COPPER MOUNTAIN
MINING CORPORATION

WHOLLY CRAPED

- ***Continental Rhyolite-Associated Polymetallic Epithermal Deposits***

COPPER MOUNTAIN
MINING CORPORATION

Volcanogenic (Epithermal) Poly-Metallic Sulphide Deposits associated with continental arcs: An unrecognized, or at least an under appreciated, deposit type, with implications for exploration in BC

Thesis

- There are numerous, significant, Ag-Au-Zn-Pb (+/- Cu, Sb, As, etc.) "epithermal" deposits related to felsic volcanism, within the Pacific Rim of Fire, that have sufficient geological similarities to one another to be considered as a "type" and modelled accordingly.

- Exploration of these deposits is not well served by mere classification as "High or Intermediate Sulphidation Epithermal"
- Some of these deposits may occur in B.C.

Key Features

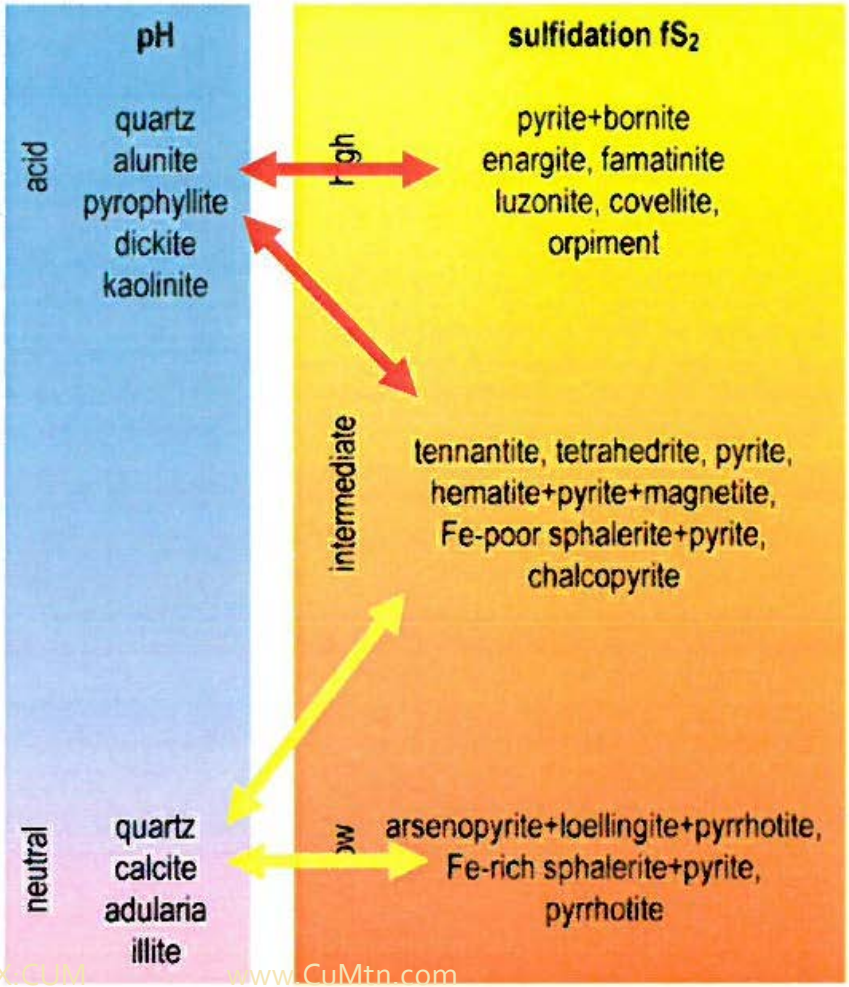
- **Polymetallic**: Ag, Pb, Zn, +/- Au, Cu, Sb, As, Sn
- Hosted within and/or genetically related to **felsic volcanism** – predominately young rhyolite flow-dome complexes (subaerial analogues of VMS?).
- Typically bulk-mineable (veins, vein-stockwork, breccias, mantos, disseminations).
- **Epithermal** Intermediate to high-sulphidation. **But not best model**!
- Variable alteration patterns, but widespread argillic alteration with concentric metal dispersion is common.
- Deposit size: ranges from 20mt to >1bt

Classification basics

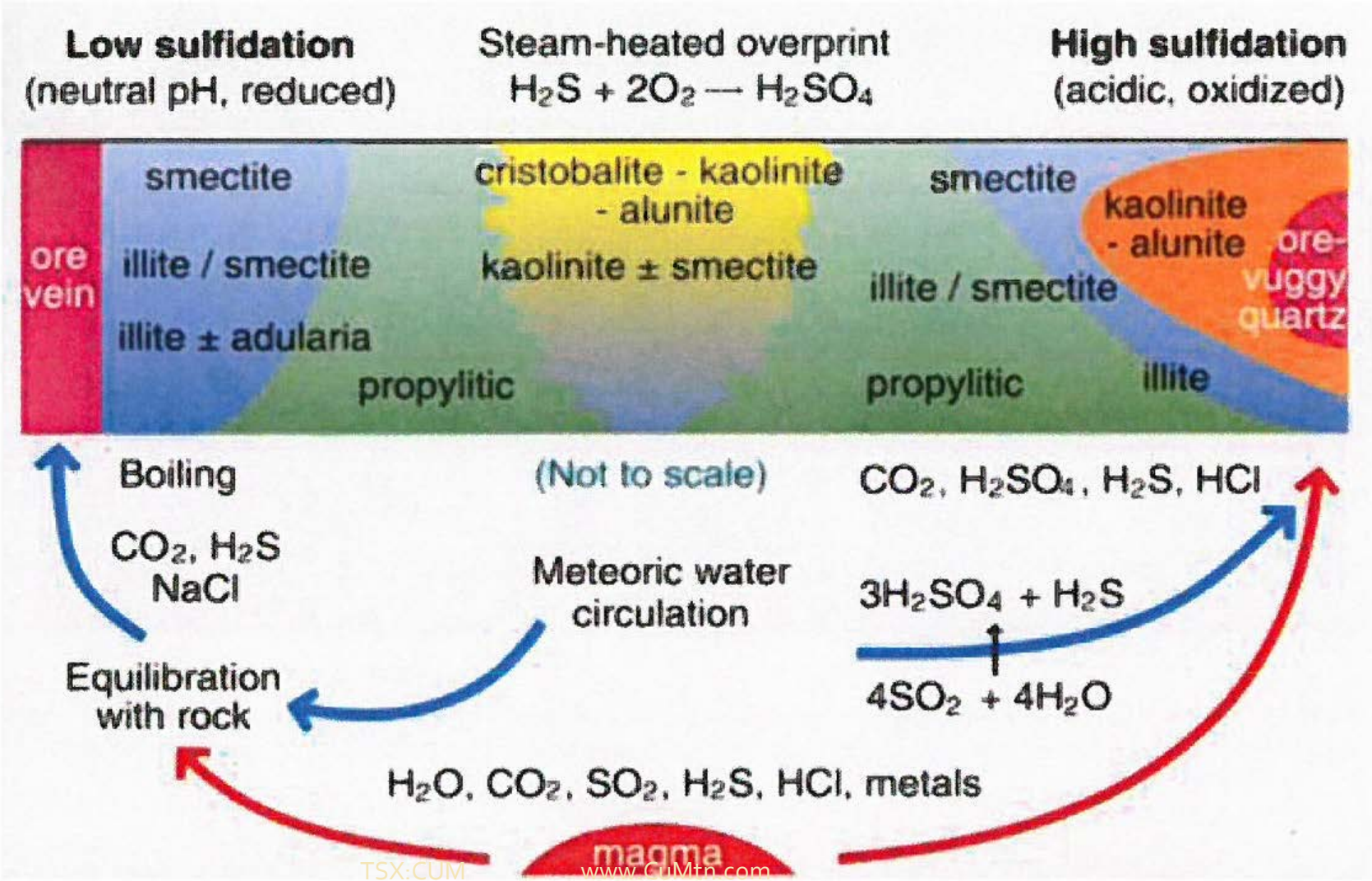
- a) Classification into groups based on similarities of structures or origins.
- b) Classification (and nomenclature) in an ordered system that indicates natural relationships and genetic associations.
- **"Classifications of ore deposits provide essential frameworks for designing exploration strategies, evaluating prospects, estimating resources, etc."**

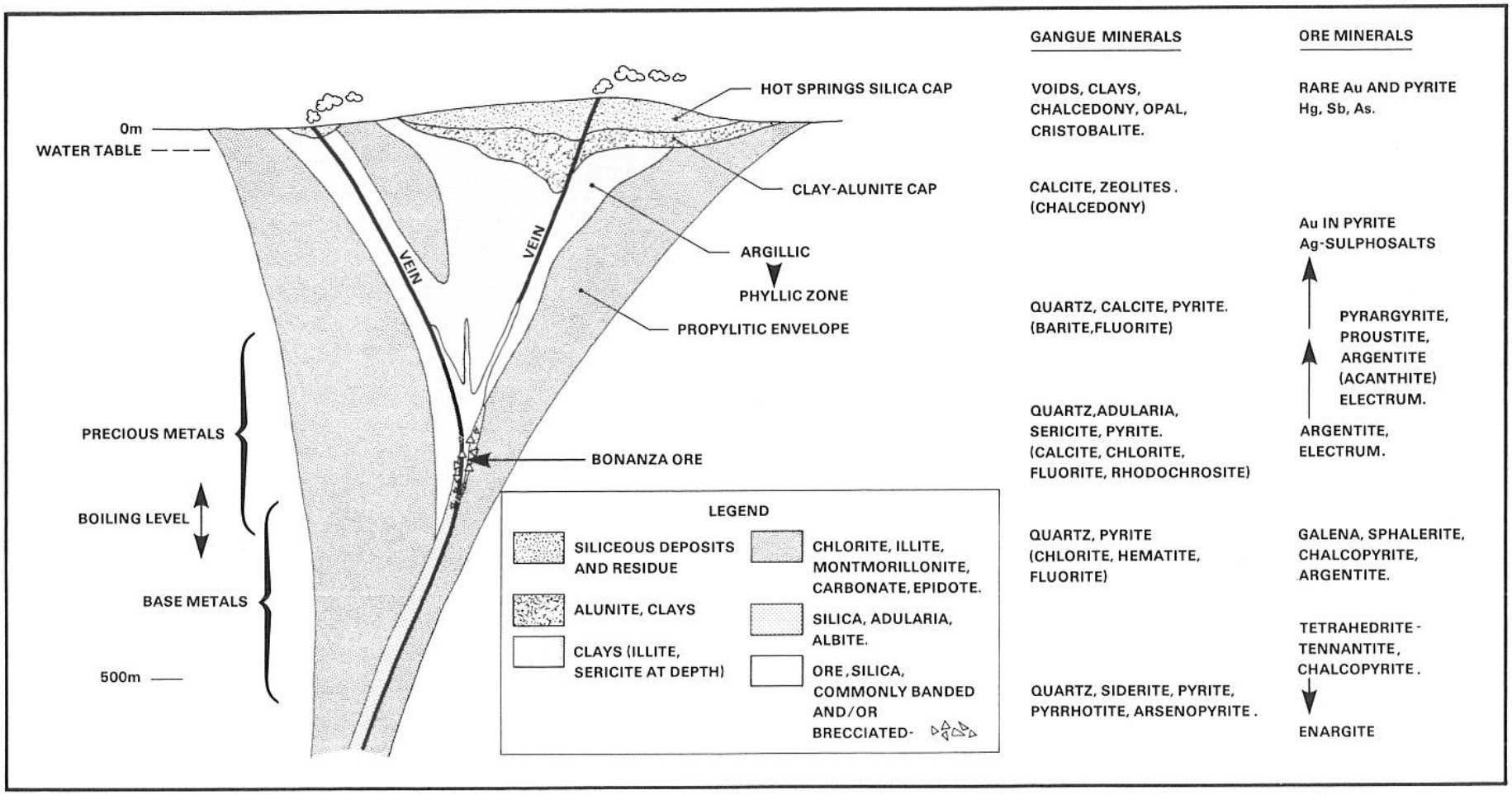
Epithermal Classification

Hybrid terminology combining gangue & sulfide mineralogy



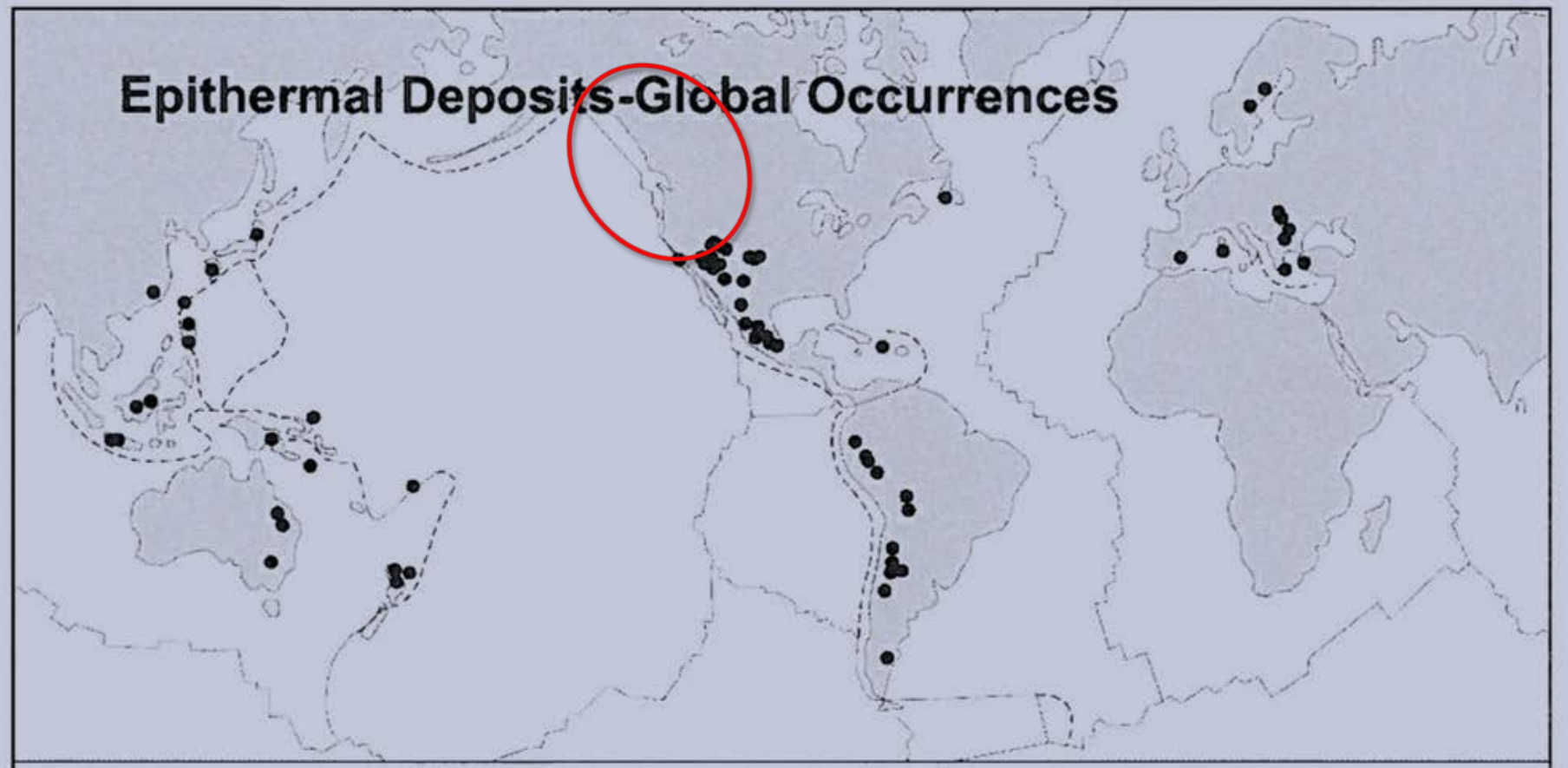
Epithermal classification





Low-sulphidation (Buchanan) model partially provides a physical framework but focus was on gold; not silver (+/- base metals), so although most of the Ag deposits were lumped into the epithermal classification, predictive exploration models are lacking.

Epithermal Deposits-Global Occurrences



•epithemal deposits occur in isolation or clustered in provinces and metallogenic belts

•they are associated with convergent plate boundaries-arcs and post-collisional belts in neutral to extensional stress regimes

•generally Tertiary and younger, but older examples known (some significant)

Selected deposits in South America

Cerro Rico de Potosi: total Ag endowment of 4 to 8 billion ounces.

Selected 'PMS' or 'VEPS' deposits: North America

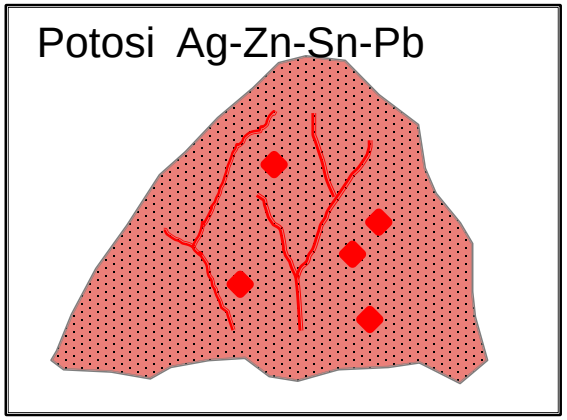
Geological Settings of VEPS deposits

- Why are felsic domes important?

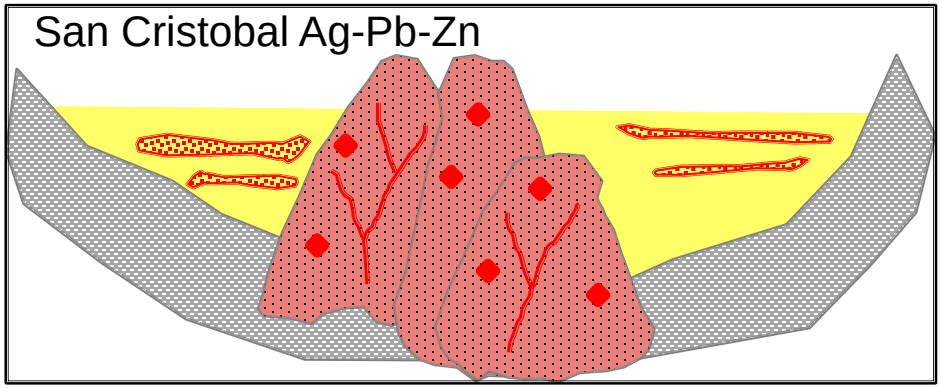
"dome forming magmas represent the devolatilized viscous residuum of volcanic eruptions…and must be depleted in volatiles to reach the surface" (Burnham, 1967).

- The escaped volatiles form part of the hydrothermal fluids and therefore resurgent dome settings are important.
- Mineralization is usually a late feature of a flow-dome complex.
- Porphyritic textures are a good indicator of 'wet' magmas.

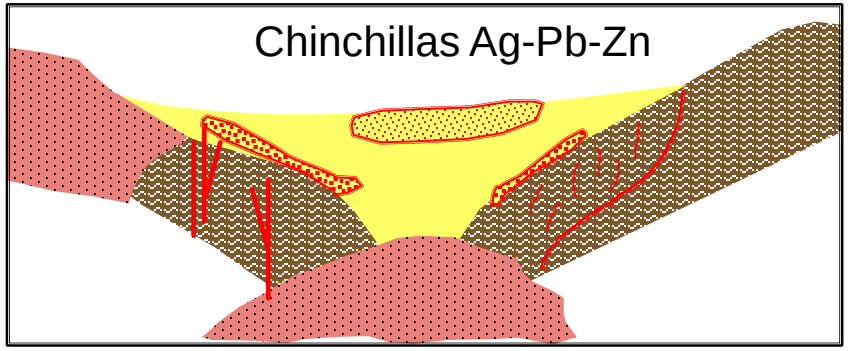
Generalized Deposit Model Examples



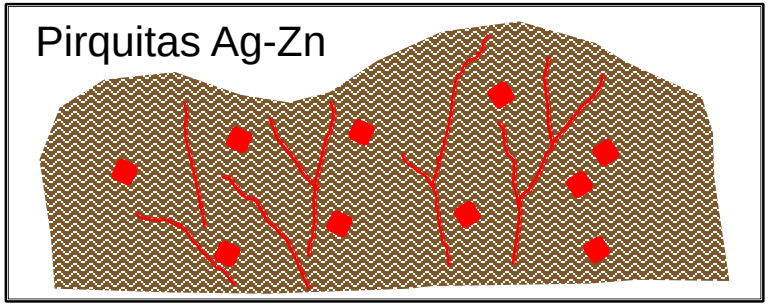
- Mineralized in shears and breccias within dacite dome complex



- Dacite dome intruding basement sediments
- Mineralization deposited in shears and breccias within domes, and as disseminated mantos in basin sediments



- Dacite dome intruding basement meta-sediments
- Diatreme event created basin; infilled with tuffs
- Mineralization deposited in shears and breccias in basement
- Mineralization in the basin tuffs is in disseminated flat-lying mantos



- Shears and breccias in Ordivician meta-sediments
- No preserved domes or volcanic source

COPPER MOUNTAIN
MINING CORPORATION

Mineralization styles

Disseminated/mantos

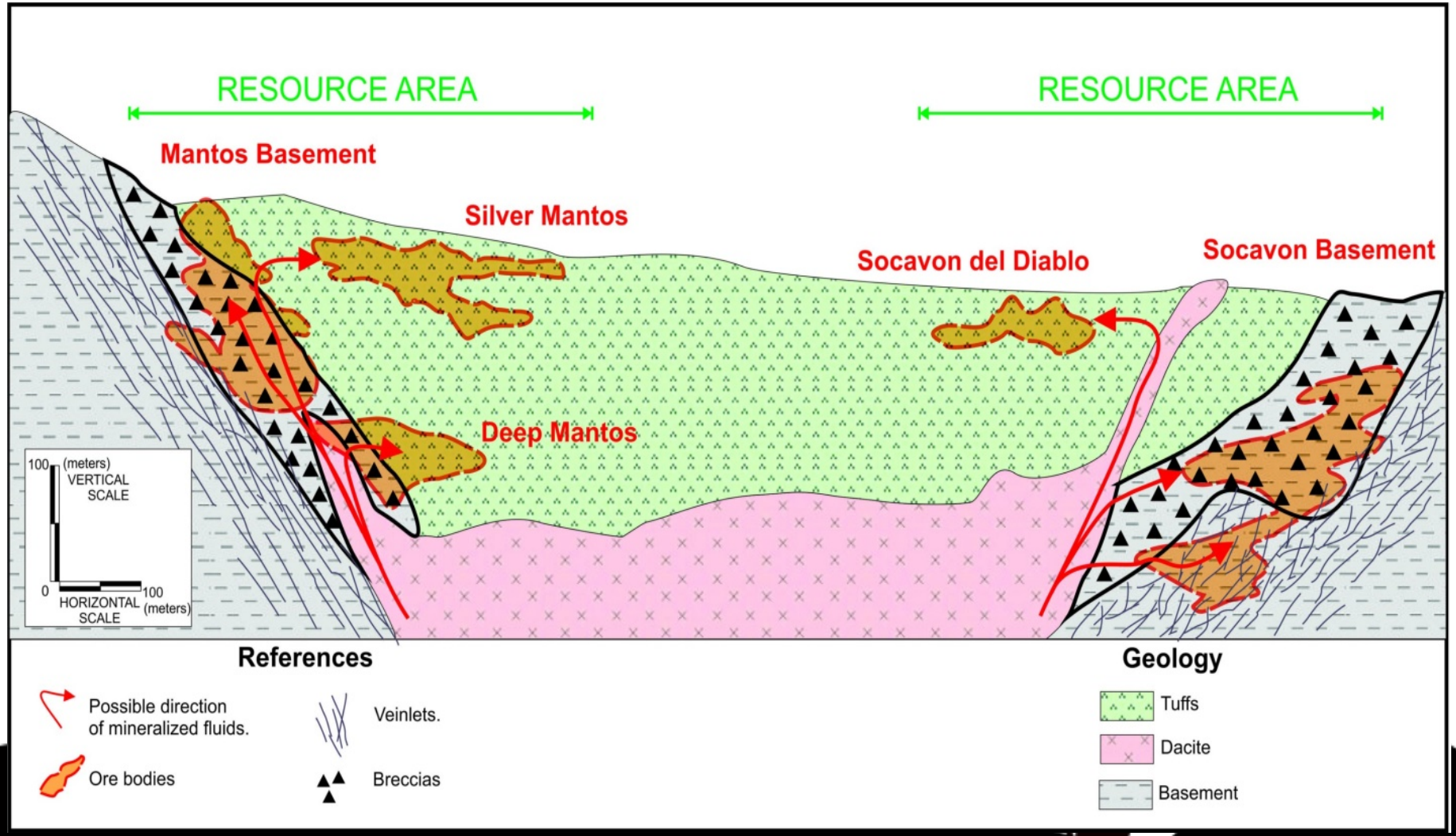
Veins / stockwork

Breccia

Mineralization

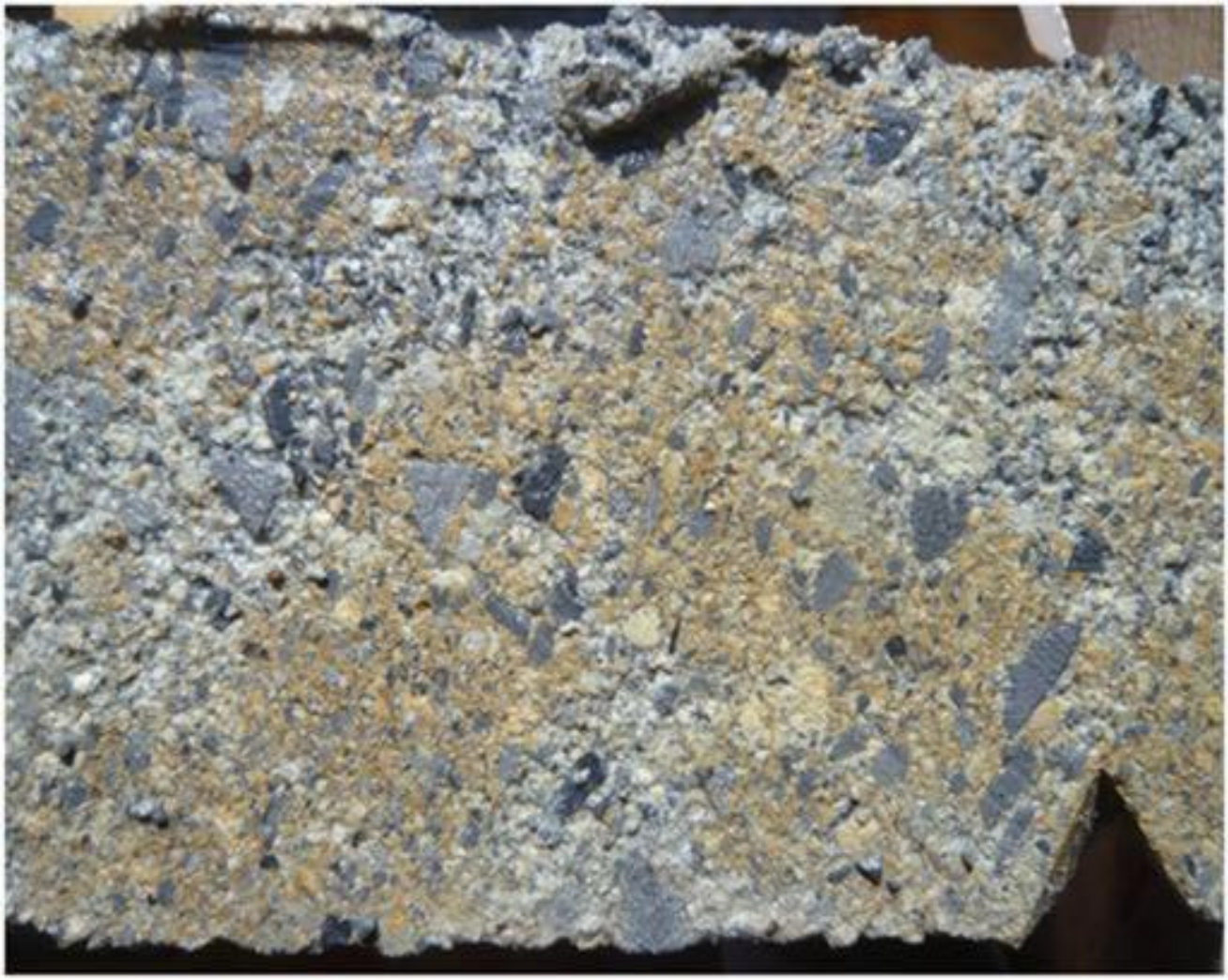
- Source of hydrothermal fluids is exsolution during magmatic crystallization +/- addition of connate/ground water.
- Hydrothermal fluids = acidic, Cl-rich brines with Ca>>Na. Sx deposition by cooling (mixing) and possibly by Eh or pH changes.
- Fluid flow (mineralization) controlled by rock/structural permeability. 'Low-perm' rocks = veining *vs* disseminated or manto style in 'high-perm rocks'.
- High silica or carbonate-rich systems can be self-sealing, leading to Bx-style mineralization.

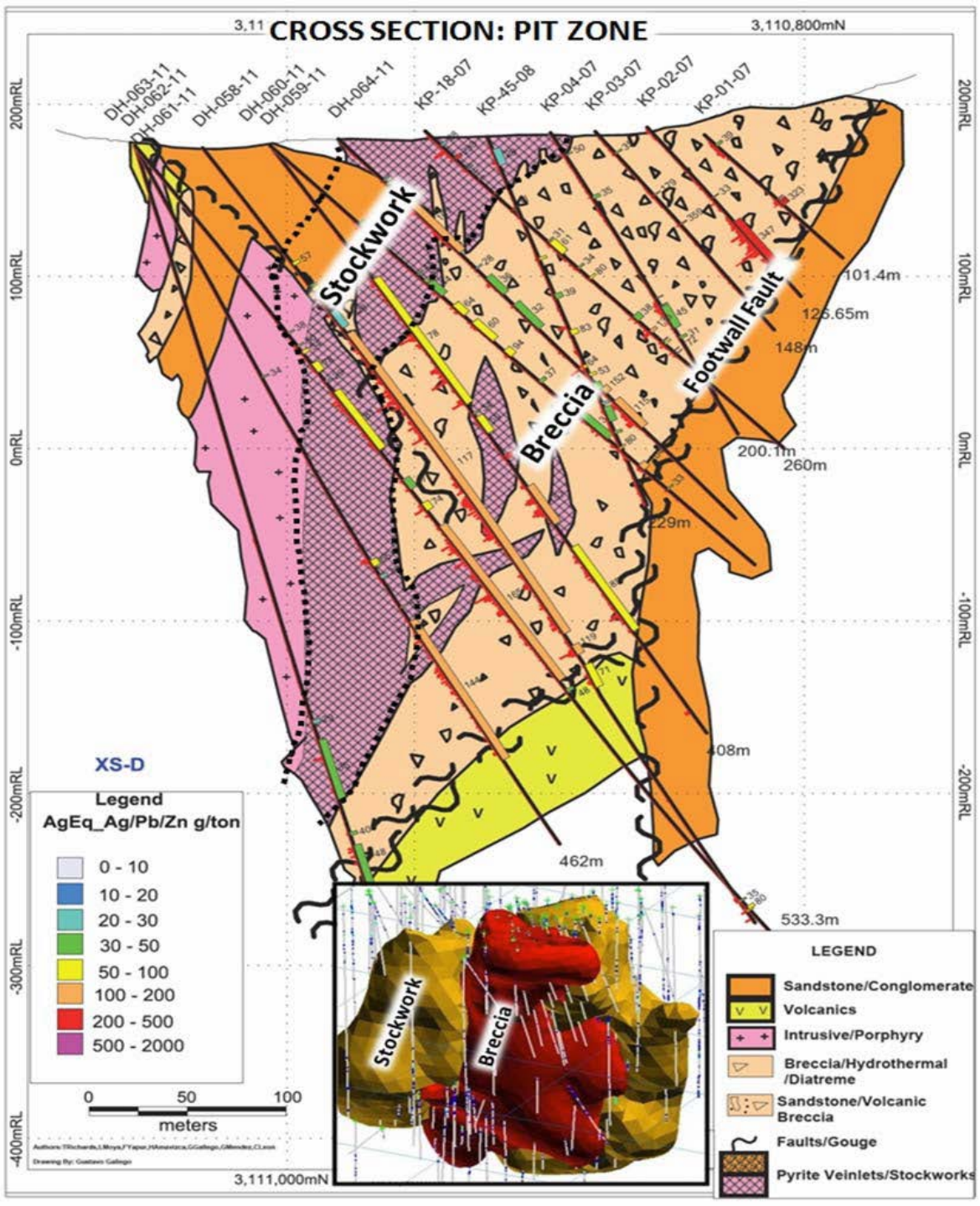
Chincillas Schematic



Chinchillas Basin Volcanic host rock

- Tuffs and breccias
- Oxidation of top few metres
- Prolonged and variable alteration including :
  - ✓ Clay
  - ✓ Sericitization
  - ✓ Carbonate
- Mainly flat-lying mantos style mineralization
- Silver in fine-grained sulphosalts, plus sphalerite and galena

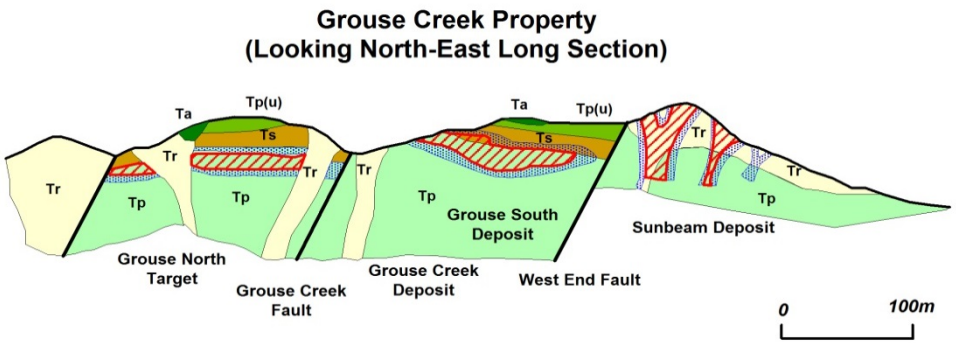


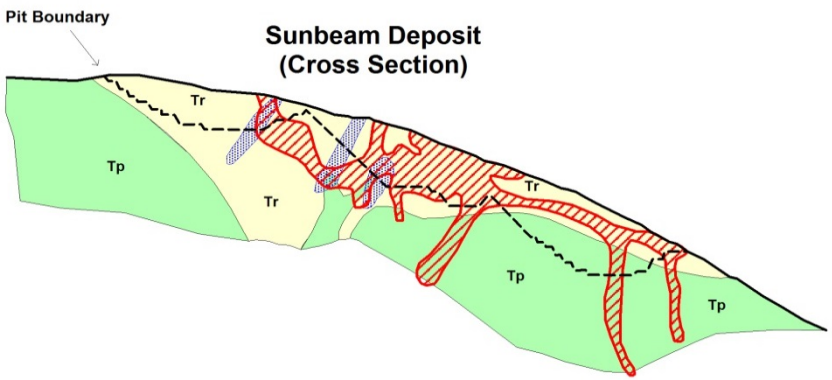


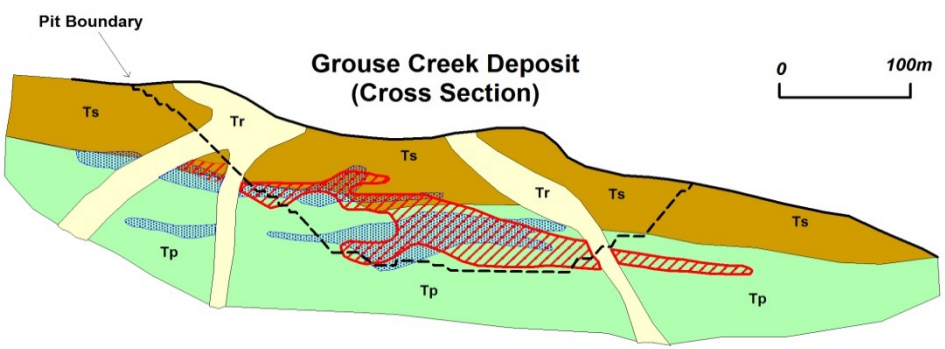
Promontorio

- Area of Miocene felsic volcanism but flow domes not described (as such)
- 45Mt @ 64g/t Ag, 0.35g/t Au, 0.47% Zn, 0.40% Pb (May 2013)
- Structurally controlled trend to mineralization
- Diatreme style felsic breccia hosted in sediments and within and adjacent to Bi-Fs porphyry.

Grouse Creek: Vein stockwork +/- disseminated mineralization.







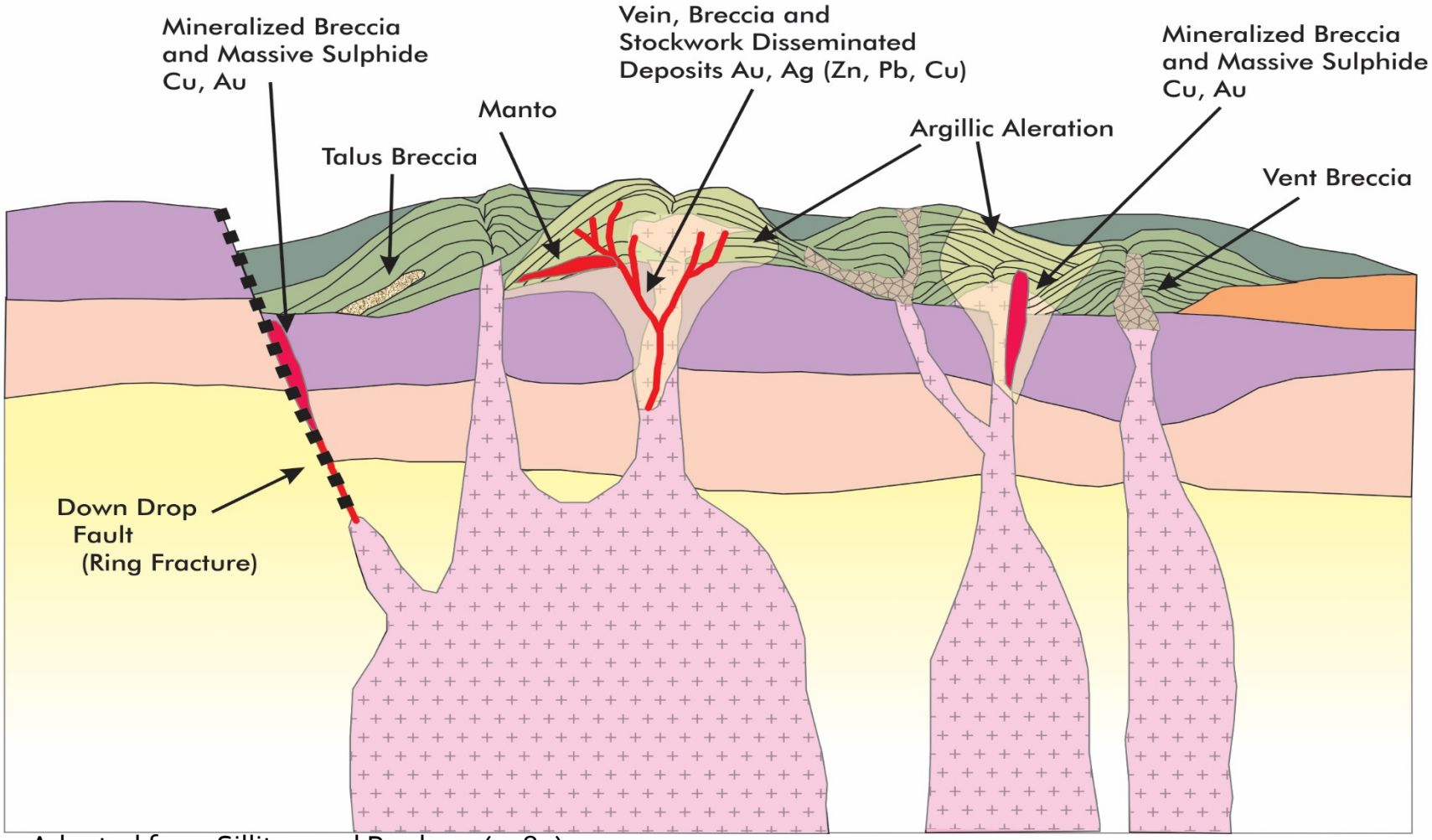
SUNBEAM AND GROUSE CREEK Au-Ag DEPOSITS, IDAHO

- Ore Zone > 0.6 g/t Au
- Silicification
- Tr — Rhyolite flows, domes and dykes
- Ta — Andesitic rocks
- Tp(u) — Upper pyroclastic rocks
- Ts — Sedimentary rocks
- Tp — Lower pyroclastic rocks

DEPOSIT SIZE

25 Mt @ 1.1 Moz Au, 23 Moz Ag

Generalized schematic model



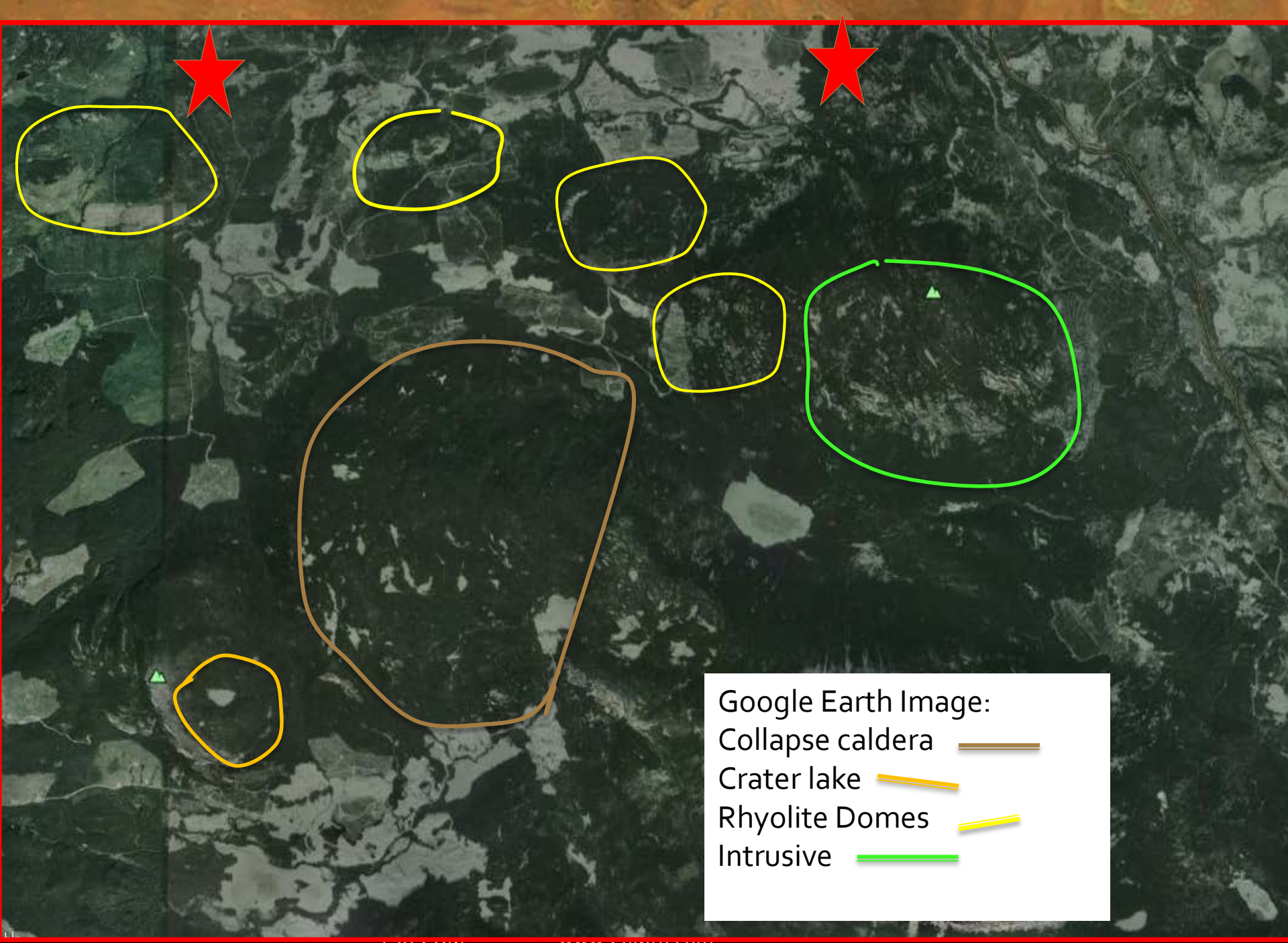
Adapted from Sillitoe and Bonham (1984).

Real World - Exploration Features

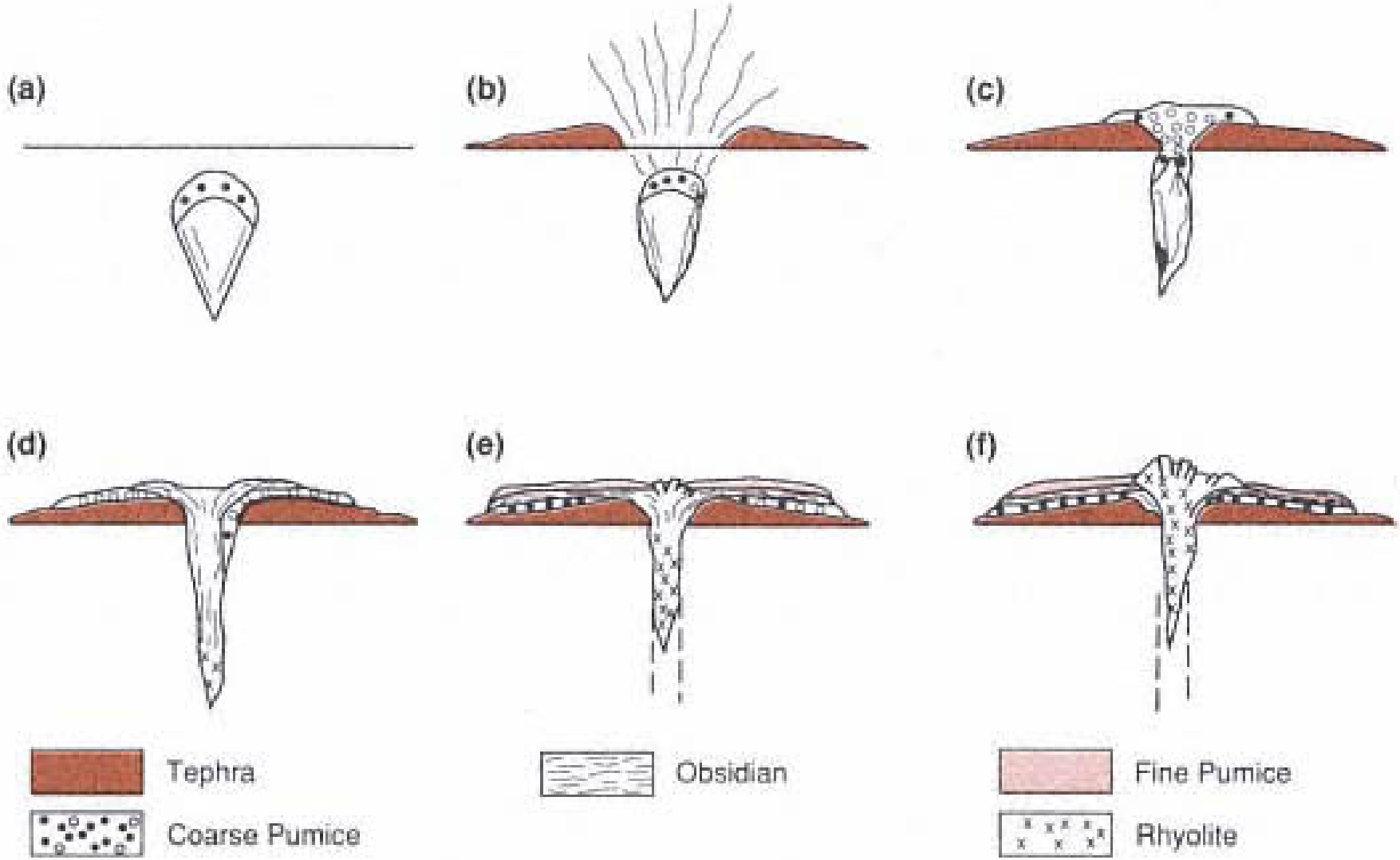
- Almost all deposits have some form of veining or disseminated Sxs and/or alteration that extend significantly beyond economic (or bulk minable) mineralization.
- Most deposits are young, since they are subject to erosion but some may be protected by later volcanism.
- There may be mineralogical and litho-chemical signatures of productive magmas.
- Gold to silver ratio increases with free silica content (and elevation of deposition?)
- Copper content appears to increase with depth.
- Basement architecture (plumbing system) likely important

Does the model work?

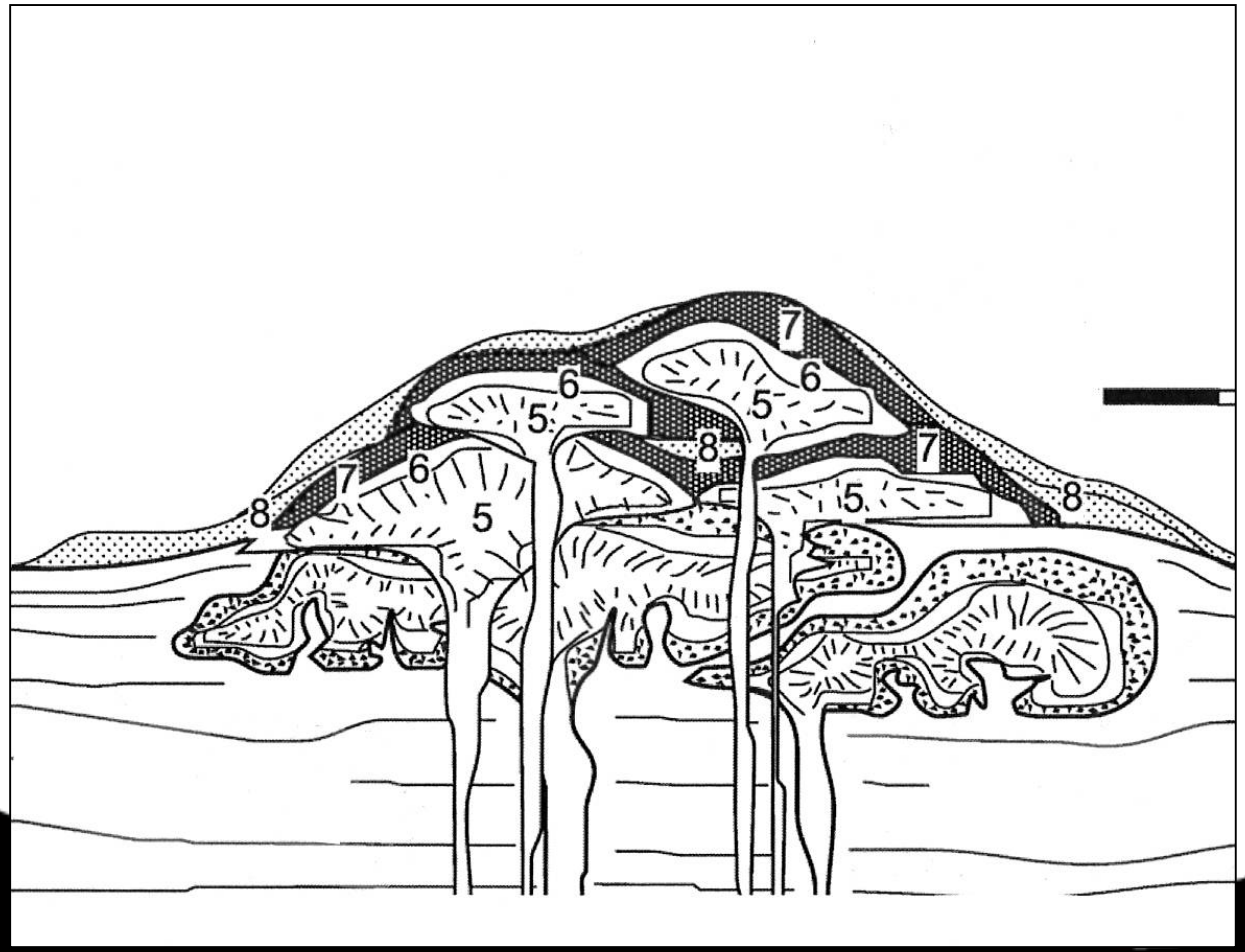
Northern BC. , extensive till cover, ugly bush…


Google Earth Image:
Collapse caldera
Crater lake
Rhyolite Domes
Intrusive

Simplified evolution of a flow-dome complex

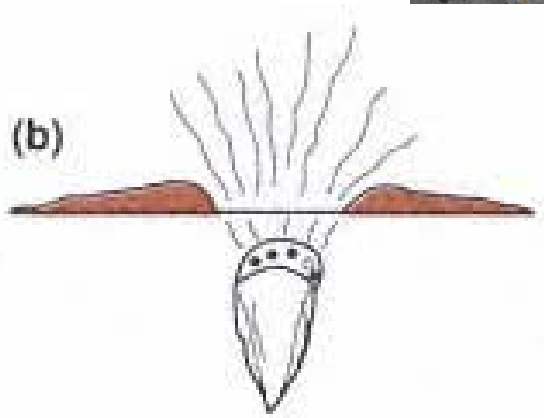


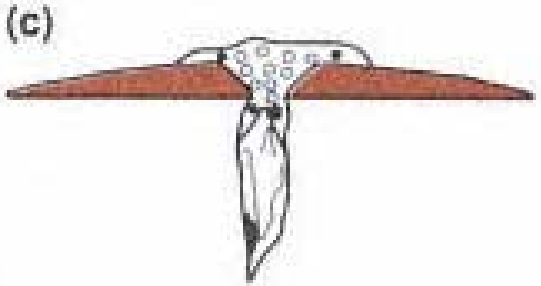
What a flow-dome might really look like, (before faulting and alteration).



Ring of pyroclastic material

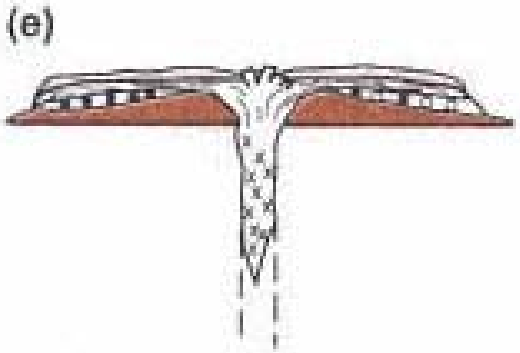
Crystal lapilli tuff, with sulphidic mud chips which may represent sediment in the marr lake.





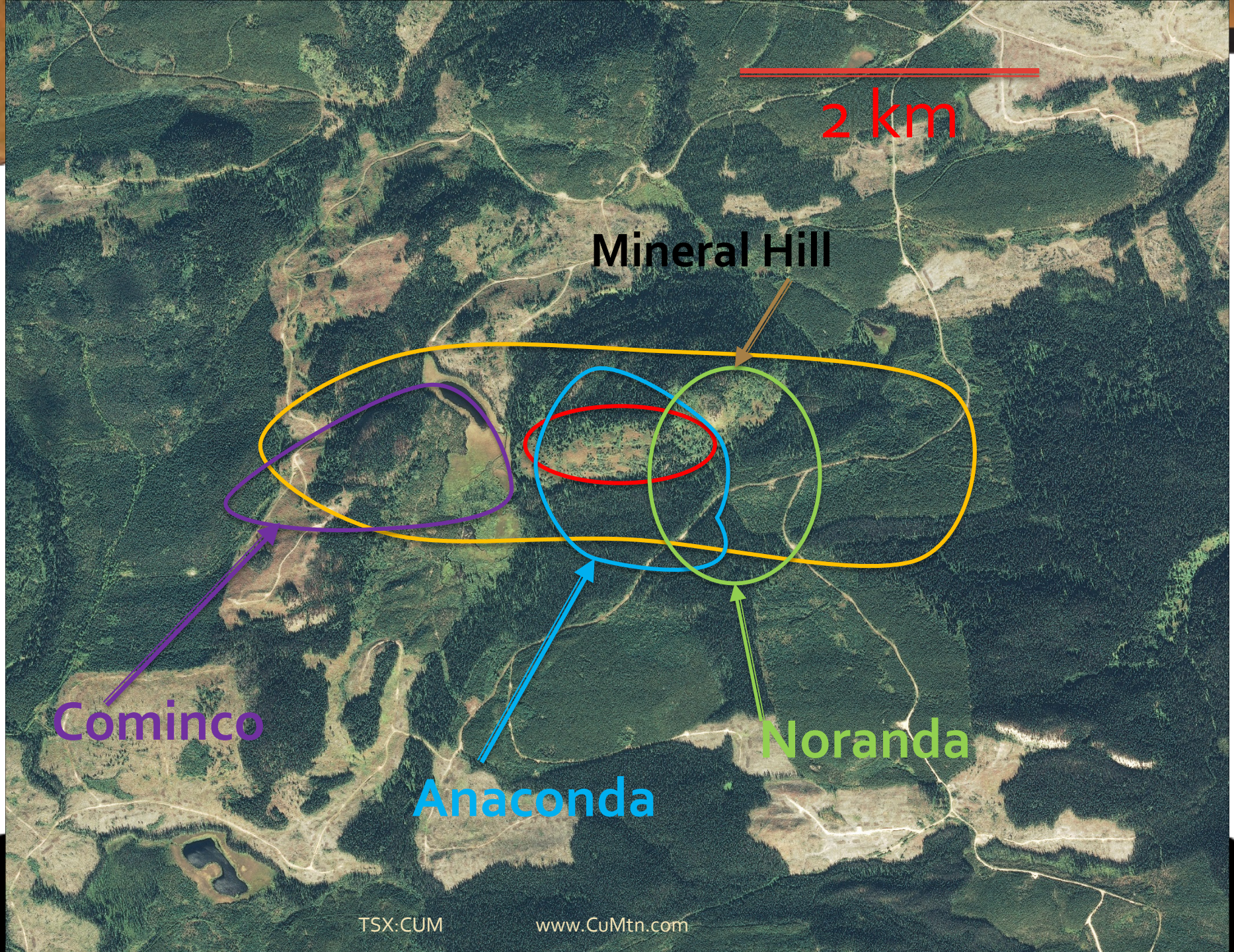
Flow-top Breccias

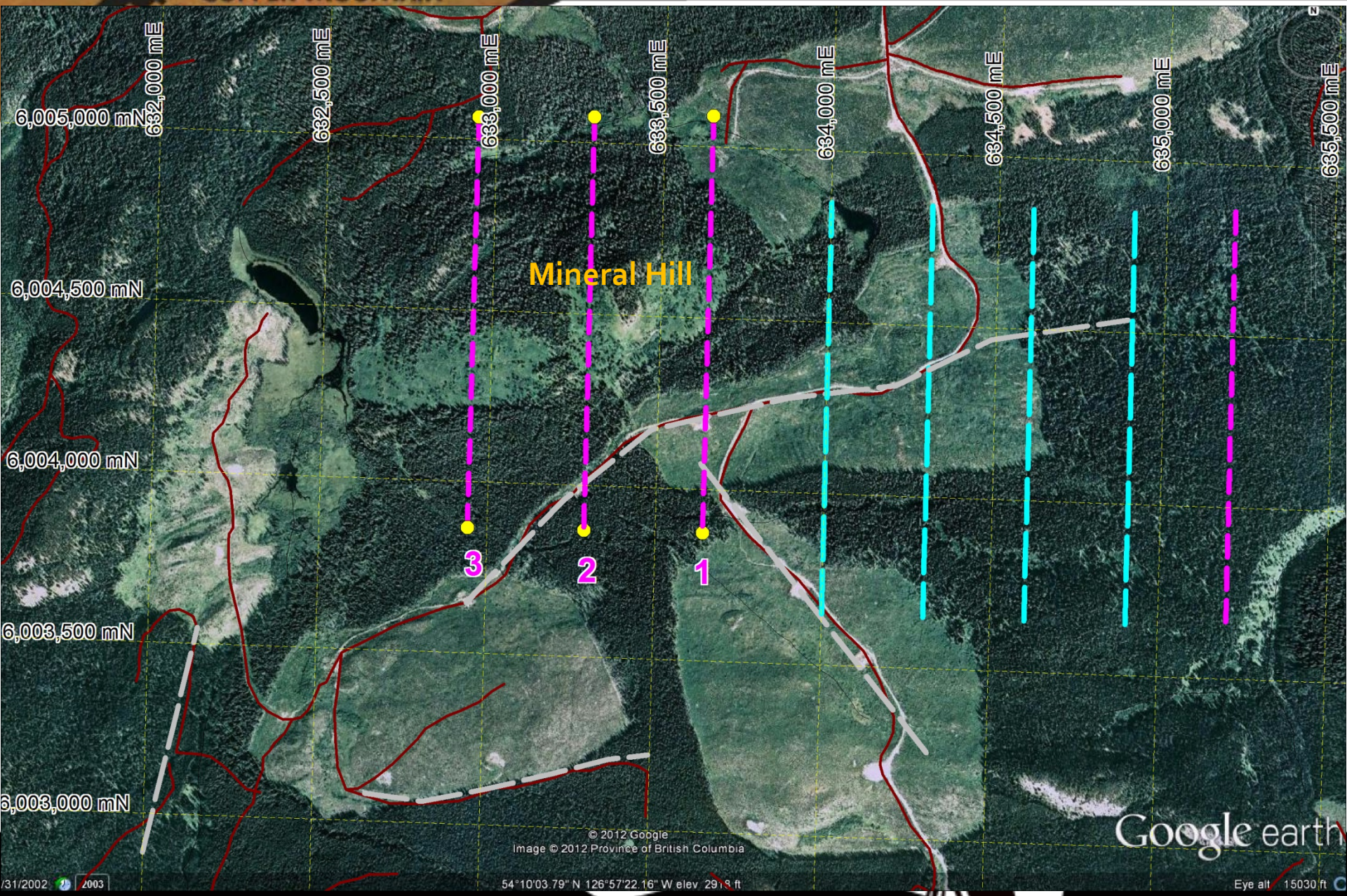
As the dome grows, the outer flow-banded skin is brecciated and pushed to the flanks.



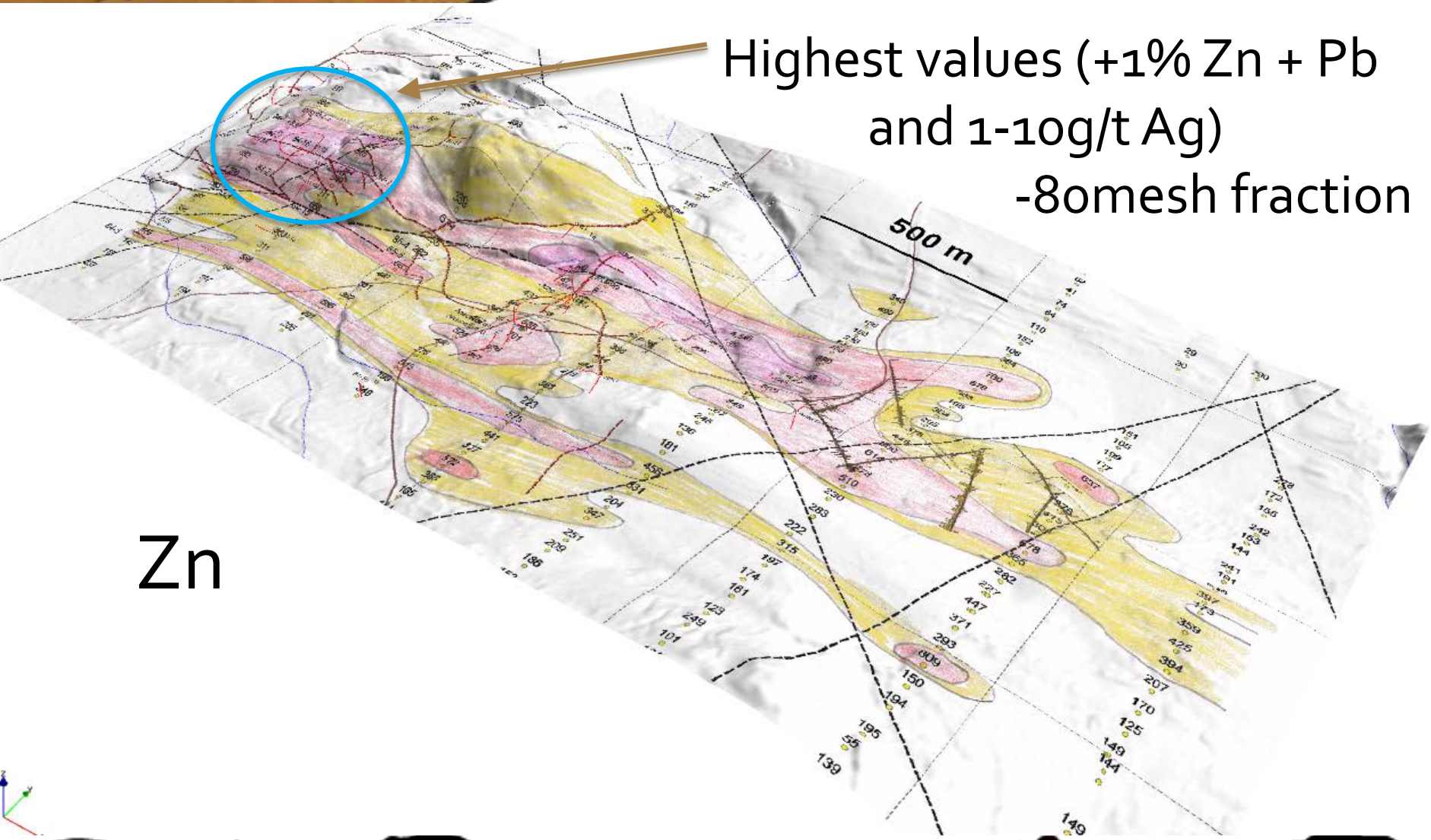
Vent Breccias

Repeated magma injection leads to extensive brecciation, although distinguishing between volcanic and hydrothermal breccias can be difficult.

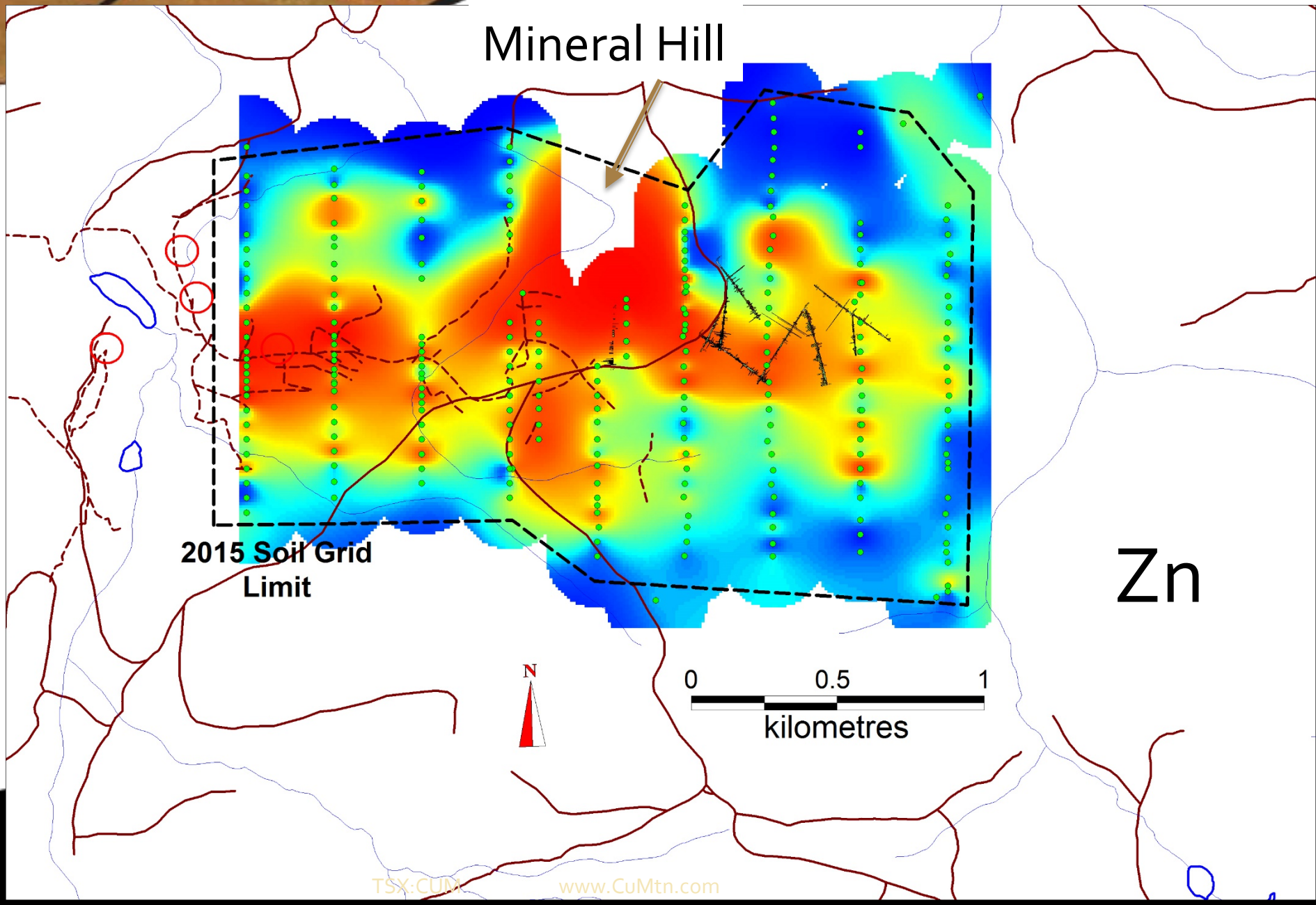

2 km
Mineral Hill
Cominco
Anaconda
Noranda

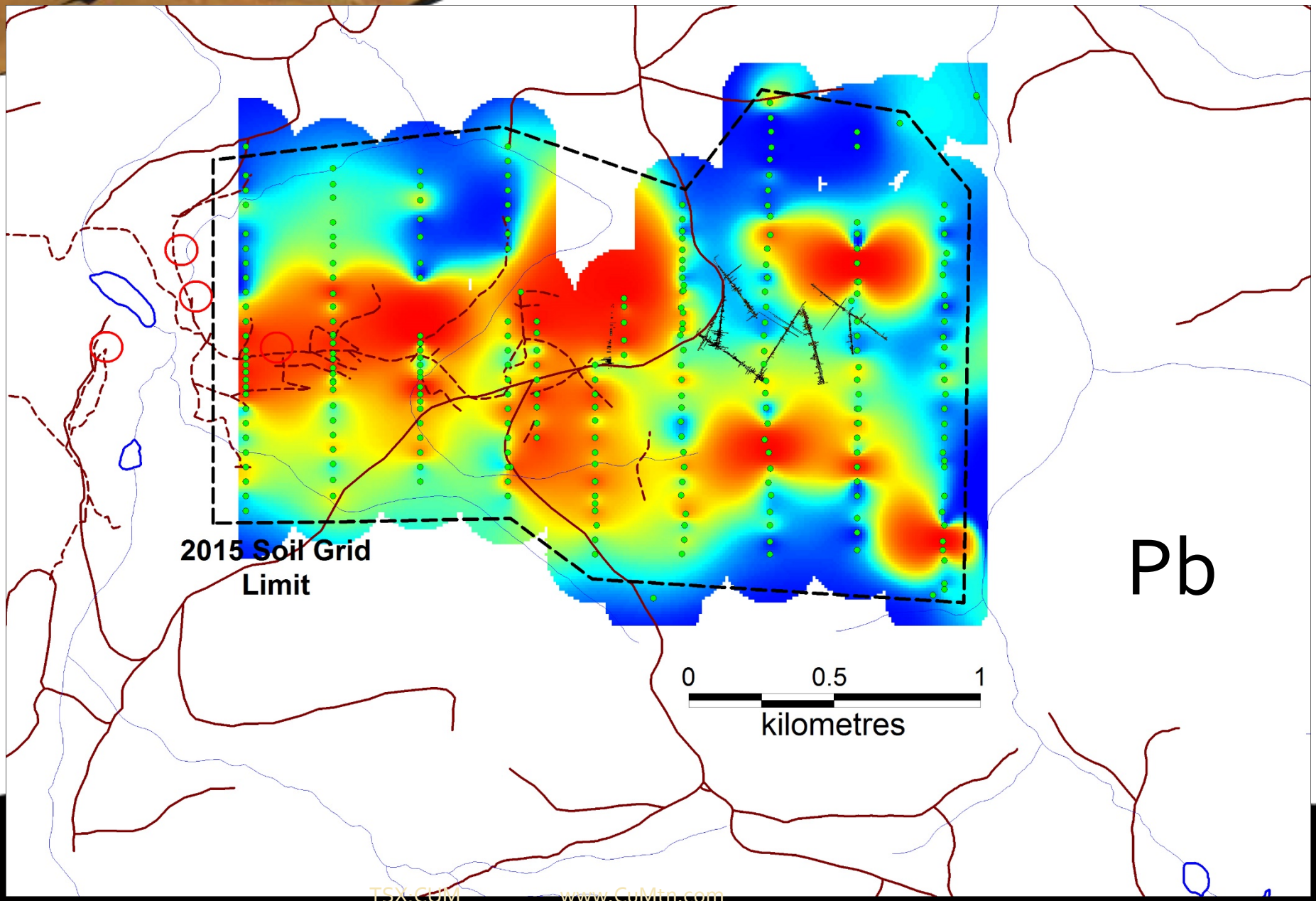

632,000 mE
632,500 mE
633,000 mE
633,500 mE
634,000 mE
634,500 mE
635,000 mE
635,500 mE
6,005,000 mN
6,004,500 mN
6,004,000 mN
6,003,500 mN
6,003,000 mN
Mineral Hill
3
2
1
© 2012 Google
Image © 2012 Province of British Columbia
Google earth
54°10'03.79" N 126°57'22.16" W elev 2913 ft
Eye alt 15030 ft

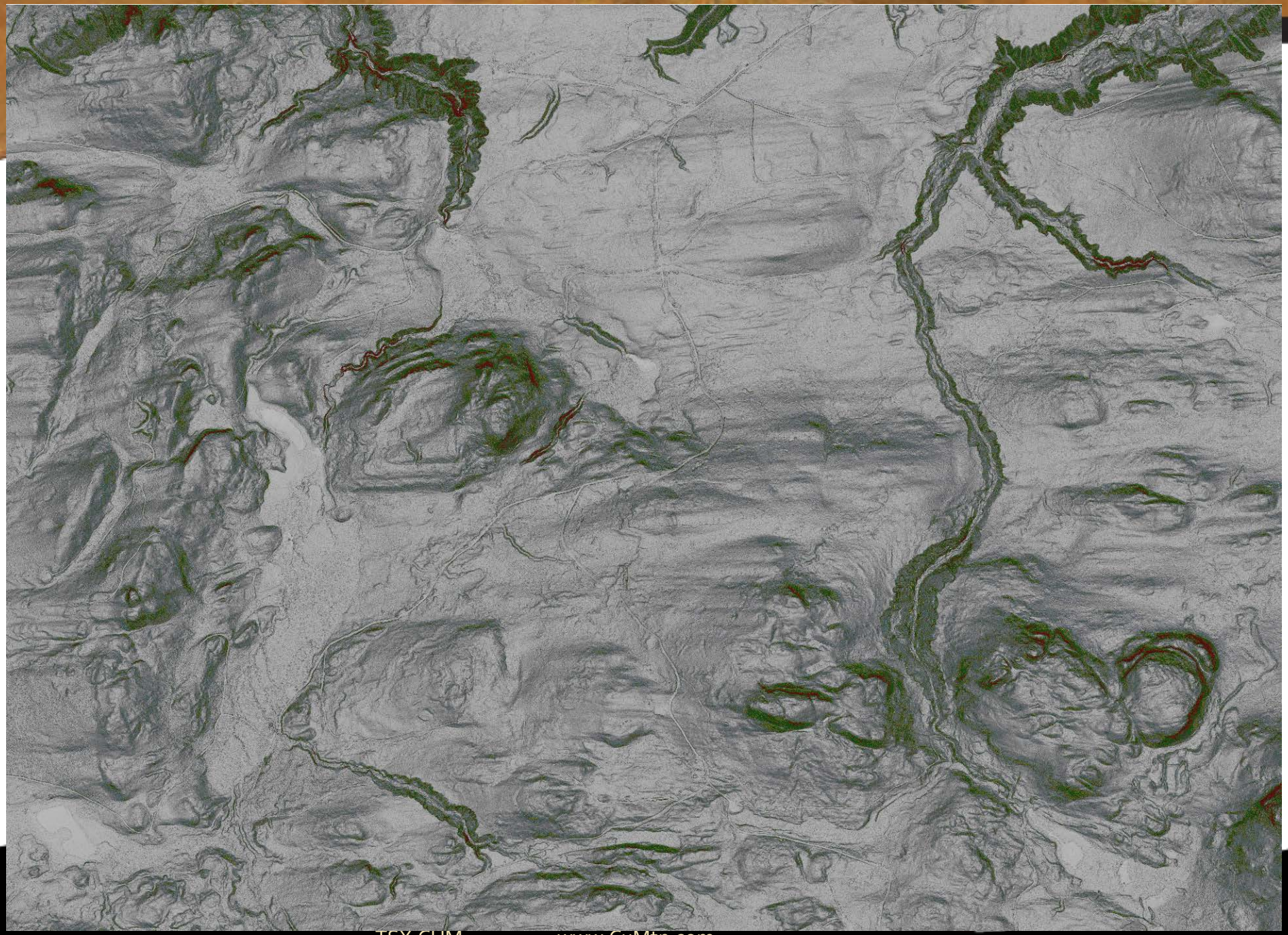
Highest values (+1% Zn + Pb and 1-10g/t Ag)
-80mesh fraction



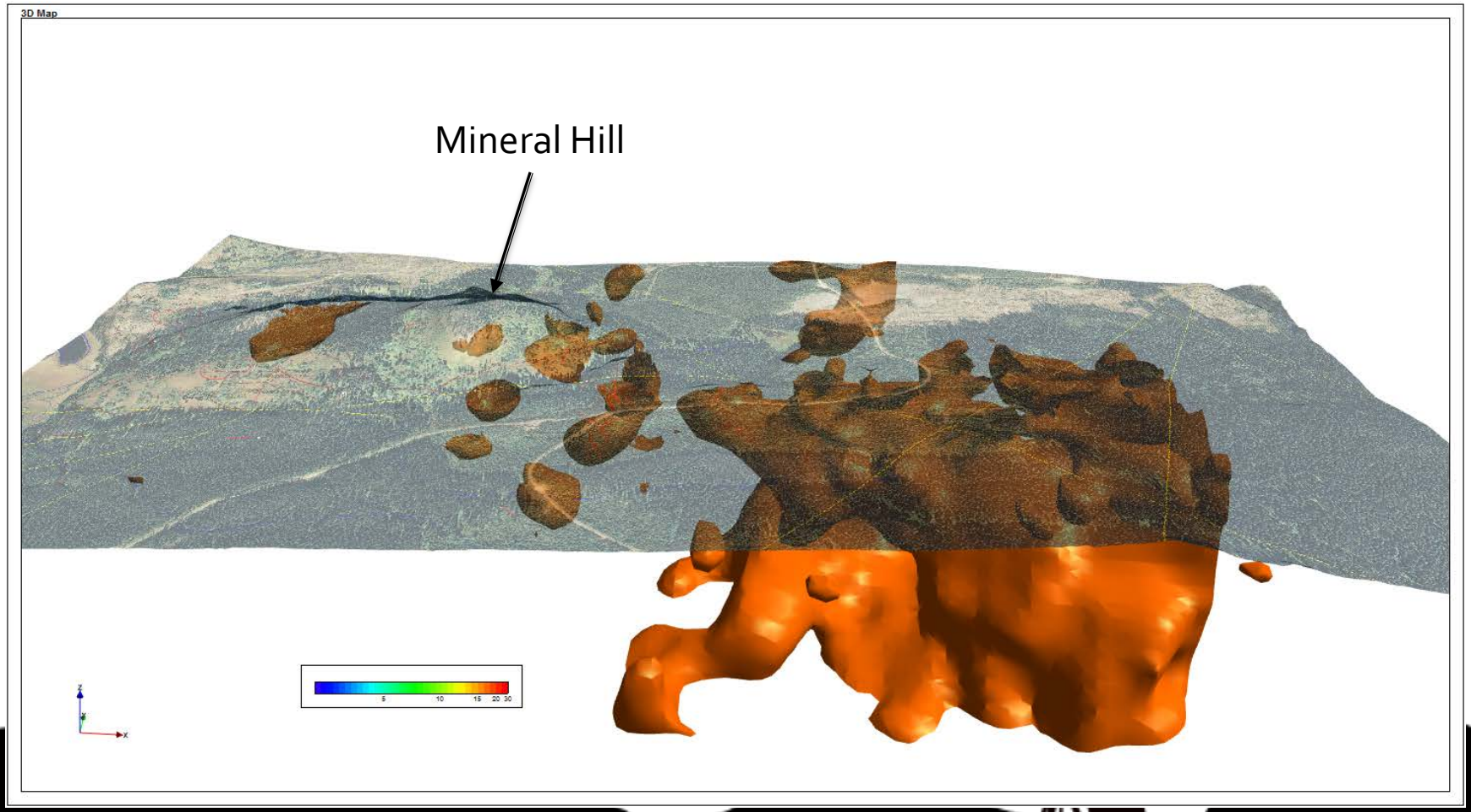
Zn


Mineral Hill
2015 Soil Grid
Limit
Zn
N
0
0.5
1
kilometres


2015 Soil Grid
Limit
Pb
0
0.5
1
kilometres

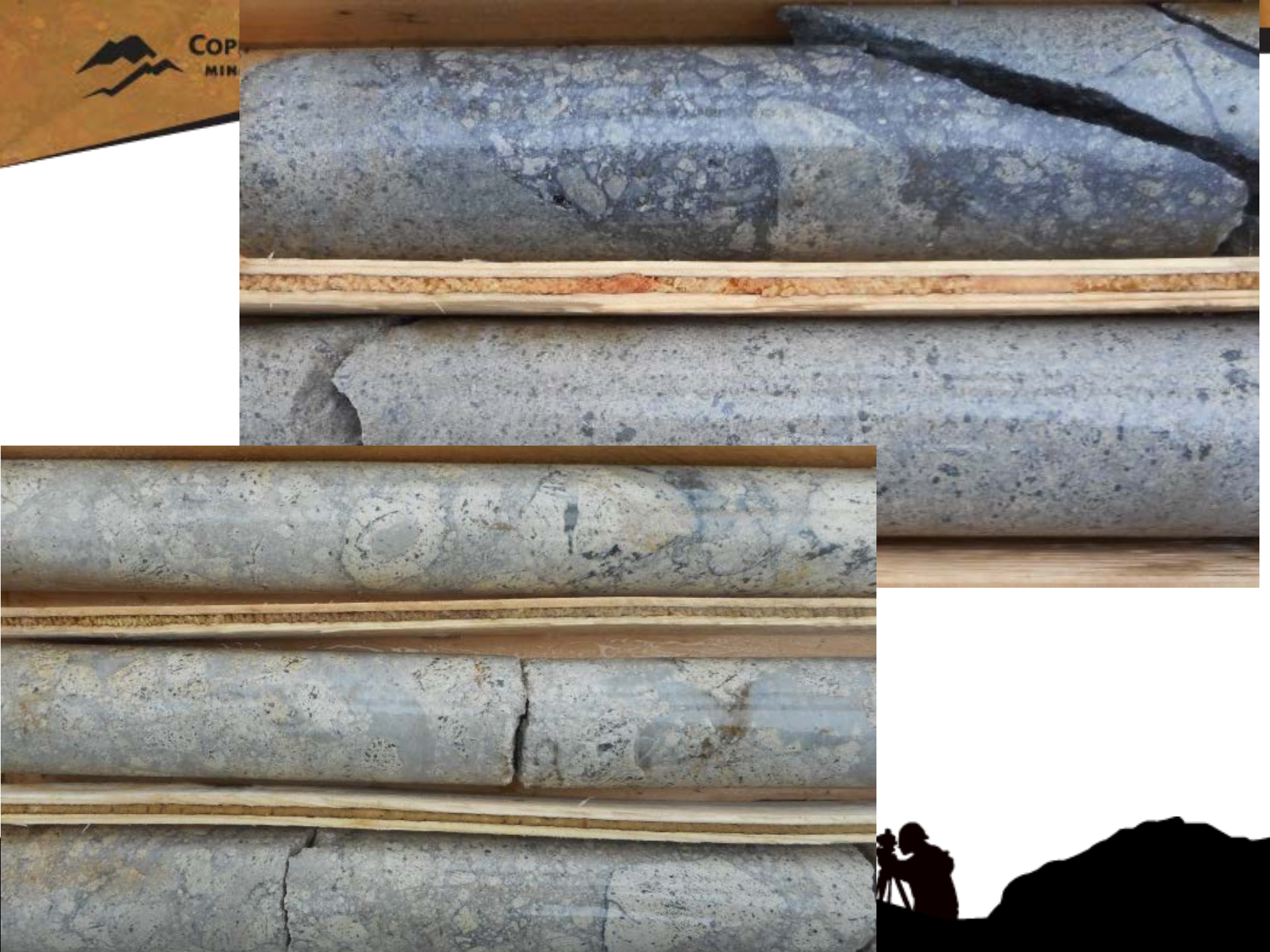


3-D chargeability (30mrads)

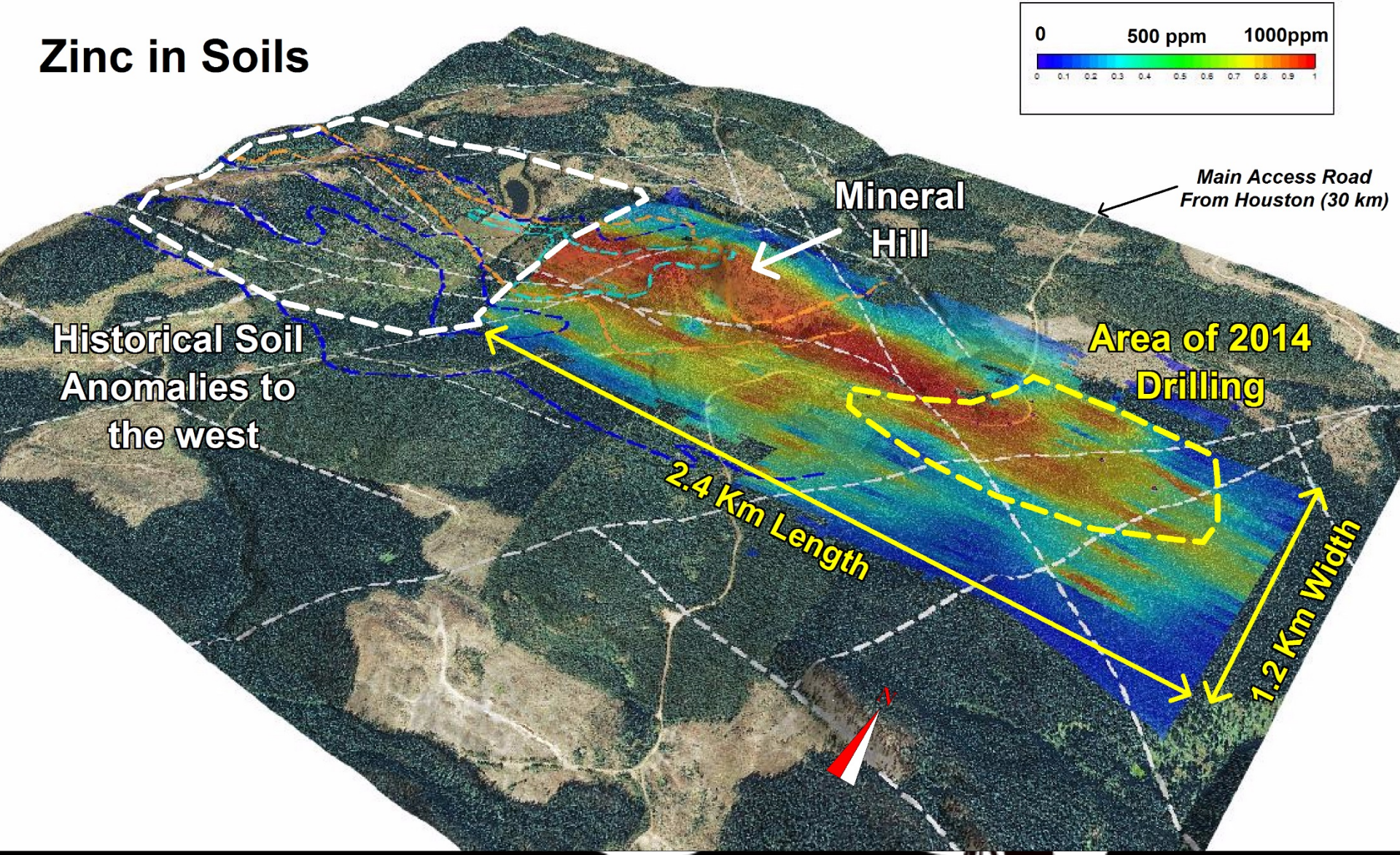


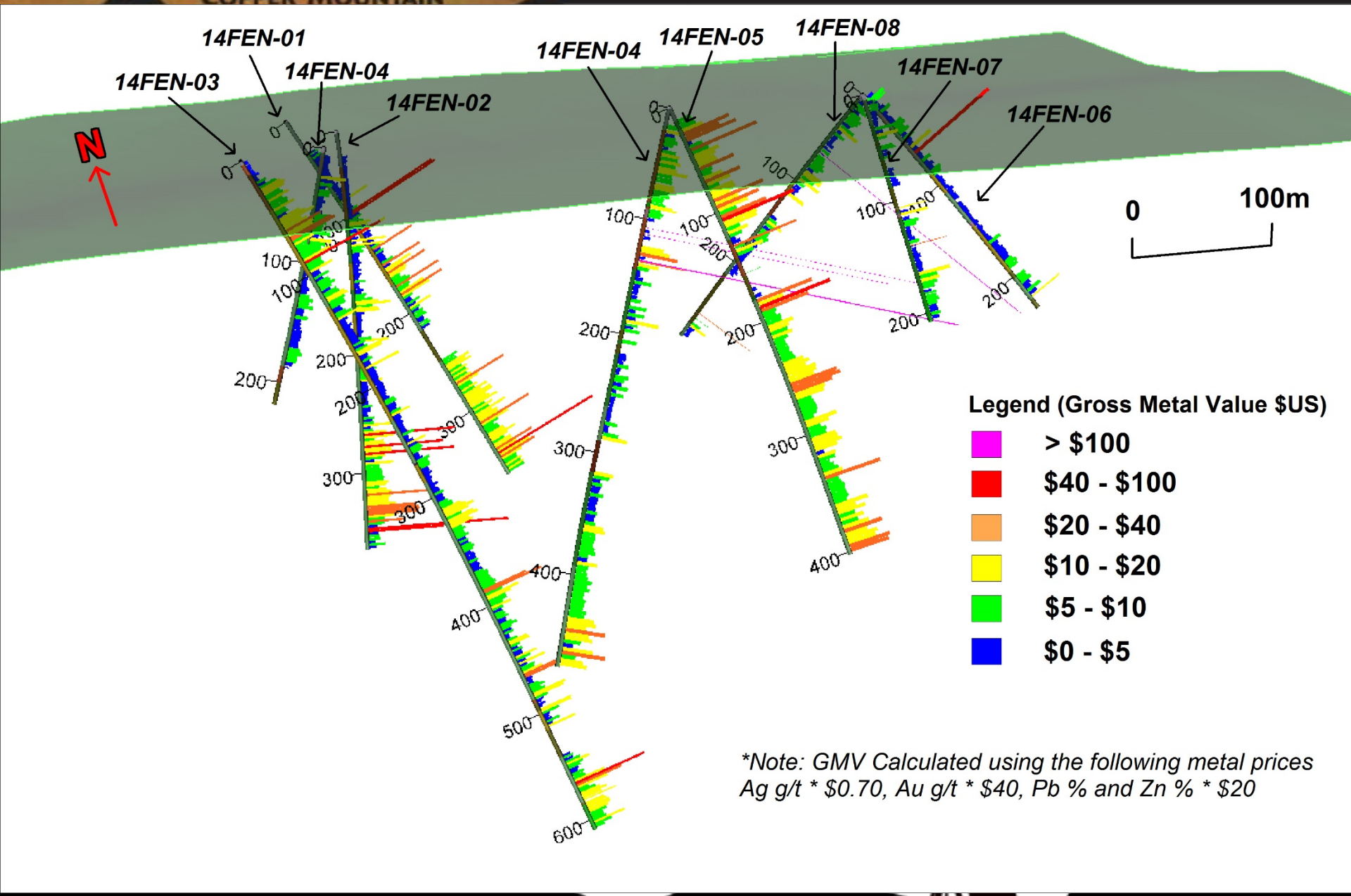
DBS (disseminated black sulphide) in rhyolite. Part fragment replacement partly disseminated in matrix. Generally fine grained Py, Sp, Ga +/- Mn.

COPPER MOUNTAIN
MINING CORPORATION

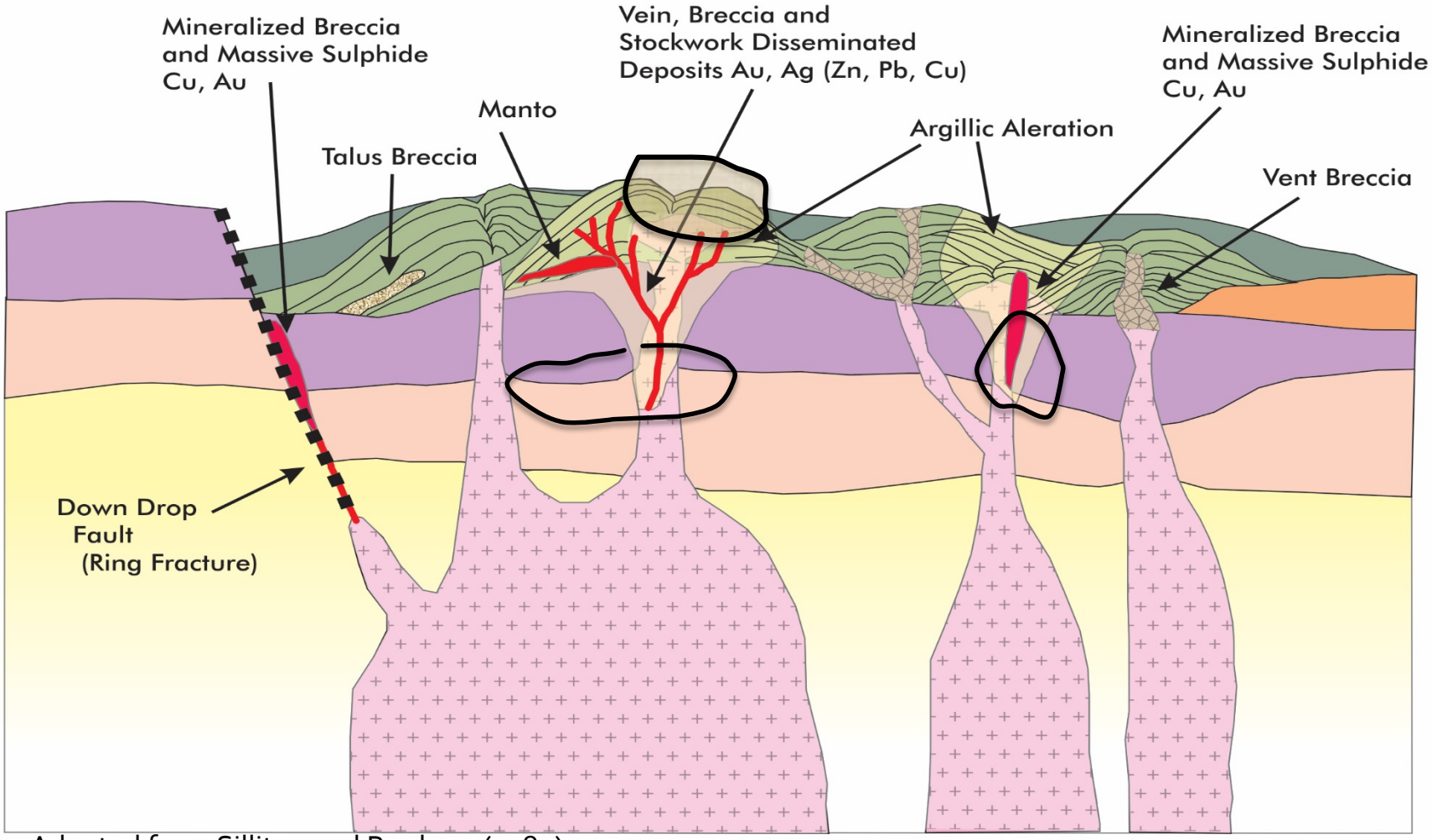

COP
MIN

Zinc in Soils



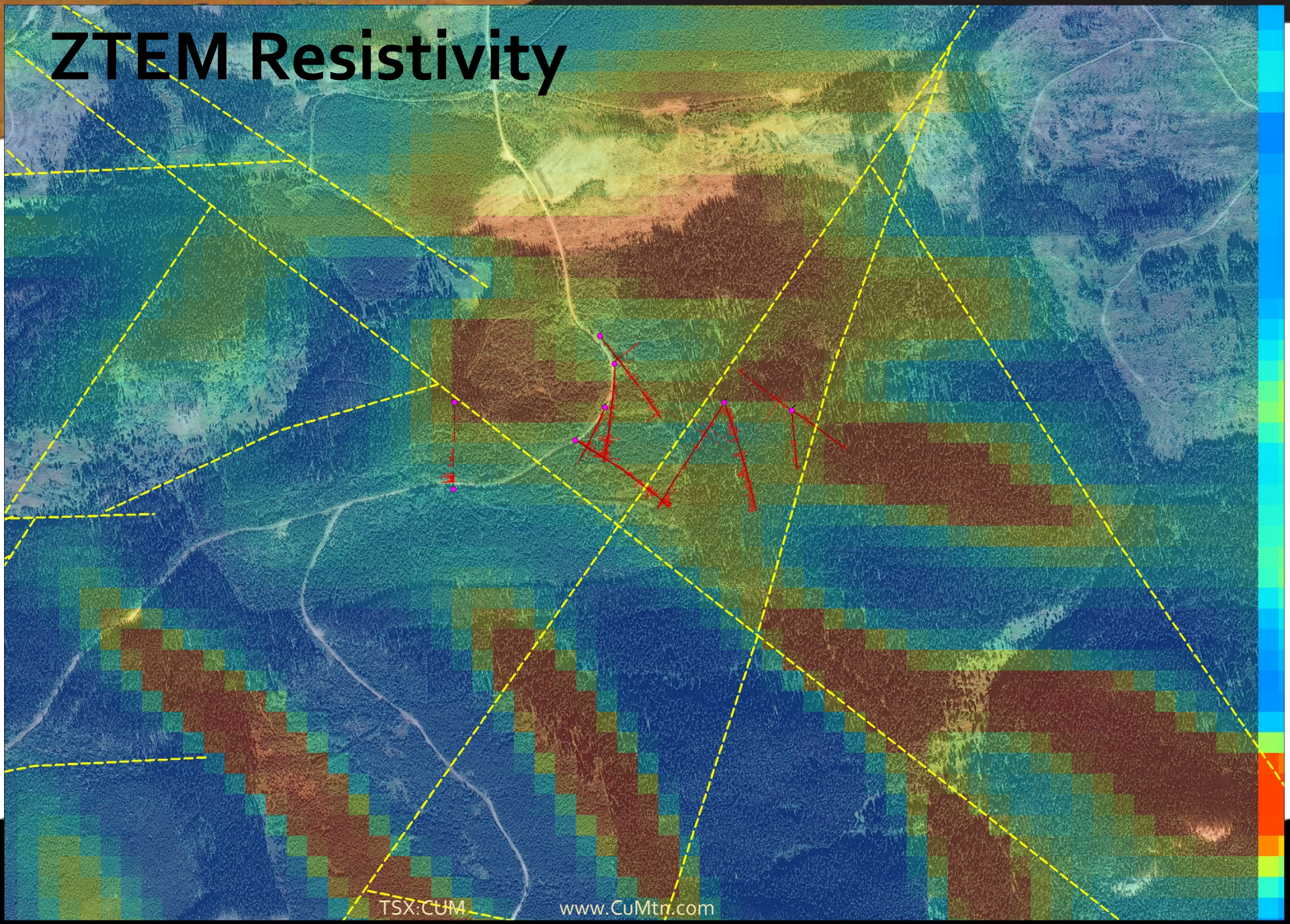

14FEN-01
14FEN-03
14FEN-04
14FEN-02
14FEN-04
14FEN-05
14FEN-08
14FEN-07
14FEN-06
N
0
100m
Legend (Gross Metal Value $US)
> $100
$40 - $100
$20 - $40
$10 - $20
$5 - $10
$0 - $5
*Note: GMV Calculated using the following metal prices
Ag g/t * $0.70, Au g/t * $40, Pb % and Zn % * $20

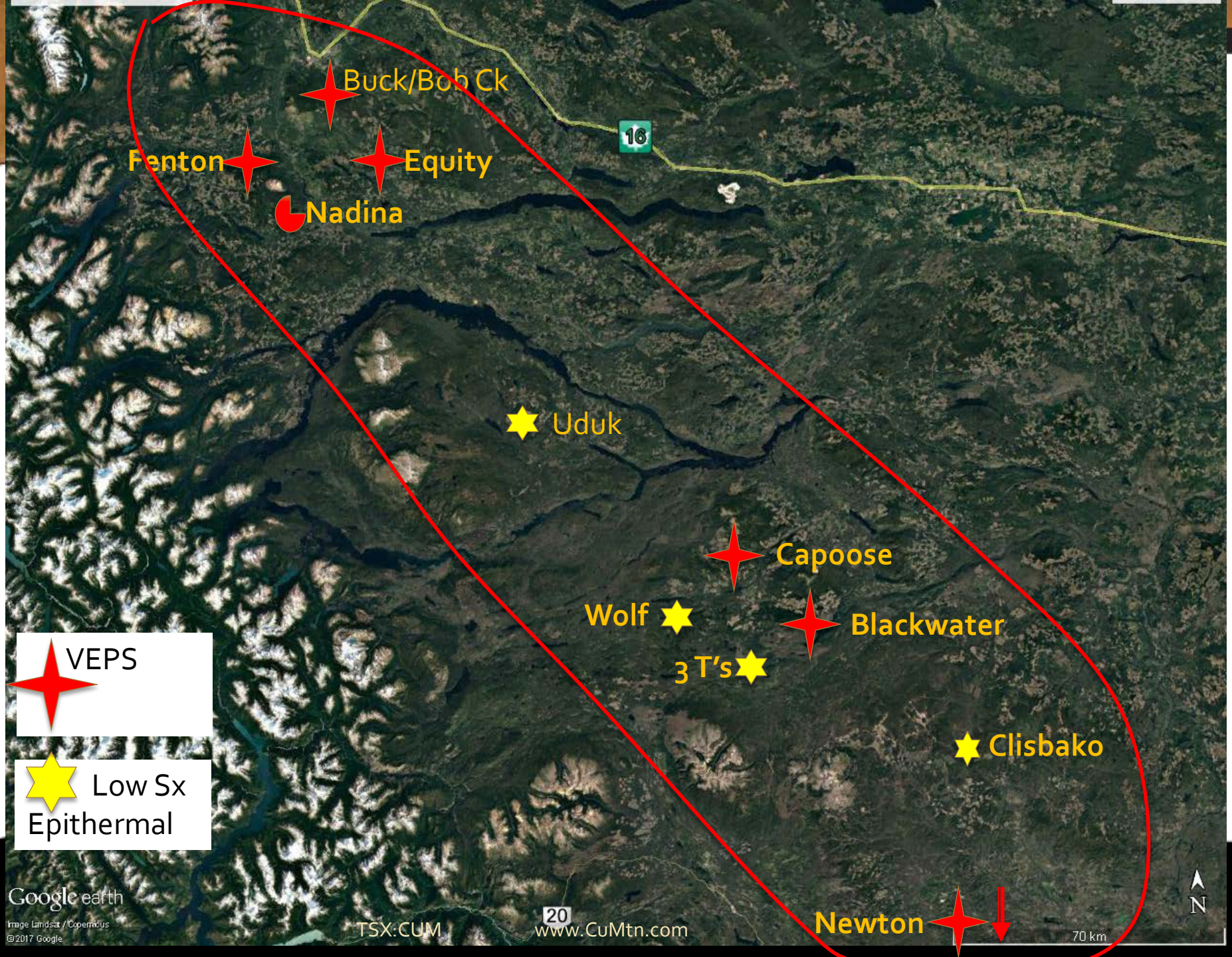
Generalized schematic model



Adapted from Sillitoe and Bonham (1984).

ZTEM Resistivity




Buck/Bob Ck
Fenton
Equity
Nadina
16
Uduk
Capoose
Wolf
Blackwater
3 T's
Clisbako
Newton
VEPS
Low Sx Epithermal
Google earth
Image Landsat / Copernicus
©2017 Google
20
70 km
N