

Highway Reward Cu-Au Massive Sulphide – A four decade journey from Exploration & Discovery to Development & Rejuvenation



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AusIMM NQ Resources Forum,

Townsville,

August 2026



AUSTRALIAN ORE DEPOSITS

EDITED BY NEIL PHILLIPS

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MONOGRAPH 32

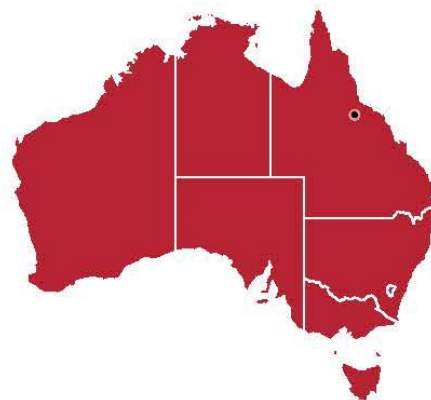


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Polymetallic massive sulfide deposits of the Mount Windsor Subprovince

S D Beams¹, T Bates², D L Huston³ and I J Morrison⁴

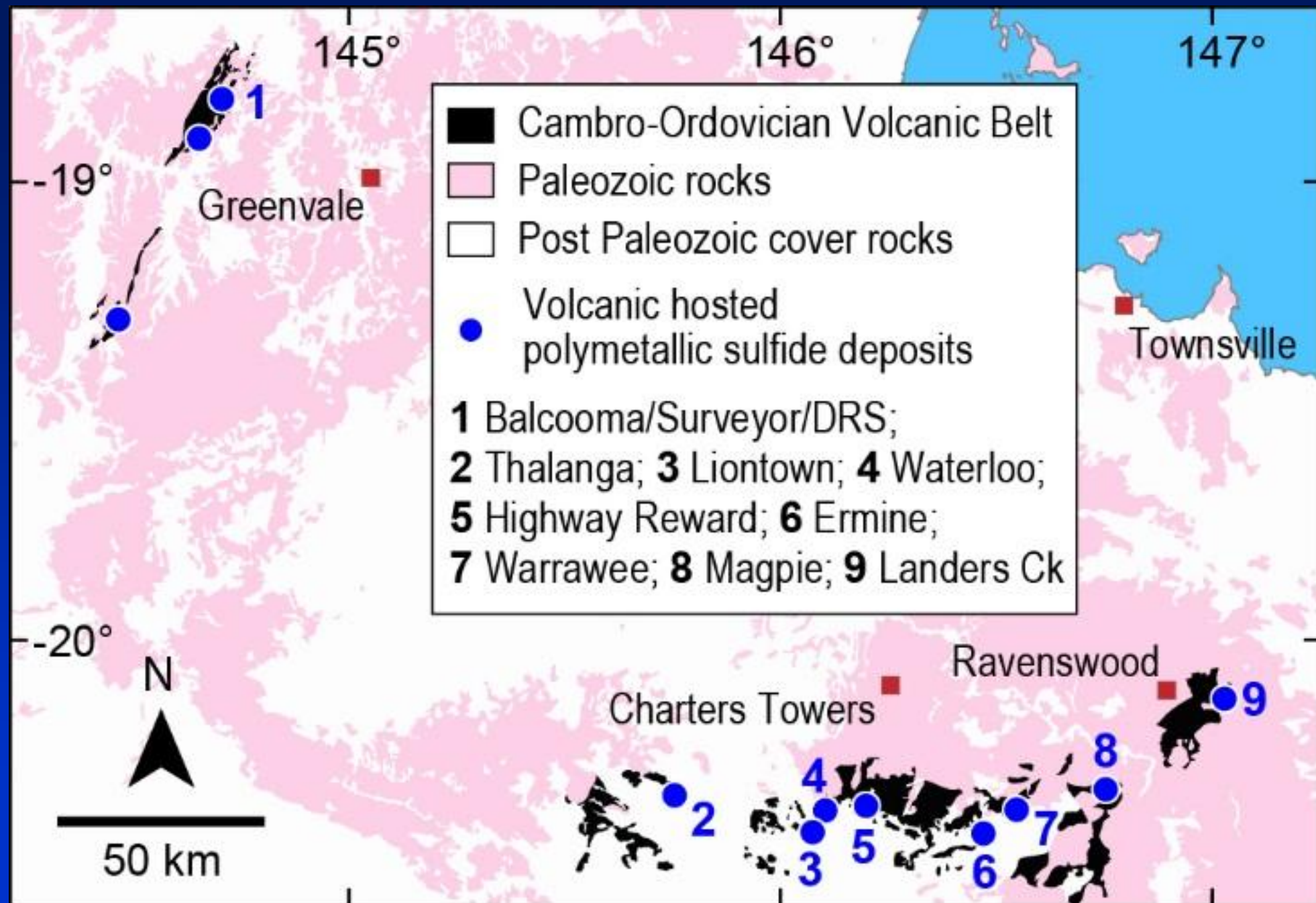
INTRODUCTION

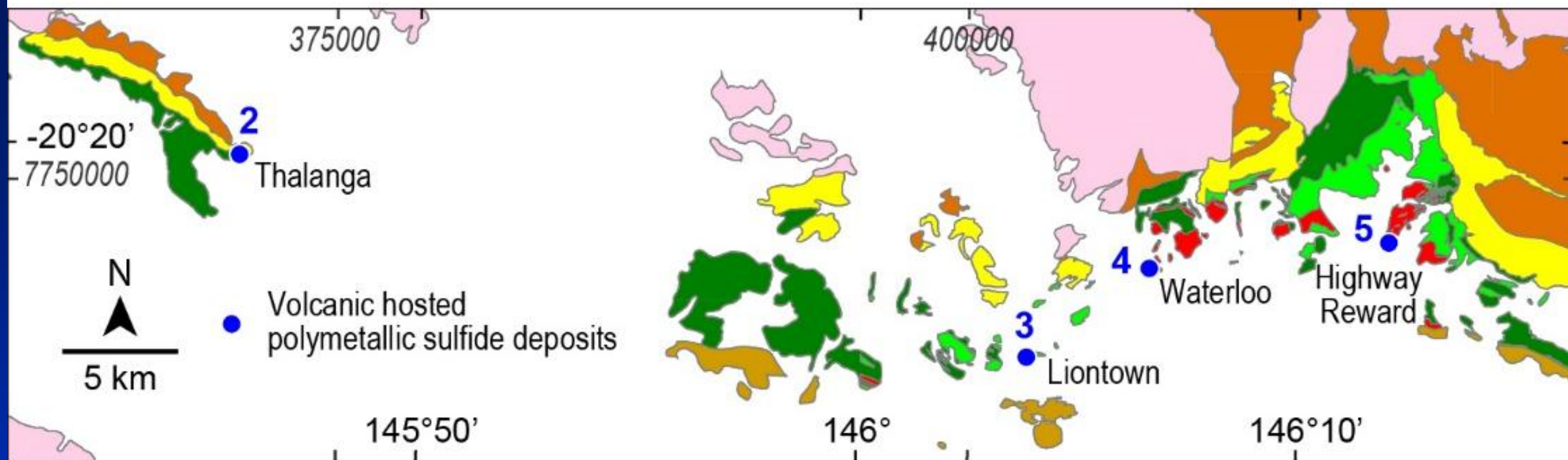
The Mt Windsor Subprovince of north Queensland consists of two geographically separate, early Paleozoic volcanic-sedimentary terranes that host several polymetallic massive sulfide deposits. The most significant deposits have had periods of mining since 1990: Thalanga (-20.34°, 145.77°), Highway-Reward (-20.37°, 146.02°) and Balcooma (-18.77°, 144.71°). The more extensive Seventy Mile Range Group, centred 35 km south of Charters Towers, trends east-west, whereas approximately 150 km to the north-west, the Balcooma Metavolcanic Group trends north-east (Figure 1). Total metal endowment across the subprovince is 0.61 Mt of copper, 1.6 Mt of zinc, 0.5 Mt of lead, 1150 t (37 Moz) of silver and 17 t (0.5 Moz) of gold.

and electromagnetic) and bedrock geochemistry were utilised to discover blind deposits contained at depth within mineralised and altered host rocks.

PREVIOUSLY PUBLISHED WORK ON THE DEPOSITS

The Mt Windsor-Balcooma deposits are hosted in a subaqueous felsic volcanic sequence with many deposits occurring at or near the interpreted host rock-sediment-water interface. Similarities are recognised with both modern analogues as well as the contemporaneous volcanic terrane of the Mt Read Volcanic Belt of western Tasmania. Historical references and key reviews are: Gregory, Hartley and Wills, (1990); Huston and Taylor (1990); Rea and Close, (1998); Berry





□ Post Paleozoic cover rocks
□ Paleozoic rocks

Rollston Range Formation

■ Sandstone/siltstone
■ Dacite

Trooper Ck Formation

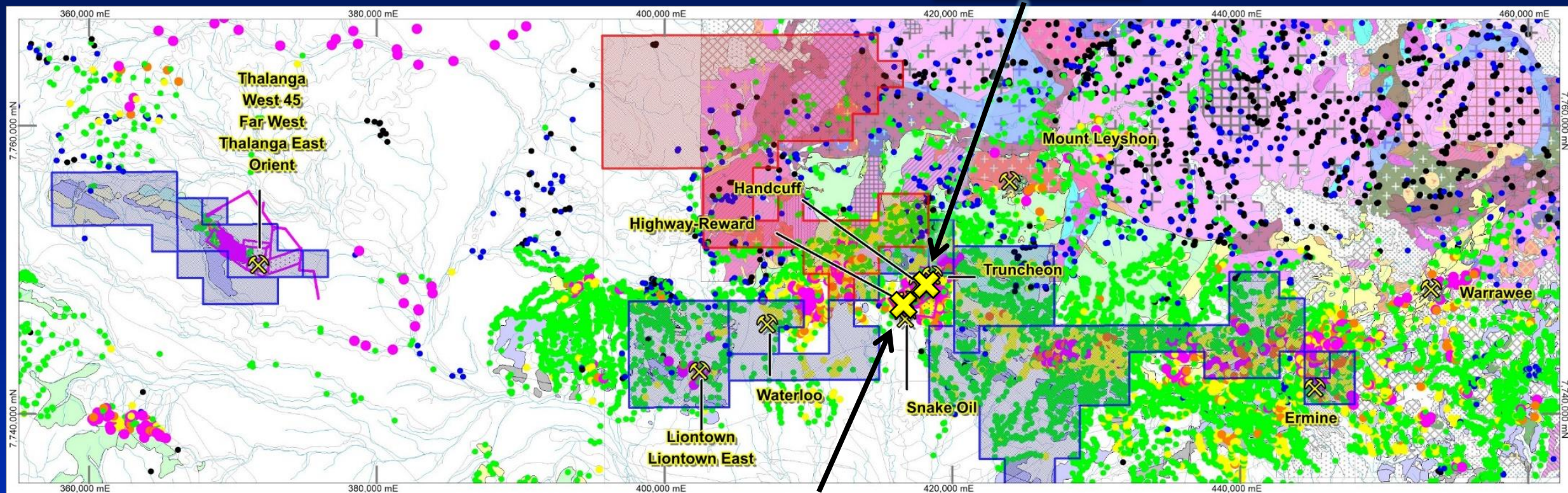
■ Volcaniclastic & sed facies
■ Andesite
■ Dacite
■ Rhyolite

Mt Windsor Formation

■ Dacite
■ Rhyolite

Puddler Ck Formation

■ Rhyolite



EXPLORATION

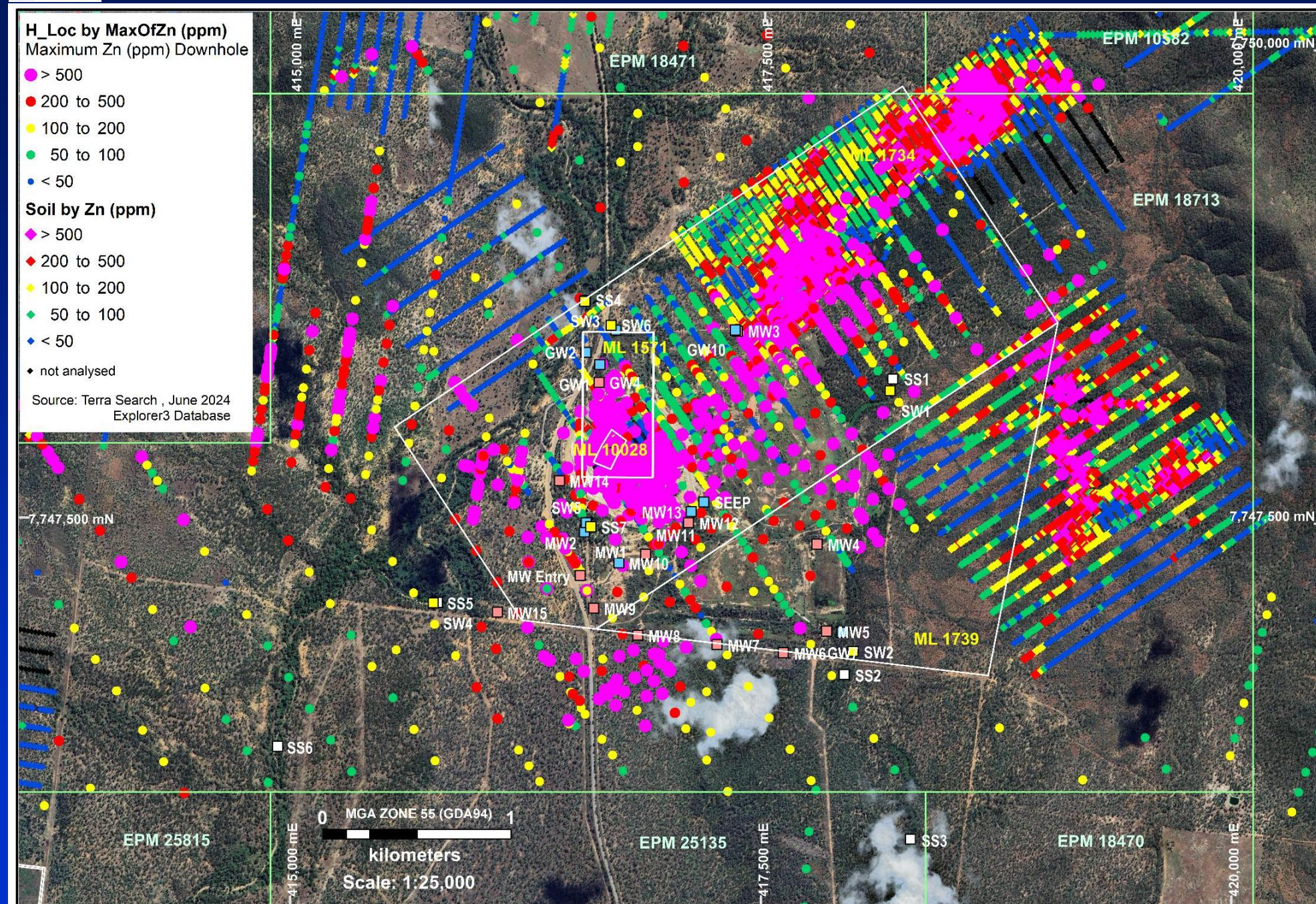
Open File
Stream Sediment
by Pb (ppm)



HIGHWAY-REWARD

Stream Sediments by Pb (ppm)

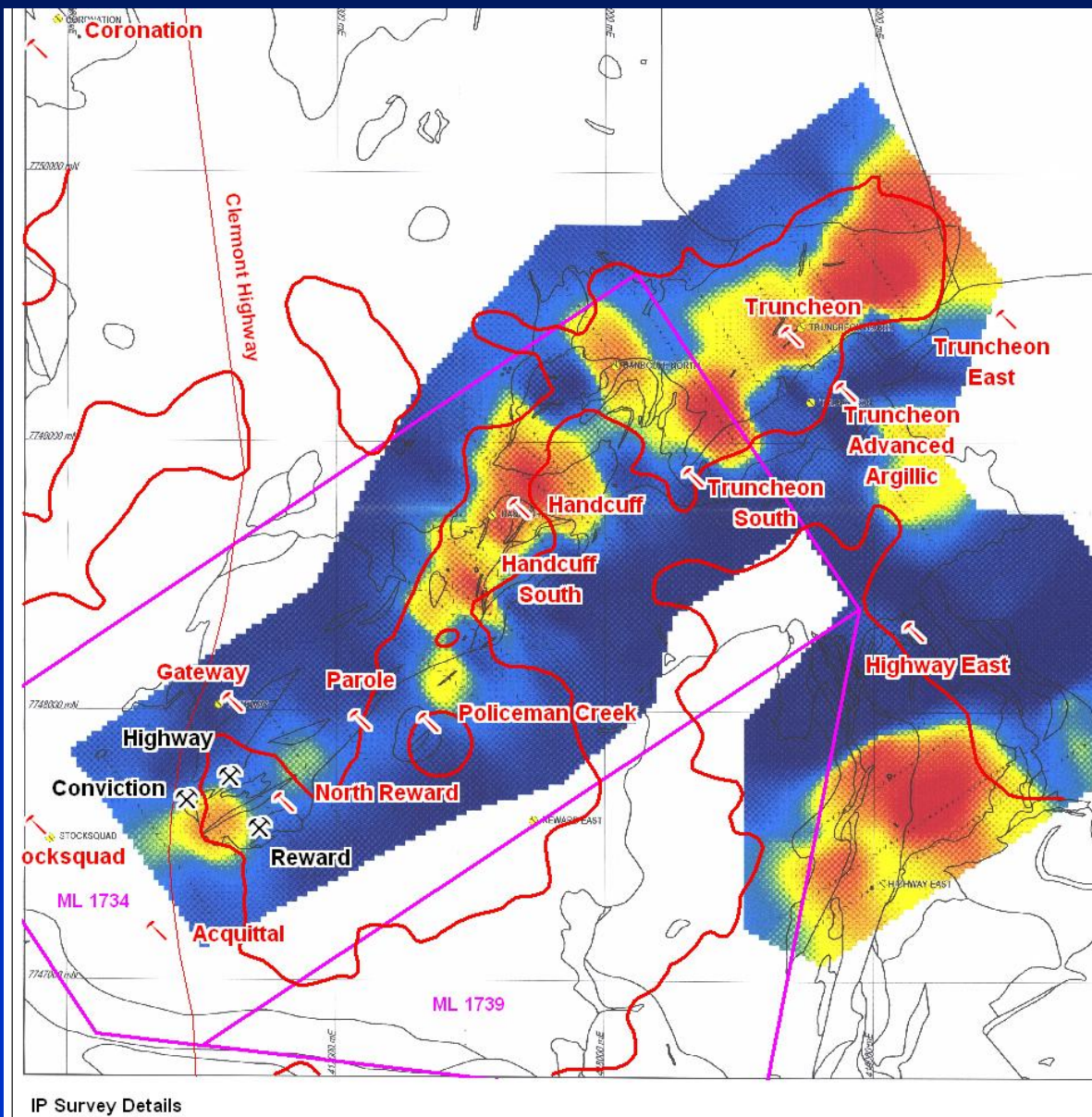
- > 100
- 75 to 100
- 50 to 75
- 10 to 50
- 5 to 10
- < 5



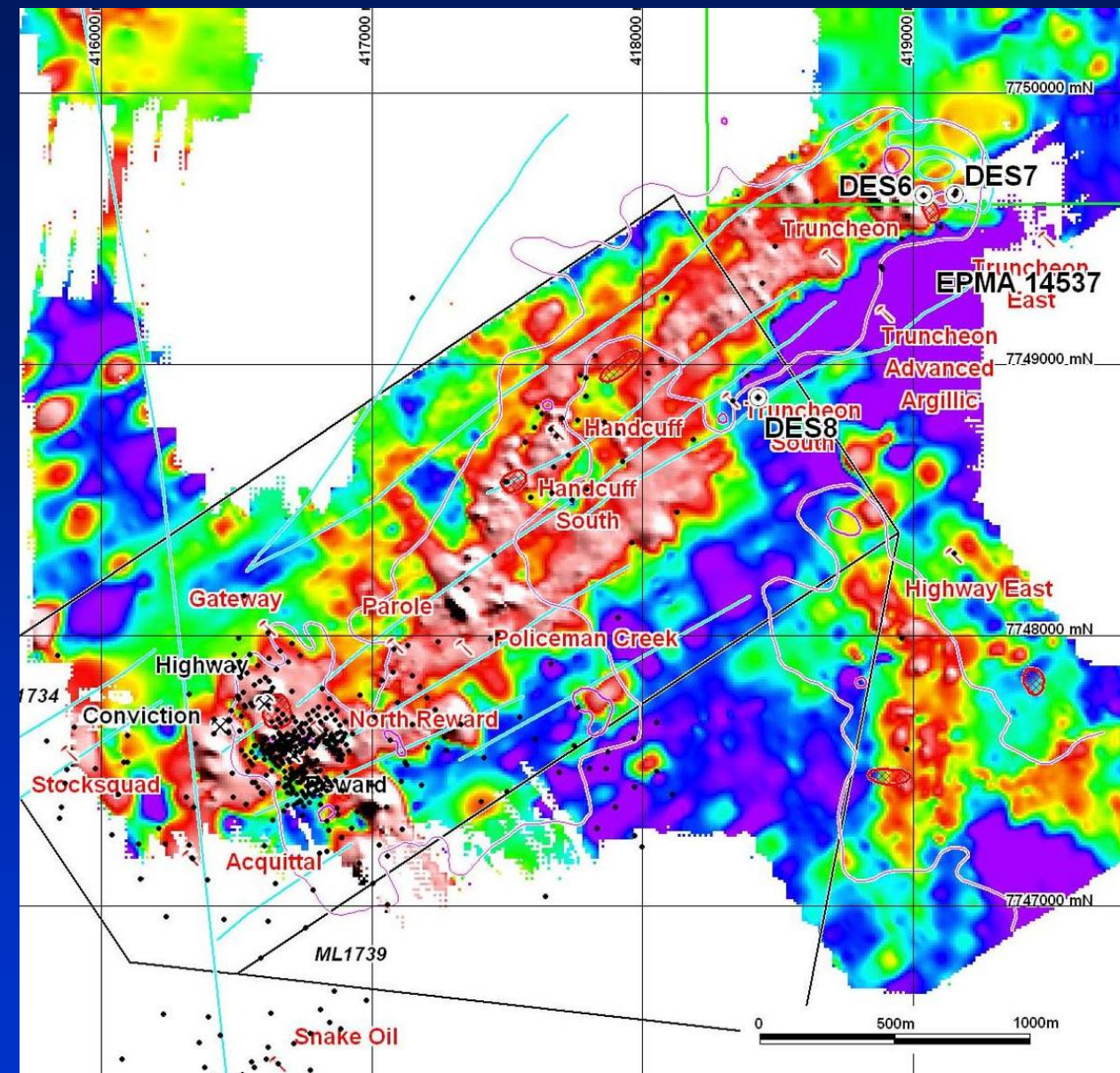
Highway-Reward

Soils/RAB

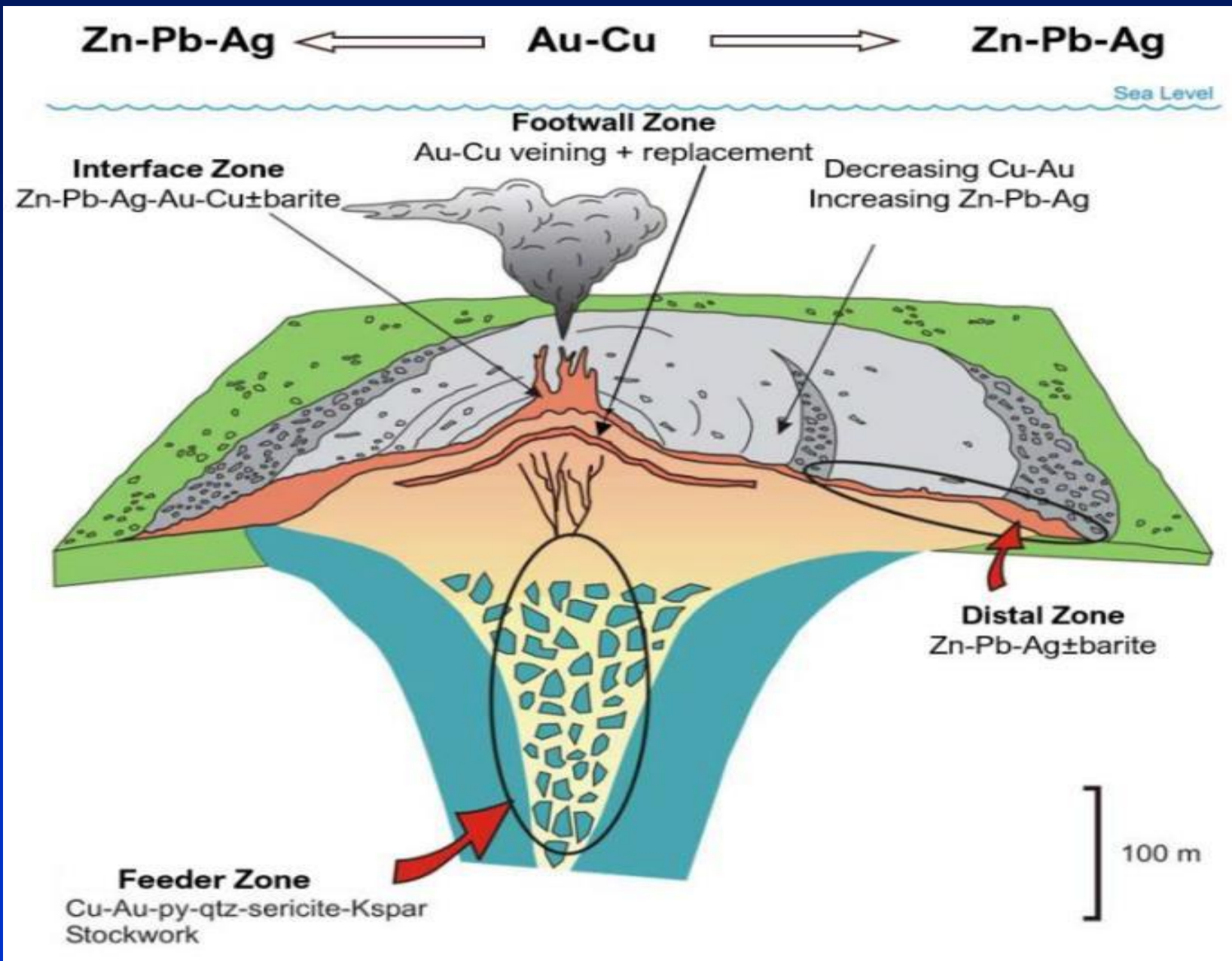
Zn >500 ppm



IP Effect



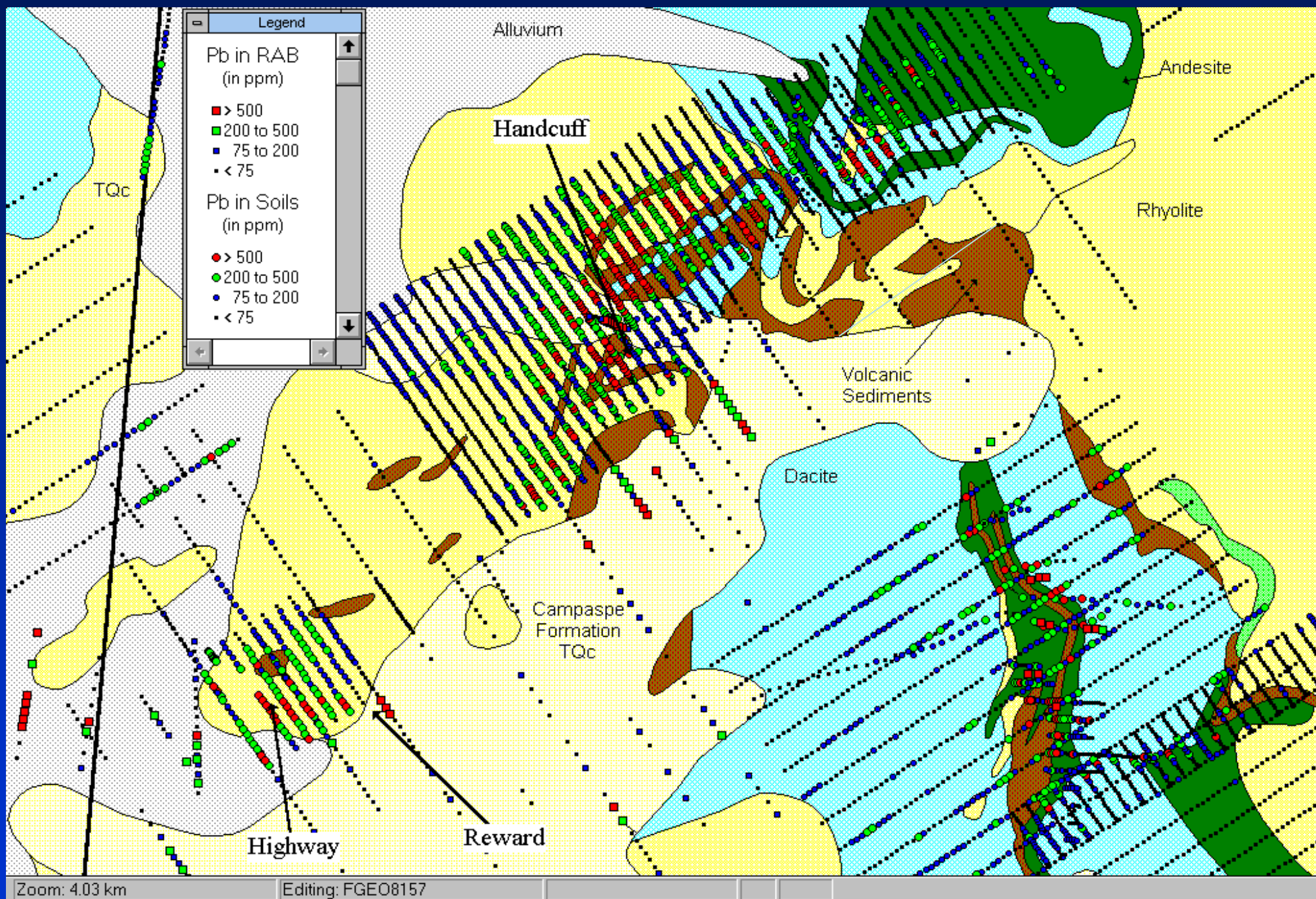
Highway-Reward Copper in Soils/RAB



Volcanic Hosted Massive sulphide model

Ref: Sunshine Metals **ASX**

- Sea floor black smokers – sulphide dominant,
- white smokers: sulphates, chemical seds.
- Often at hiatus in between volcanic flows.
- Feeder Zone Cu-Au-Py
- Deformation likely to effect geometry of massive sulphide bodies.
- Geochem Zoning pattern has similarities to intrusive related systems



Esso on the
road to
Discovery
1974-1987
Highway Grid
area
Truncheon to
Handcuff and
on to Highway
Reward
City Resources-
NQR 1987

After Handcuff ,key elements of a plausible model for development of economic deposit

This potential lies primarily to the south of the recent drilling between Handcuff and the Highway Mine (Plate 18) where outcrop is obscured by Tertiary Campaspe sediment cover and laterite development.

The key elements of a plausible model for the development of an economic deposit in this area are:

1) a thick (approximately 50m) pyritic sequence of altered volcanics and fine-grained siliceous (chert) units carrying elevated Au values (already evident at Handcuff);

2) a deep weathering profile developed over this pyritic sequence, which upgrades the primary Au values to economic grade by surficial and supergene enrichment in the oxidised zone.

If some leaching is present, lending to supergene enrichment, the surface values may be low and subsurface exploration techniques would be required. The depth of weathering necessary for this upgrading process to operate is present at the Highway Mine, where at least 50m of oxidised material is present. Evidence from 1980-1984 core and RAB drilling indicates similar thick weathered zones are present between the Highway Mine and Handcuff and west of the Highway in the Stocksquad area.

AUTHORITY TO PROSPECT 3380M

MT. WINDSOR PROJECT 348

SIX-MONTHLY REPORT FOR PERIOD ENDING

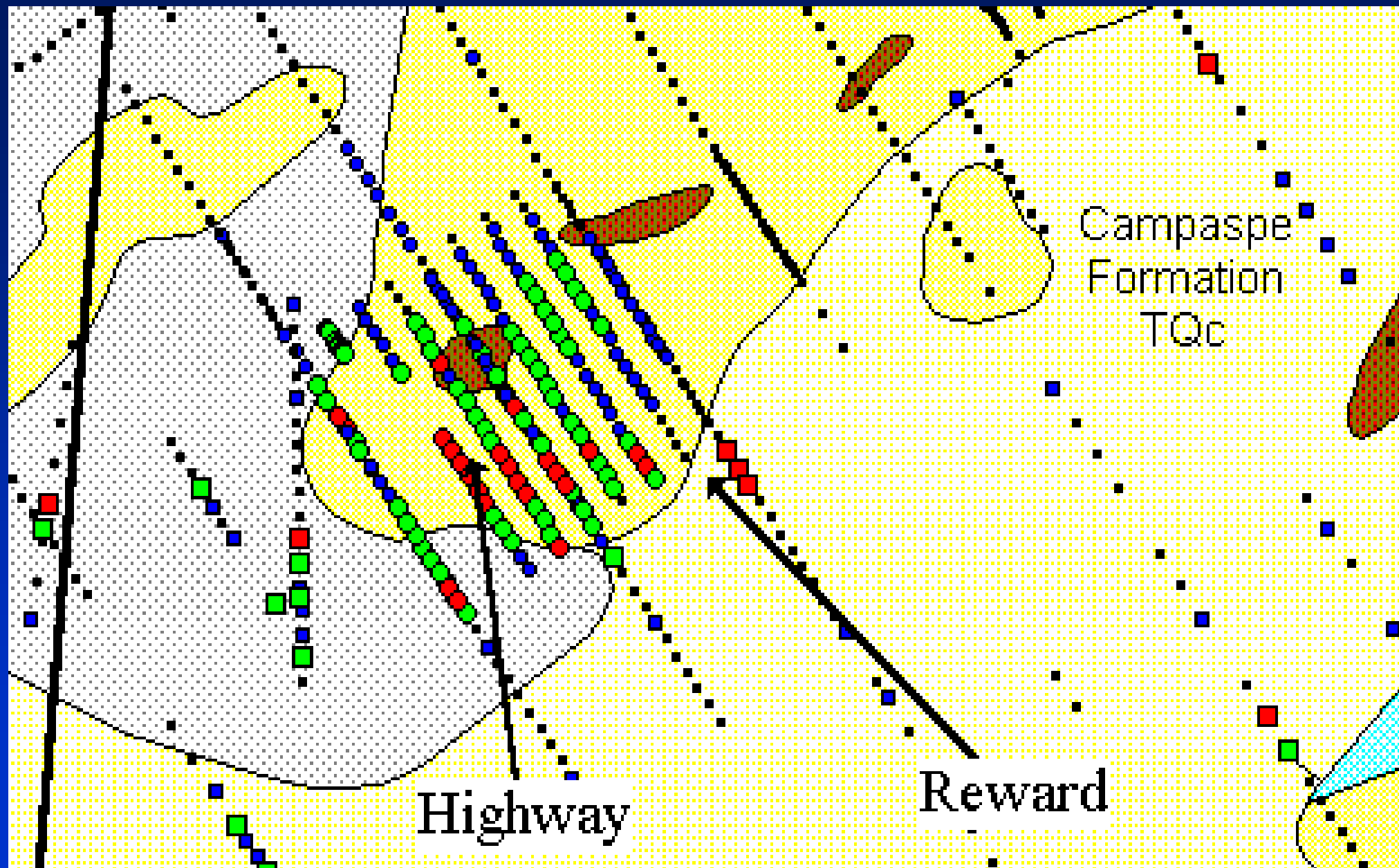
DECEMBER 17, 1986

S.D. Beams
Minerals Dept.
Esso Australia Ltd.
Townsville

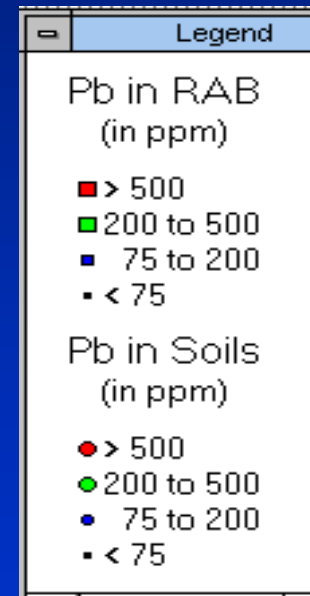
CR 16484

- Thick pyritic sequence altered volcanics and cherty units
 - Deep weathering profile aiding supergene enrichment
 - Some leaching at surface, deposits could be blind : subsurface exploration is required
- Deeper weathering evident to SW at Highway mine ,along with anomalous Au, Cu, base metals detected in bedrock drilling.

Integration Multiple data sets Pb in soil & RAB with Geology



Soil Geochem on
outcrop , RAB
results from
30m to 80m
depth



0

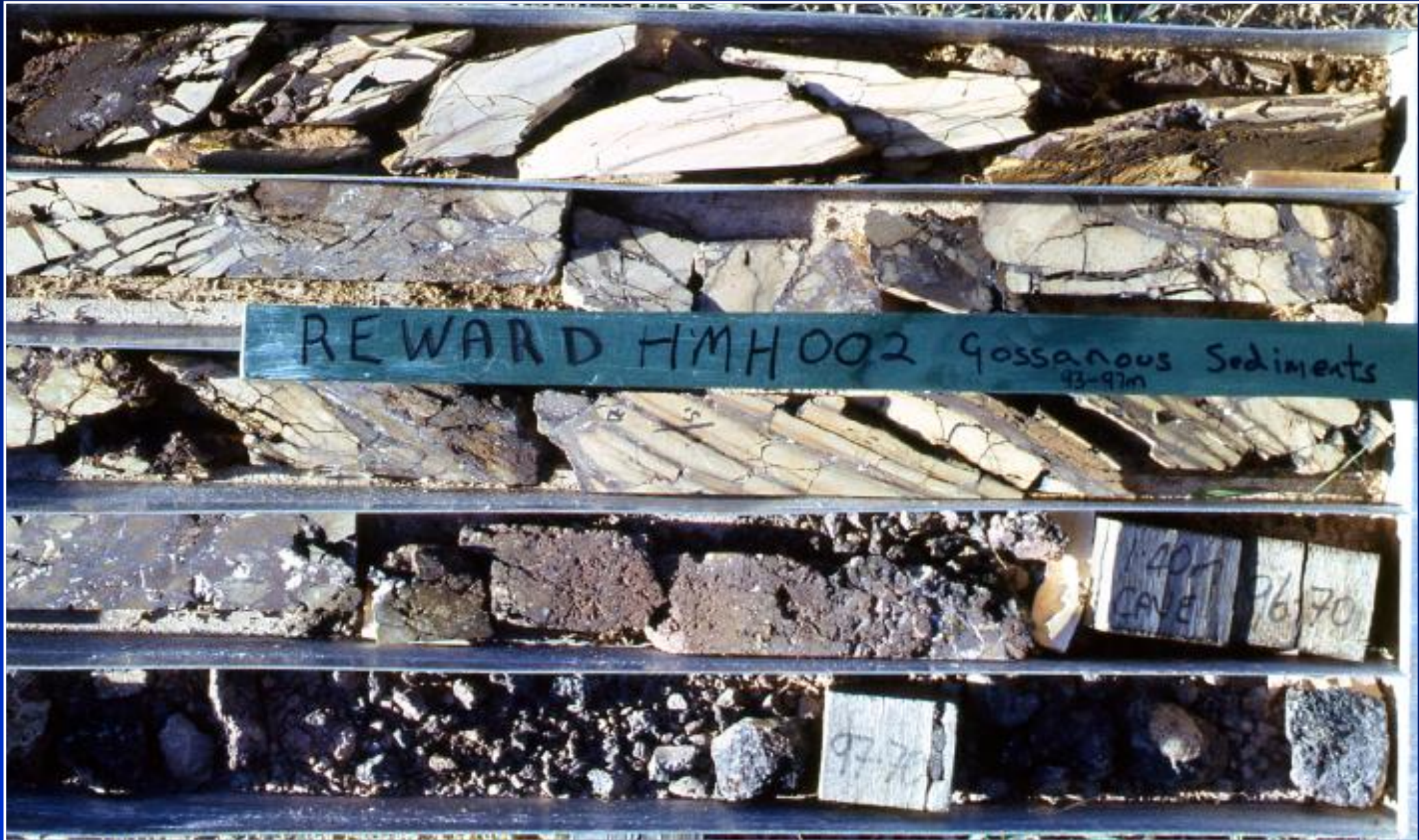
200m



Deeply weathered Highway Gossan: surface outcrop, baritic, gold bearing heavy leached clay.

Known since the 1950s – too small for Esso/BHP /EZ to worry about.

Reward Gossanous & Ferruginous Siltstone 95m , minor Cu-Au



DISCOVERY

Terra Search Drilling Discovery Hole HM034 : 1987 100m massive sulphide @ 1g/t Au, 30m @ 3.5% Cu: Leanda Drilling



1987 Hole HM034
City Resources – North Qld Resources,
North .
Terra Search Drill Supervision

Section of Massive Pyrite + Cpy



1987

Hole HM038

100m south of HM034

Massive pyrite :

167m @ 0.79% Cu,

0.65 g/t Au

206m-375m

City Resources –

North Qld Resources

North

2025 Hole HRDD001 Loyal Metals - Terra Search Drill Supervision

Even though mined 30 years ago – a lot is still down there Eagle Drilling.





**Hole HR001
145m**

massive pyrite

**@ 0.58% Cu,
0.73g/t Au.**

**7g/t Ag,
1.5% CuEq.
176m-321m.**

**Includes 17m at
3.15% CuEq(1) -
2.03% Cu,
0.93g/t Au,
and 6.9g/t Ag
: 199m-216m.**

**6m at 4.28% CuEq
(1) - 3.32% Cu,
0.75g/t Au,
and 8.3g/t Ag
: 314m – 320m**



DEVELOPMENT

Highway

Gold Oxide Pit

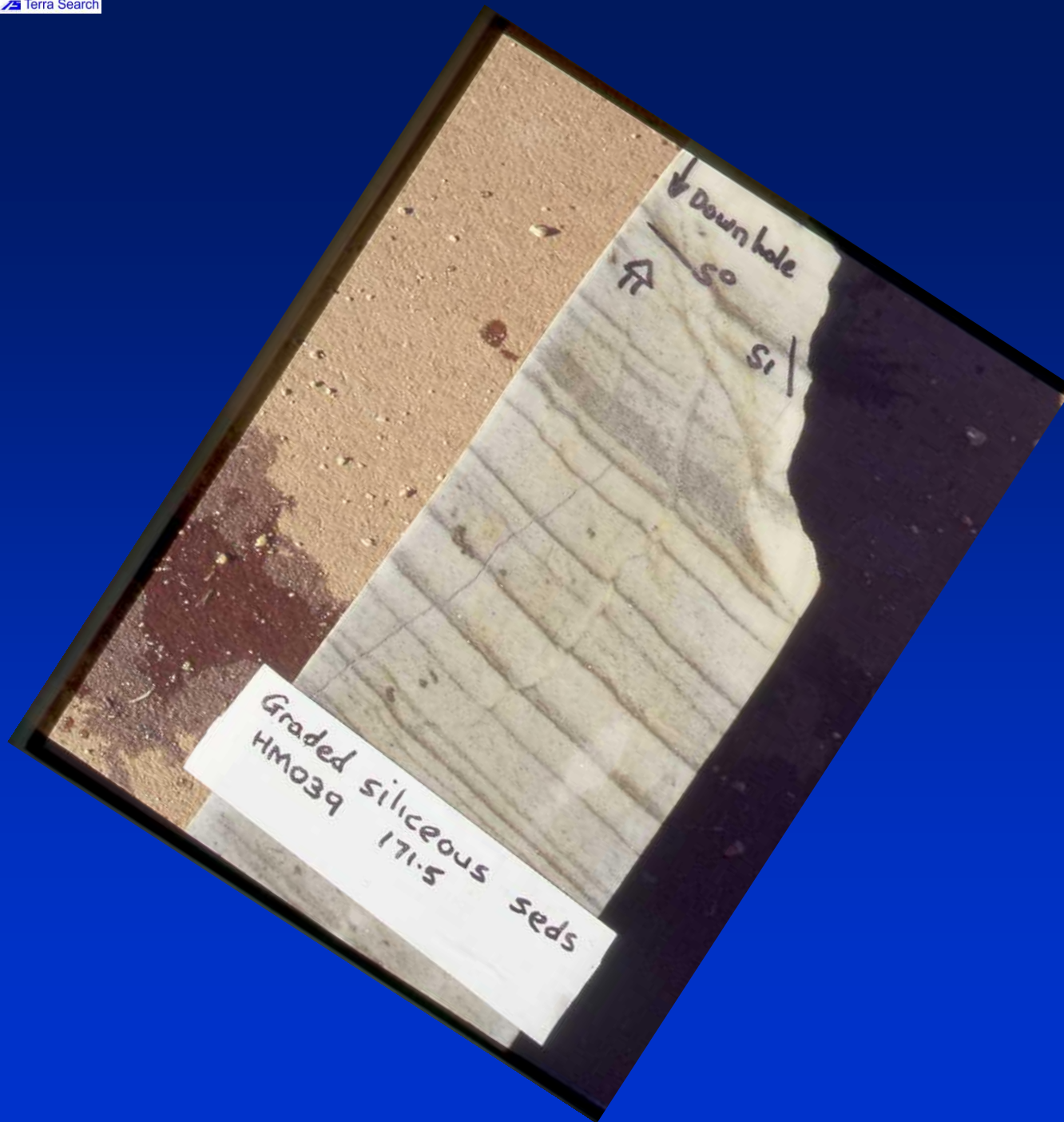
1988

Looking north,
Mining Oxide ,
gossanous breccia,
blind to surface,
leached clay altered
siliceous volcanics.



**Reward Pit
1996**

**Looking south,
Mining Oxide &
supergene
overlain by
Campaspe
cover
sediments.**

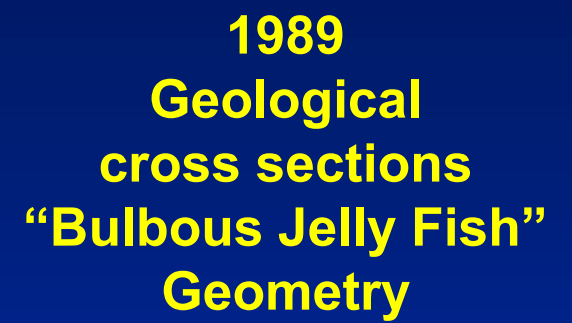


Reward

Structural Interpretation insights from bedding, cleavage , lineation measurements of drill core (Beams & Laing,1989)

Limited oriented core .

Game changer , established that stratigraphy was mostly relatively gently south to south west dipping . But cleavage was steep and striking NE – SW parallel to structural grain/foliation in the Highway Synform. Reward massive sulphide was cleavage parallel - probably recrystallized , deformed into pipe or lens like geometry.



Mineralisation Styles

Oxide 14m @ 5.99 g/t Au

Supergene 28m @ 5.17% Cu, 0.5 g/t Au

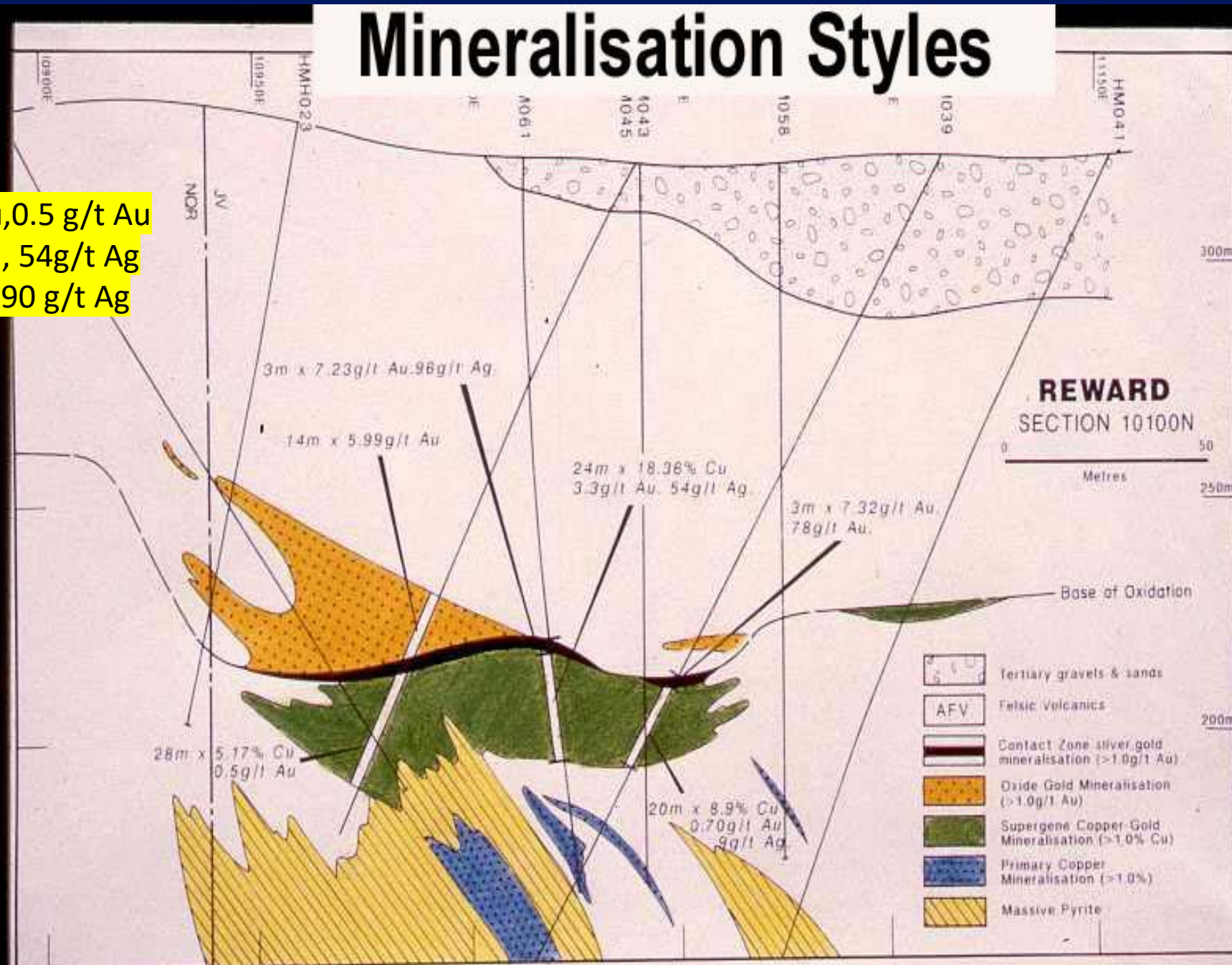
24m @ 8.38% Cu, 3.3 g/t Au, 54g/t Ag

20m @ 8.9% Cu, 0.7 g/t Au, 90 g/t Ag

OXIDE

SUPERGENE

PRIMARY



Reward Oxide Gold HMM006 72m -131m

Baritic Bx, part of 61m @ 5g/t Au





**Base of oxidation
(108m deep) oxide
zone (low Cu)
overlies supergene
copper chalcocite-
covellite .**

**Vertical Hole
HM043
108m-119m
11m @ 7.6% Cu**



Massive Chalcocite

HM061
117m-118m
45.8 % Cu,
5.9 g/t Au

Reward Supergene Copper



Mining Reward 1998

Supergene High Grade
Copper 8%

Reward Supergene – Reconciliation

1998 – Pre JORC.

High Quality Historical Data should not be dismissed

- **Final Ore Reserve**
 - 514,100t @ 10.00% Cu And 1.70 g/t Au (Marginal COG 1.6% Cueq Used Below 1200RL)
- **Grade Control**
 - 543,300t @ 9.48% Cu And 1.57 g/t Au
- **Final Production**
 - 543,500 @ 9.57% Cu And 1.40 g/t Au

HIGHWAY REWARD PIPE

Reward Oxide Gold
140,000 t @ 3.7 g/t Au

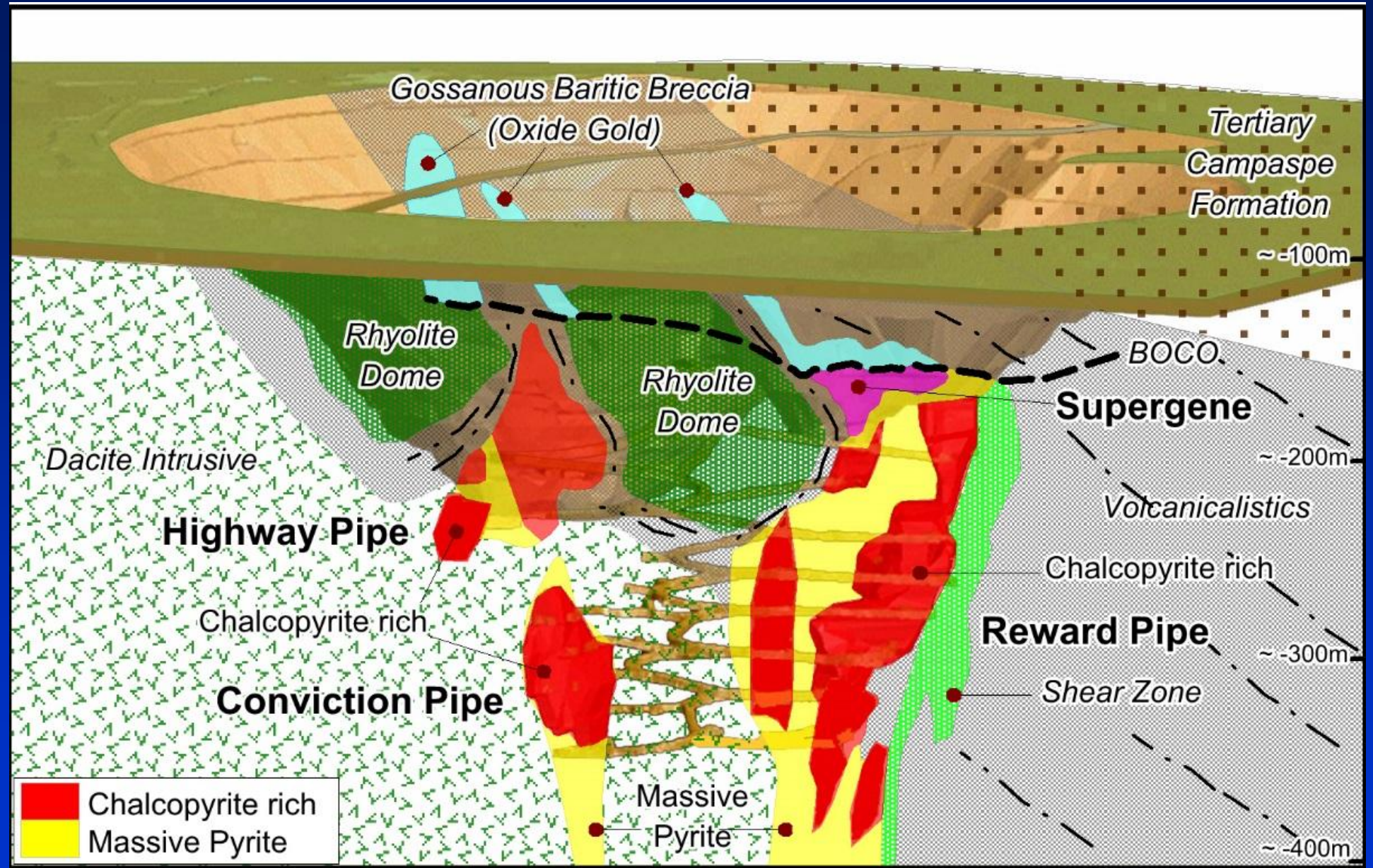
Reward Supergene
745,000 t @ 8.7% Cu , 1.5 g/t Au

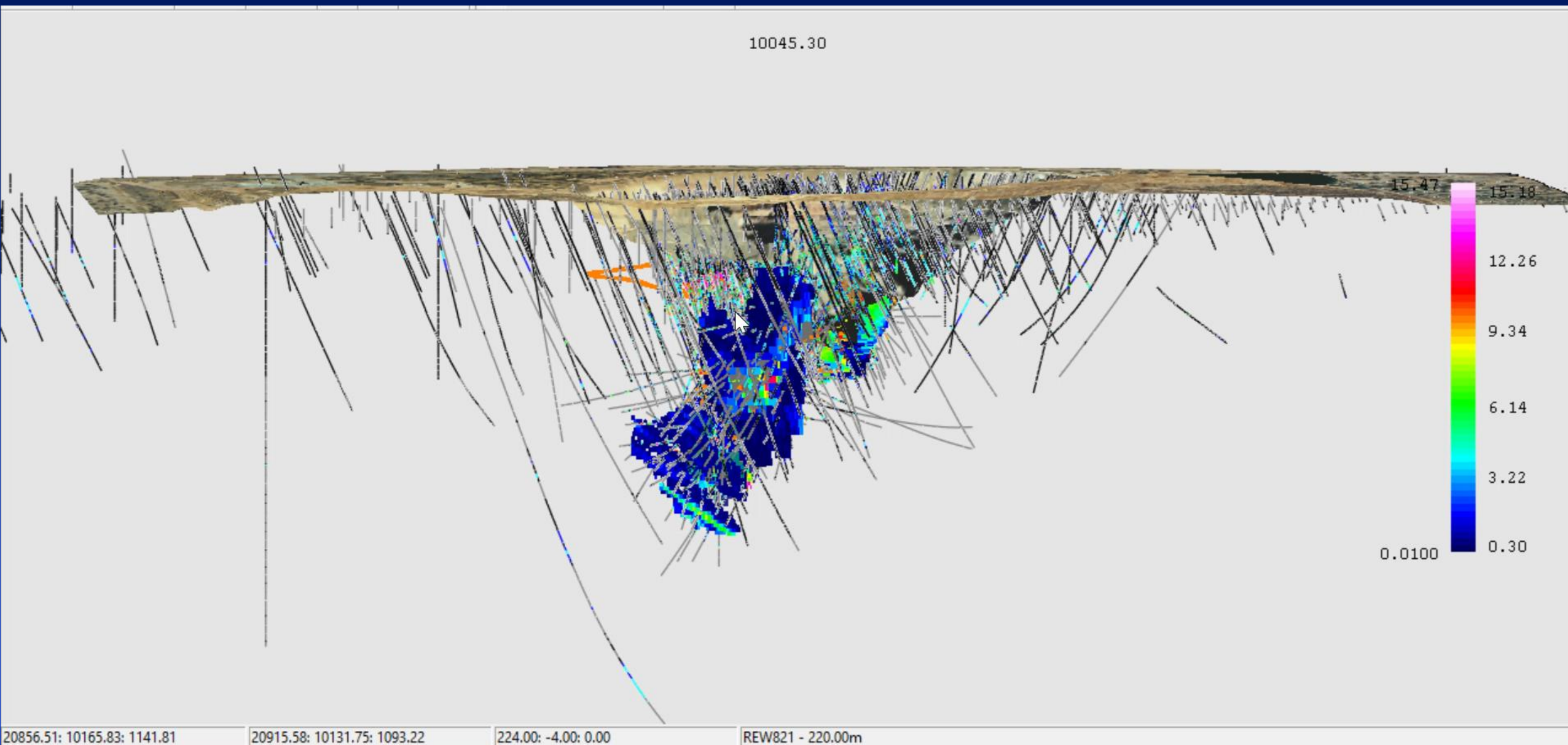
Highway Pipe
1,390,000 t @ 6.3% Cu ,

Conviction Pipe
460,000 t @ 5.8% Cu

Upper Reward Deeps
580,000 t @ 5.8% Cu

Lower Reward Deeps
130,000 t @ 4.4% Cu





HIGHWAY- REWARD RESOURCE / RESERVE RECONCILIATION

Deposit/Ore body	Resource			Mined		
	Tonnes	Cu%	Au g/t	Tonnes	Cu%	Au g/t
HIGHWAY-REWARD						
Open Pit Total	2,516,000	5.5	1.3	2,188,500	6.4	1
Underground Total	1,576,980	5.1		1,466,265	4.7	
Pit and Underground Total	4,092,980	5.4	1.2	3,654,765	5.7	

Resource at Current 2026 Prices AUD\$ 3.5 billion.

Copper Metal Mined

208000 Tonnes

@US\$9500/t

US\$1.98 Billion AUD\$2.87B

Au Mined (approx.)

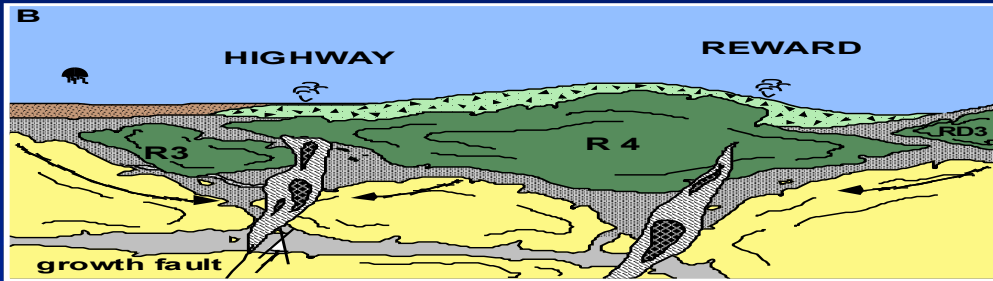
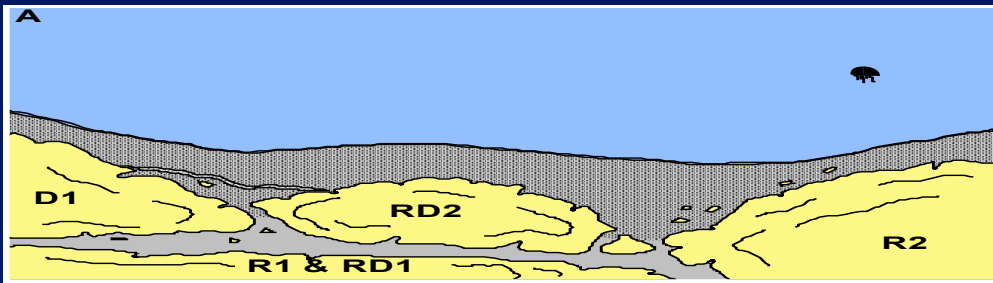
90000 ounces

@US\$4600/oz

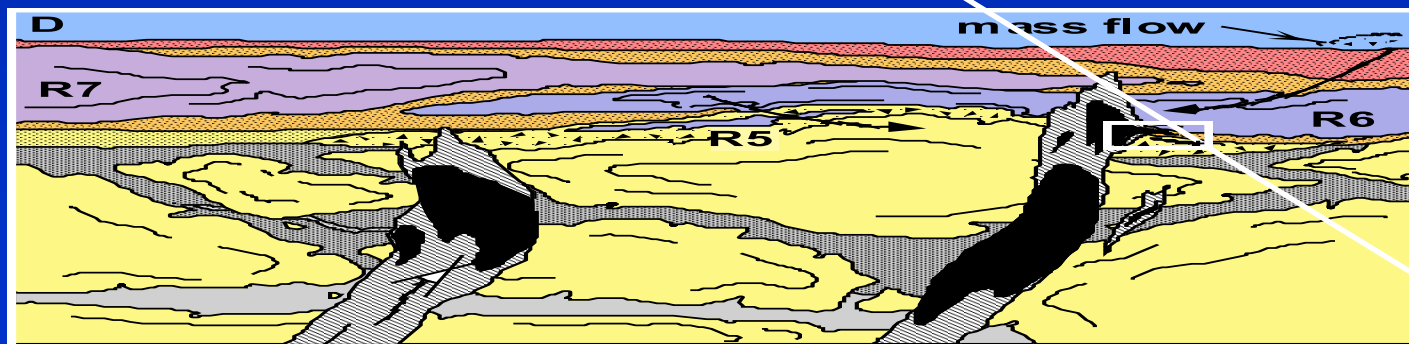
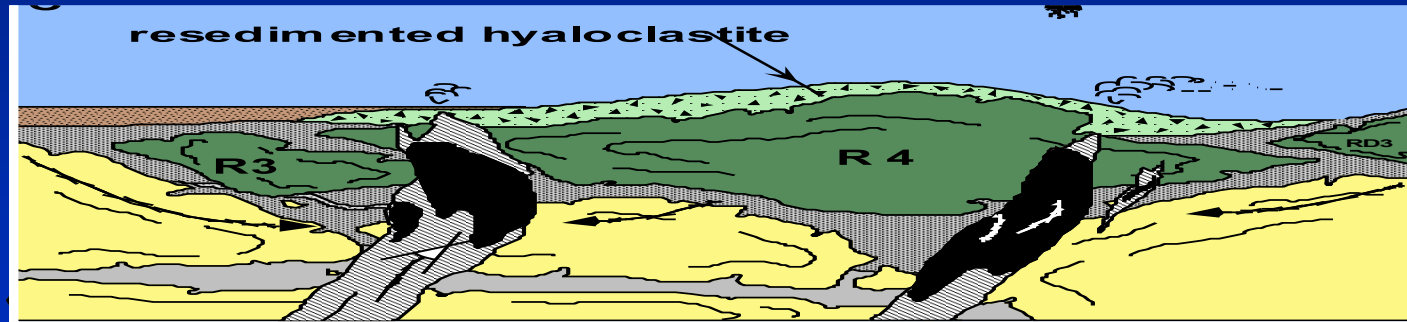
US\$414 million AUD\$600M

Aberfoyle Resources/ Thalanga
Copper Mines Pty Ltd

Genesis of the Highway Reward orebodies & Volcanic Facies Mark Doyle PhD, CODES Uni Tas

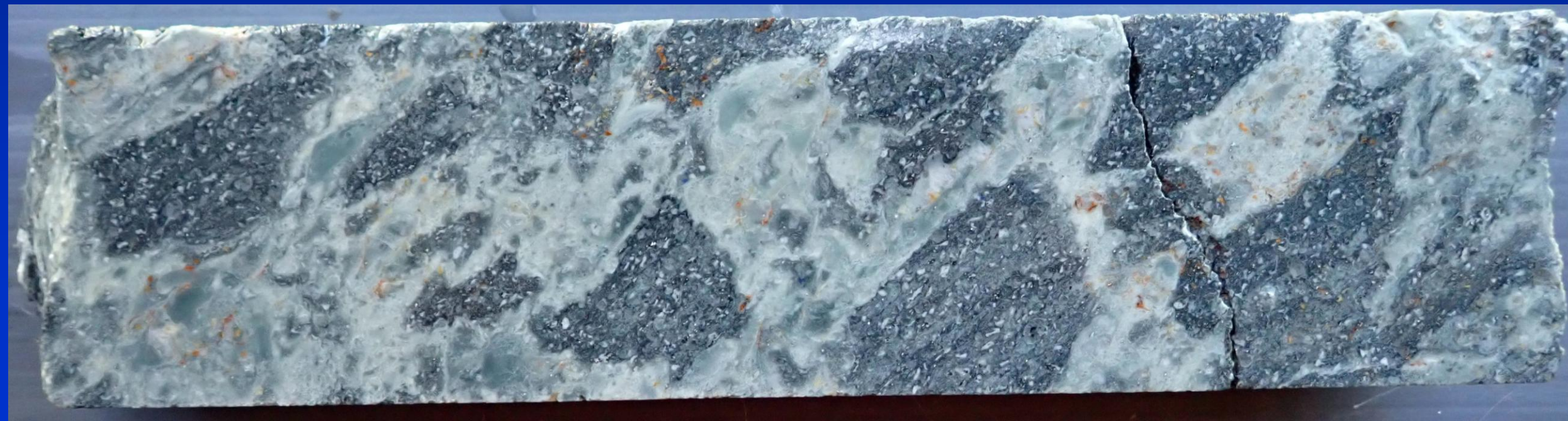


not to scale





25HRDD002 :
125.19-125.44m;
144.62m-144.78m.
Chaotic mixture of
dacite fragments in
siliceous matrix –
peperite &
recemented
hyaloclastite breccia..





Highway Reward Mine Site

Closed 2005

Rehabilitation 2005-2007

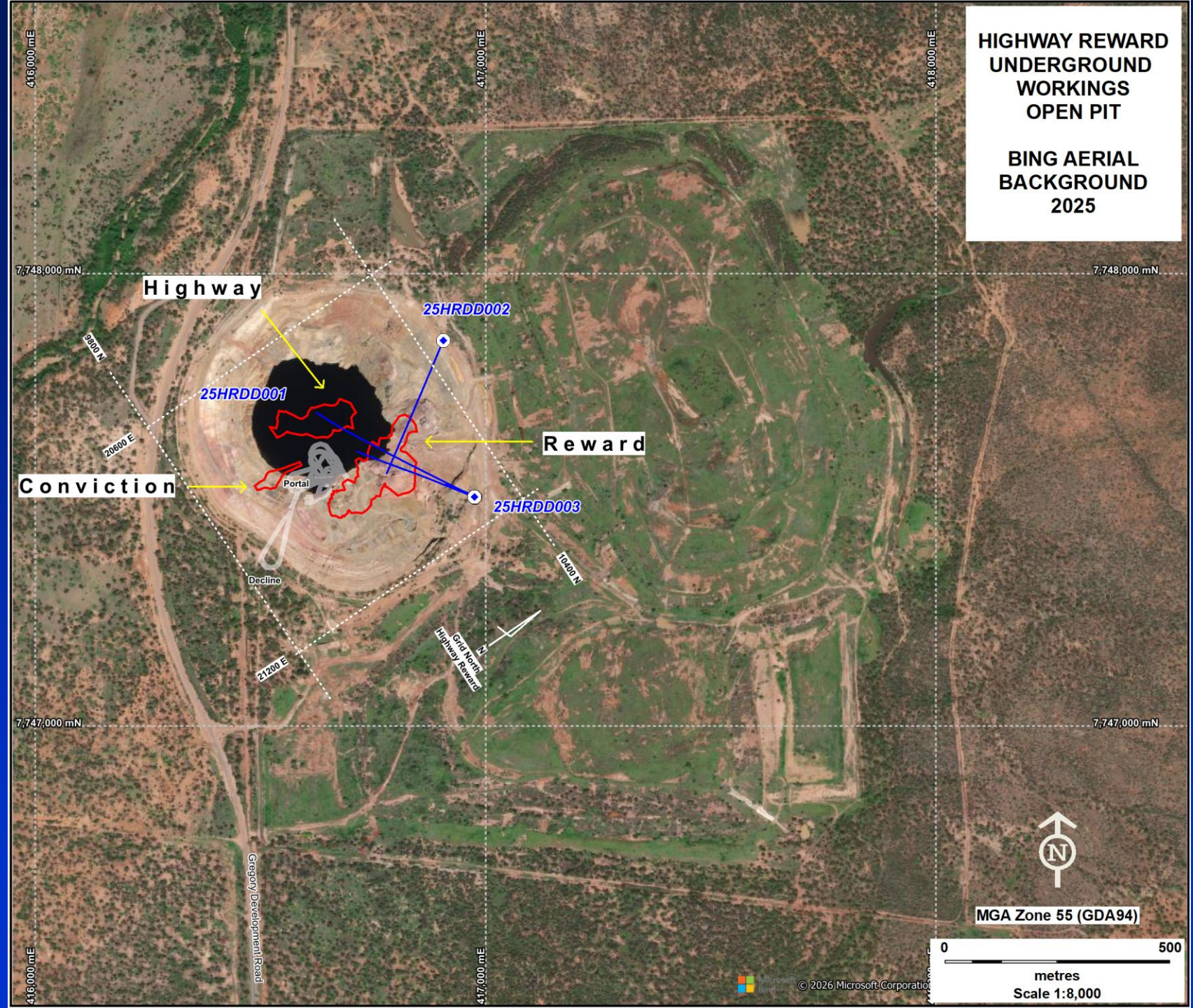
Highway Reward Mine : Rehabilitating Waste Heap 2011. Now a low range of hills , one of the few areas with no weeds. Looking West

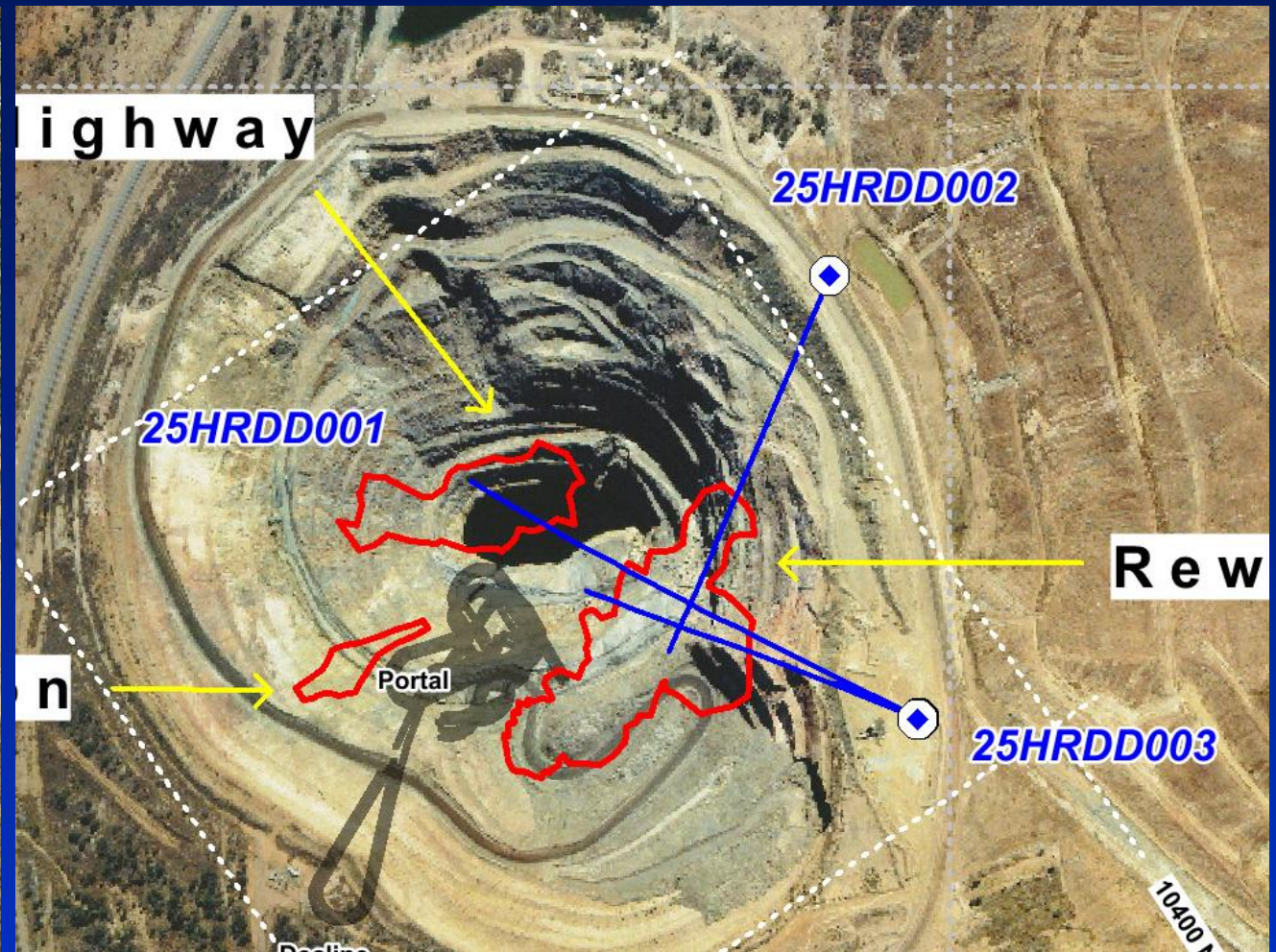
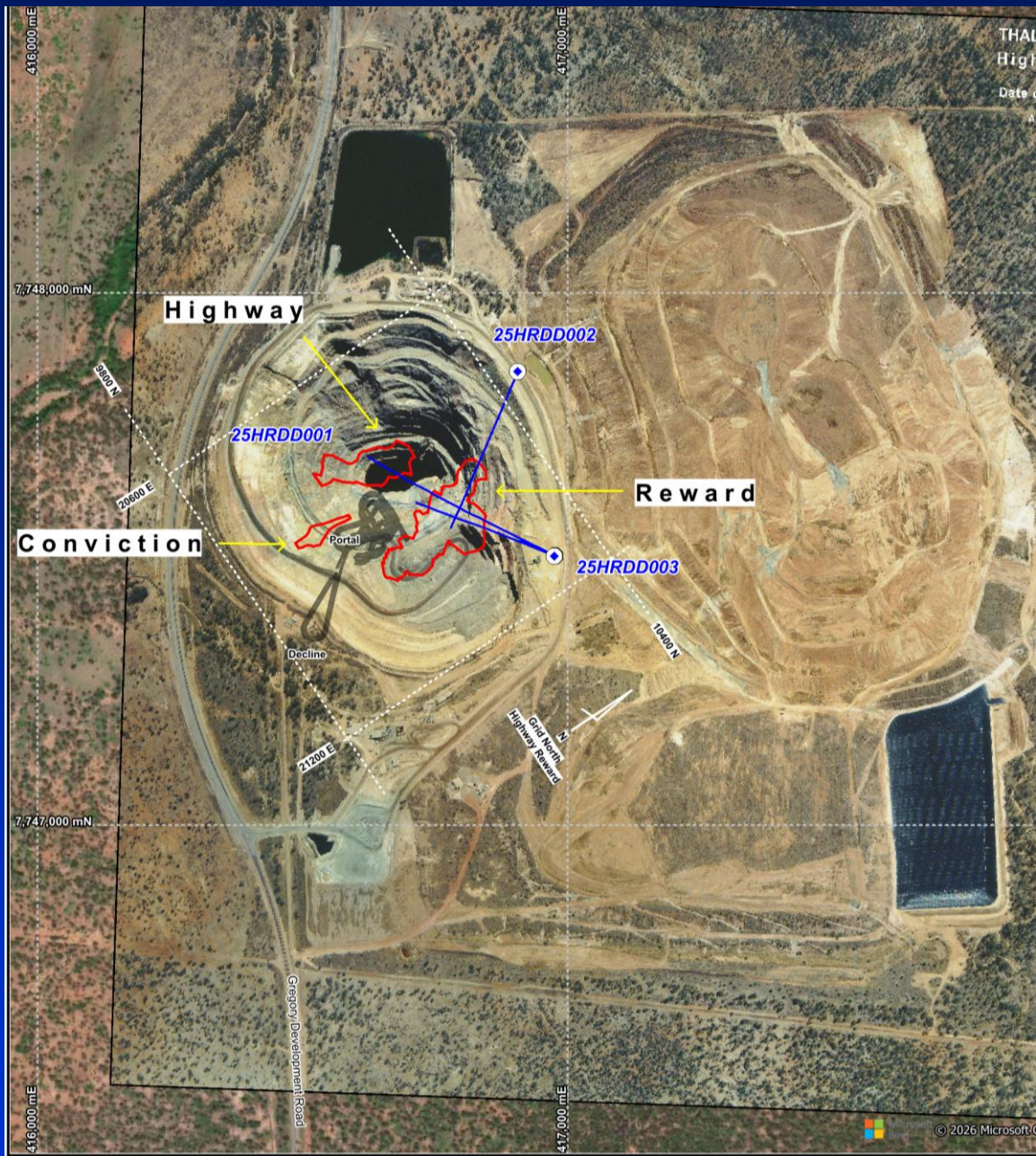


Highway Reward Pit

Plan view of
massive
Sulphide pipe
outlines
100m-150m
below surface

Bing Aerial
2025





REJUVENATION

HIGHWAY REWARD
UNDERGROUND
WORKINGS
OPEN PIT

AIRPHOTO
BACKGROUND
2004

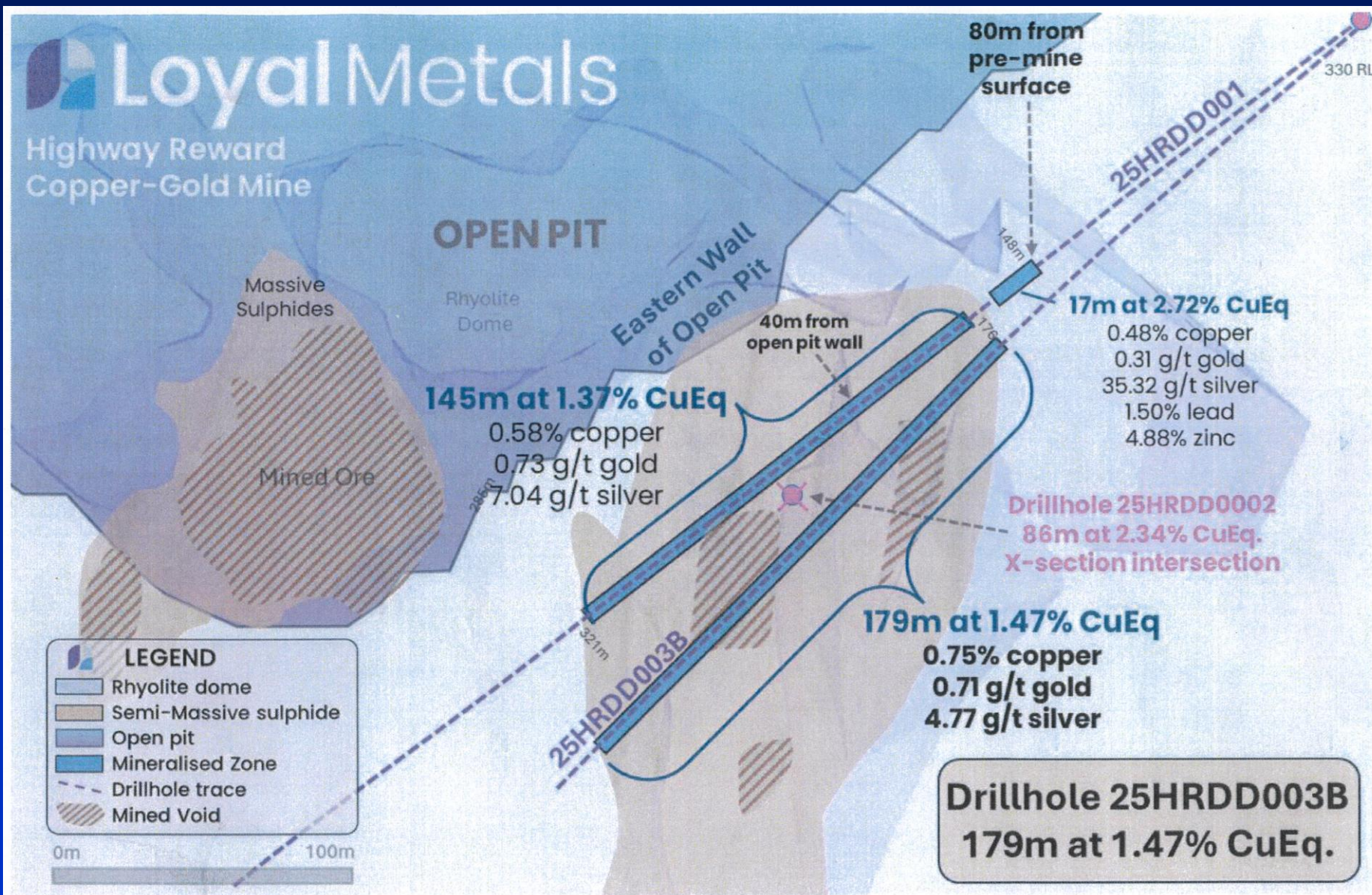


Figure 1: Drill hole 25HRDD001 and 25HRDD003 - Cross Section View Northeast. Assays confirm a large, thick, near-surface, high-grade Copper-Gold-Silver mineralised zone with strong continuity and a new shallow, zinc rich - massive sulphide - polymetallic zone ~80 m from surface.

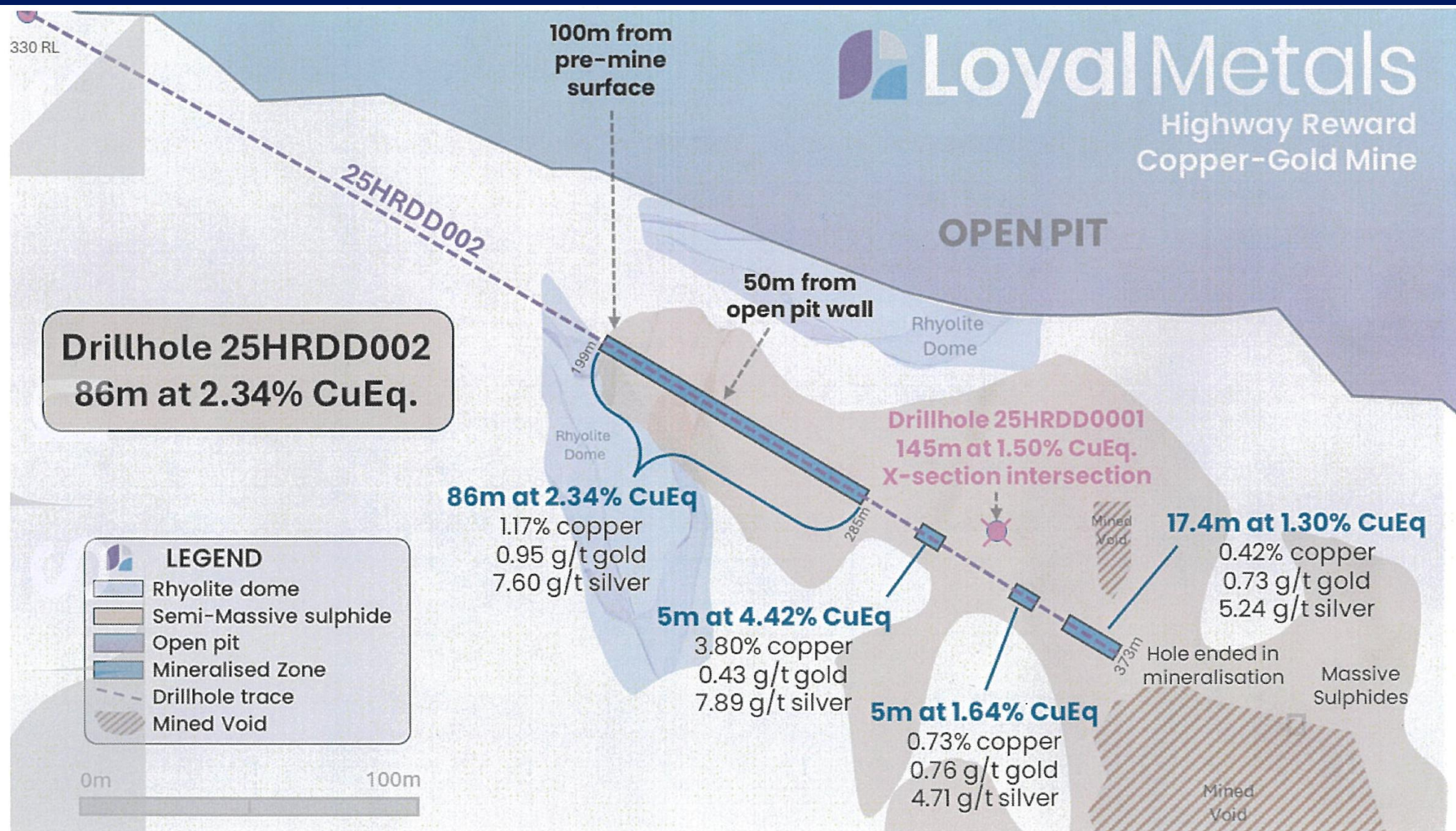


Figure 2: Drill hole 25HRDD002 – Cross Section View Southeast. Intercept of semi-massive and disseminated supergene formed chalcocite zone within the upper part of the Reward Massive Sulphide Pipe hosted in volcaniclastic. Deeper underground workings mined copper in chalcopyrite within the massive sulphide VHMS pipe.



25HRDD002 : 216m-227m , 11m @ 4.38 g/t Au .

siliceous and oxide gold zones

Poor core recovery recorded in vuggy , spongy gossanous zones.

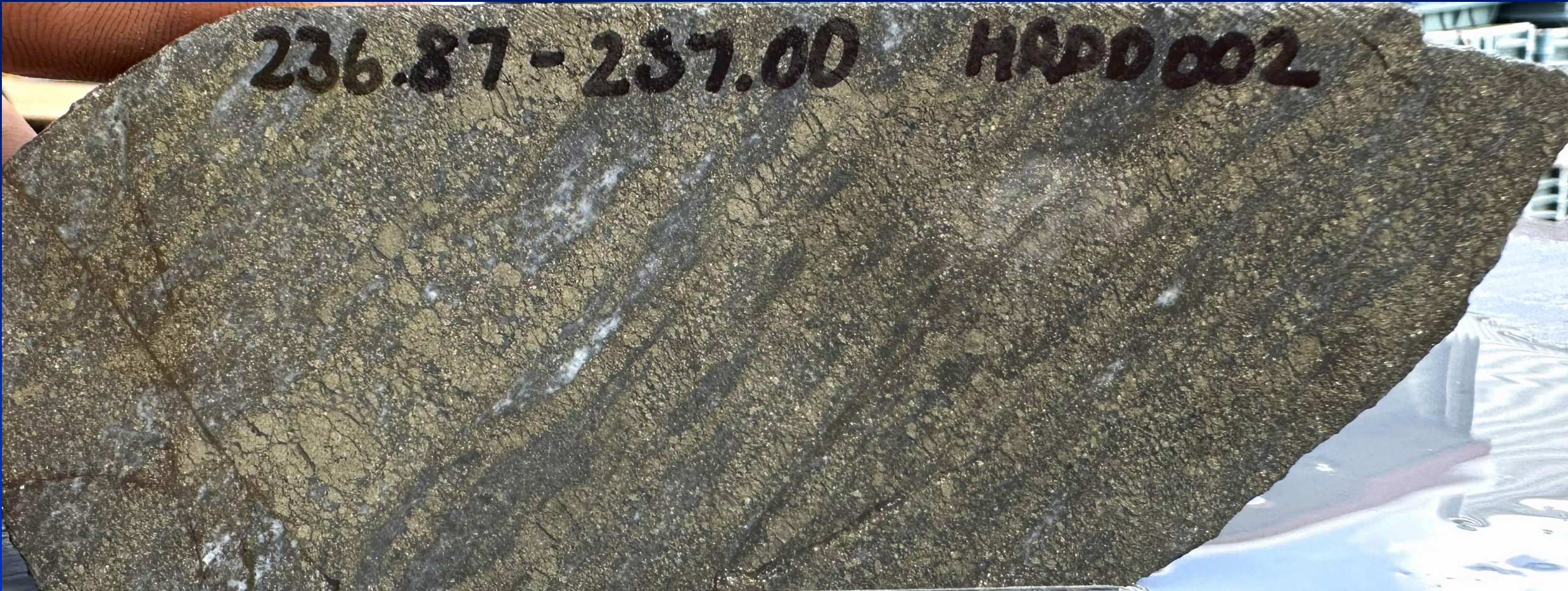


25HRDD002 : 232m-238m , 6m @ 2.22 % Cu, 0.8 g/t Au .

Includes 1m @ 5.61 % Cu , 236m-237m, chalcocite rich massive pyrite.

Generally good core recovery.

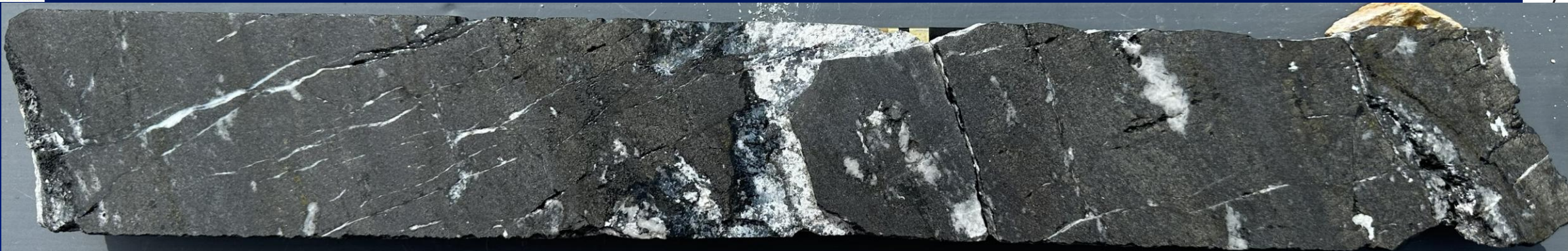
Contact between gossanous cherty volcaniclastics (uphole) and supergene zone (downhole).



25HRDD002 : 236m-237m 1m @ 5.61% Cu, 0.69 g/t Au .
Chalcocite bearing supergene-massive sulphide zone



25HRDD003: 182.32m
gently dipping contact
fine grained cherty &
silty volcanoclastics
replaced by fine
disseminated and
massive sulphide
downhole.



151.04m: Massive Sphalerite with minor Chalcopyrite, Galena, Barite, weak Layering/Banding



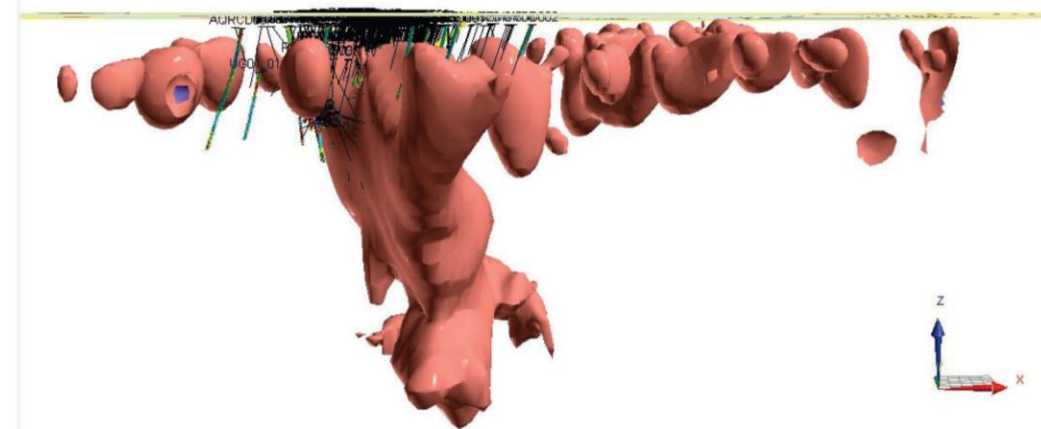
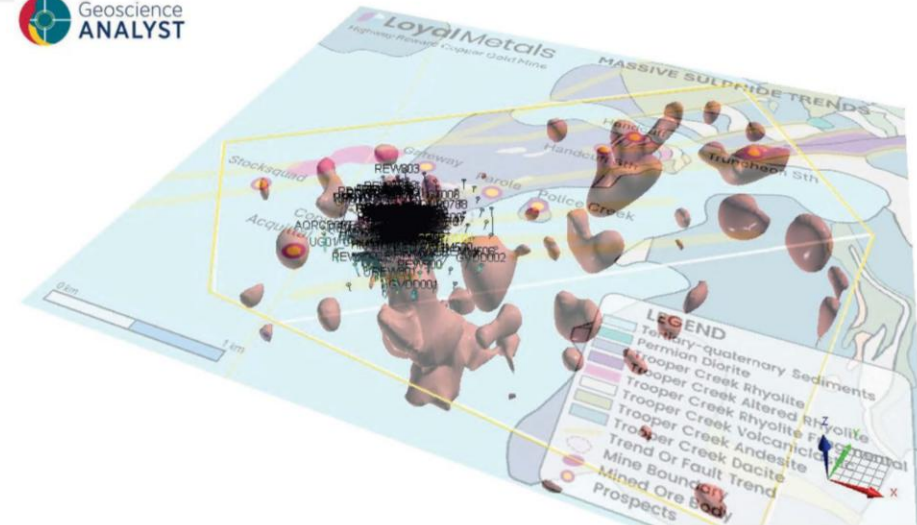
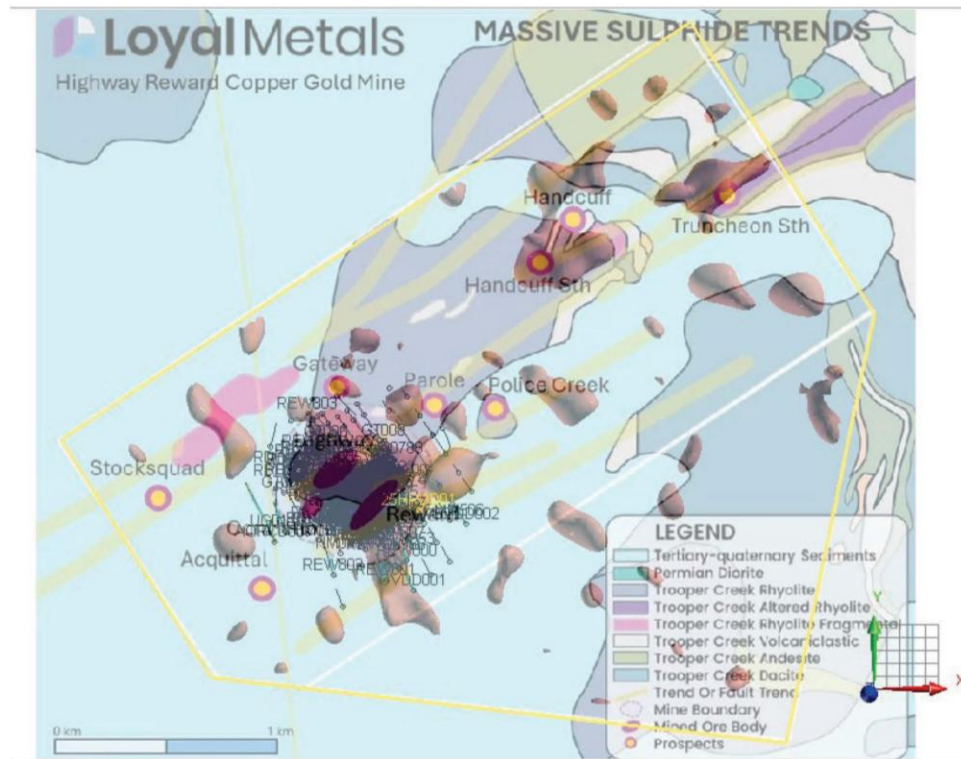
25HRDD001 : 151m. Massive iron poor sphalerite, galena, barite, minor chalcopyrite , very low pyrite. Assay 150-m-152m : 2m @ 1.41 % Cu, 0.83 g/t Au, 123 g/t Ag, 25.8% Zn, 4.96% Pb, 0.14% As, 0.26% Ba, 19.5% S, 3.48% Fe.

Future Exploration Utilization of major technological advances guided by improved understanding of geology and mineral system.

Gravity 3D Modelling with Geology



Density isosurfaces 0.08 to 0.15g/cc



- **BREAKING NEWS ;**
- **LOYAL METALS CORPORATE UPDATE**
On 20 August 2026, Loyal Metals Shareholders approved a Scheme Implementation Deed with PT Bumi Resources Tbk under which Bumi agreed to acquire 100% of the issued shares in Loyal by way of a court-approved scheme of arrangement for cash consideration of A\$0.45 per share. The transaction values Loyal Metals at approximately A\$79.1 million on an in-the-money equity value basis . .