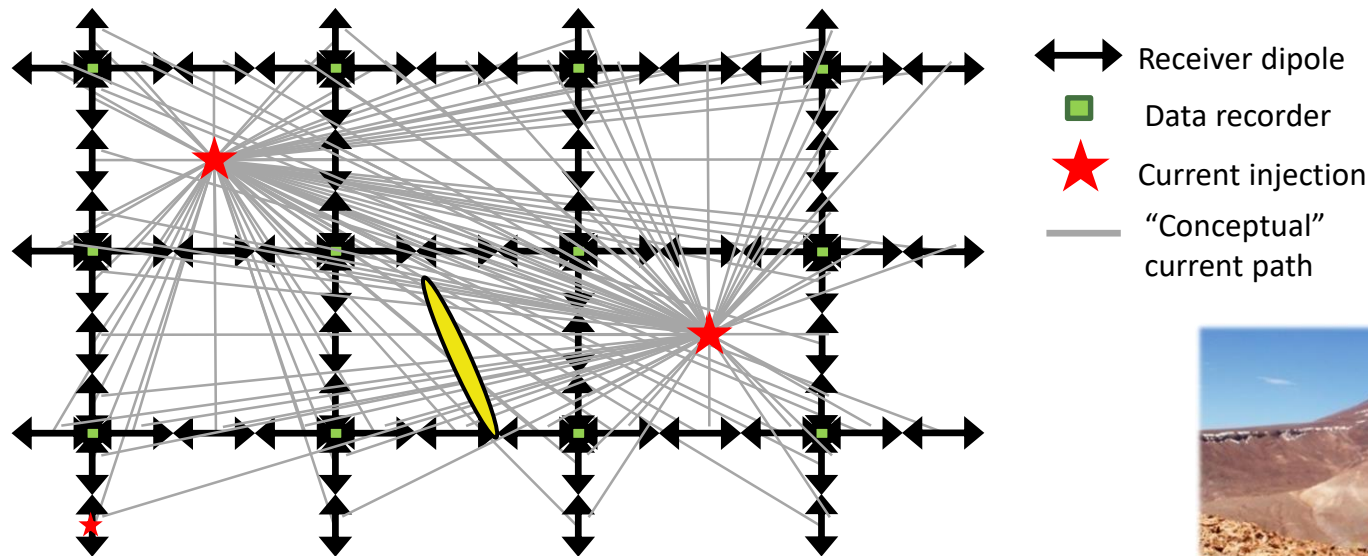
Example of a 2D resistivity inversion
showing influence of off-line feature

2D Geophysics

If you drill this..
you may miss ?



Interrogating and imaging in all directions



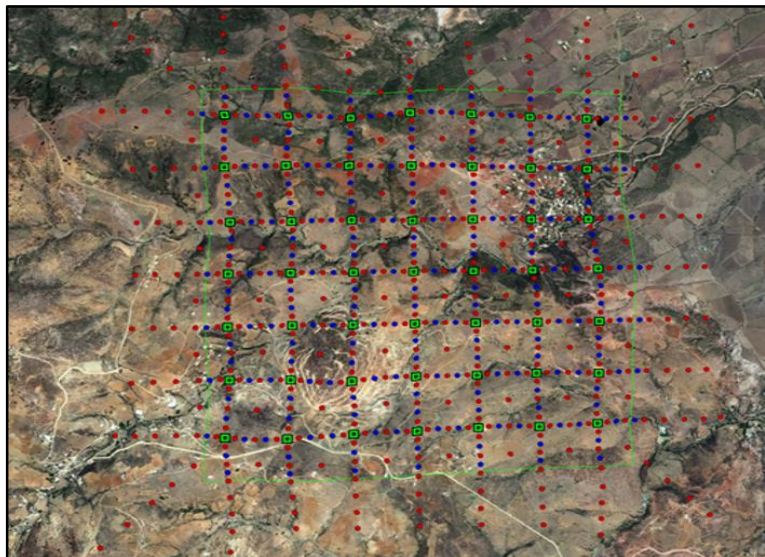
- True 3D measurement (DCIP)
- Simultaneous receiver sampling
- Omni-directional data free from receiver geometry bias





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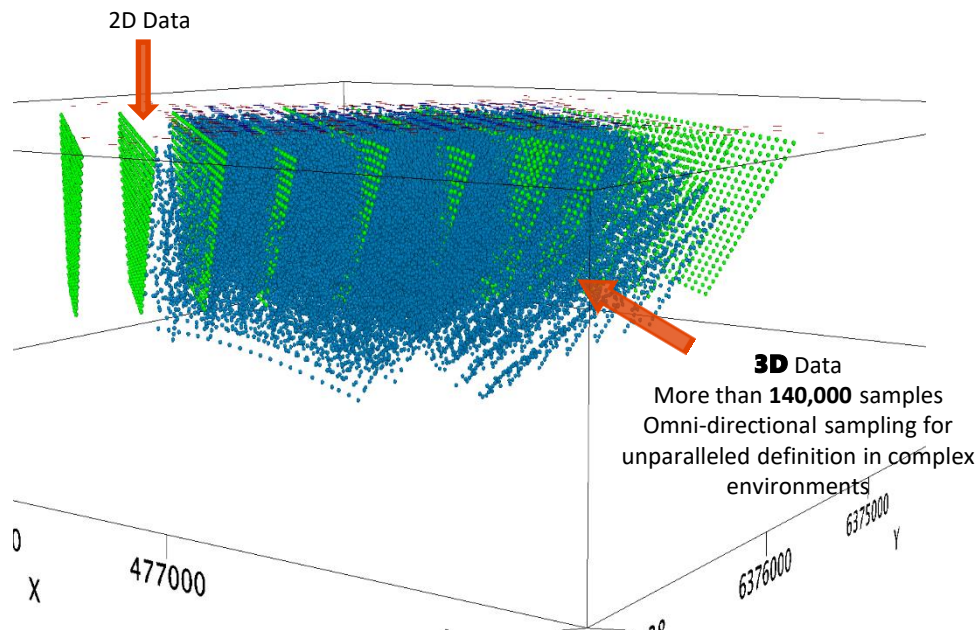
Large Survey footprint
(2km x 2km and more)



- ◆ Tx
- Rx
- Data Logger

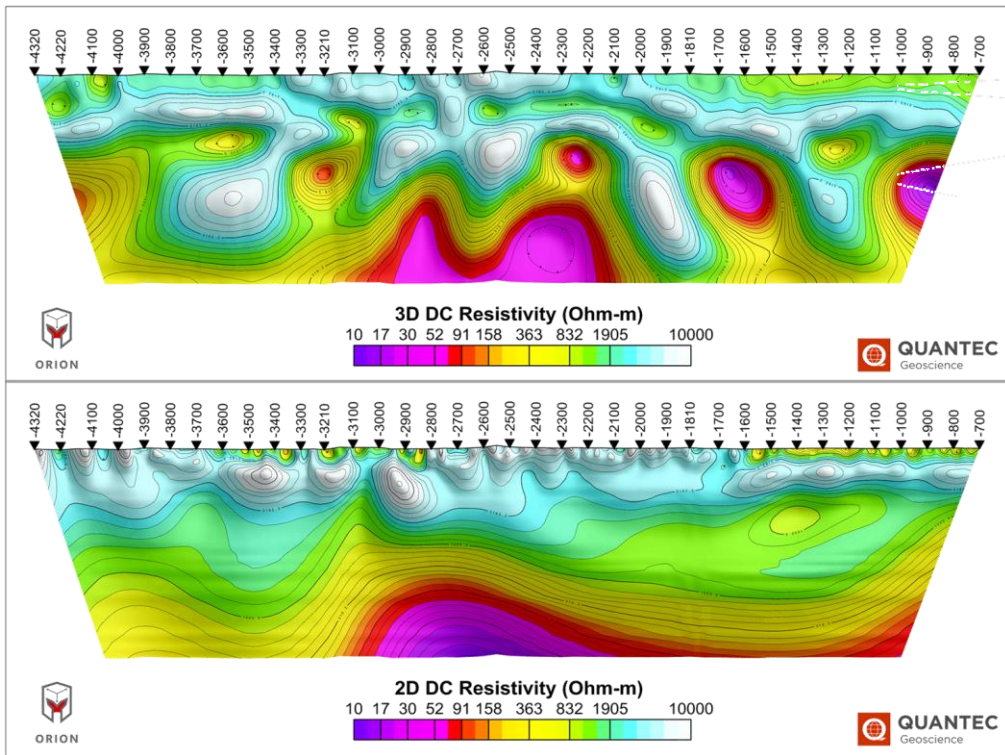


Sampling everything (from all directions)





Improving resolution and detection



Resistivity data acquisition from multiple lines (2D slice through a 3D inversion)

Resistivity data acquisition from 1 line (2D Inversion)



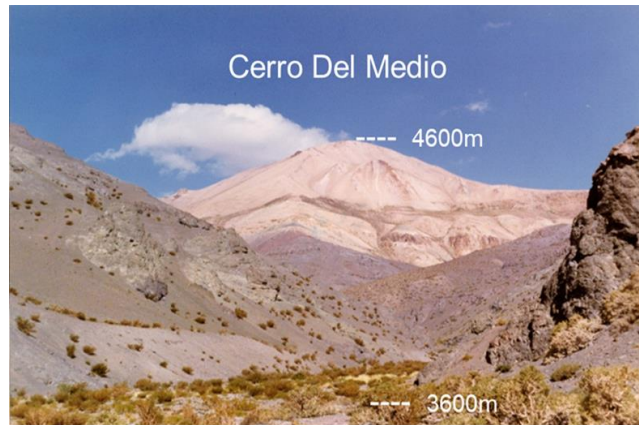
Recent Exploration Case Examples of Deep Earth Imaging

- Santa Cecilia, Chile
- Bolivar Skarn , Mexico

Santa Cecilia, Chile

History

- ☐ 1983- Helicopter-borne reconnaissance by M. Hernandez and D. Thomson
- ☐ 1984-1990- Anglo American Chile
- ☐ 2009- Ground magnetic survey
- ☐ 2010- CSAMT and Mobile Metal Ion (MMI)
- ☐ 2011-2012- CSAMT coverage and drilling
- ☐ 2012- QUANTEC ORION 3D DCIP/MT





Regional Settings

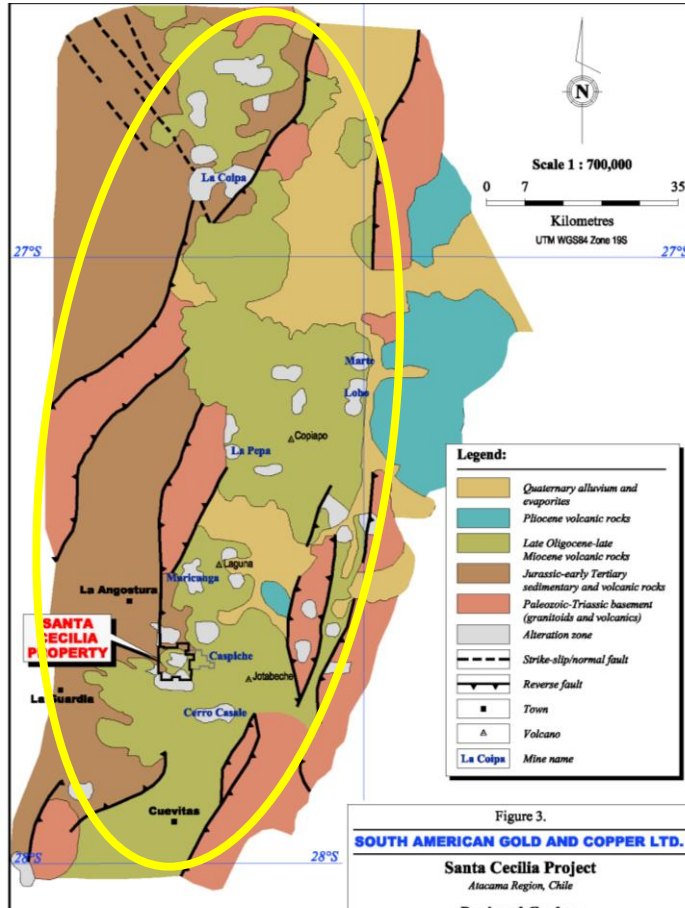


Figure 3.
SOUTH AMERICAN GOLD AND COPPER LTD.
Santa Cecilia Project
Atacama Region, Chile

- Maricunga Mining Belt (Mining District)
- Folded Formations of Upper Triassic Caspiche
- Oligocene to Lower Miocene Aguas Blancas and Rio Nevado Formations
- Porphyry intrusives, diorites and Qz-diorites & alteration zones

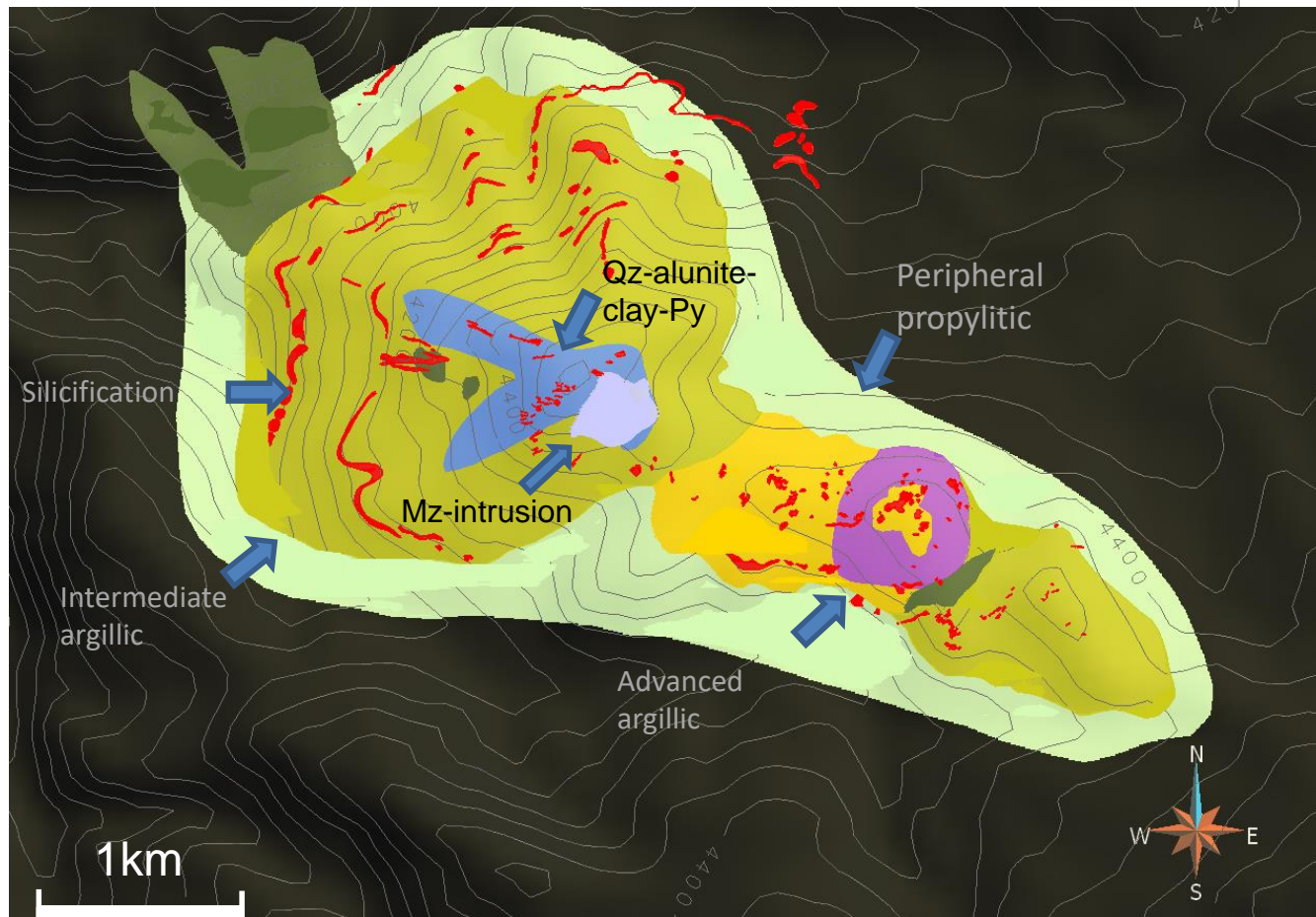


Cordillera
Belt





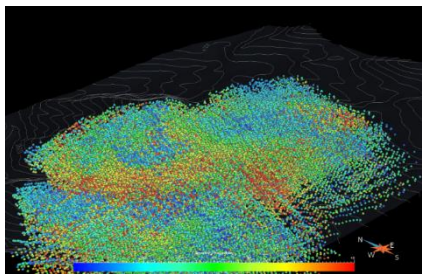
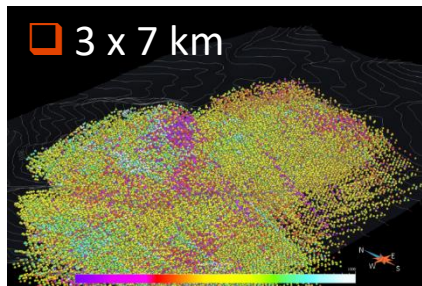
Intense Hydrothermal Alteration



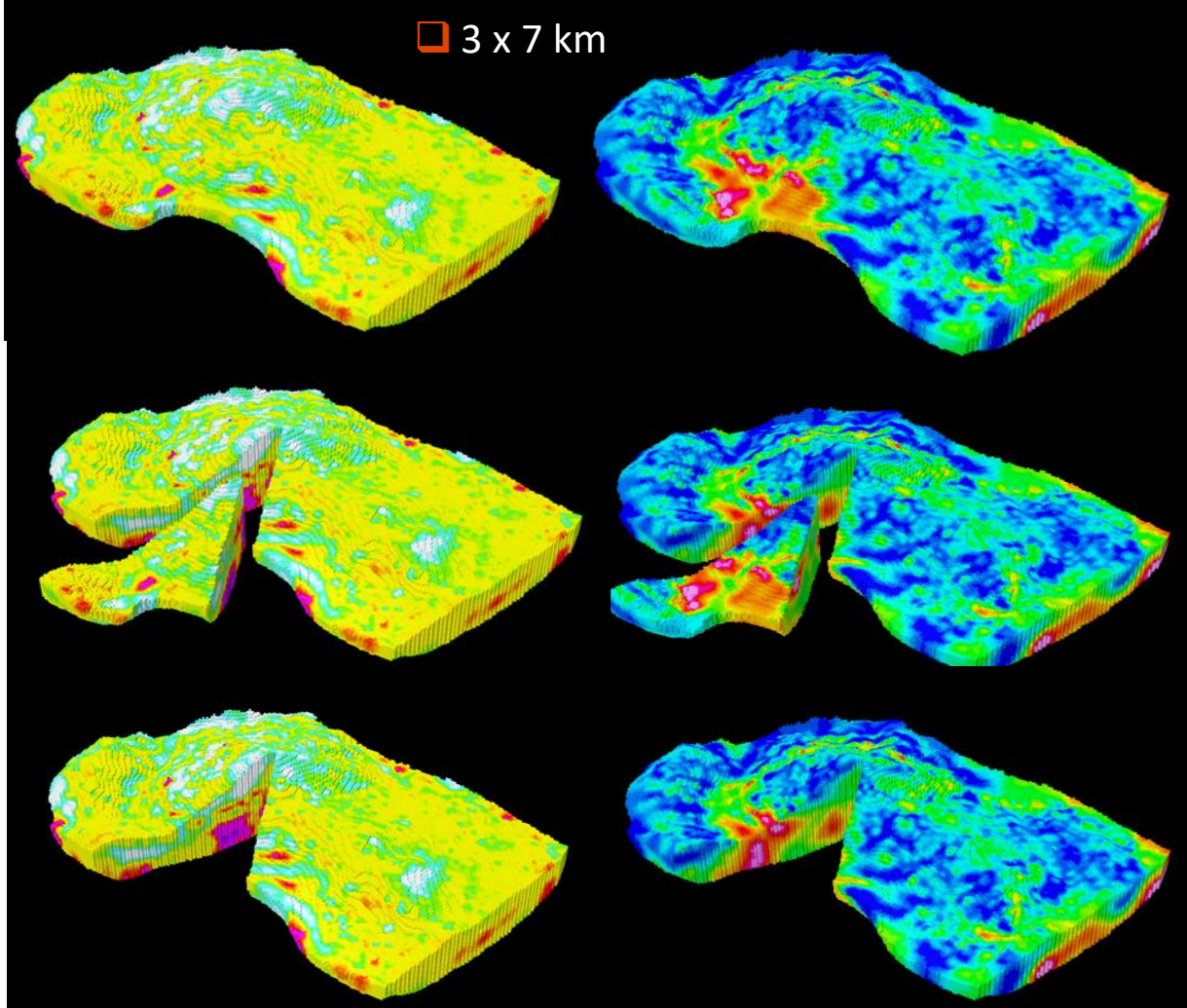


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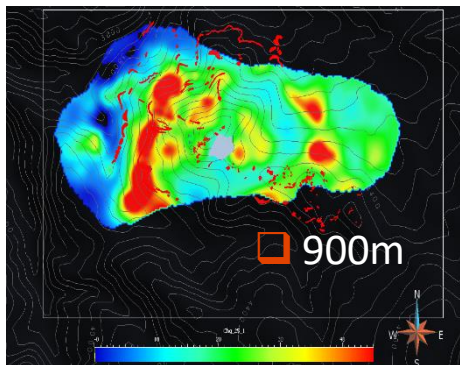
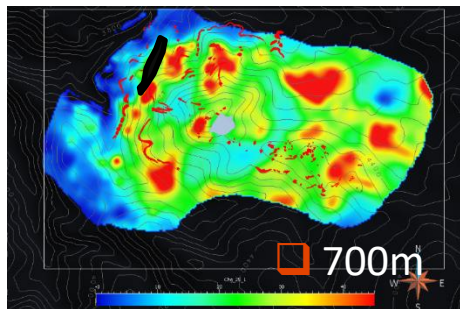
High volumes of data collected
over broad areas



More data =
More Accurate Models

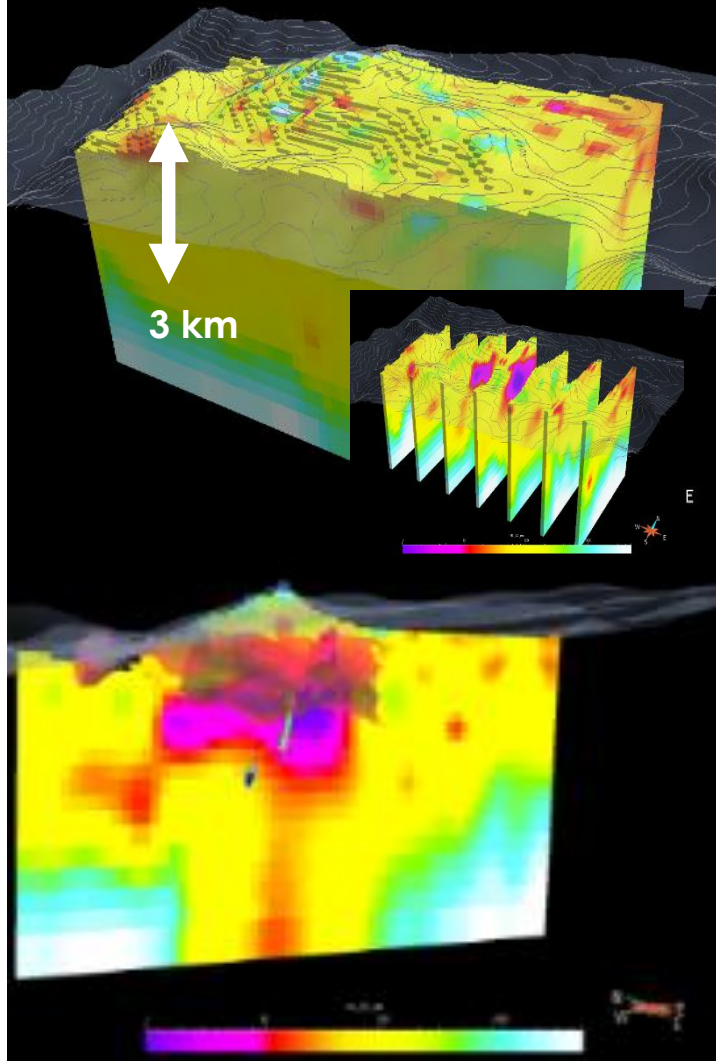


Deep IP Information for drill planning



Deep MT Resistivity data is collected during the same period

- 3D inversions of 3D data
- Accurate representation of subsurface
- High resolution to > 2000m

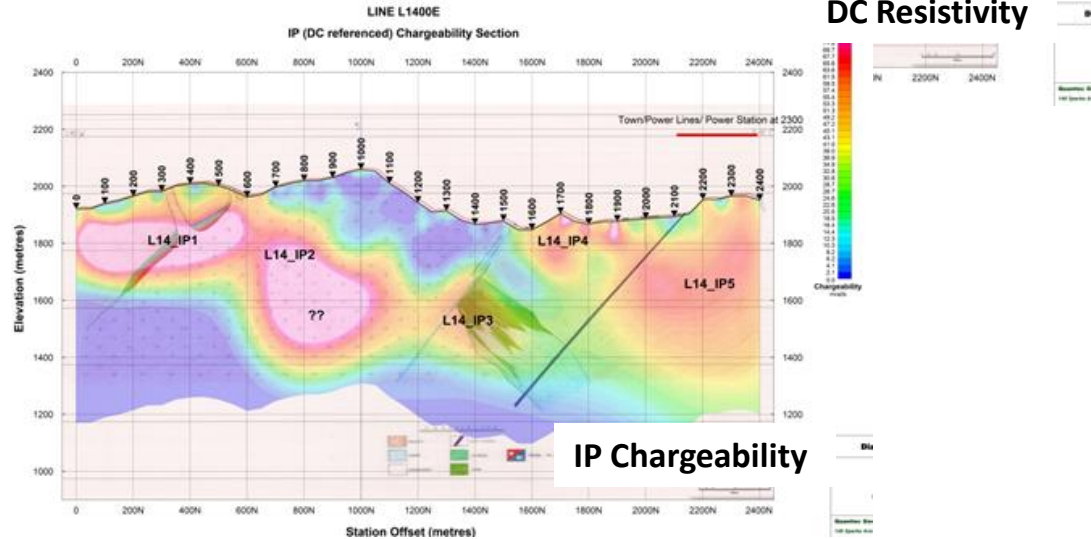
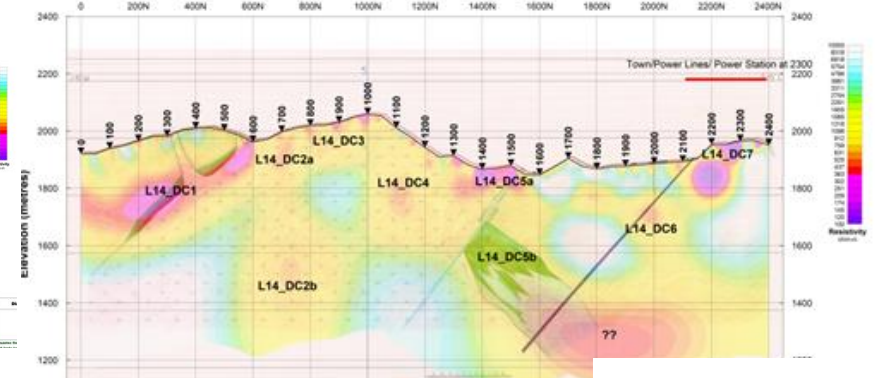
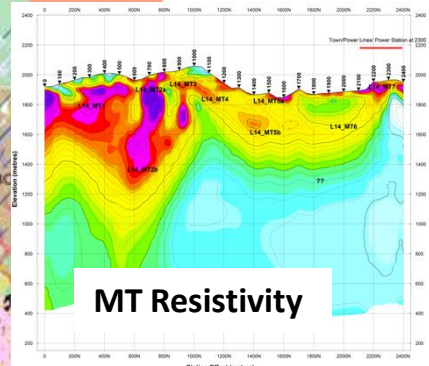
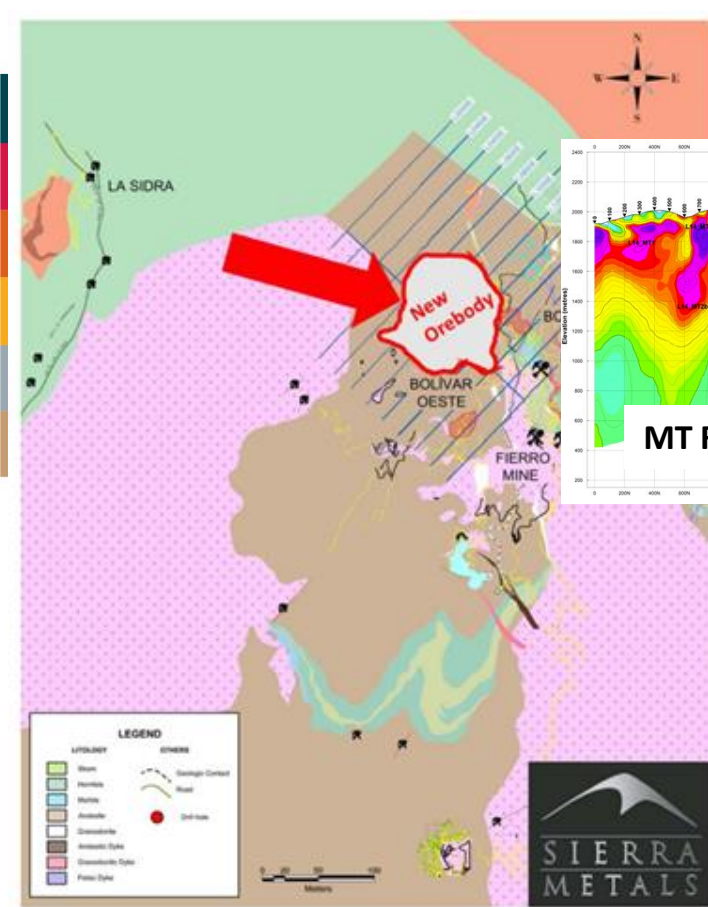


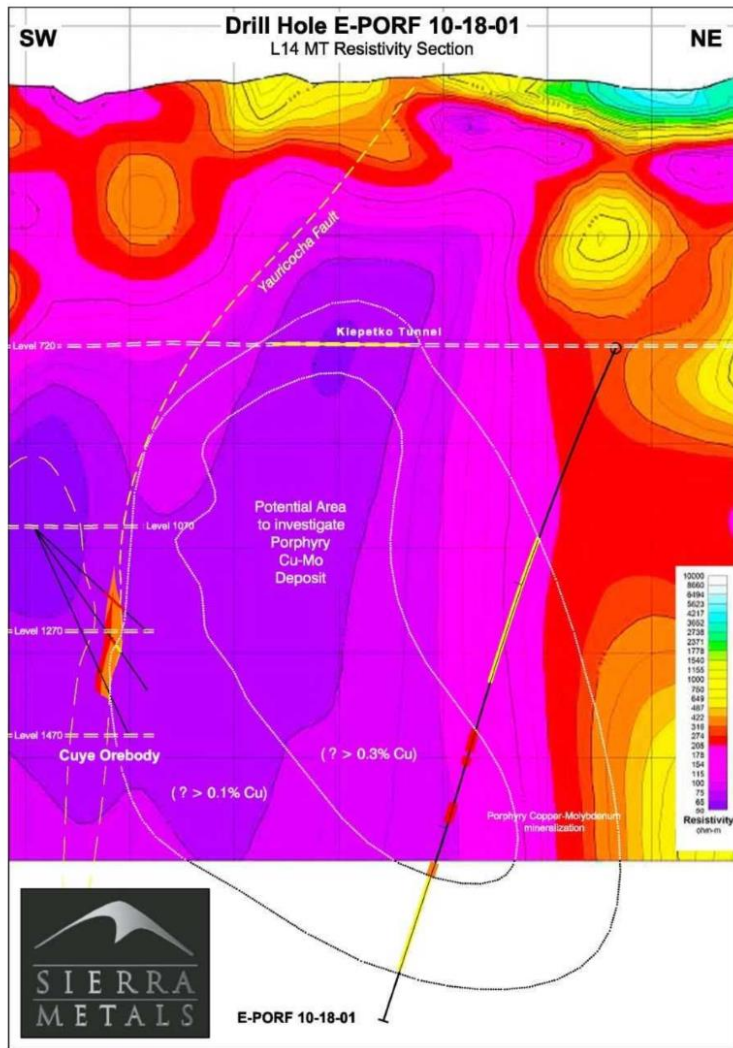
Exploration Objectives

- Use TITAN 24 DC/IP & MT to help delineate the Bolivar deposit for drill targeting.
- Map and delineate near-surface zones associated with Skarn mineralization.
- Map and delineate deep-seated alteration zones and structure that could control or host mineralization.
- Focus drilling thereby reducing overall drilling costs.
- Mine Planning



2017 Bolivar North-west . Lines 1400





More importantly....in Peru



PARA SU PUBLICACION INMEDIATA
Bolsa de Toronto: SMT
Bolsa de Lima: SMT
Bolsa NYSE American: SMTS

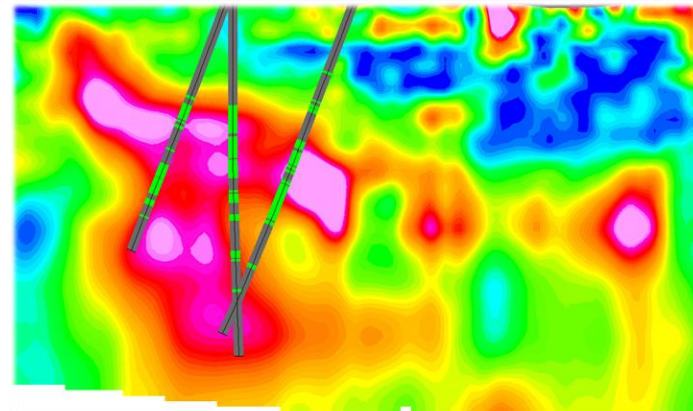
No. 32-2018

SIERRA METALS CONFIRMA MINERALIZACION PORFIDICA EN SU MINA YAURICOCHA EN PERU, RESULTADOS POSITIVOS INCLUYEN 22 METROS DE 0.46% DE COBRE, 134 PPM DE MOLIBDENO, Y 10.73 PPM DE COBALTO

- ☐ Drilled from 720 level to 1394 metres deep
- ☐ Intersections from 798m through 980m

Conclusions

- ❑ Deep imaging helps explore deeper terrains
- ❑ Mapping key parameters accurately to depth, such as resistivity and chargeability provides improved targeting and a thorough approach to exploration
- ❑ More companies are finding exploration success by incorporating these technologies earlier into their process and planning
- ❑ Large areas can be explored cost effectively

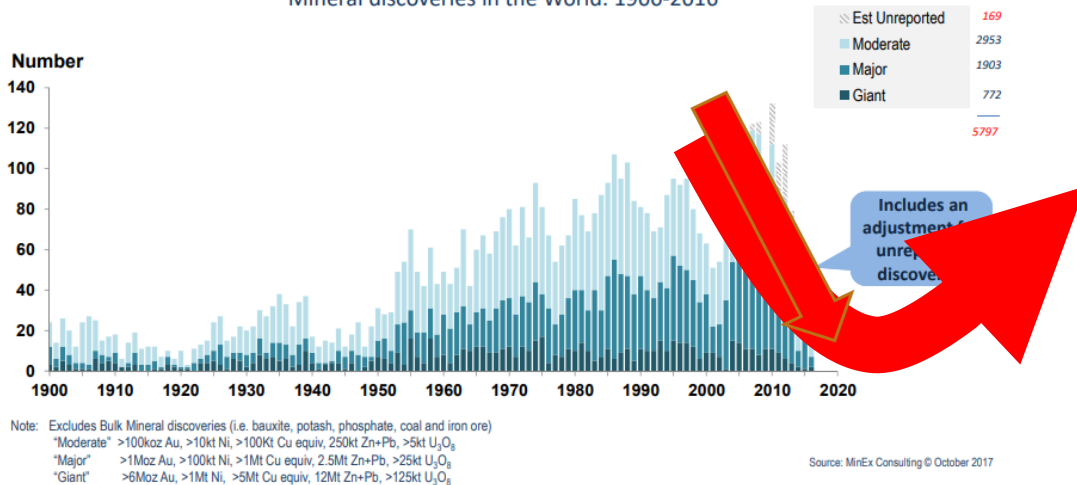


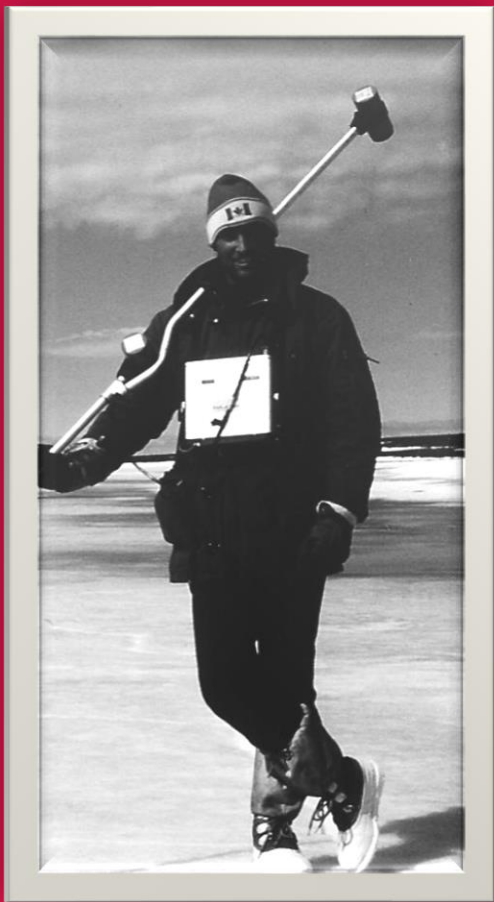


Technology for Discovery

Number of discoveries by size

Mineral discoveries in the World: 1900-2016





Acknowledgements:

Sierra Metals

Grupo Mexico

CMG

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