

Integrating Exploration Data to Develop and Modify Exploration Models: Case Studies from two Sites in Indonesia. Implications for Exploration.

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Acknowledgements

The management of Prosperity Resources Limited and Paramount Mining Corporation, Perth are acknowledged and thanked for giving permission to use exploration data from their project in Southern Aceh, northern Sumatra and West Java for this presentation.

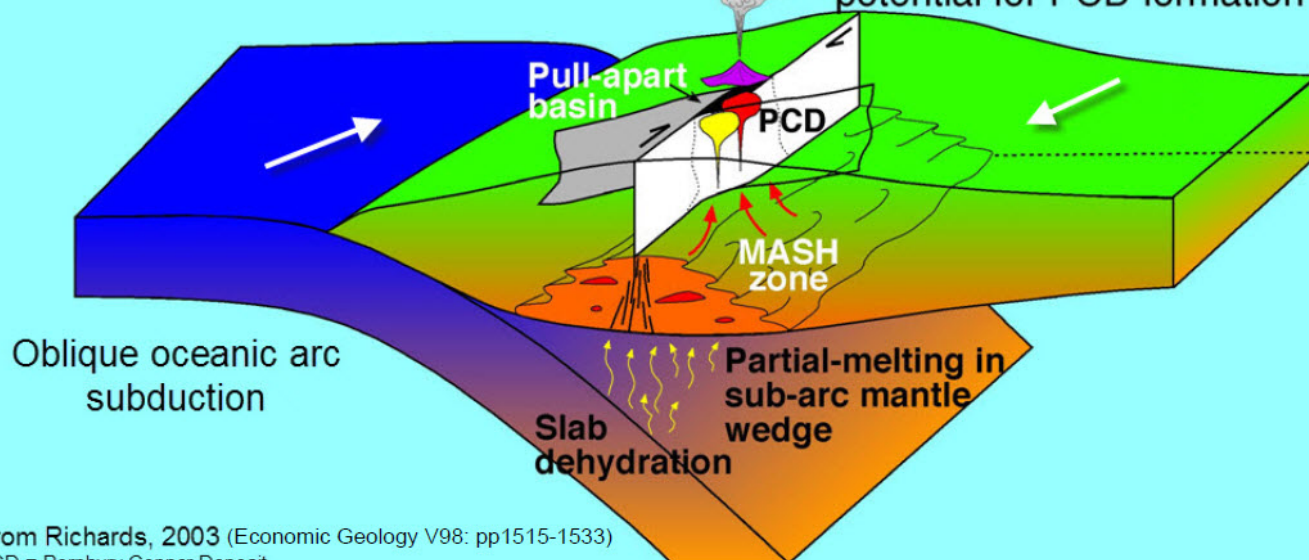
The field exploration was undertaken by a small group of dedicated Indonesian and expatriate geologists and assistants who accepted the struggle and found satisfaction and reward in seeing discovery of new or significant extensions to bodies of mineralisation.



click to view presenter
notes

Shear: Magmas rise buoyantly up
dilational transpressional zones

Composite volcanoes develop
above shallow magma chambers;
potential for PCD formation



From Richards, 2003 (Economic Geology V98: pp1515-1533)
PCD = Porphyry Copper Deposit

Click to turn off note or
just go to next slide

Presenter

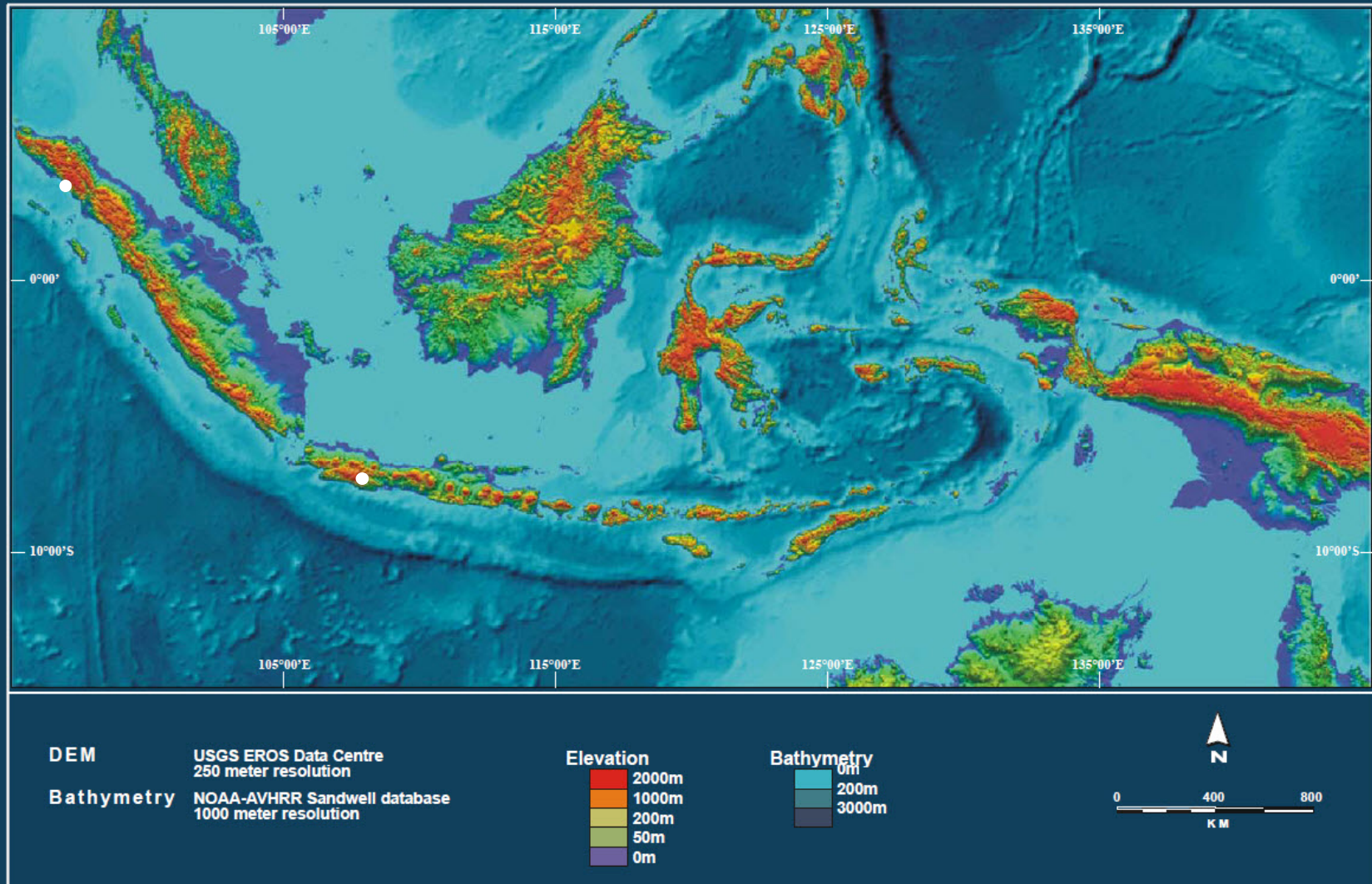
1/11/2014 3:52:51 PM

Scroll through notes

where necessary, be subject to continuous change as the knowledge base in a project area increases, along with the increasing range of experience and interpretive skills the explorationist gains over time. It is important to vary the model to fit the field data, not try to force that data to fit a model picture. It may be important to abandon one model regardless of how strongly pushed by management or others when facts

Displaying presenter notes in PDF file – these can be ignored or opened
as shown – not all slides have notes, only those with small icon top left
corner of slide.

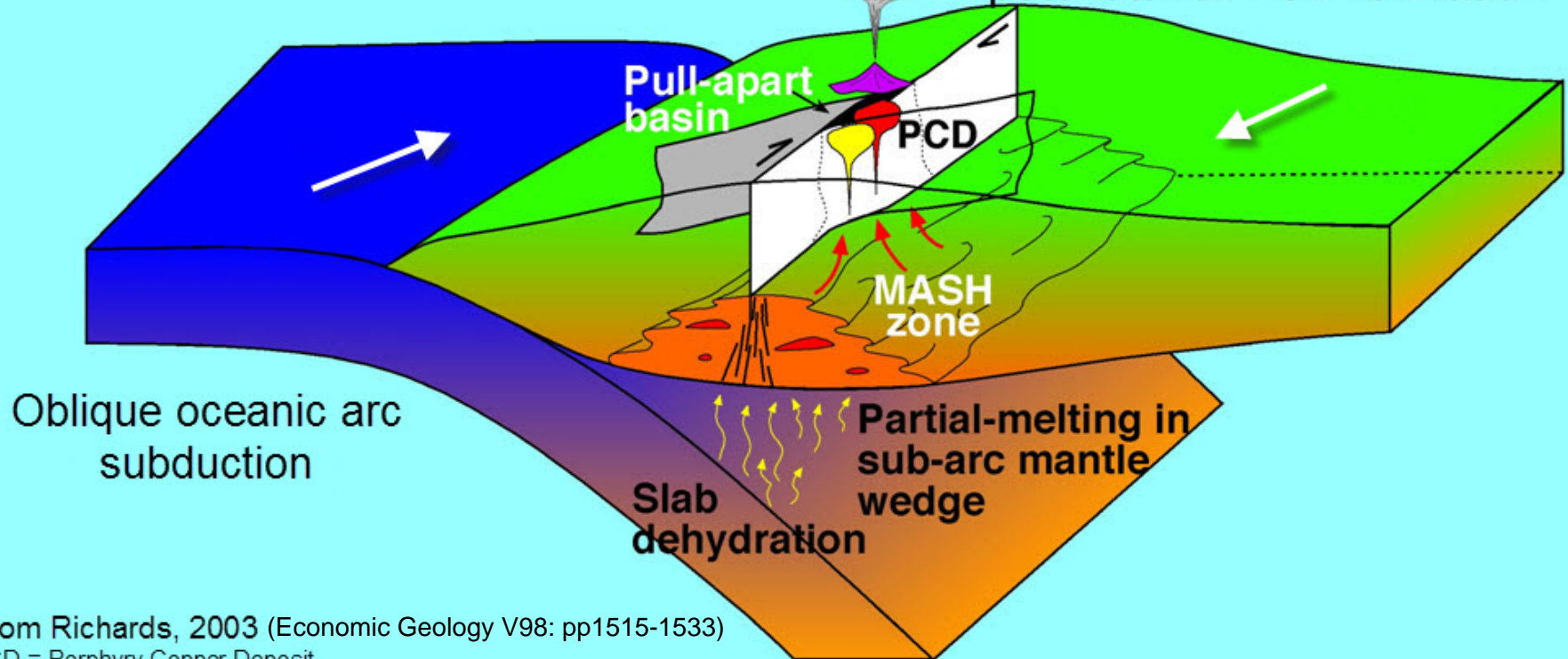
Digital Elevation Model and Bathymetry of Indonesia



The Indonesian Archipelago

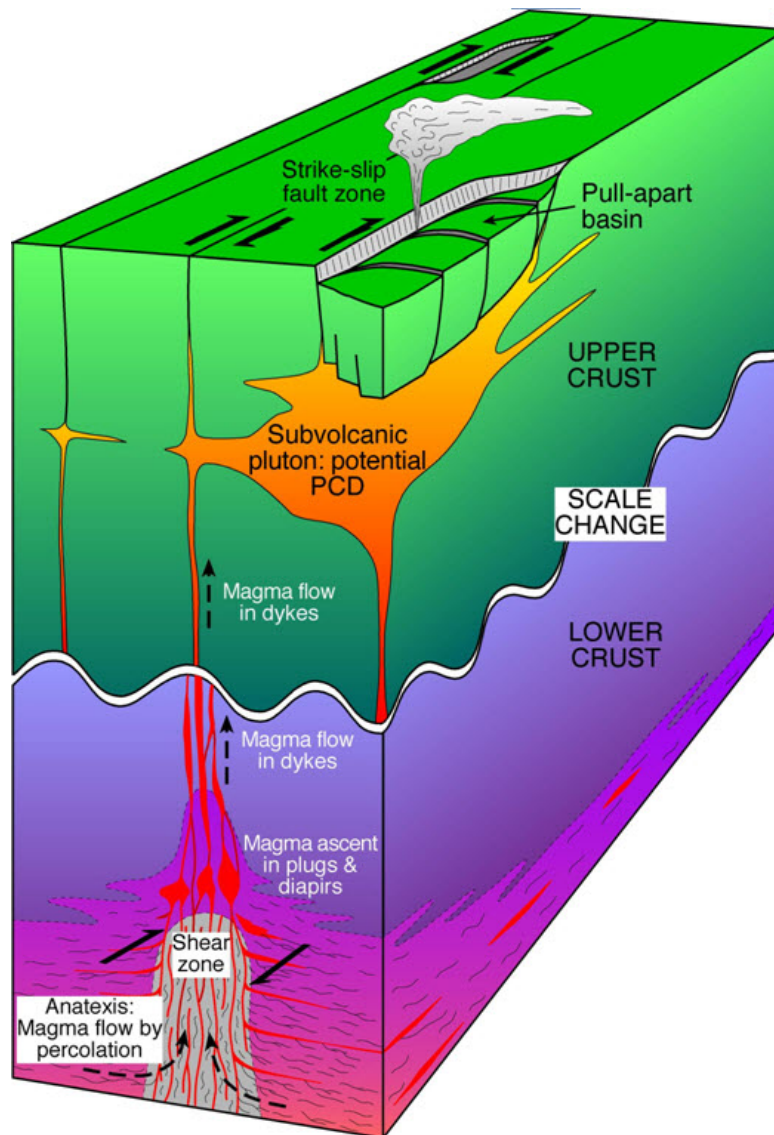
Shear: Magmas rise buoyantly up dilational transpressional zones

Composite volcanoes develop above shallow magma chambers; potential for PCD formation

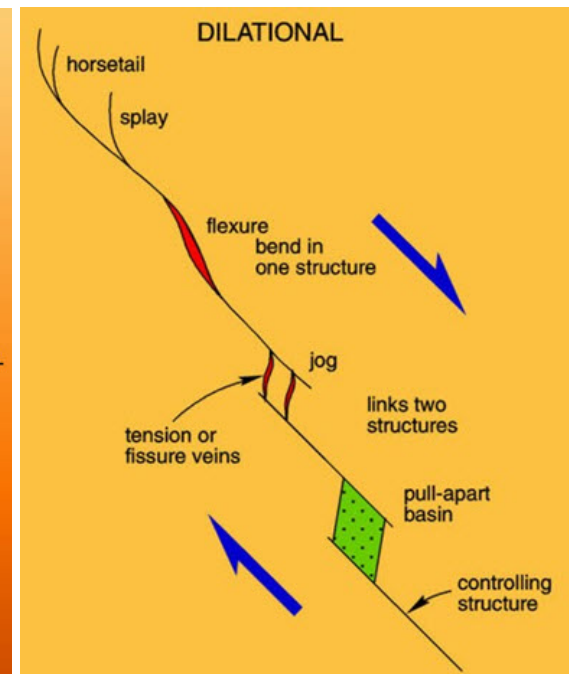
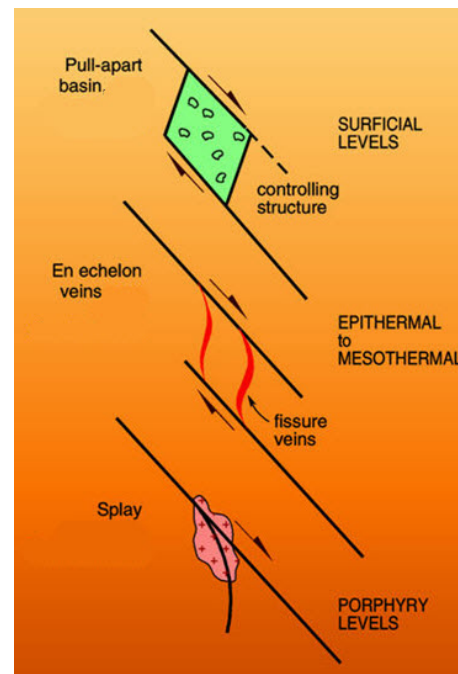
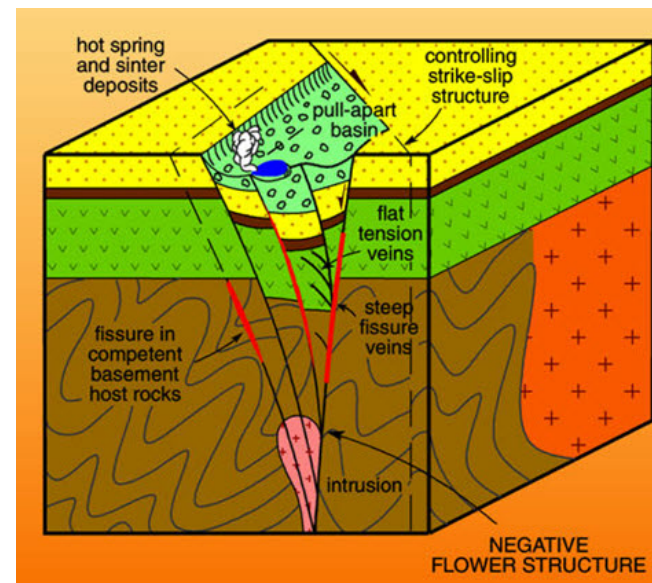


From Richards, 2003 (Economic Geology V98: pp1515-1533)
PCD = Porphyry Copper Deposit

Subduction Zones & Island Arc Model Setting
We start learning and exploration with conceptual models

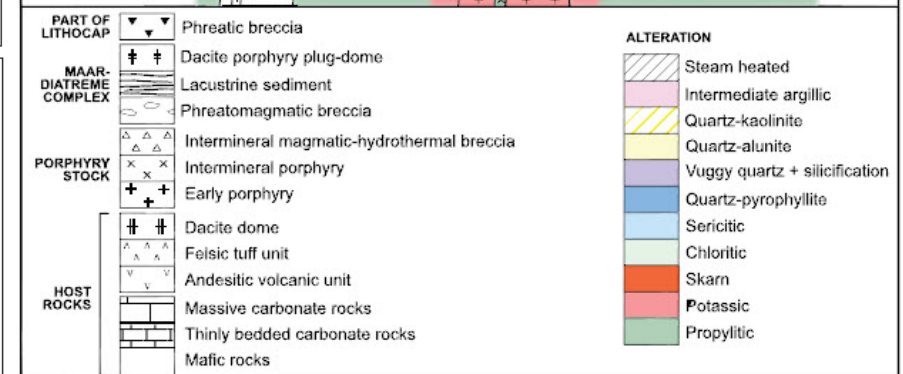
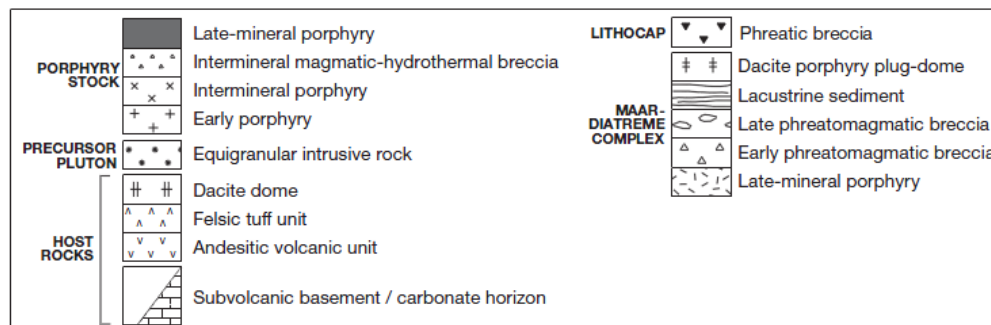
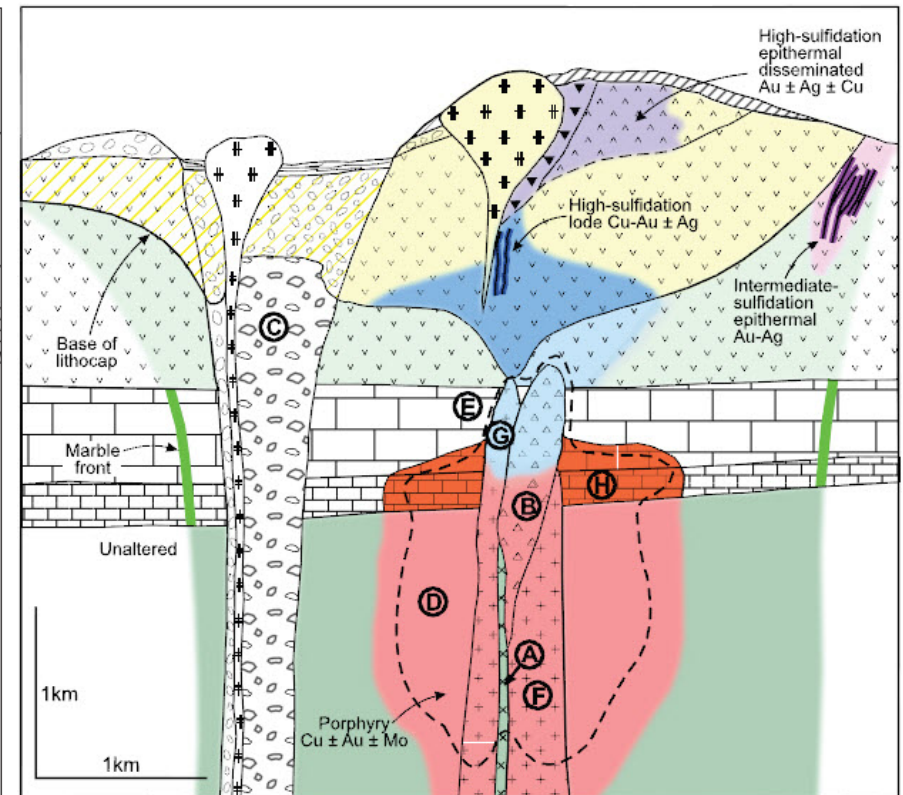
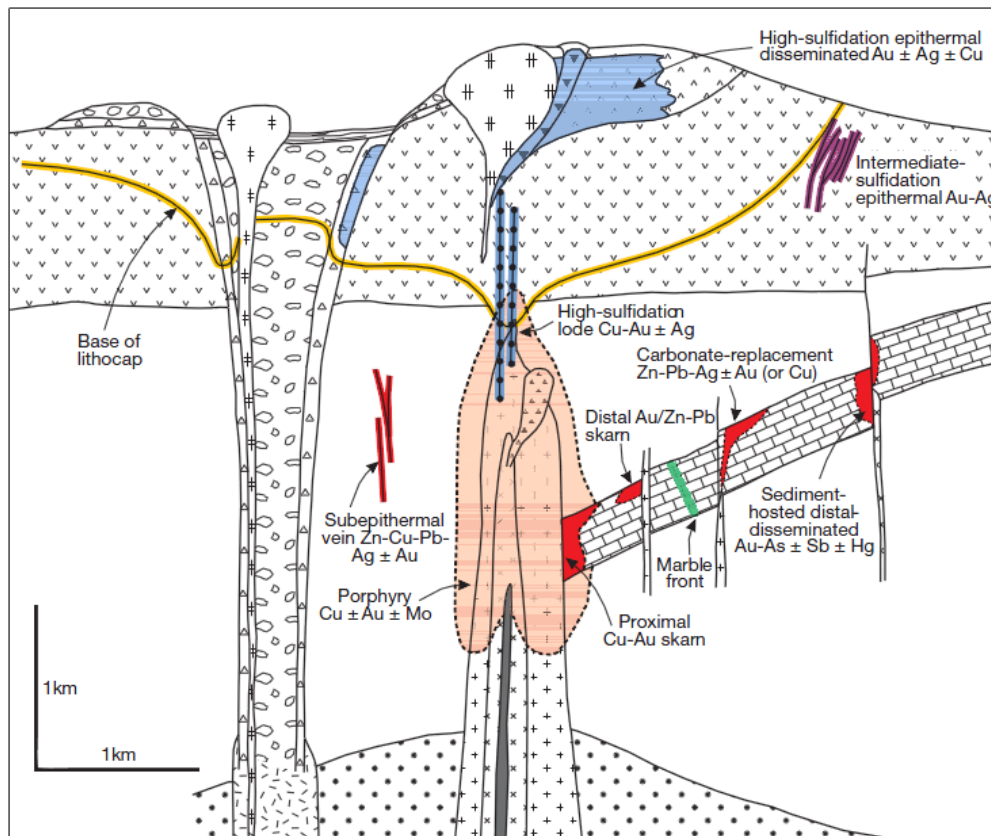


From Richards, 2003
Economic Geology V98: pp1515-1533
(PCD = Porphyry Copper Deposit)



From Corbett & Leach

Expressions of structural host sites for mineralisation

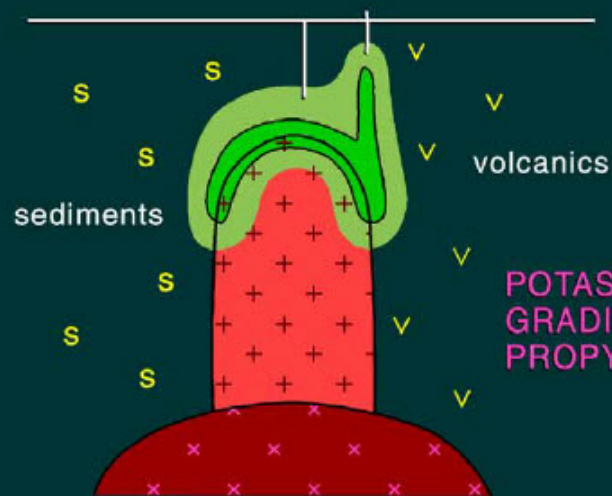


Sillitoe conceptual models of porphyry and related mineralised systems.

12261

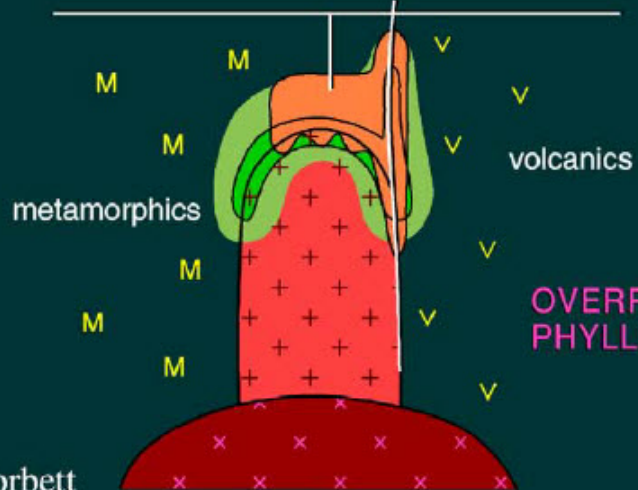
SECTION

PLAN



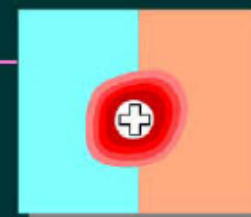
above intrusion

intrusion exposed

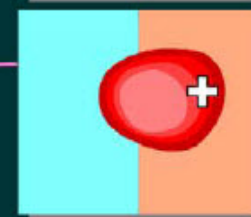


high level

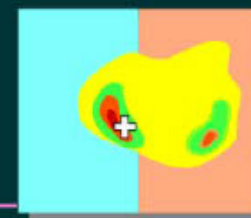
at depth



spot high



donut high



magnetite destruction

magnetite destruction
relict magnetic
highs in
magmatic arc

**AEROMAGNETIC SIGNATURES
IN PORPHYRY SYSTEMS**

Corbett

Geophysical & alteration expression of mineralisation



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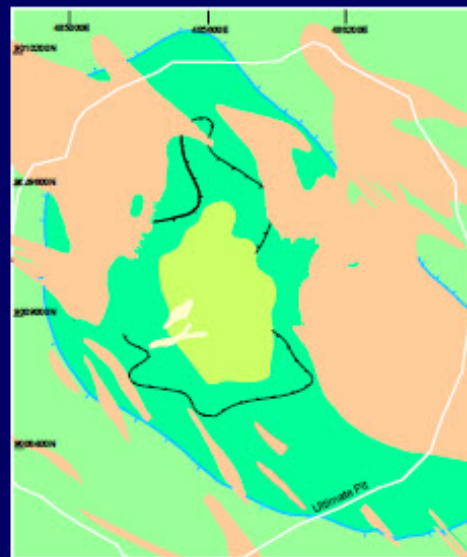
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Batu Hijau - Indonesia



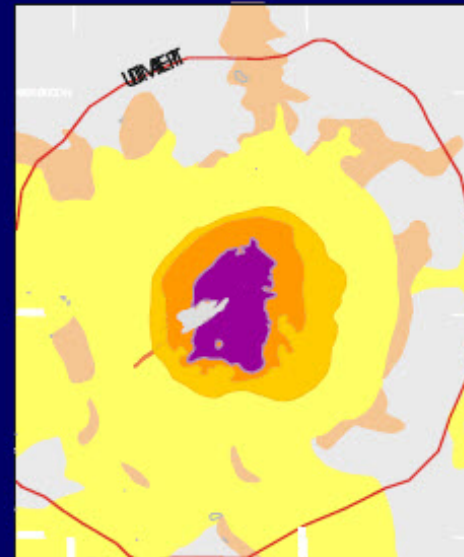
Geology

- Young Tonalite
- Intermediate Tonalite
- Equigranular Quartz Diorite
- Porphyritic Quartz Diorite
- Porphyritic Andesite Intrusive
- Volcanic Lithic Breccia
- Fine Grained Volcaniclastics



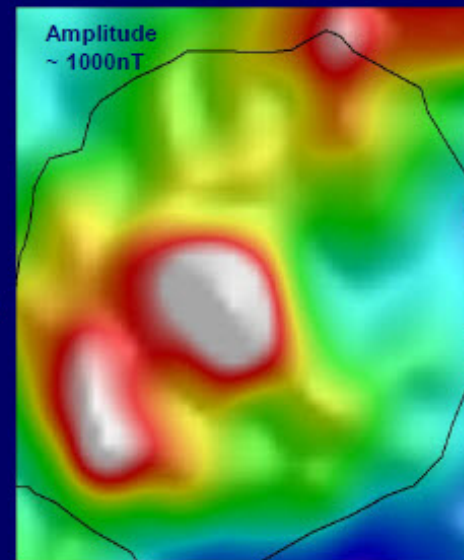
Alteration

- Moderate to Strong Secondary Biotite
- Sericite - Chlorite +/- Clay
- Feldspar Destroyed (Clay - Mica)
- Epidote Present



Sulphides

- Bornite + Chalcopyrite
- Chalcopyrite Dominant
- Chalcopyrite > Pyrite Zone
- Pyrite > Chalcopyrite

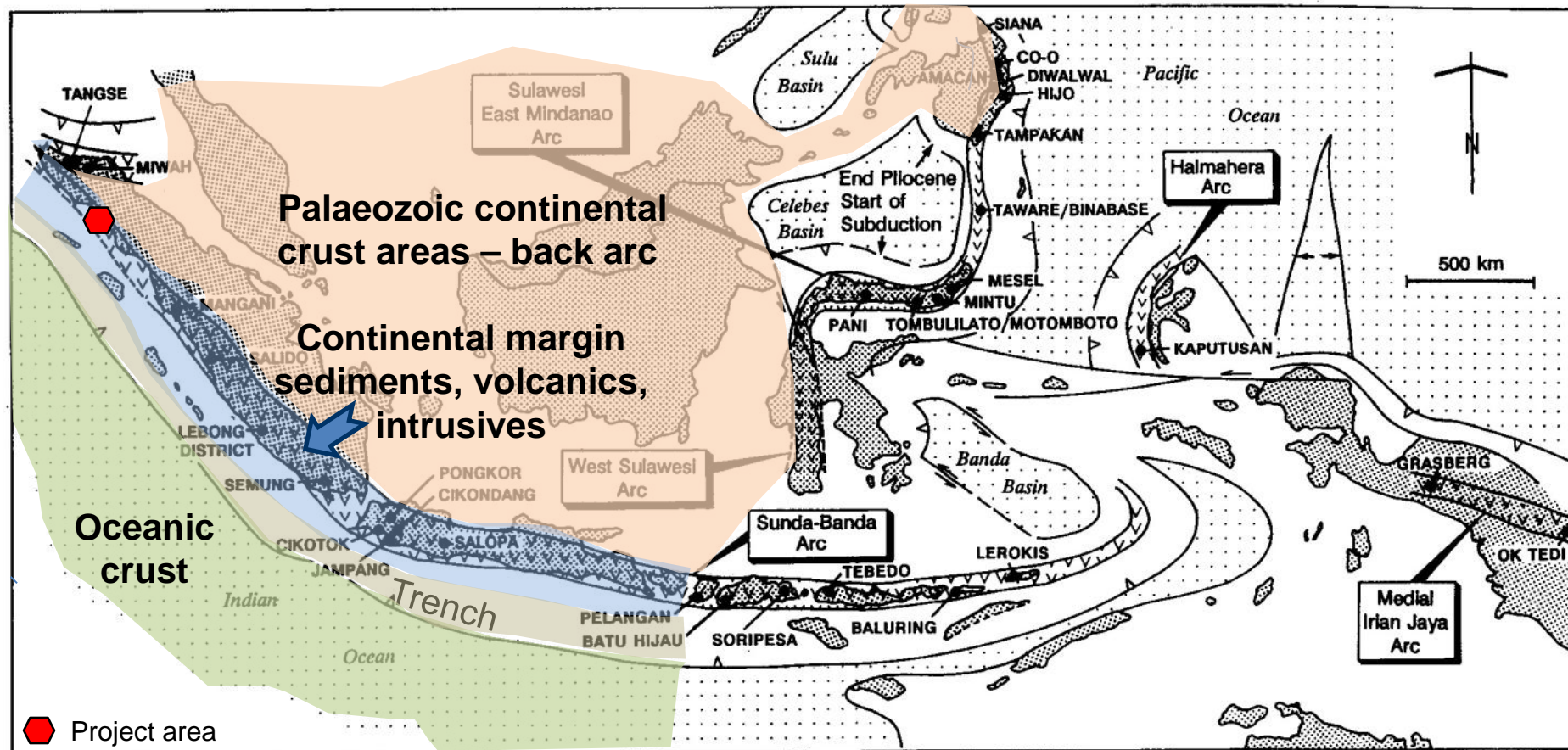


Magnetics

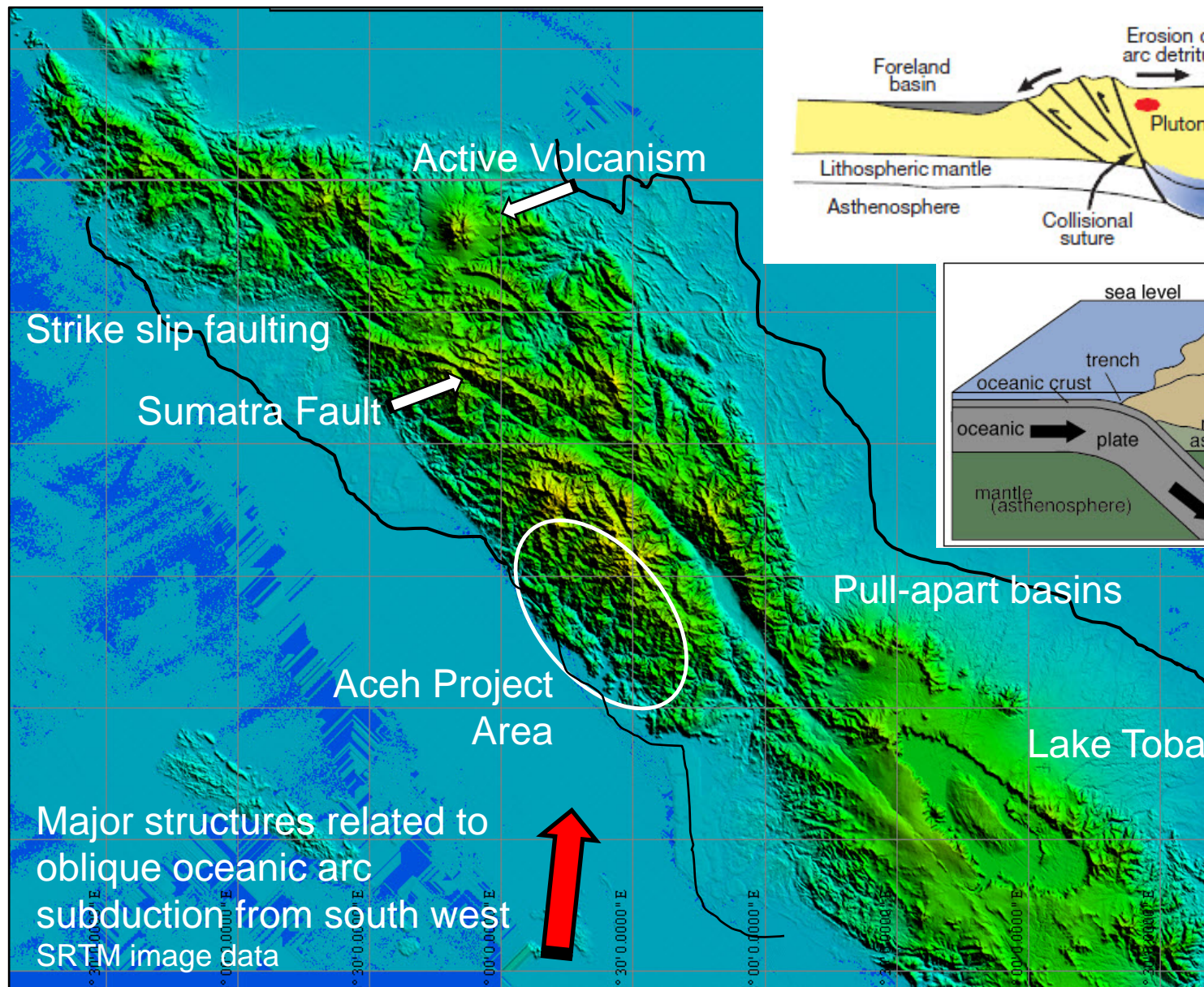
RTP



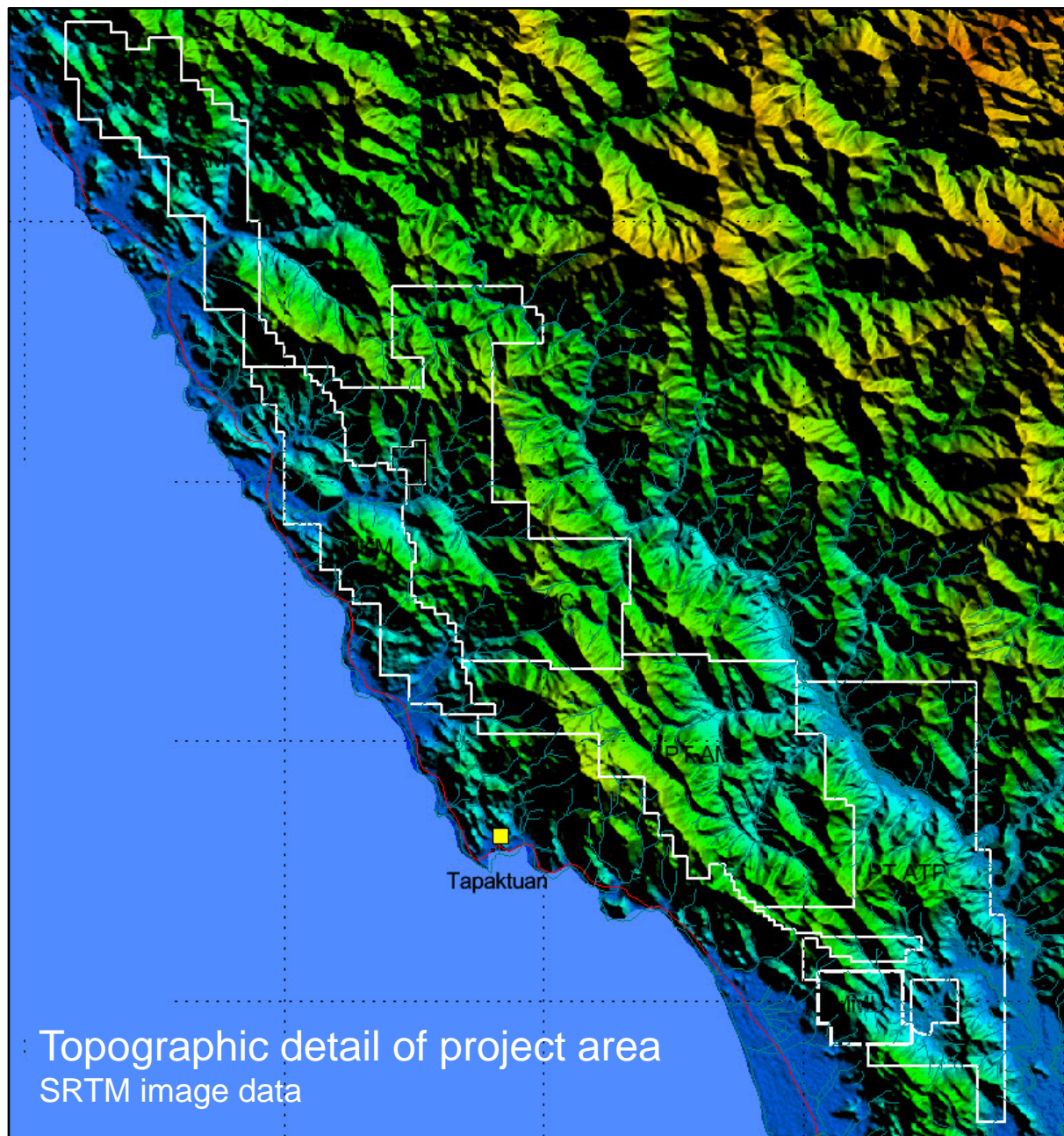
Regional setting of project areas and mineral deposits



Pliocene palaeogeography and magmatic arcs of the Indonesian region showing major mineralised centres. Sumatra Fault defines a major break between the old Palaeozoic continental crustal areas and the continental margin in a classic island arc trench setting.



The terrain in Aceh is an exercise in fractals – just as bad at all scales and even harder when you have to work in it.





The topography really is as bad as you think.



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Home of the Sumatran tiger, Asian elephants and pygmy rhinoceros.



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Intensely sheared
clastic sediments



Magnetite-pyrite
endoskarn

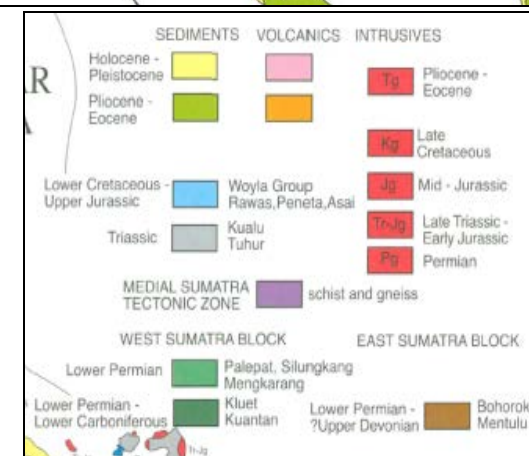
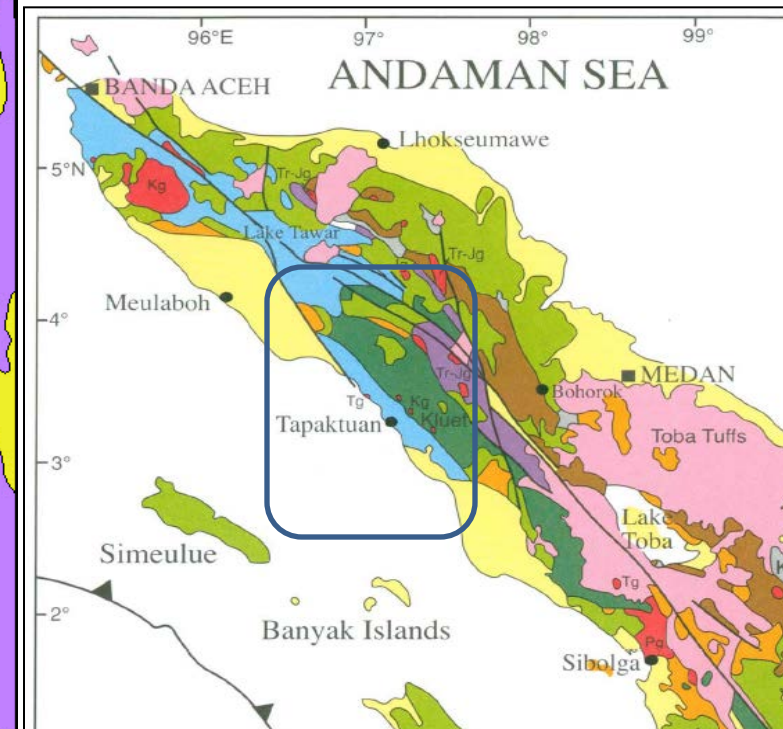
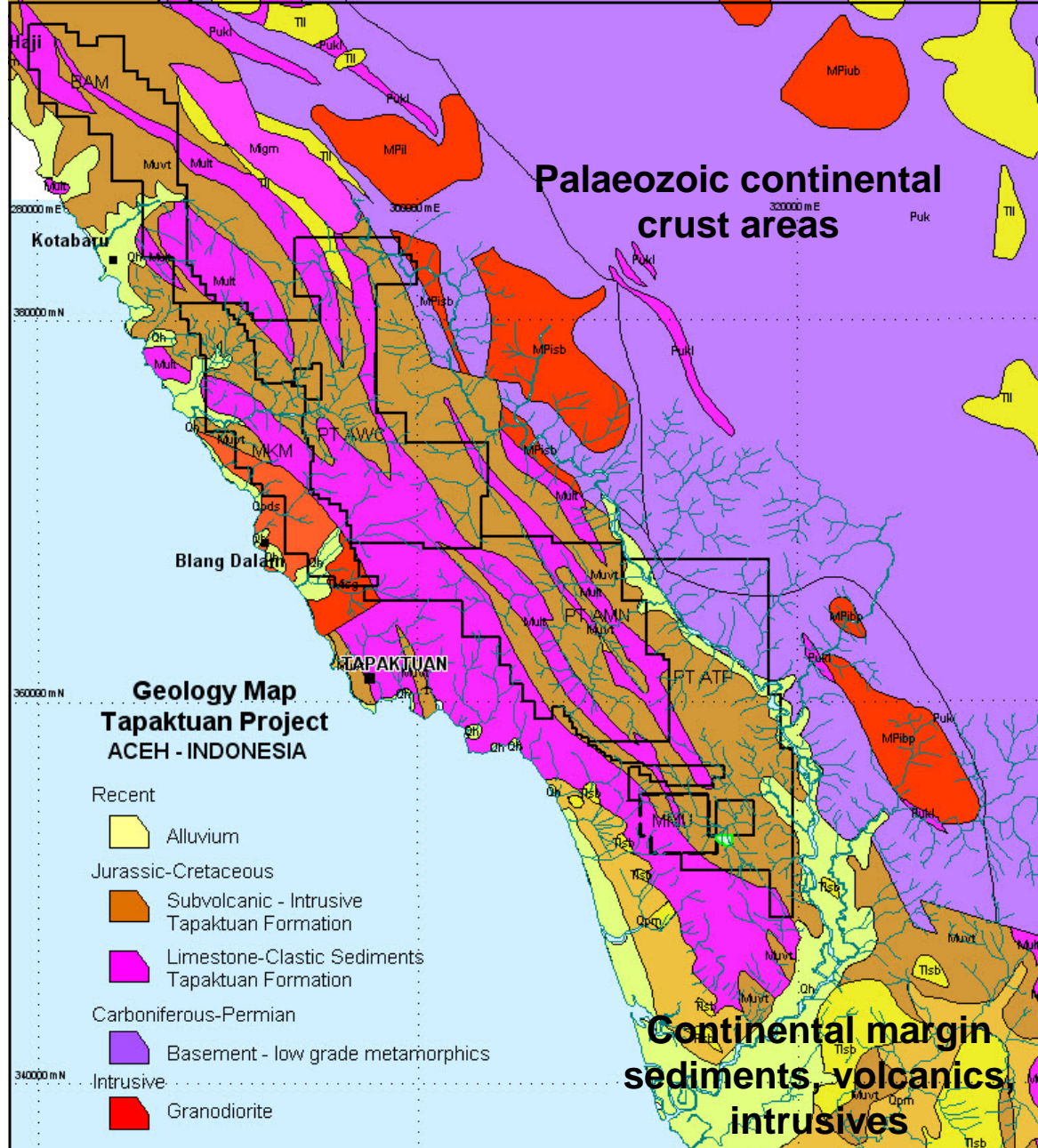


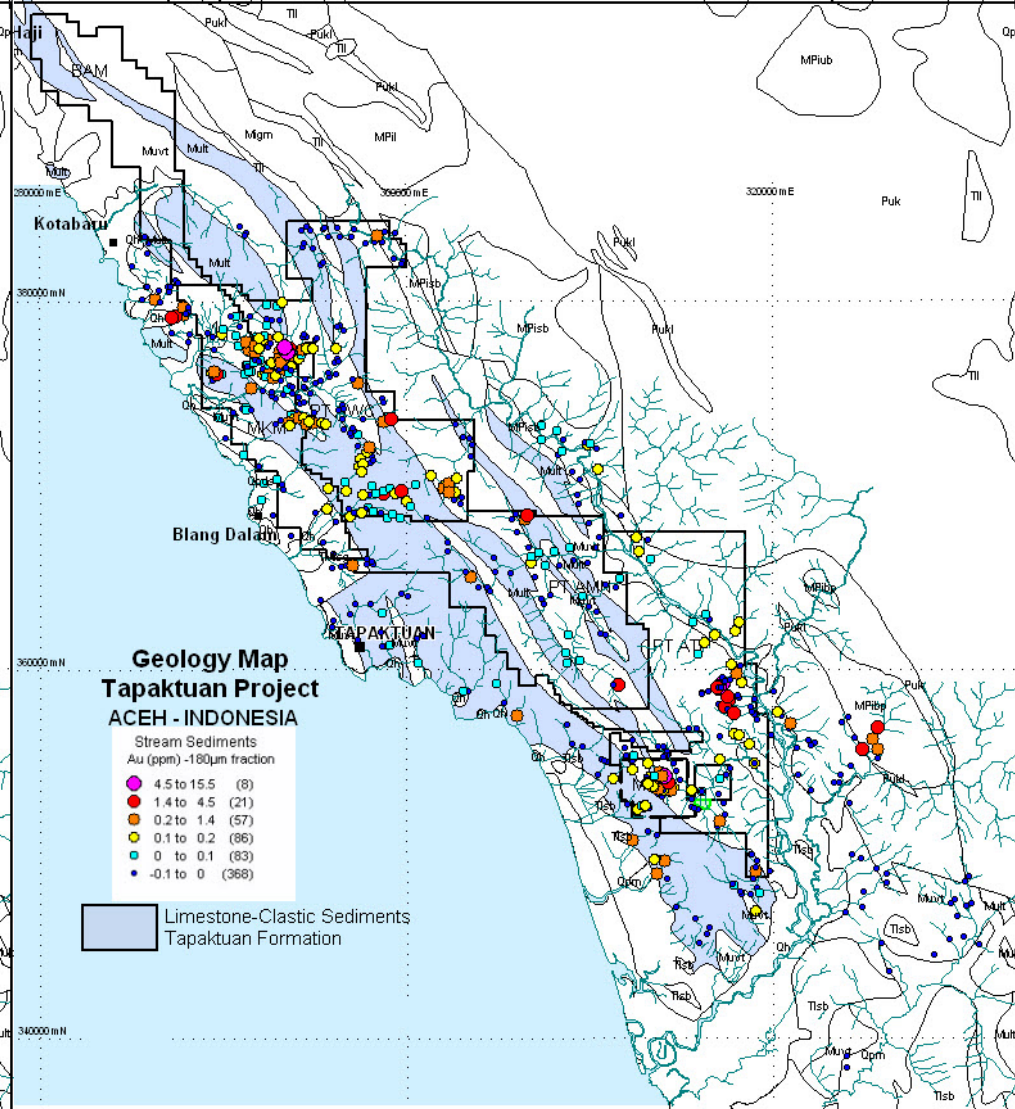
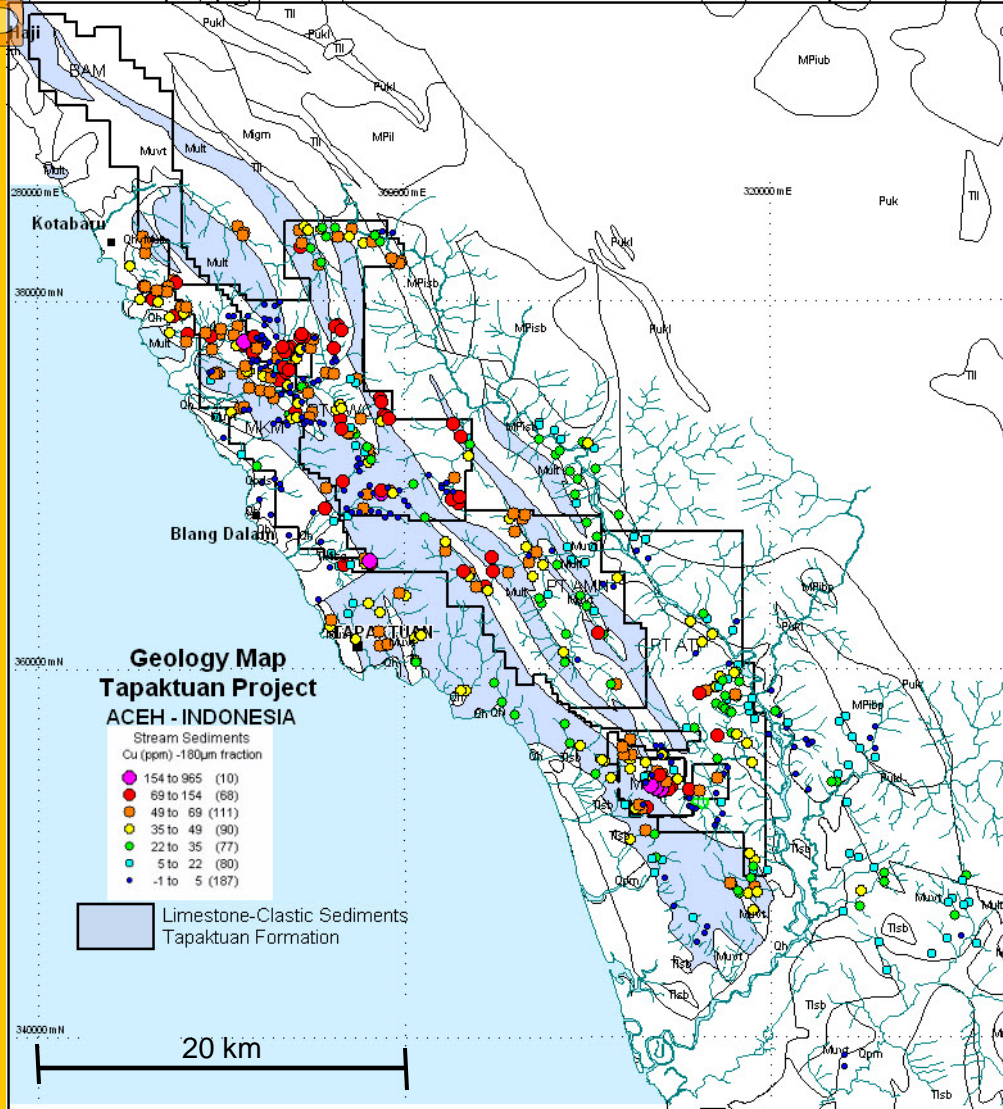
Polymictic clastic
sediments



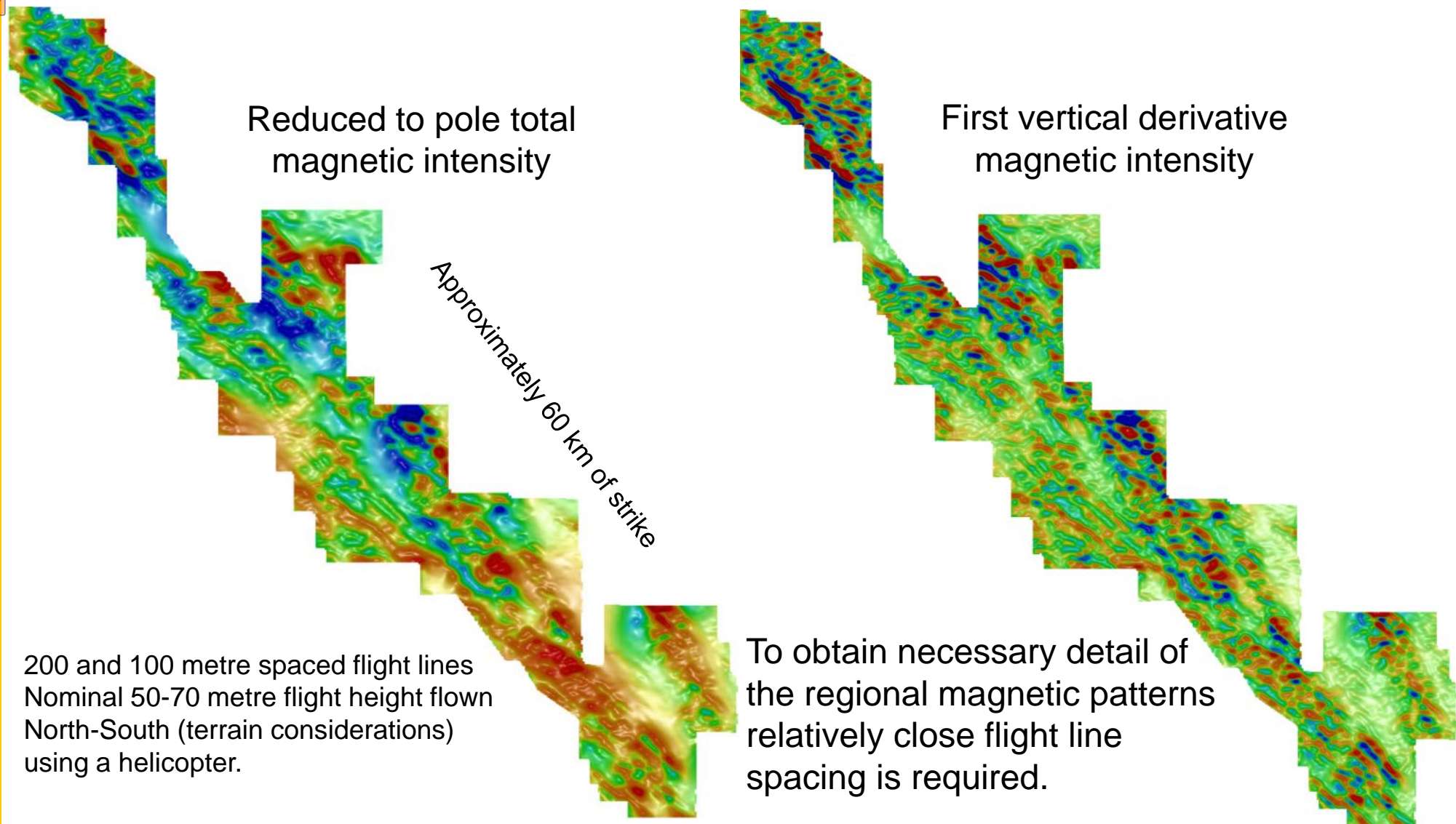
Intrusive-limestone (marble)
contact

Continental margin facies rocks

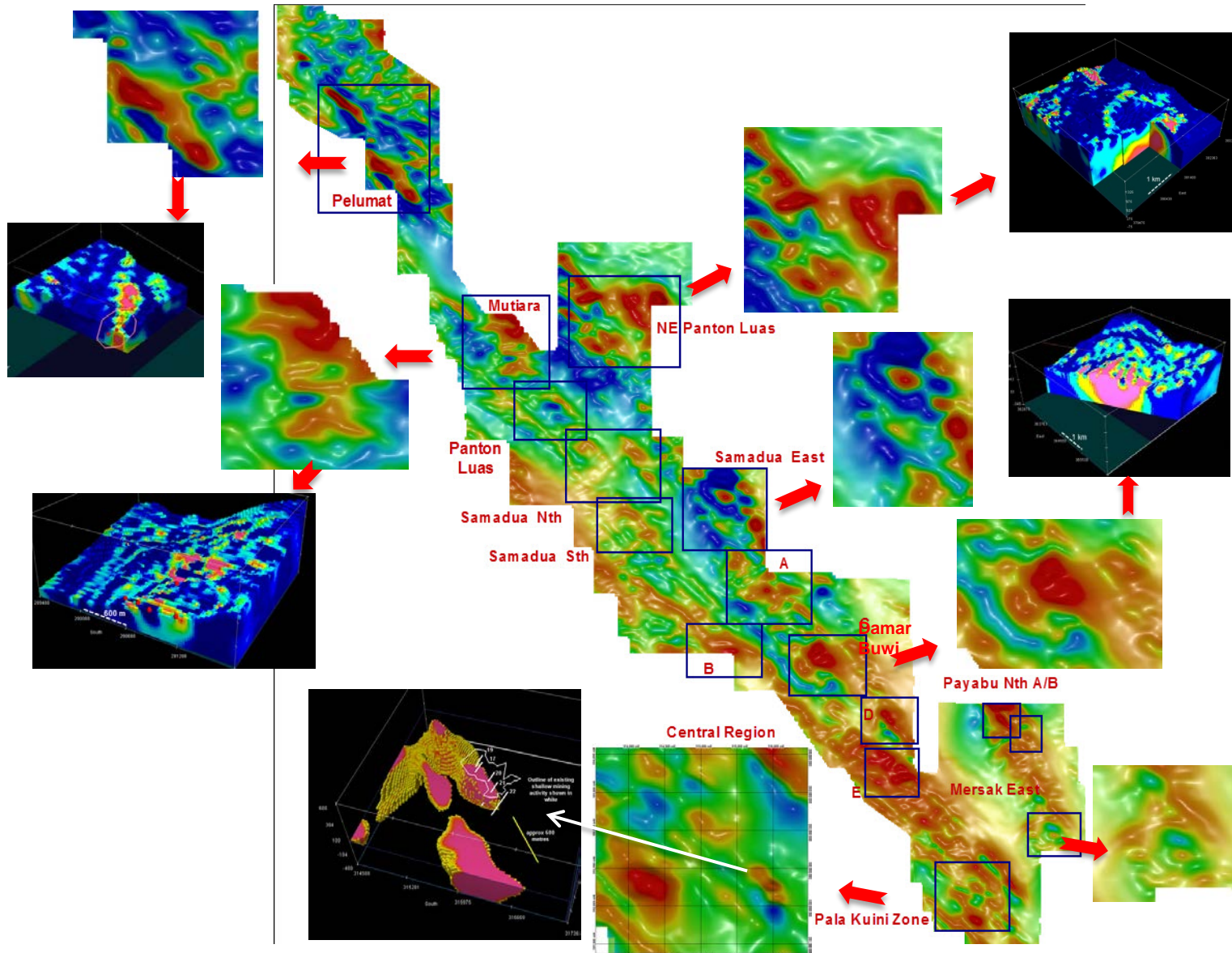




Regional stream sediment survey undertaken by Rio Tinto in early 1990s before the Aceh conflict commenced highlighted a number of regions of potential interest. Later sampling by a Meekatharra Minerals-Teck JV located gossanous outcrop at the two most prominent sites.



Due to access & logistical constraints geological mapping and detailed heliborne magnetics were used early in the program to outline regional setting, aid interpretation and for definition of target sites.

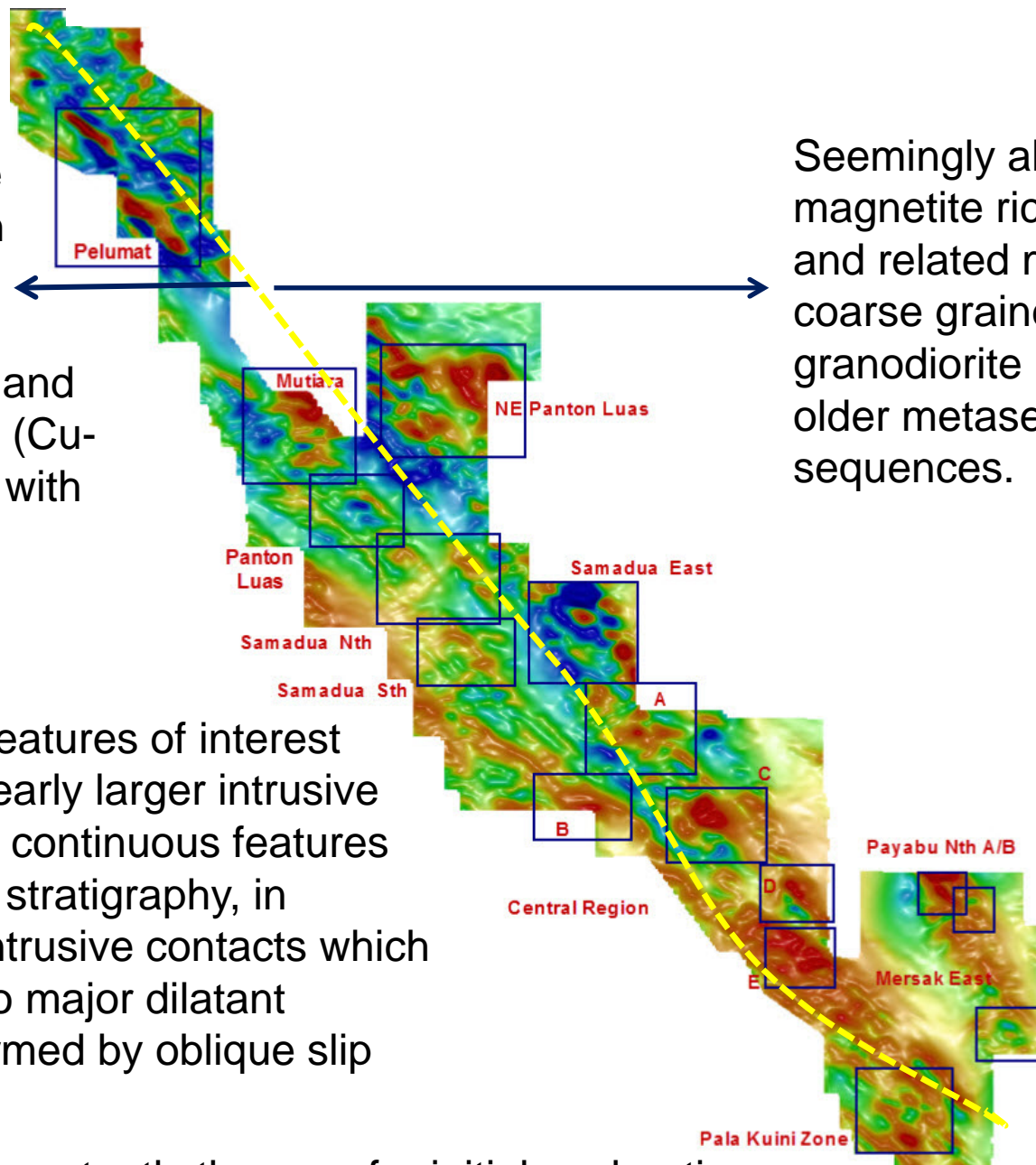


Airborne magnetic data detail and 3D inversion modelling merged with field mapping enabled anomaly discrimination.

Mineralised magnetite bearing endoskarns in elongate microdiorite intrusives and garnet-wollastonite prograde and retrograde exoskarns (Cu-Au-Mo) about contact with limestone

Numerous magnetic features of interest highlighted – some clearly larger intrusive bodies, others narrow continuous features mirroring the mapped stratigraphy, in particular limestone-intrusive contacts which however are related to major dilatant regional structures formed by oblique slip arc deformation.

Seemingly all barren magnetite rich endoskarns and related magnetite rich coarse grained diorite to granodiorite intrusives into older metasedimentary sequences.



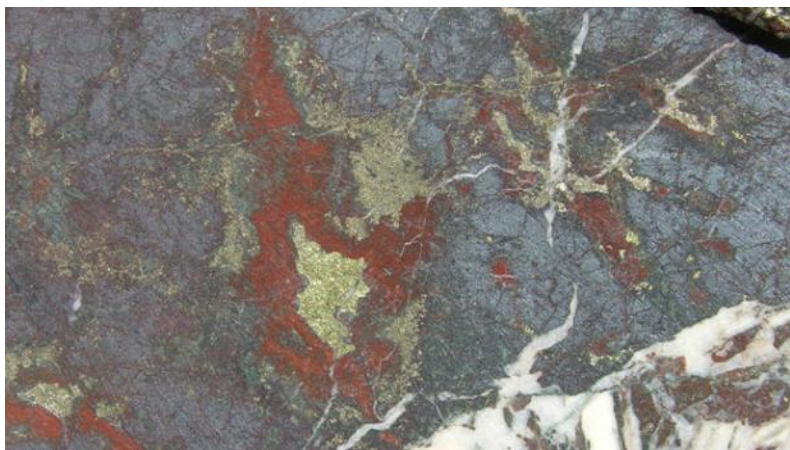
Importantly the area for initial exploration could be significantly reduced.



(17 metre interval from 212 metres @ 1.27g/t Au and 0.7% Cu)



Example of outcropping magnetite endoskarn hosted within epidote-bearing retrograde altered microdiorite

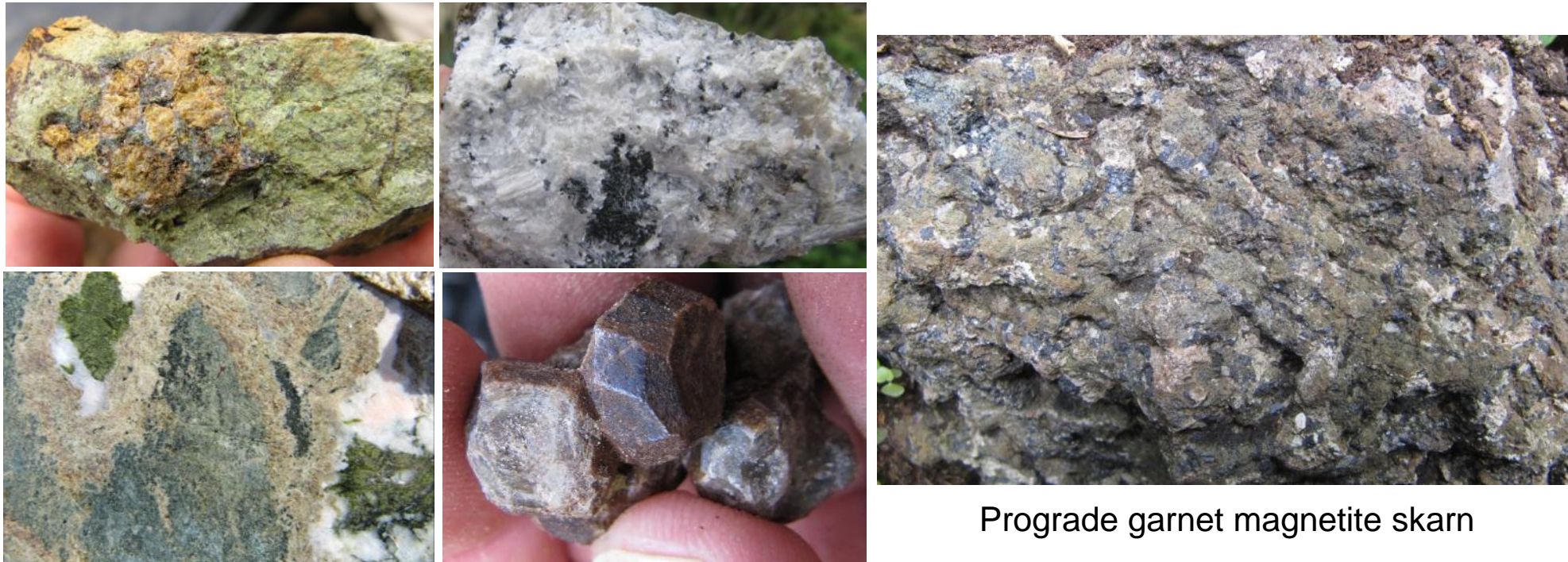


(1 m interval 1.47 g/t Au; 0.49% Cu)

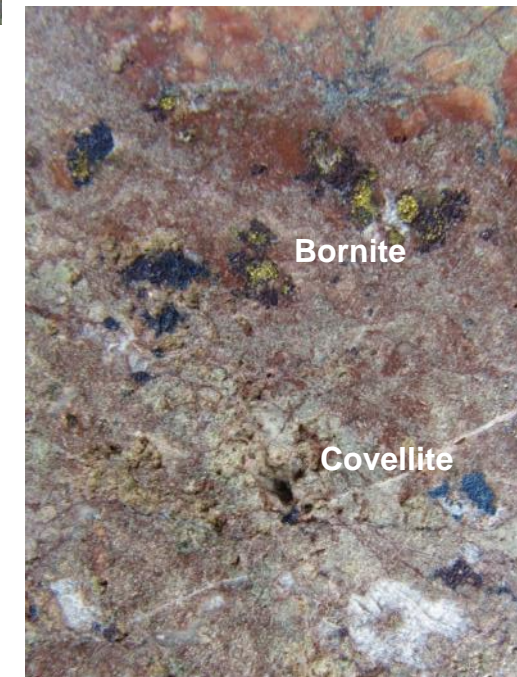
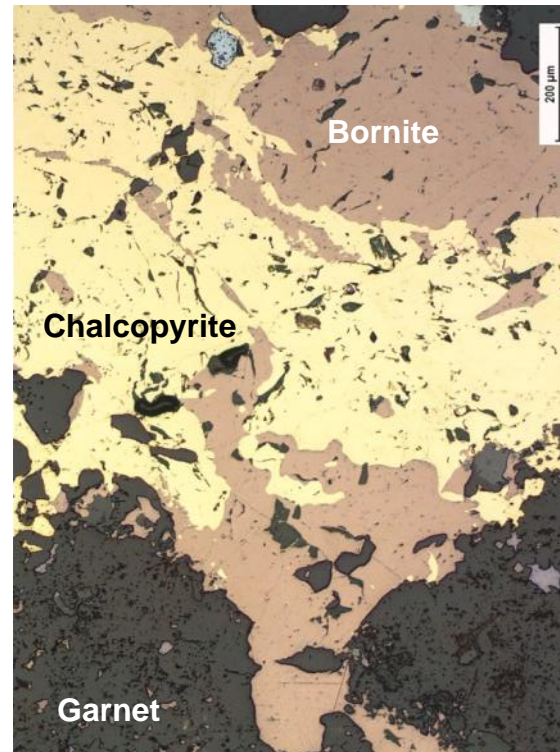
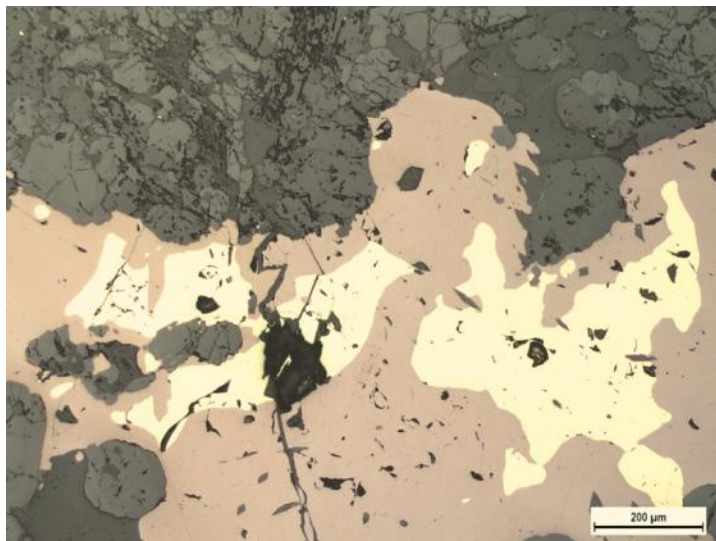
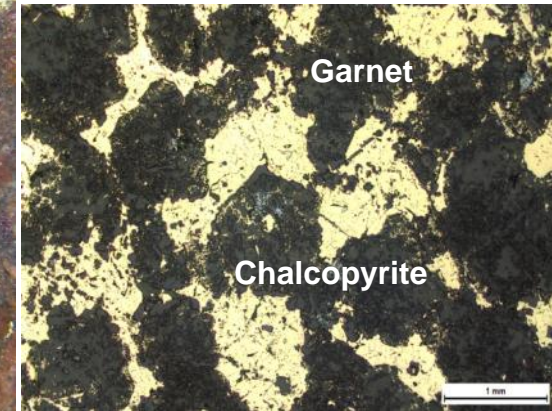
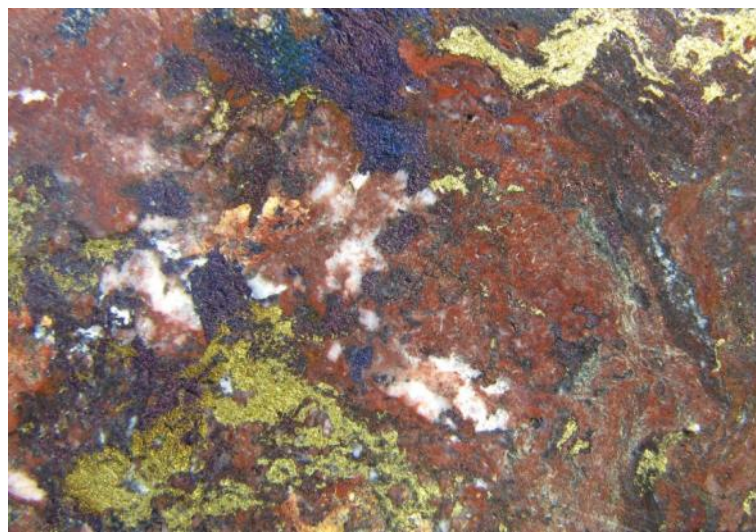
Early drilling was focused on the strongly magnetic microdiorite hosted targets with results giving sufficient encouragement to expand activities to other regional targets.

§ Mapping demonstrated that pronounced magnetic lows marginal to intense linear magnetic features were often sites for prograde garnet-pyroxene±wollastonite skarns which subsequently became altered by mineralised hydrothermal fluid derived from the intrusive. These intrusives are anomalous in Au and Cu and contain abundant magnetite.

§ High grade retrograde Au-Cu skarns occur as irregular pipe-like bodies adjacent to the intrusive margin or associated with often large limestones blocks incorporated within the intrusion. These are readily located using routine soil and rock geochemistry across the target zone.

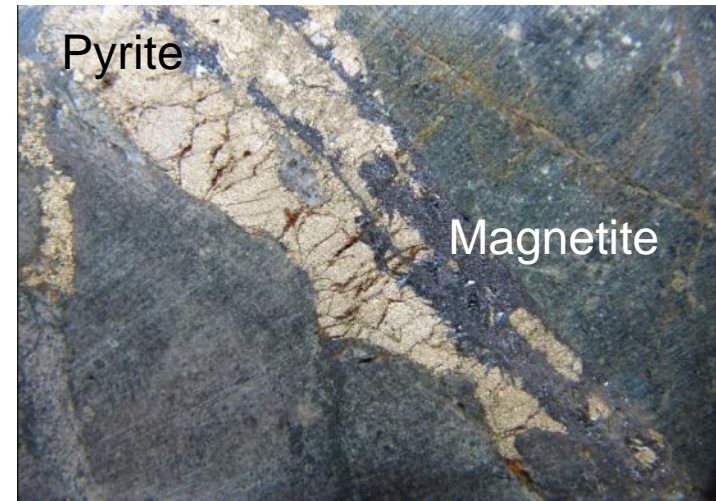


Prograde garnet magnetite skarn

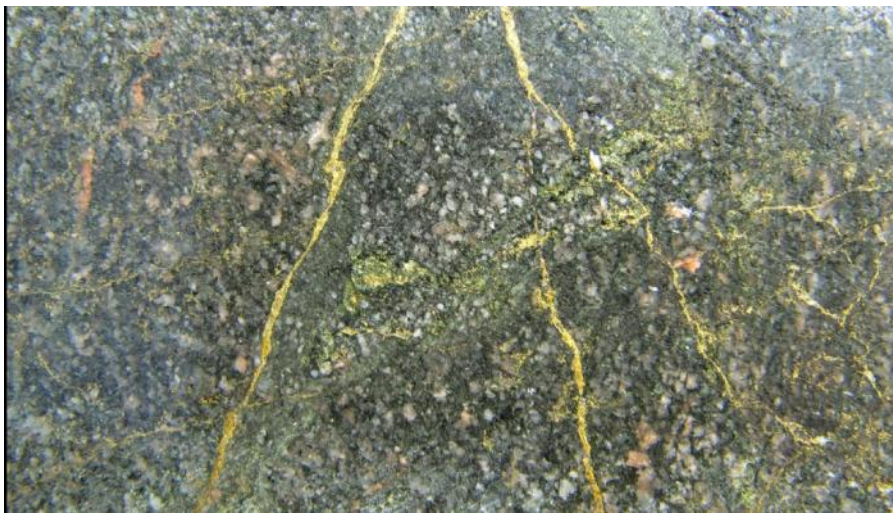


Mineralisation is dominated by bornite-chalcopyrite assemblages in retrograde skarns; magnetite-chalcopyrite in prograde endoskarns within the microdiorite intrusives.

Examples of high grade skarn mineralisation



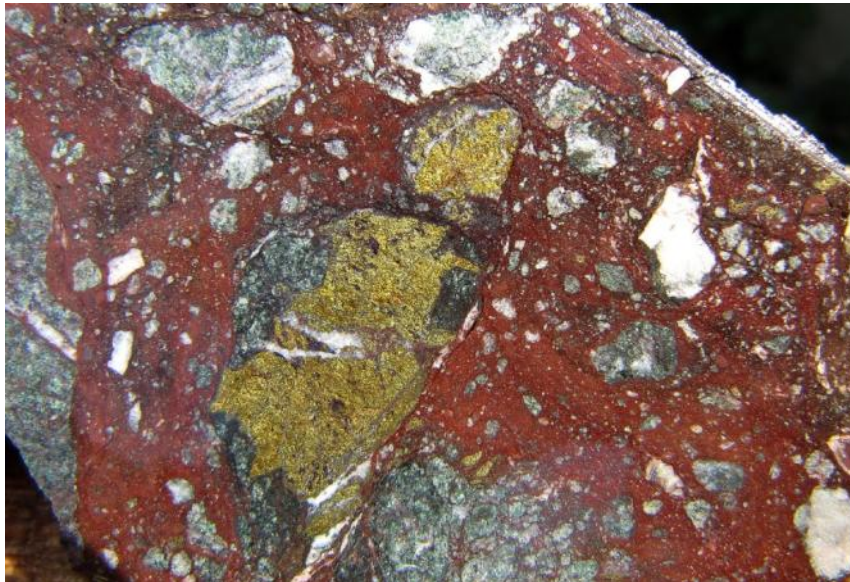
Hydrothermal features are seen as magnetite veins, alteration of magnetite to pyrite, miarolitic cavities lined with feldspar and bornite crystals, pyrite-chalcopyrite vein fill within microdiorite.



Chalcopyrite as late fracture fill



Mylonitic fabric high compression shear surface

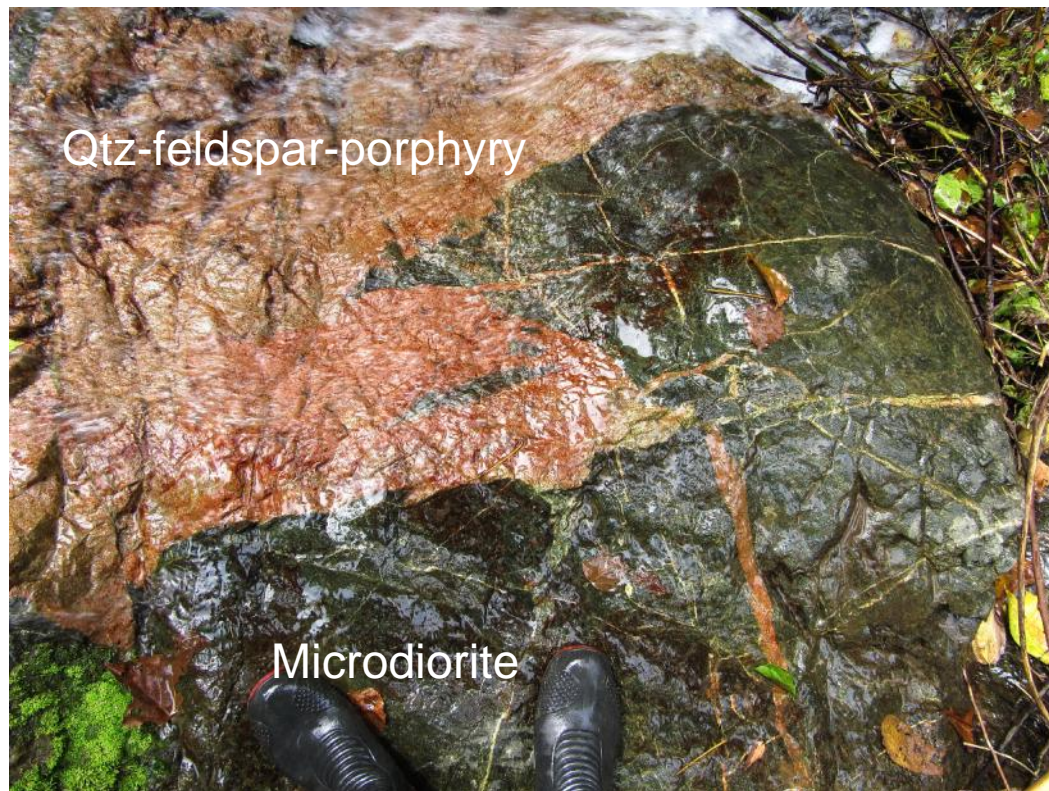
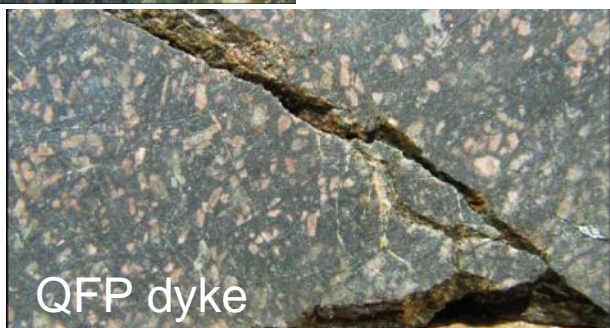
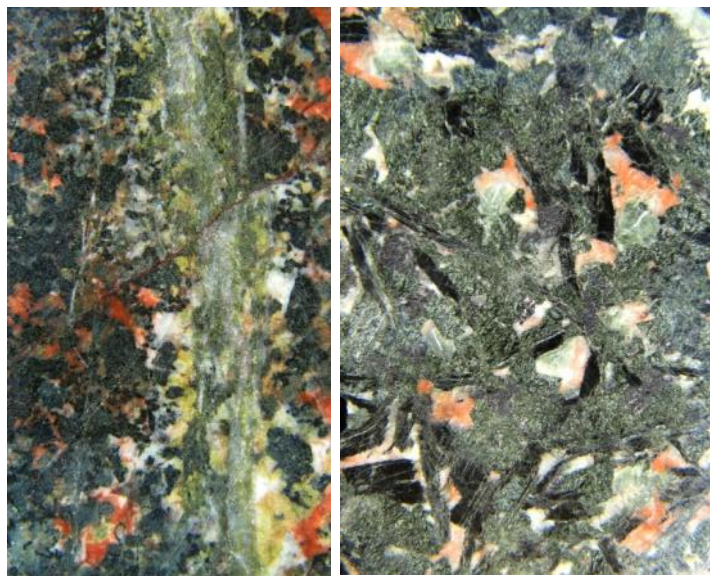


Late hydrothermal breccias with limestone & mineralised microdiorite clasts



Polymictic intrusive breccia

Evidence of tectonic and intrusion related events

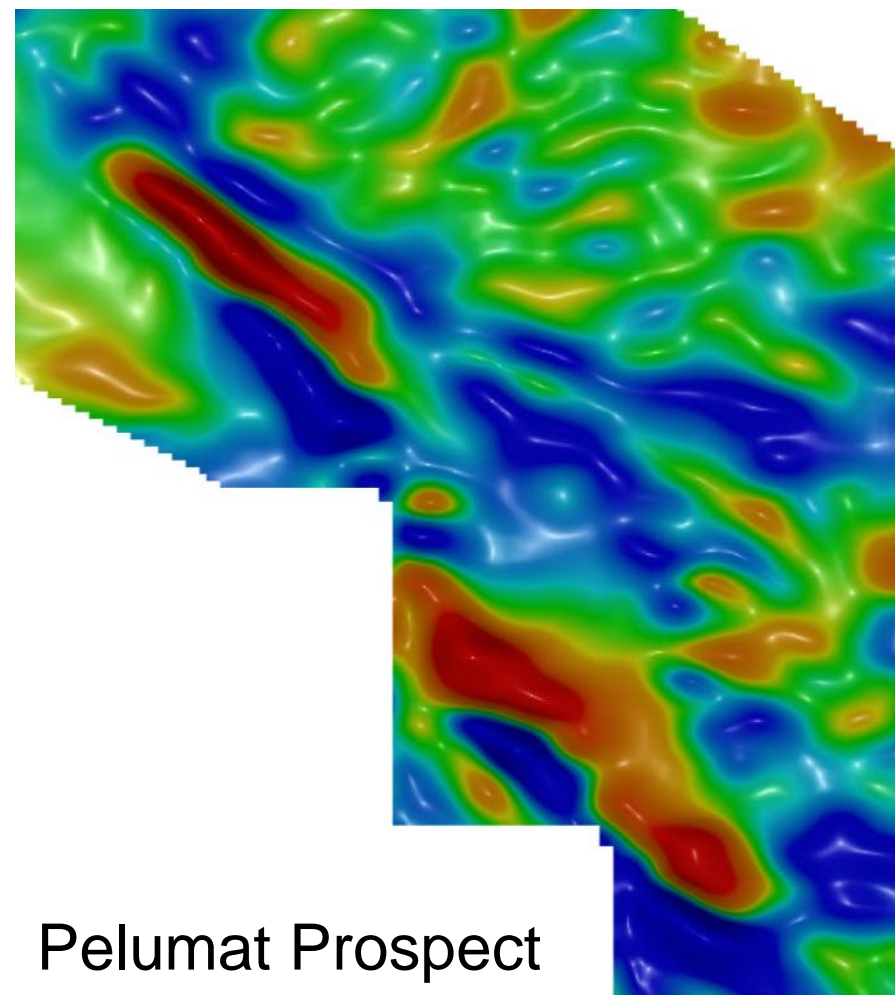
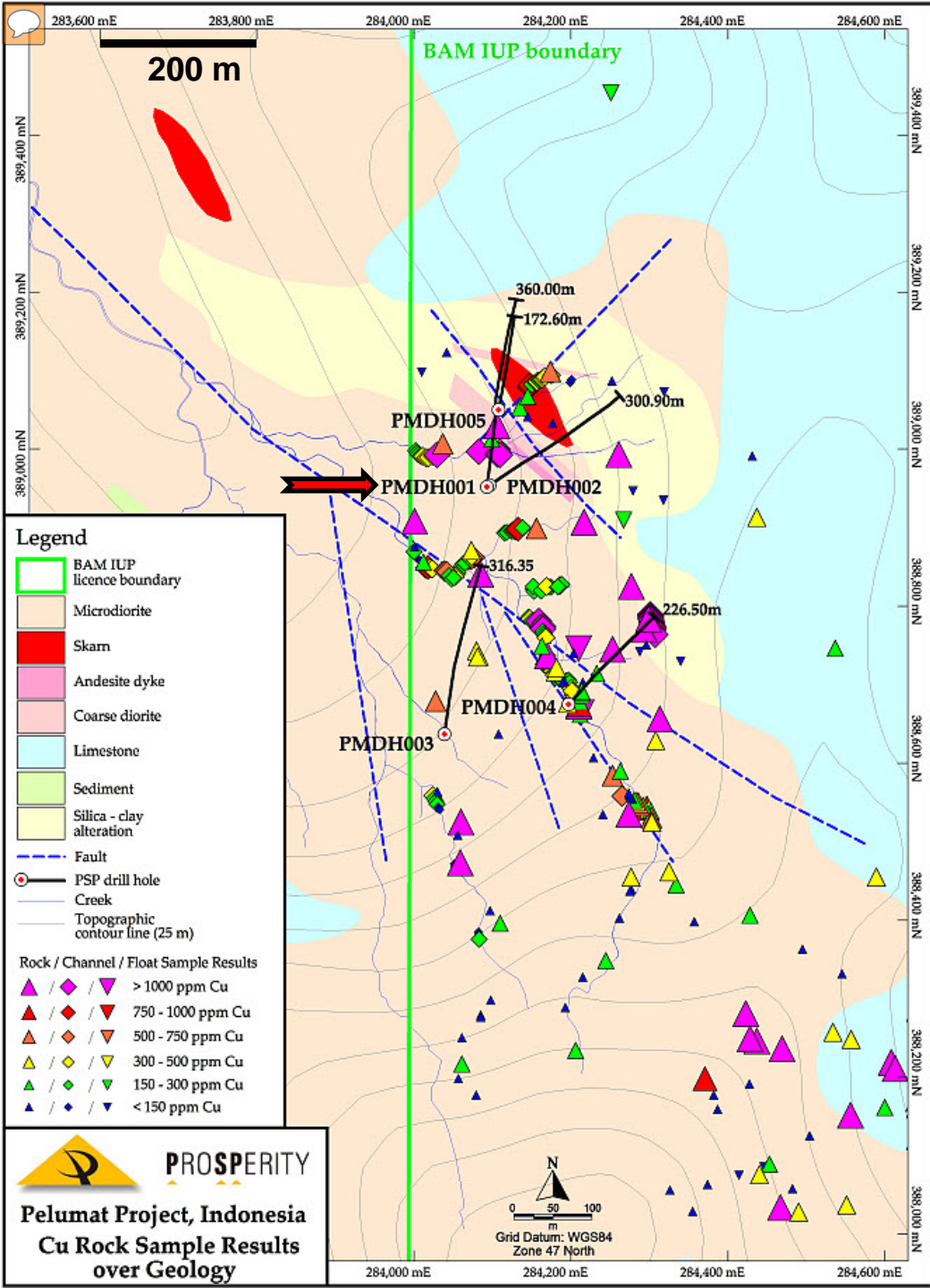


Qtz-feldspar-porphyry

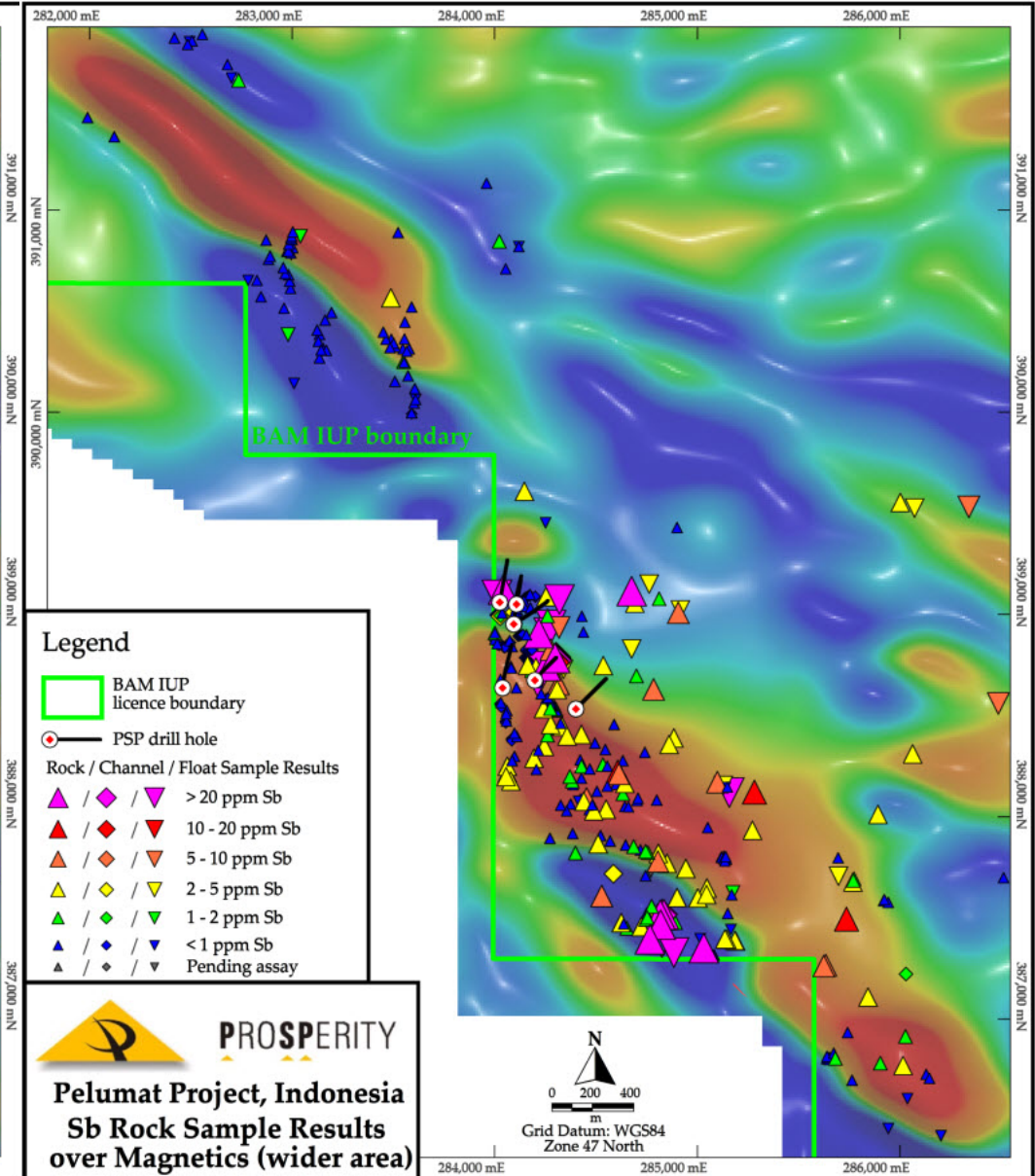
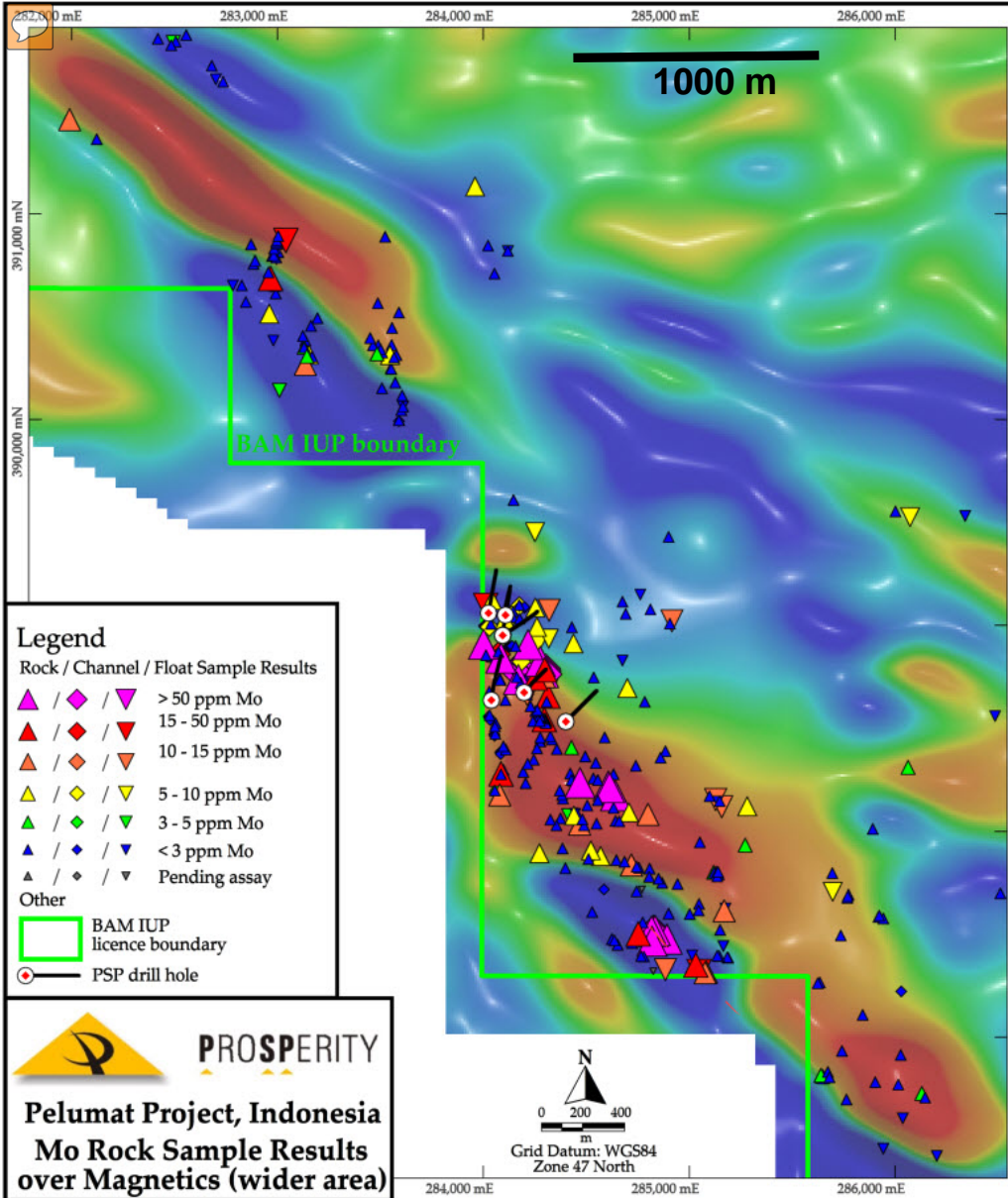
Microdiorite

Ongoing intrusive activity occurs as fracture fill reflecting continuing dilation along the same structural pathways



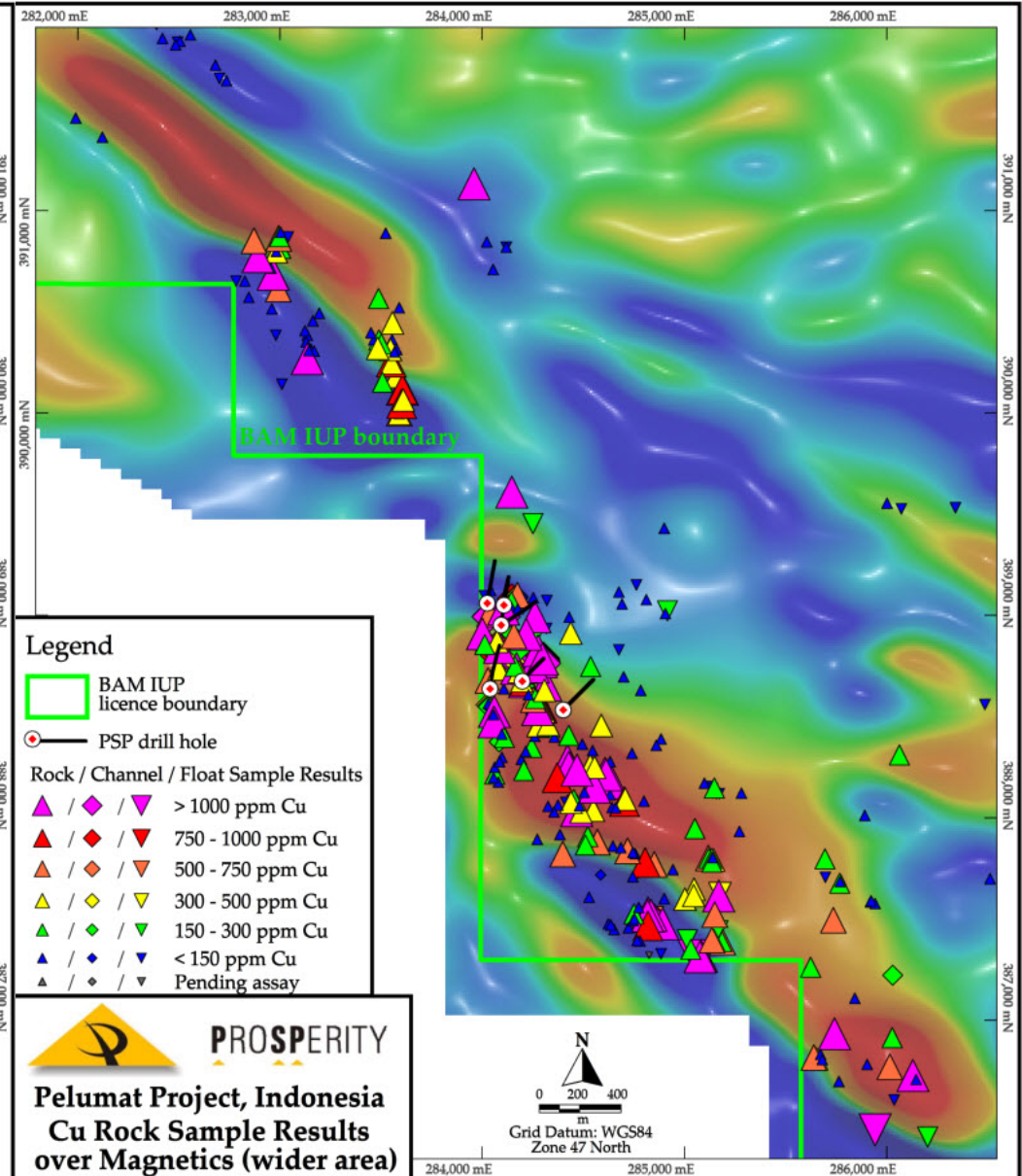
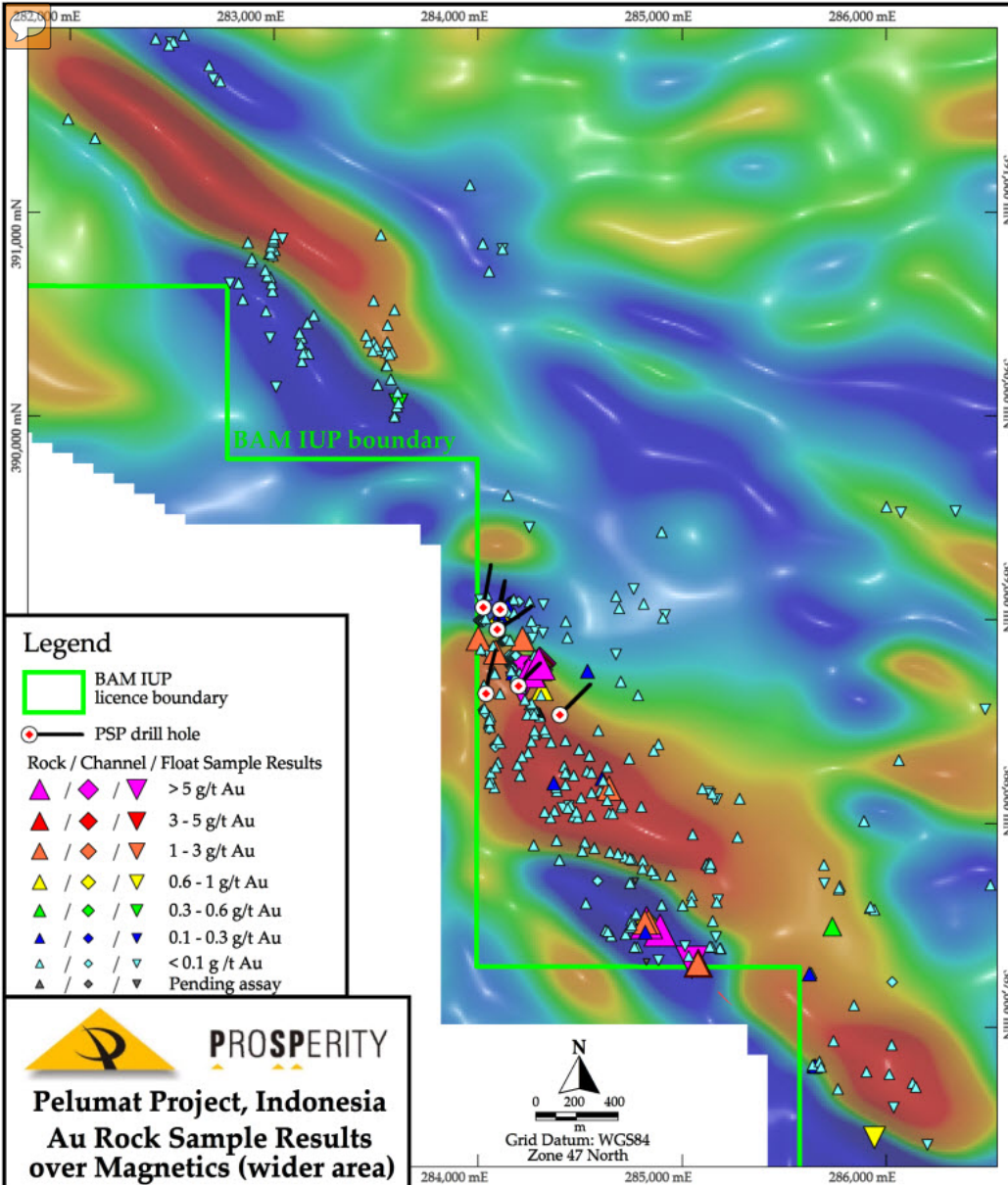


Pelumat Prospect
Geology & Magnetic
expression.

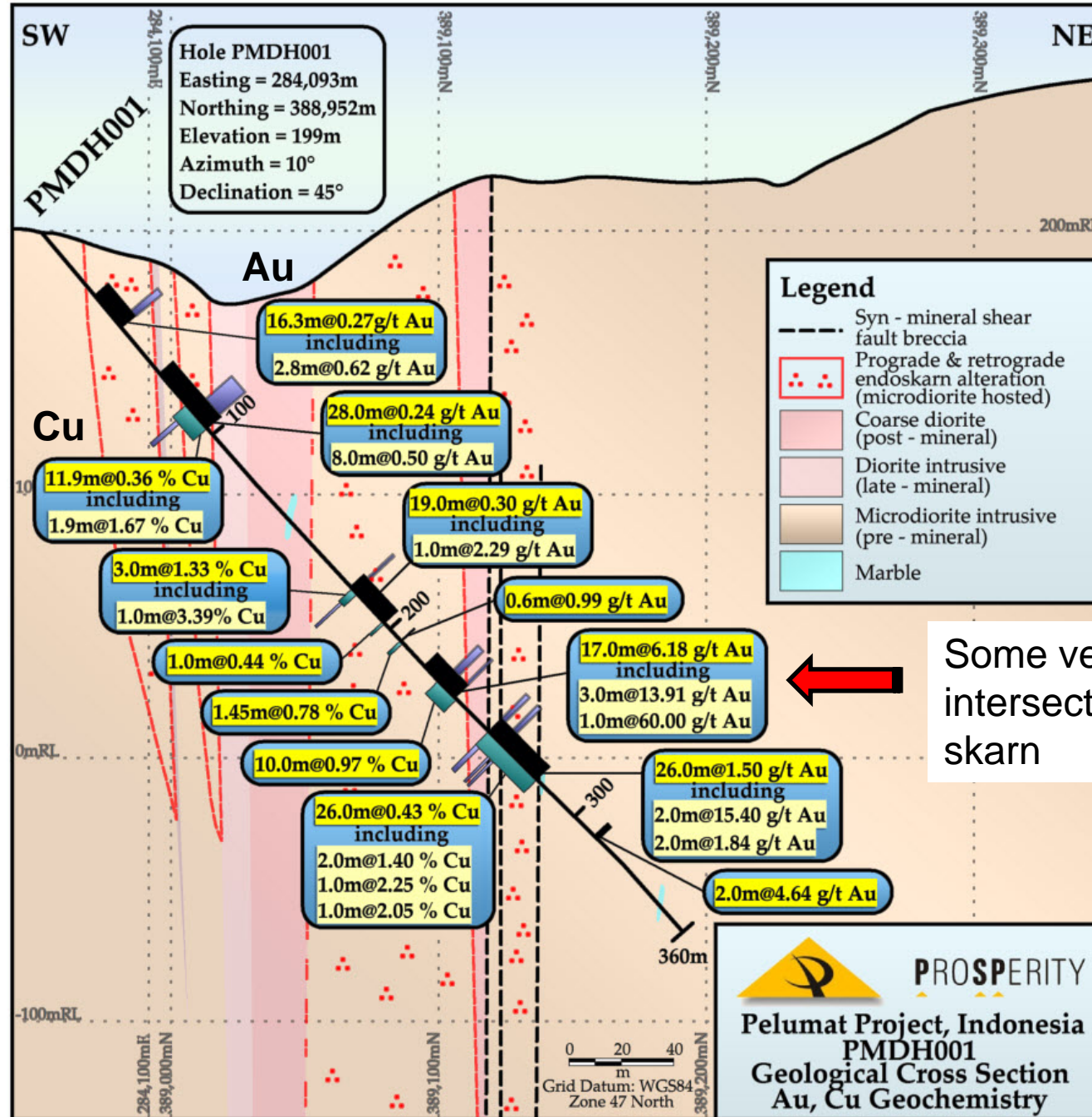


Rock chip Results over RTP TMI Image

Mo-Sb rock chip results



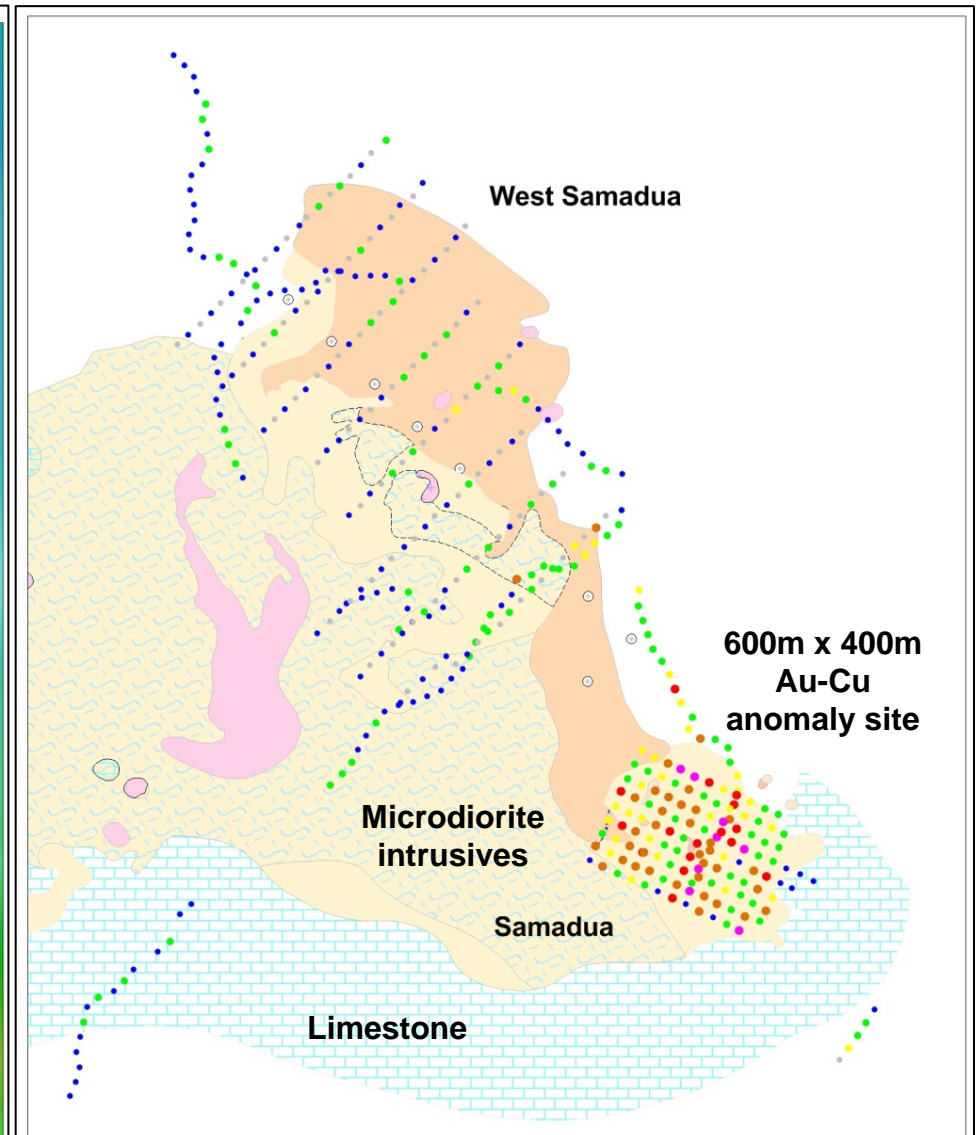
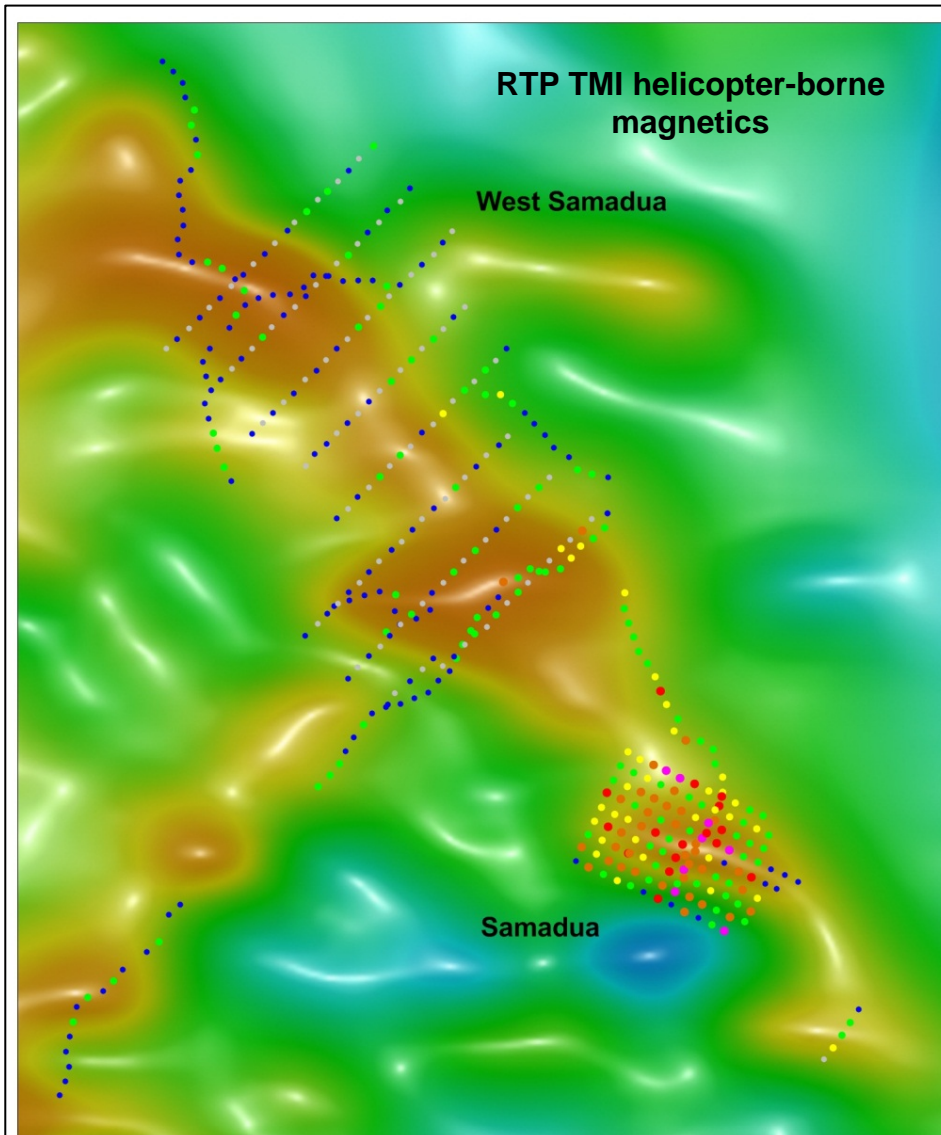
Rock chip Results over RTP TMI Image Au-Cu rock chip results



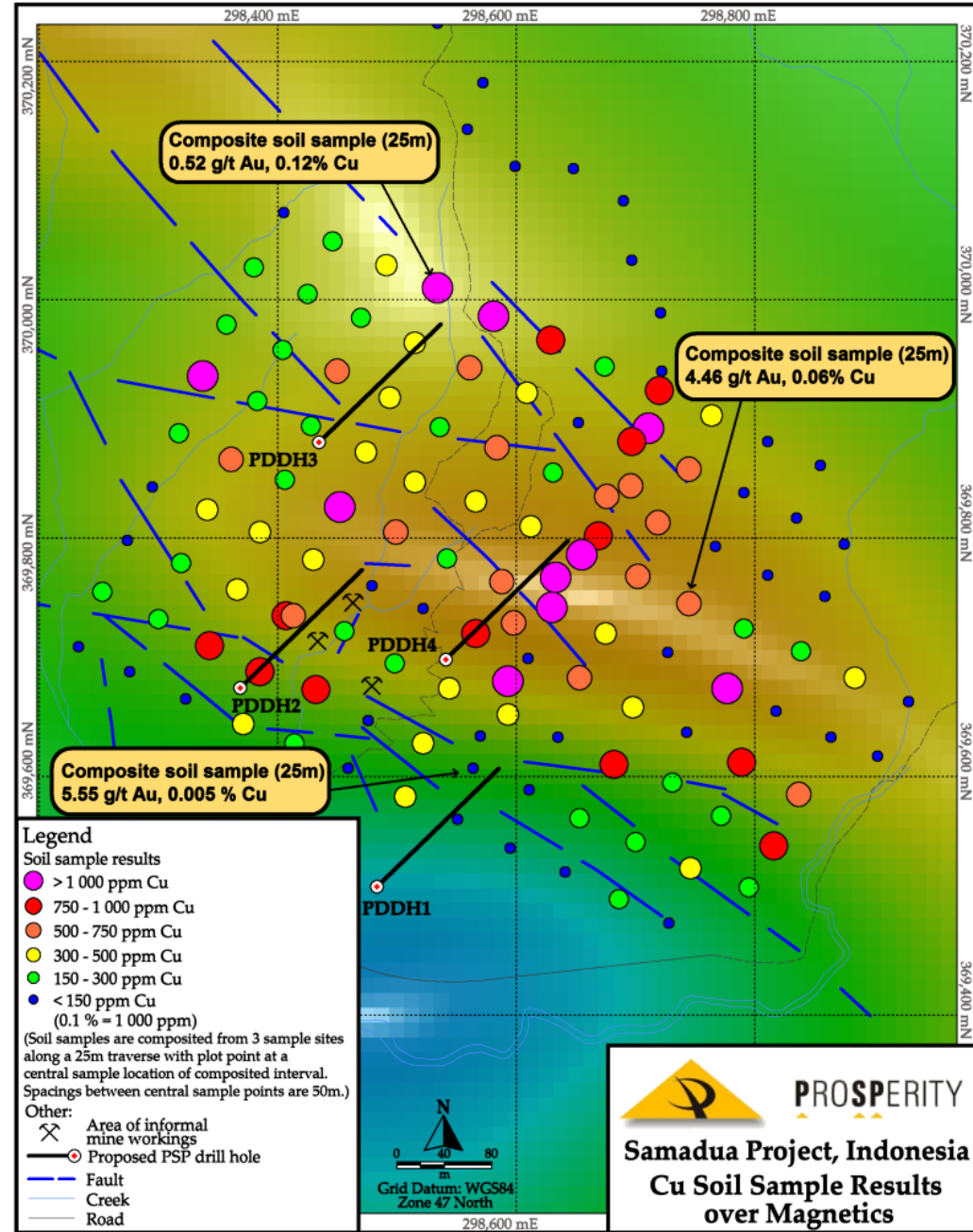
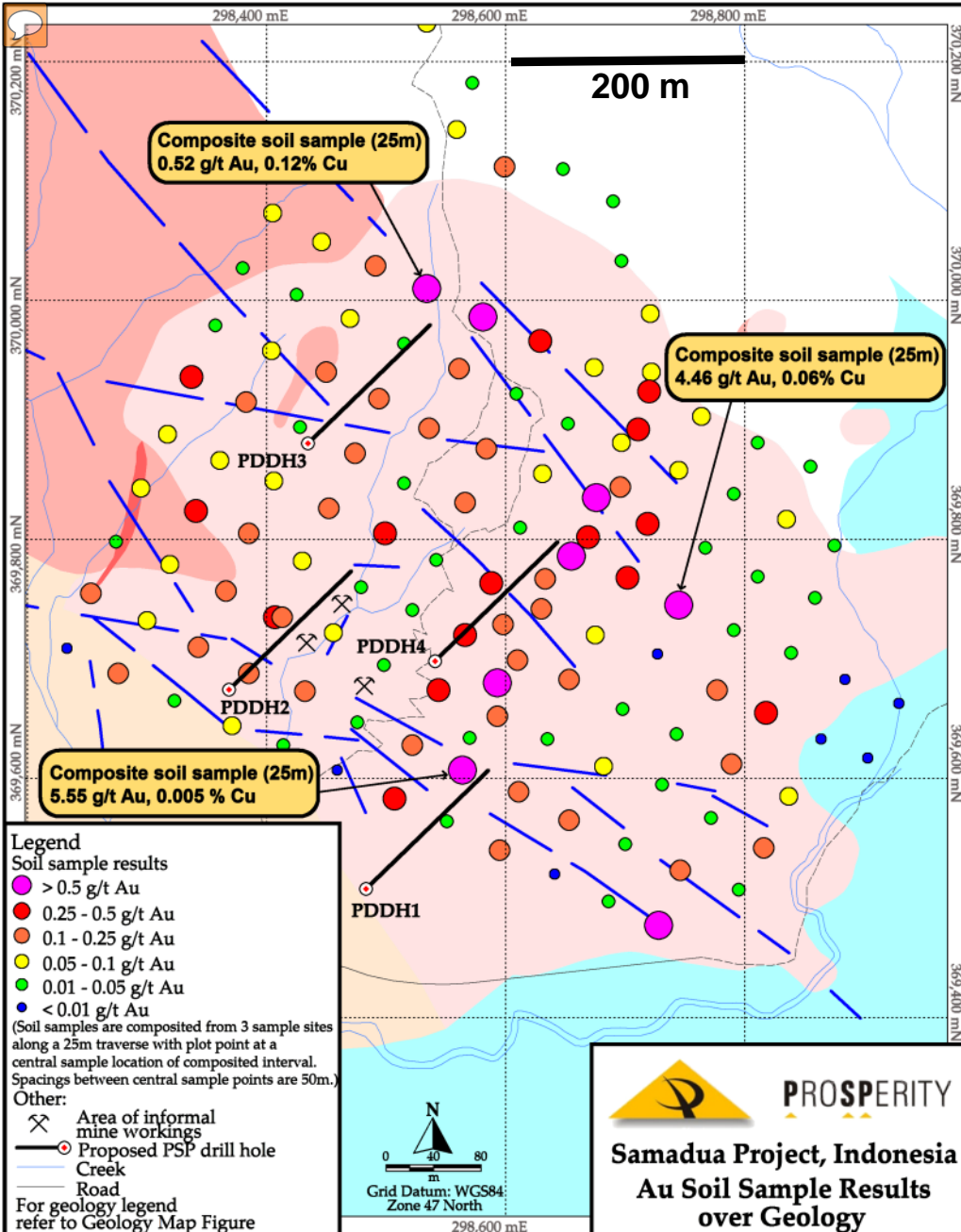
Some very high grade intersections in retrograde skarn



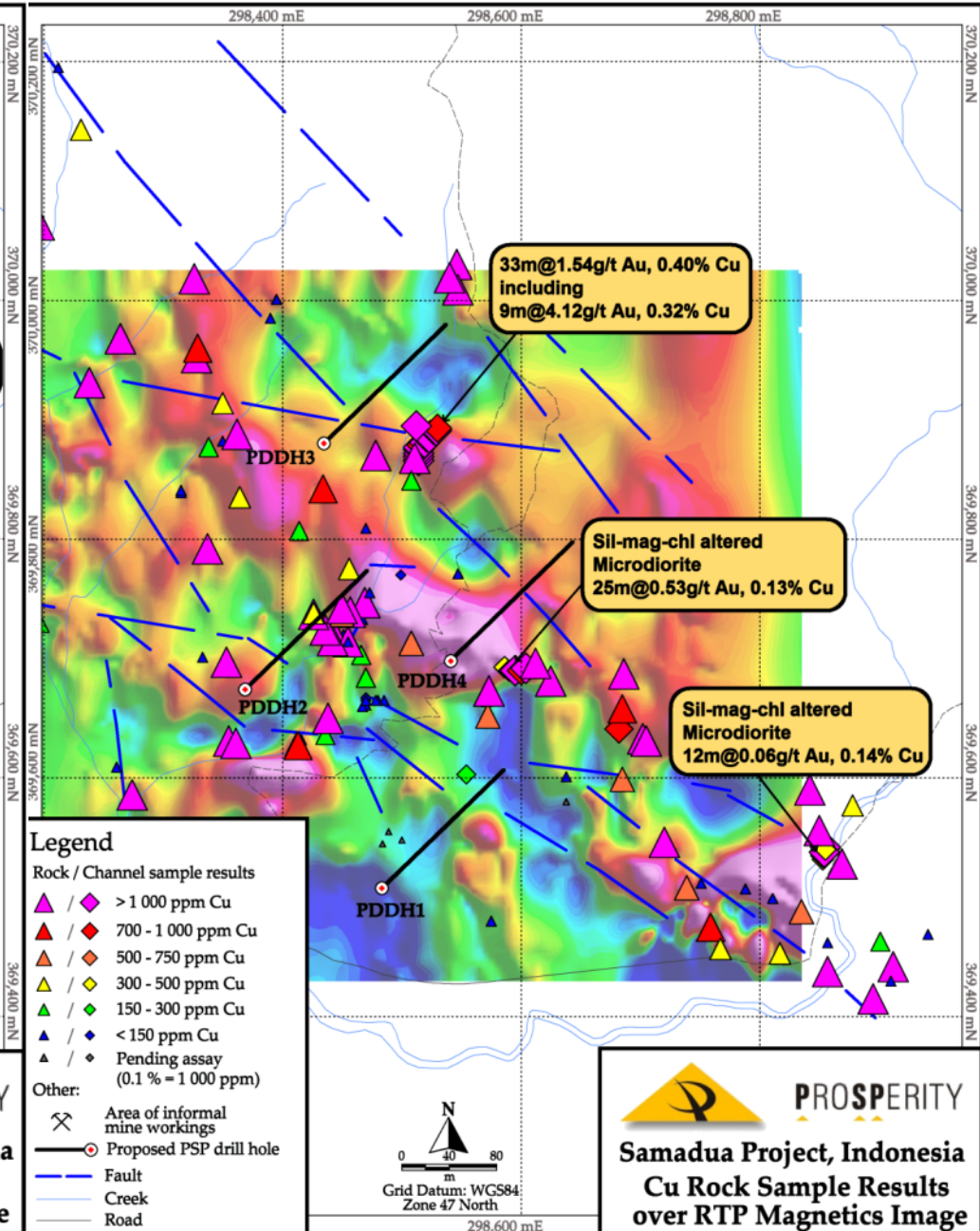
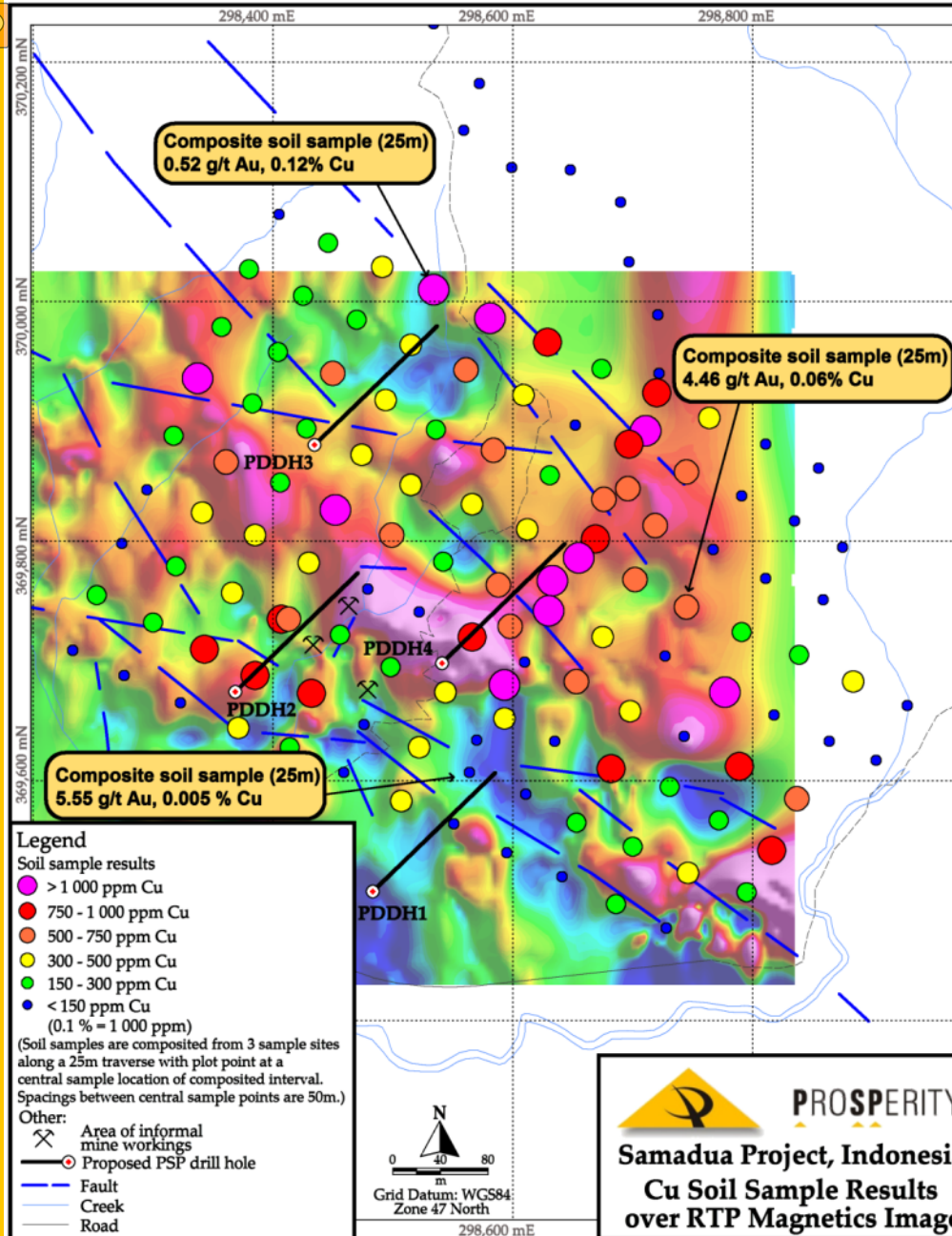
Samadua Project – Location in the clouds



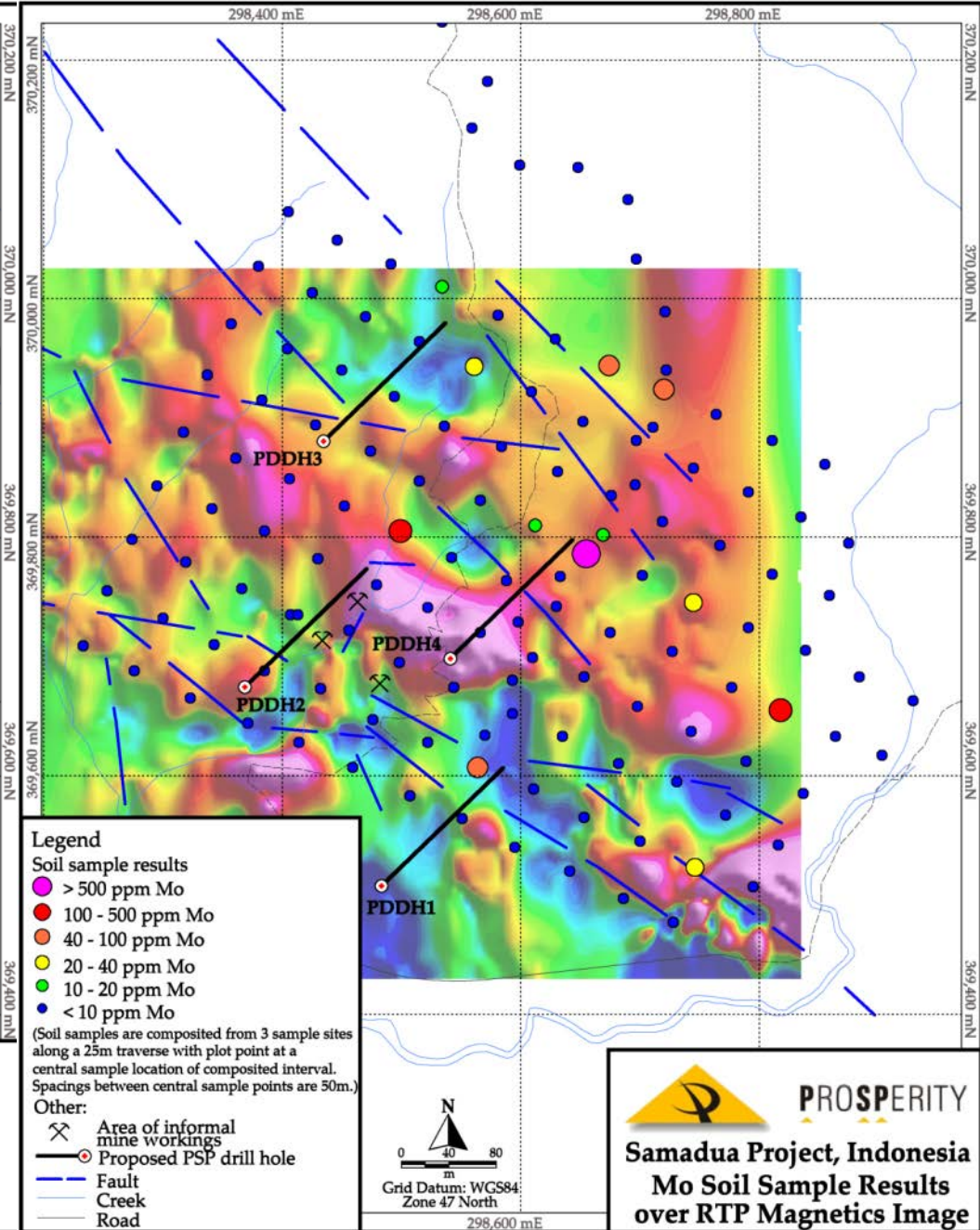
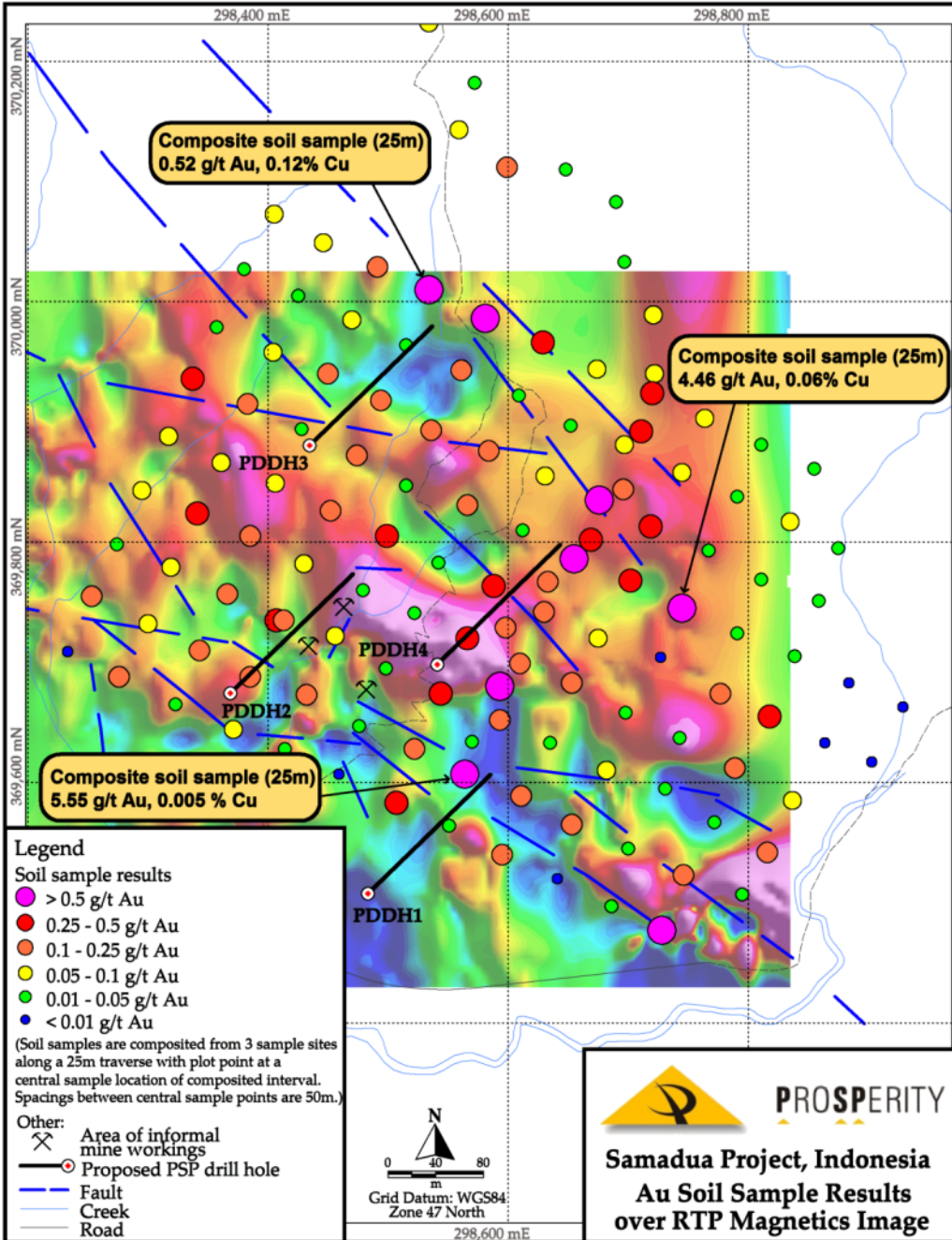
Samadua Project – Magnetism, geology and Cu-Au-Mo geochemistry



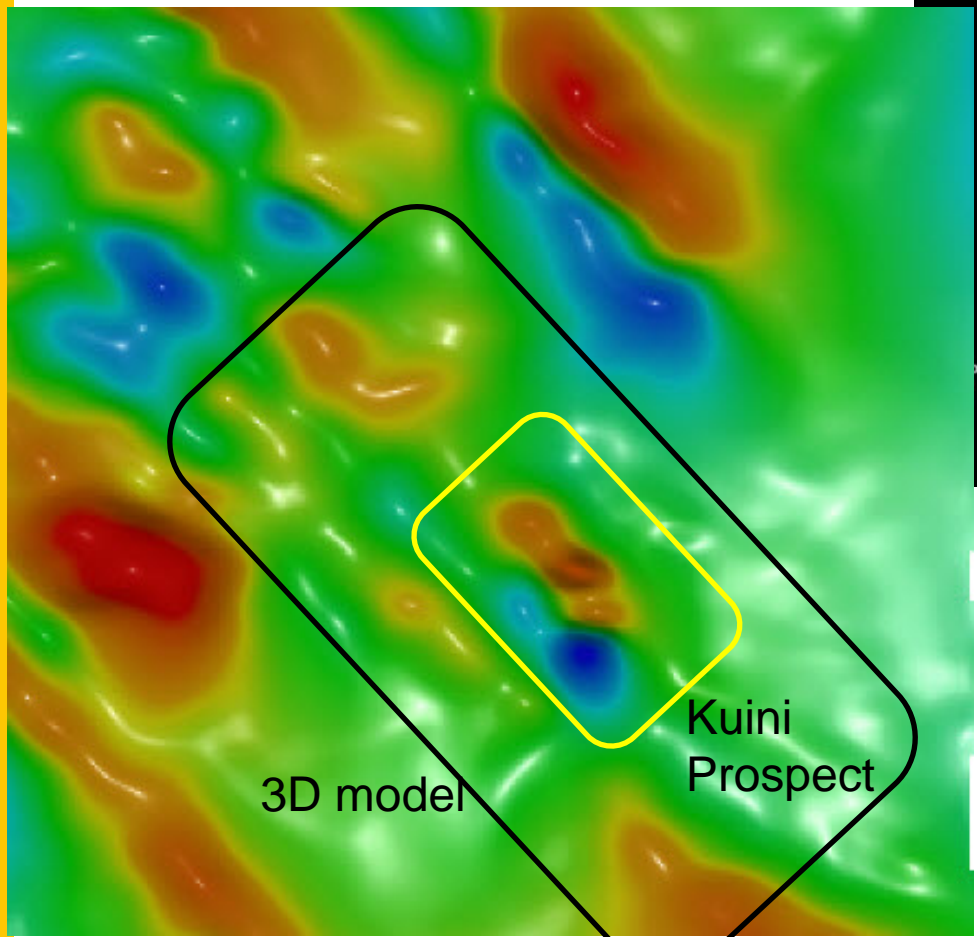
Samadua – Au & Cu in soil samples over geology & magnetics



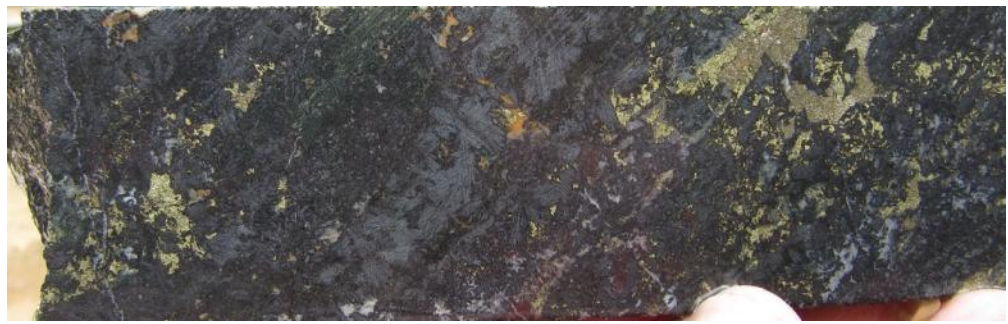
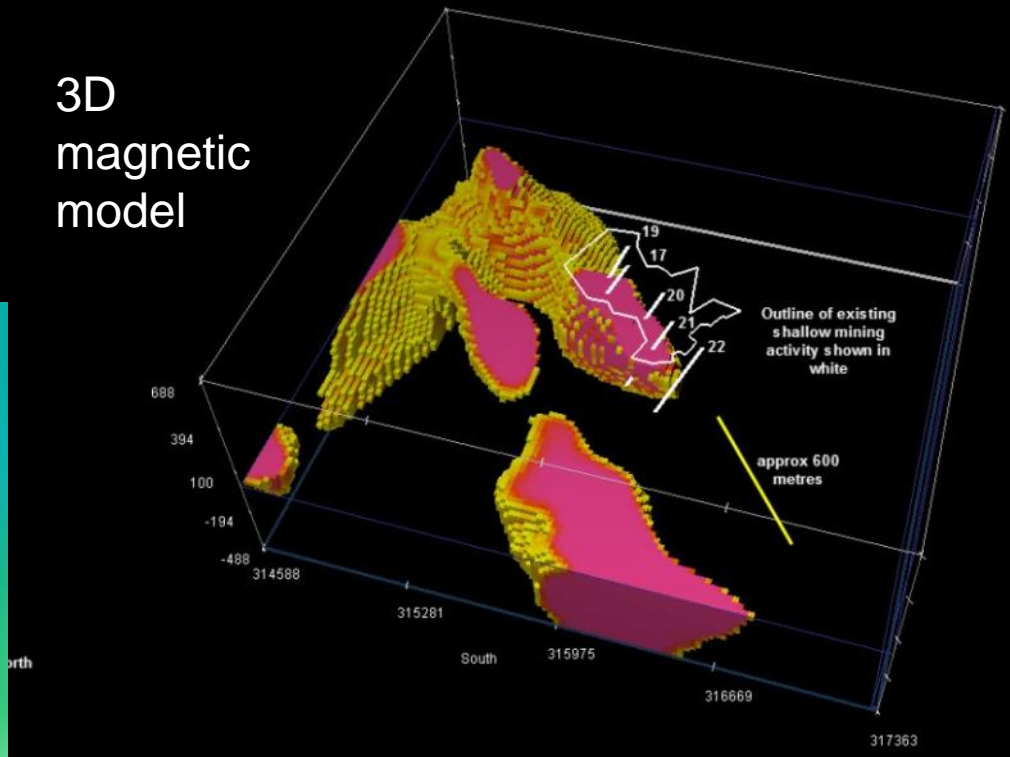
Samadua Cu rock chip and soil results over detailed ground RTP TMI magnetism image



Samadua Au – Mo soil results over detailed ground RTP TMI magnetics image

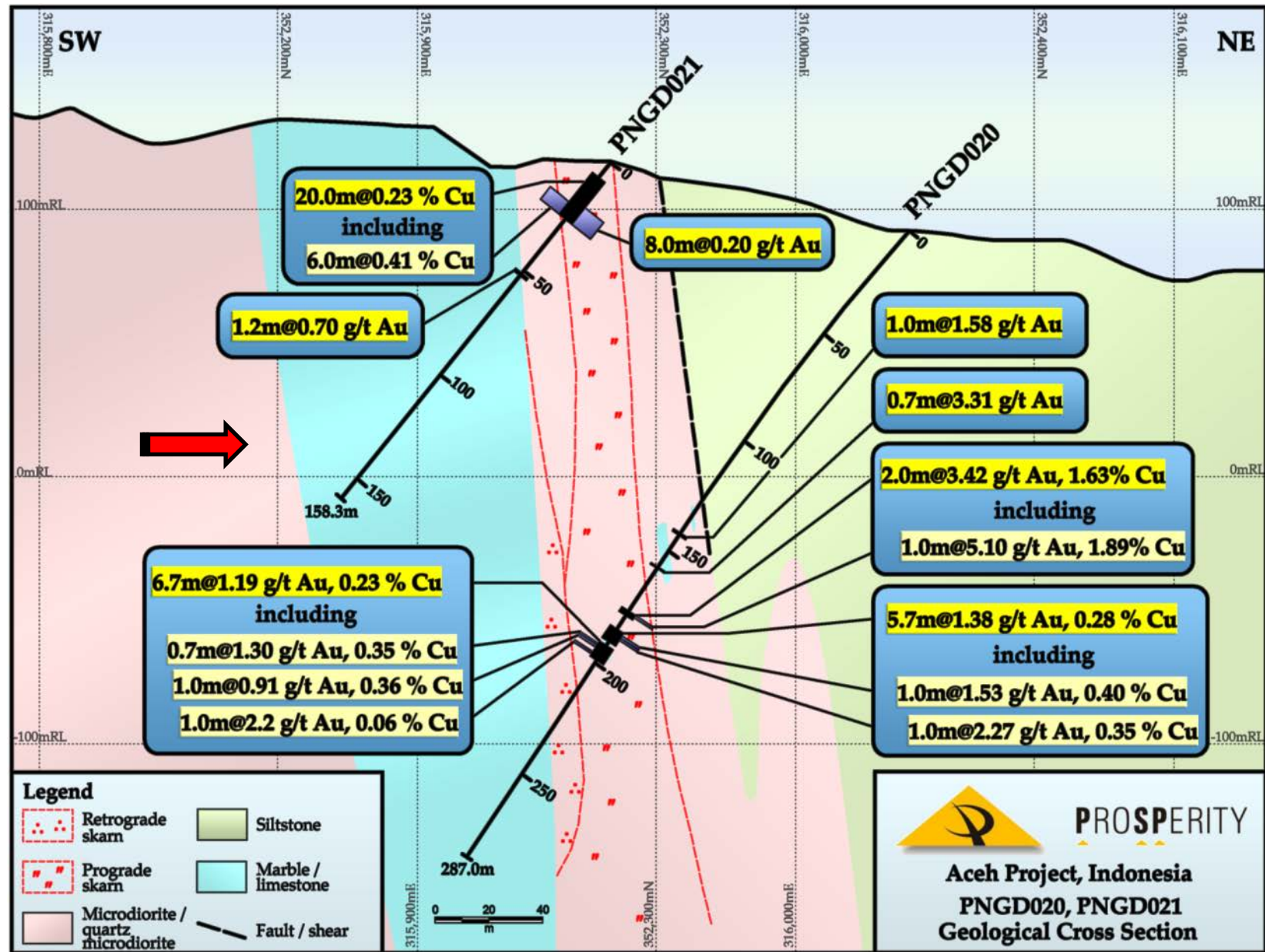


3D
magnetic
model

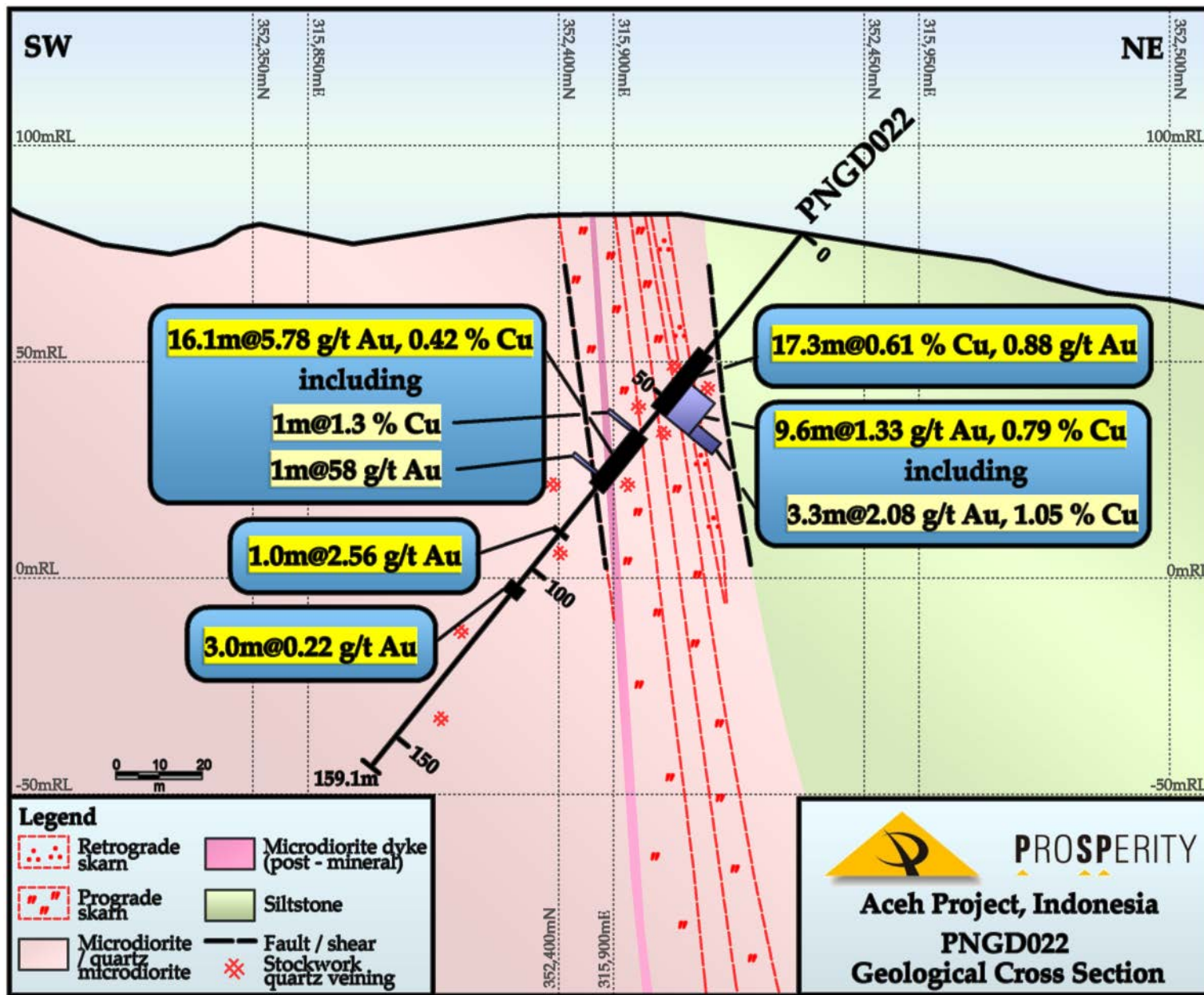


Magnetite-chalcopyrite endoskarn

Kuini Cu-Au-Mo Prospect



Kuini Prospect – endoskarn skarn near margin of intrusive. Note blocks of limestone in intrusive.



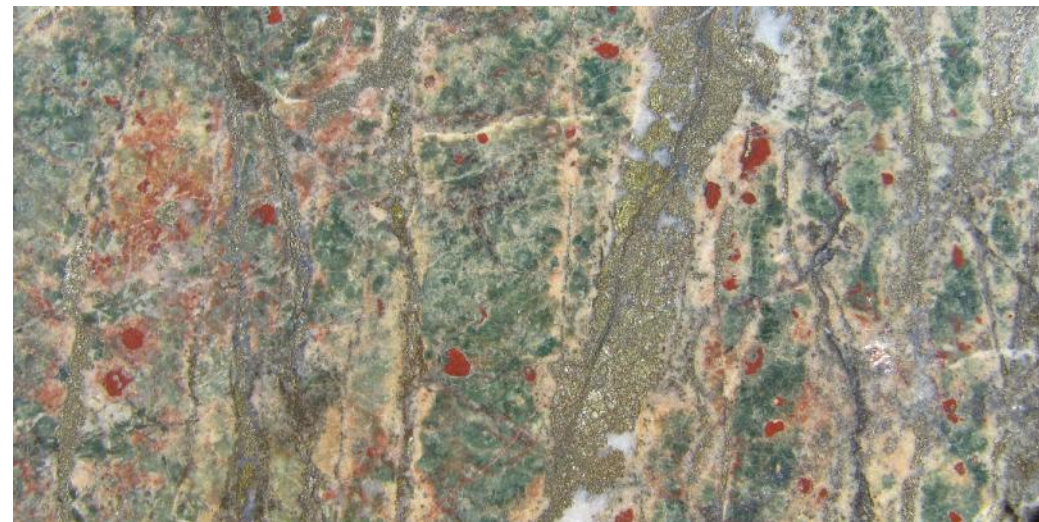
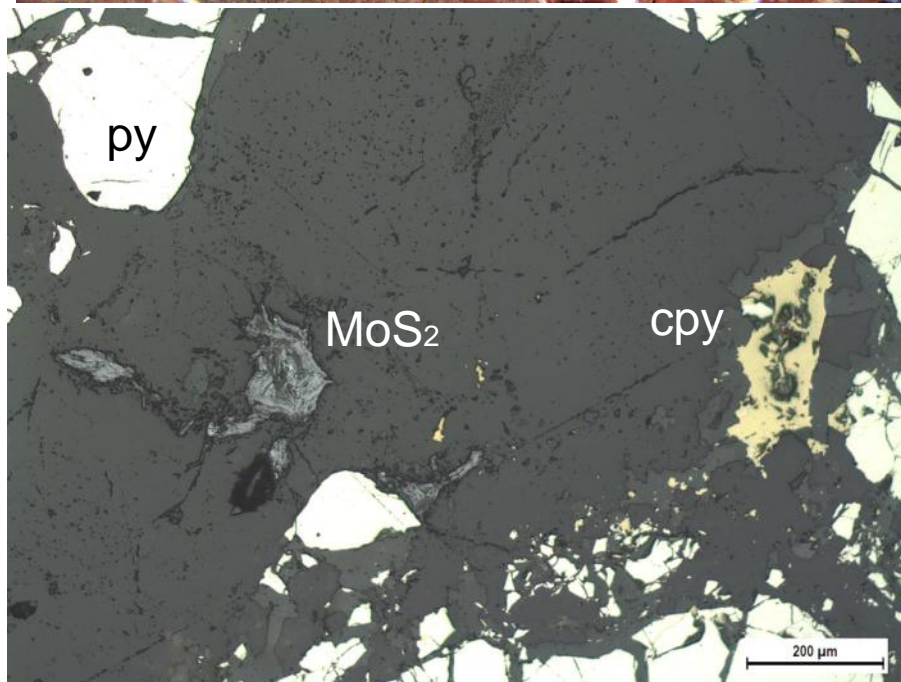
Kuini Prospect – retrograde skarn near margin of intrusive against major structural break.



Hydrothermal magnetite veins after hematite



Hydrothermal magnetite veins

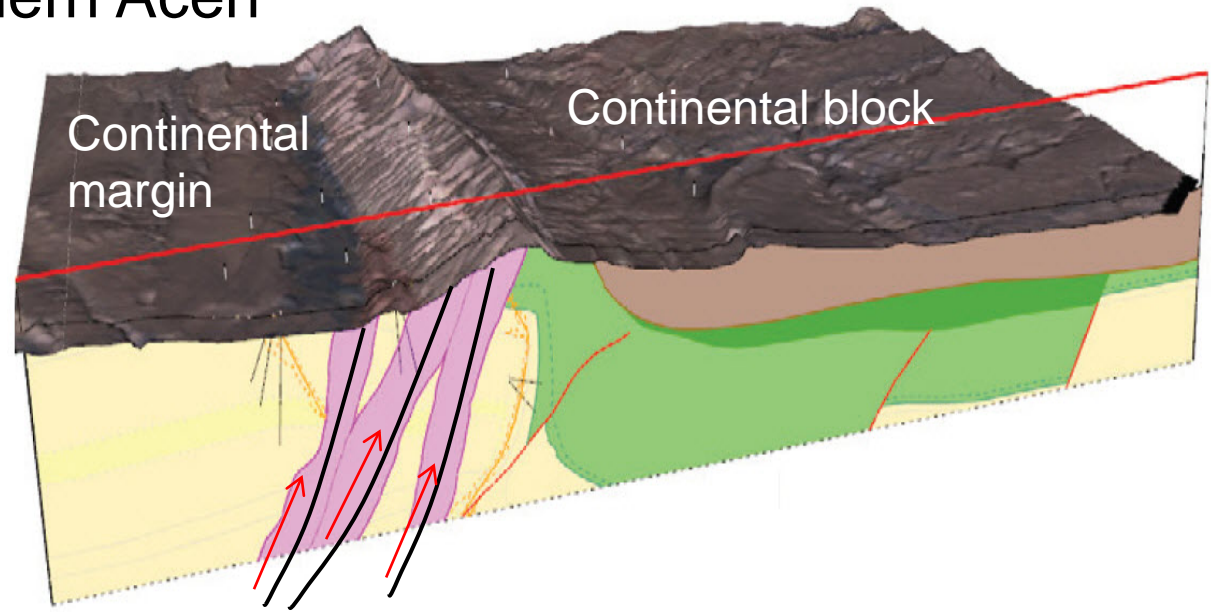


Molybdenite-chalcopyrite-pyrite sheared and retrograde endoskarn



General model for southern Aceh region

Oceanic arc subduction

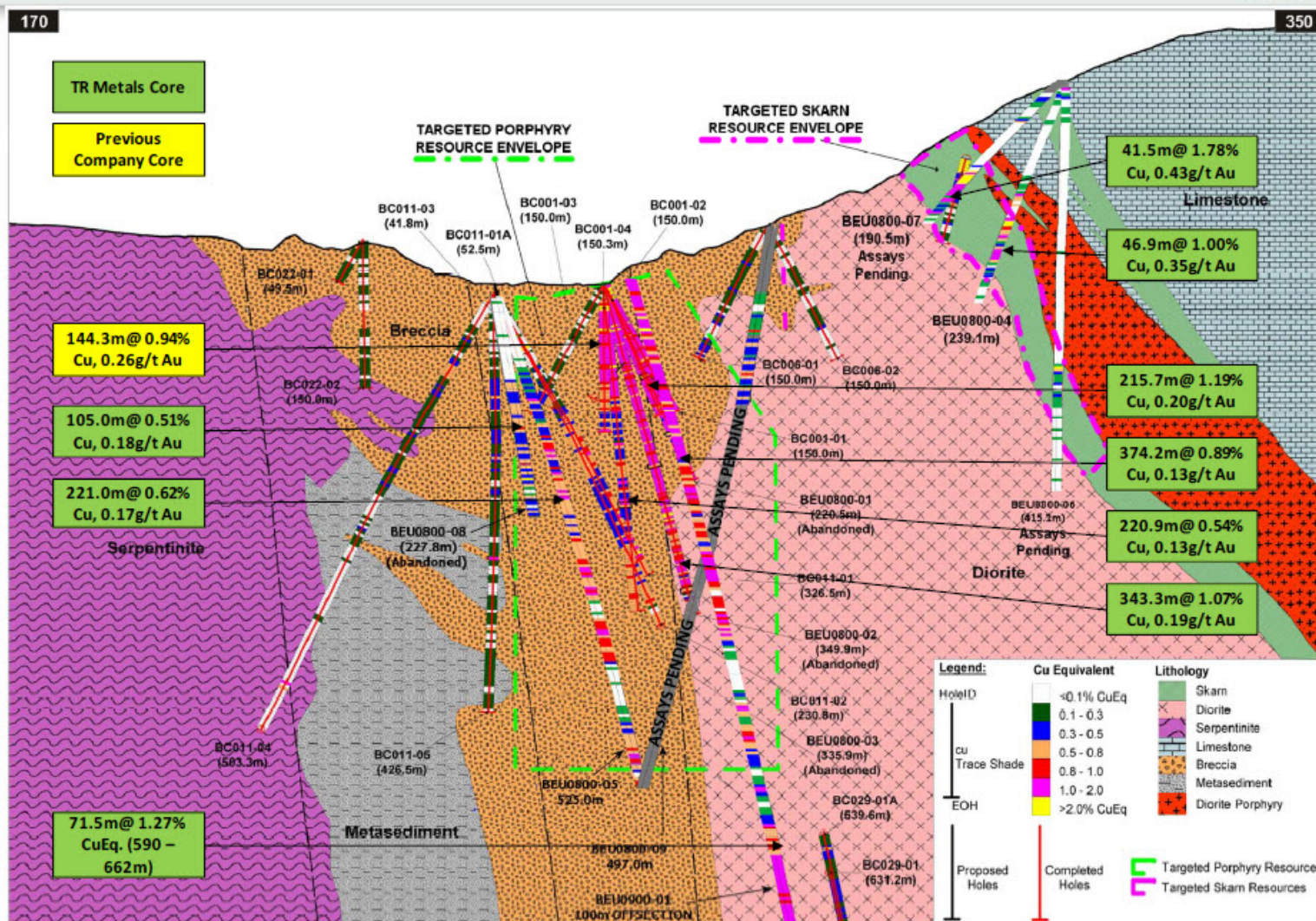


- § Magma intrusion is associated with structurally active dilatant regional fault traces.
- § Hydrothermal fluids sourced from the intrusions are also constrained by the structural boundaries and structural offsets related to the faults.
- § Magnetite crystallisation enables the structures to be identified in aeromagnetic surveys. Routine multi-element soil and rock geochemistry can identify ore mineralisation.
- § There may be extensive local alteration of intrusion hosted and country rock (skarns) and there is generally post mineralisation deformation.

Beutong Copper Project

Potential for large open pit mineable copper-gold-molybdenum resources close to infrastructure

TIGERS
REALM METALS



Beutong exploration project area north of Pelumat
– approximately 150 Mt indicated and inferred.

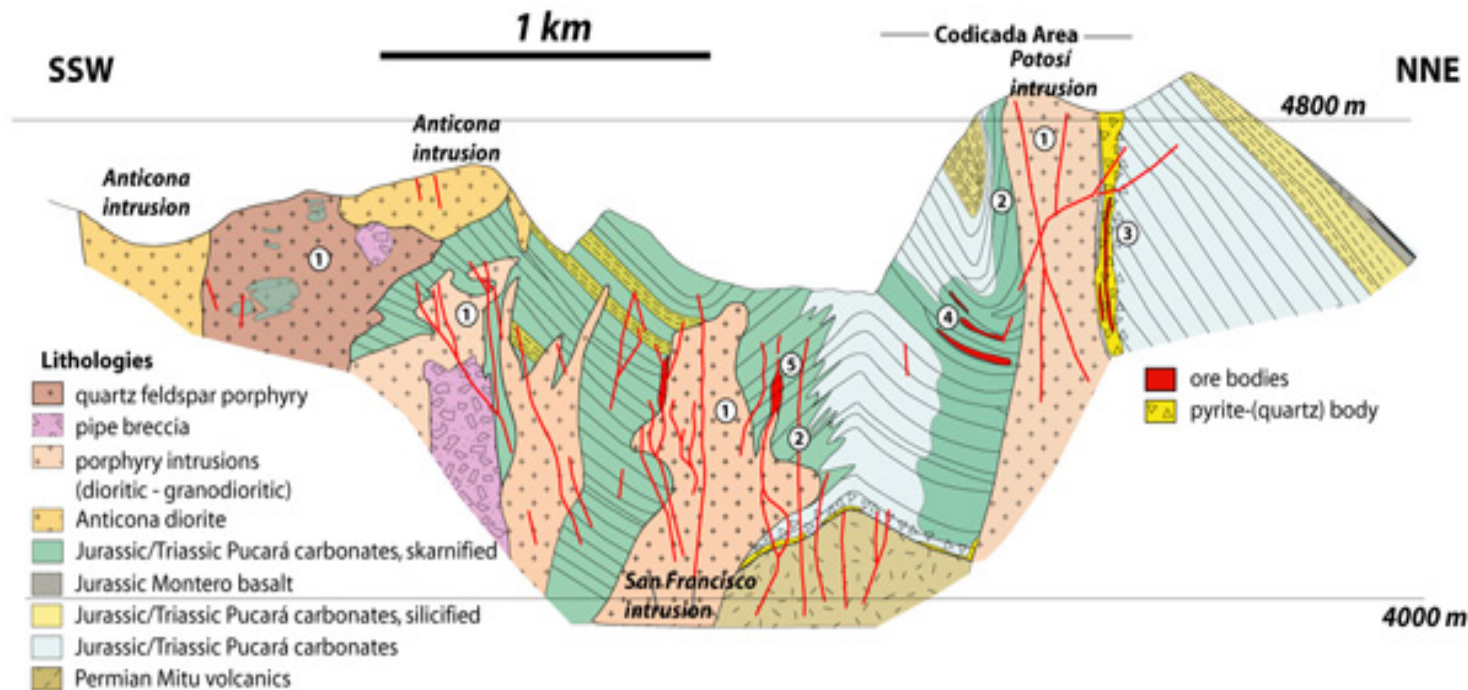


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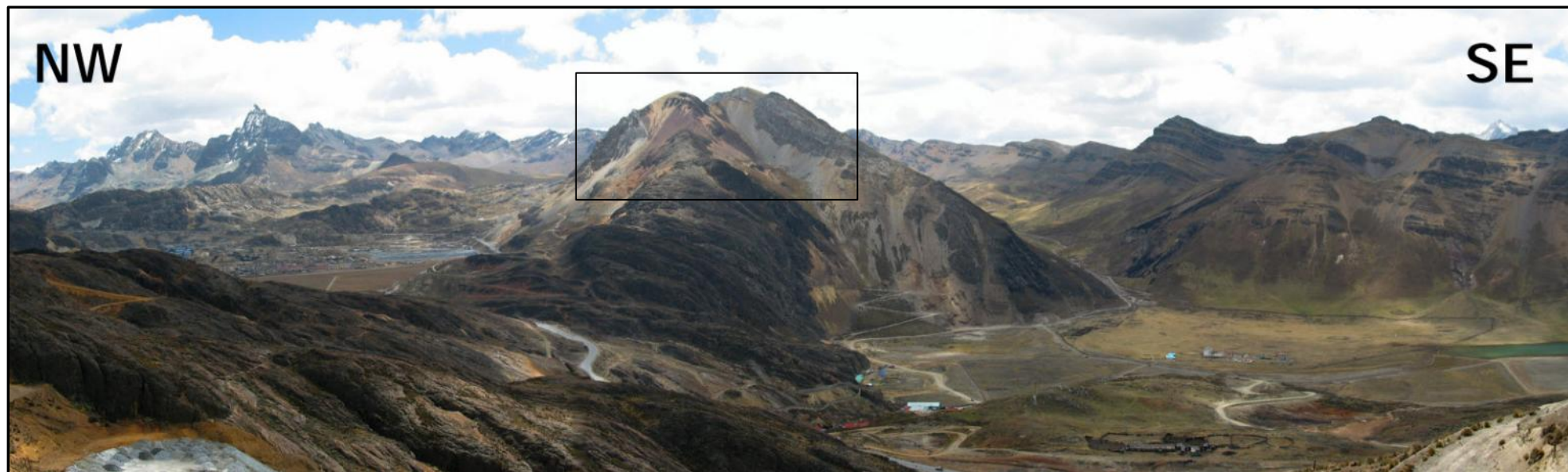
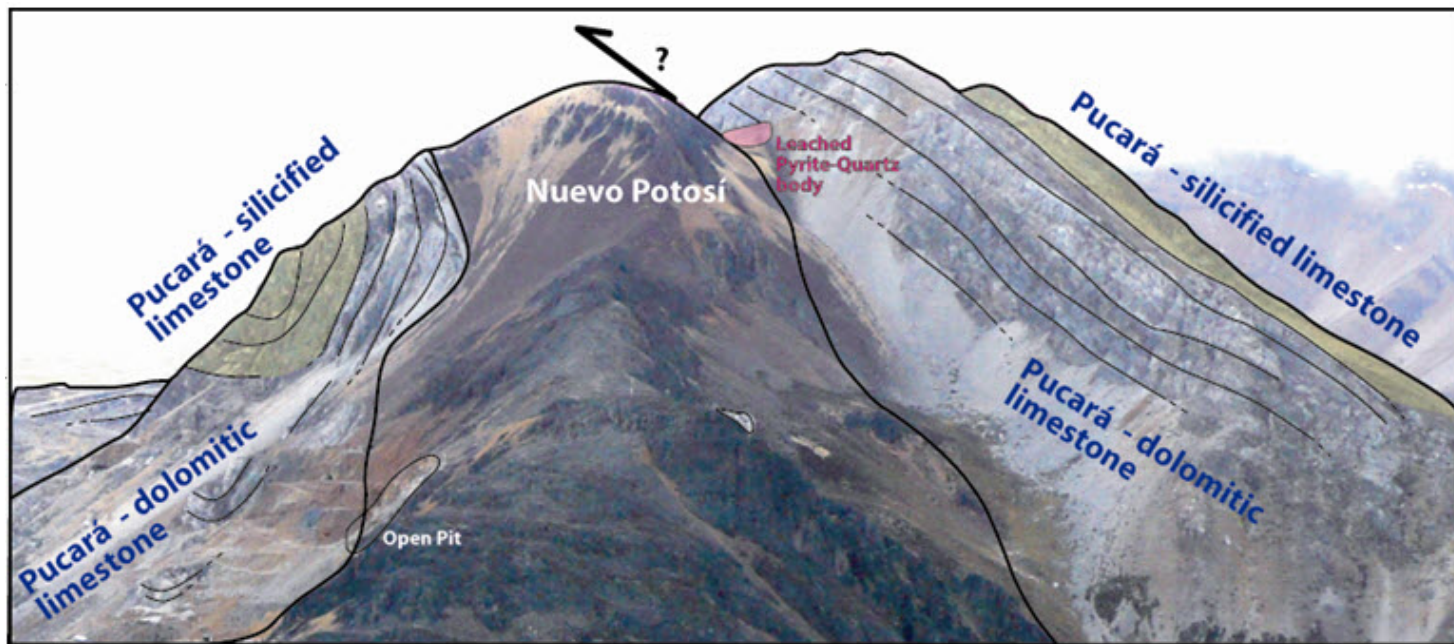
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An analogue at the other side of the world – without the trees



Summary geological section through Morococha District, Peru

After Leon (2007)




Potosi Intrusion, Codiciada Area, Morococha, Peru
Thanks to Honza Catchpole for the images.

Farewell to Aceh



Now to Java



Exploration of Gunung Rosa Au-Ag-base metal mesothermal vein system in an eroded volcanic complex, Western Java, Indonesia



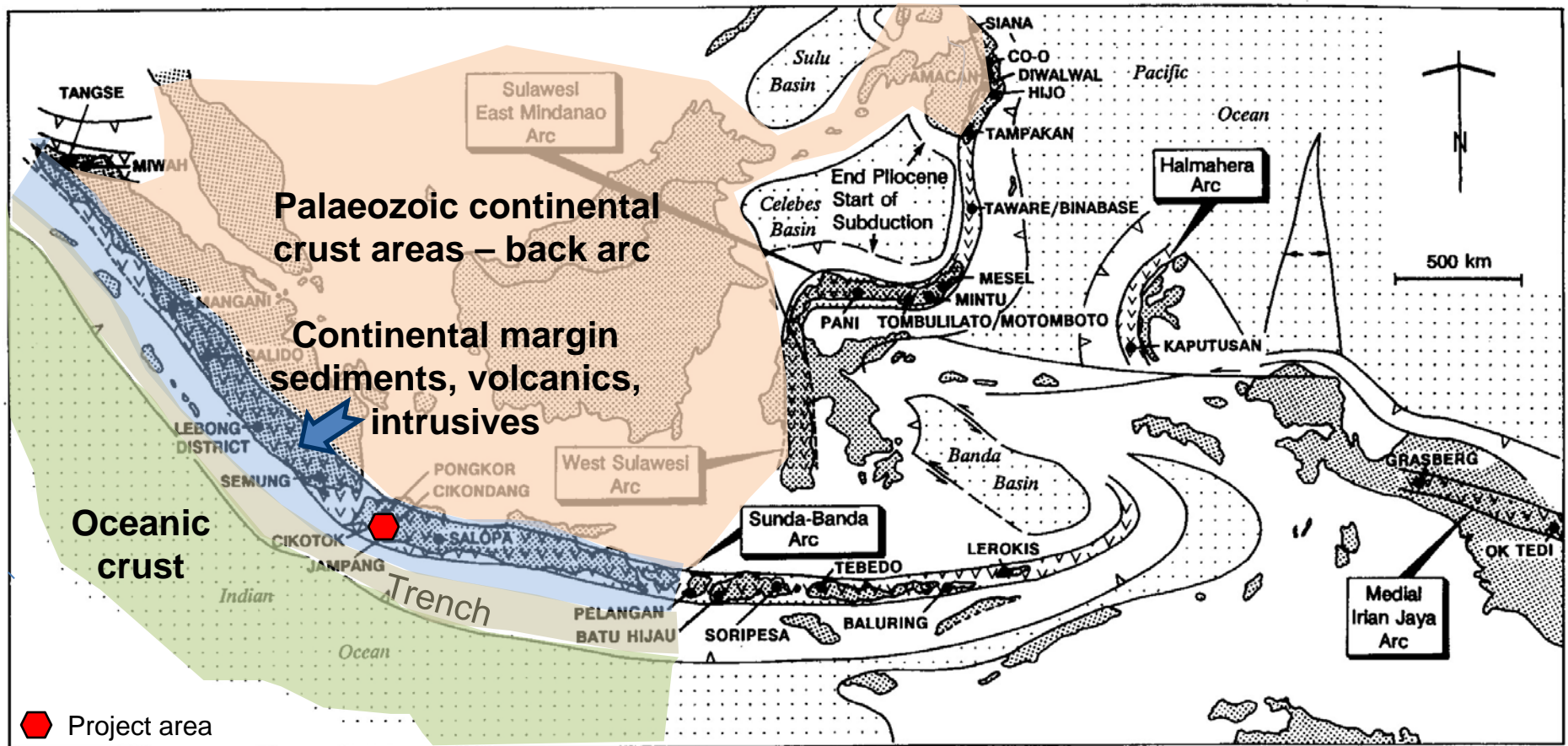
RUTHERFORD
MINERAL RESOURCE CONSULTANTS
ABN: 60 396 553 906



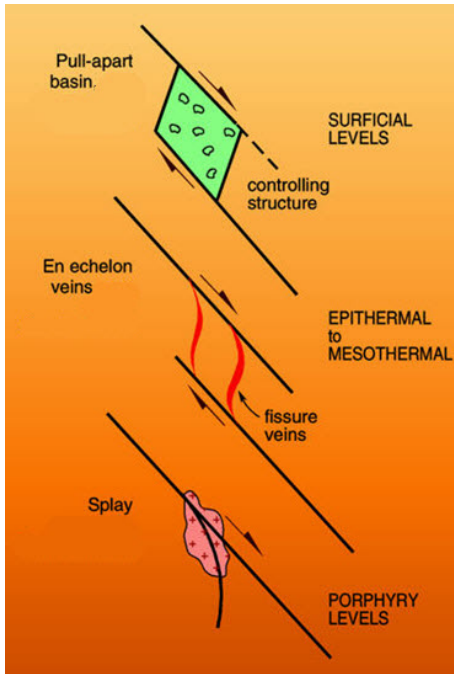
UNSW
AUSTRALIA



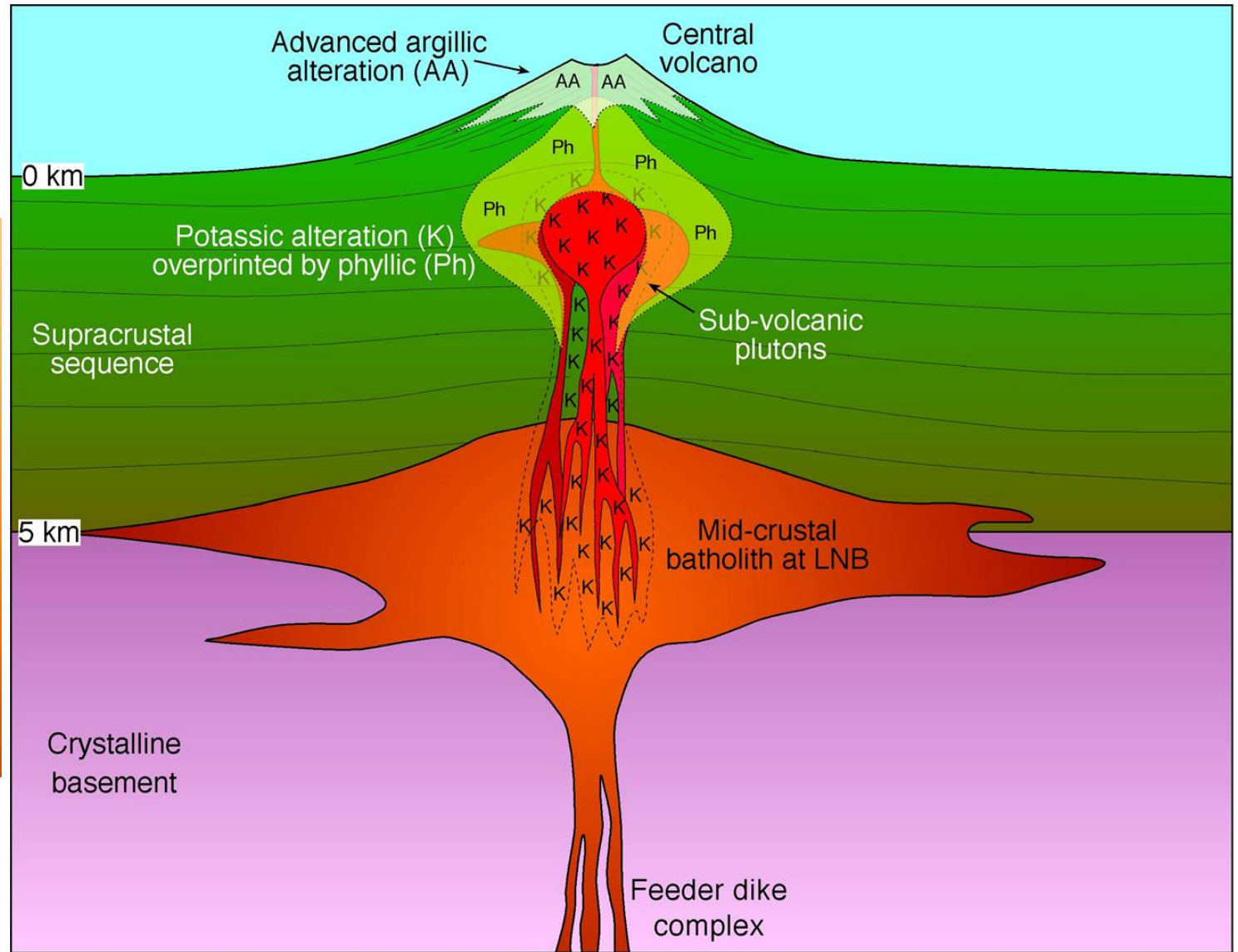
Location of the Gunung Rosa Project



Pliocene palaeogeography and magmatic arcs of the Indonesian region showing major mineralised centres.



Structural model as mineralisation host



Schematic volcanic intrusive model of Richards (2003)

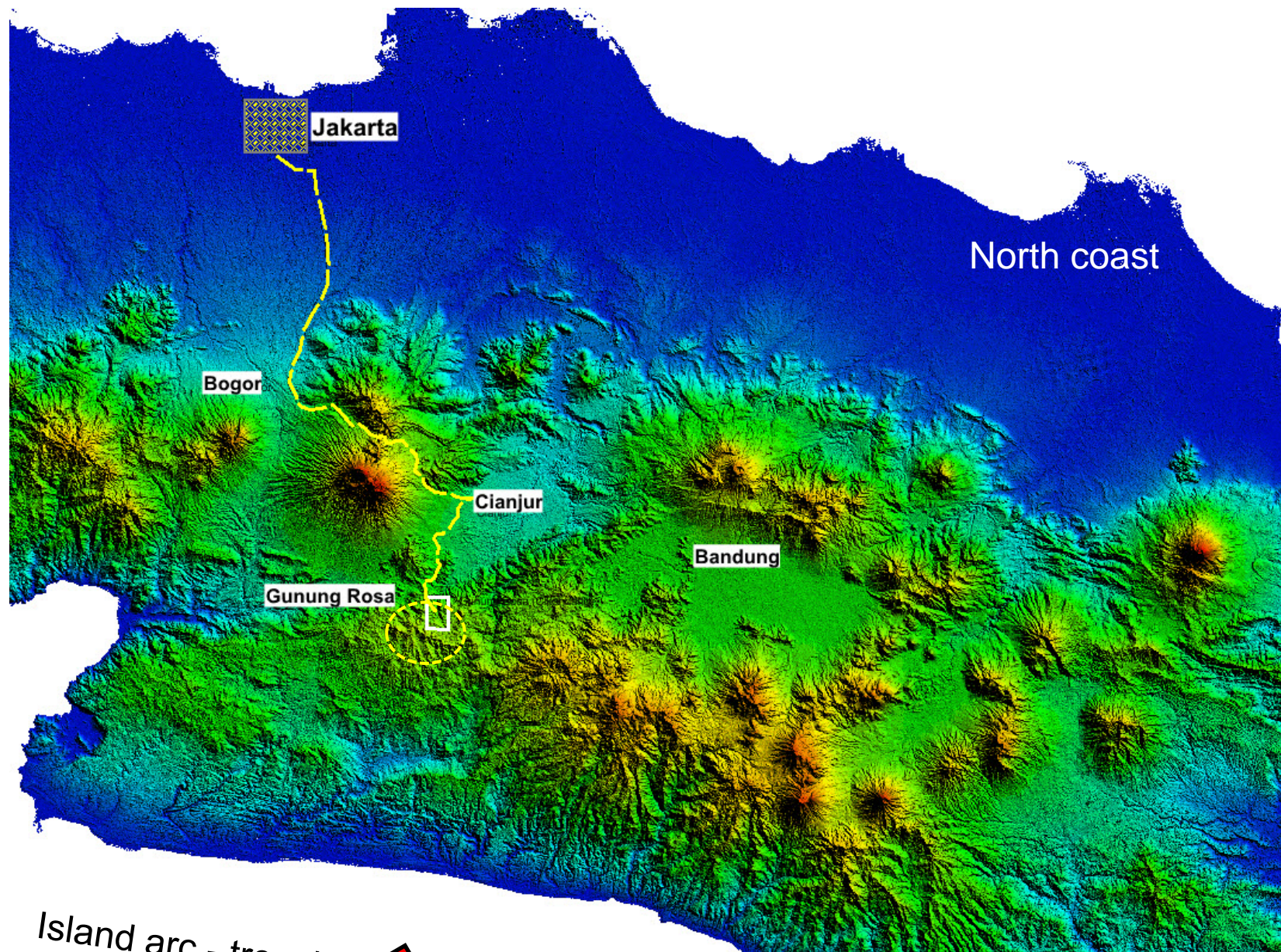
Economic Geology V98: pp1515-1533



Mt Mahameru behind Mount Bromo, East Java.

This highlights the short life of volcanic intrusive centres in active tectonic zones





Island arc - trench



subduction

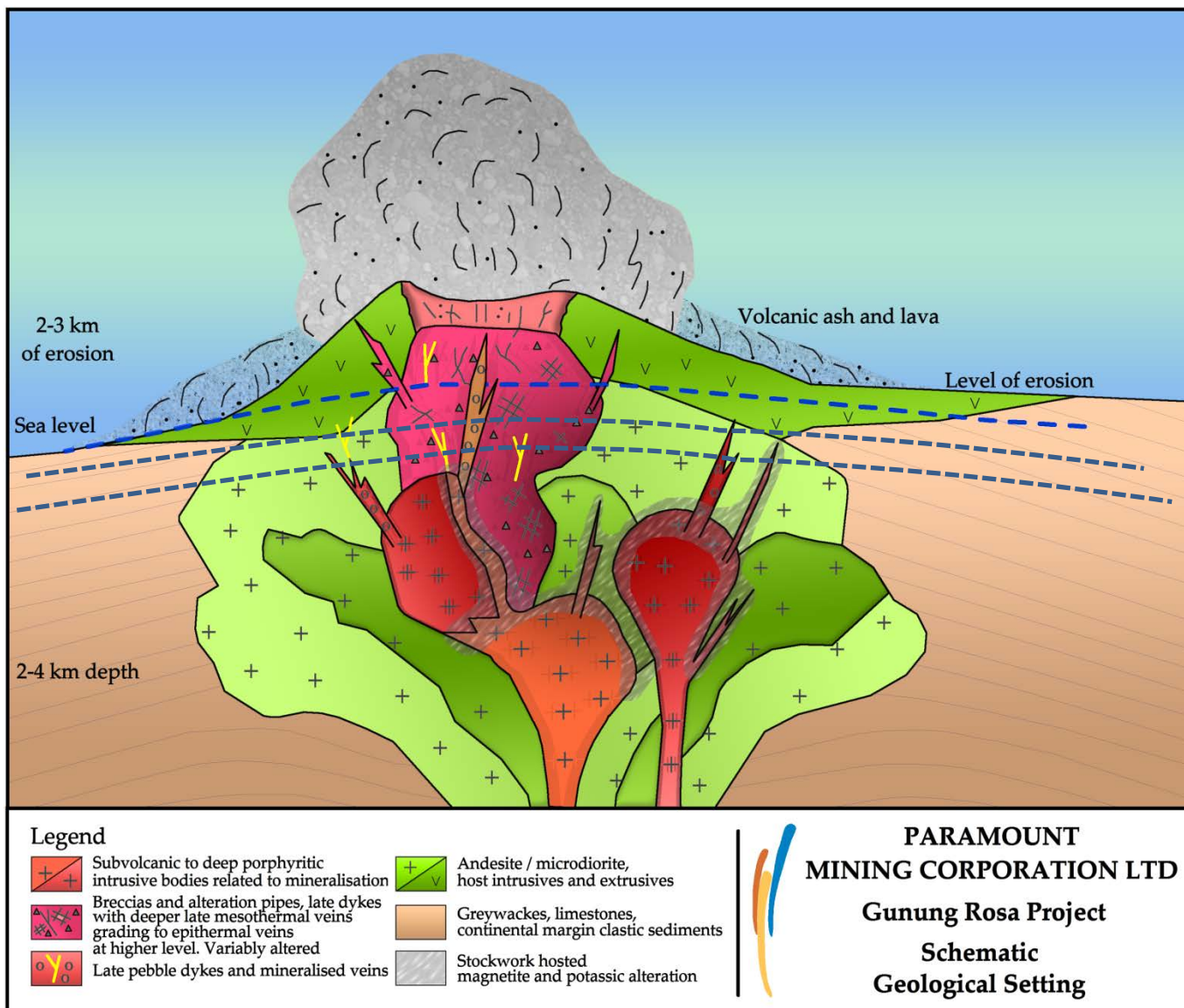
Western Java



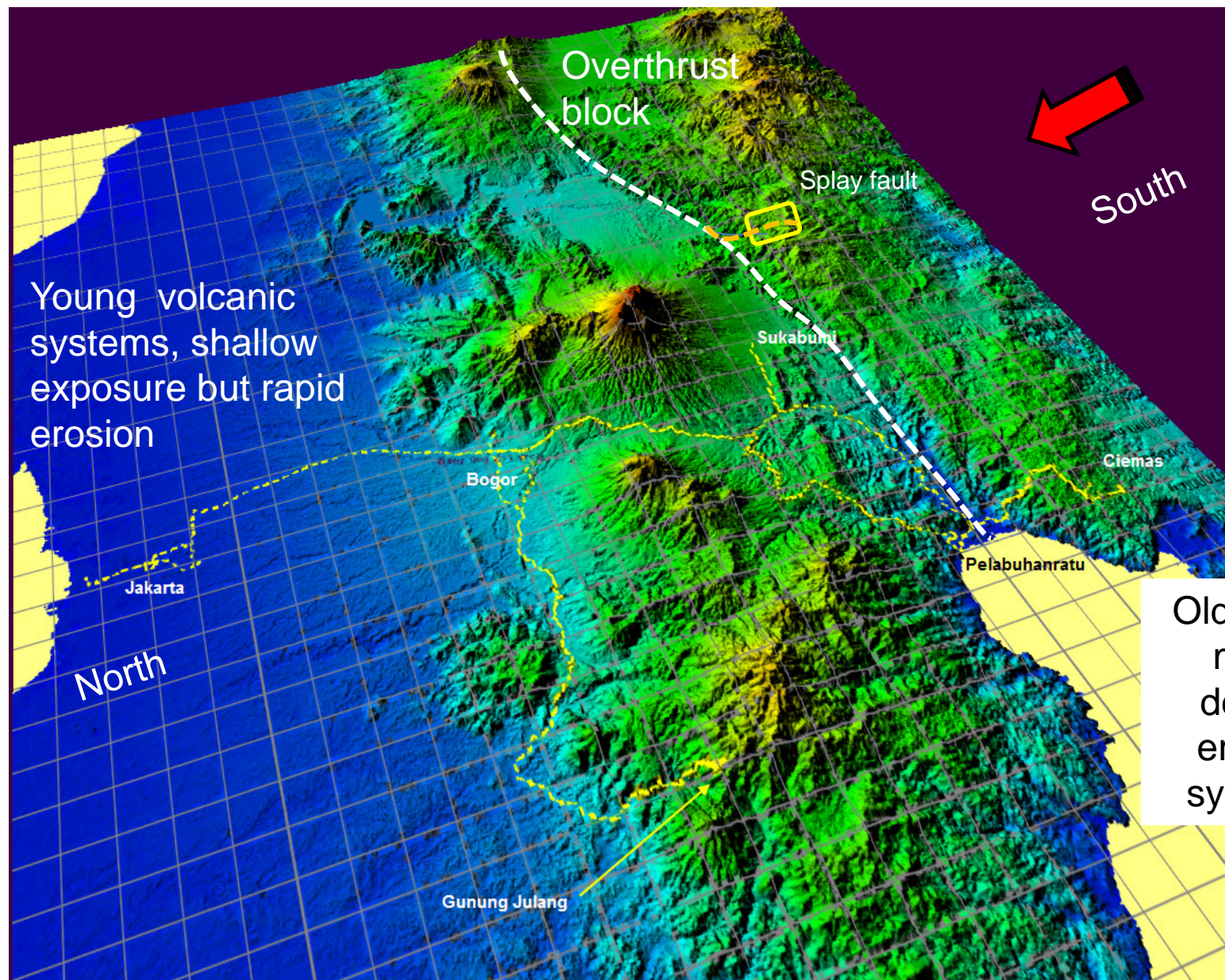
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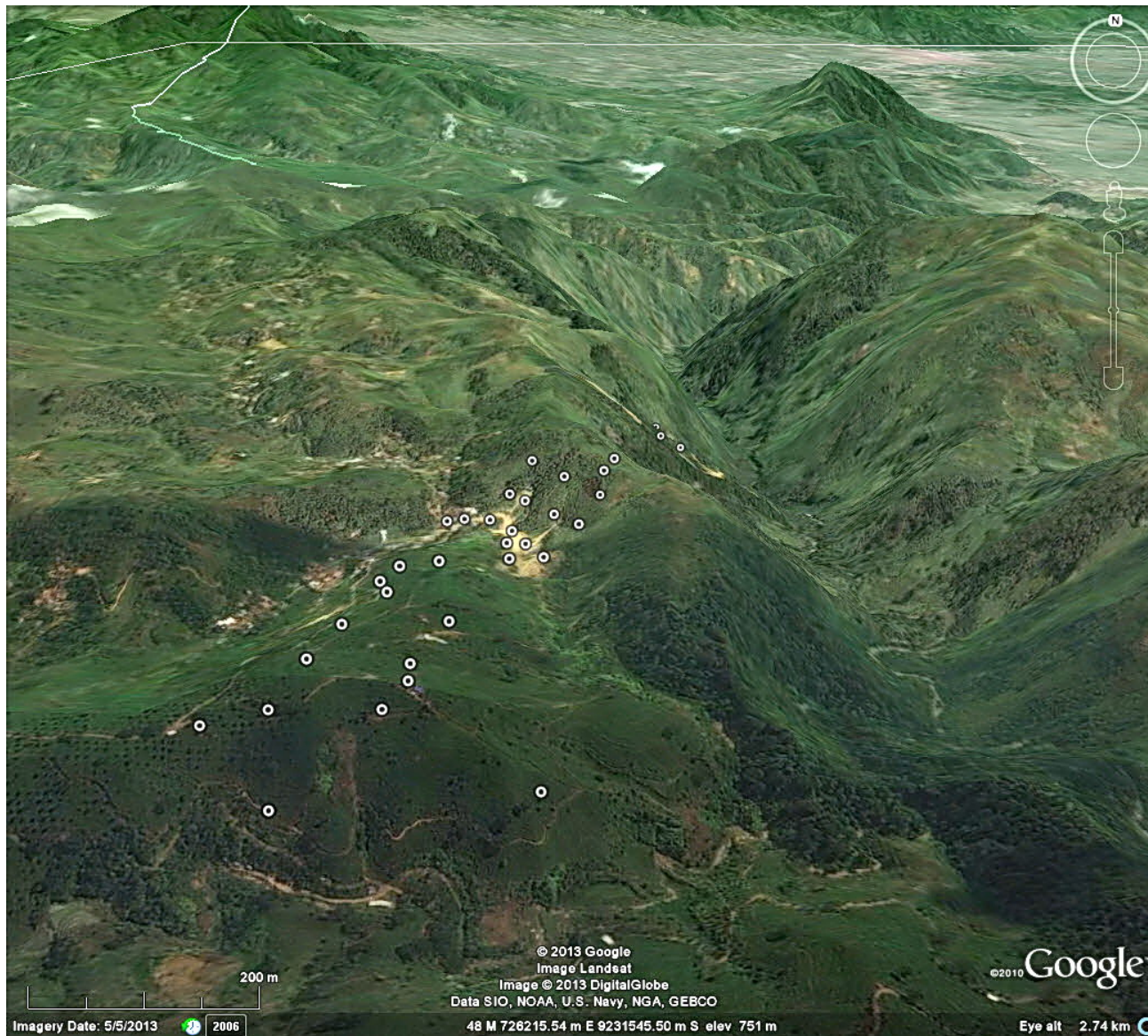
UNSW
AUSTRALIA



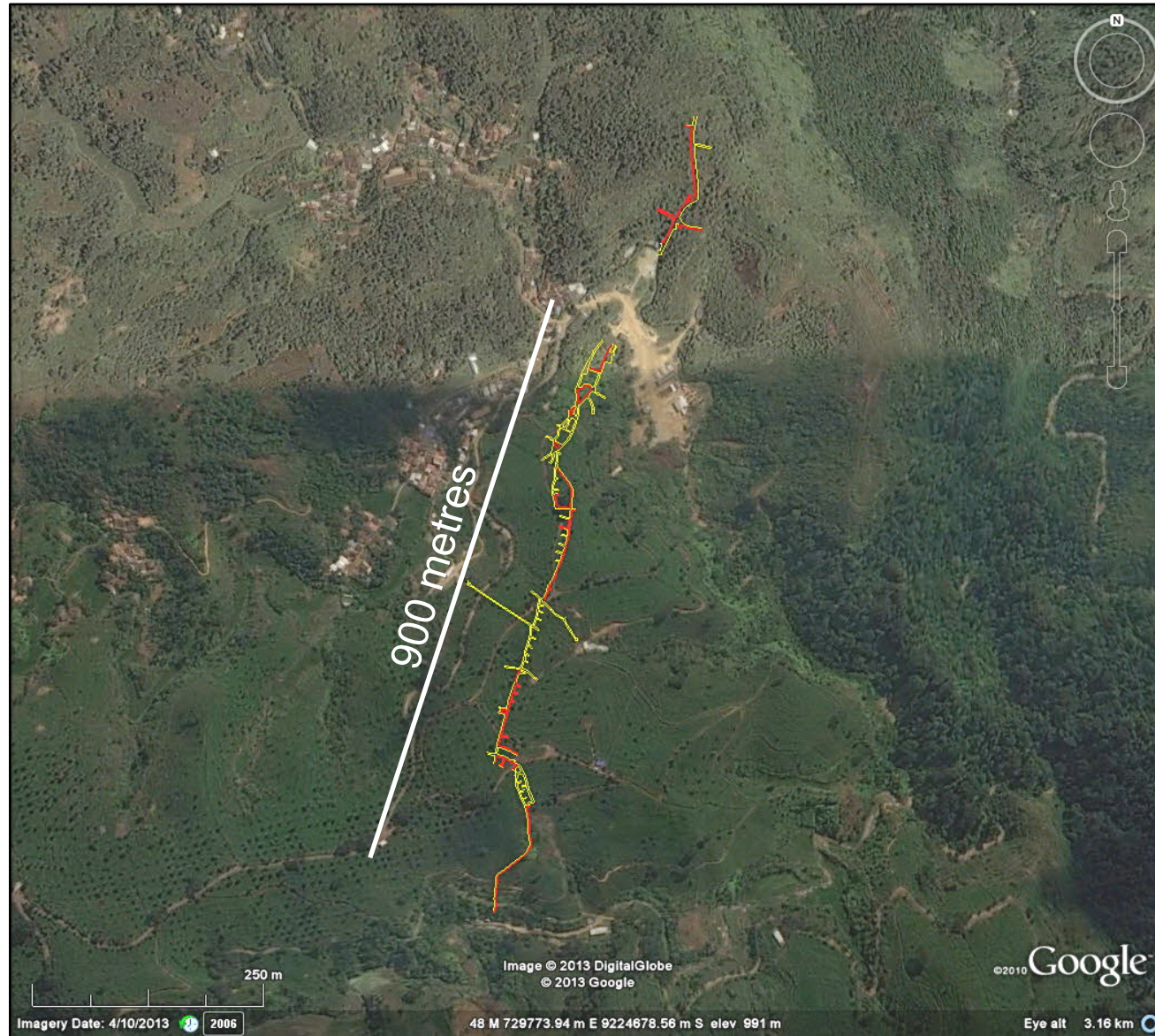
Schematic model of a volcanic intrusive centre



Tectonic setting southern coast of Java



Terrain in the Gunung Rosa project area
(2X vertical exaggeration)



Location of historic underground mining activities



The proposed 1992 plant site as seen today. It is planned to reuse this for the new development.
Vein trace shown by yellow dashed line.
North to right, view to west.

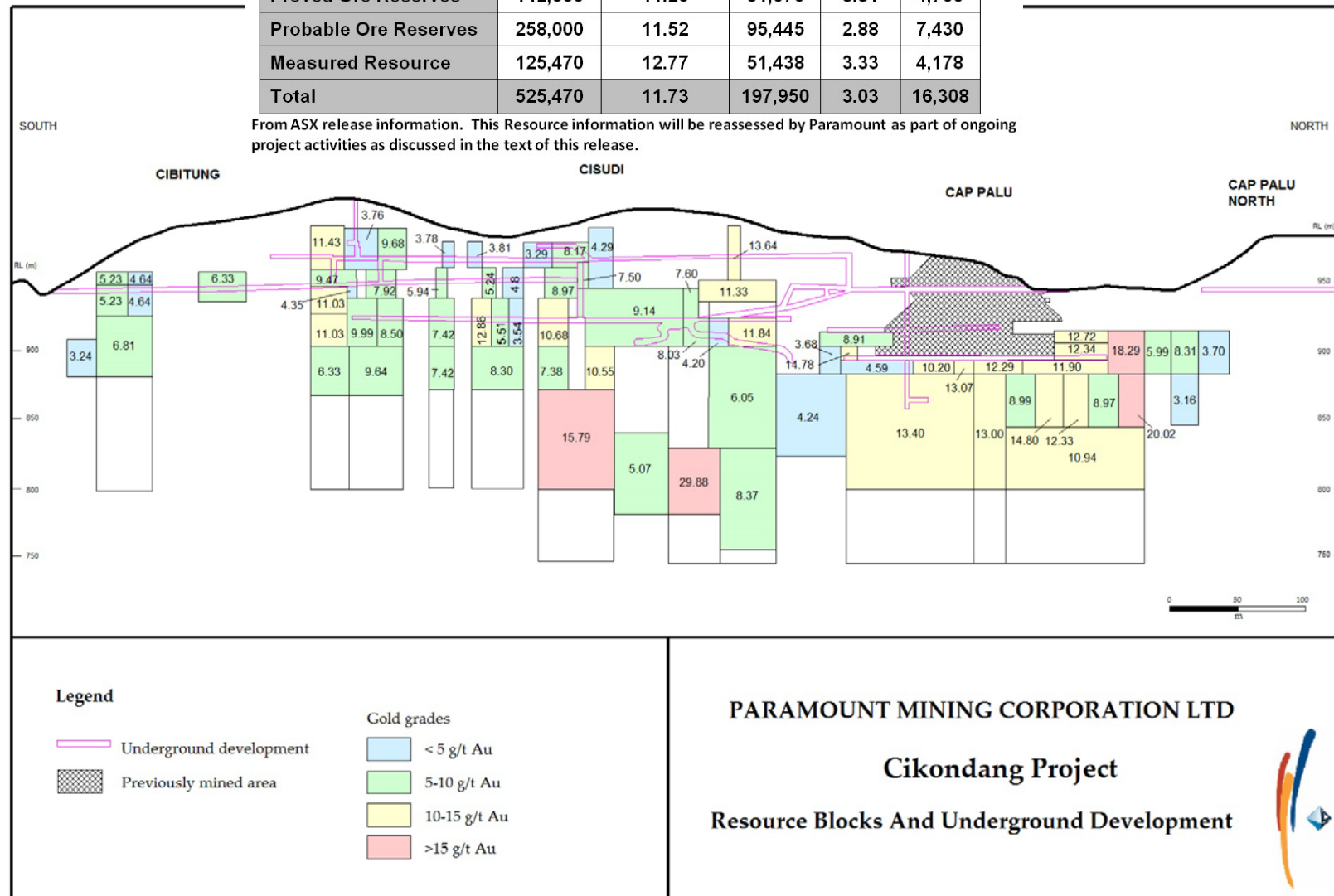


Tea plantation covers much of the area of interest beneath which the main vein occurs but it rarely outcrops.

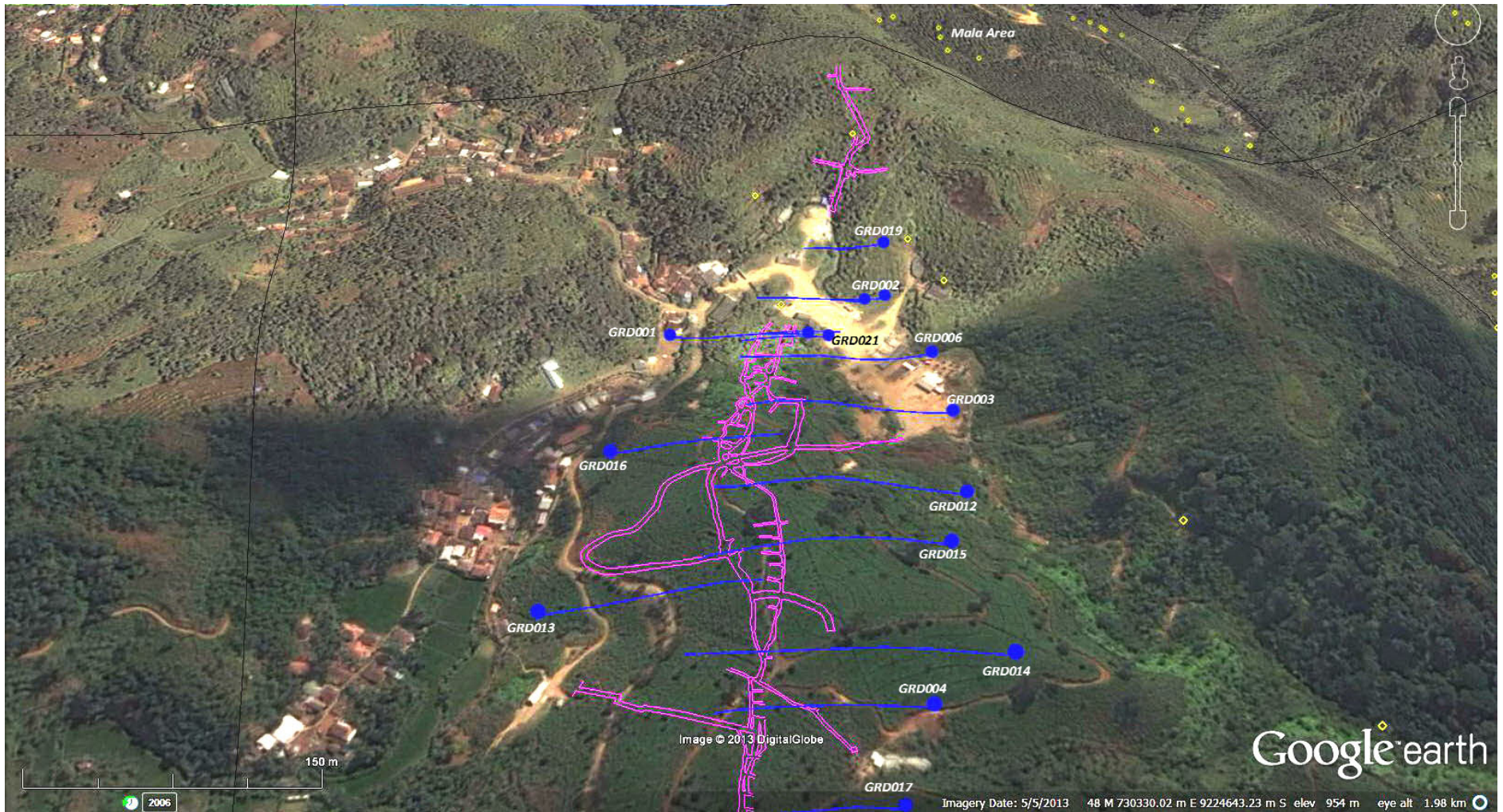
Century Mines and Metals NL Resources above 900m RL using 3g/t cut off.

	Tonnes	Au g/t (cut)	Au oz	Zn %	Zn t
Proved Ore Reserves	142,000	11.20	51,070	3.31	4,700
Probable Ore Reserves	258,000	11.52	95,445	2.88	7,430
Measured Resource	125,470	12.77	51,438	3.33	4,178
Total	525,470	11.73	197,950	3.03	16,308

From ASX release information. This Resource information will be reassessed by Paramount as part of ongoing project activities as discussed in the text of this release.



Historic mining and resource assessment blocks as in 1992.
(Data from Century Mines and Metals NL - ASX Report)



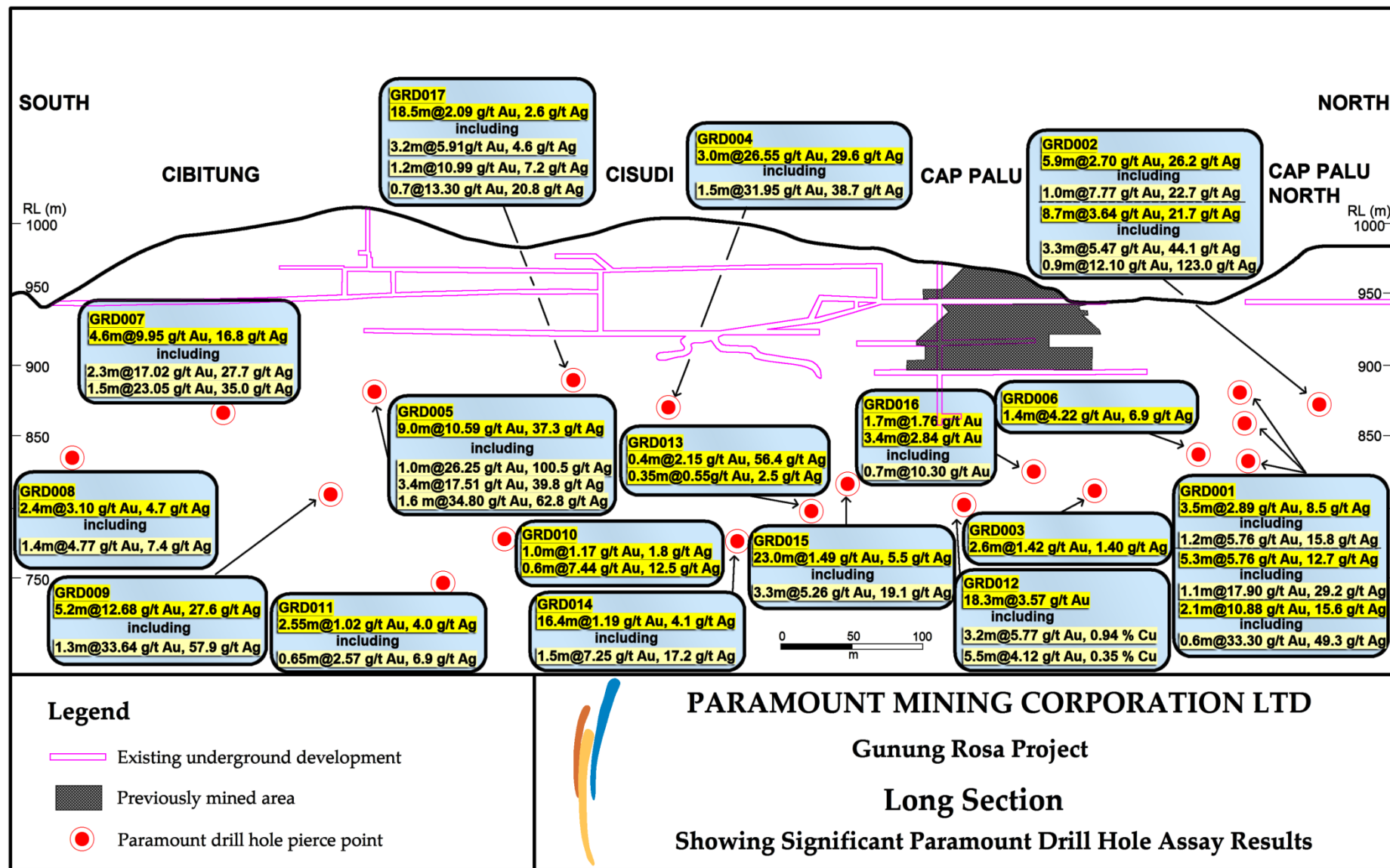
A 17 hole due diligence drilling program was undertaken from mid 2011 - early 2012 beneath the main 1992 development workings.



Main vein mined out in old workings



Cap Palu decline



Summary results 17 hole due diligence program mid-2011-early 2012
 All sub 900 m RL and below water table and old workings

GUNUNG ROSA Hole GRD004- High Grade Intersection 152.8 – 155.8 Metres (Recovery ≈ 95%)

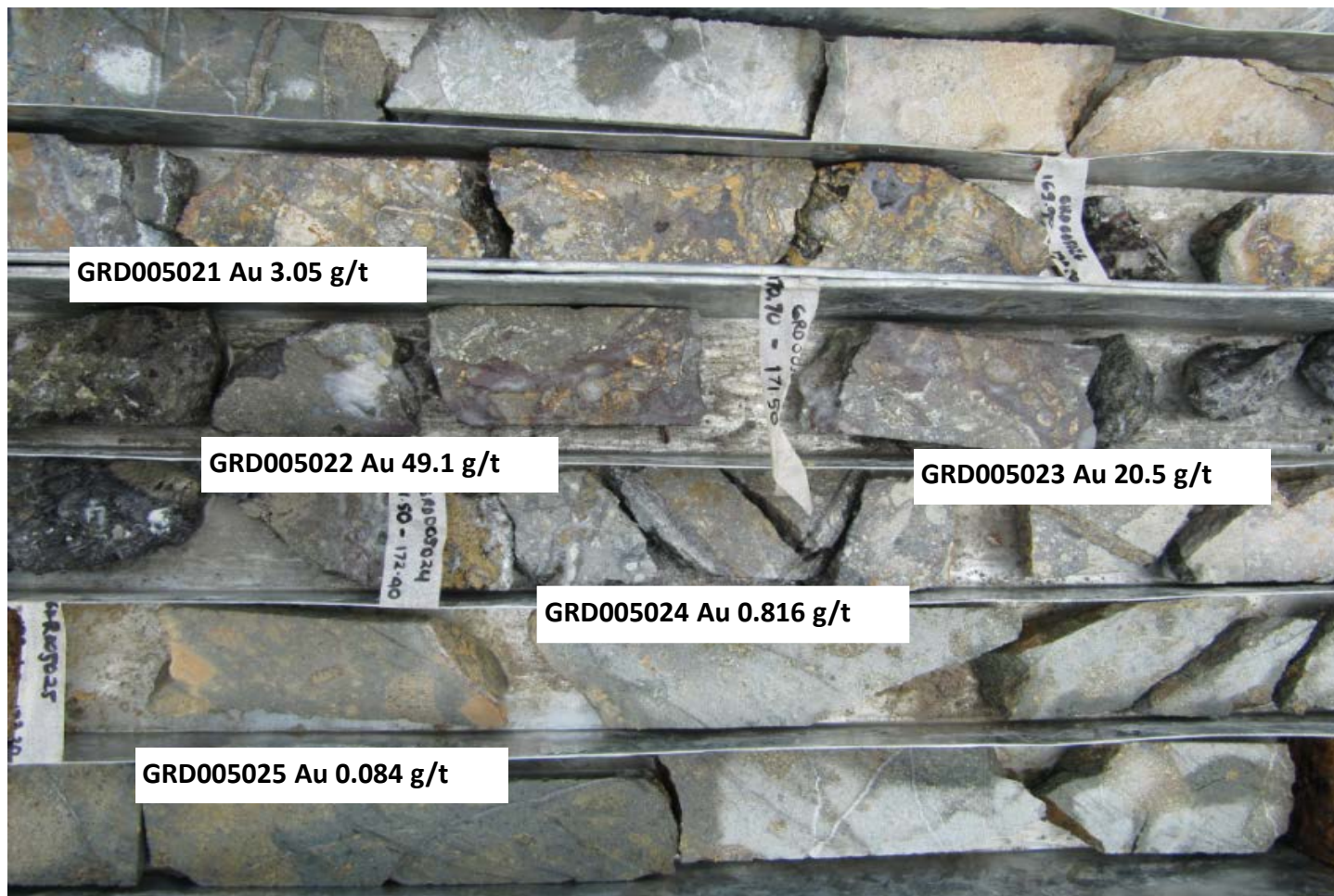
Drill Pad GRD004



3.0 m @ 26.55 g/t Au; 29.6 g/t Ag; 0.29% Zn



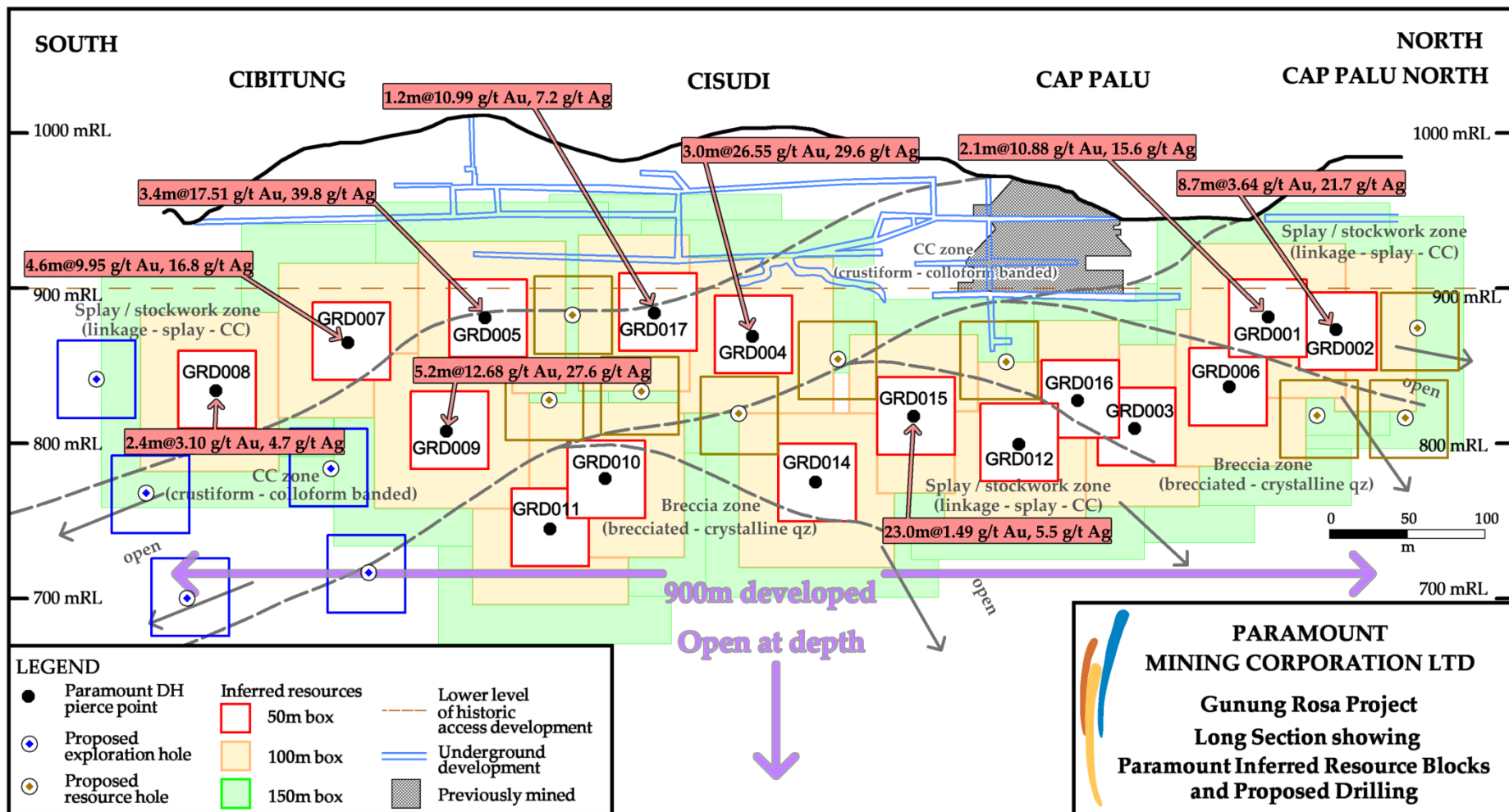
GUNUNG ROSA Hole GRD005- High Grade Intersection 168.9 – 172.4 Metres (Recovery ≈ 95%)



GUNUNG ROSA – Hole GRD009 Assay Results – Grade Distribution in Hole

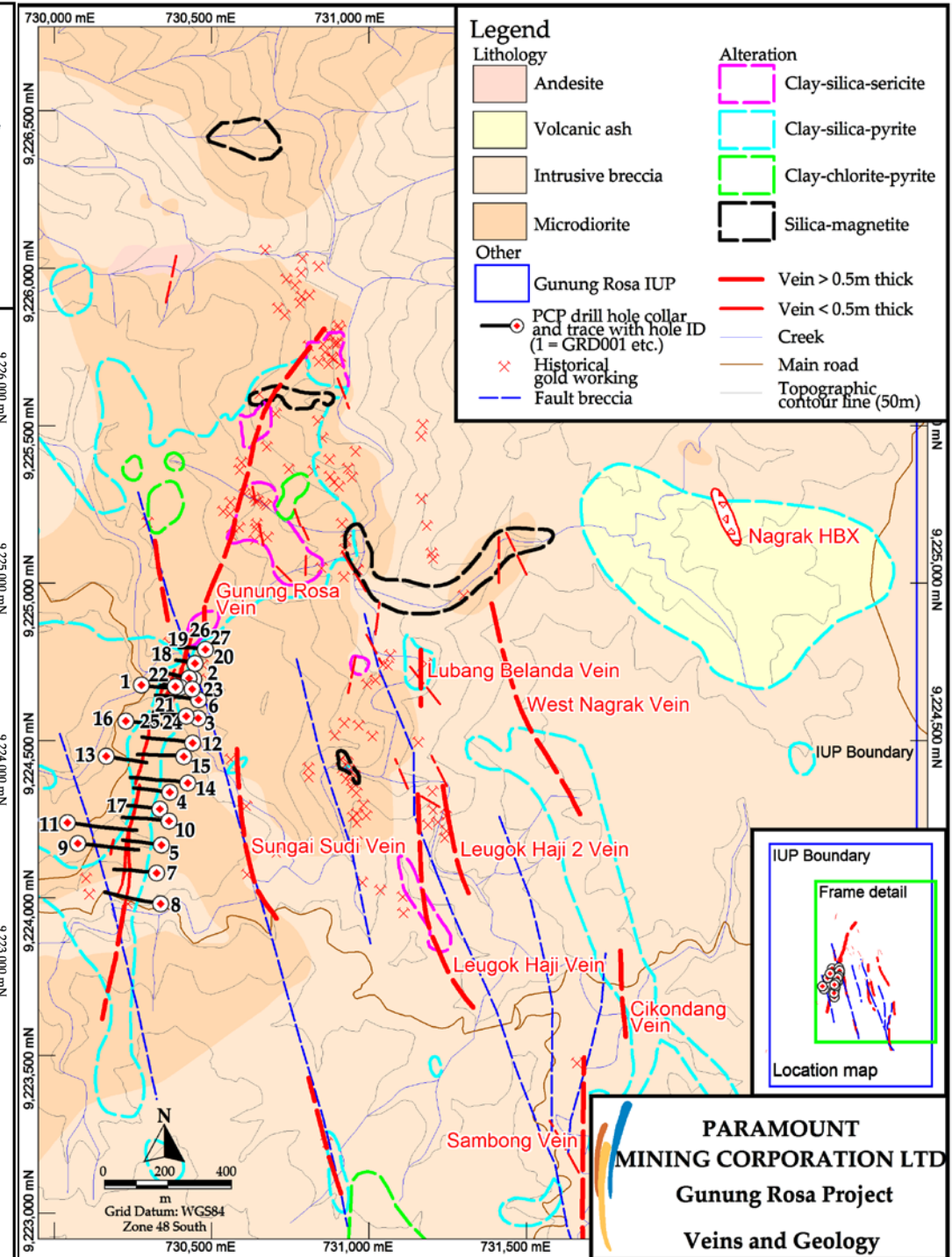
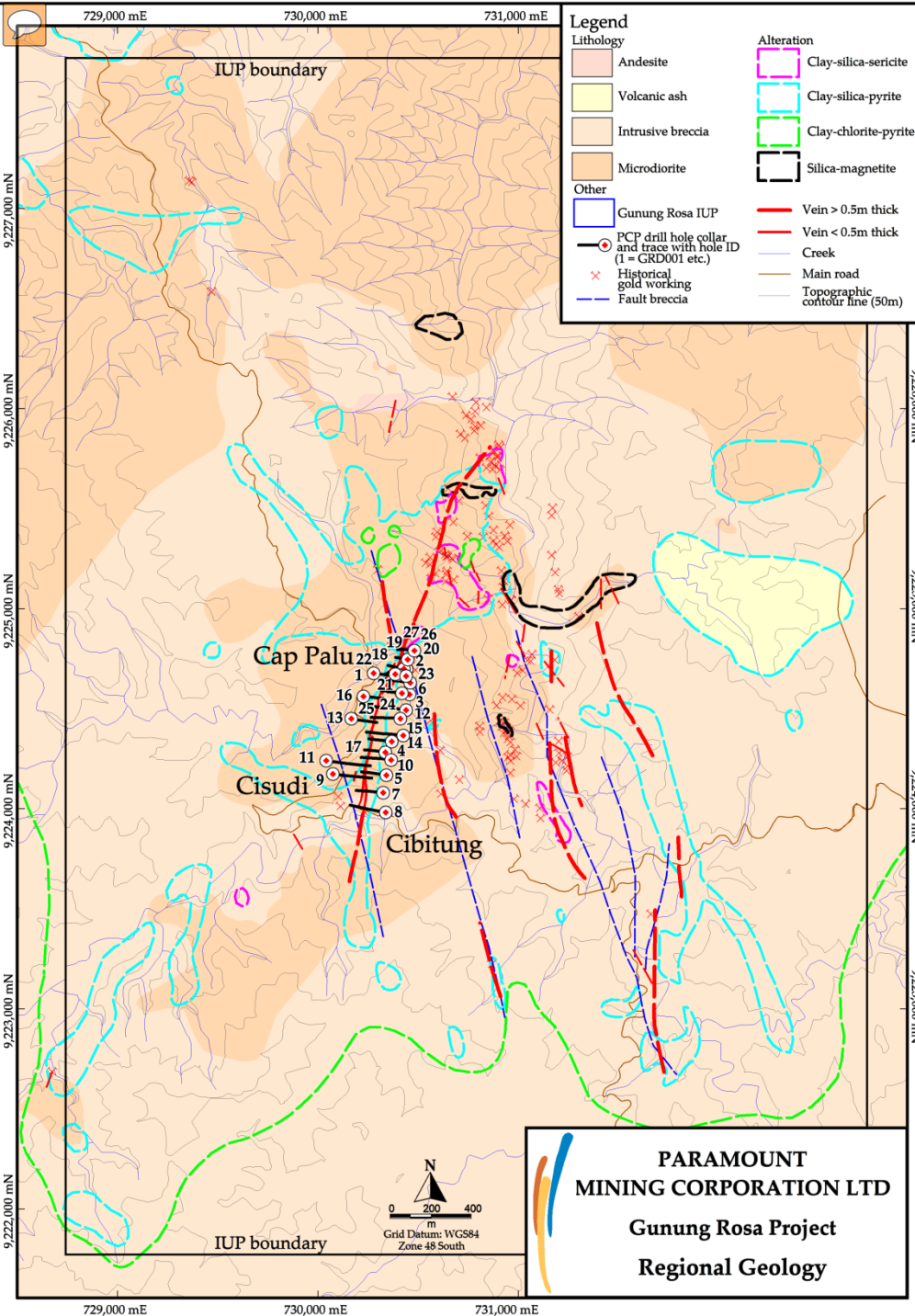
	From	To	Interval	Au g/t						
GRD009034	220.50	221.30	0.80	0.35						
GRD009035	221.30	222.30	1.00	0.25						
GRD009036	222.30	225.30	3.00	0.02						
GRD009037	231.35	232.35	1.00	0.17						
GRD009038	232.35	233.35	1.00	0.12						
GRD009039	233.35	234.35	1.00	0.04						
GRD009040	234.35	235.35	1.00	0.14		m-g		m-g		
GRD009042	235.35	236.15	0.80	3.80		3.04				
GRD009043	236.15	237.15	1.00	0.33		0.328				
GRD009044	237.15	238.15	1.00	0.48		0.477				
GRD009045	238.15	238.75	0.60	9.07		5.442		5.442		
GRD009046	238.75	239.25	0.50	7.63		3.815		3.815		
GRD009047	239.25	240.05	0.80	5.94		4.752		4.752		
GRD009049	240.05	240.75	0.70	25.70		17.99		17.99		
GRD009050	240.75	241.35	0.60	42.90		25.74		25.74		
GRD009051	241.35	242.45	1.10	3.41		3.751		3.751		
GRD009052	242.45	243.35	0.90	4.96		4.464		4.464		
GRD009053	243.35	243.75	0.40	0.48		0.1928				
GRD009054	244.25	245.15	0.90	3.16		2.844				
GRD009055	245.15	246.15	1.00	0.27						
GRD009056	246.15	247.15	1.00	0.04	9.30	72.8358	7.83	5.20	65.954	12.68

9.3 m @ 7.83 g/t ; including 5.2 m @ 12.68 g/t



Inferred Resource estimation at stated cut off grades for areas below 900m RL
 (2m minimum vein width, 0.5m mining dilution)

Cut off	Tonnes*	Average Au Grade	Au oz*	Ag oz	Cu tonnes	Pb tonnes	Zn tonnes
No cut off	3,161,080	4.51	458,090	1,137,270	9,250	13,330	45,880
1 g/t	2,793,580	5.01	449,330	1,077,690	8,440	13,180	44,740
1.5 g/t	2,467,240	5.50	435,950	1,045,220	8,230	13,020	43,810
2 g/t	2,165,160	5.89	409,360	975,530	7,830	12,210	40,440
3 g/t	1,978,350	6.24	396,130	877,660	6,710	11,990	40,250



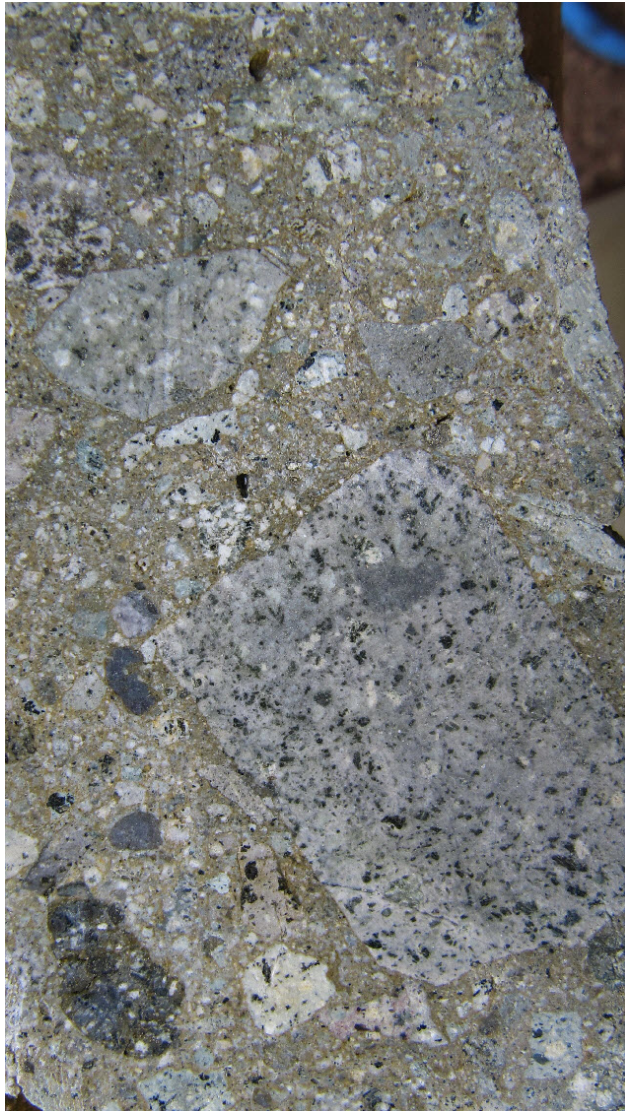


Field mapping revealed a range of intrusive and breccia events with various of alteration relationships and styles suggesting quite a different history than had been interpreted historically.

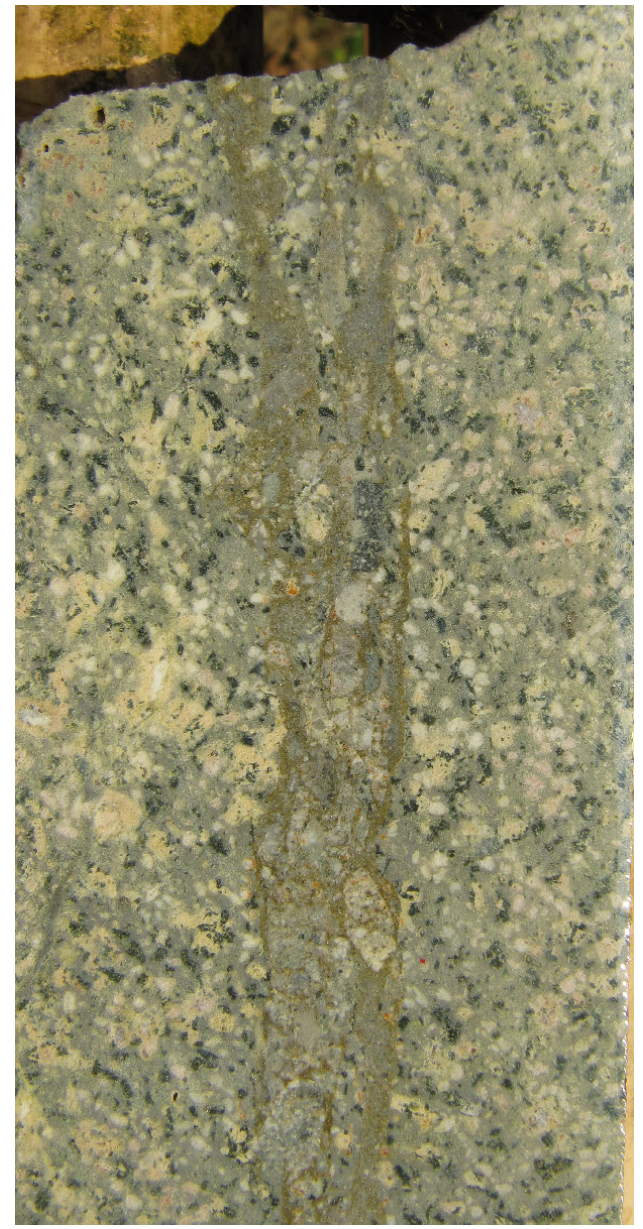


Milled breccia dykes, advanced argillic & silica pyrite alteration

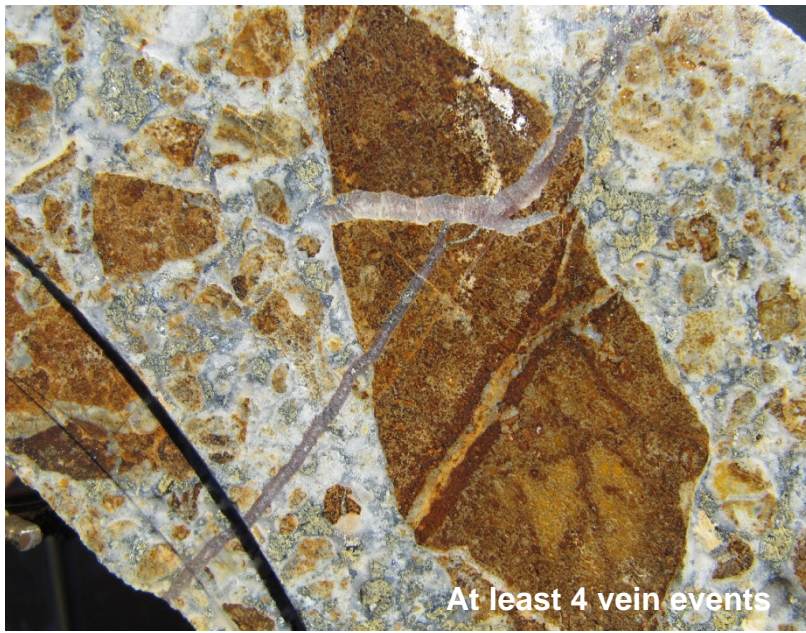




Milled polymictic and hydrothermal breccias, mesothermal veins



Pebble breccia dykes in weakly to strongly altered intrusive.



Northern end of vein system – Cap Palu. Typically broader sections lower grade.



Southern end vein system. Chalcedonic silica fill, coarser sulphides. Far north vein breccia.

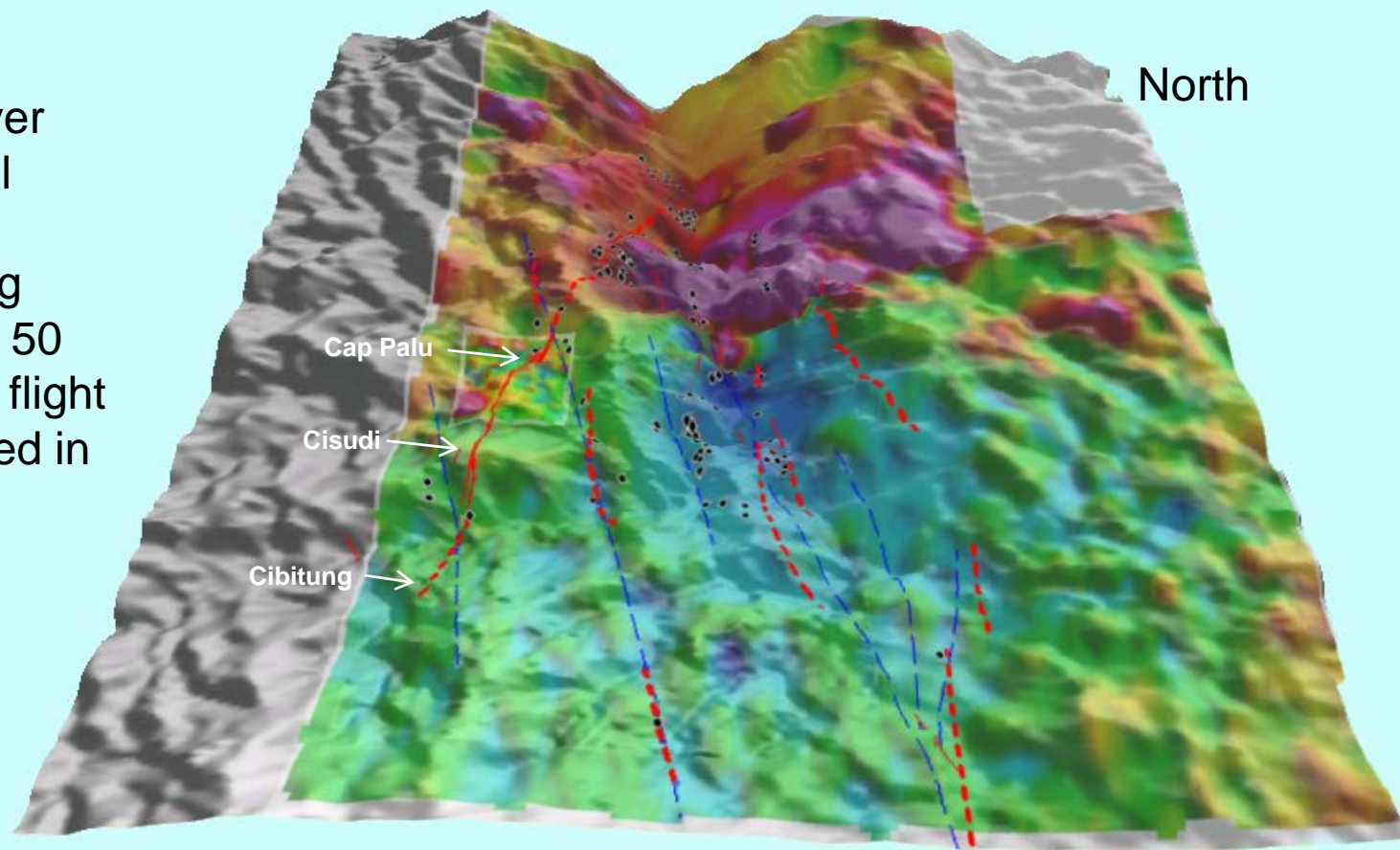
Sulphide veins & breccia

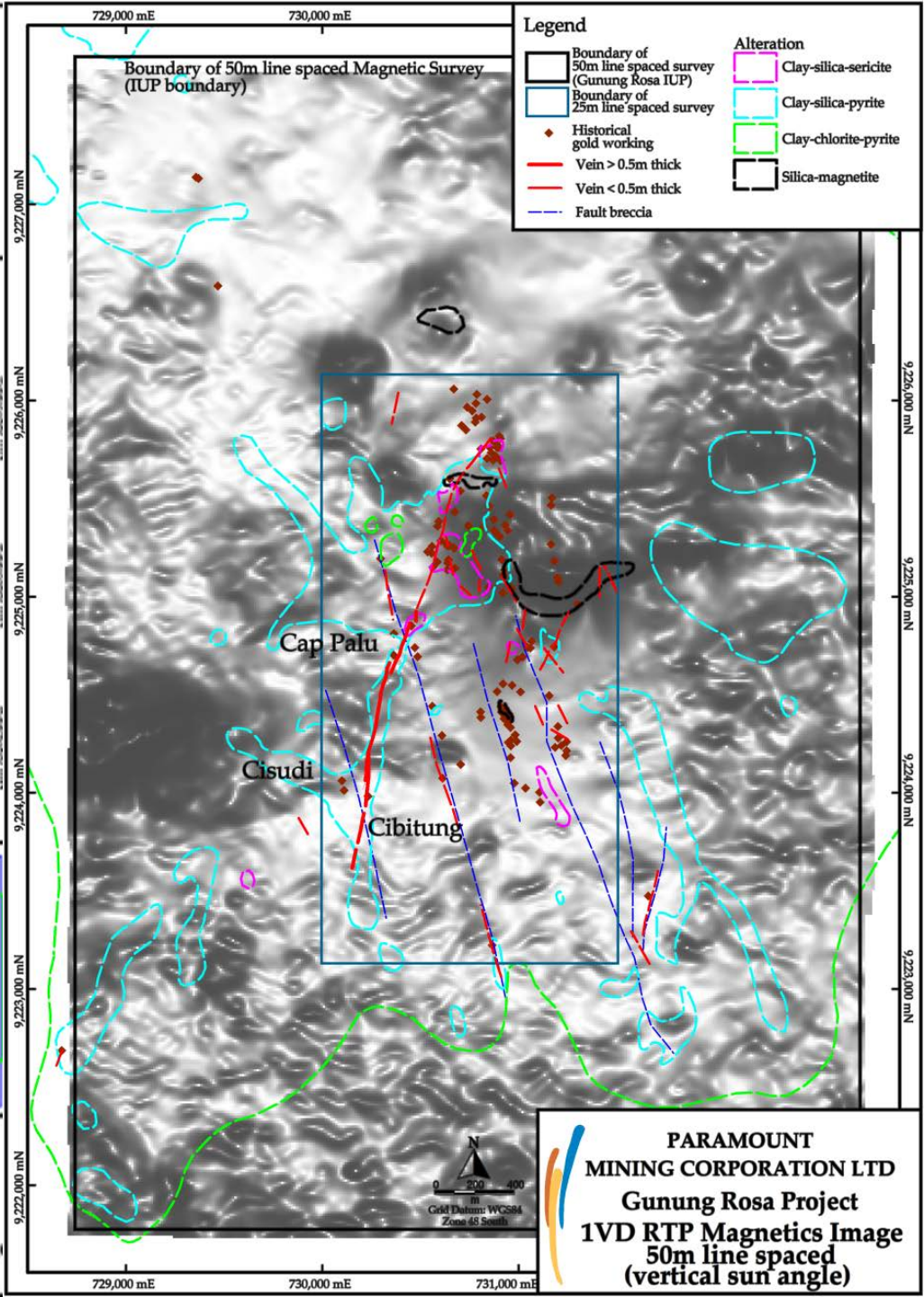
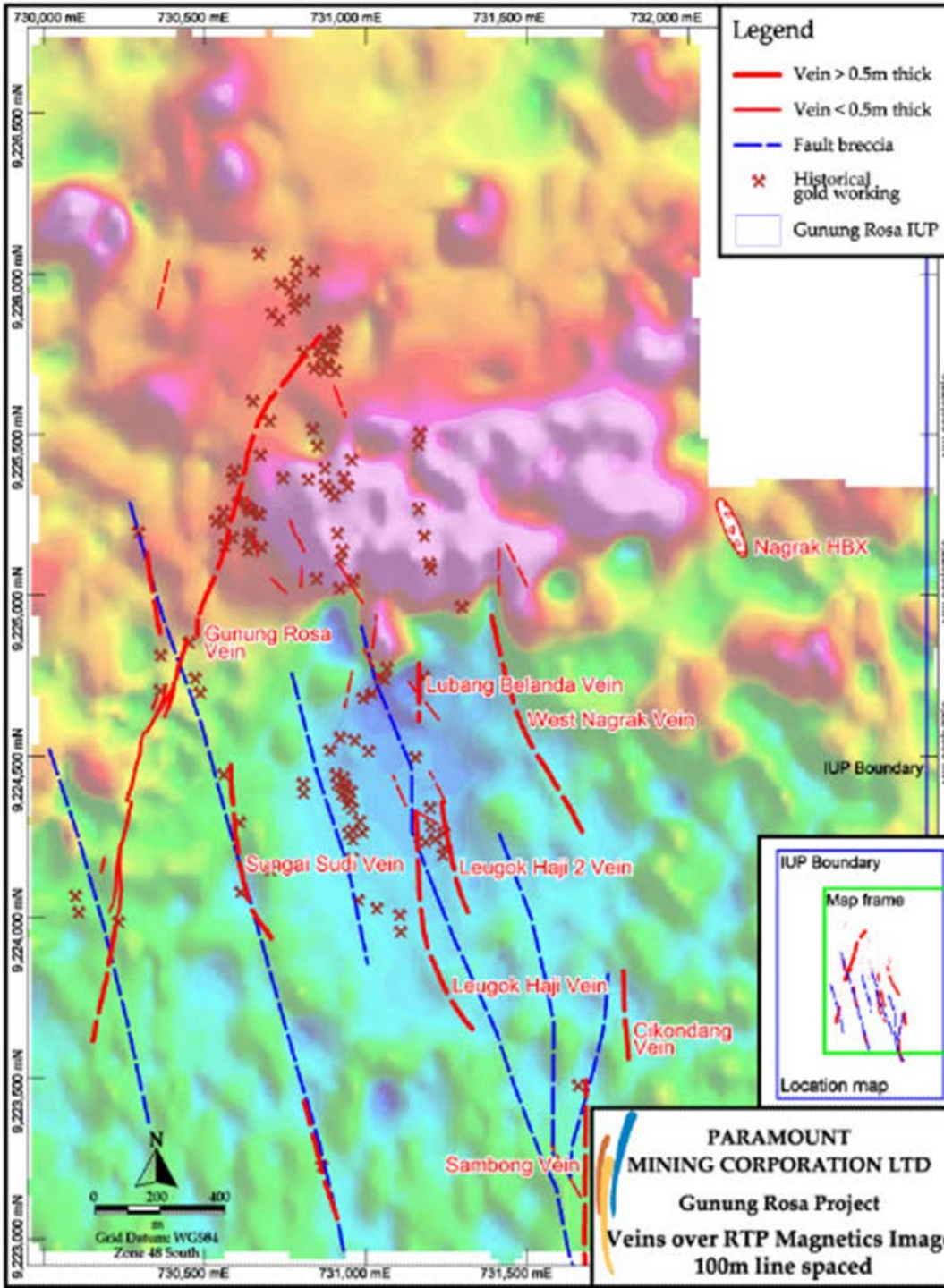


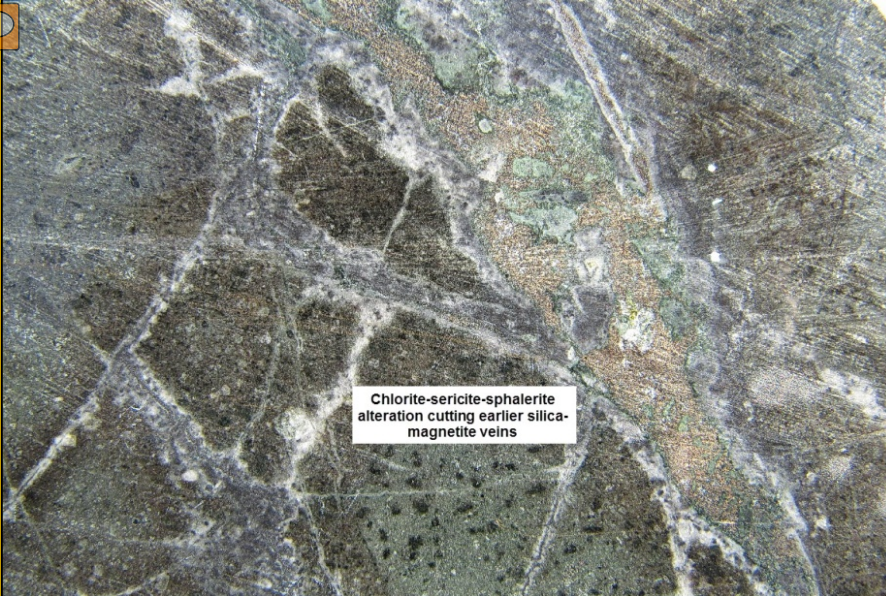


RTP TMI magnetics over
3D digital terrain model

Survey was flown along
north south lines using 50
and 100 metre spaced flight
lines and was completed in
under 2 days.



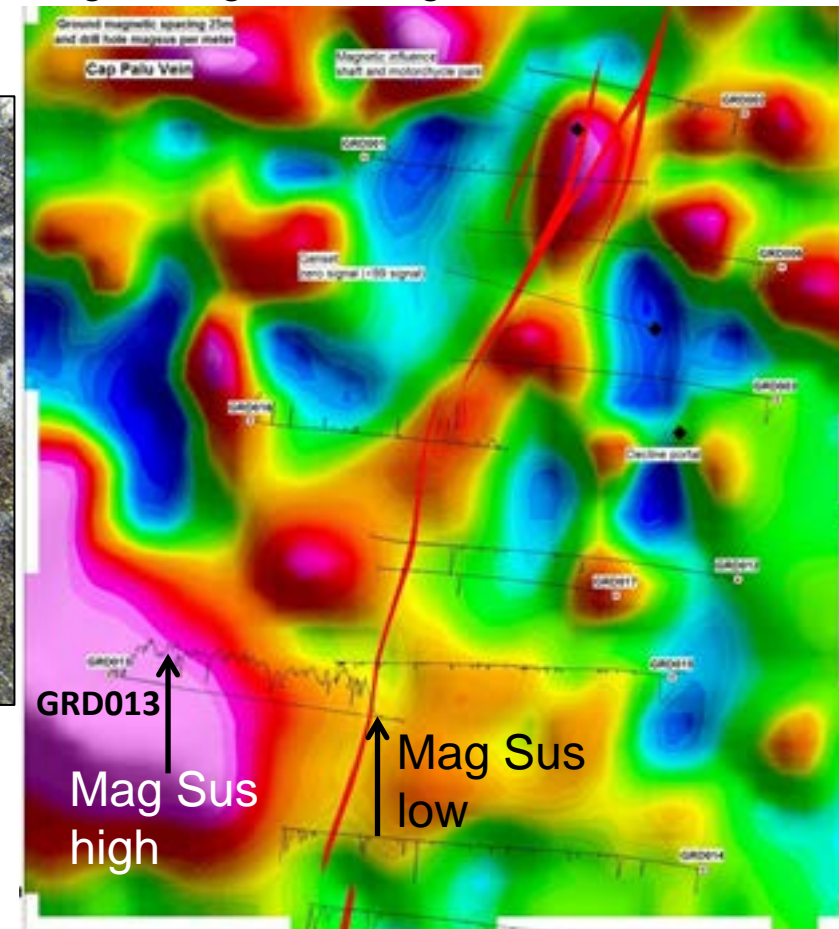


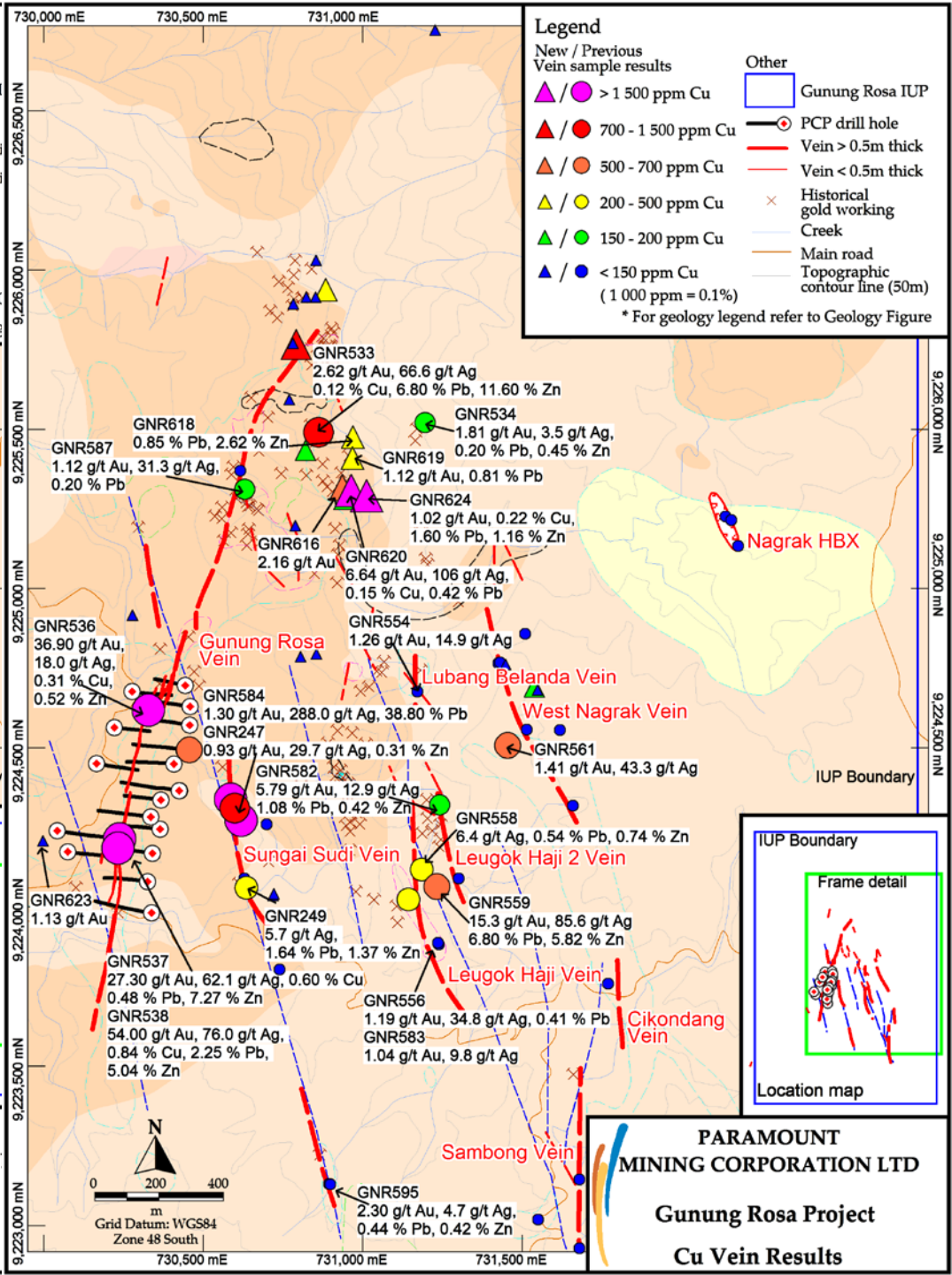
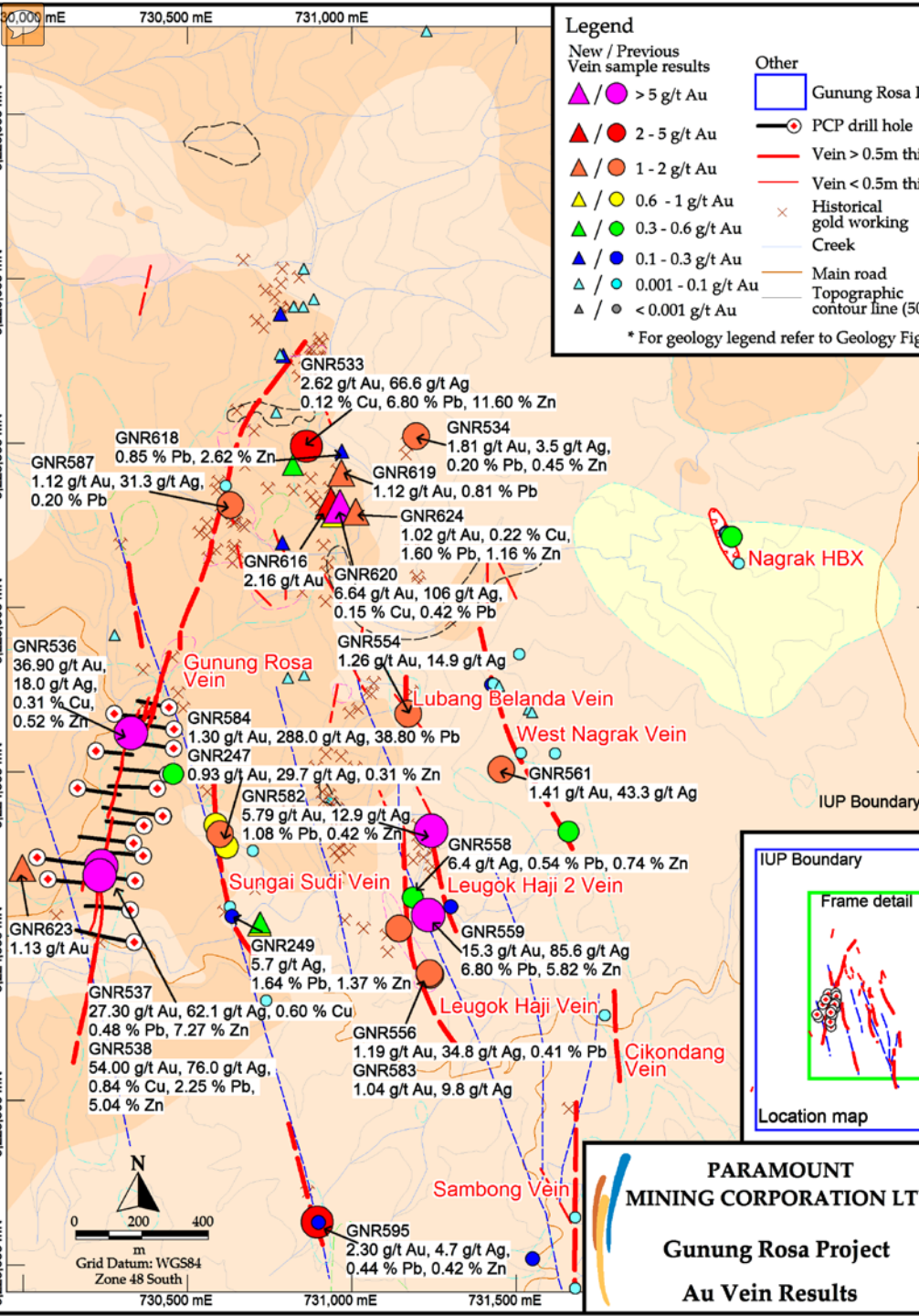


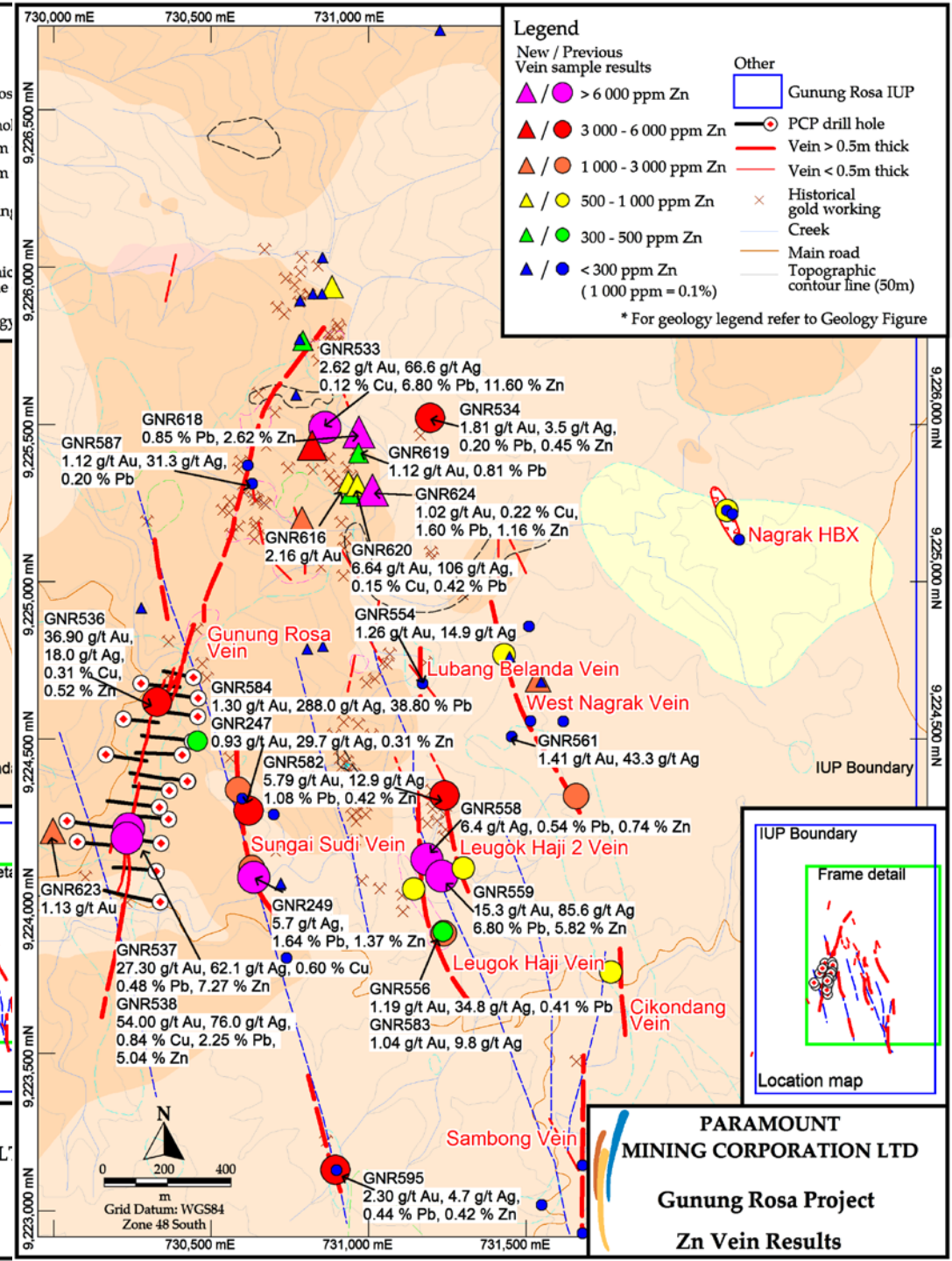
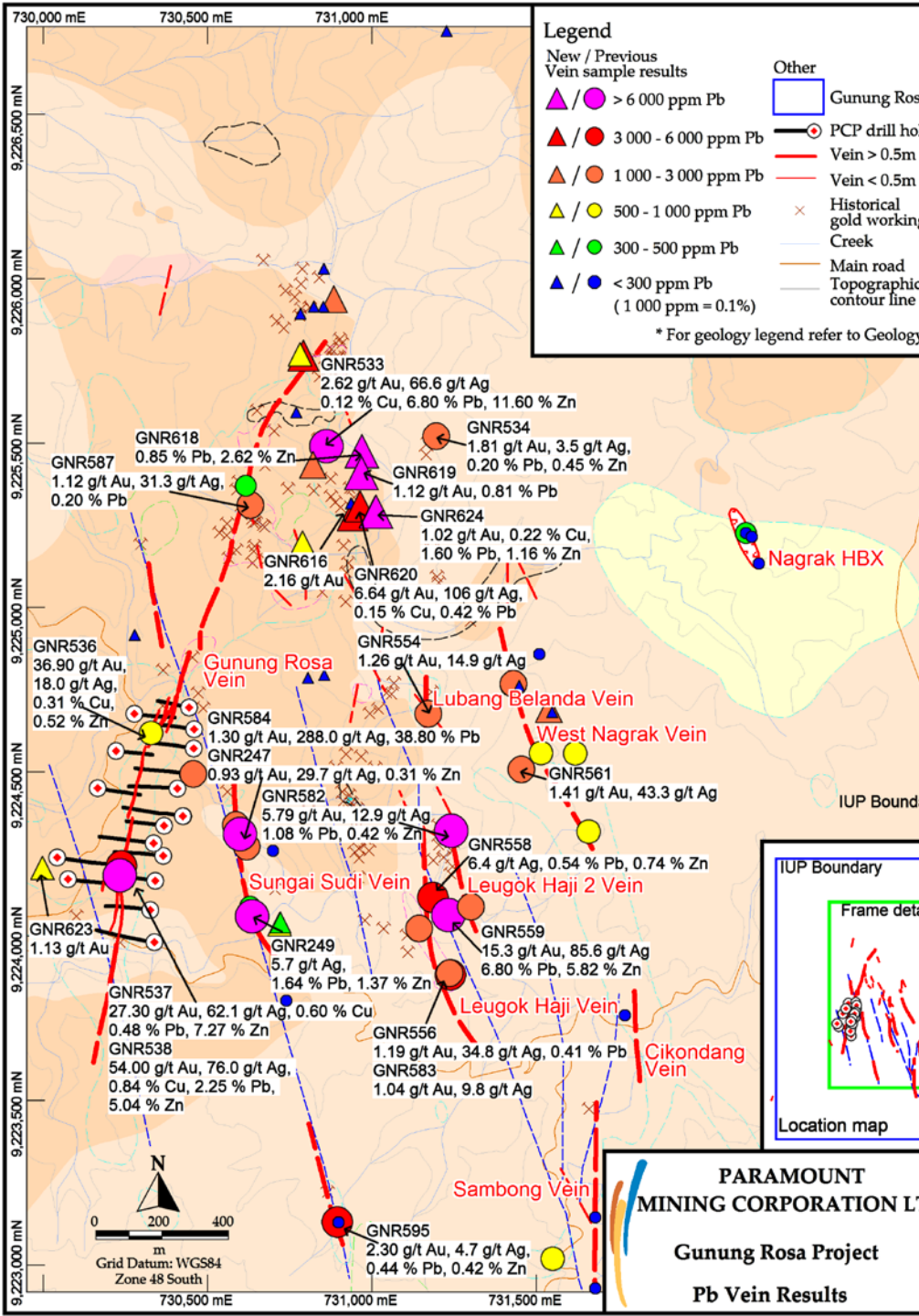
Silica-magnetite stock work veins in microdiorite with dark biotite in selvage along vein margins Hole GRD013

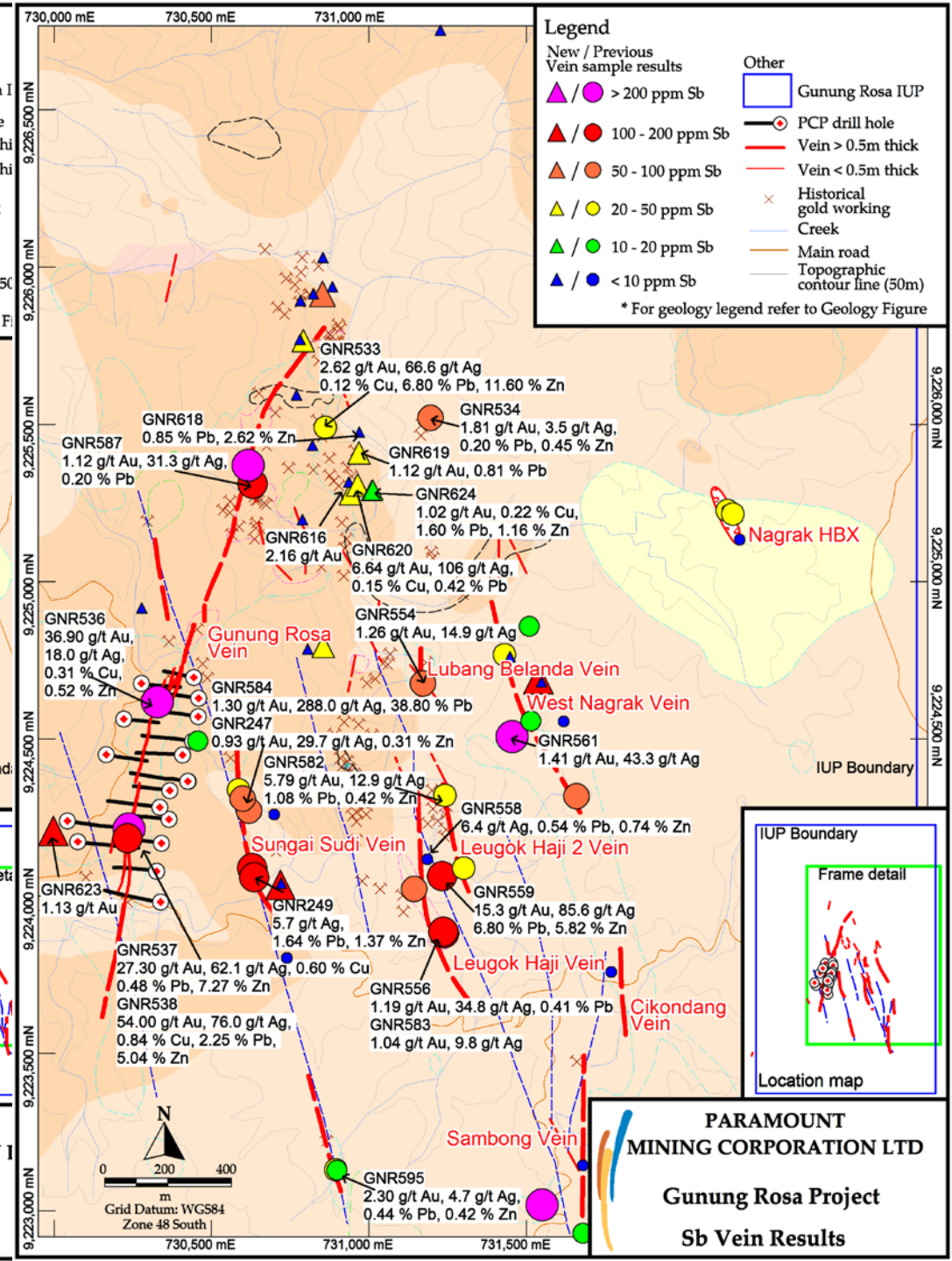
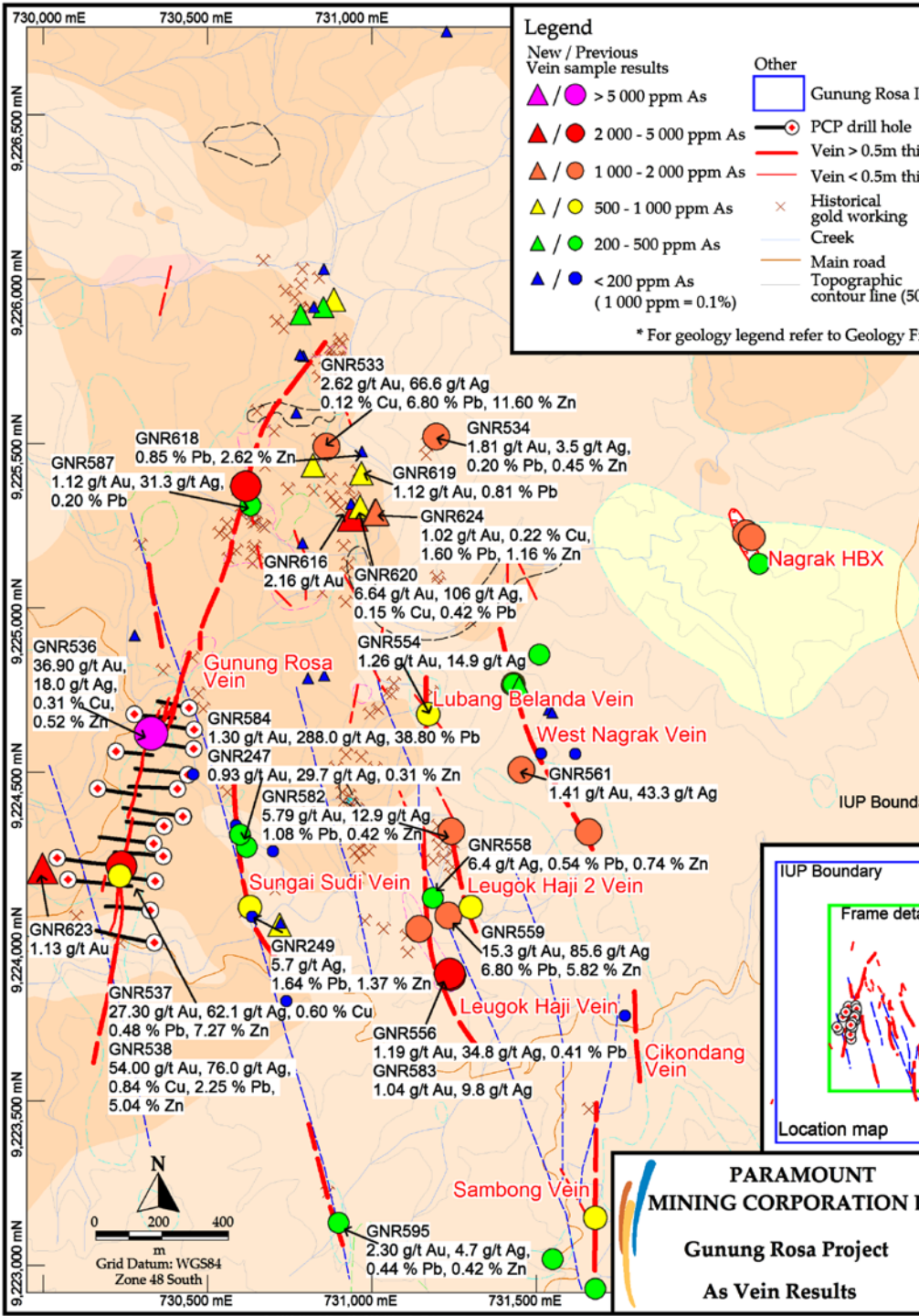


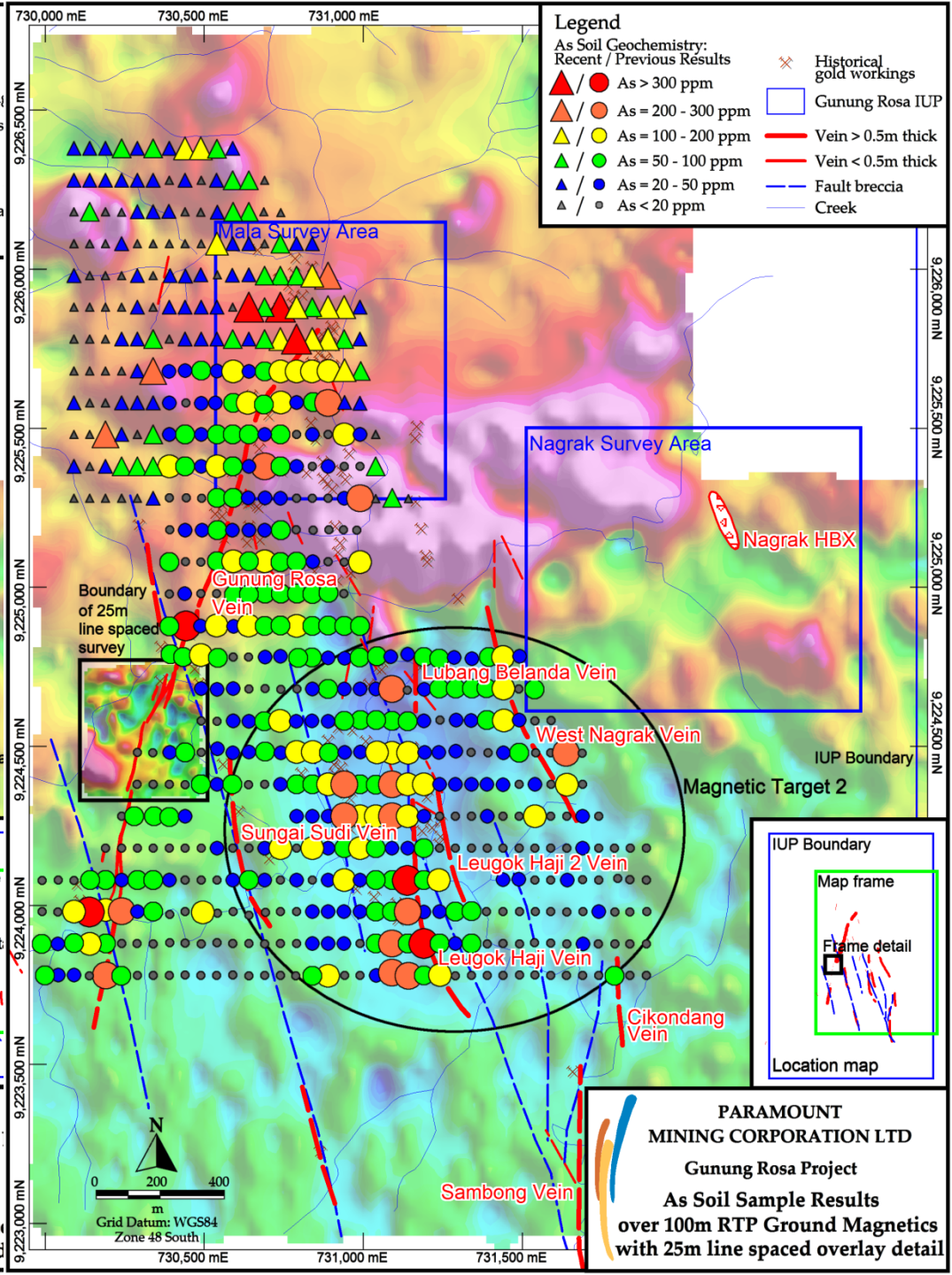
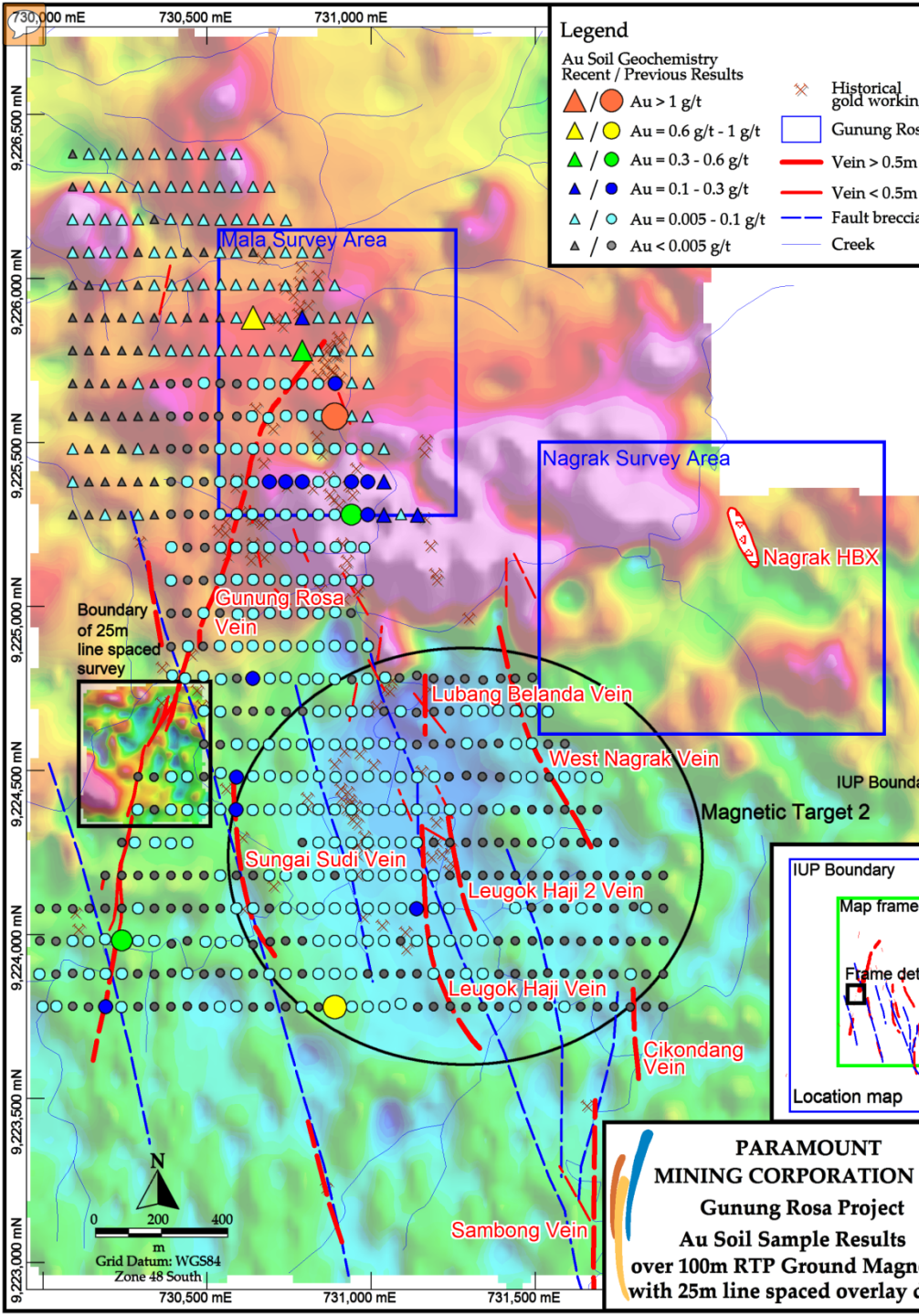
Magnetite destruction related to vein and wall rock alteration can be delineated by detailed ground magnetics.

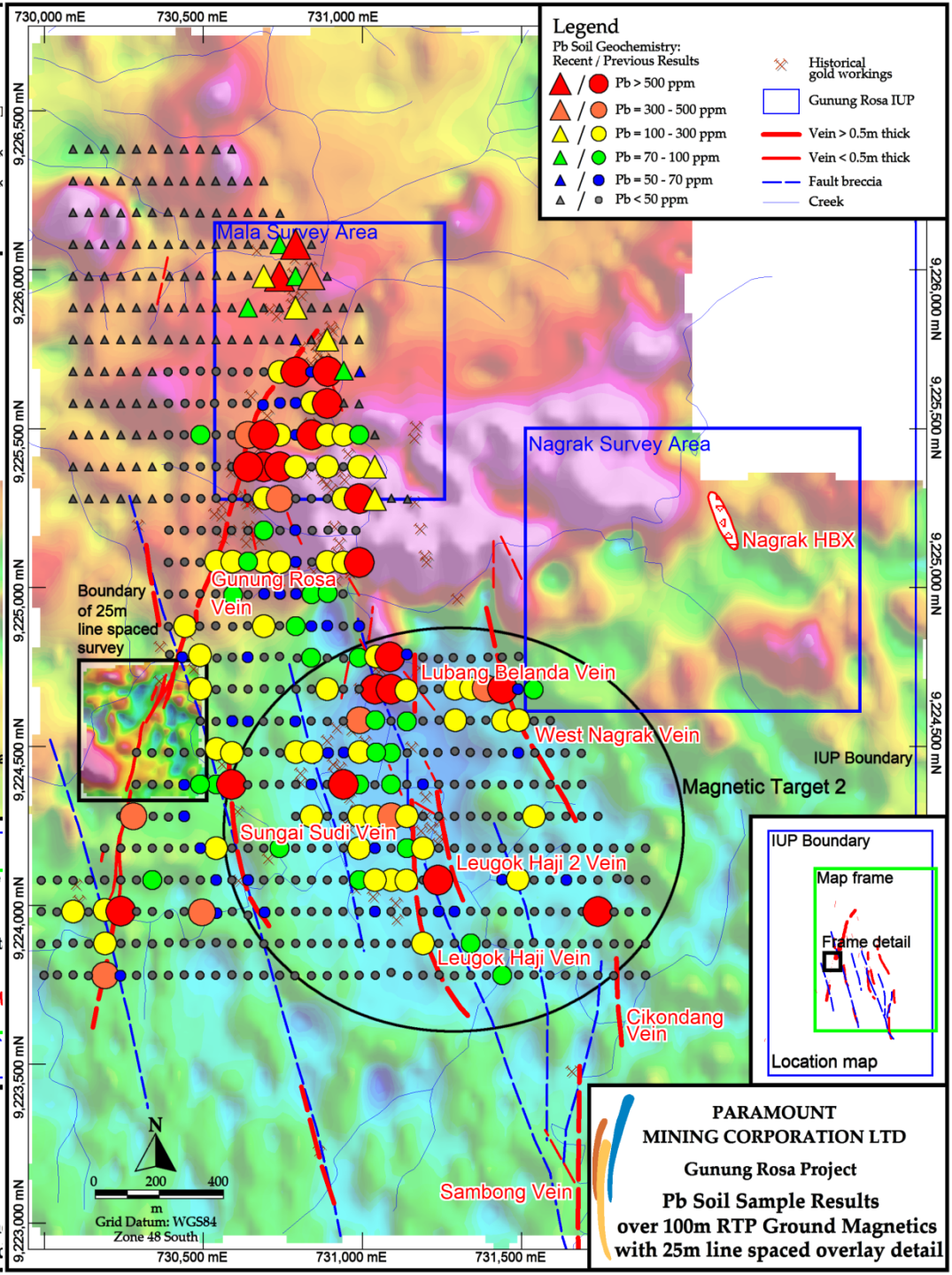
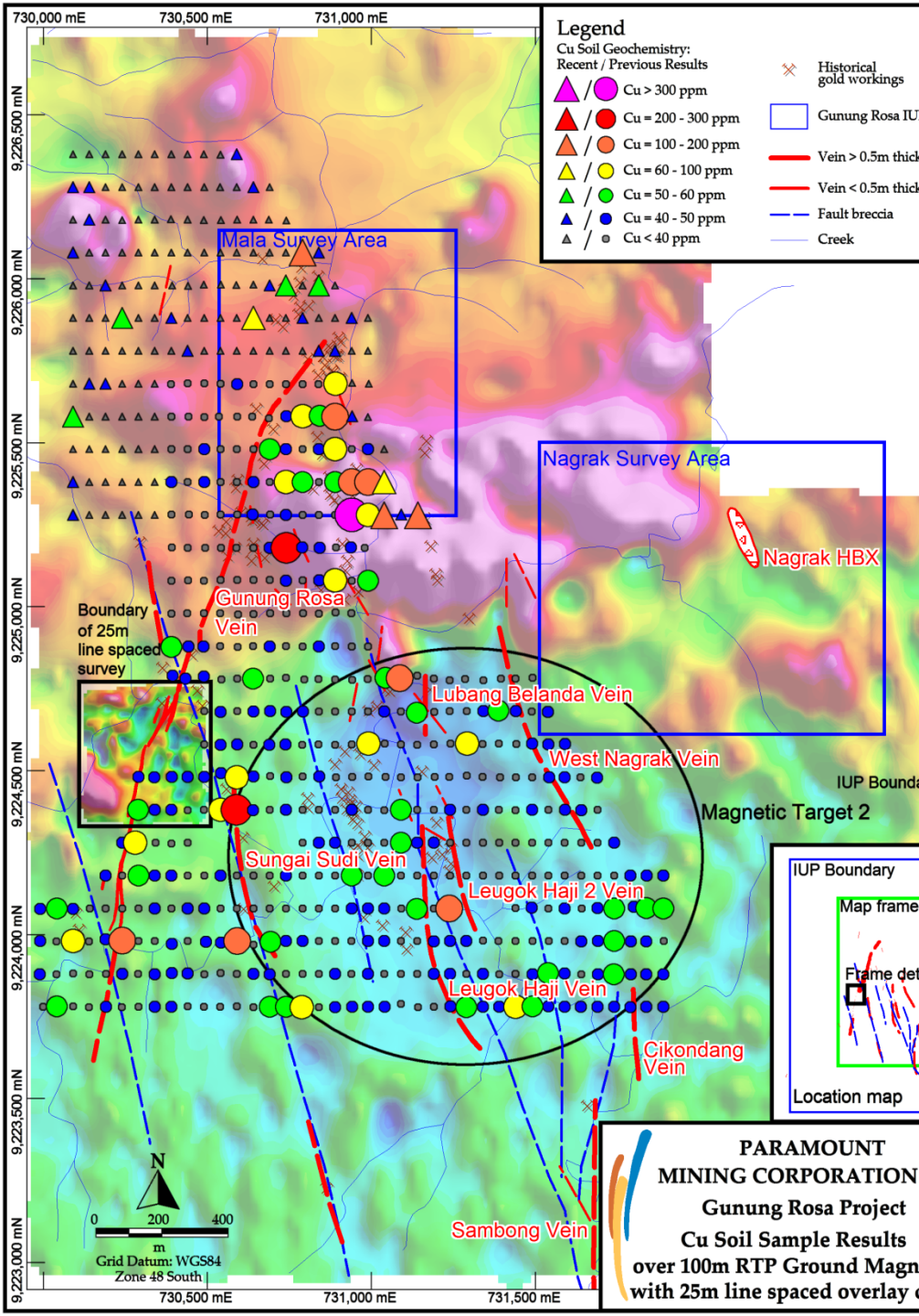


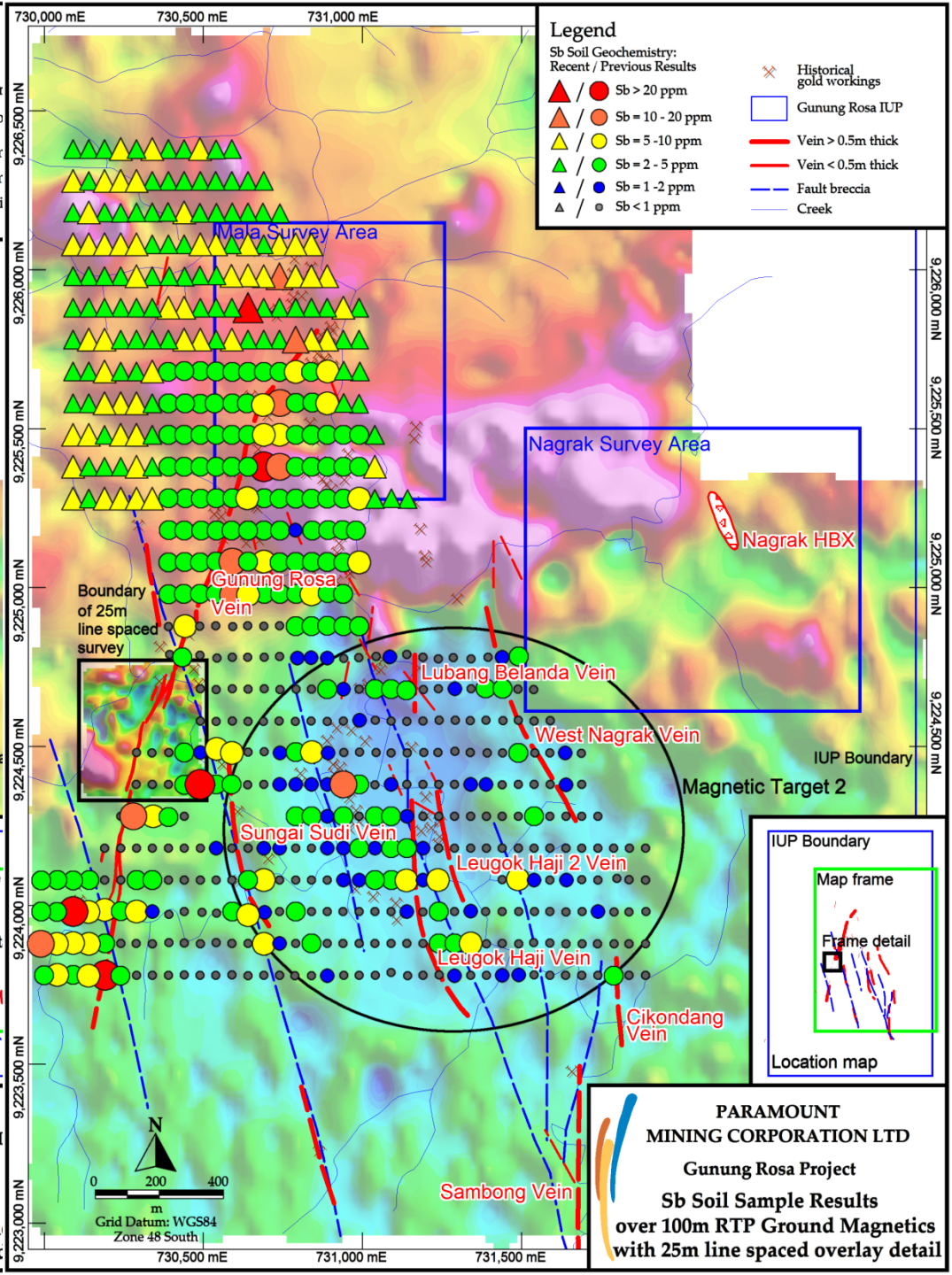
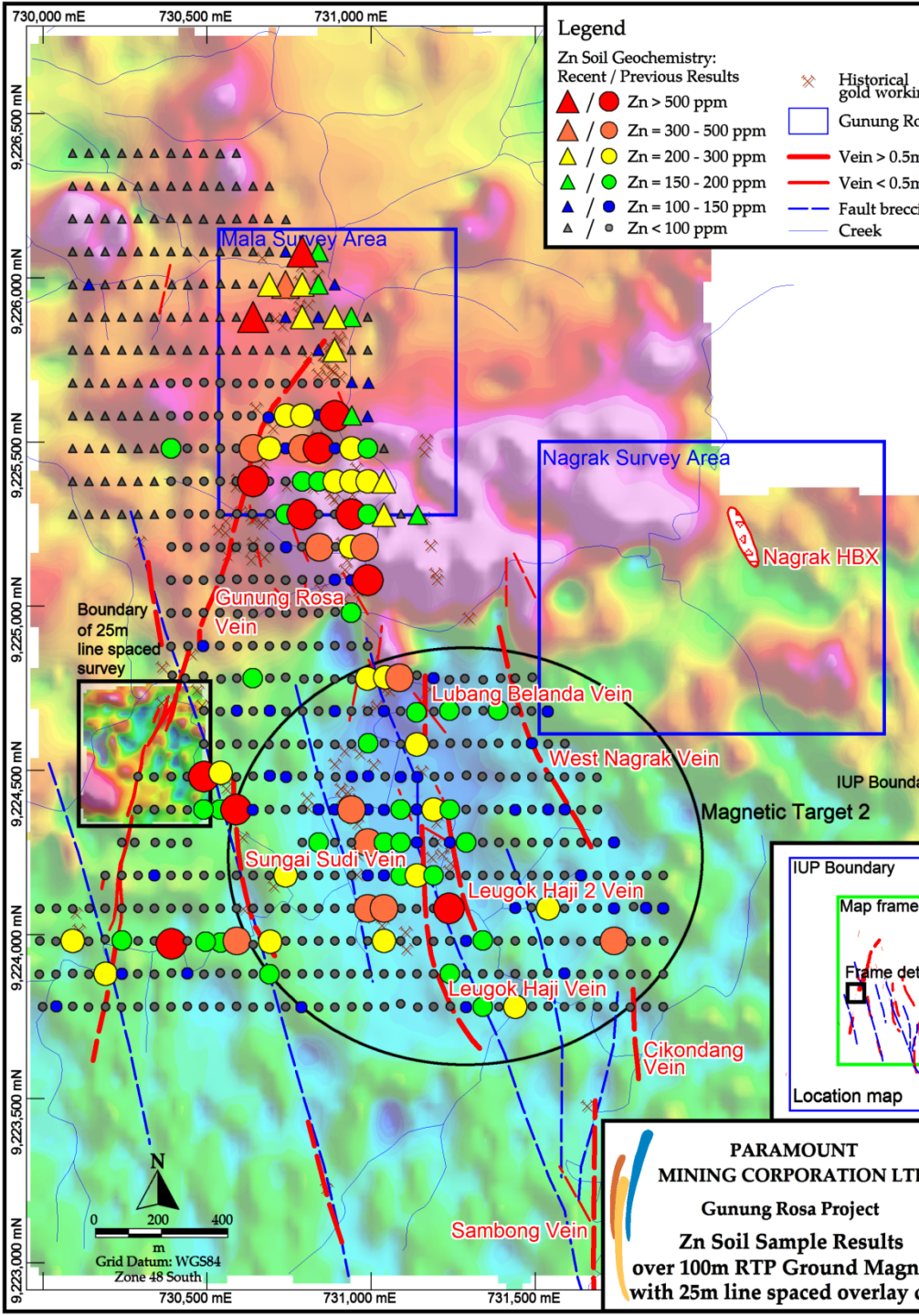


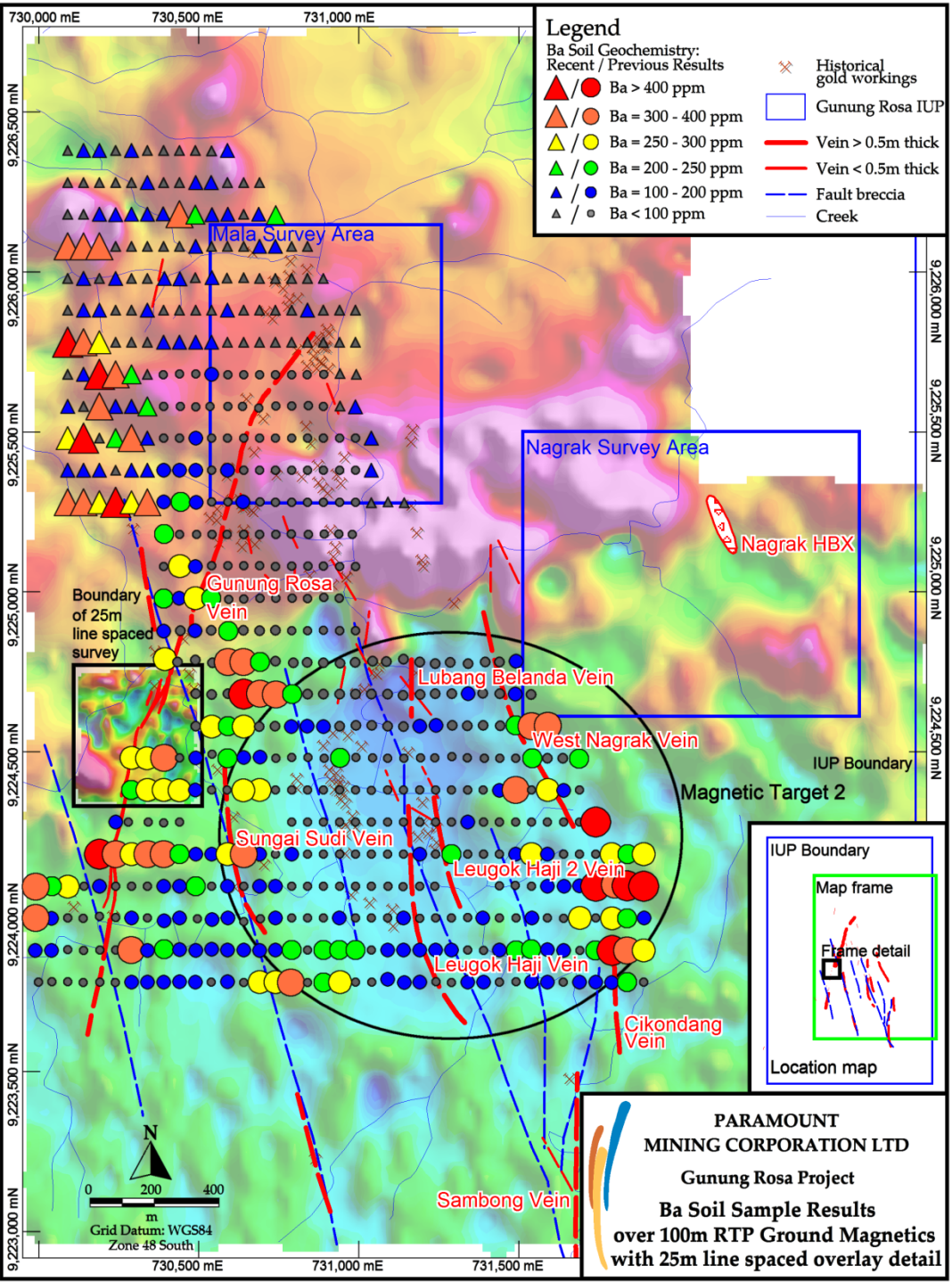
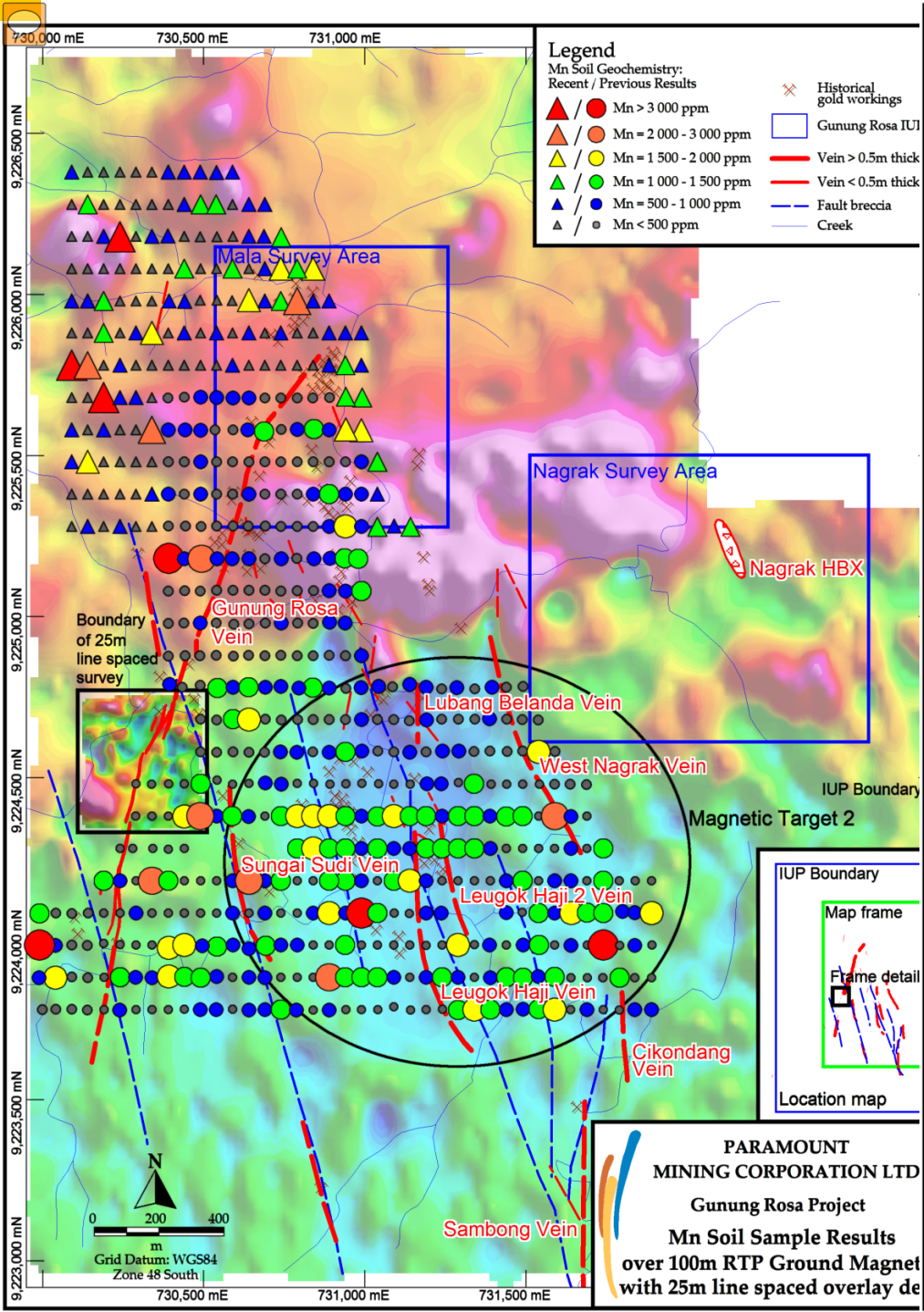












Preliminary metallurgical studies are very positive.

The Gurung Rosa Composite has a Au grade of 11.4 g/t. It also contains 52 g/t Ag, 7.08% Zn, 2.54% Pb and 0.61% Cu.

80% of the gold in the Gurung Rosa Composite is contained in the +0.038 mm fraction which accounts for 56% of the mass.

Gravity upgrading using a Falcon Concentrator and panning achieved a concentrate containing 2835 g/t Au and 1175 g/t Ag (Test 3 Pan Con 1) which represented 0.1% of the feed mass. The tailings product contained 6.5 g/t Au.

Bulk sulphide flotation of the ore showed that it was possible to recover a concentrate of 30% of the feed mass which contained more than 96% of the Au and Pb and more than 98% of the Zn and Cu (FLT.01).

The effect of conducting differential flotation on a cyanide leach residue was investigated in FLT.06. Despite the poor separation between metal sulphides the two-staged process resulted in the recovery of 92% Au, 90% Ag, 98% Zn, 94% Cu, 91% Pb and 30% of the mass.



Clay-silica-pyrite sample with supergene Au (147 g/t) being guarded by a drone.