What Lies Beneath?

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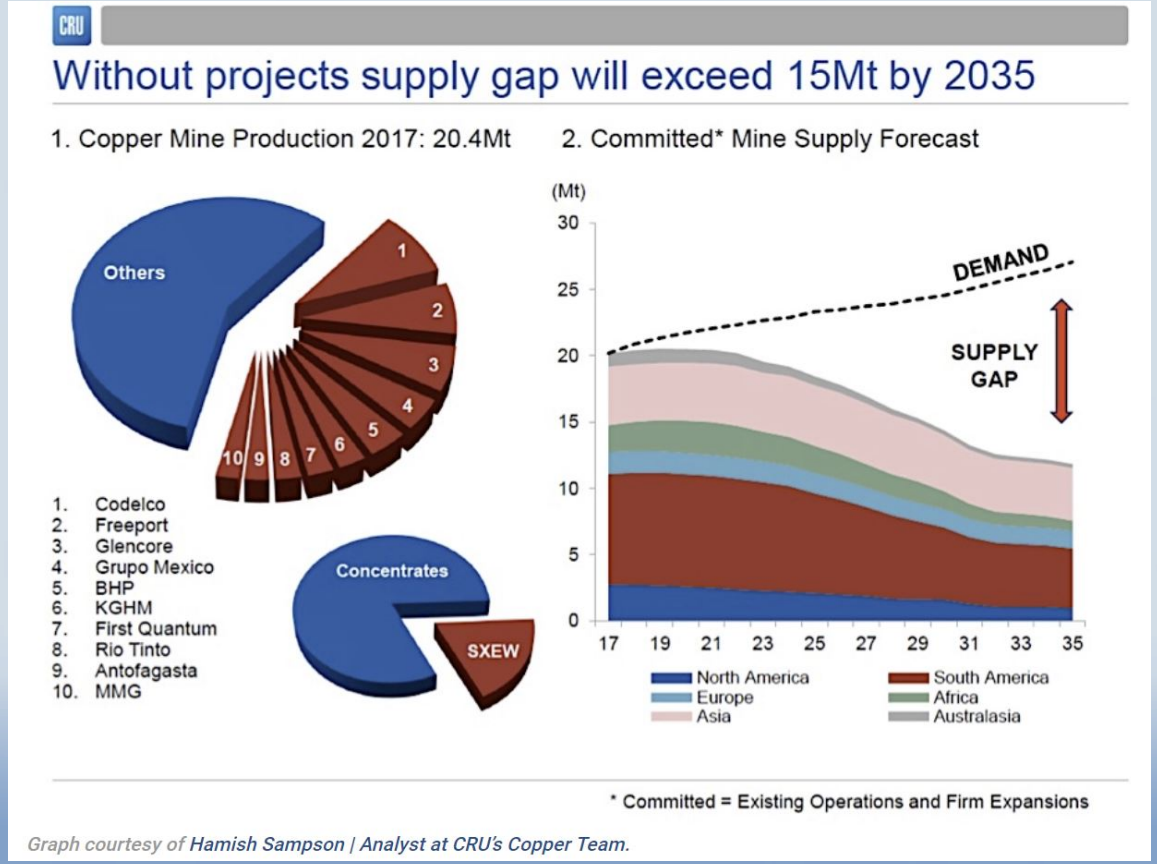
  - Mag/IP inversion
- Daniel Sattel-EM Solutions
  - MT Inversion
- Martyn Unsworth-University of Alberta
  - Morrison Assessment

INTRODUCTION



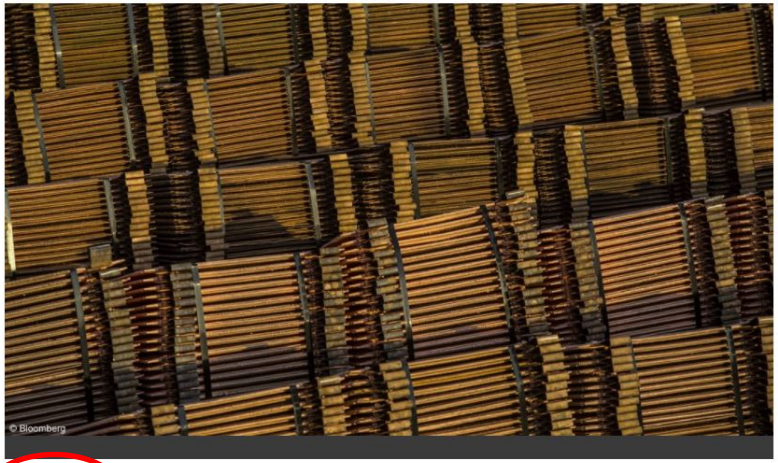
Graph courtesy of Hamish Sampson | Analyst at CRU's Copper Team.

Major shortfalls in Cu supply are predicted as existing deposits are mined out. While there is a overhang of known deposits, many of these are of lower grade and or in settings which are considered high risk for political, economic or logistical reasons (i.e. lack of water).

New discoveries with higher grades, even if not open pitiable, will be attractive and could 'jump' the development queue. The industry however, has been slow to develop the technology to discover and mine deep deposits; this is expected to change in the next decade.

INTRODUCTION

BHP says copper output needs to double in 30 years, criticises pricing system



3RD DECEMBER 2020

BY: REUTERS

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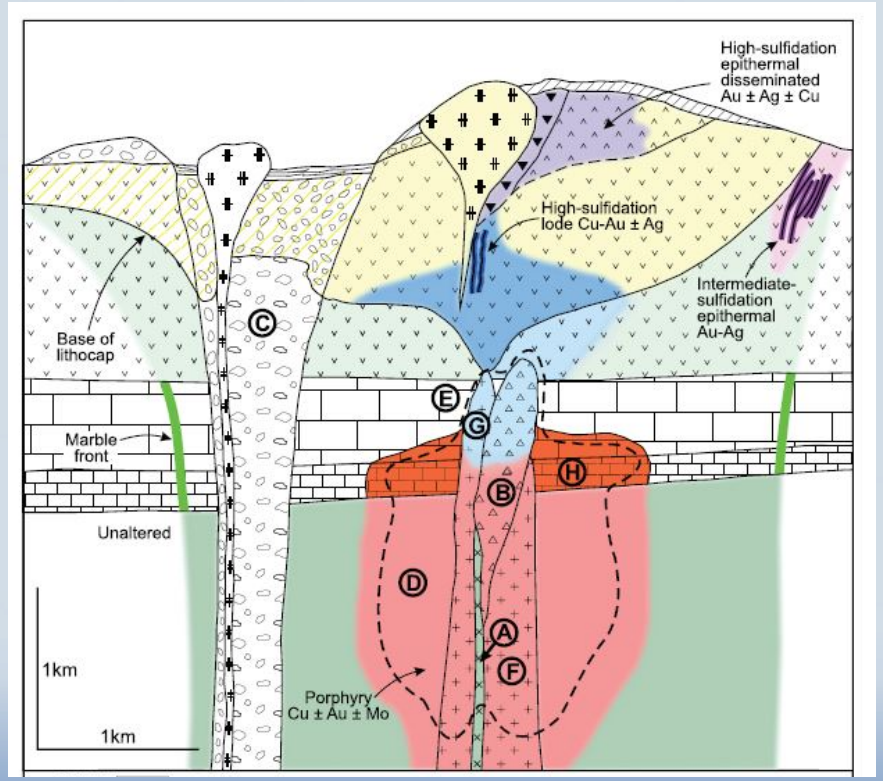
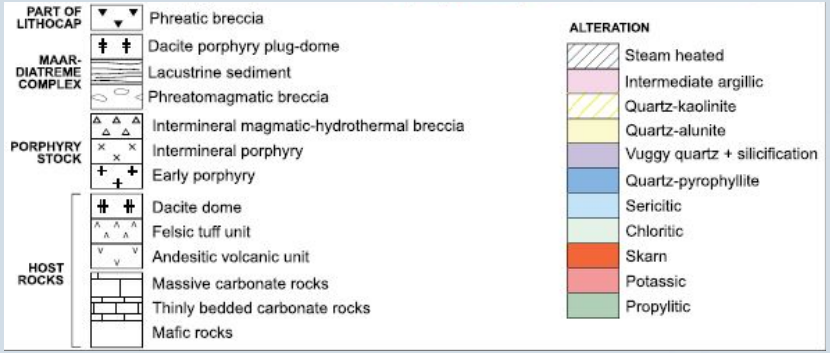
Copper production must double in the next 30 years to meet demand driven by global trends towards decarbonisation and electrification, a senior BHP executive said on Thursday.

PORPHYRY GEOLOGICAL MODEL





Geological models tend not to be targeting models and while it is recognized that high concentrations of sulfides can occur with the porphyry environment it is not requirement.

Sillitoe 2012

PORPHYRY GEOPHYSICAL MODEL

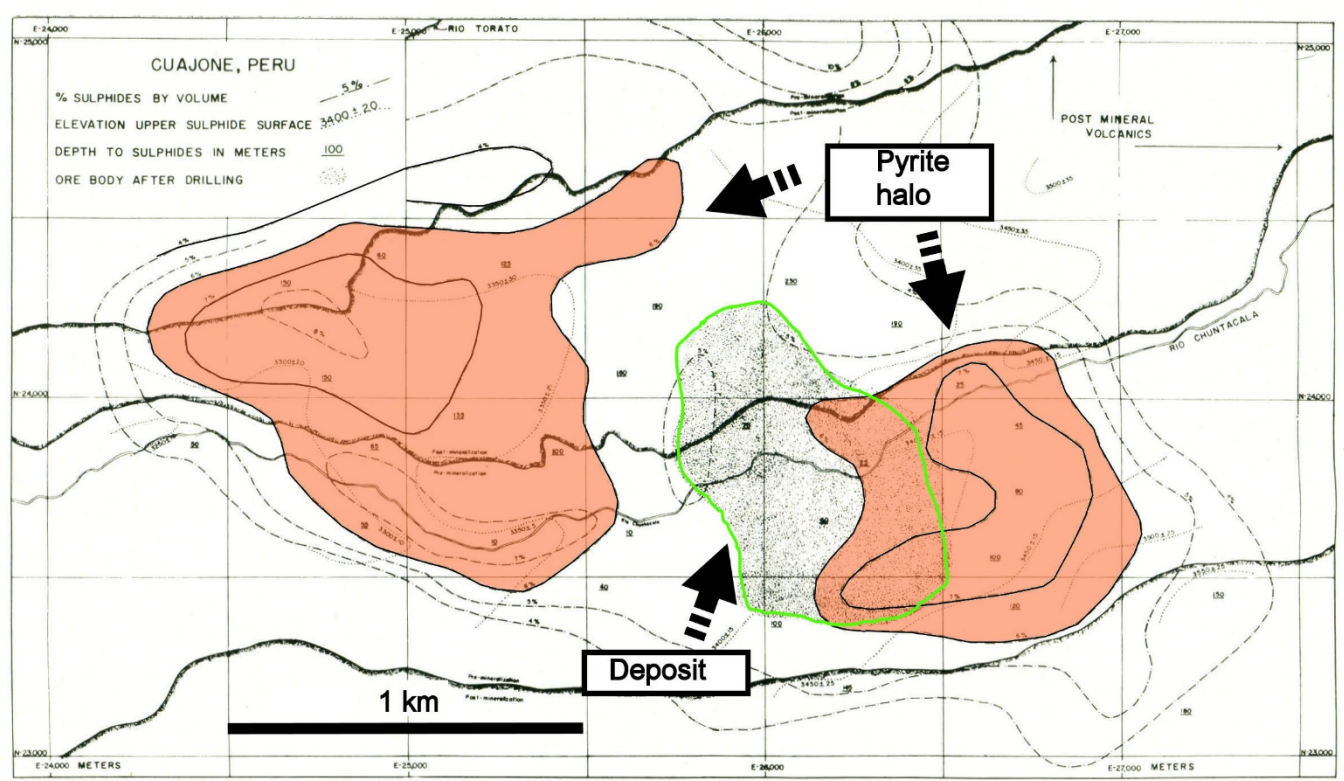
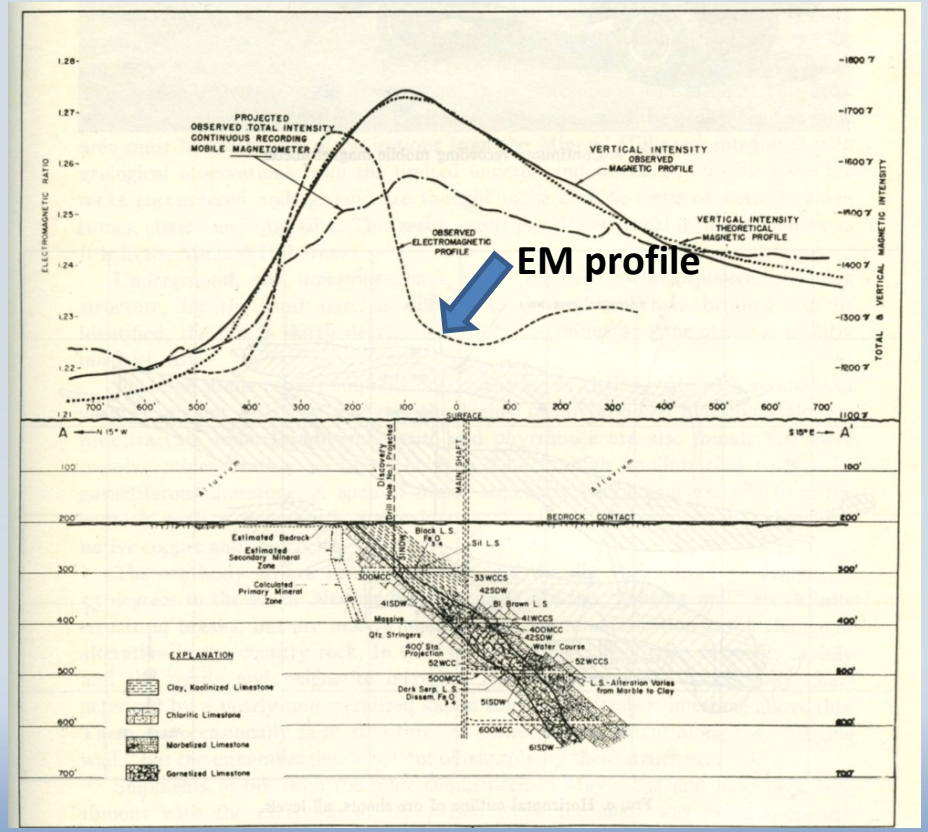


FIG. 1. Results of IP Survey at Cuajone, Peru, showing deduced percent sulfides by volume and depth to sulfides.

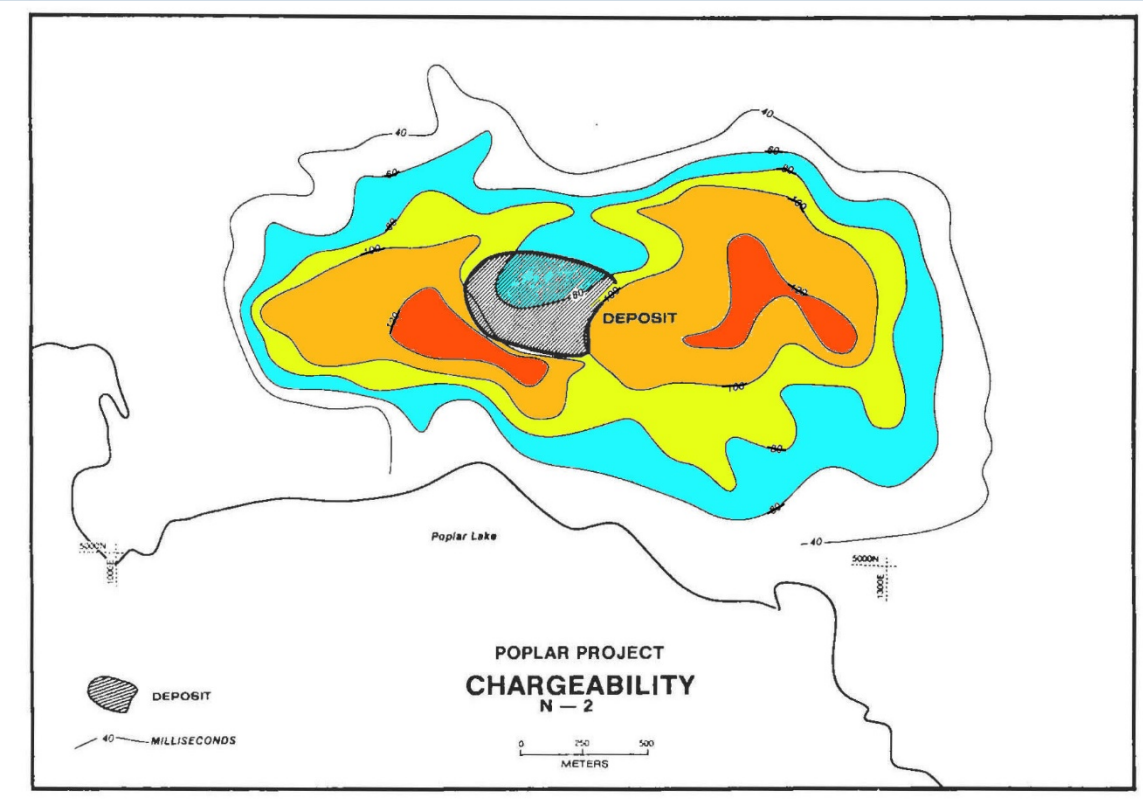
Newmont-1951

PORPHYRY GEOPHYSICAL MODEL



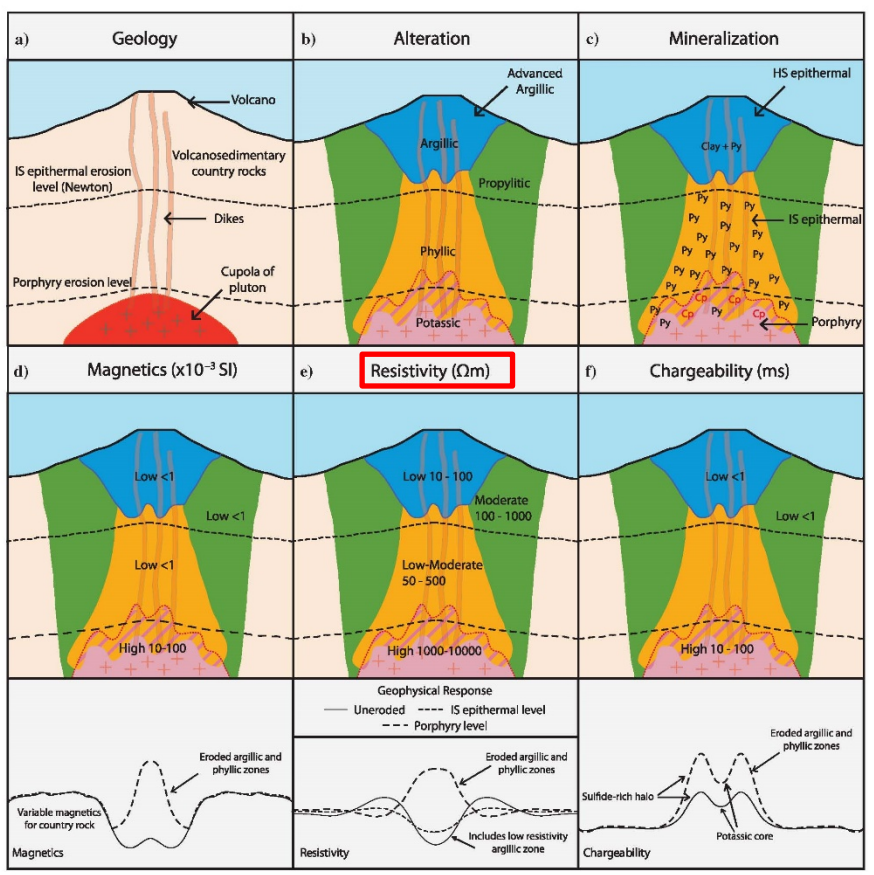
Pima-1951

PORPHYRY GEOPHYSICAL MODEL



Utah-1975

PORPHYRY COPPER-GOLD DEPOSITS-GEOPHYSICAL RESPONSE

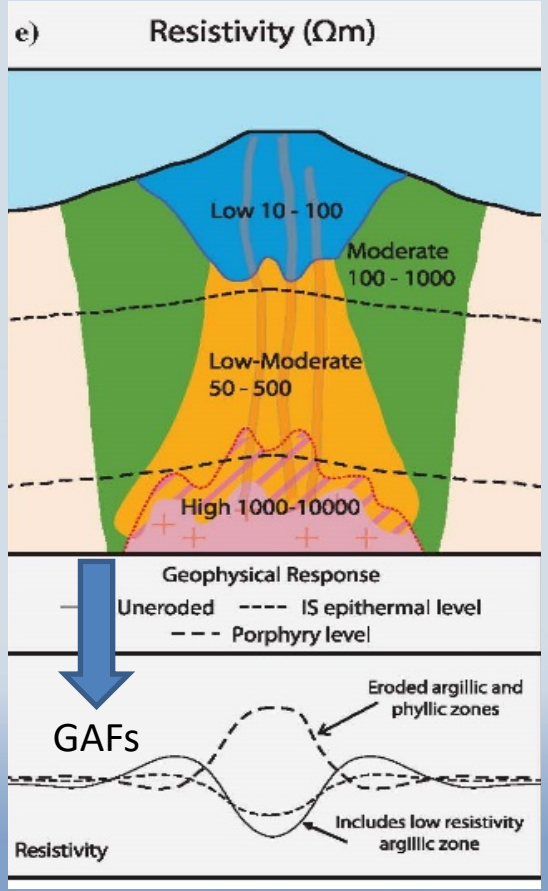


Non-sulfide sources of low resistivity are common as well (argillic and phyllic alteration) but these zones are often removed by erosion.

Condor's work suggests that some conductive features (termed GAFs or Geophysically Anomalous Features) could be quite deep in the porphyry system.

After Richards in Hübert et al., 2016

PORPHYRY COPPER-GOLD DEPOSITS-GEOPHYSICAL RESPONSE



PORPHYRY COPPER-GOLD DEPOSITS-GEOPHYSICAL RESPONSE

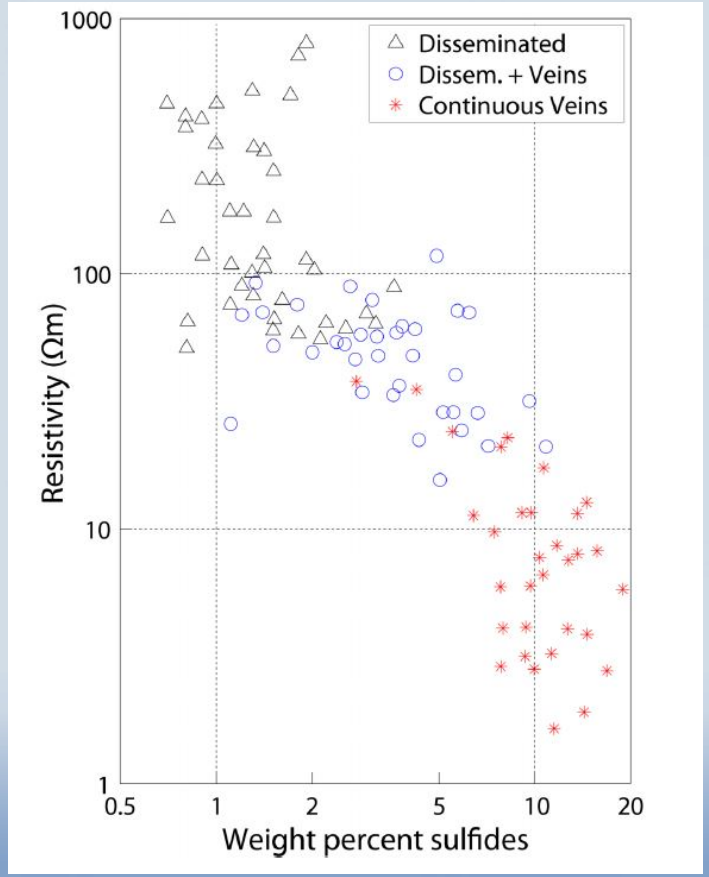


Figure 2 Relationship between sulfide weight percentage and electrical resistivity based on 109 in-situ measurements at porphyry deposits by Nelson and Van Voorhis (1983). For disseminated or discontinuous veins (< 3% wt.) the resistivity tends to be high and variable. As interconnectivity increases, there is a more direct relationship between increasing sulfide weight percent and decreasing resistivity. Modified from Nelson and Van Voorhis (1983).

Sulfide sources are likely the source of the strongest conductance associated with porphyry systems.

PORPHYRY COPPER-GOLD DEPOSITS-EXAMPLES

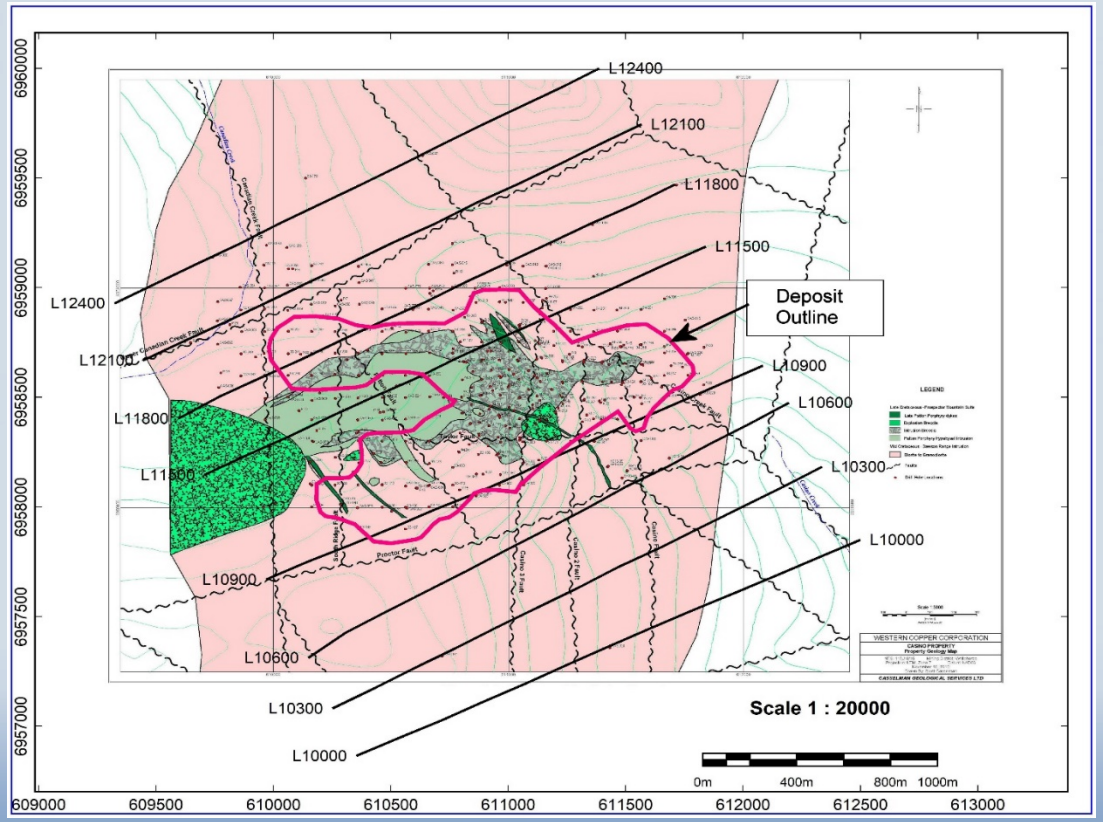
Deposit Name	Location	Survey/Data Types	Processing work carried out by
Casino	Yukon	Titan IP/MT	Condor
Morrison	BC	ZTEM/MT	Condor/University of Edmonton
Bingham	Utah	MT	Fugro
Resolution	Arizona	MT/ZTEM	Fugro/Condor
Collahuasi	Chile	TEM	Glencore
Santa Cecilia	Chile	CSAMT/Orion (IP-MT)	Quantec

PORPHYRY COPPER-GOLD DEPOSITS-LOCATIONS

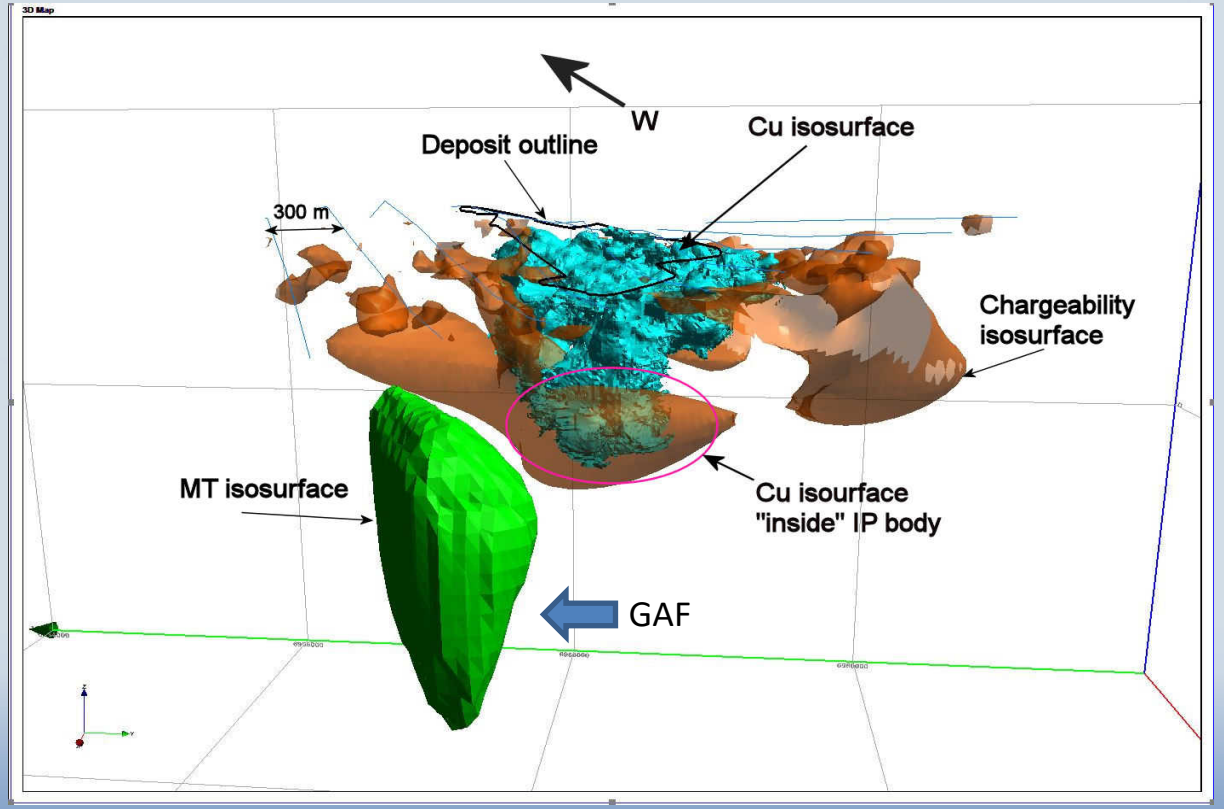
This is an ‘opportunistic’ list of porphyry deposits who have recognized GAFs. The expectation is there could be many more.

No geological research is known which would attempt to predict the likely presence of a GAF.

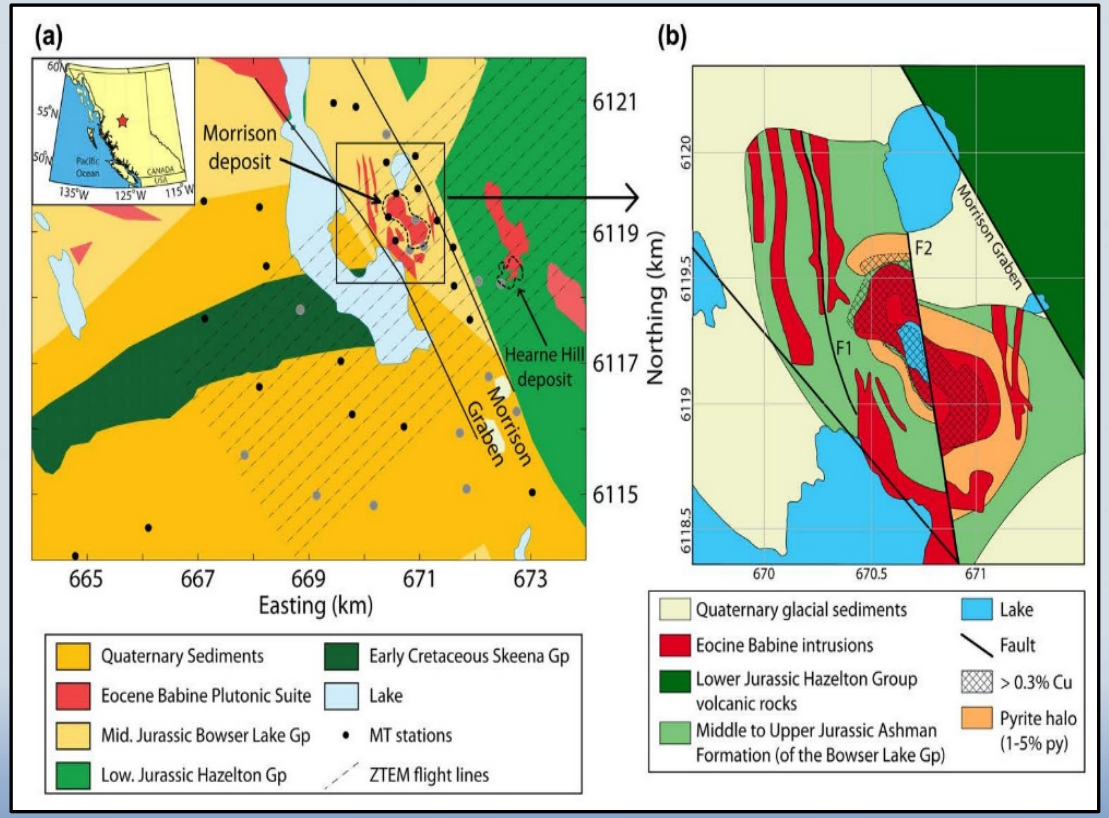
CASINO-YUKON



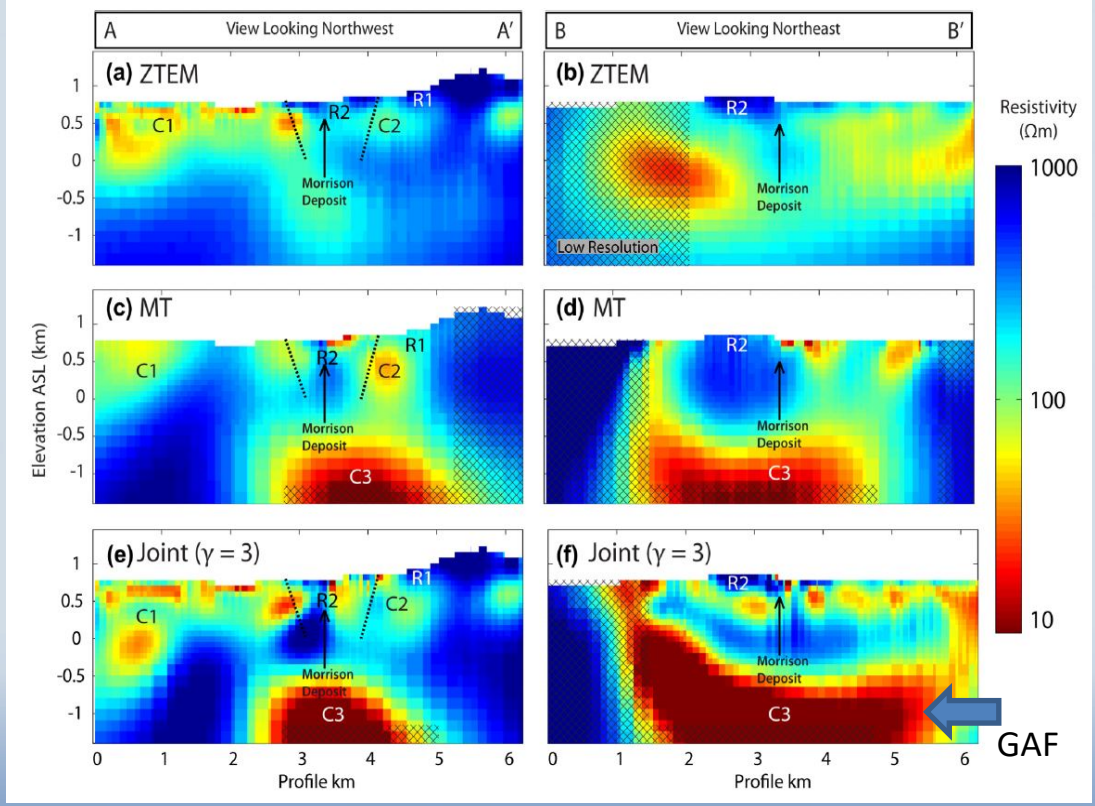
CASINO-YUKON



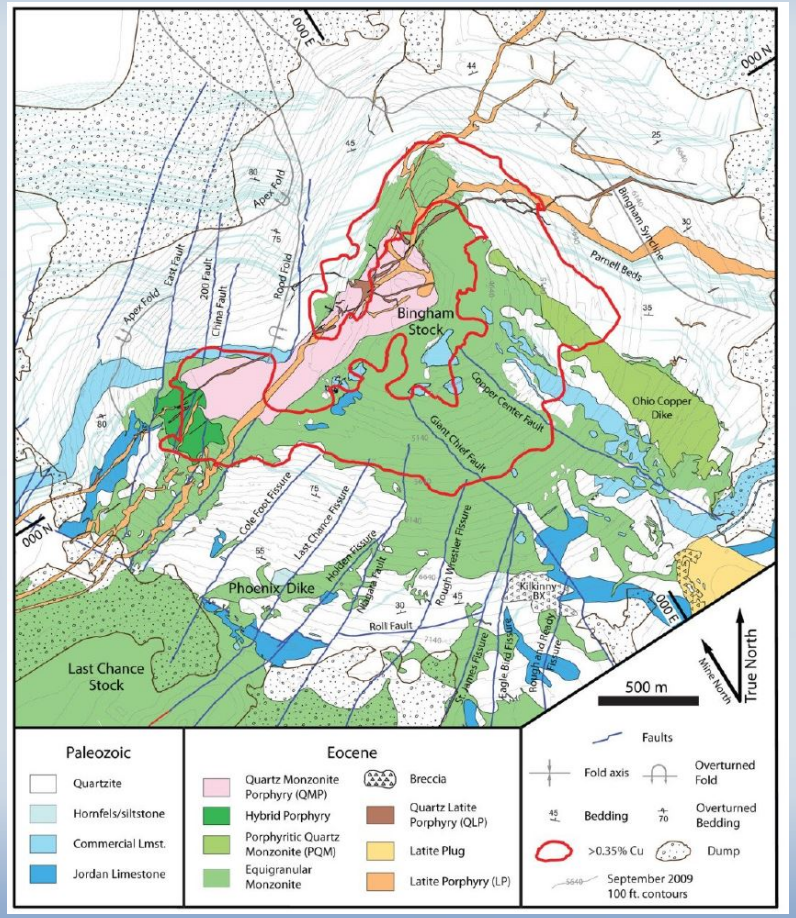
MORRISON-BC



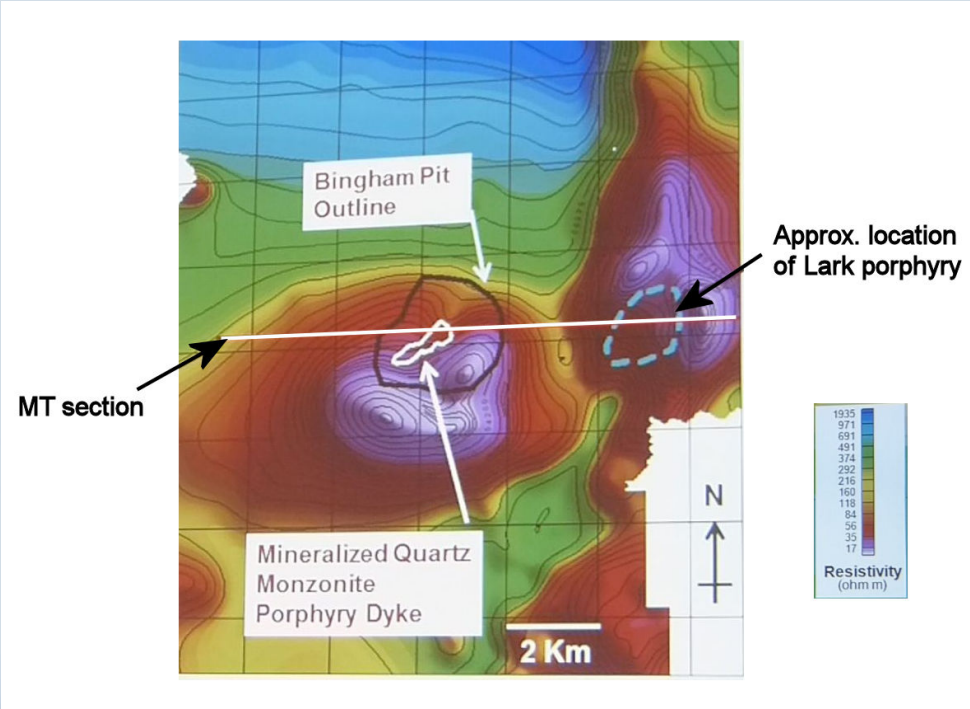
MORRISON-BC



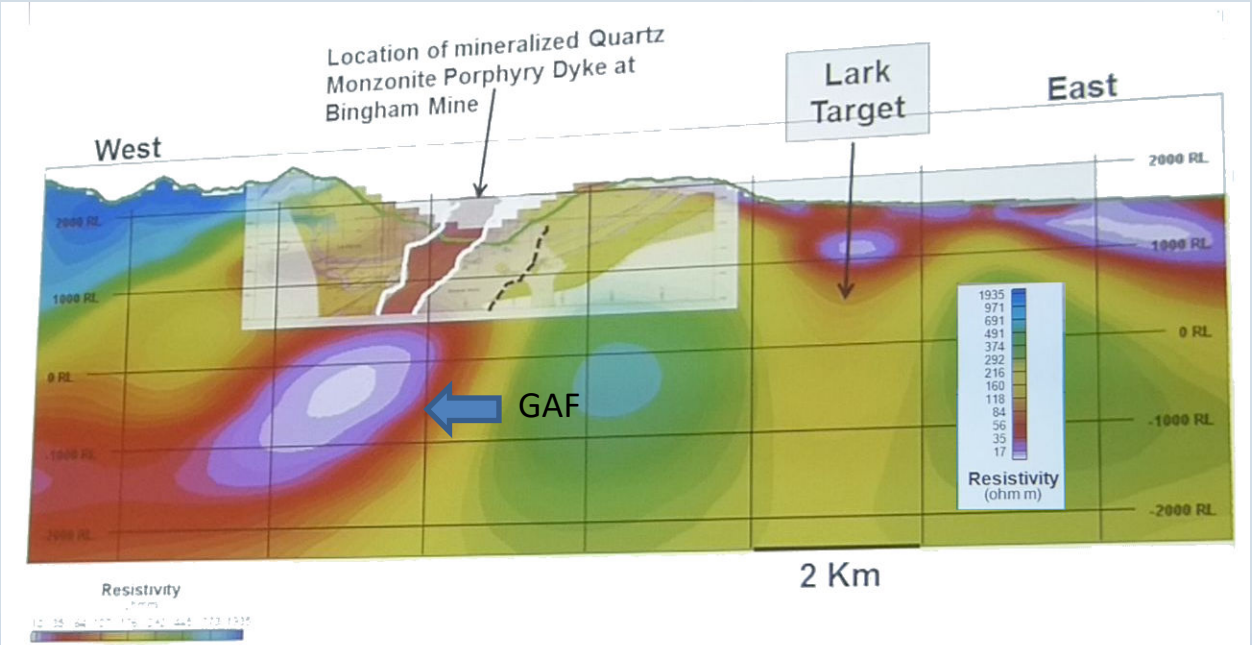
BINGHAM-UTAH



BINGHAM-UTAH

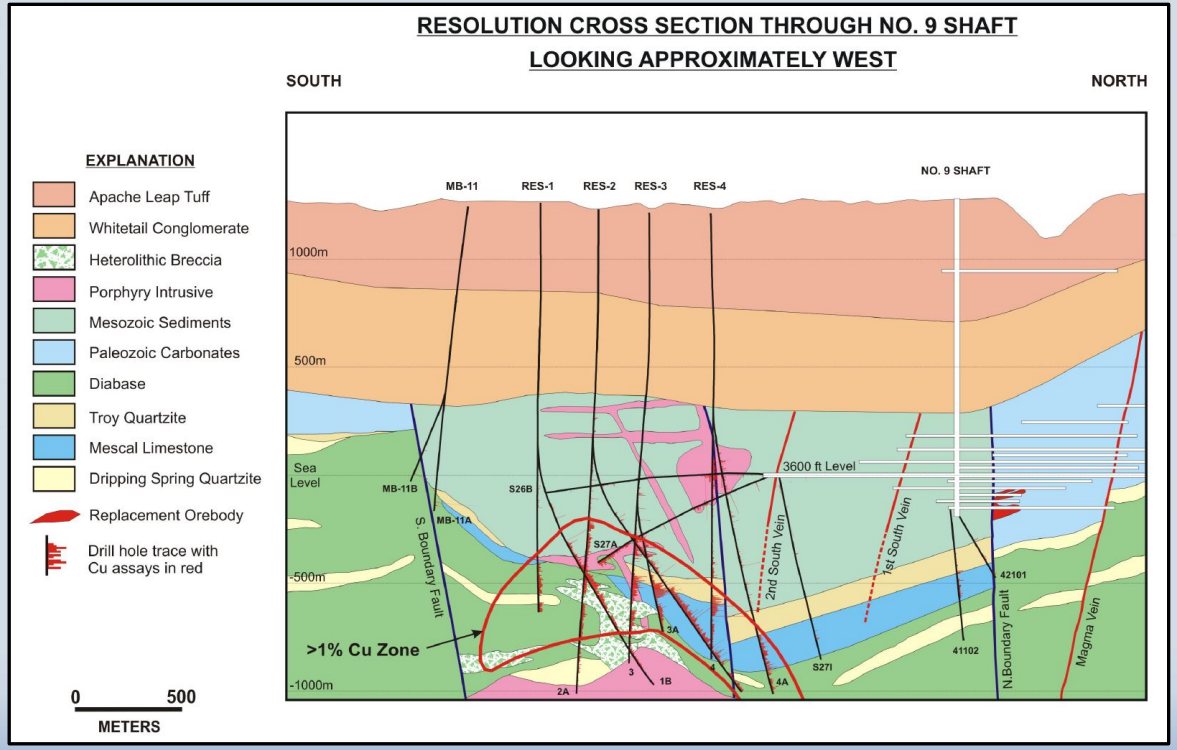


BINGHAM-UTAH

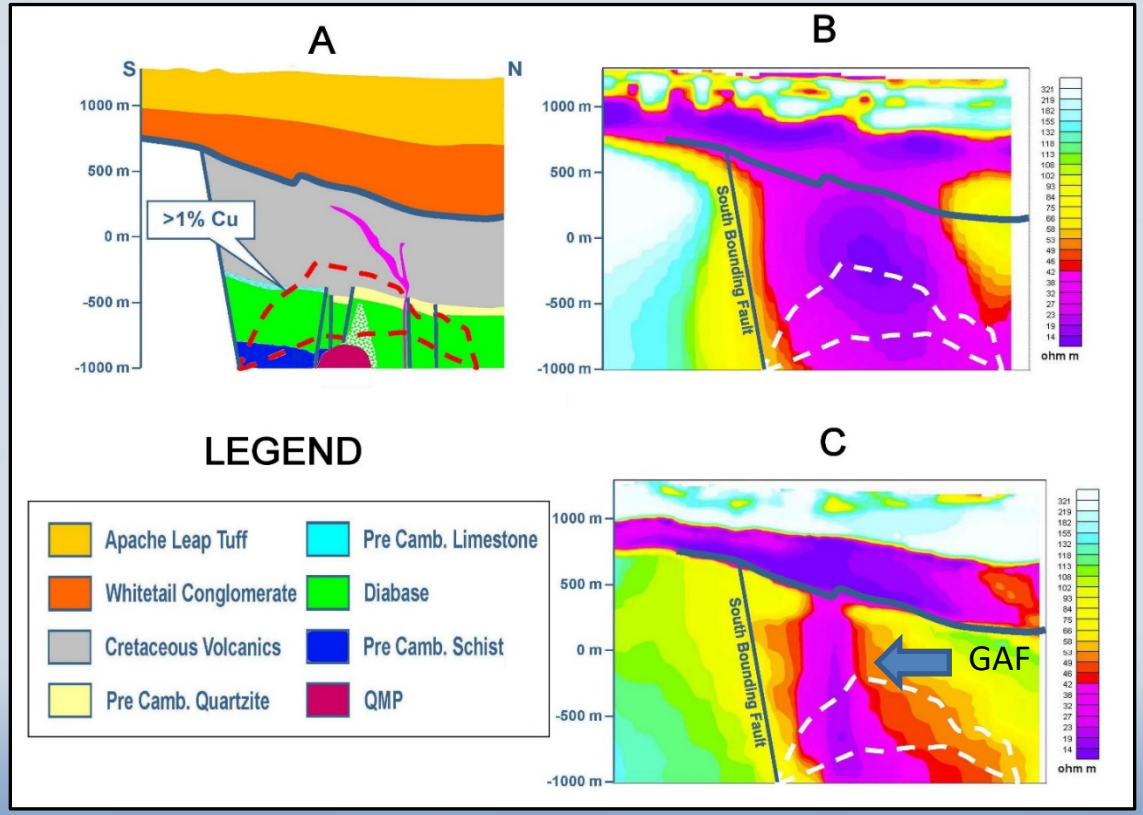


The MT model indicates a low resistivity feature coincident with the mineralized Quartz Monzonite Porphyry dyke at the Bingham Mine. A similar but less intense feature was identified as the target for the porphyry system at Lark.

RESOLUTION-ARIZONA

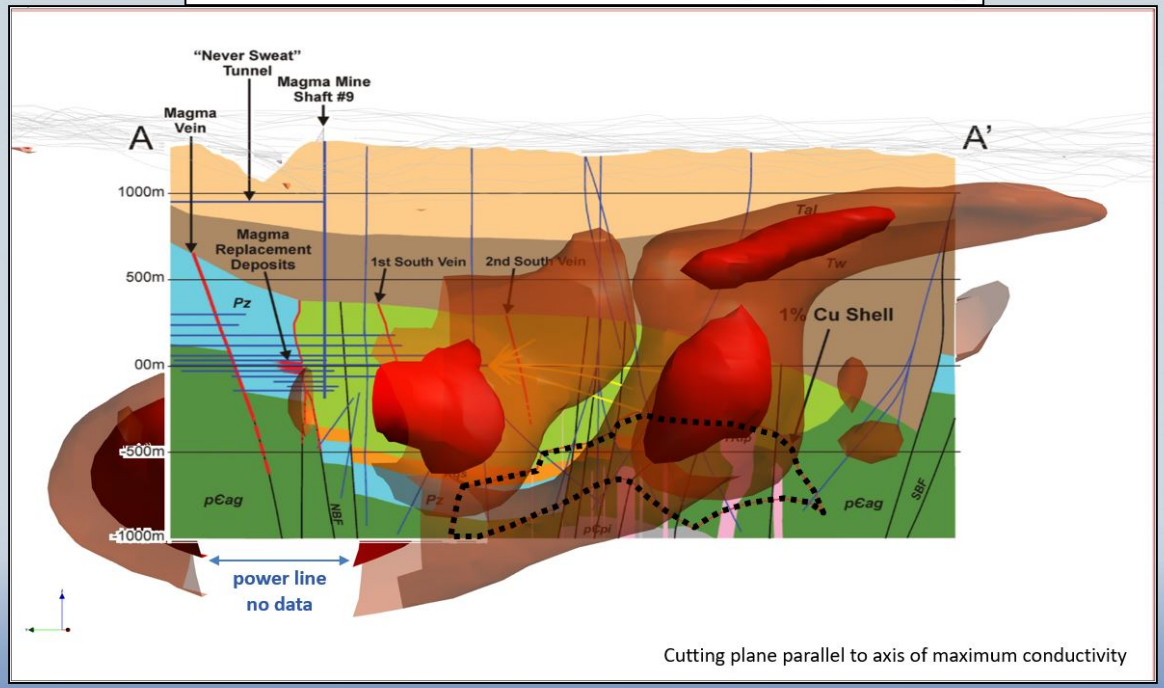


RESOLUTION-ARIZONA

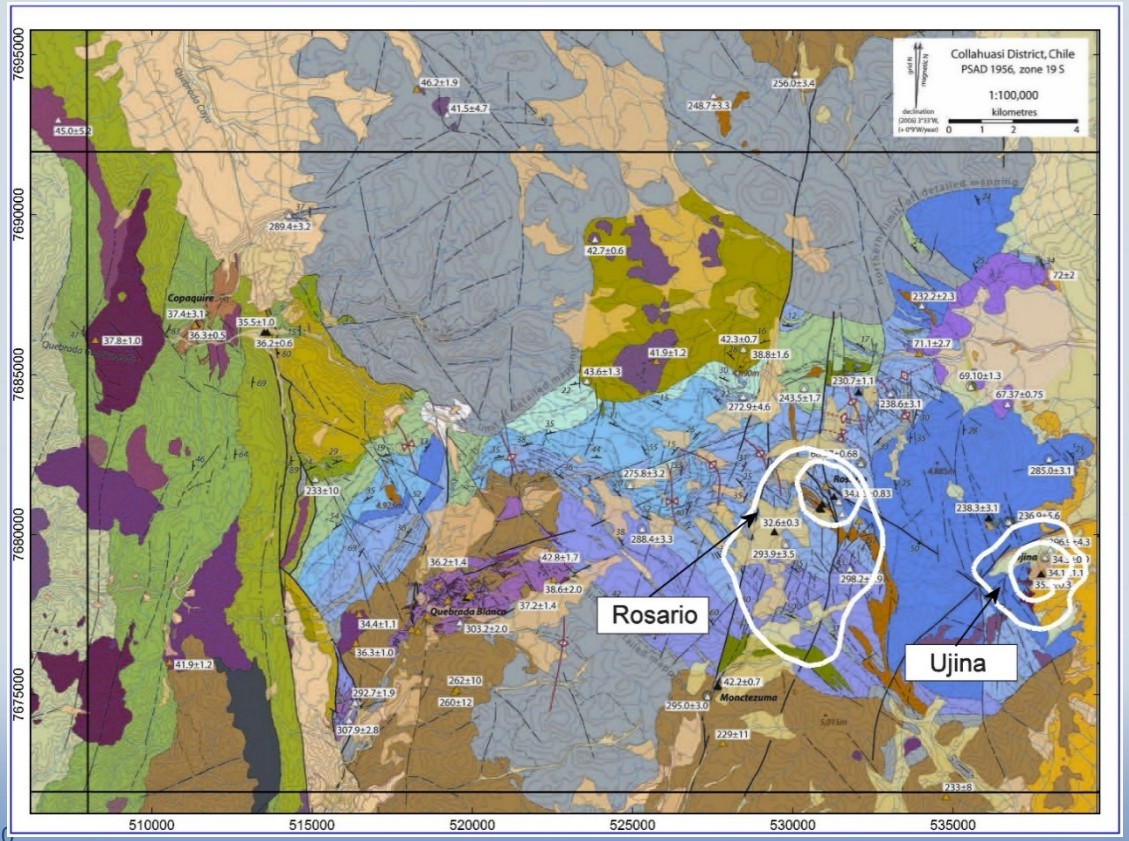


RESOLUTION-ARIZONA

Isosurfaces of 3D Modeled Conductivity (10, 20 mS/m)



COLLAHUASI-CHILE



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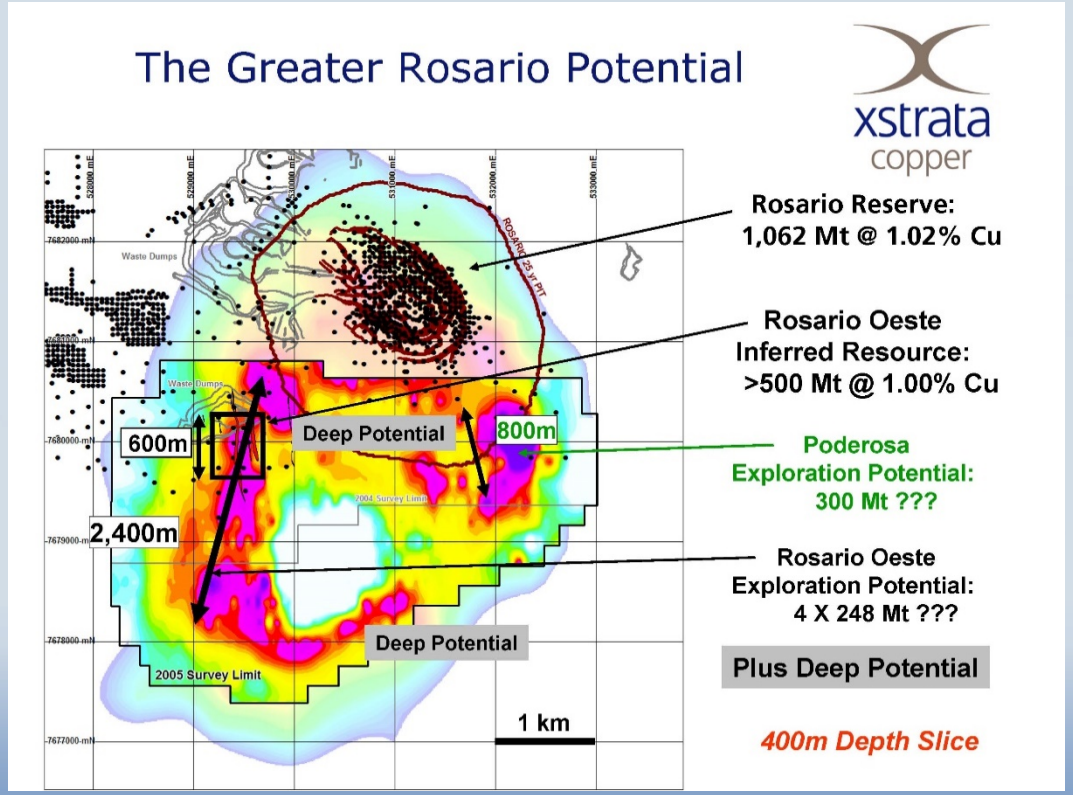
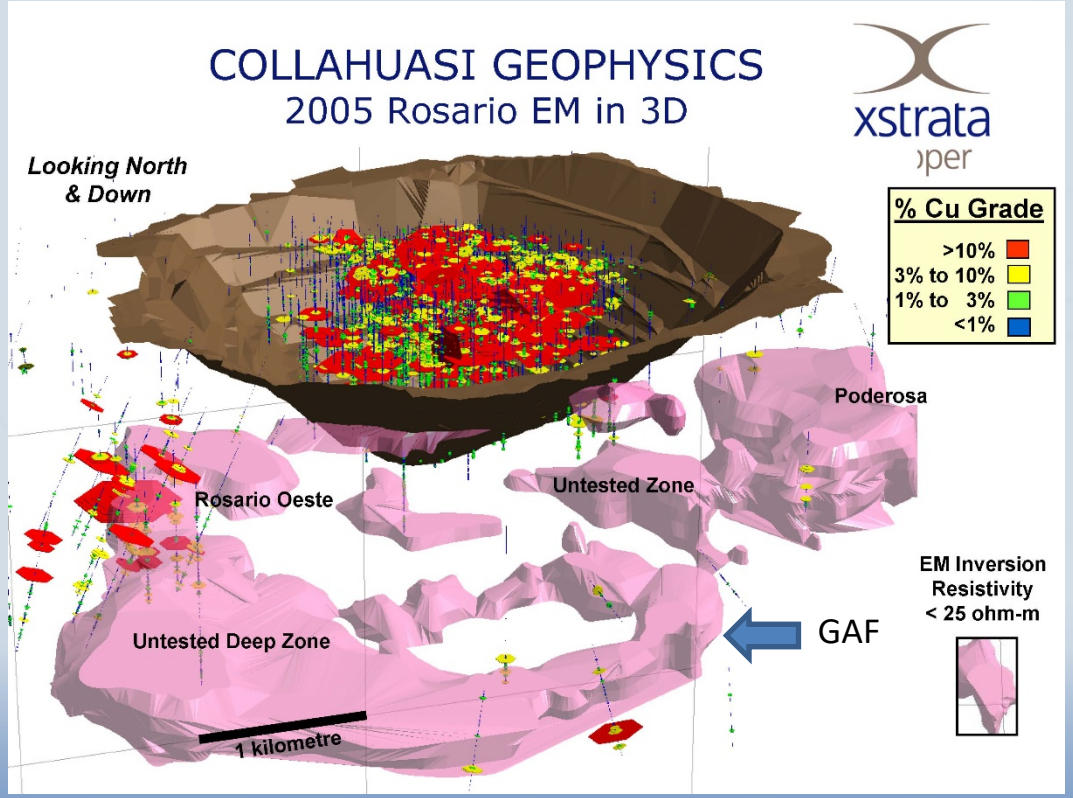
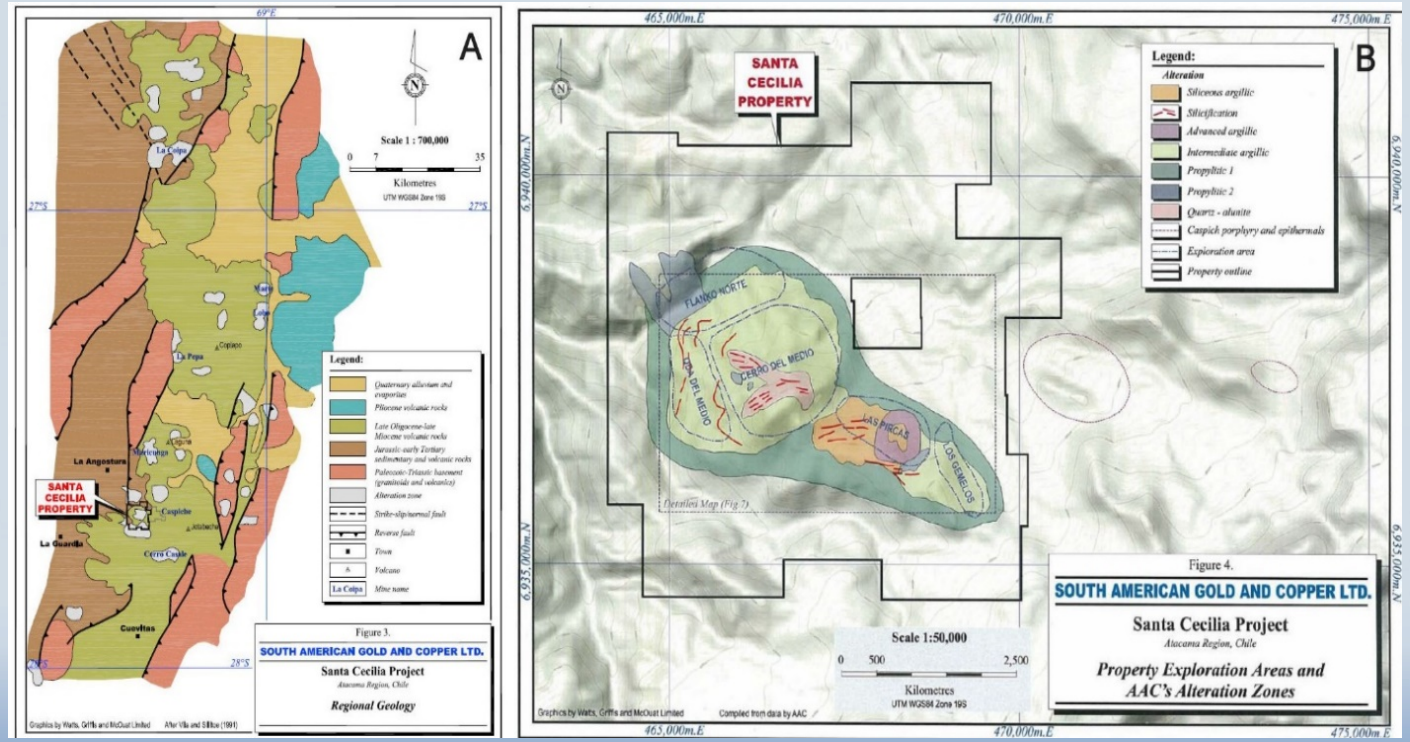


COLLAHUASI-CHILE



SANTA CECILIA-CHILE



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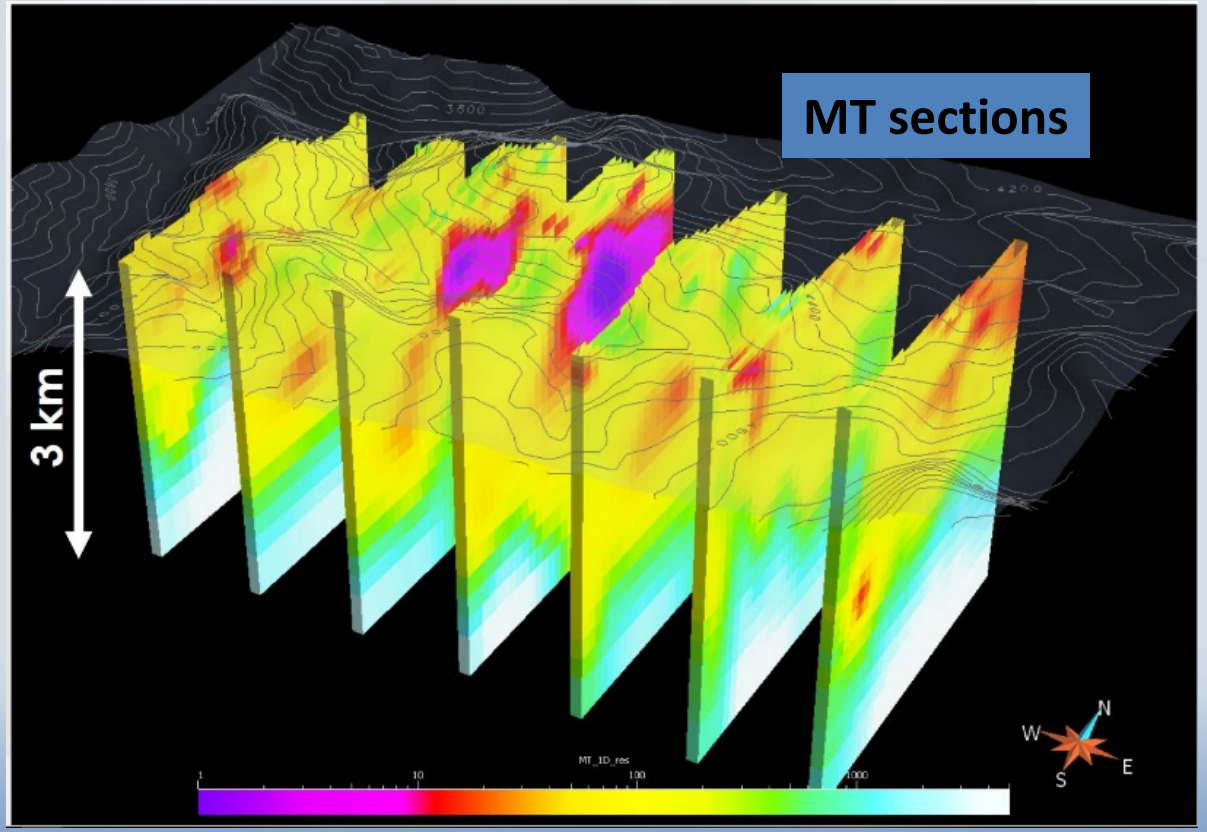

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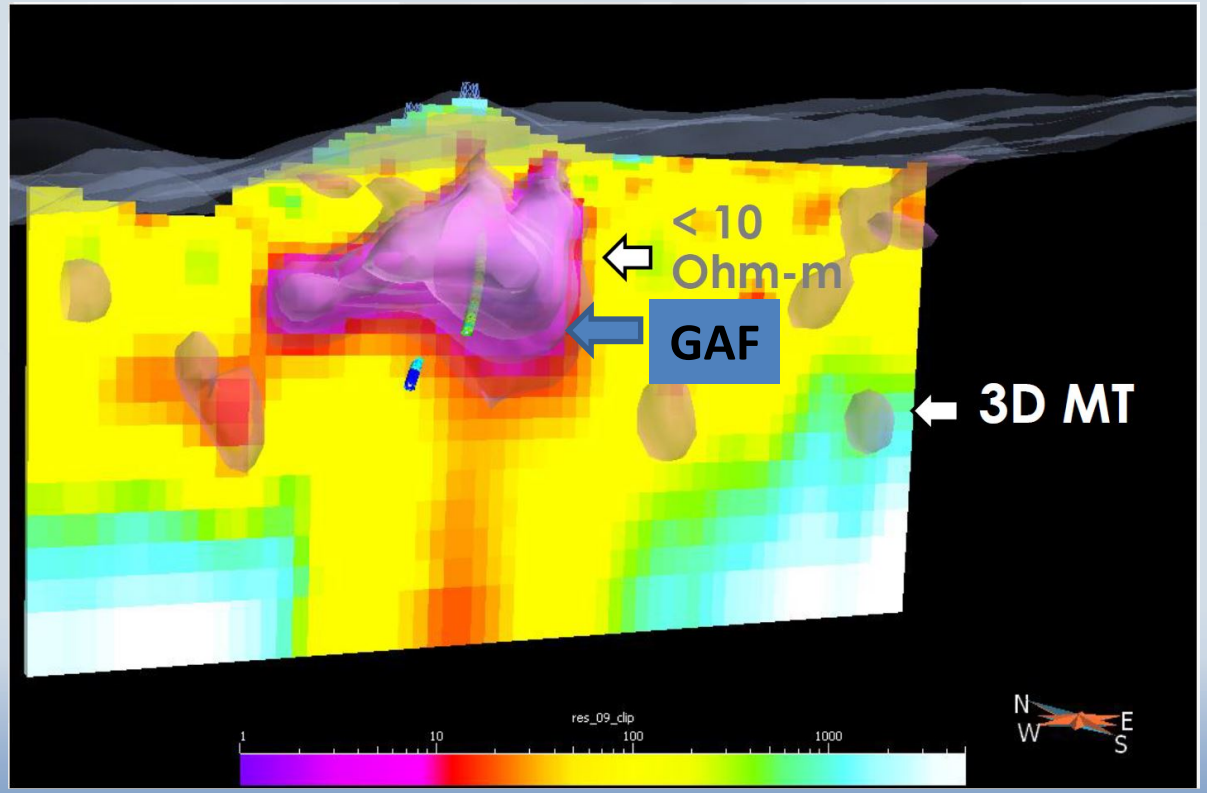
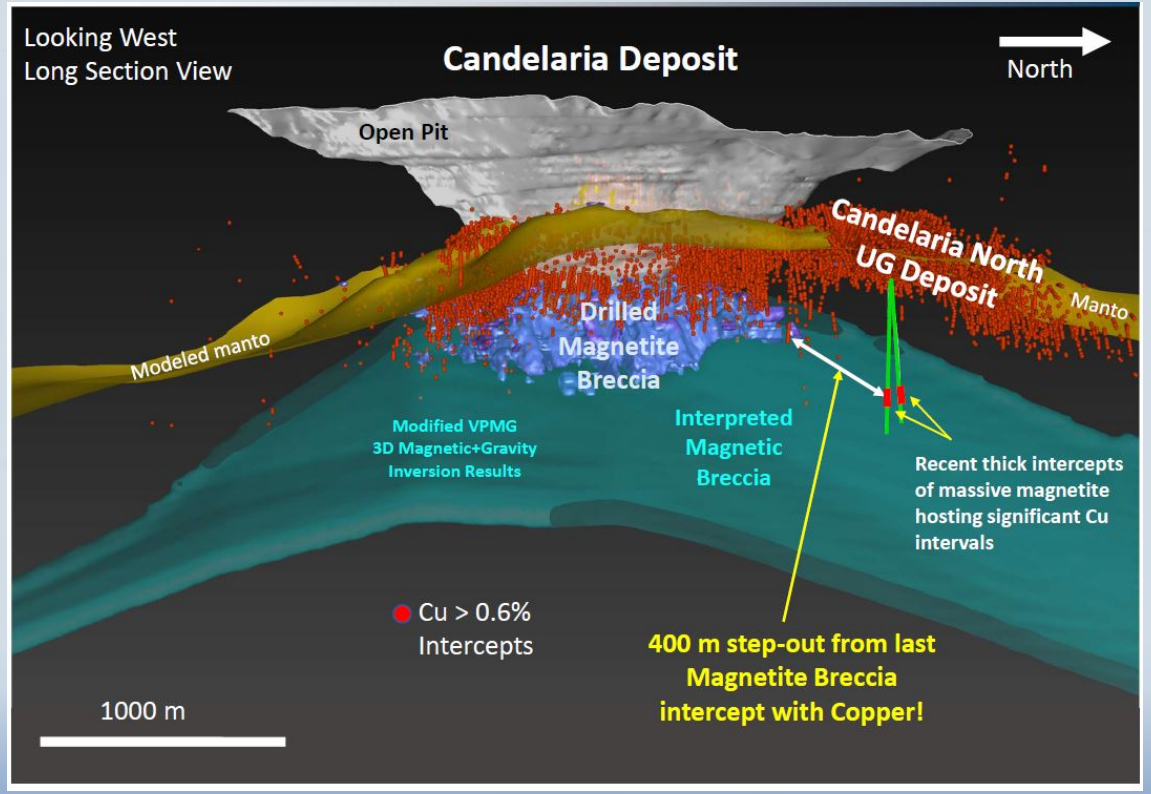


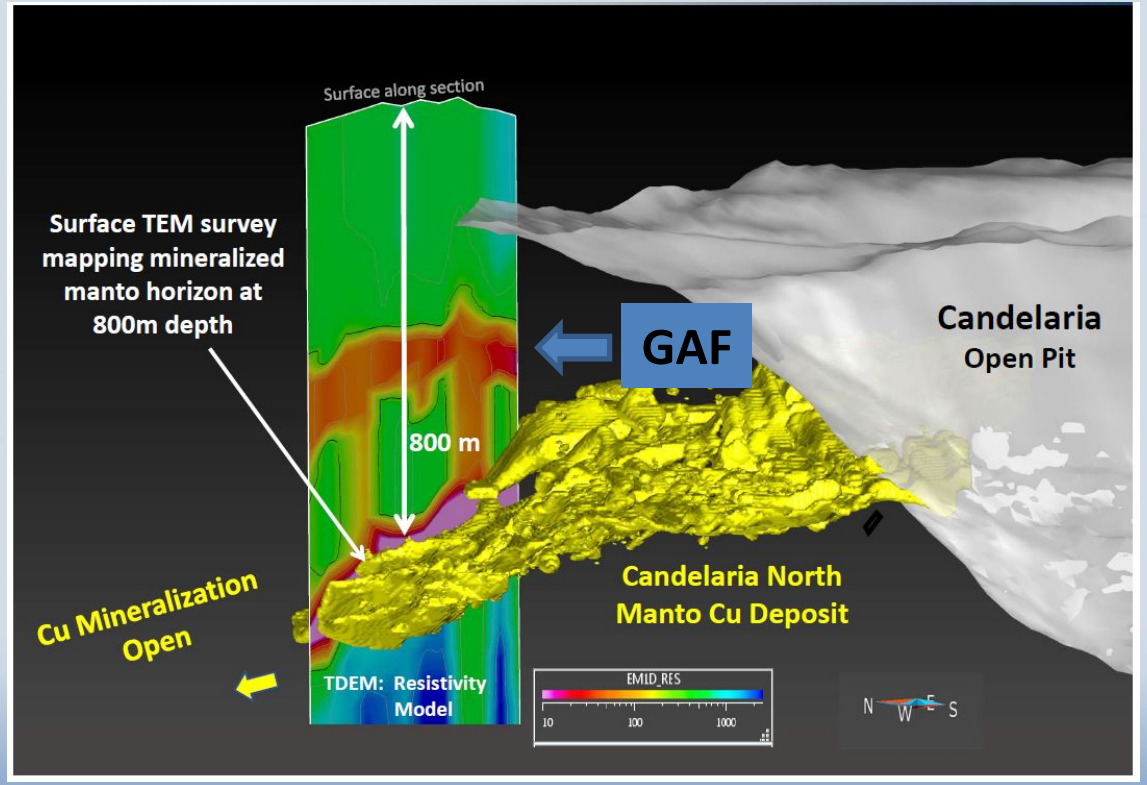
IOCG-EXAMPLES

Deposit Name	Location	Survey/Data Types	Processing work carried out by
Candelaria	Chile	TEM	Lundin
Santo Domingo	Chile	VTEM/ZTEM	Condor
Olympic Dam	South Australia	MT	University of Adelaide

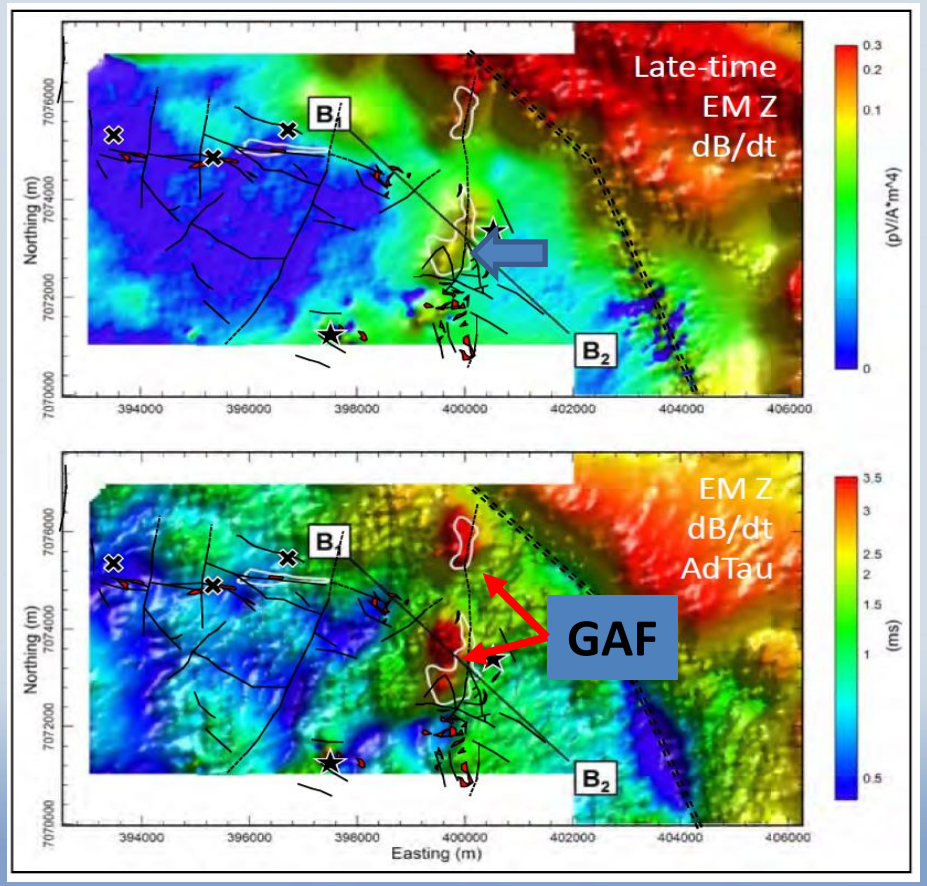
Candelaria-Chile



Candelaria-Chile



Santa Domingo-Chile



Olympic Dam-South Australia