Cu Deposits of the Western Succession, Mt Isa

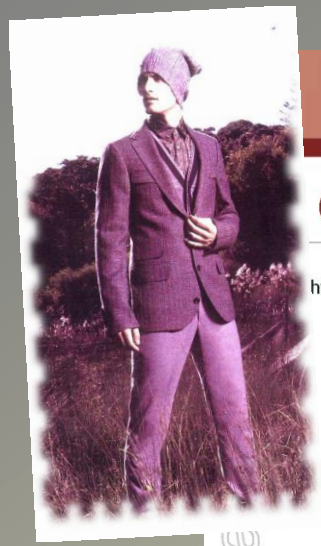
Styles, Origins, Footprints

G M Derrick, *G M Derrick Geology*

CODES Exploration on the Edge Symposium Hobart

29 Oct 2008

Who reads these?



CopperCo Limited - Forward Looking Statements

his presentation contains "forward looking statements". Such forward looking statements include, without limitation:

- estimates of future earnings, the sensitivity of earnings to metal prices and foreign exchange rate movements;
- estimates of future metal production and sales;

Geoff reserves the right to make forward looking statements, about all the things that annoy or get up the nose – the things that television producers glorify in programs such as "Grumpy Old Men". In this world I get upset about conspicuous consumption, of the sort one can see constantly in the glossy magazine accompanying the Financial Review for example . Who needs a pair of $185,000 diamond-encrusted stilletos, or spends $2000 a night to stay at a beach resort in the tropics with no shade, or requires a watch worth $10,000; what's wrong with my 1980 Seiko?? How long do we have to put up with the fashion wank, where overpaid designers make clothes no one will ever wear? But most of all, what gets up my nose are the cretinous pony-tailed advertising copy writers who just have no idea about the finer points of fishing. . .

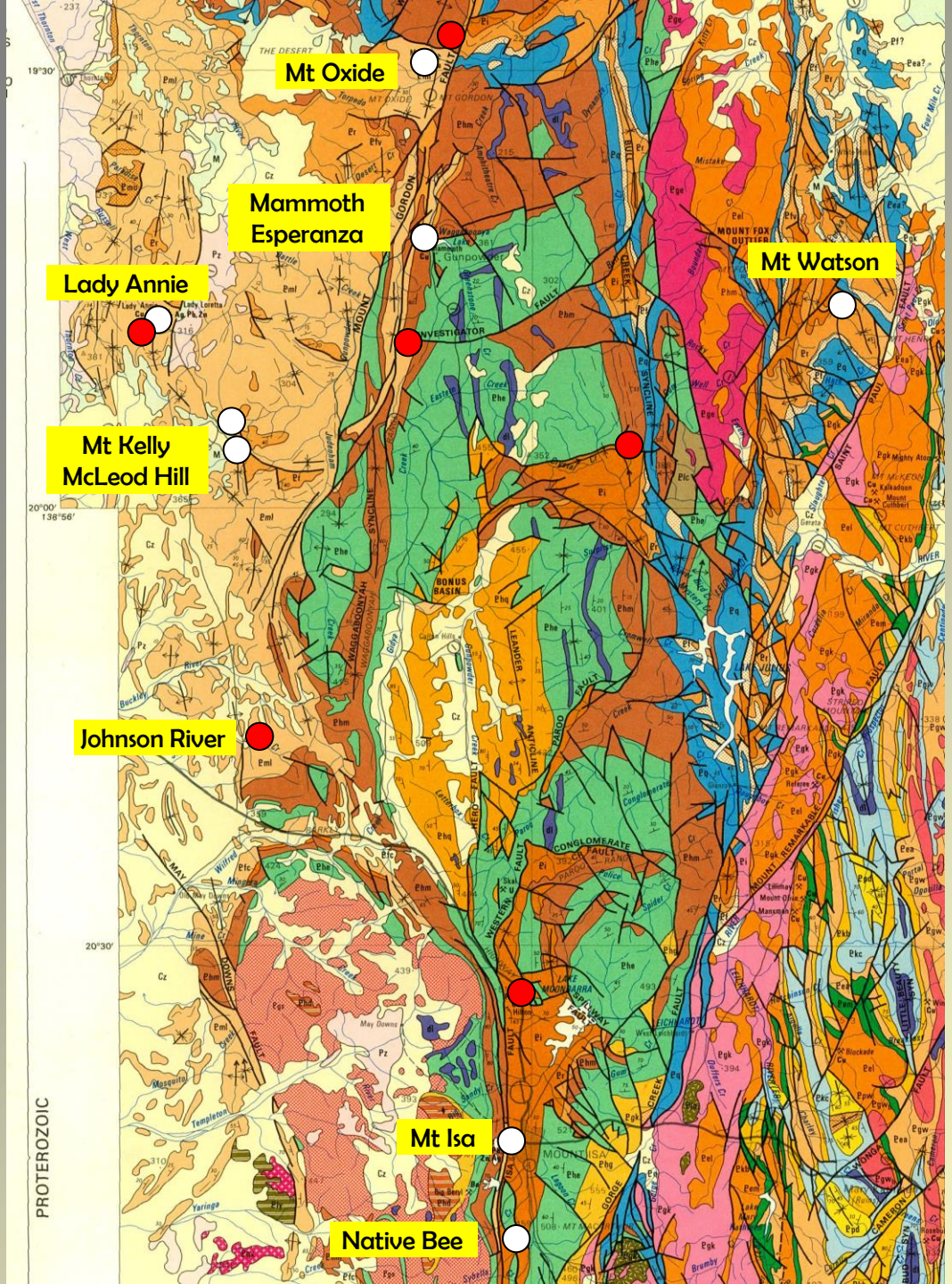
formation relating to mineralisation and resources used in ... based upon information prepared by competent p
dance with the JORC Code and has previously been re... k Exchange Ltd.

Geoff Derrick – Cu deposits of the Western Succession, Mt Isa
CODES Exploration on the Edge, Hobart, Oct. 2008

Possibly a Tassie trout stream, but these advertising types have never heard of a fly rod, and worse still, they use as a prop an old 1965 sidecast fishing reel. . .

WHERE DO THEY FIND THESE PEOPLE?

Let's put frivolity and ignorance aside. . .



Regional Geology, Western Succession and location of Cu deposits

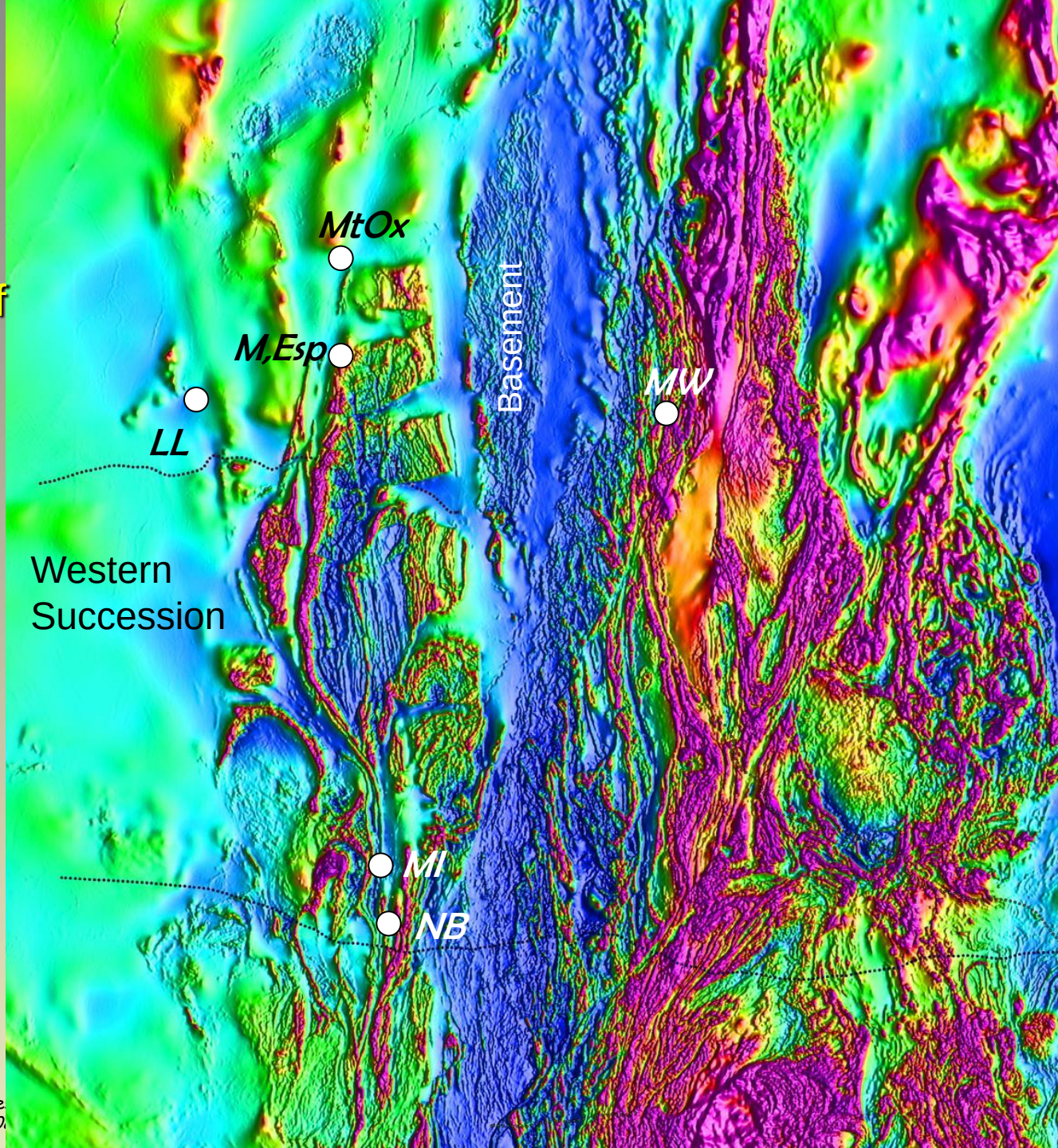
Major & significant Cu deposits, western succession

Areas of significant drilling 2007-2008 ??

1680 1640Ma	*Mt Isa-McNamara Gp*
1750Ma	*Quilalar Fmn cover suite*
1770Ma	*Eastern Creek Volcs - basalts*
1860Ma	*Ewen Granite basement*
	Kalkadon Granite basement

50 km

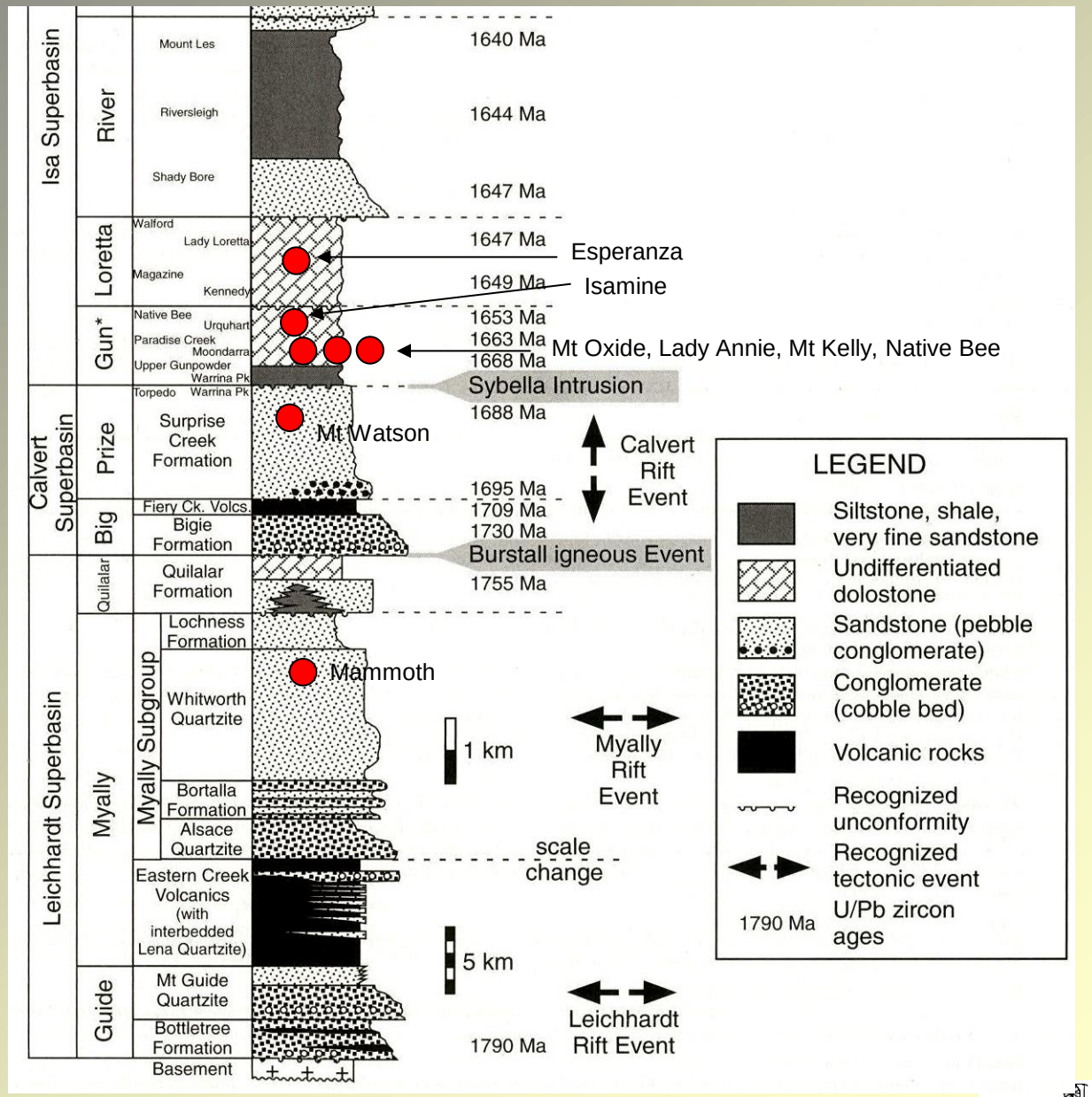
Basalts of the Eastern Creek Volcanics dominate the magnetic landscape of the Leichhardt River Fault Trough



In this area alone, there may be 50,000 km³ of basalt as potential source rock for Cu

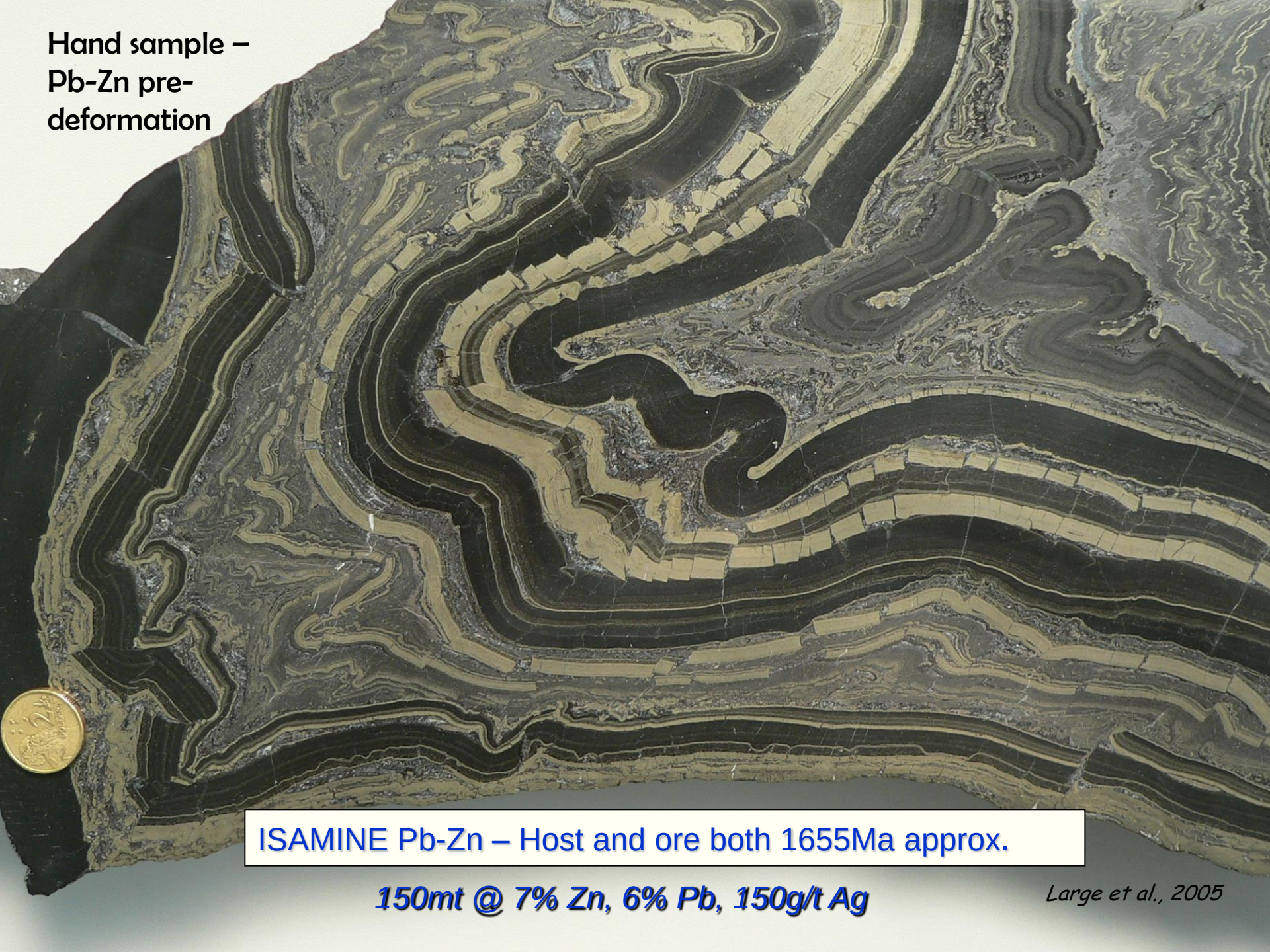
Host rocks to Western Succession Cu deposits

MT ISA OROGENY 1600 TO 1500 Ma approx.
(D1 to D3: D2 ~1550Ma; D3 1500Ma)



Superbasins, supersequences, formations and ages (from Polito et al., 2006)

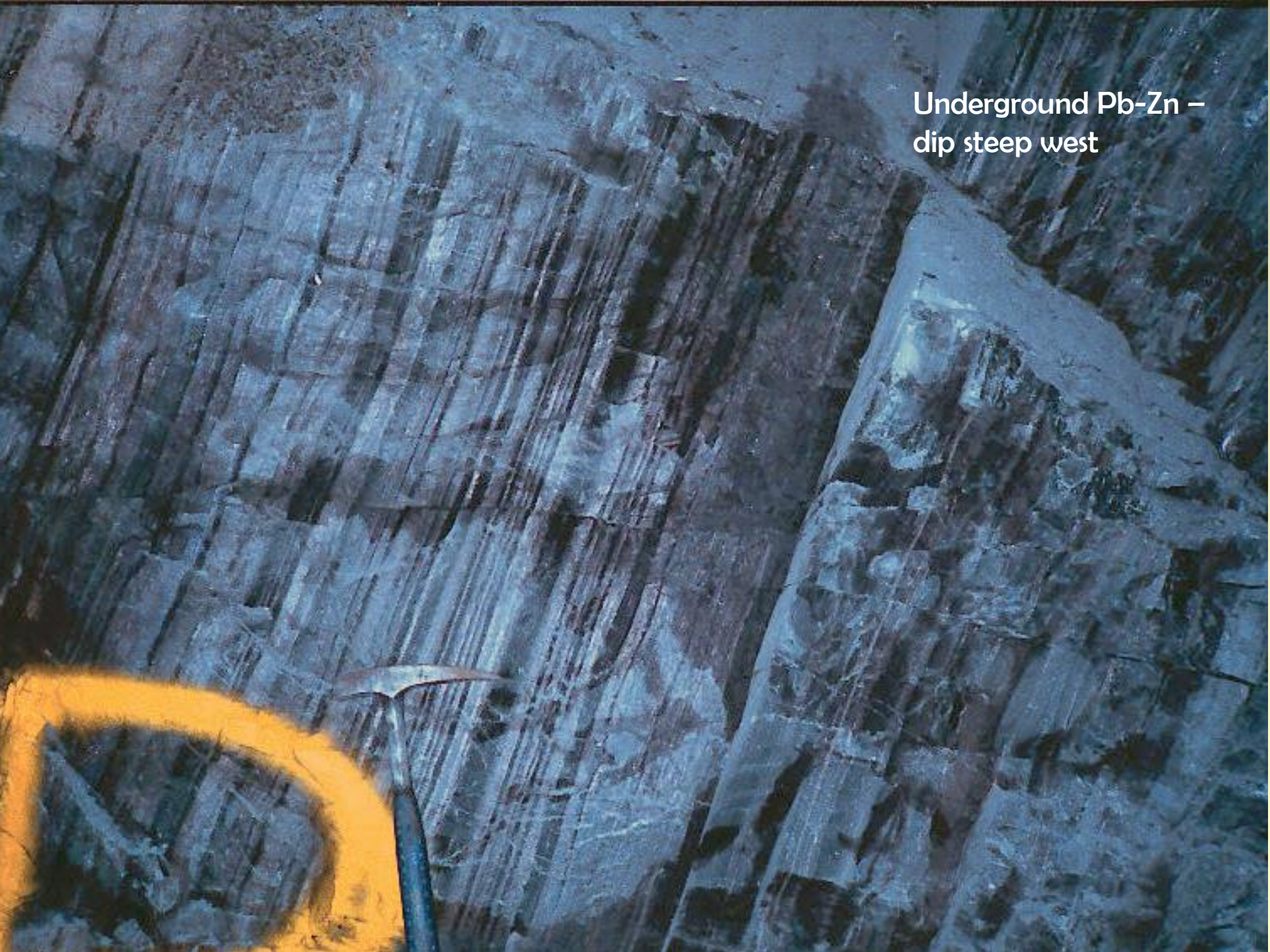
STYLES of MINERALISATION

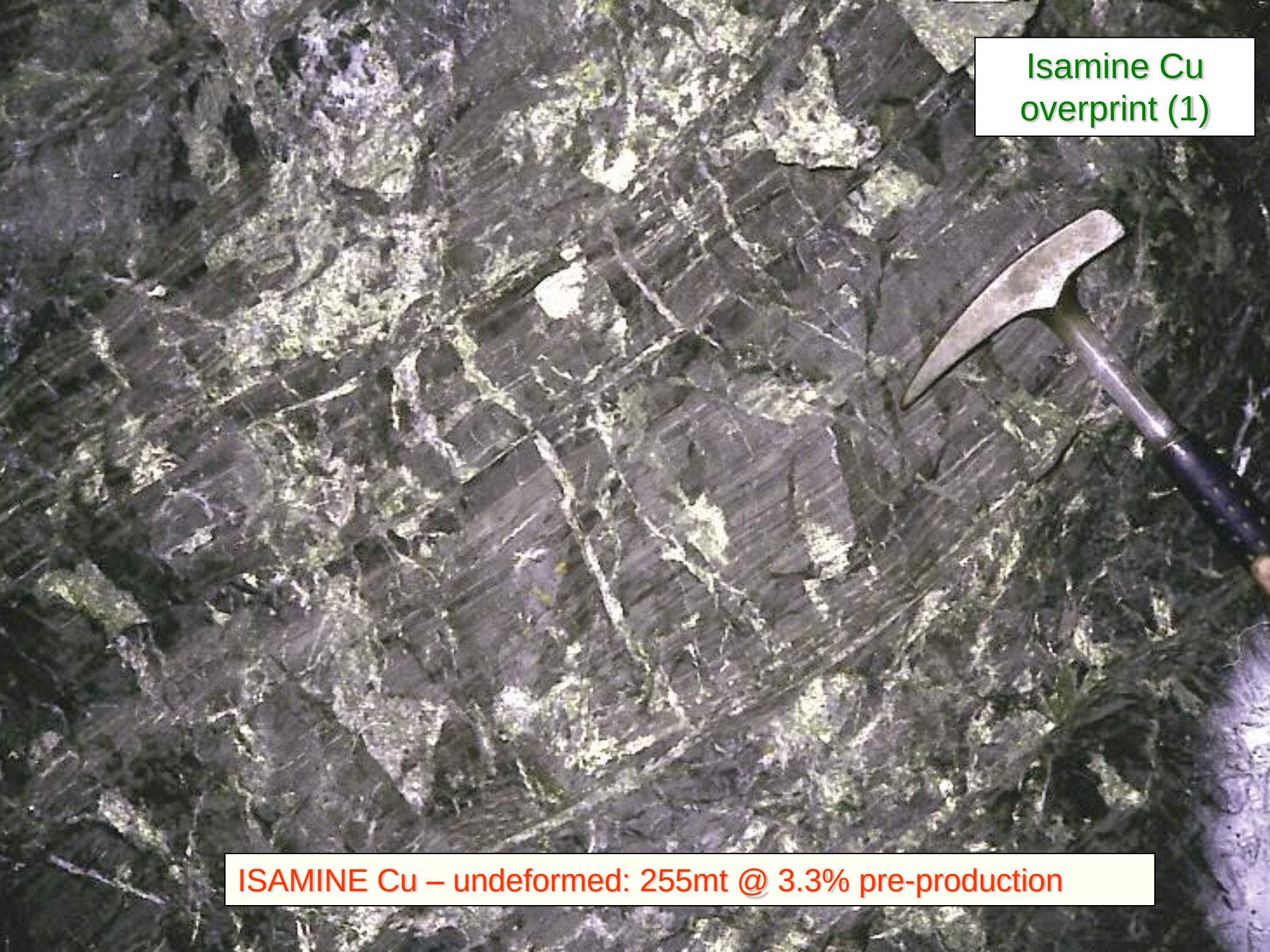


ISAMINE Pb-Zn – Host and ore both 1655Ma approx.

150mt @ 7% Zn, 6% Pb, 150g/t Ag

Large et al., 2005


Underground Pb-Zn –
dip steep west


Isamine Cu overprint (1)
ISAMINE Cu – undeformed: 255mt @ 3.3% pre-production


Isamine Cu
overprint (2)

VERY BASIC TIMING RELATIONSHIPS

Urquhart Shale hosts Pb-Zn deposit, and both are about the same age ~1650Ma

Regional greenschist facies metamorphism produces phengitic micas, stilpnomelane, talc, siderite, biotite etc, during Mt Isa Orogen, mainly D1-D2, 1600 to 1550 Ma; Urquhart Shale folded.

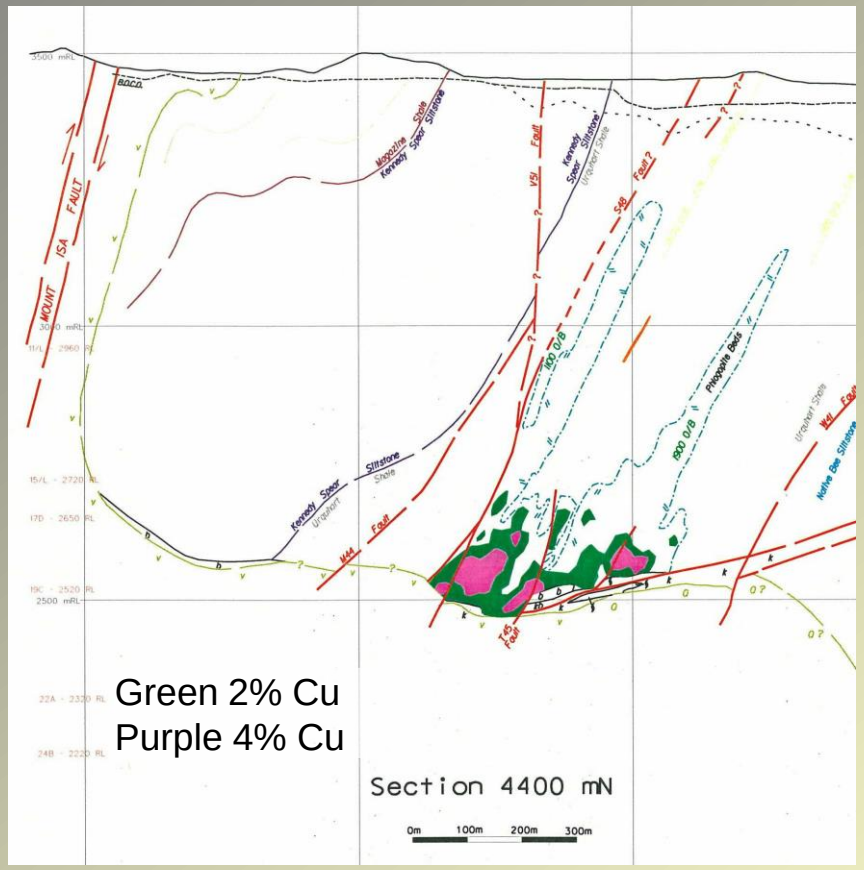
The main Cu vein stockwork formed ~1500Ma or younger, overprints metamorphic minerals, and is itself largely undeformed

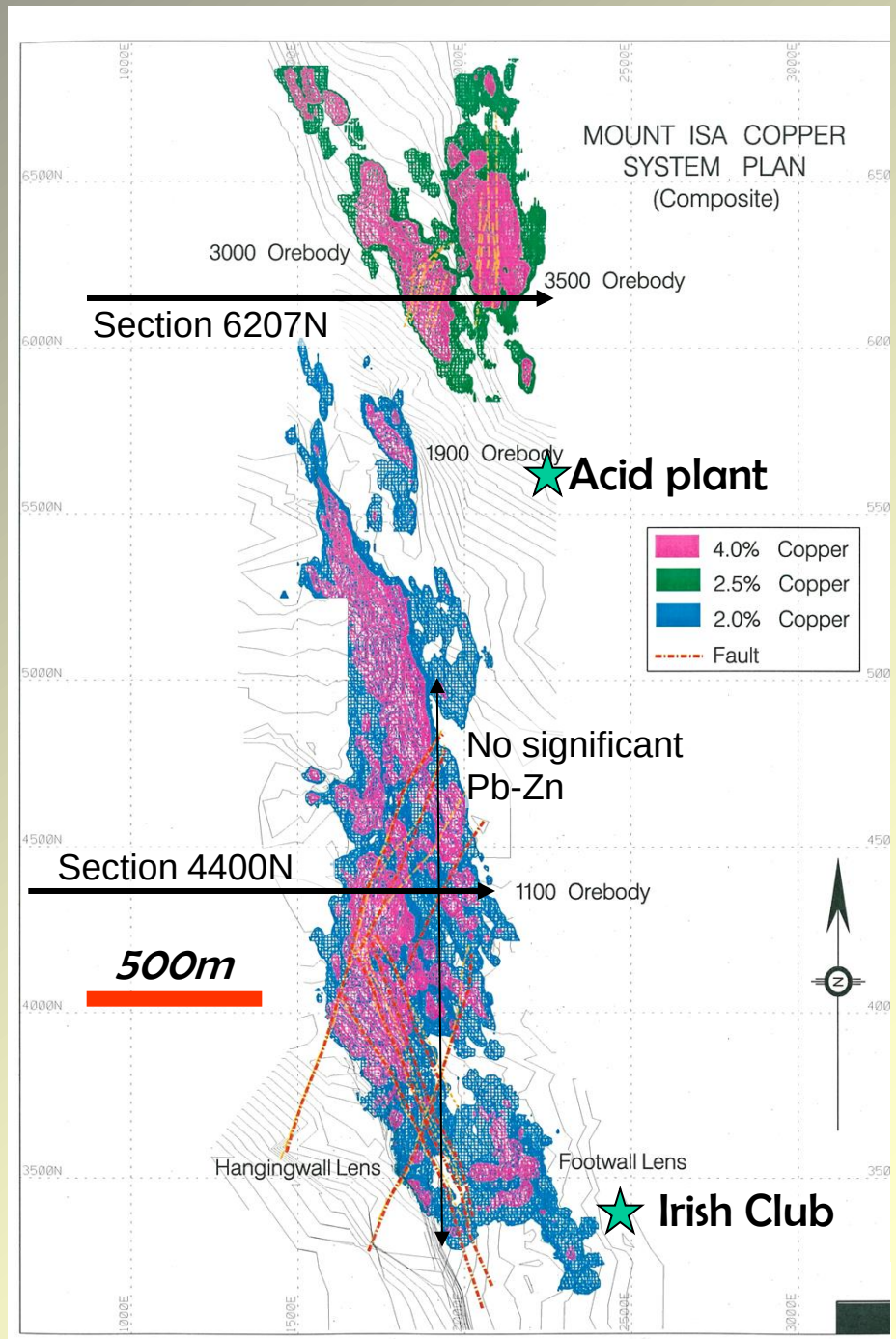
CONCLUDE that peak regional metamorphism temporally separates the Pb-Zn-Ag and late metamorphic Cu mineralisation. COGENESIS IS SIMPLY NOT AN OPTION.

Mt Isa - Inclined view to north

Southern limit, 1100 orebody

The 1100 and 1900 Cu orebodies – 2.6km of strike length



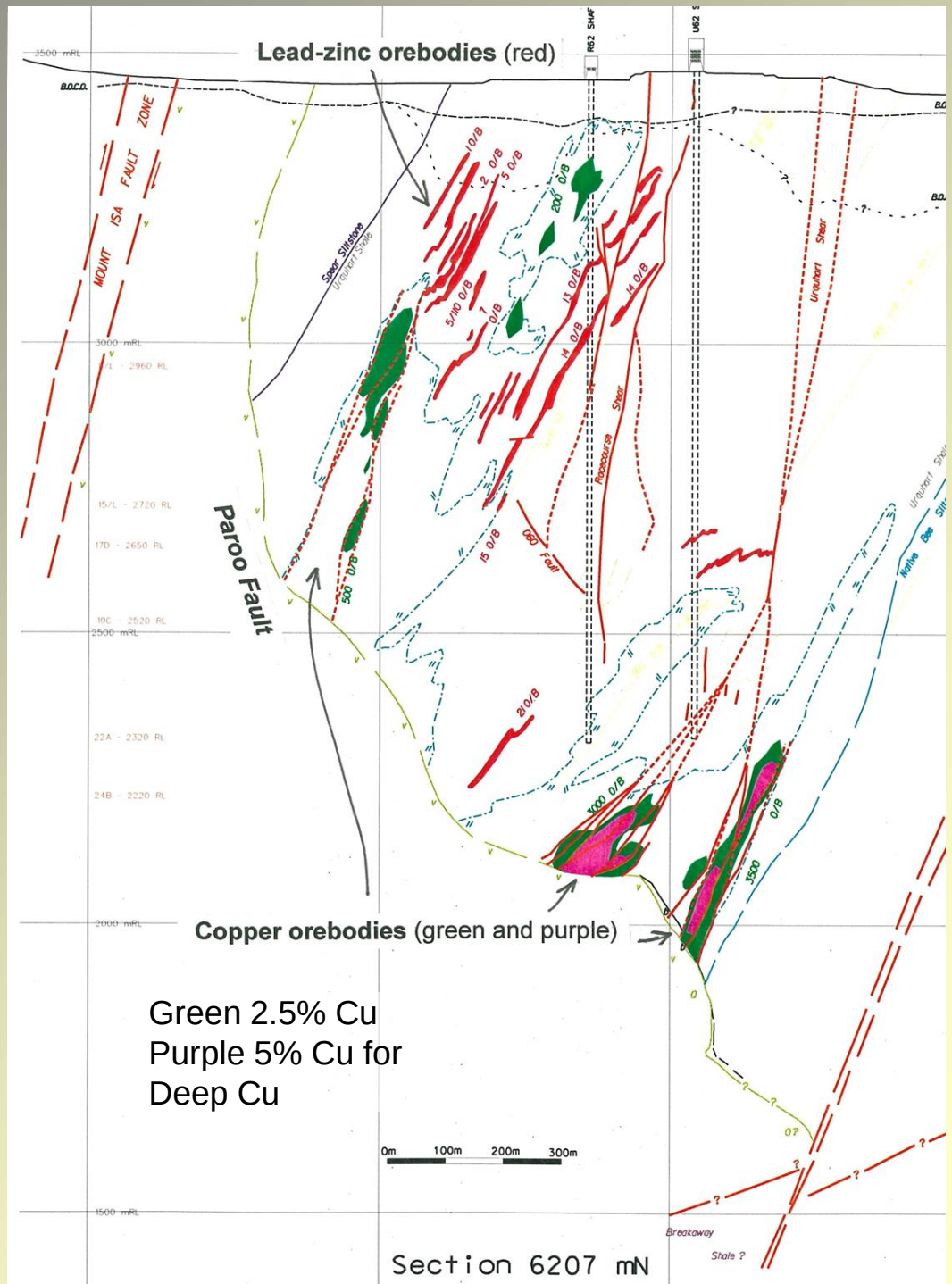


Geoff Derrick – Cu deposits of the Western Succession, Mt Isa
CODES Exploration on the Edge, Hobart, Oct. 2008

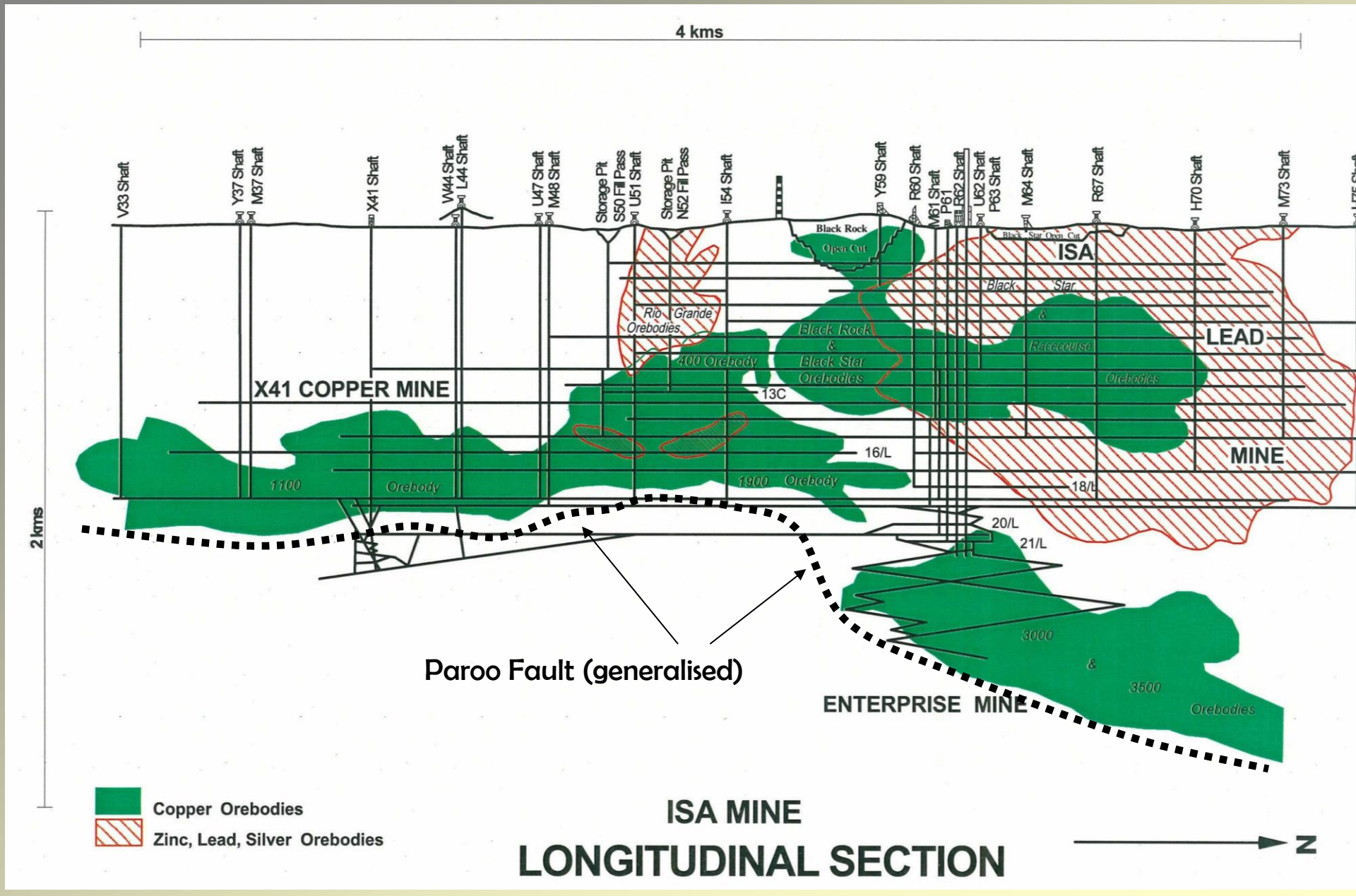
The 3000 and 3500 Cu orebodies –

1.2 to 1.8km below surface , production 1996 to present

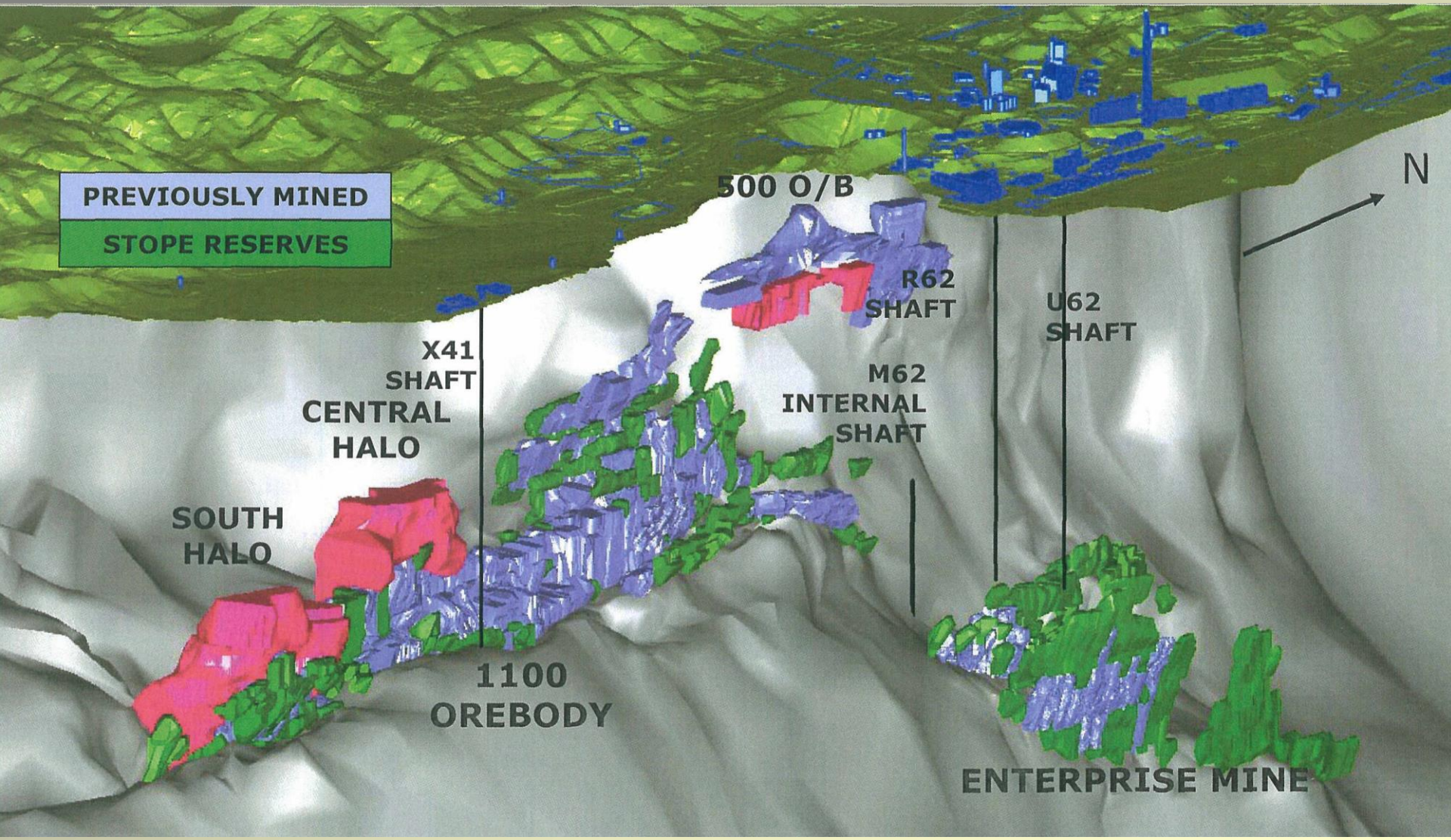
Note the folded Paroo Fault and underlying greenstones of the ECV, and limits of silica-dolomite alteration outlined in blue line. The low-grade fringe mineralisation at higher levels is the basis of the Mt Isa "Super Pit"



The MAGNIFICENT Paroo Fault

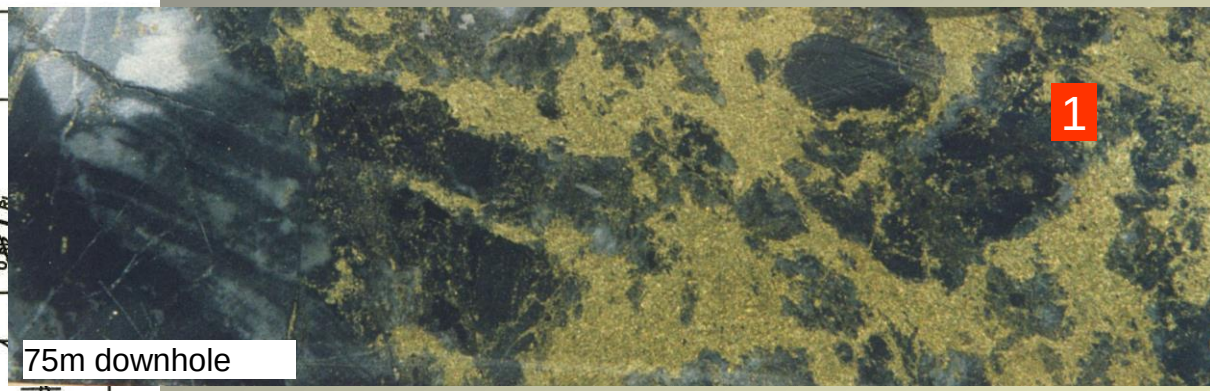


The 3D view, Isamine Cu

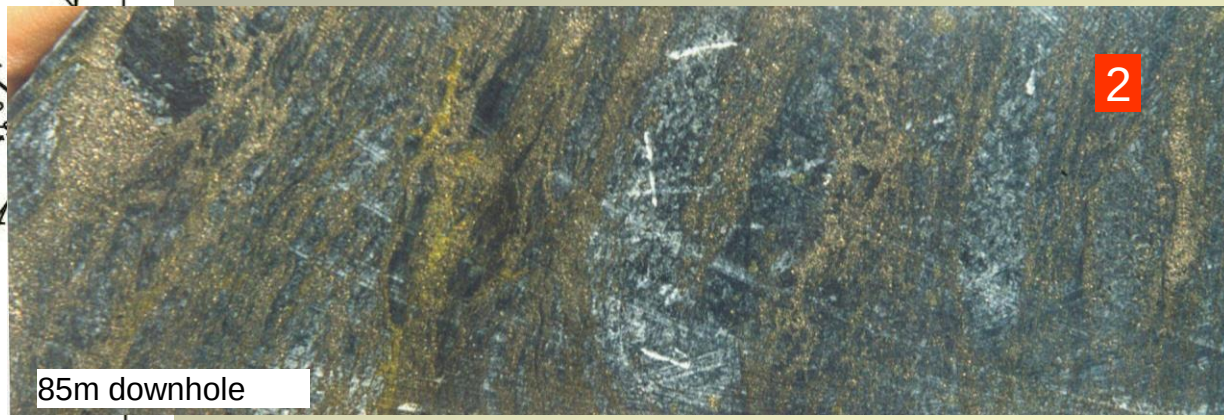


Note that Pb-Zn orebodies are not shown in this XStrata Copper diagram

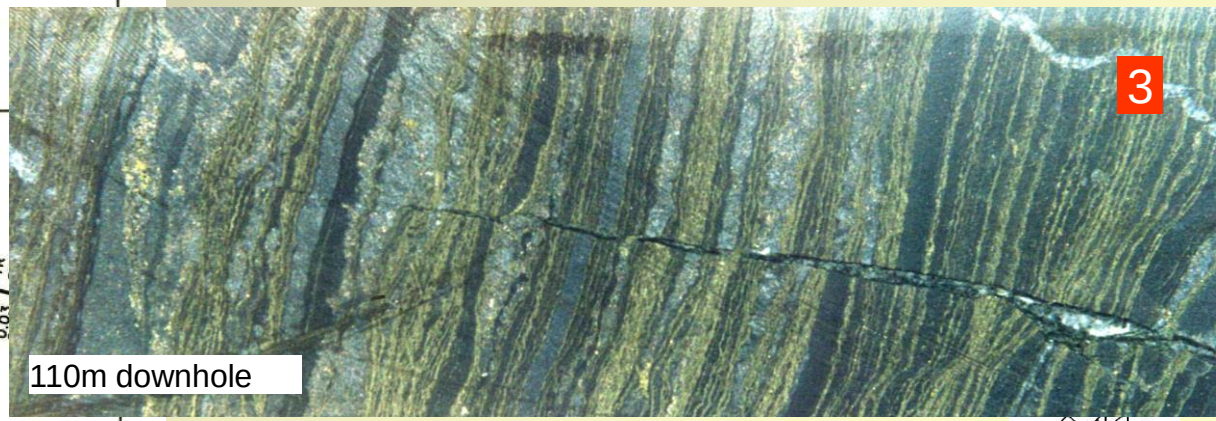
Isamine Cu 3500 orebody



Cpy-qtz in silic. siltstone



Weakly banded altered silt with po, cpy and TALC alteration



Footwall recryst. pyritic dolomitic siltstone

Isamine Cu - the Alteration Envelope

Pb-Zn-py and dolomitic siltstone distal to Cu

Recrystallised and sparry dolomite-altered py and dolomitic siltstone proximal to Cu

Isamine Cu - silica dolomite alteration

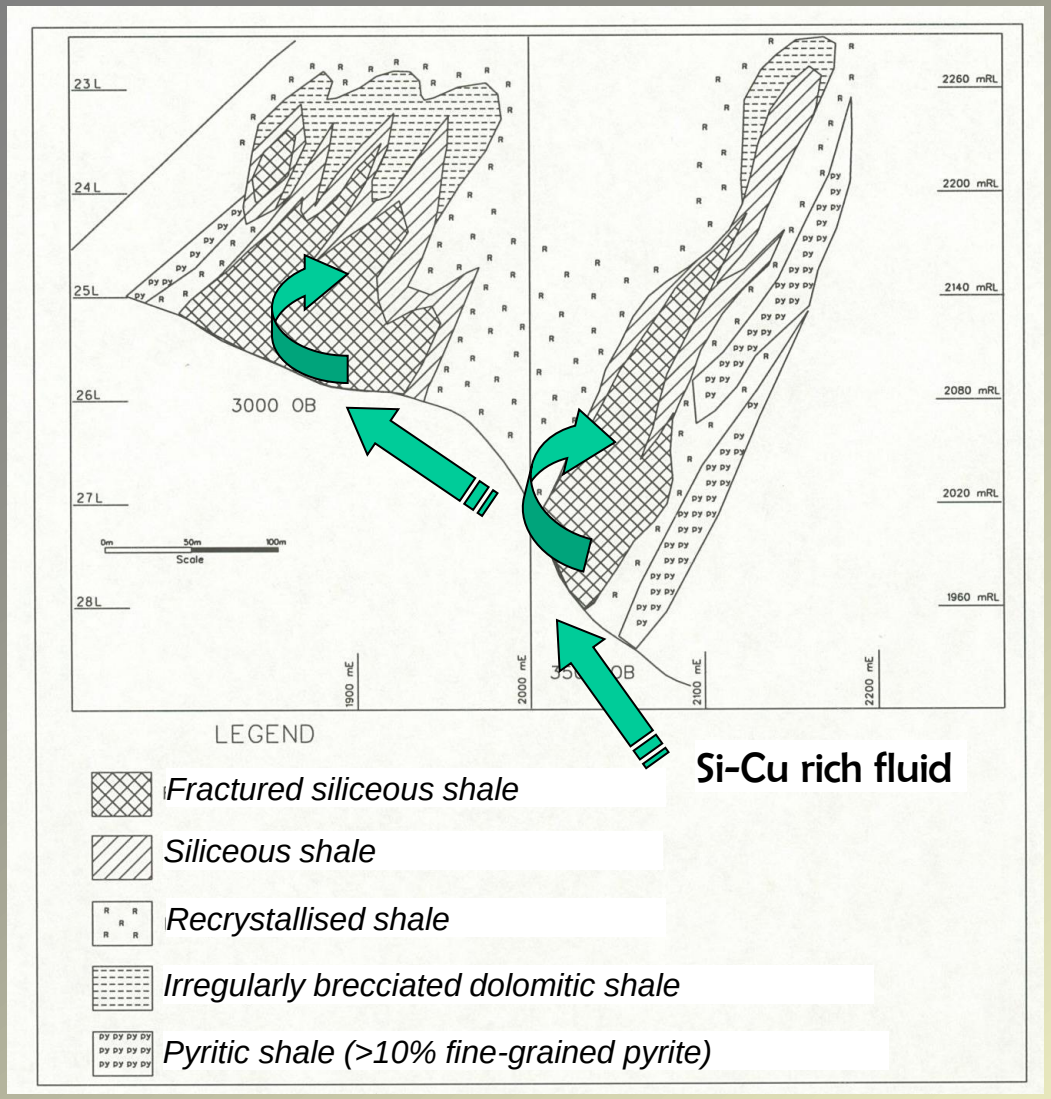
High grade Cu with qtz close to Paroo F

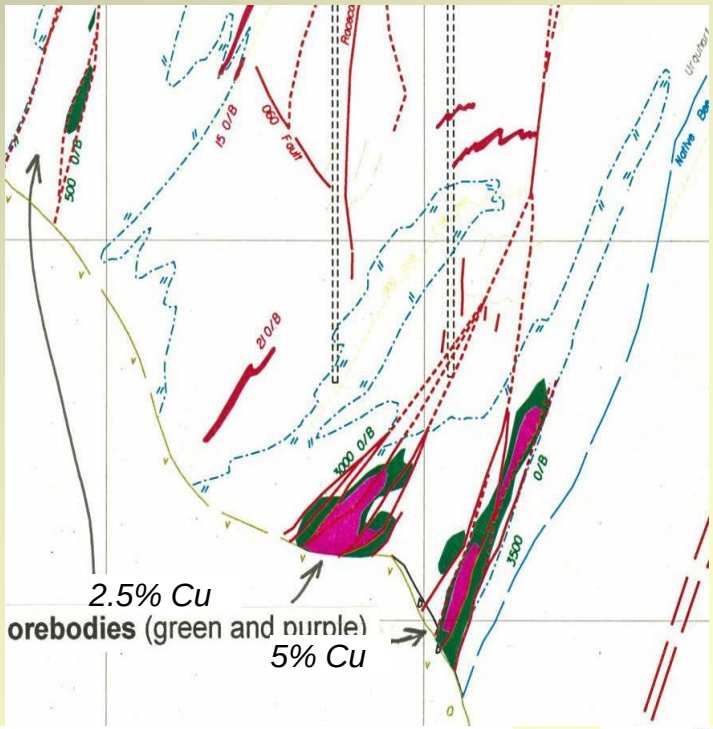
Alteration	Texture	'Rock Type'
Silicification	Brecciated	Fractured siliceous shale
Silicification	Bedding preserved; little or no brecciation	Siliceous shale
Dolomitisation	Brecciated ~	Irregularly brecciated dolomitic shale
Dolomitisation	Bedding preserved; little or no brecciation	Recrystallised shale

lowest grade Cu with dolomite far from Paroo F

The 'silica-dolomite' is a massive influx up and along the Paroo Fault of silica-rich fluid into a dolomitic package; with silica replacement close to the Paroo Fault, saturation of fluid with carbonate generates redeposition of 2nd generation dolomite on the upper and outer fringes of the alteration system.

Isamine Cu - similar sections near 6207N

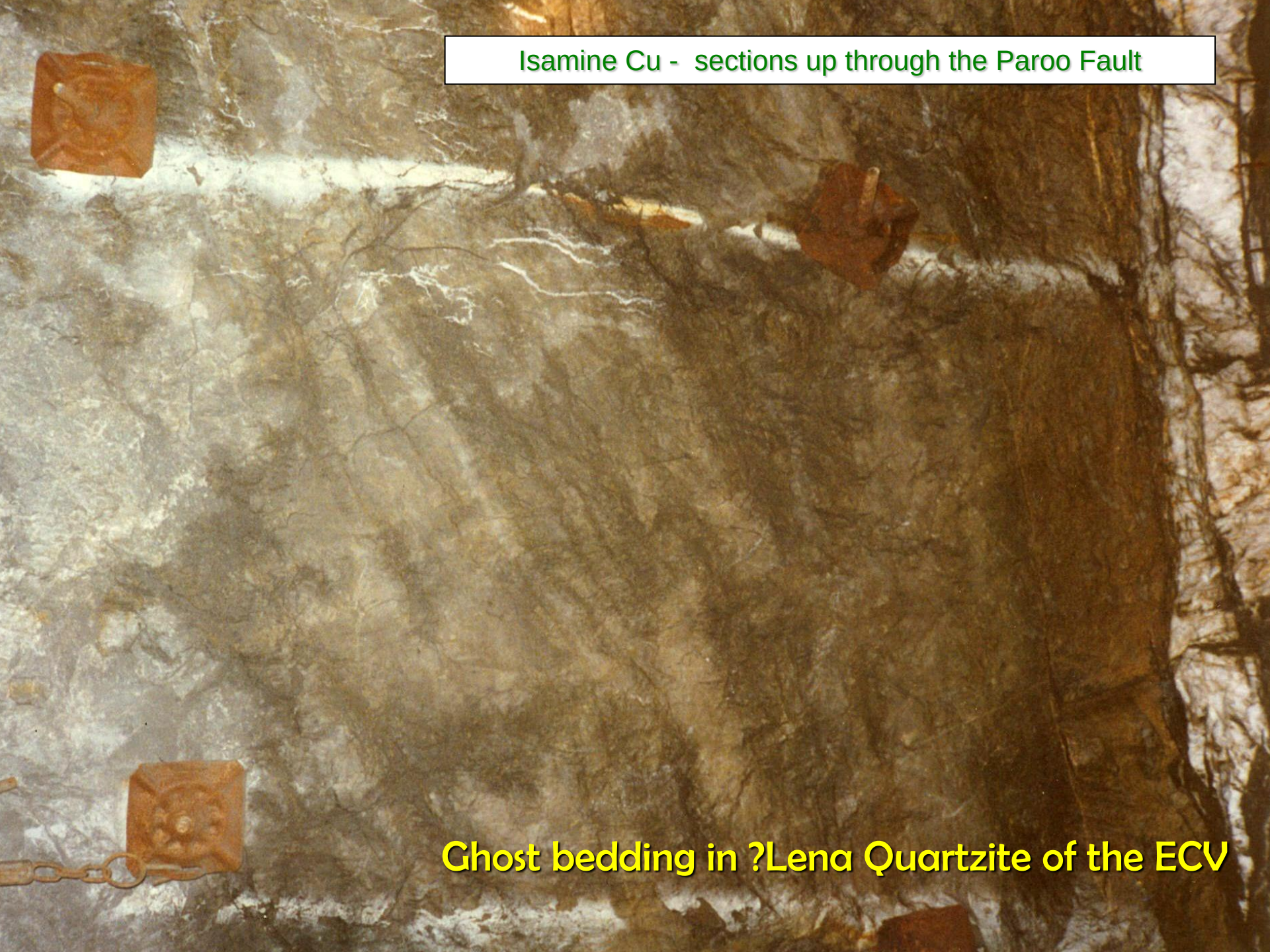




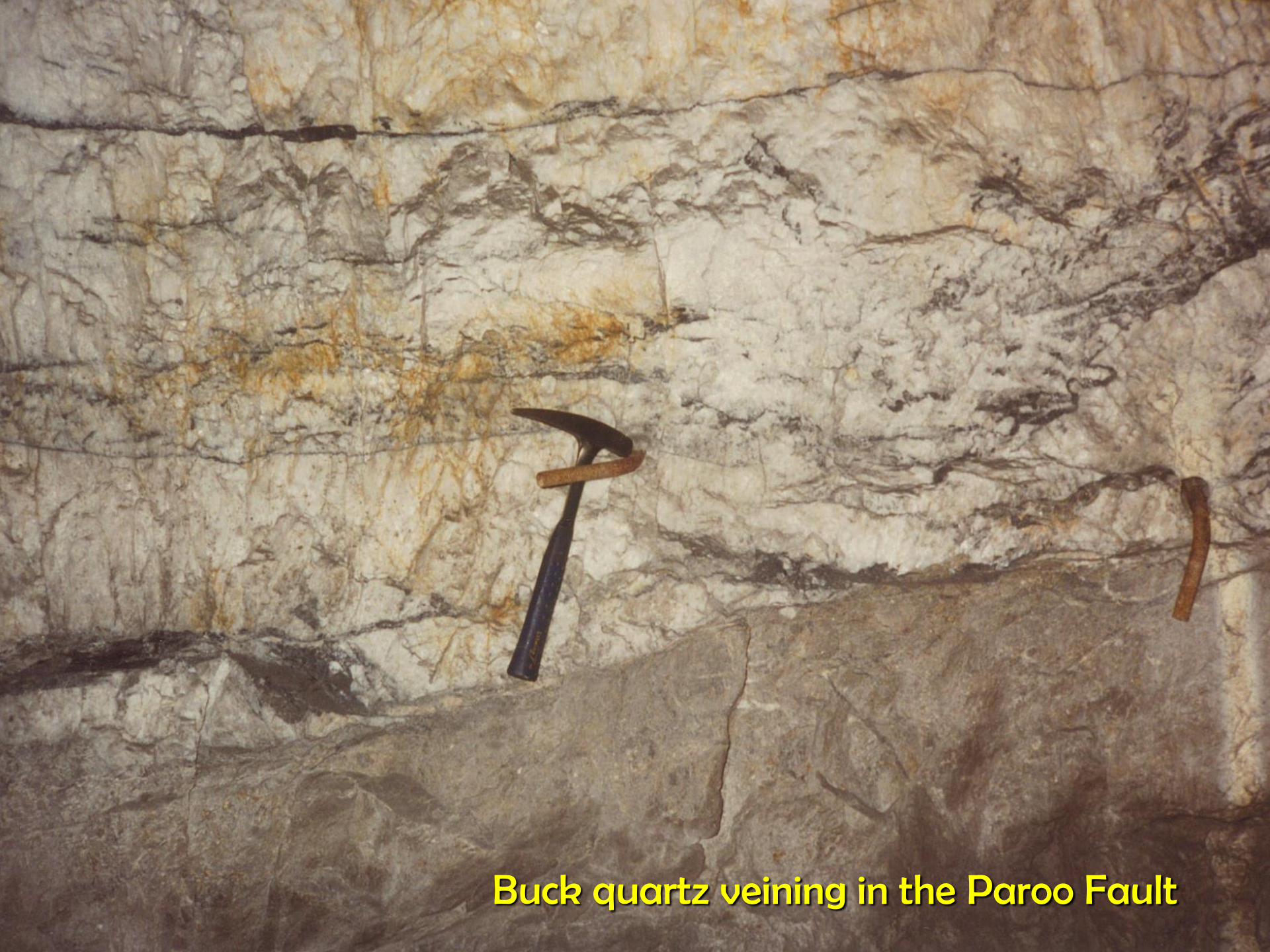
Data from S.Law, MIM 1998-2000

Relations between grade and texture

Isamine Cu - sections up through the Paroo Fault



Ghost bedding in ?Lena Quartzite of the ECV



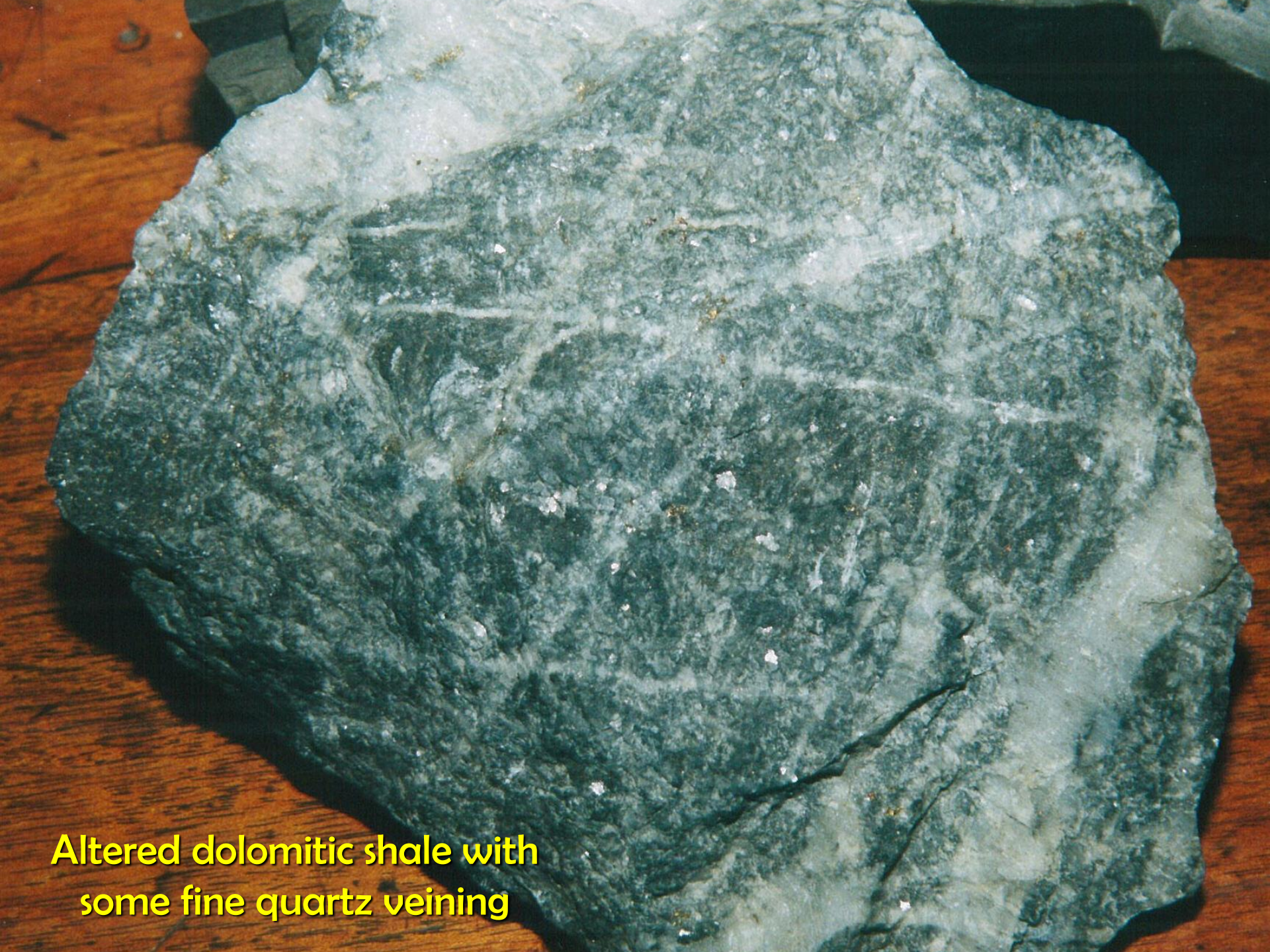
Buck quartz veining in the Paroo Fault

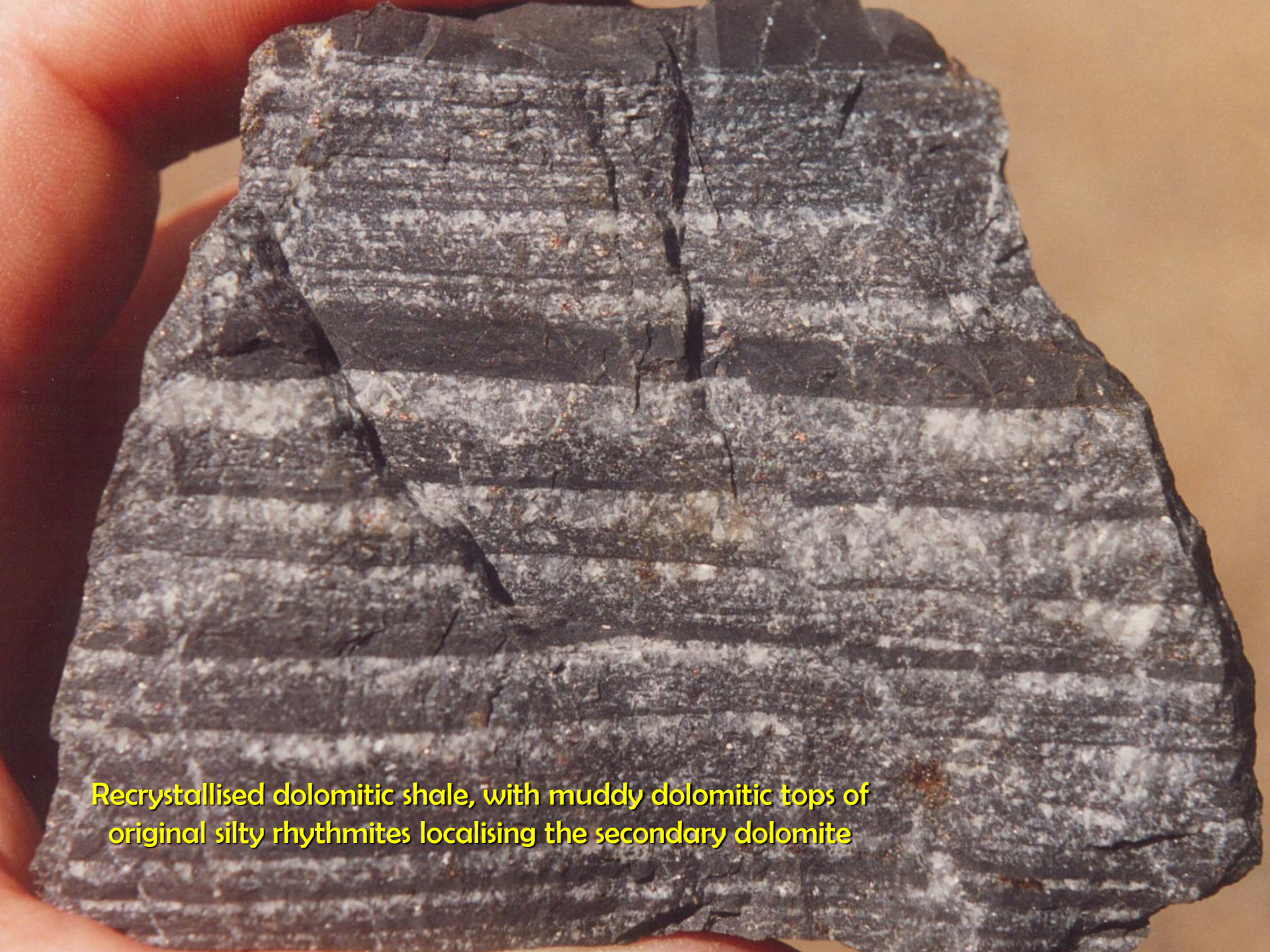
Carbonaceous mylonite below 1100 o/b in the Paroo Fault zone


High grade
siliceous Cu ore


Fractured siliceous shale with
cpy and relict bedding


Brittle siliceous shale,
unmineralised


Altered dolomitic shale with
some fine quartz veining


Recrystallised dolomitic shale, with muddy dolomitic tops of
original silty rhythmites localising the secondary dolomite

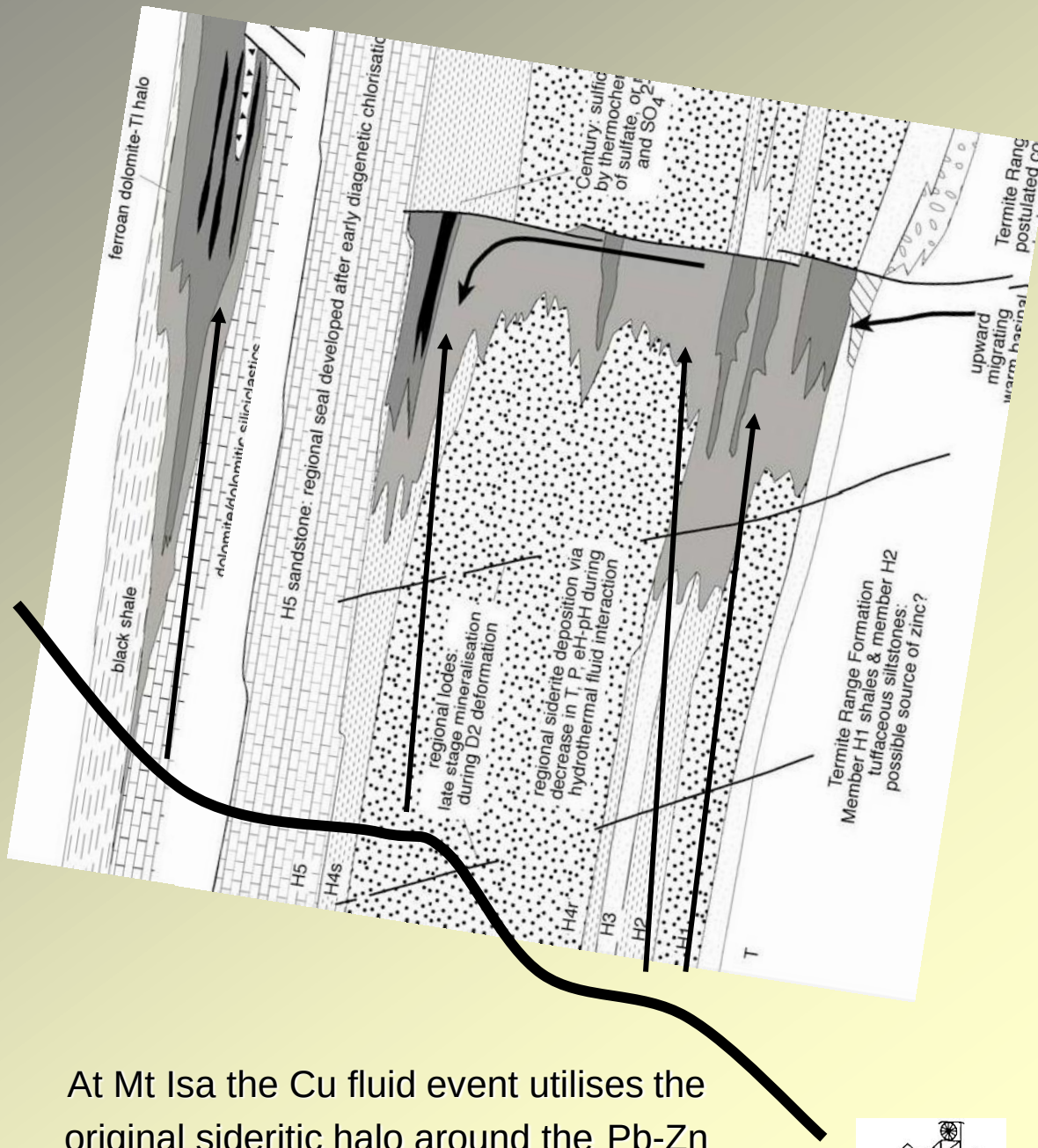

The Cu event also added more pyrite to the system, along fractures then along bedding

Interdigitation of Cu and Pb-Zn

Using HYC and Century as examples, note the siderite alteration halo, which promotes the decarbonation reaction *Kf + ankerite + H_2O = biotite + calcite + CO_2.* .

The abundance of CO2 is an important contributor to vein formation and propagation along faults and bedding in the competent rock.

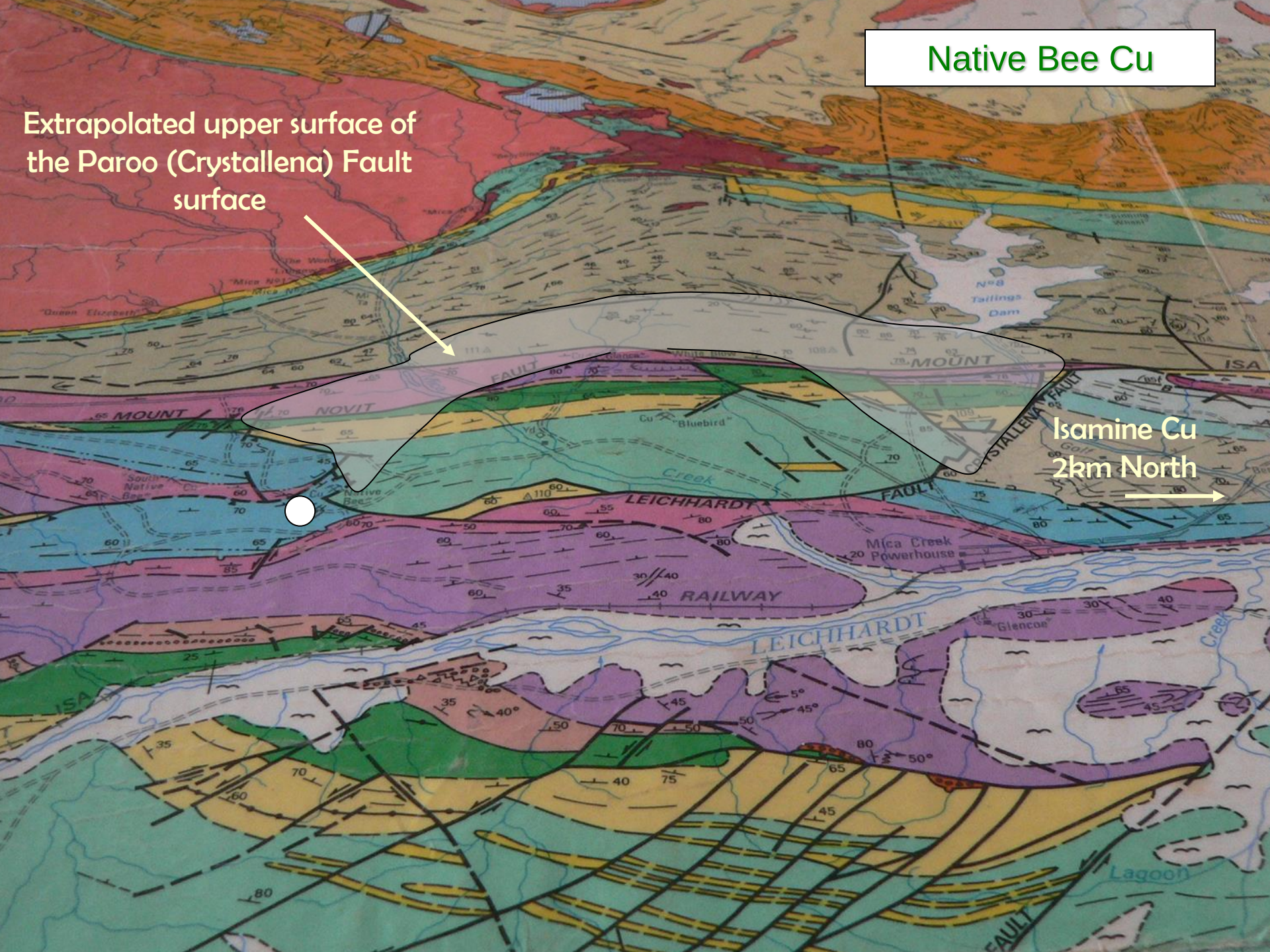
Waring et al 1998



At Mt Isa the Cu fluid event utilises the original sideritic halo around the Pb-Zn

Native Bee Cu

Dolomite and dolomitic siltstone of Native Bee Dolomite with secondary Cu along fractures

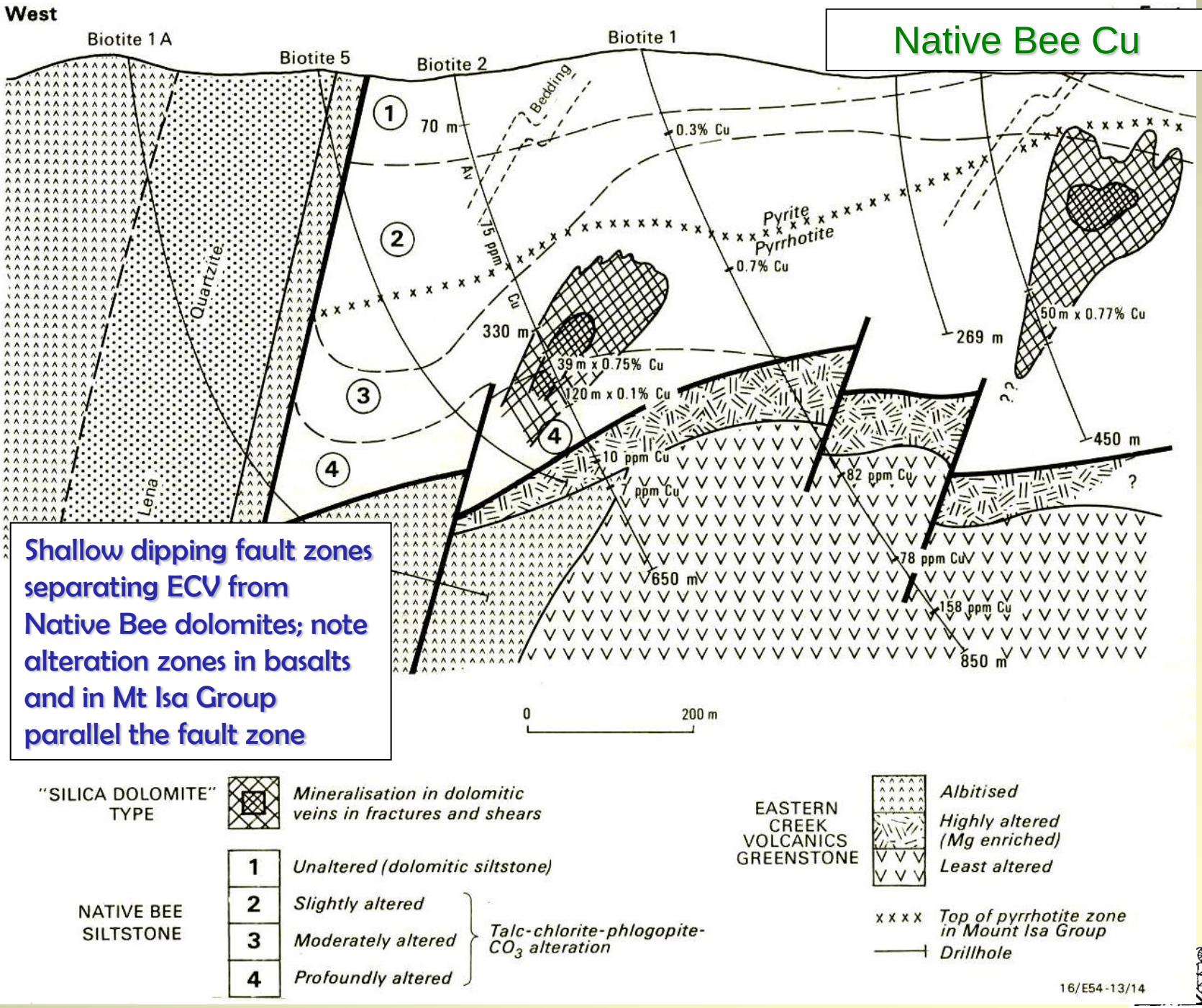

Native Bee Cu
Extrapolated upper surface of the Paroo (Crystallena) Fault surface
Isamine Cu
2km North
MOUNT
NOVIT
FAULT
LEICHHARDT
RAILWAY
Mica Creek
Powerhouse
Cu "Bluebird"
Native Bee
No 8
Tailings
Dam
ISA
Glencore
Lagoon

Native Bee Cu

More "SILICA-DOLOMITE" Alteration

Altered and fractured dolomitic siltstones with sparry dolomite, quartz, pyrrhotite, cpy and py mineralisation, some talc

Native Bee Cu

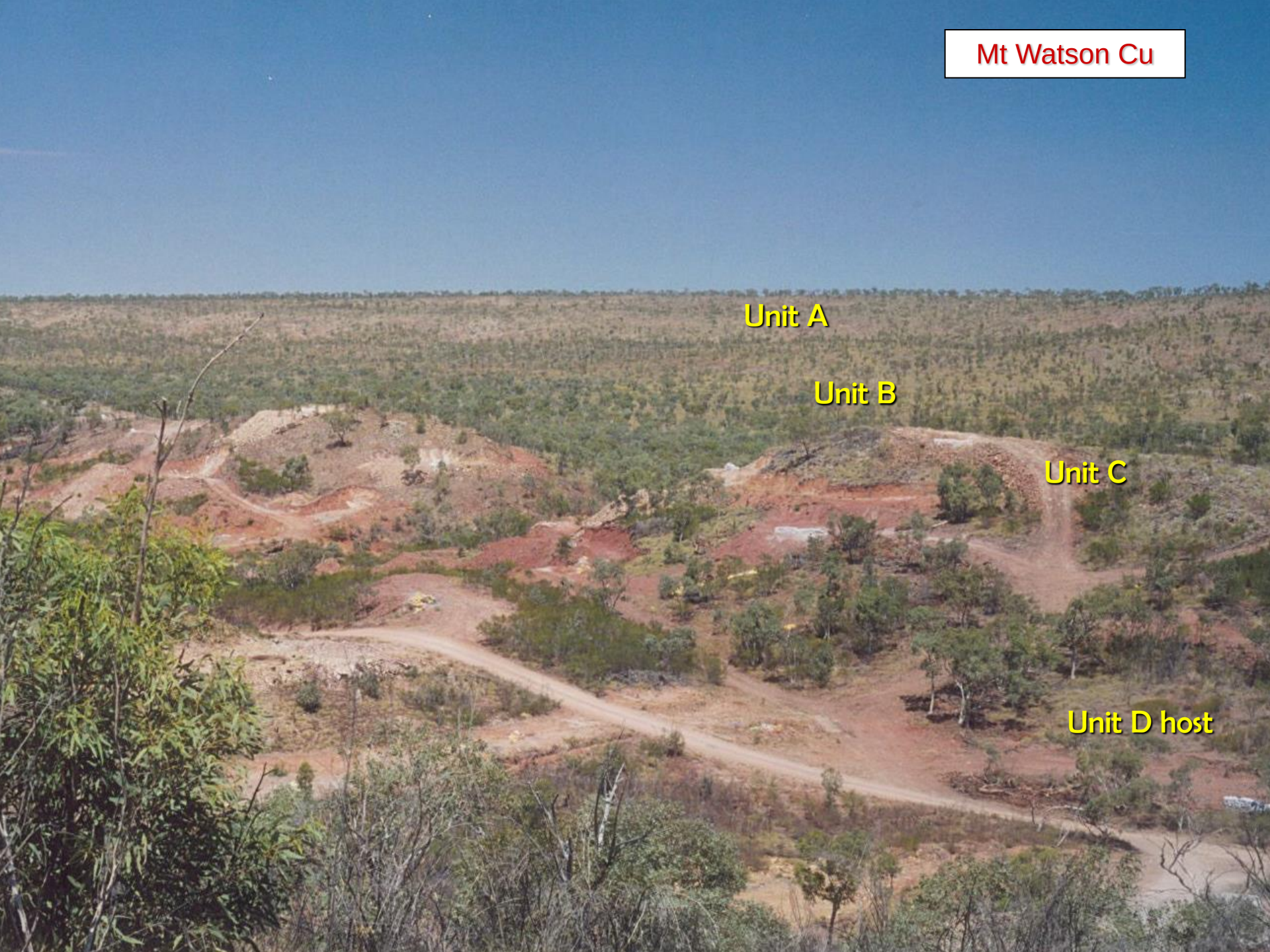


Shallow dipping fault zones separating ECV from Native Bee dolomites; note alteration zones in basalts and in Mt Isa Group parallel the fault zone

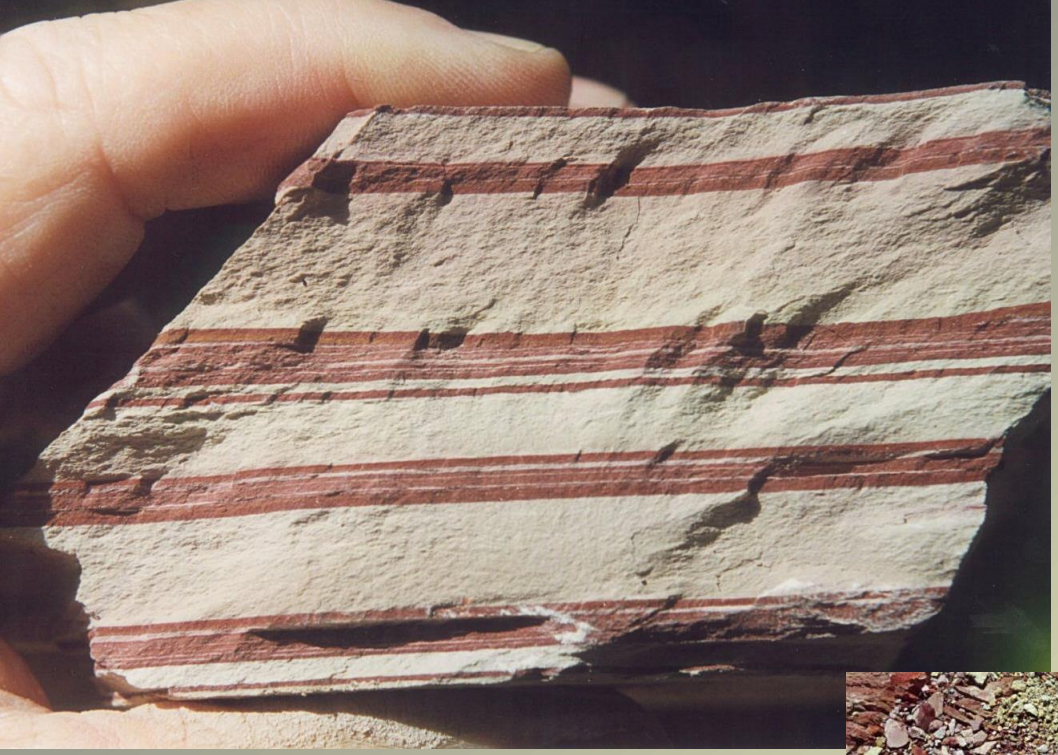
Native Bee tells us that you can derive Cu mineralisation with silica-dolomite alteration in units other than Urquhart Shale, and without the presence of Pb-Zn deposits.


Mt Watson Cu
5 km
48 km
Image © 2008 TerraMetrics
Image © 2008 DigitalGlobe
139°51'06.82" E elev 275 m
Streaming 100%


Mt Watson Cu
Basal Mt Isa Gp qtzite
Unit D
Unit D
Unit C
Unit B
Subtle fault structure
in synform
Unit A Surprise Ck Fmn
Image © 2008 DigitalGlobe
©2007 Google™

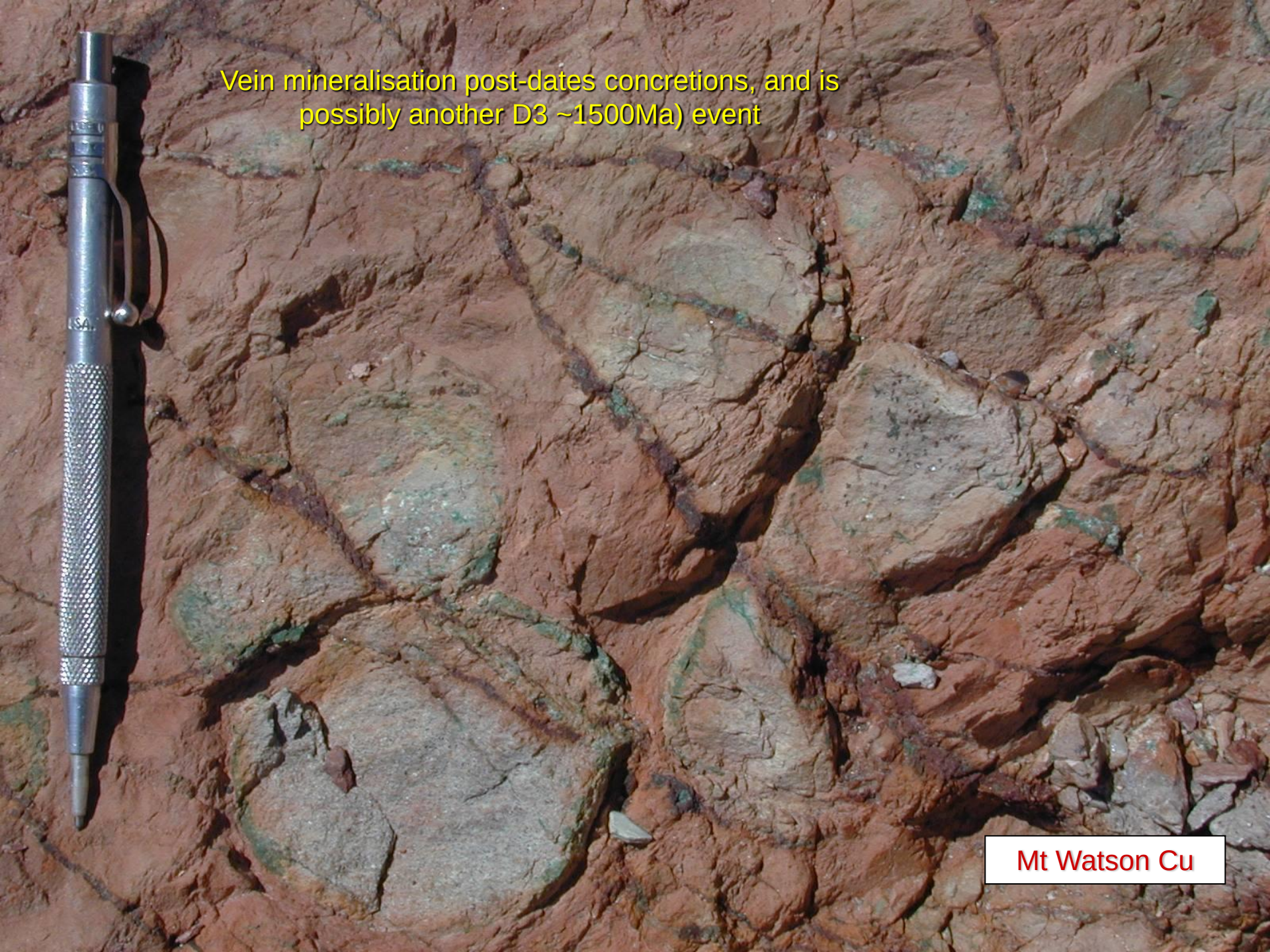

Mt Watson Cu
Unit A
Unit B
Unit C
Unit D host

Mt Watson Cu



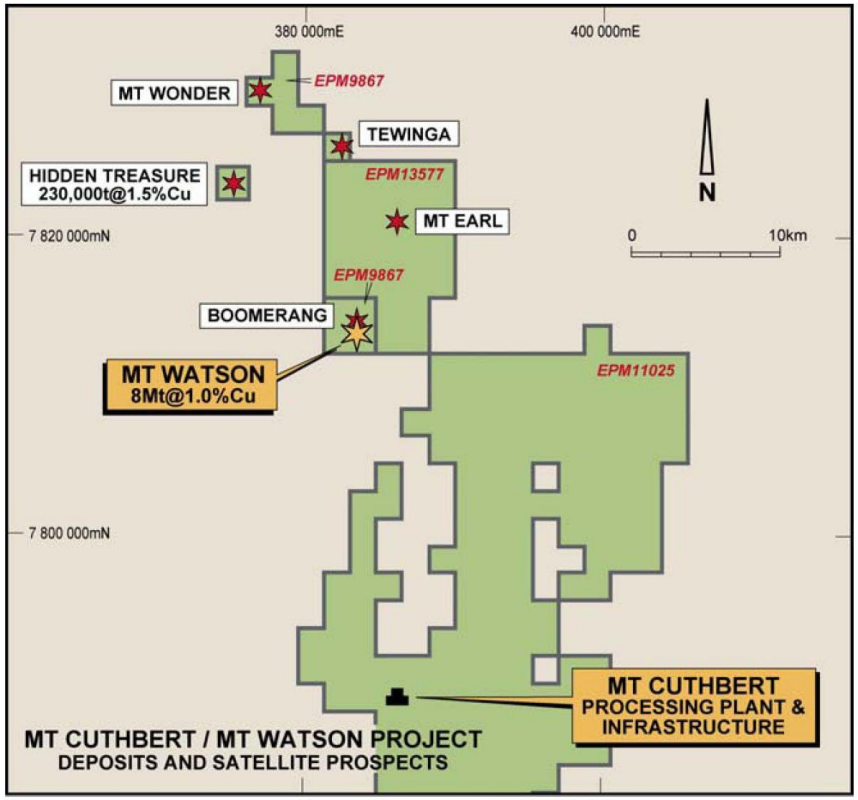
'Ribbon' or 'biscuit' laminated siltstones in outcrop are reduced and carbonaceous at depth

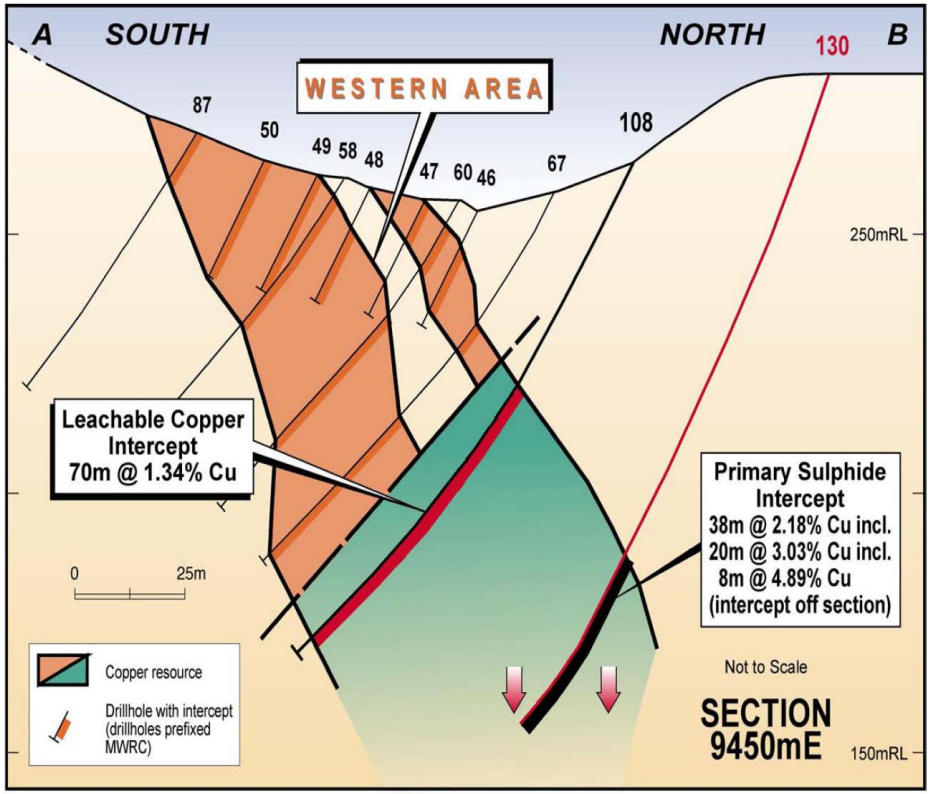
The siltstone is highly concretionary, with concretions to 20cm


Vein mineralisation post-dates concretions, and is possibly another D3 ~1500Ma) event
Mt Watson Cu

Typical oxidised vein mineralisation trucked 25km to SXEW plant at the old Mt Cuthbert operation

Leichhardt Regional Exploration

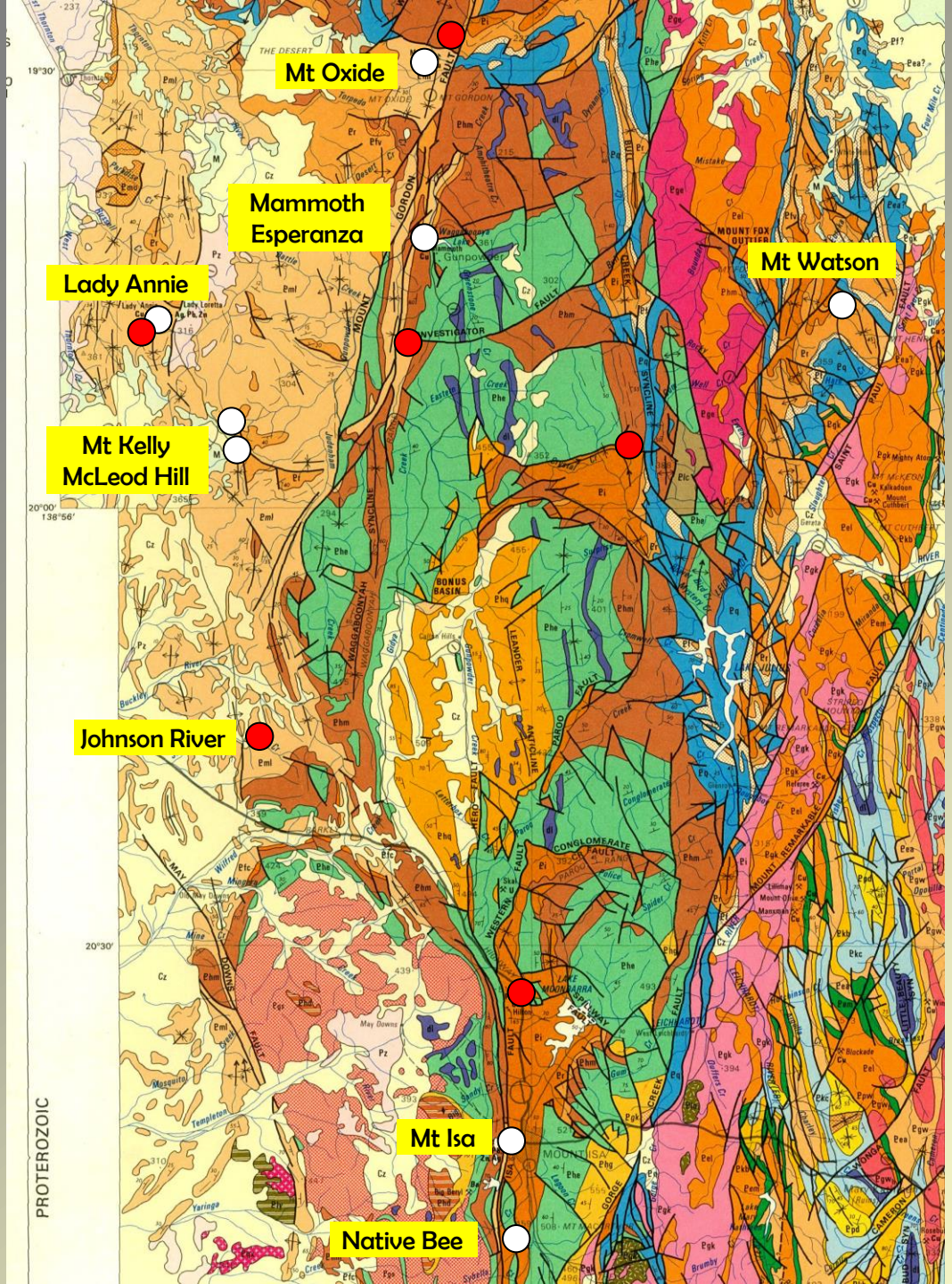




Mt Watson Deposit: WESTERN ZONE CROSS SECTION
INITIAL PRIMARY SULPHIDE INTERSECTION, JULY 2004

- Resource Width & Grade Intersections at Earl, Tewinga, Mt Wonder and Boomerang
- Ongoing potential at Mt Watson and Mt Cuthbert
- Proven Primary Sulphide Potential


Bunya Mts
Qld



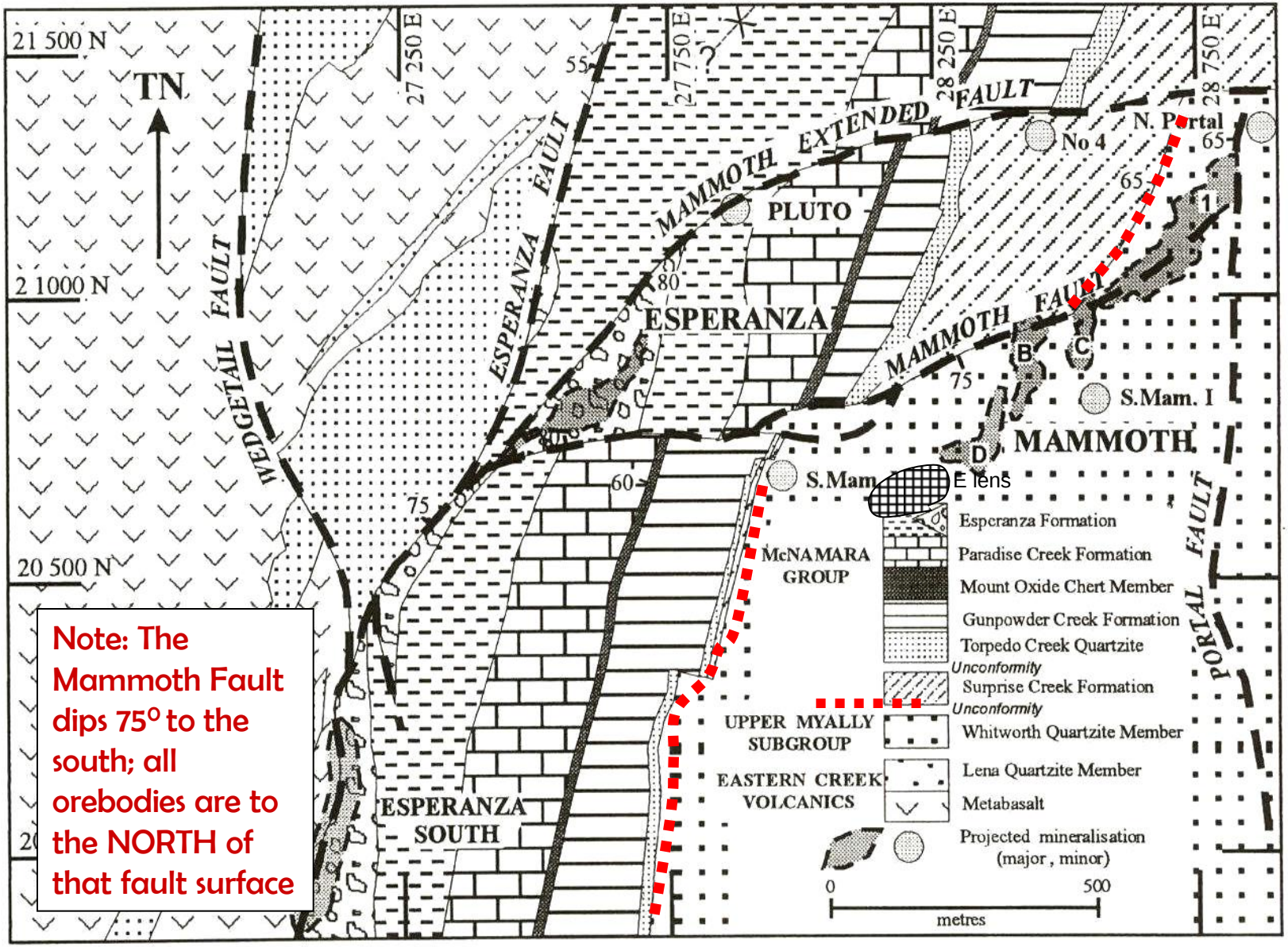
Regional Geology, Western Succession and location of Cu deposits

- Major & significant Cu deposits, western succession
- Areas of significant drilling 2007-2008 ??

1680 1640Ma		*Mt Isa-McNamara Gp*
1750Ma		*Quilalar Fmn cover suite*
1770Ma		*Eastern Creek Volcs - basalts*
1860Ma		*Ewan Granite basement*
		Kalkadon Granite basement

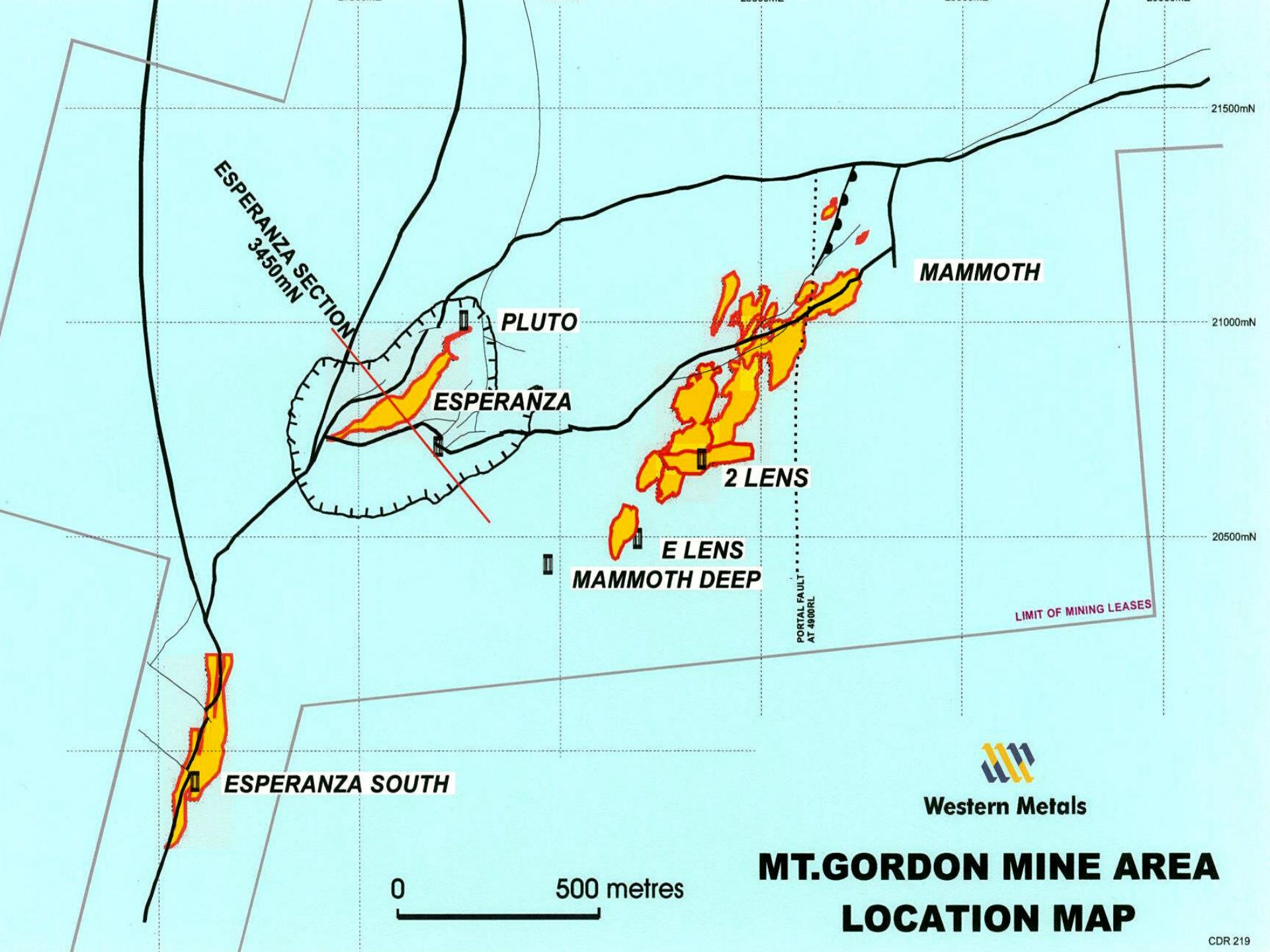
50 km

Mammoth and Esperanza Cu

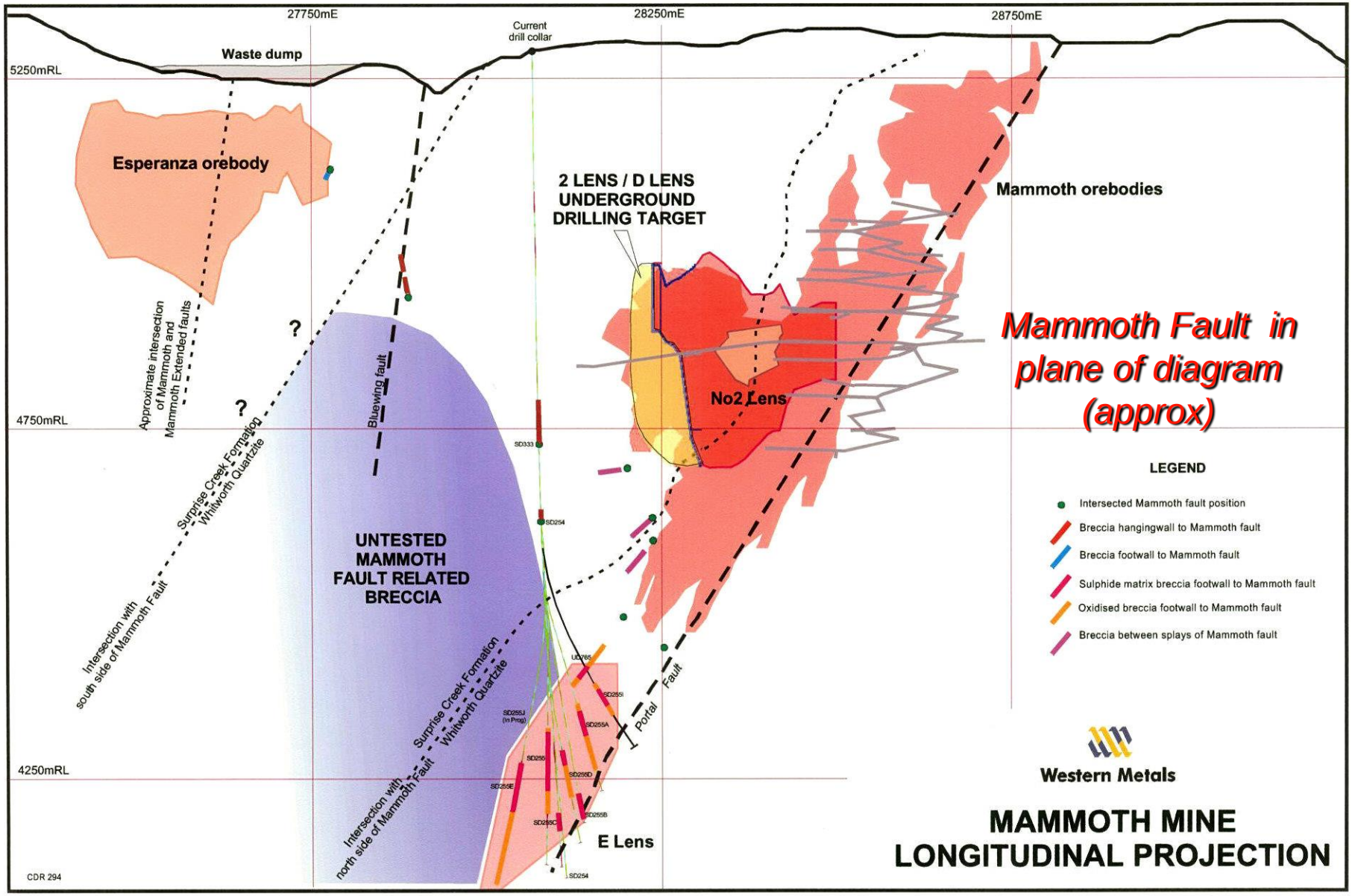


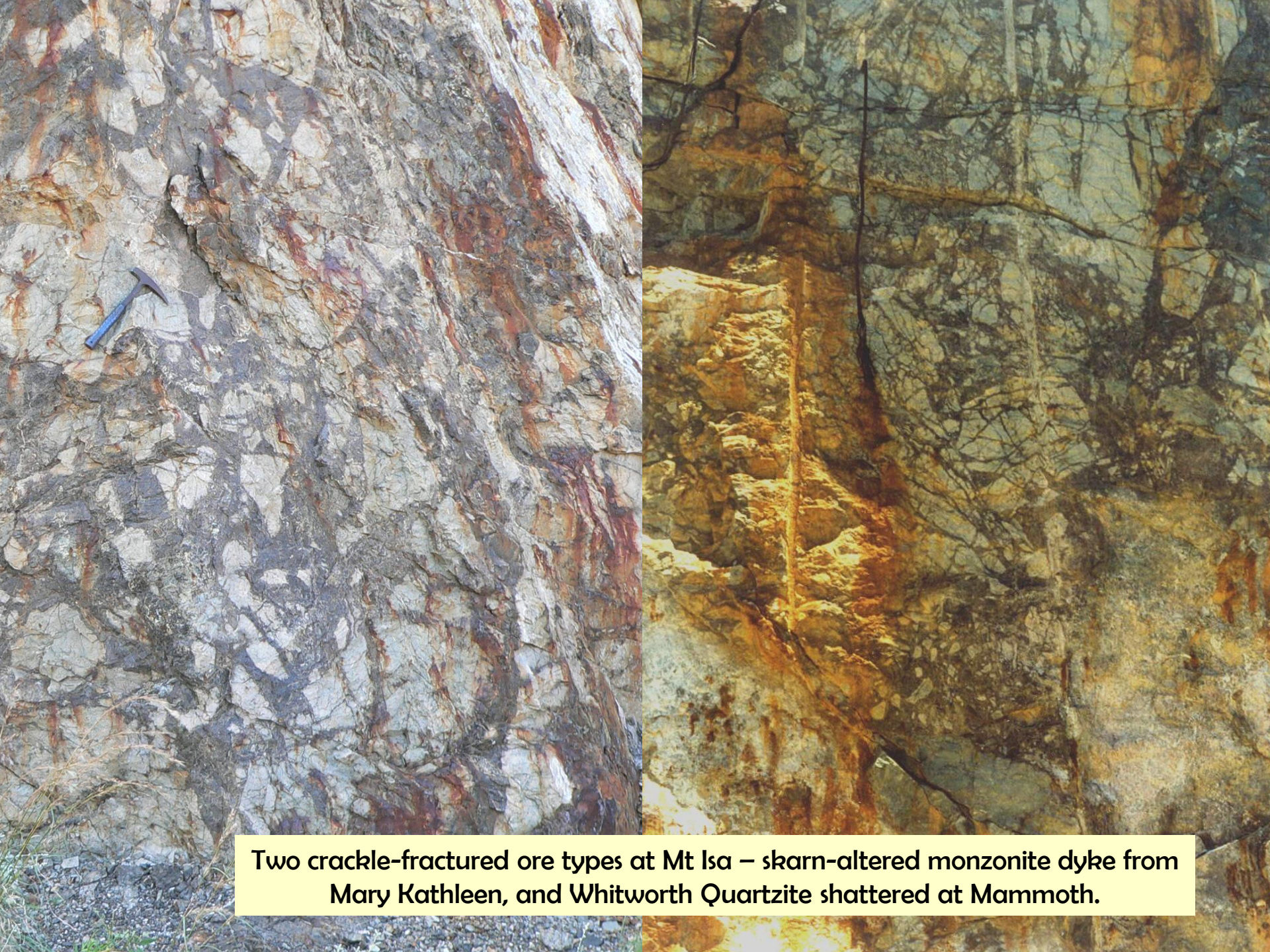
Note: The Mammoth Fault dips 75° to the south; all orebodies are to the NORTH of that fault surface


Surprise Creek
Fmn 1700Ma
Myally bedding trace in
vertical beds
Whitworth Qtzite
age 1770Ma

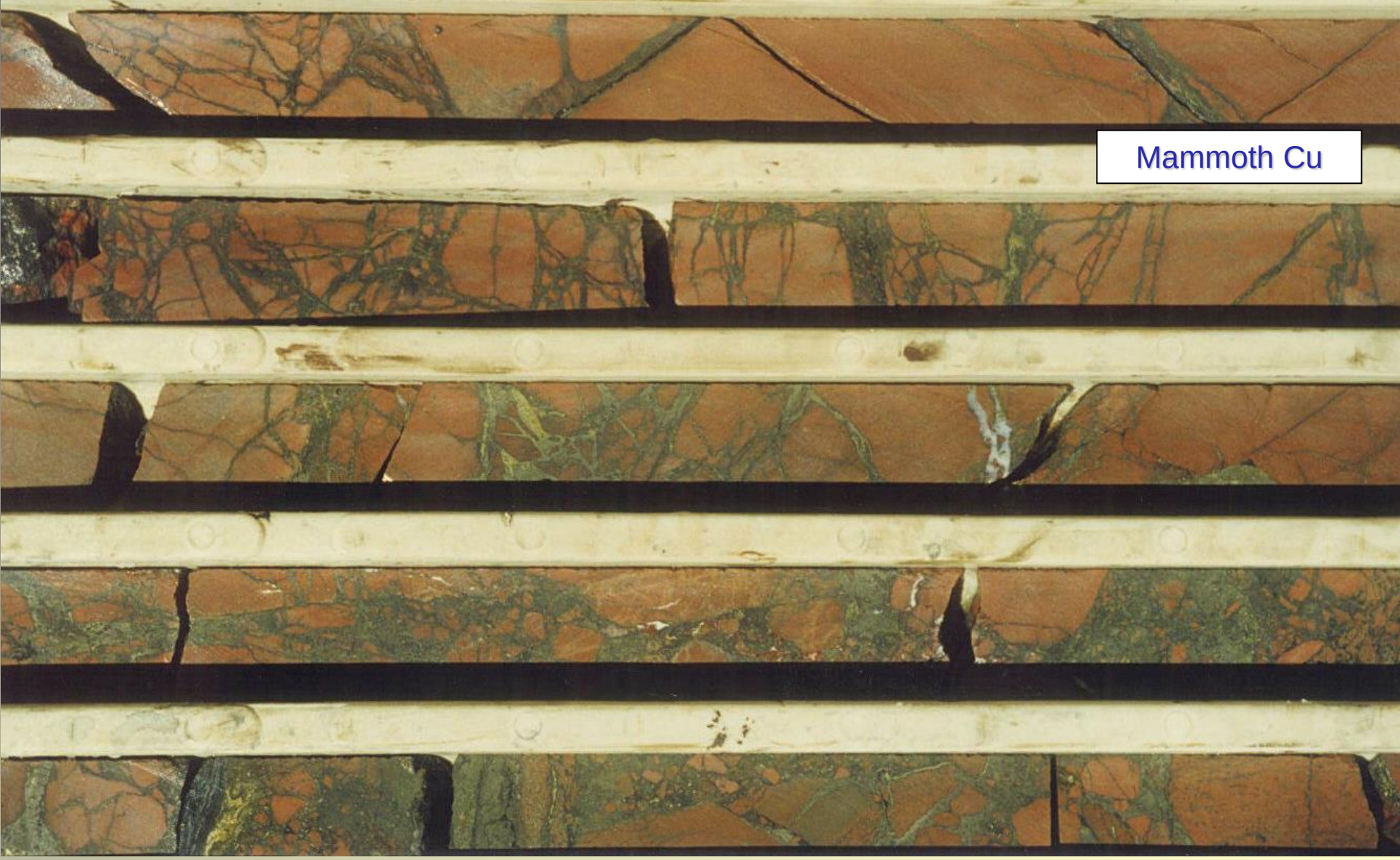

21500mN
21000mN
20500mN
ESPERANZA SECTION
3450mN
PLUTO
ESPERANZA
MAMMOTH
2 LENS
E LENS
MAMMOTH DEEP
PORTAL FAULT
AT 4900RL
LIMIT OF MINING LEASES
ESPERANZA SOUTH
0
500 metres
Western Metals
MT.GORDON MINE AREA
LOCATION MAP
CDR 219

Of all orebodies, Mammoth requires a heightened skill in thinking in the 3rd dimension





Two crackle-fractured ore types at Mt Isa – skarn-altered monzonite dyke from Mary Kathleen, and Whitworth Quartzite shattered at Mammoth.

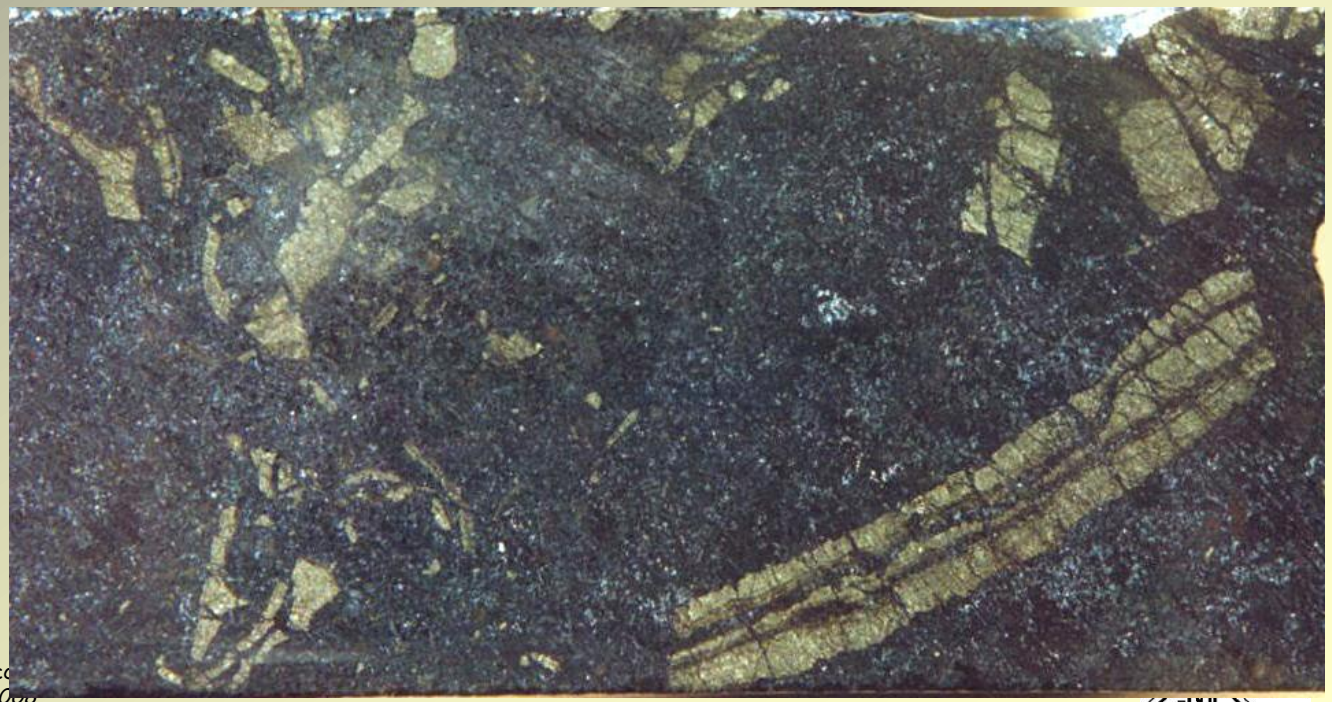


Mammoth D3 Cu – progressive hydrothermal fracturing in brittle massive pink feldspathic quartzite of Myally Sugroup; density of fracturing ranges from clast supported (top) to matrix-supported (base); sulphides mainly py, minor cpy and chalcocite.

Mammoth Cu

Mammoth D3 – two generations of pyrite in vein wall cutting brecciated feldspathic quartzite, with some minor dark chalcocite

Massive chalcocite flooding with fragments or earlier-formed colloform pyrite veins



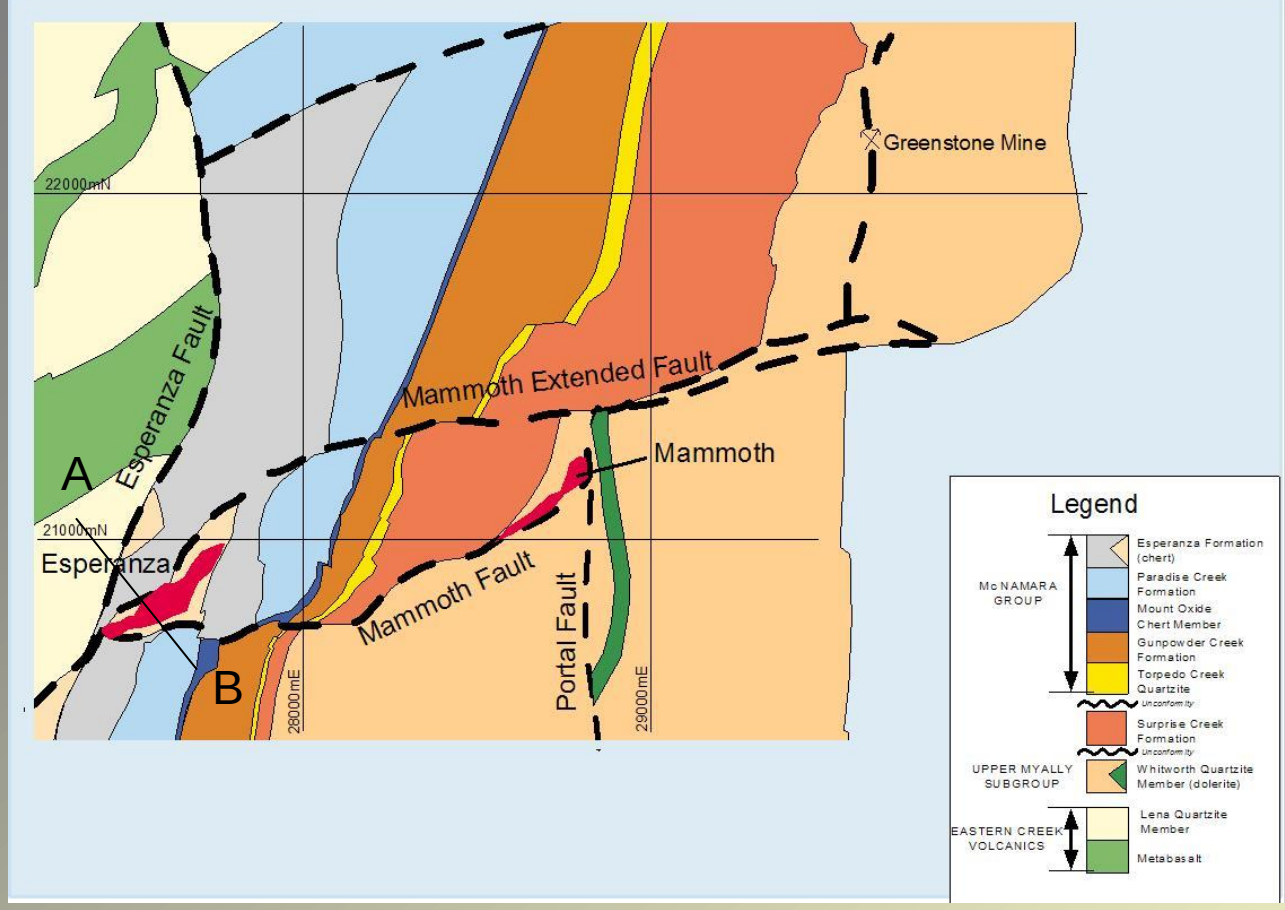

Mammoth Cu
Possible
hypogene bornite
in qtzite

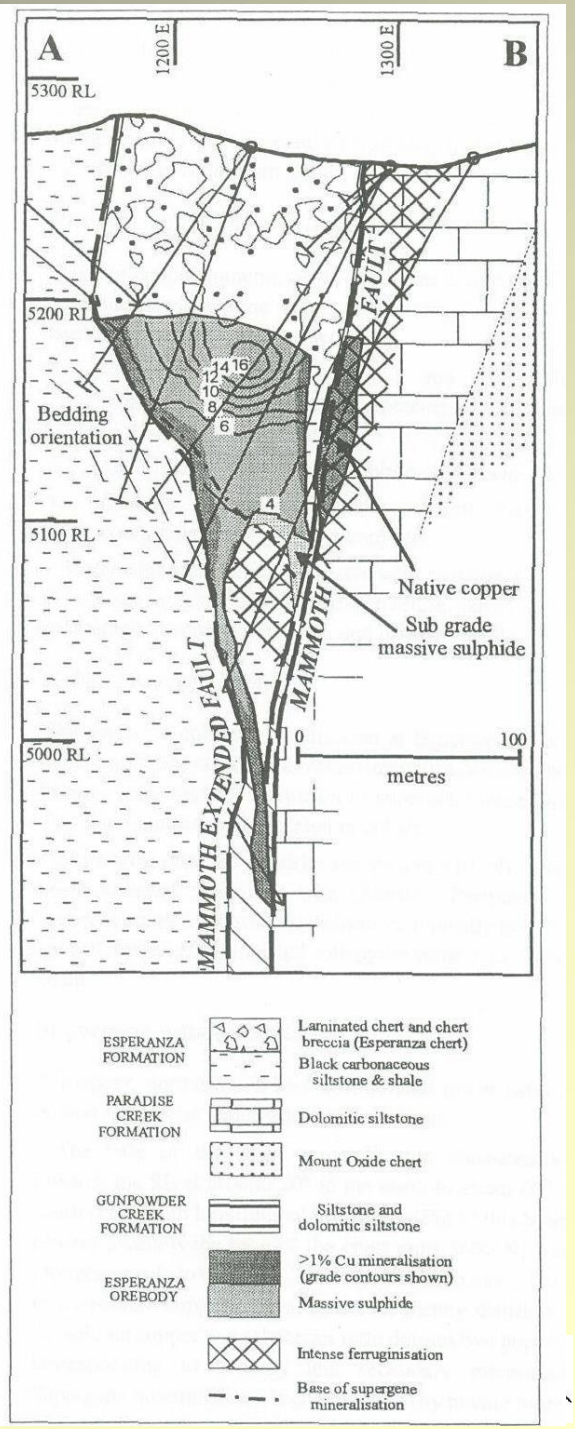
Mammoth Cu

Massive chalcocite in pink feldspathic quartzite; this may be supergene

Massive chalcocite in heavily chlorite-altered sandstone breccia. This may be hypogene type

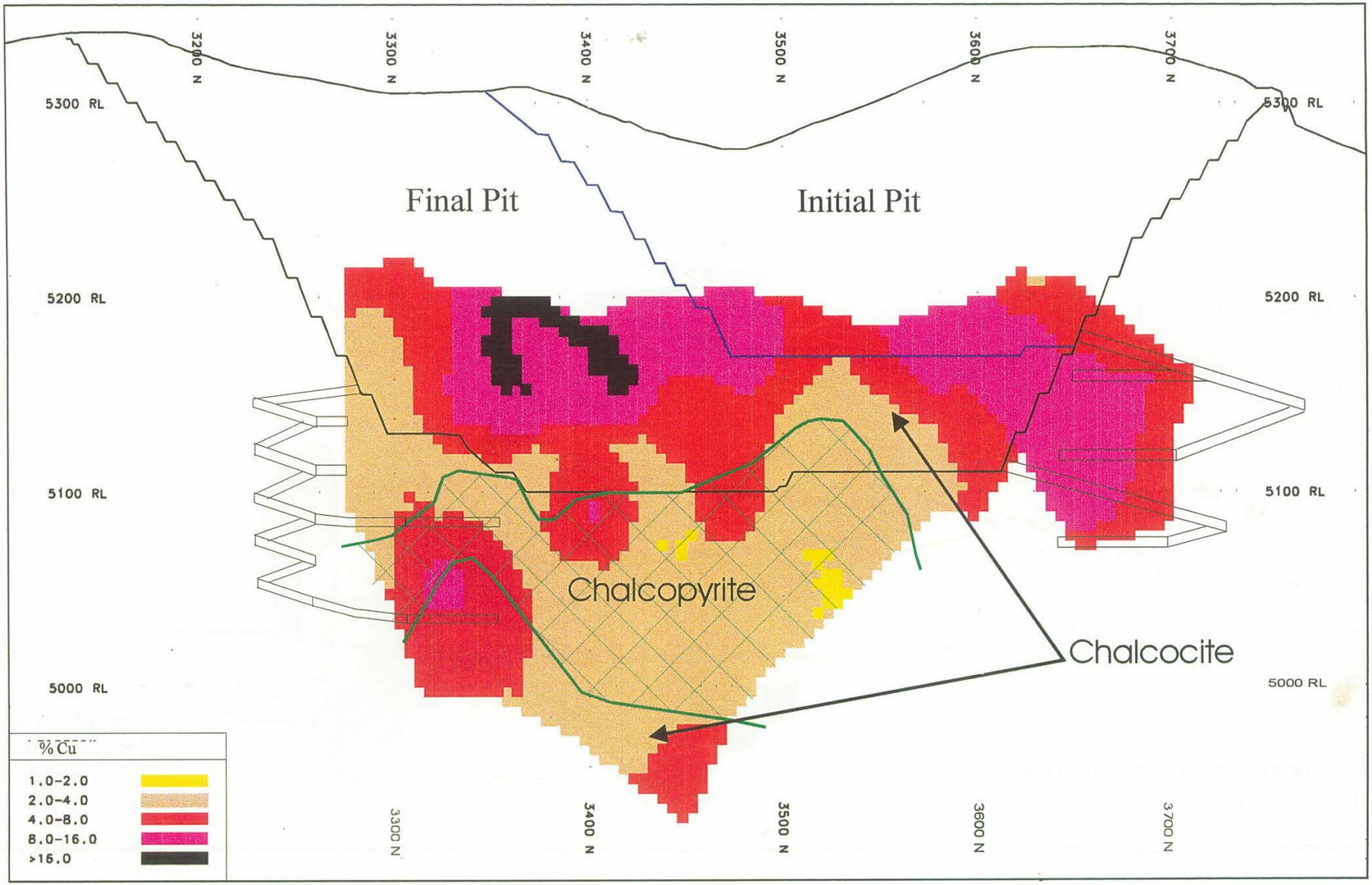

Esperanza Cu
Esperanza South, where
terrain is challenging



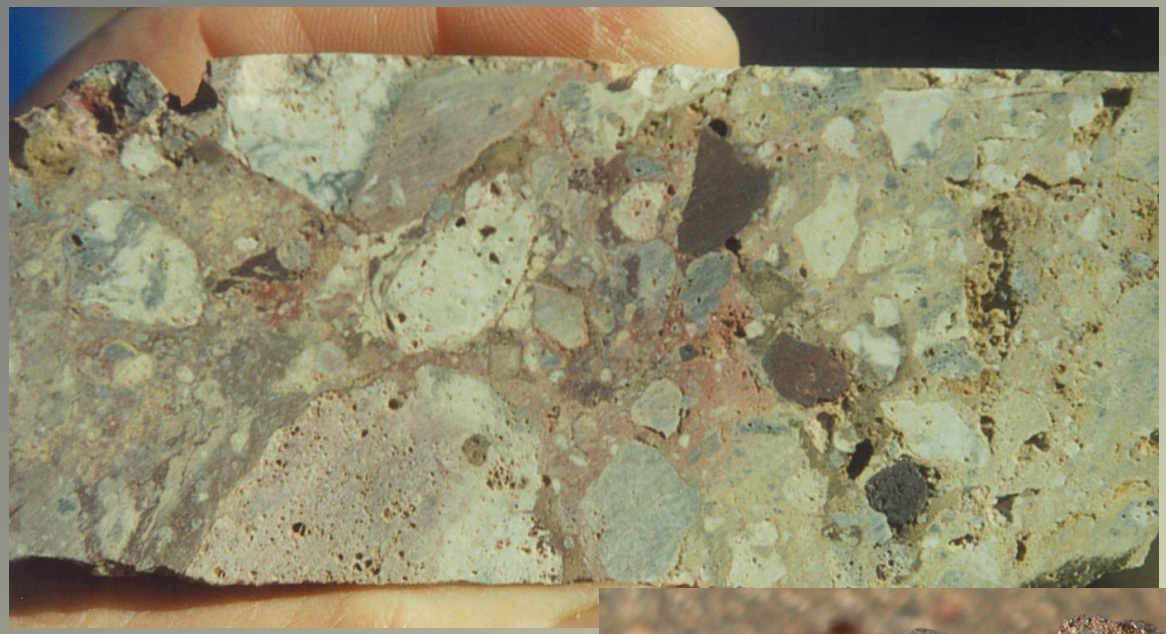


Esperanza was difficult to drill because of the massive chert cap to the main orezone; Sillitoe considered it to be an epithermal deposit; chert could also be due to leaching of carbonates and collapse in weathering domain.

Esperanza Orebody - Longitudinal Projection



Esperanza view to SW; Mammoth Extended F to right, Mammoth F to left; transition zone from oxidised chert breccia cap to complex pyrite-Ag wad at start of supergene zone, with chalcocite beckoning



Chert breccia in drillcore – 1 or 2 metres per day if lucky

Chert breccia just above the supergene chalcocite zone, with all sorts of iridescent iron oxides.

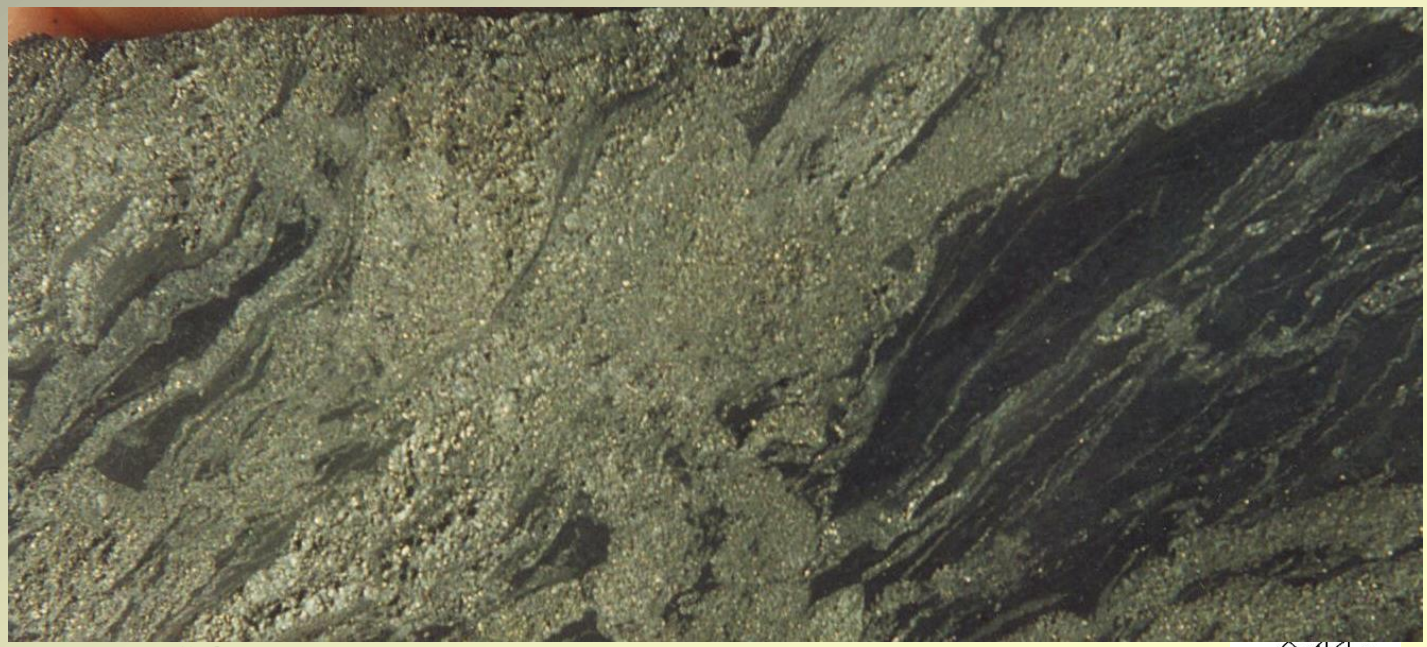
Esperanza Cu

Supergene : pyrite-rich ‘sand’ – friable, free-running in places; just below chert cap

Supergene : from left, Ag-rich pyrite-carbonaceous wad, pyrite-chalcocite wad, pyrite-flooded grey dolomitic siltstone

Esperanza Cu

Host rocks are pyritic, carbonaceous siltstones of Esperanza Fmn (1650Ma)



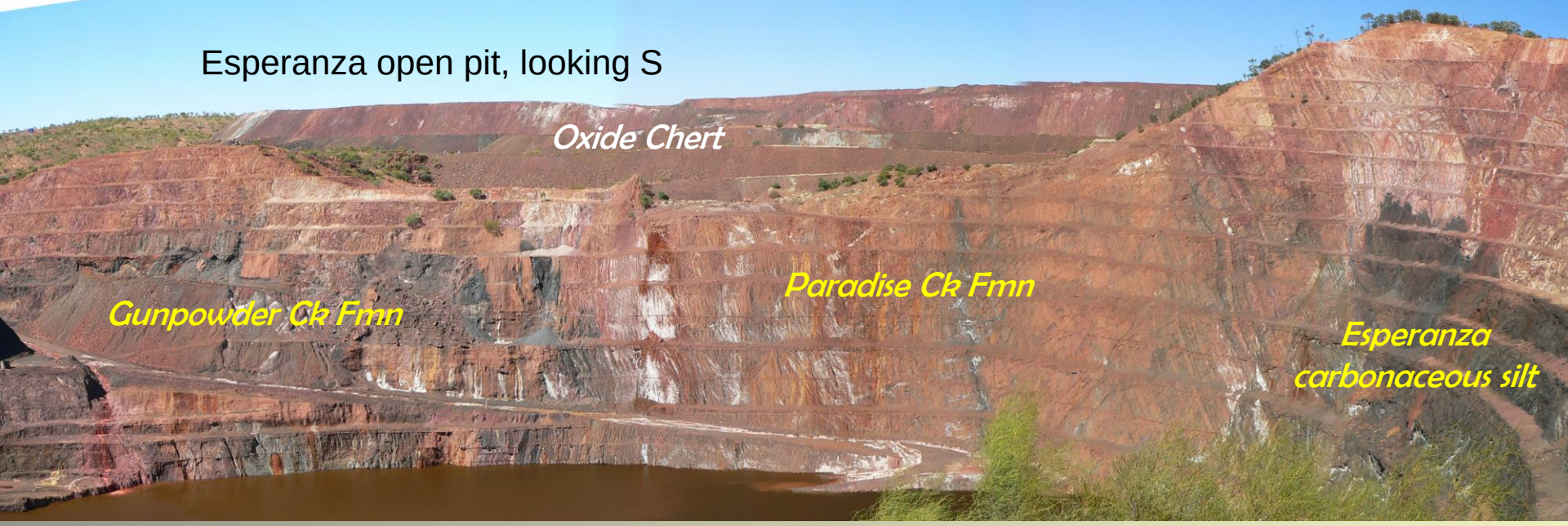
Pyrite is both framboidal and vein type of at least two generations or more

Esperanza Cu

SUPERGENE CHALCOCITE

Sooty chalcocite with pyrite (top) and very high grade chalcocite with minor pyrite grains (right); Direct shipping ore graded 30% Cu

Esperanza open pit, looking S

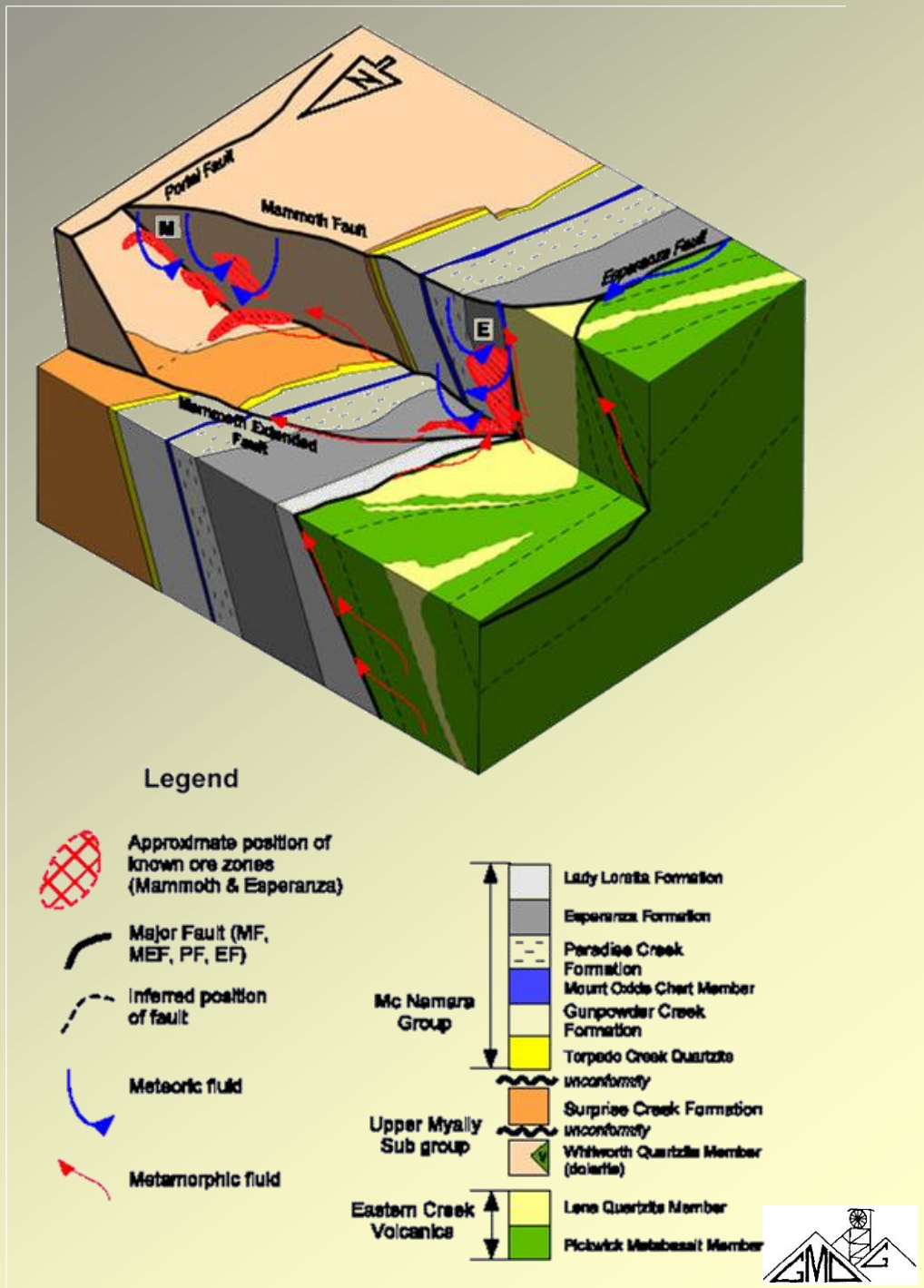


Esperanza open pit, looking W

3D View to SE

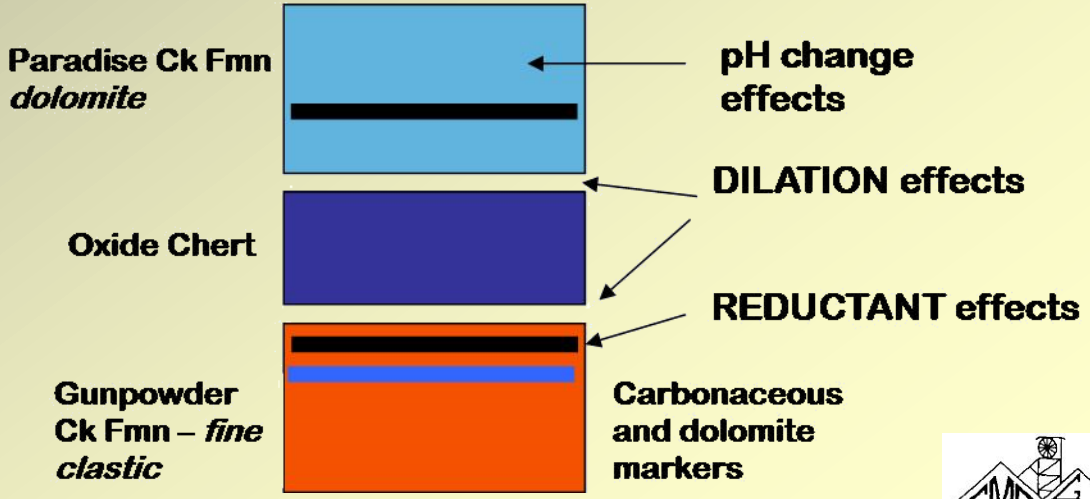
Schematic model of Mammoth and Esperanza orebodies formed in D3 transpression and synchronous with fluid flow; metamorphic water (red arrows) generated by devolatilisation of ECV basalts focussed into dilatant fault zones during periods of high fluid pressure, where it mixes with deeper circulating crustal (meteoric) waters

From Clark, 2003

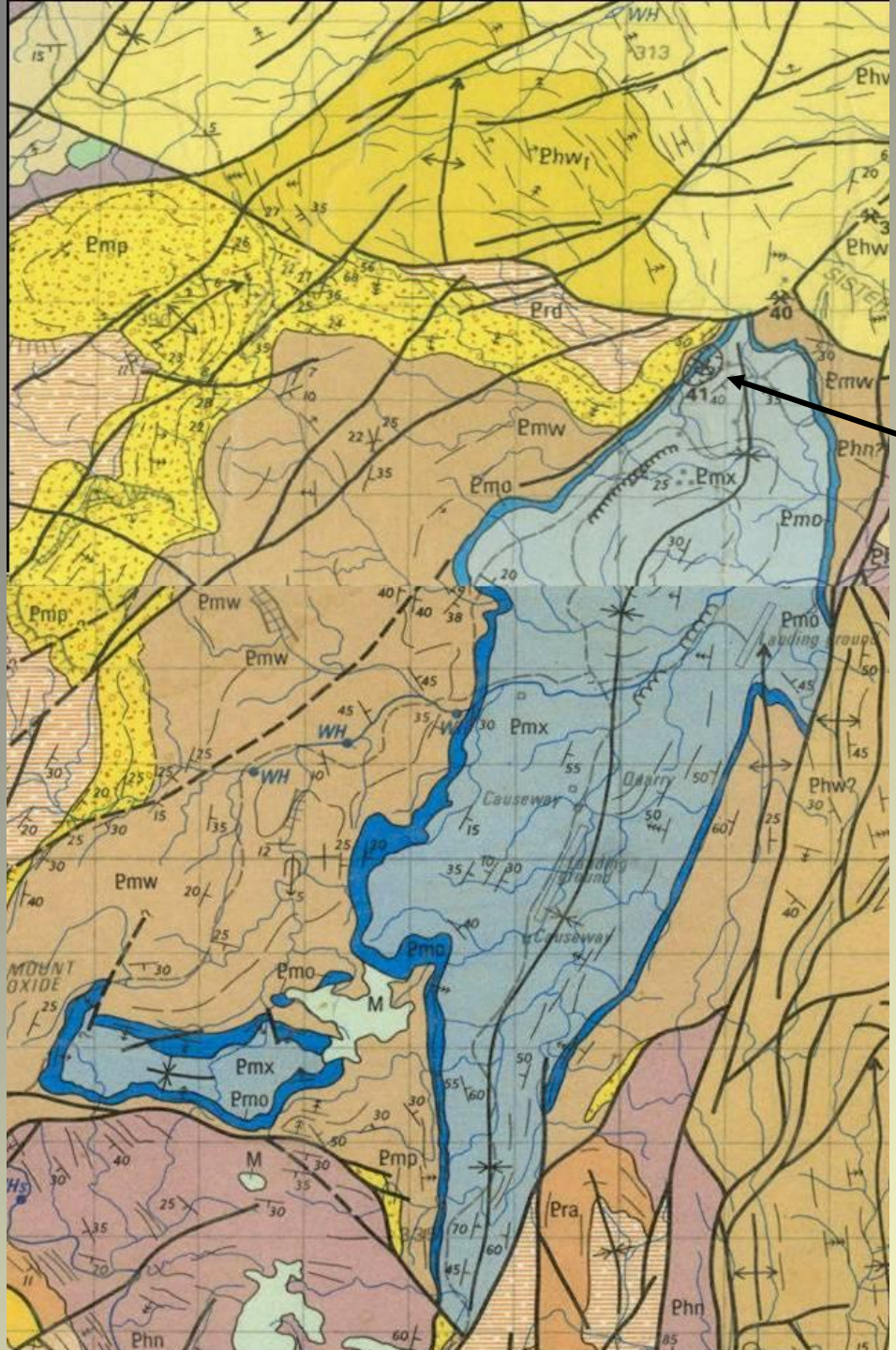


Classic outcrop of the triplet at Barr Creek, between Mammoth and Mt Oxide. A consultant structural geologist has called the Oxide Chert a "blastomylonite", with no stratigraphic integrity

The Cu triplet, Western Succession



Mt Oxide Cu

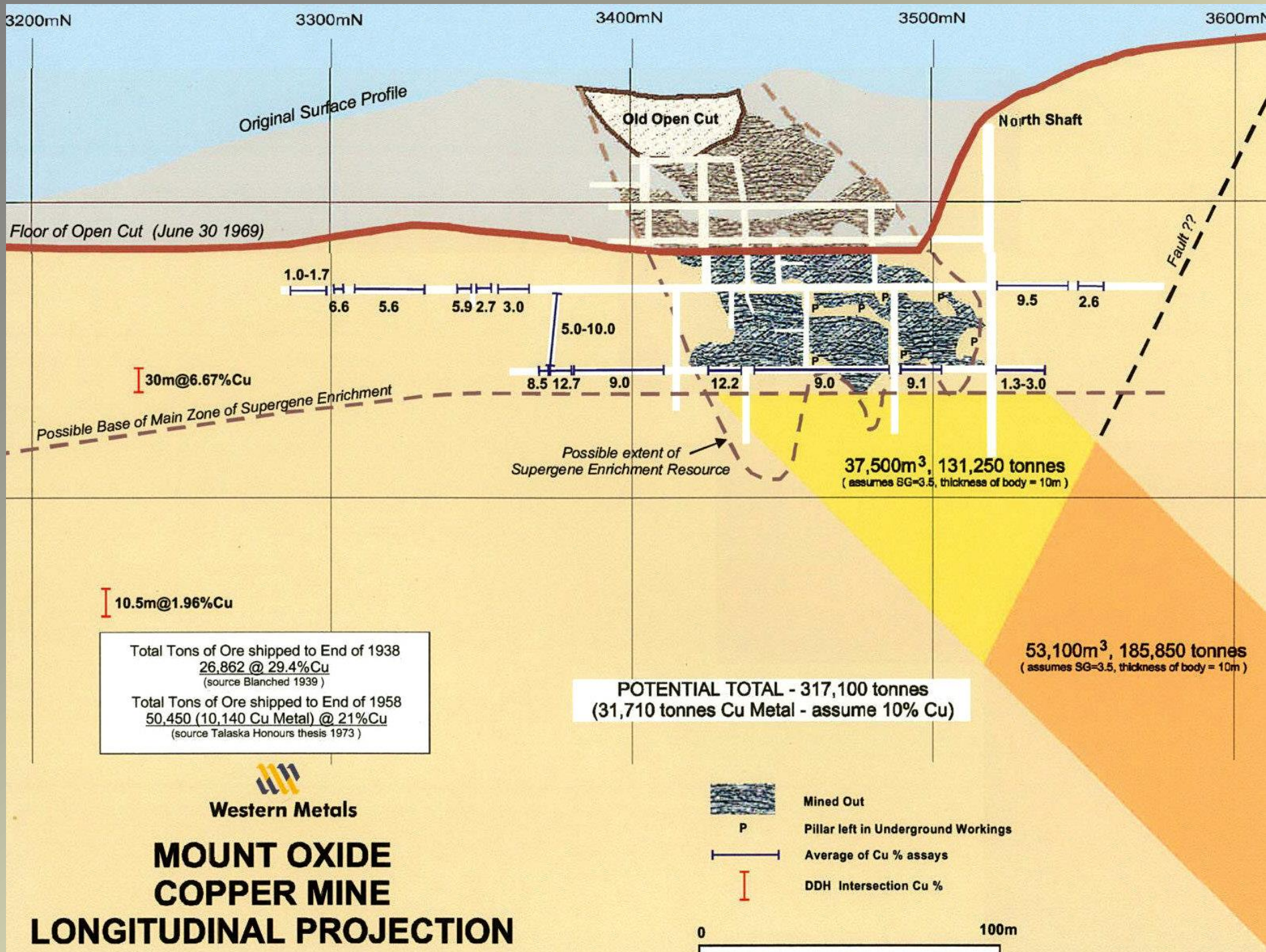


Location of Mt Oxide within a syncline of McNamara Group, including the "Cu triplet"; dark blue is Oxide Chert, light blue is Paradise Creek Fmn.

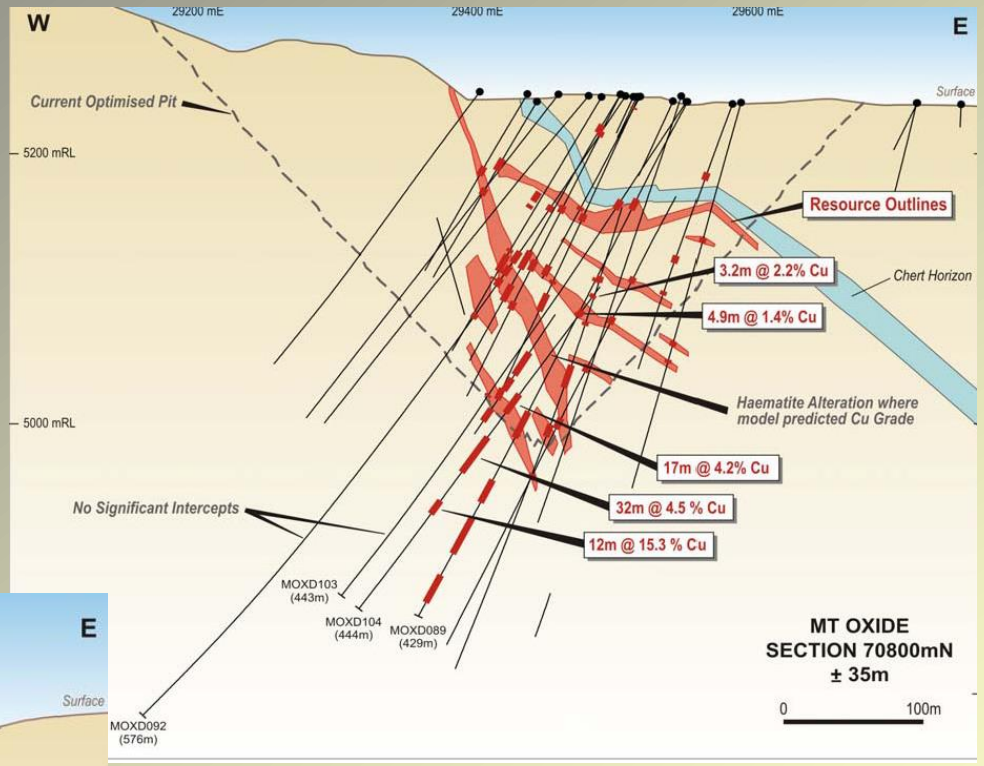
Deposit is located in a triple-junction fault system, hosted by carbonaceous sediments of the Gunpowder Creek Fmn., with faulting to the west, in the stratigraphic footwall

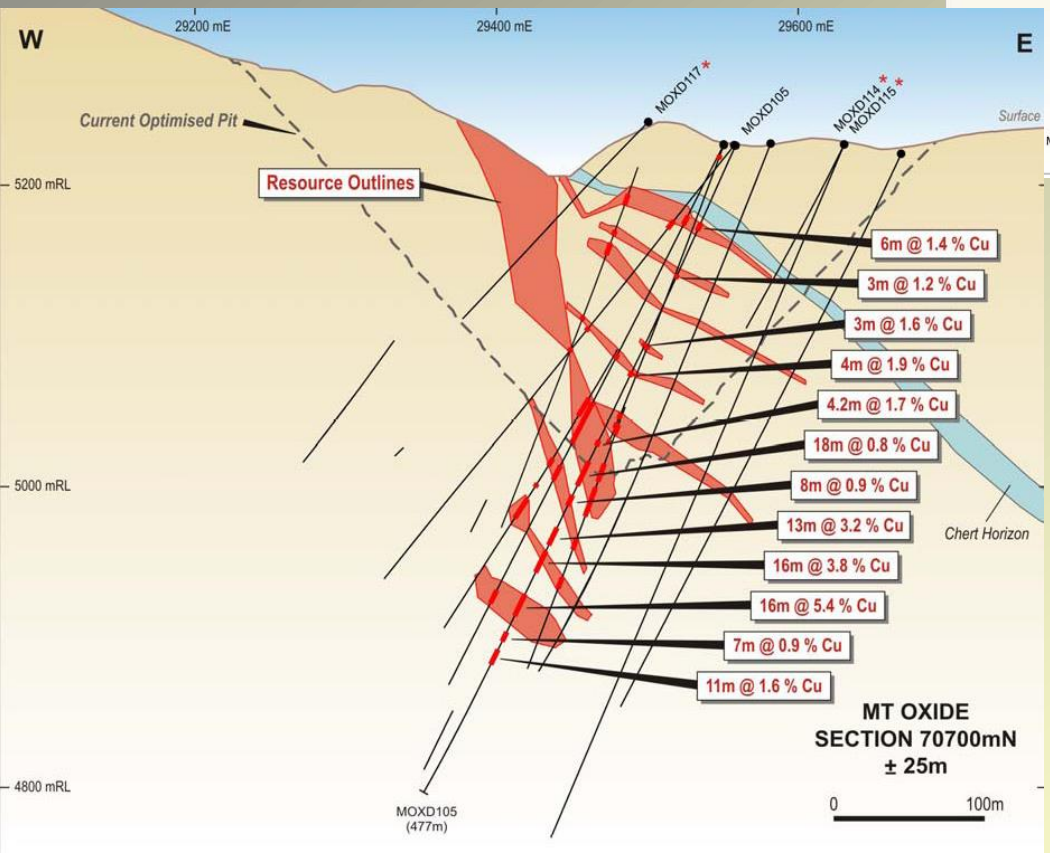
Mt Oxide open pit, looking south; all drilling has been from the east, collared in east-dipping Paradise Creek Fmn; Oxide Chert is about parallel with the benches

Mt Oxide open pit, looking NNE; open pit has pH ~2. Vegetated hill to north has extensive hematitic breccias with potential.


3200mN
3300mN
3400mN
3500mN
3600mN
Original Surface Profile
Old Open Cut
North Shaft
Floor of Open Cut (June 30 1969)
Fault ??
1.0-1.7
6.6
5.6
5.9
2.7
3.0
5.0-10.0
9.5
2.6
30m@6.67%Cu
8.5
12.7
9.0
12.2
9.0
9.1
1.3-3.0
Possible Base of Main Zone of Supergene Enrichment
Possible extent of
Supergene Enrichment Resource
37,500m3, 131,250 tonnes
(assumes SG=3.5, thickness of body = 10m)
10.5m@1.96%Cu
Total Tons of Ore shipped to End of 1938
26,862 @ 29.4%Cu
(source Blanched 1939)
Total Tons of Ore shipped to End of 1958
50,450 (10,140 Cu Metal) @ 21%Cu
(source Talaska Honours thesis 1973)
53,100m3, 185,850 tonnes
(assumes SG=3.5, thickness of body = 10m)
POTENTIAL TOTAL - 317,100 tonnes
(31,710 tonnes Cu Metal - assume 10% Cu)
Western Metals
MOUNT OXIDE
COPPER MINE
LONGITUDINAL PROJECTION
Mined Out
P
Pillar left in Underground Workings
Average of Cu % assays
DDH Intersection Cu %
0
100m

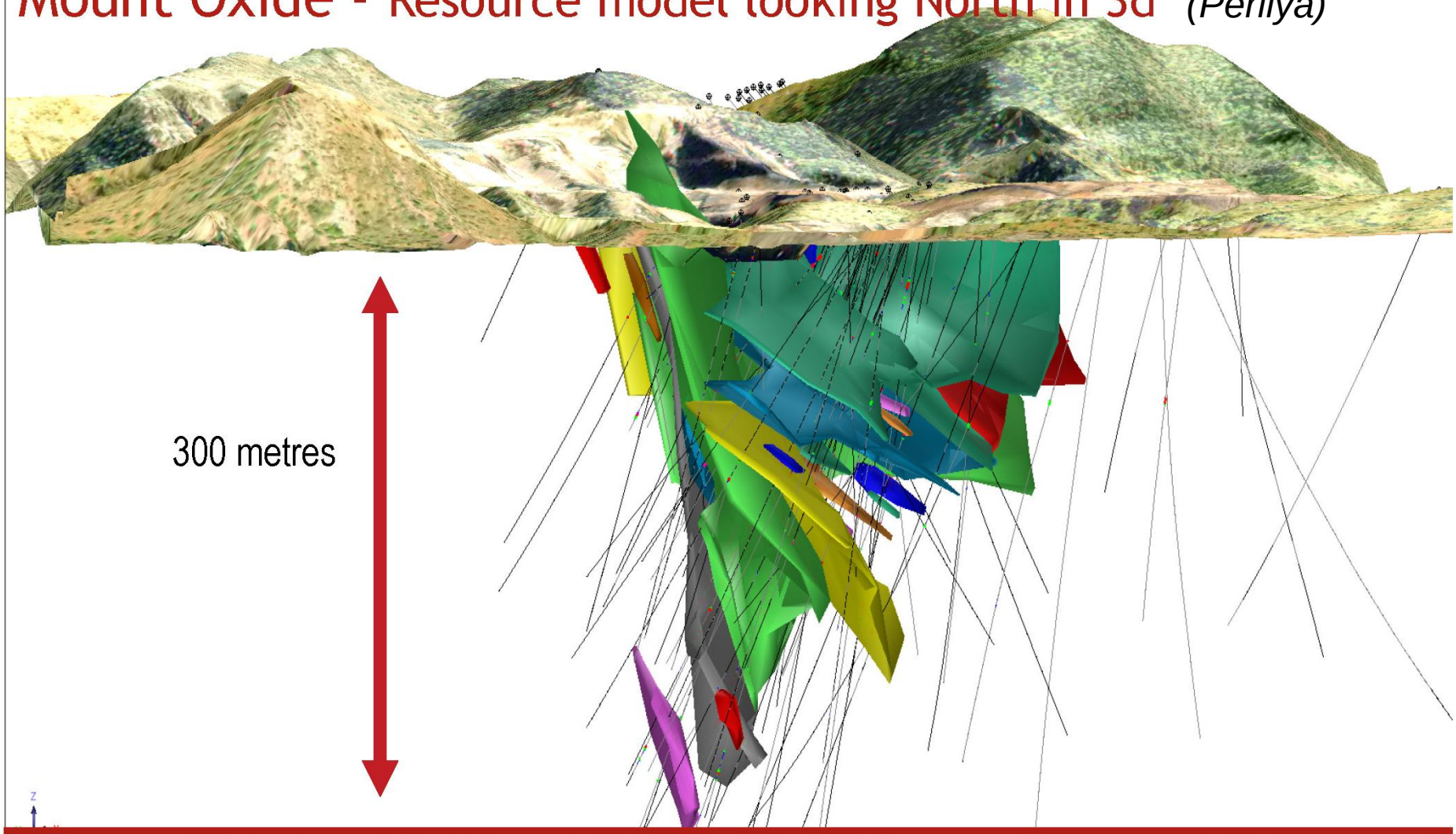
Typical cross sections – note Oxide Chert marker and mineralisation stratabound and in steeper structures. Recent drilling indicates underground potential. Note optimised open pit.





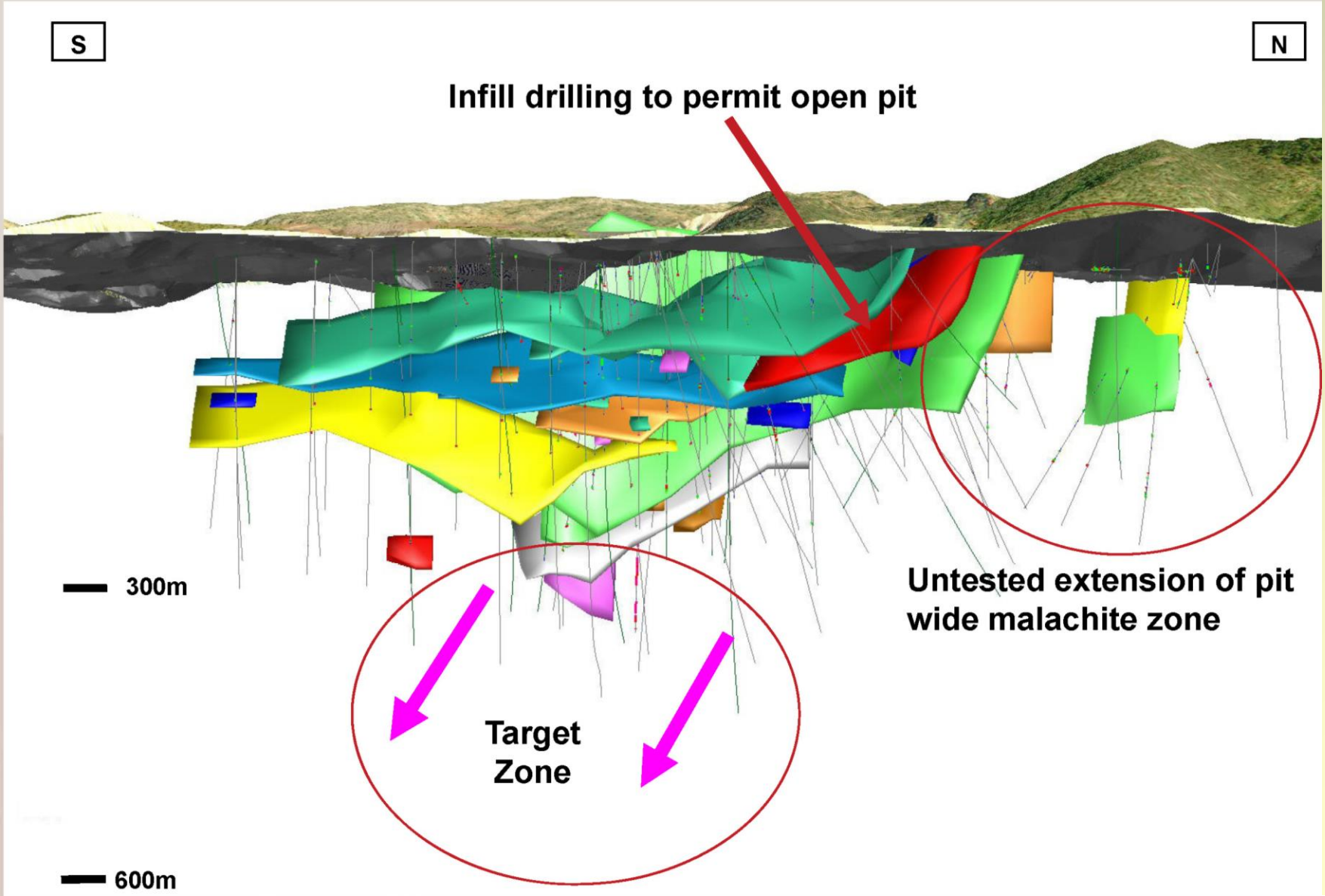
Mt Oxide Cu

Mount Oxide - Resource model looking North in 3d *(Perilya)*



Mount Oxide Resource model looking North in 3d, demonstrating the relationship of shallow and low angle stratigraphic mineralised lenses and vertical structures at depth

Mount Oxide - Drilling Program up to December 2008



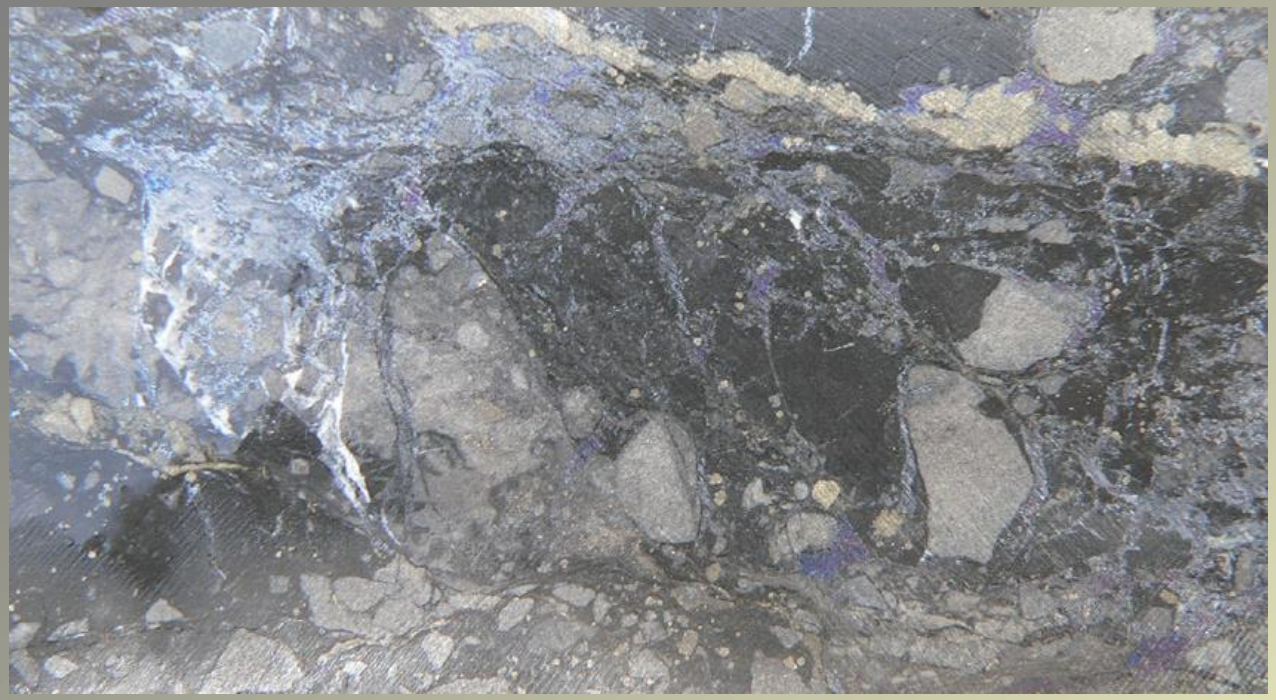

Mt Oxide Cu
Oxidised ore in dense microvein networks in bleached siltstone

Drillcore samples of typical mineralised Gunpowder Ck Fmn, Mt Oxide.

Mt Oxide Cu

Pyrite vein in gritty sandstone (or milled breccia??) of Gunpowder Ck Fmn

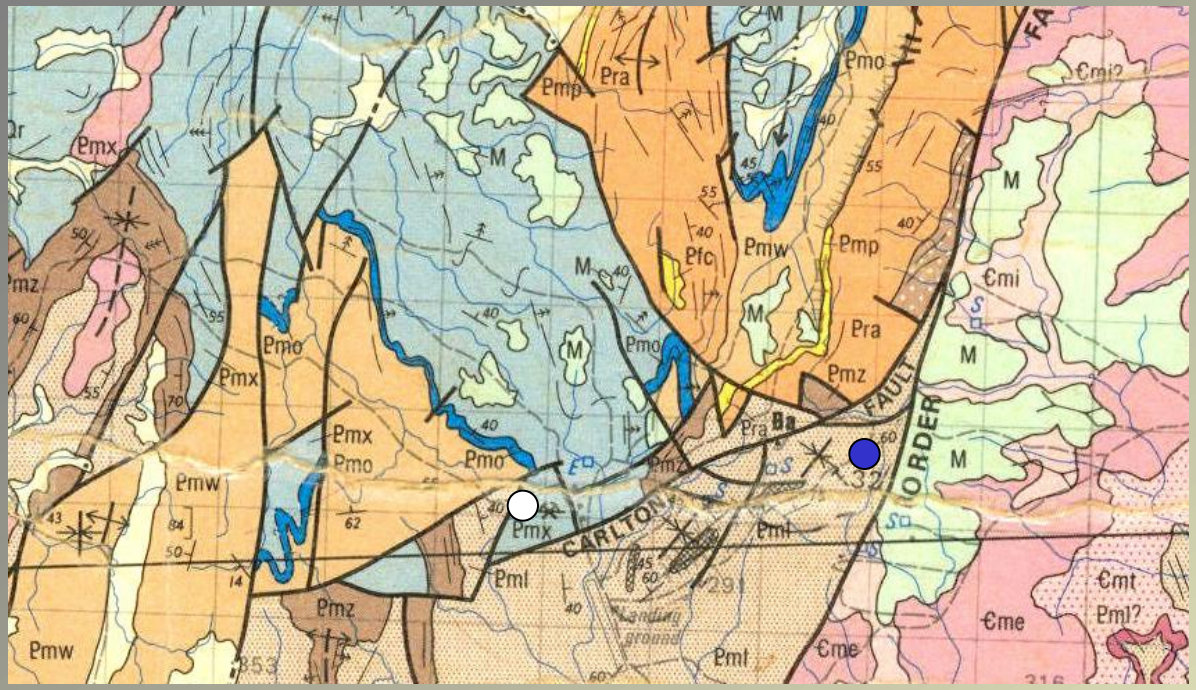
?Bornite in matrix-supported sulphide breccia in siltstone



Mt Oxide Cu

Breciated siltstone with late chalcocite-pyrite mesh-textured veins and matrix, with both milled fragments and bedded siltstone clasts.

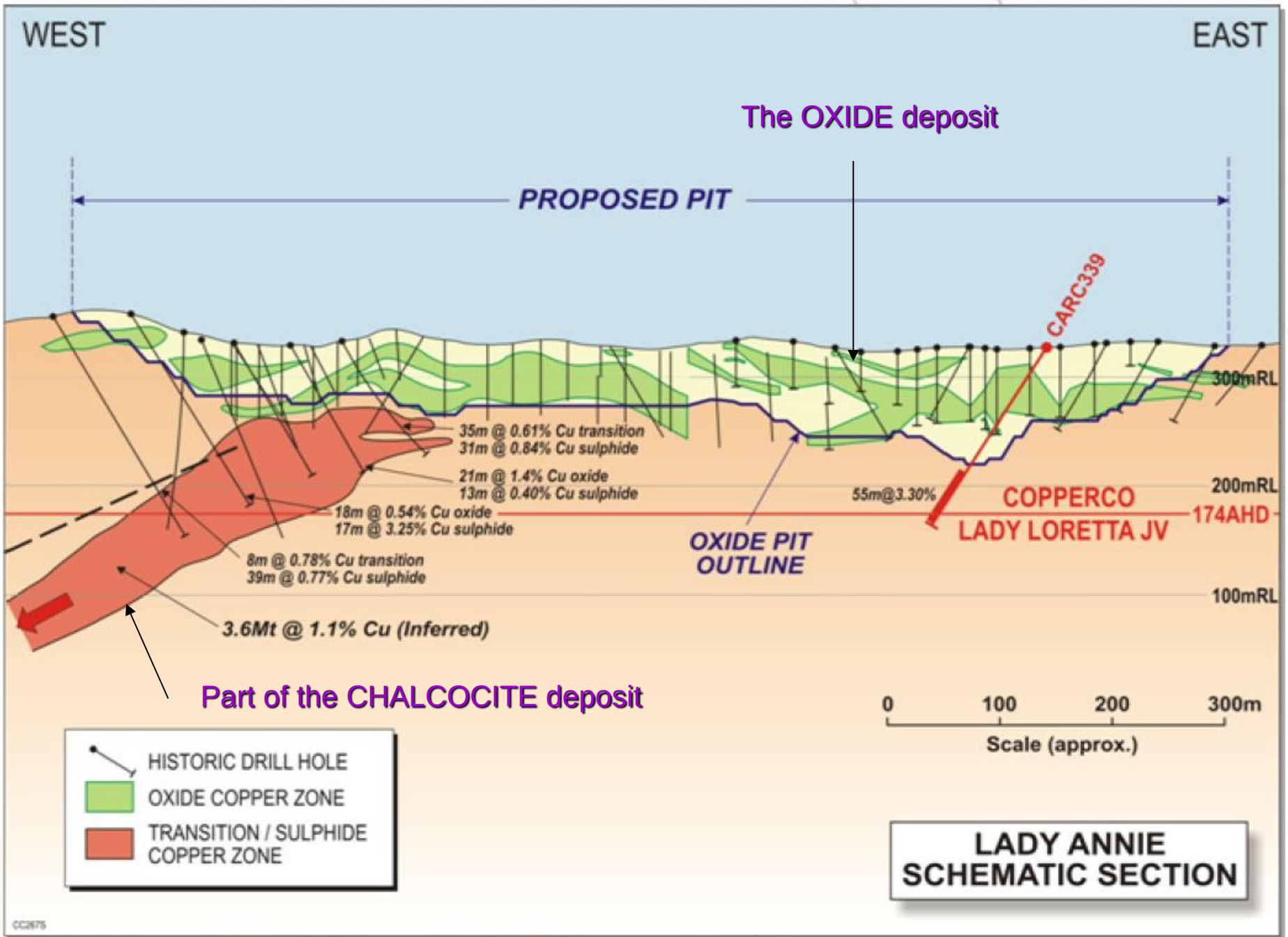

Rufus at Stanthorpe



Lady Annie

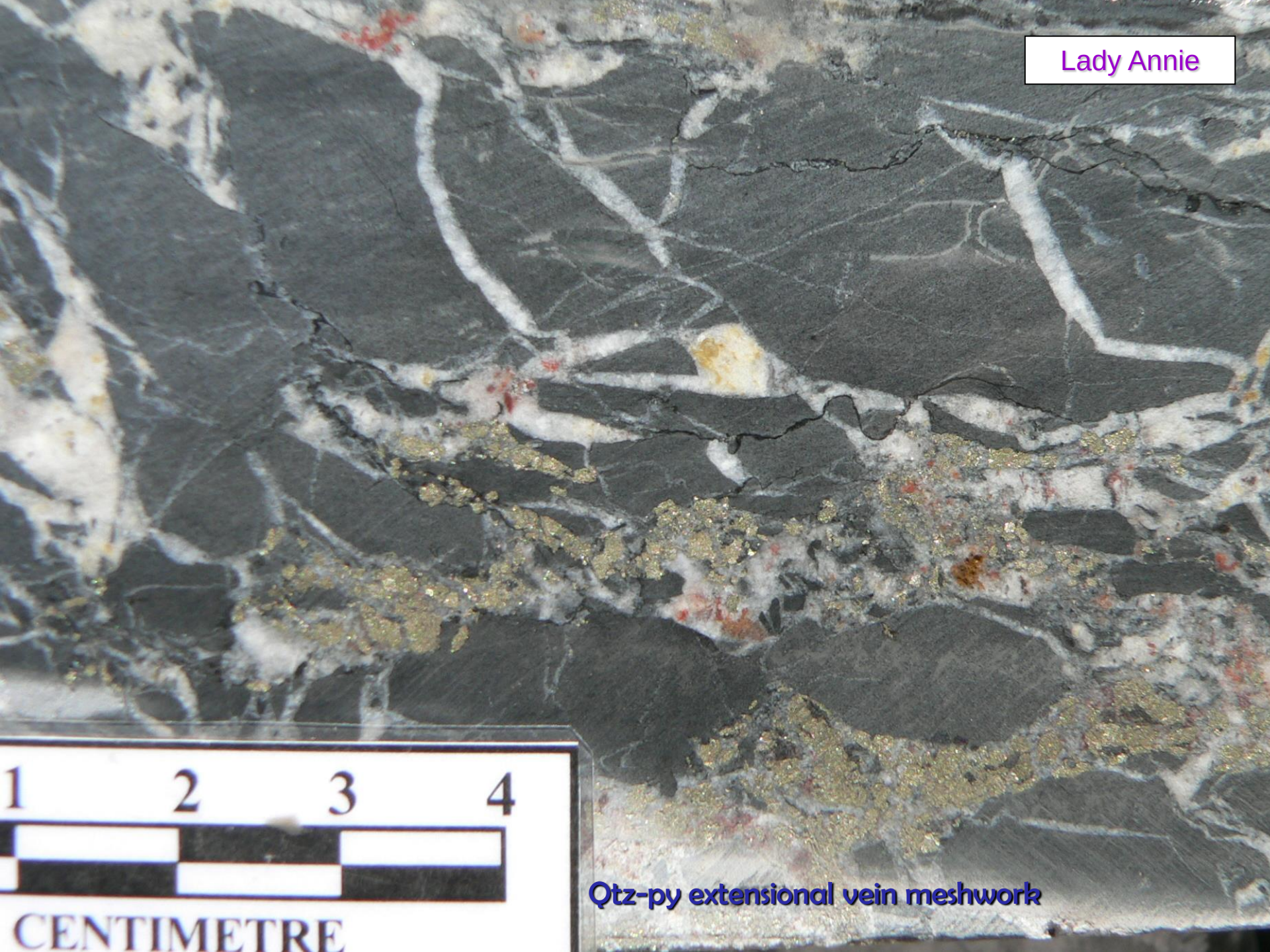
Lady Annie (white dot) west of Lady Loretta (blue dot). Old workings at LA very hematitic, view to west. Map shows LA hosted in Paradise Creek Fmn dolomites, but carbonaceous rocks not far away.

Lady Annie Copper Deposit – long section

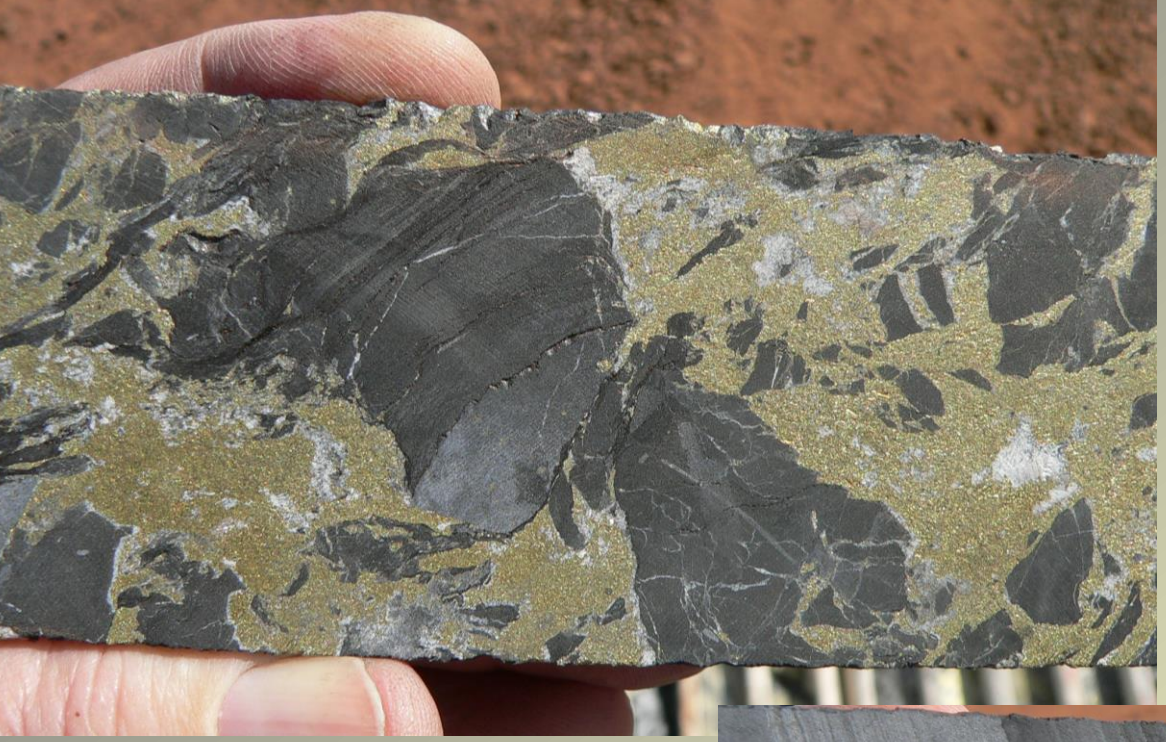


Lady Annie

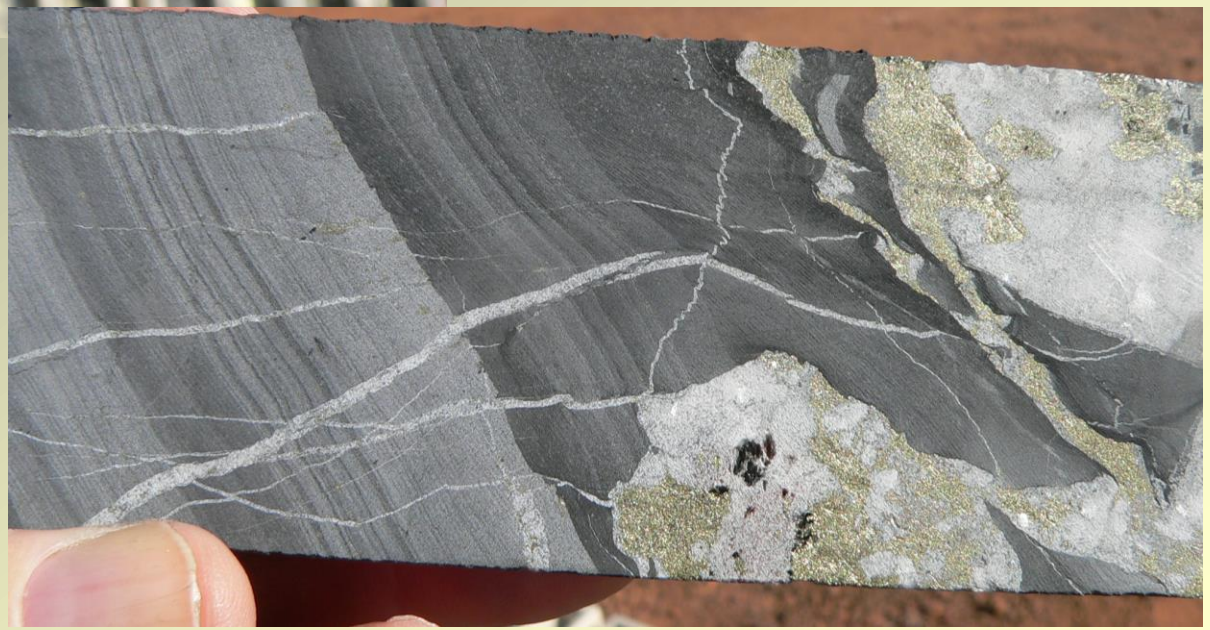
Typical secondary ore forming the major feedstock to the SXEW operation at Mt Kelly to the south


Lady Annie
1 2 3 4
CENTIMETRE
Qtz-py extensional vein meshwork

Lady Annie

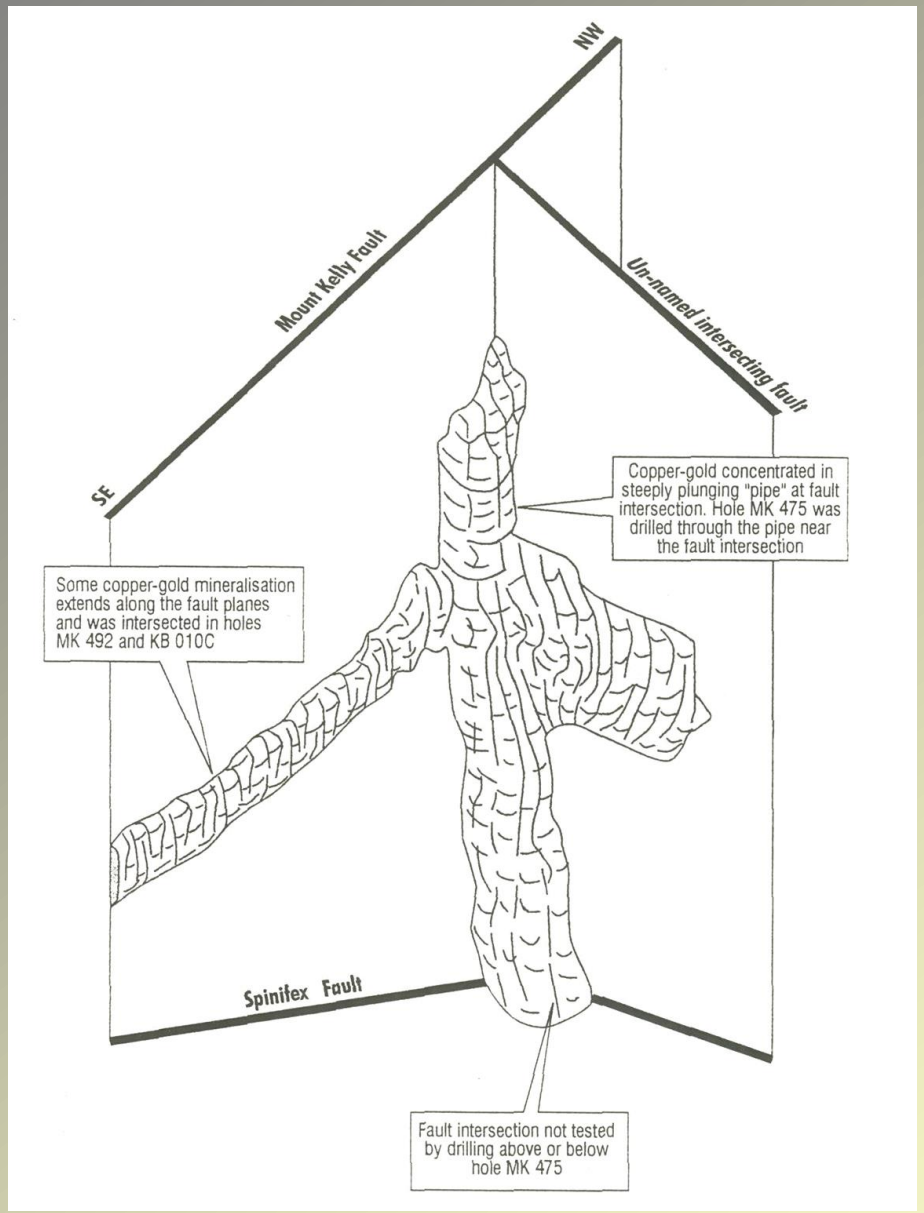


Brecciated grey
?carbonaceous siltstone with
py-cpy sulphide breccia



Laminated siltstone with
qtz-calcite-py veining

A final comment on the gold at Mt Kelly

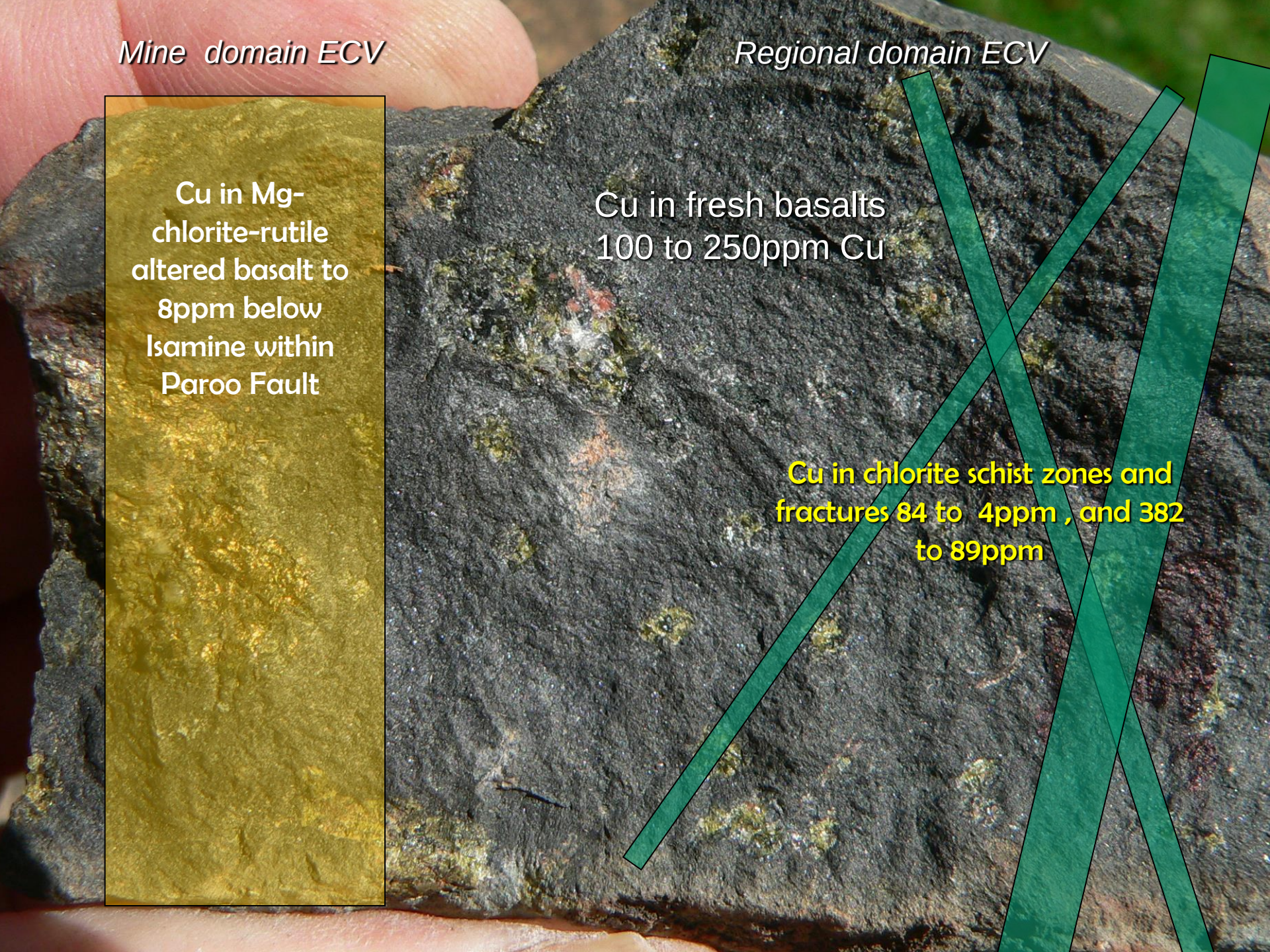


Mt Kelly has an intercept of about 50m @ 20g/t Au or more; this is the conceptual model from Pegmont Mines illustrating the result, which is ghost like

ORIGINS of MINERALISATION Brief and simple


ECV basalts as far as
the eye can see. . . .


With cpy in amygdales,
assays 200-300ppm Cu


Mine domain ECV
Regional domain ECV
Cu in Mg-chlorite-rutile altered basalt to 8ppm below Isamine within Paroo Fault
Cu in fresh basalts 100 to 250ppm Cu
Cu in chlorite schist zones and fractures 84 to 4ppm , and 382 to 89ppm

Siderite-calcite-magnetite-chlorite-qtz with minor cpy in ECV 8km east of Isamine

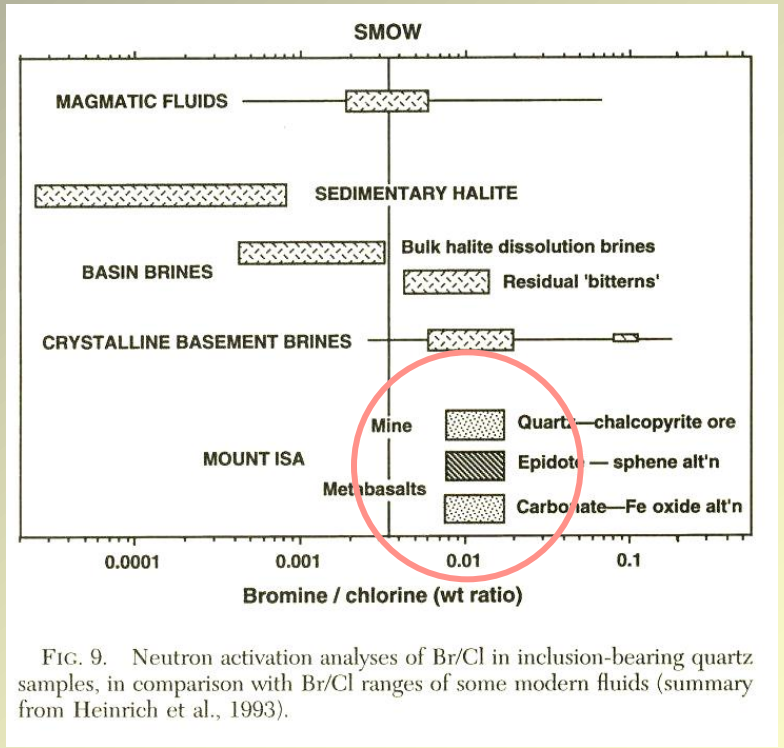


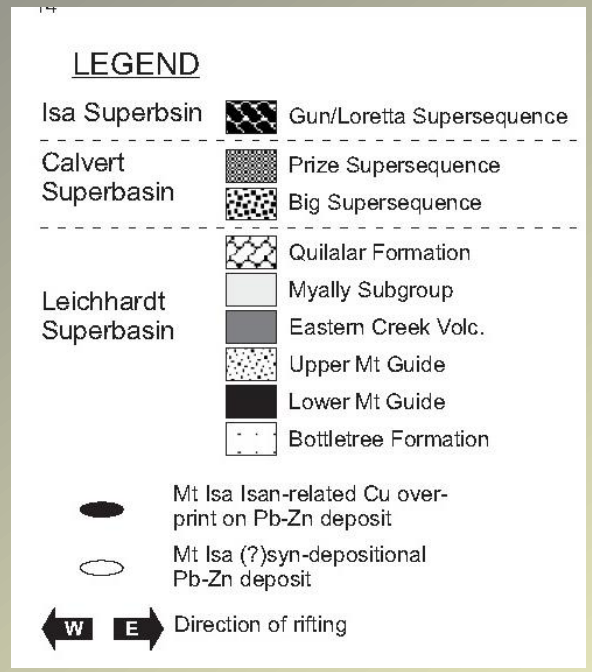
FIG. 9. Neutron activation analyses of Br/Cl in inclusion-bearing quartz samples, in comparison with Br/Cl ranges of some modern fluids (summary from Heinrich et al., 1993).

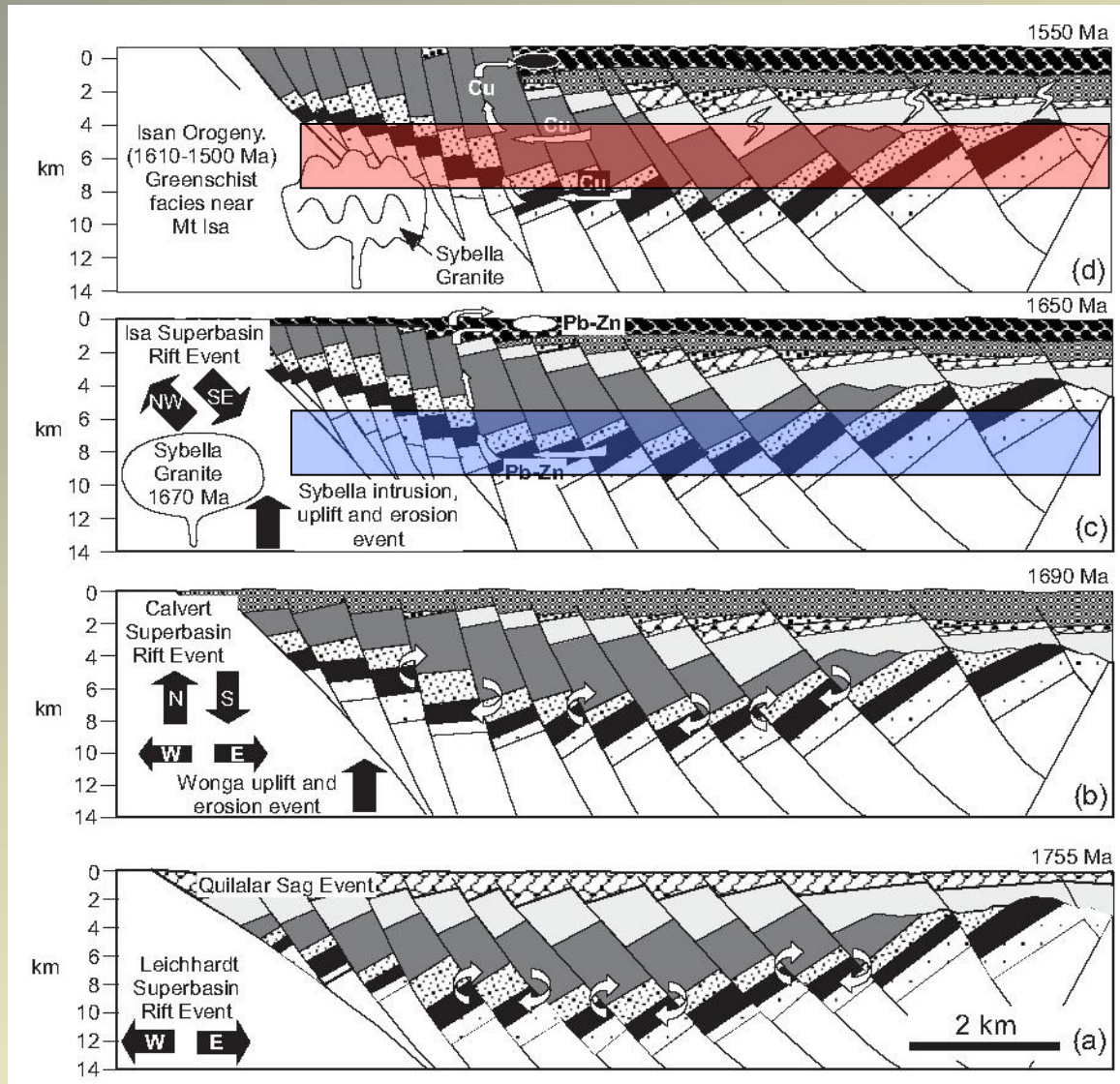
Quartz in these veins show the same Br/Cl ratios as quartz from Cu ore at Isamine.

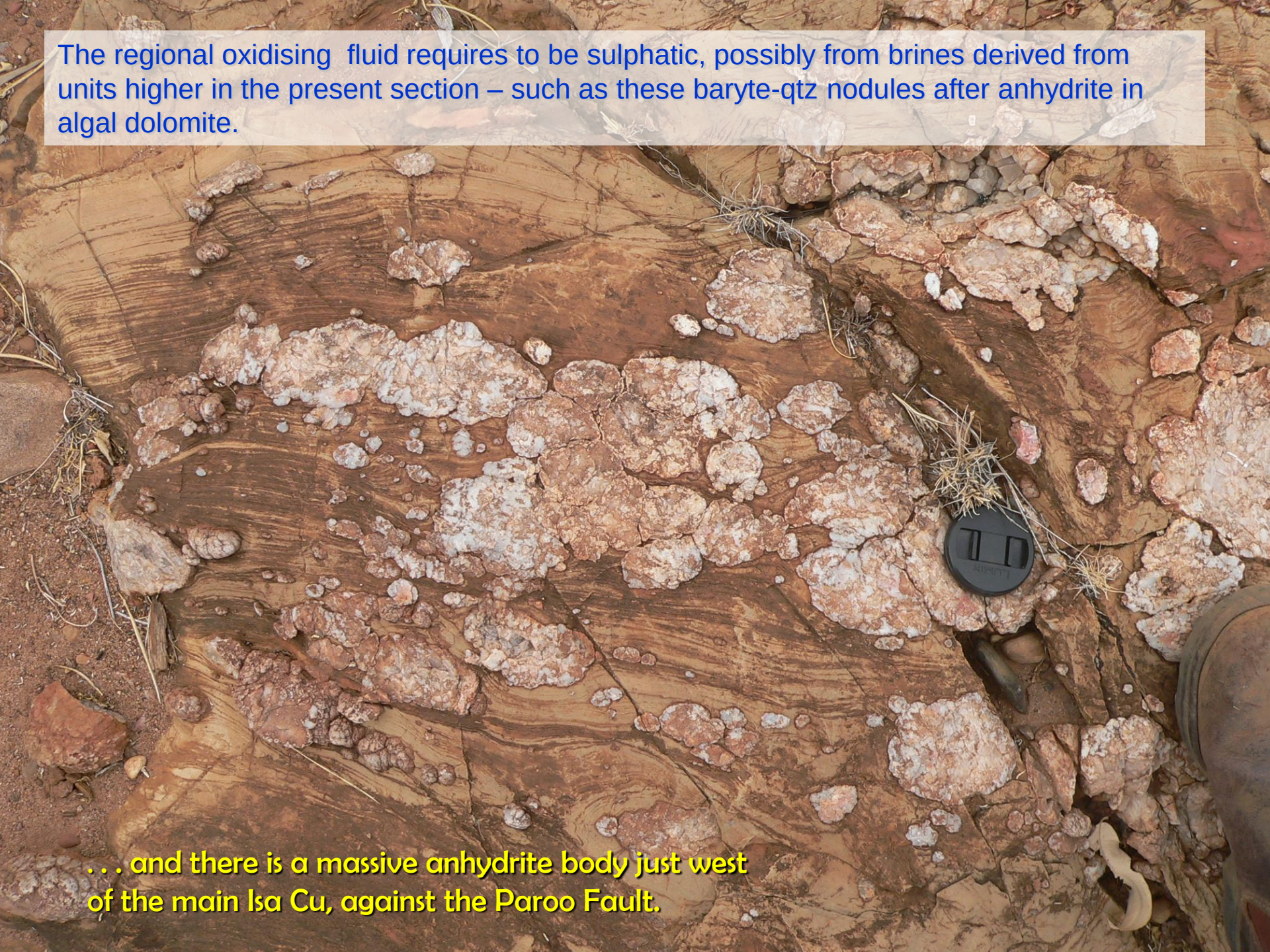
Heinrich et al., 1995

Support the fluid flow models of Heinrich et al (see volume) and recent work by Polito et al 2006 on diagenetic activity in deep aquifers

TWO-STAGE EXTRACTION OF METALS





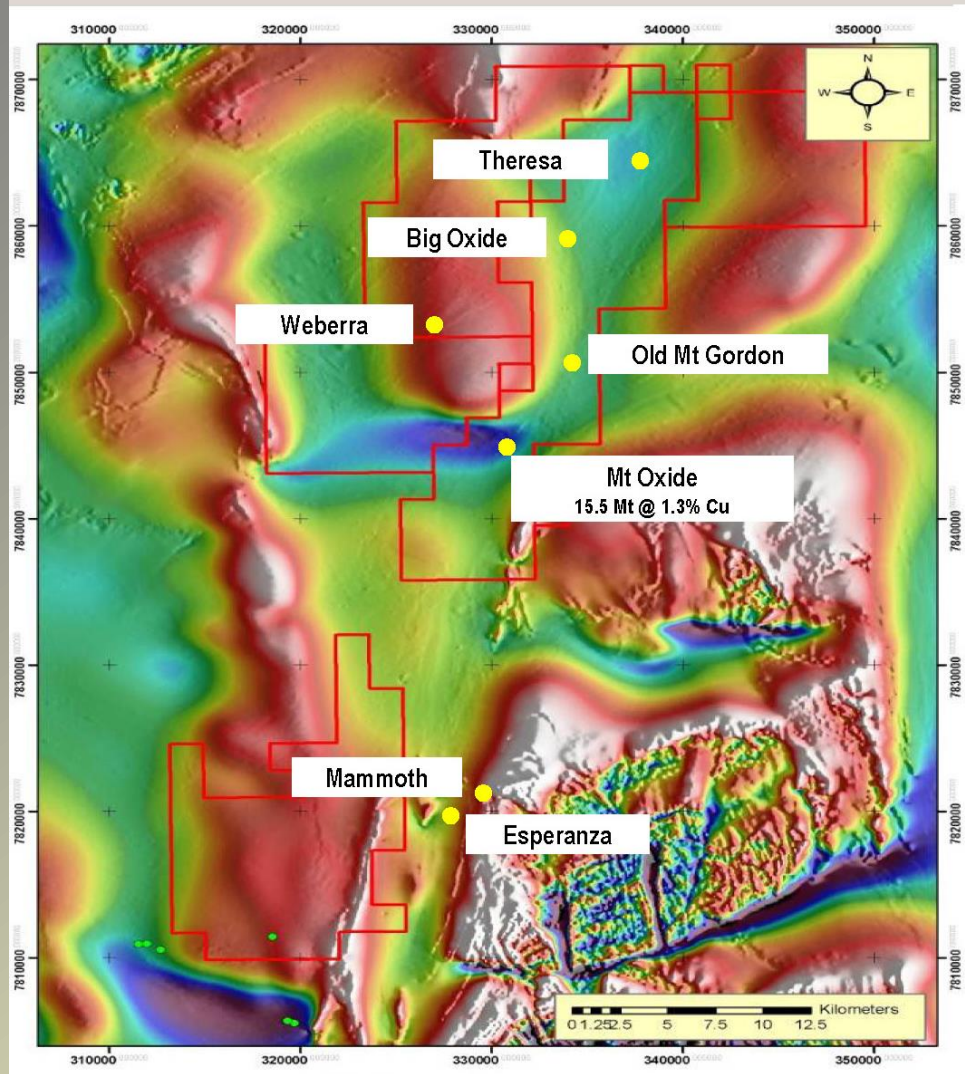

The regional oxidising fluid requires to be sulphatic, possibly from brines derived from units higher in the present section – such as these baryte-qtz nodules after anhydrite in algal dolomite.
. . . and there is a massive anhydrite body just west of the main Isa Cu, against the Paroo Fault.

Possible footprints

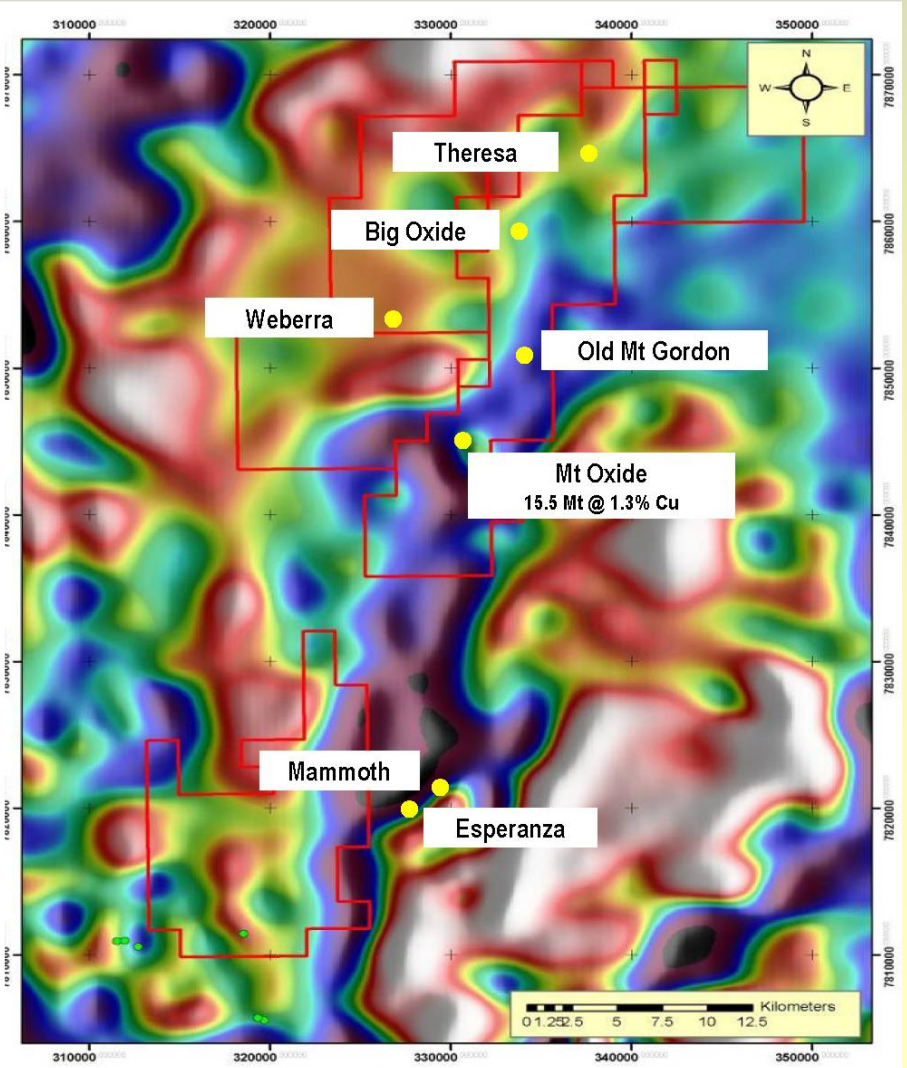
STRONG OR SUBTLE?

Chase ECV positions in the subsurface (1)

Mount Oxide - IOCG Targets – Magnetics and Gravity



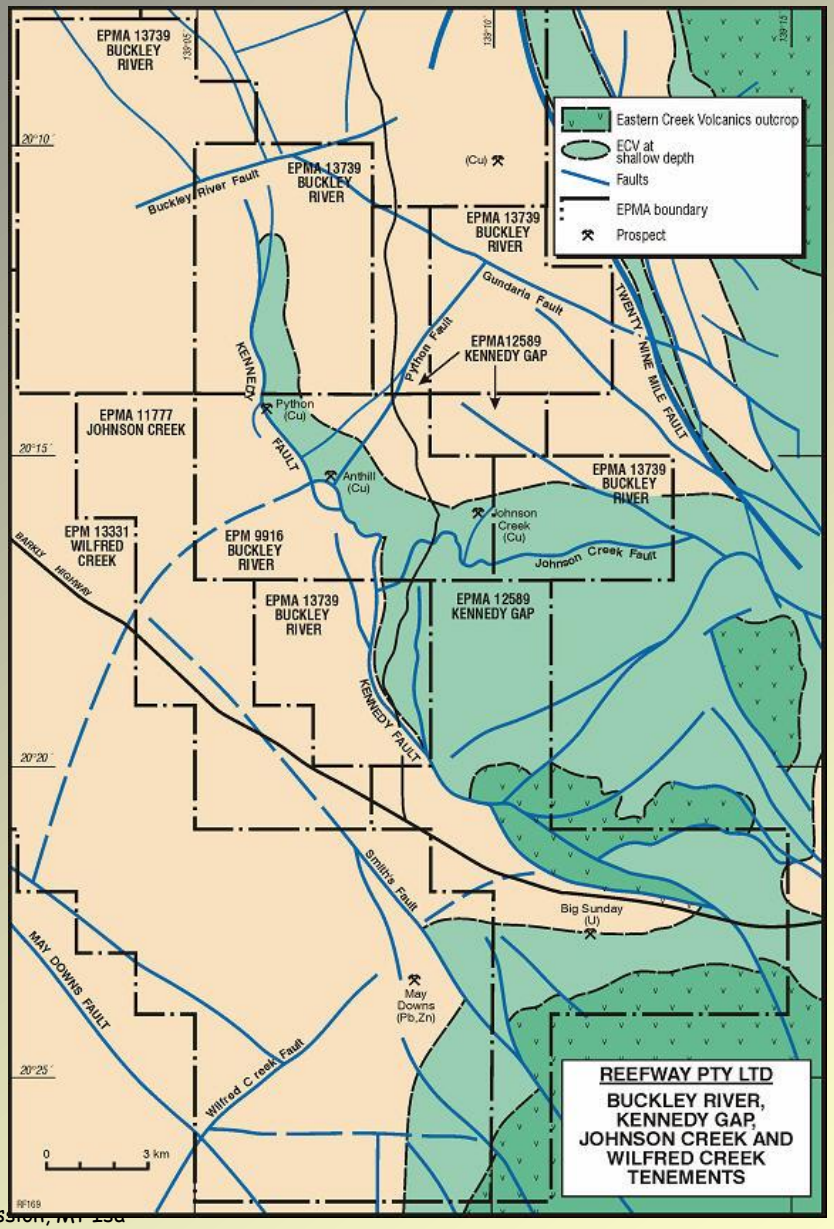
TMI Magnetics



Bouger Gravity

Chase ECV positions in the subsurface (2)

Copperco at Buckley River, with ECV interpreted at shallow depth; note the folded faults!

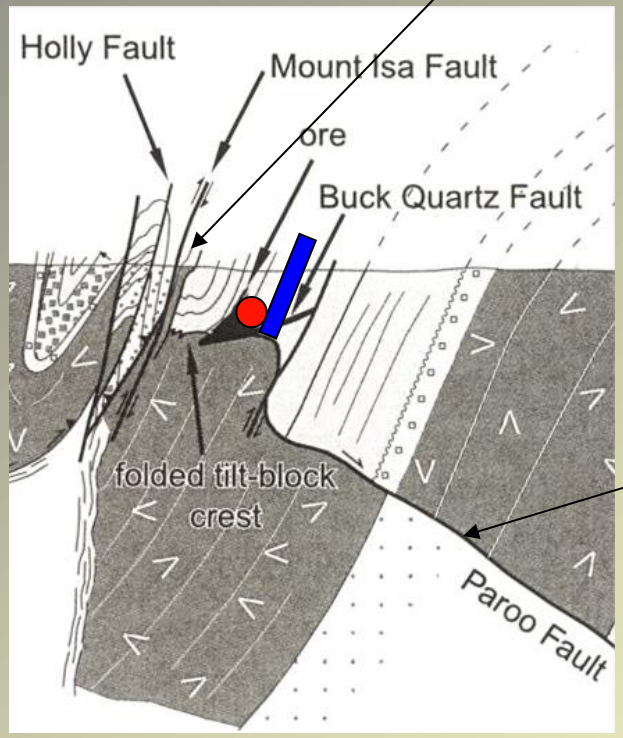


Or simply try to understand the best footprint of all – the Paroo Fault and the identification of early faults after unravelling of the D1 to D3 inversion

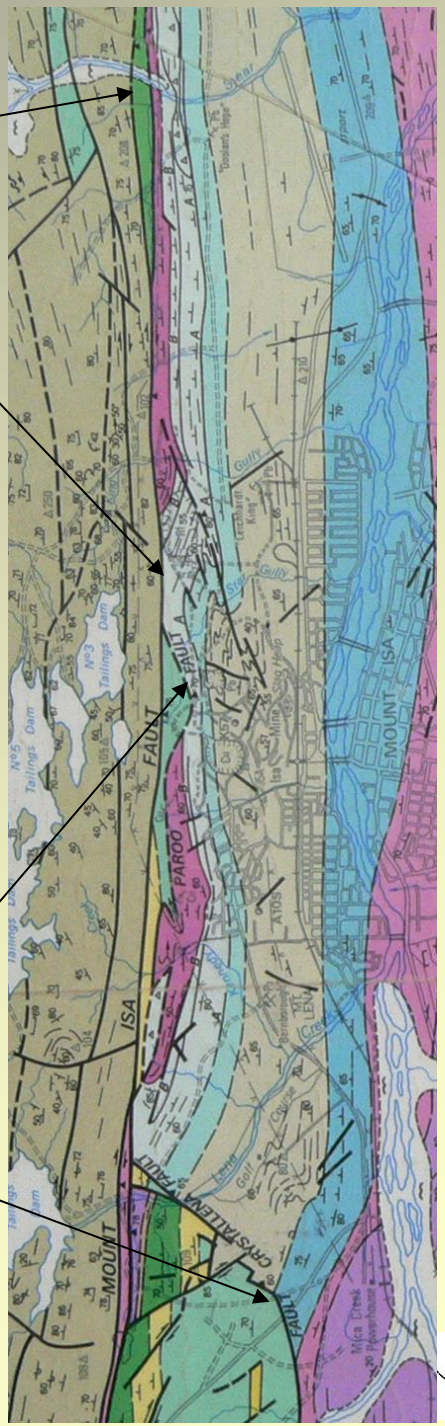
FOLDED FAULTS OFFER THE BEST CONDITIONS FOR CREATING THE DILATION AND OTHER STRUCTURAL CONDITIONS NECESSARY FOR MINERALISATION

NOTE: There are TWO faults of D2-D3 age – the Mt Isa Fault and the Paroo Fault

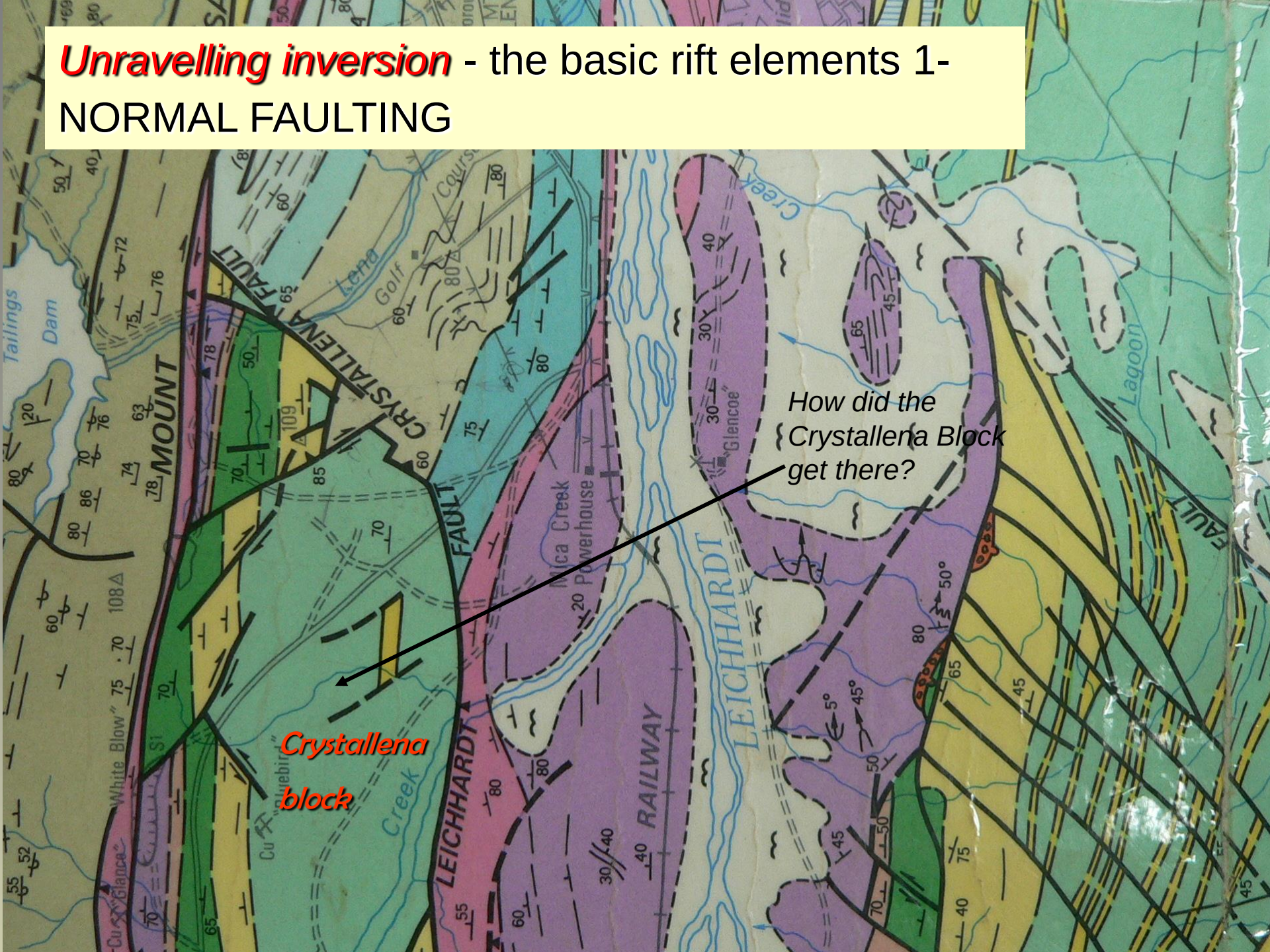
The MT ISA FAULT is steep and unmineralised



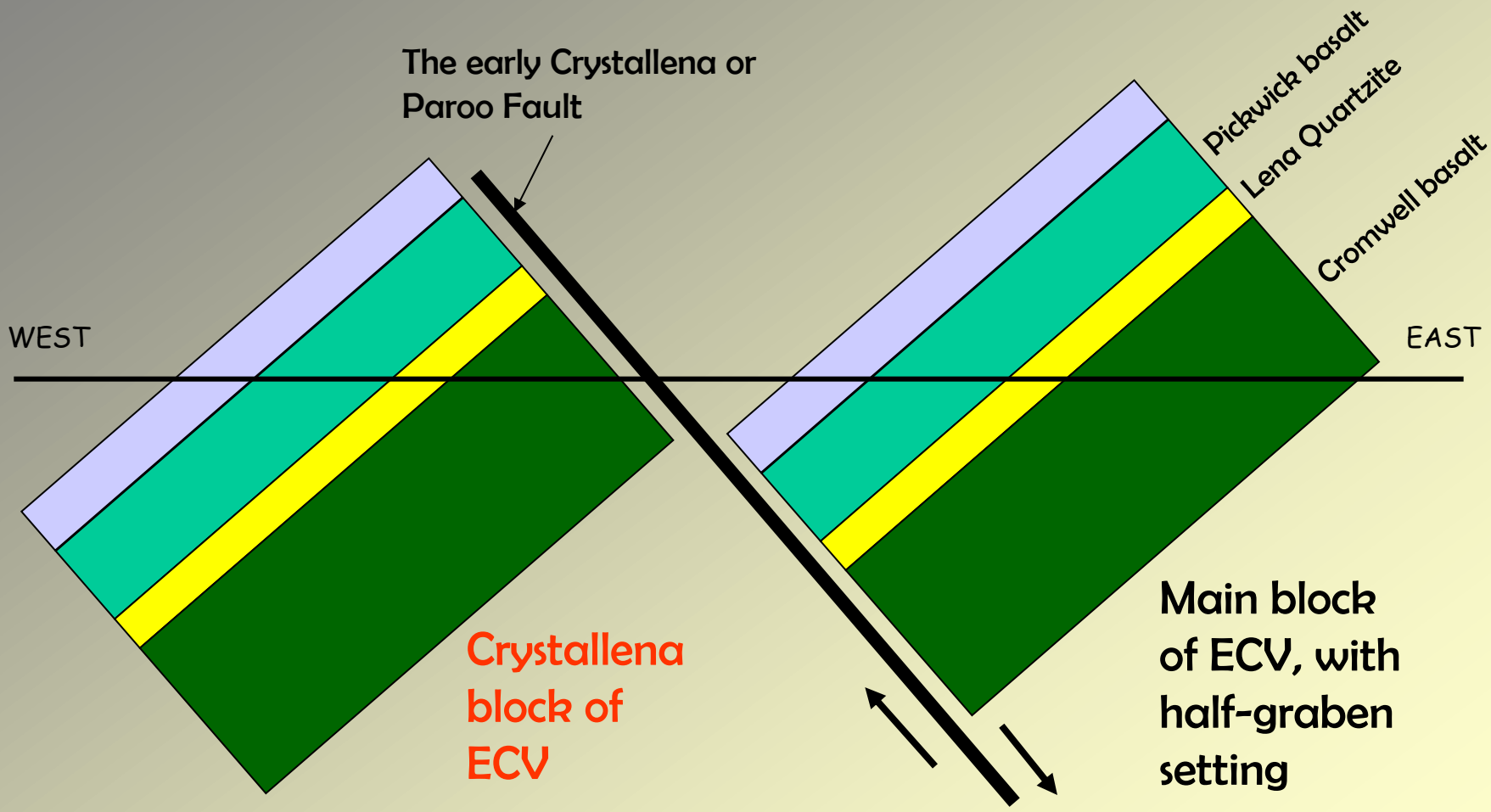
The PAROO FAULT is folded and mineralised



Unravelling inversion - the basic rift elements 1- NORMAL FAULTING

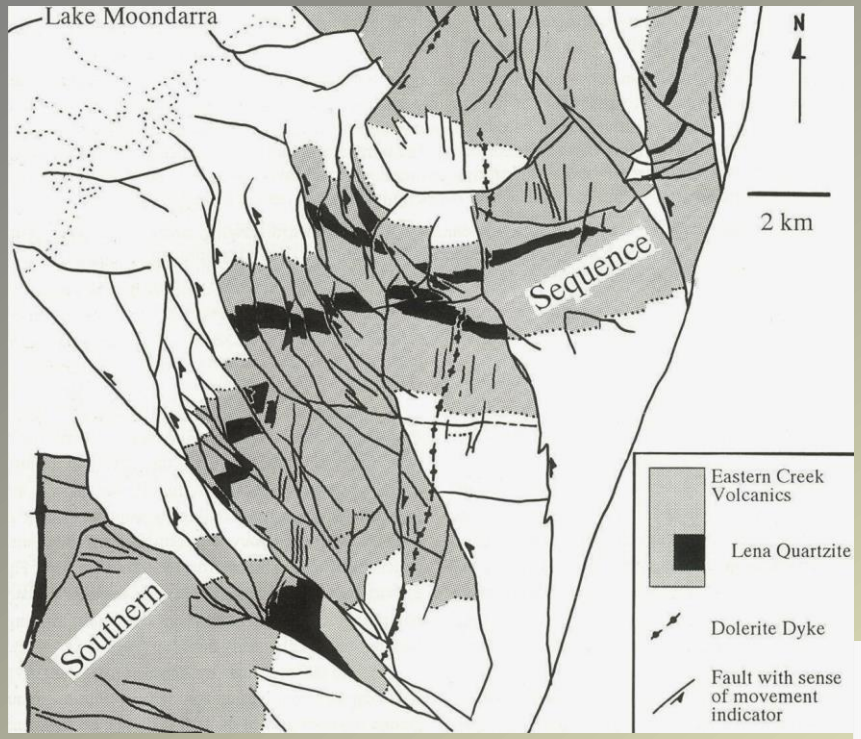


Simple NORMAL FAULTING is elegant and believable



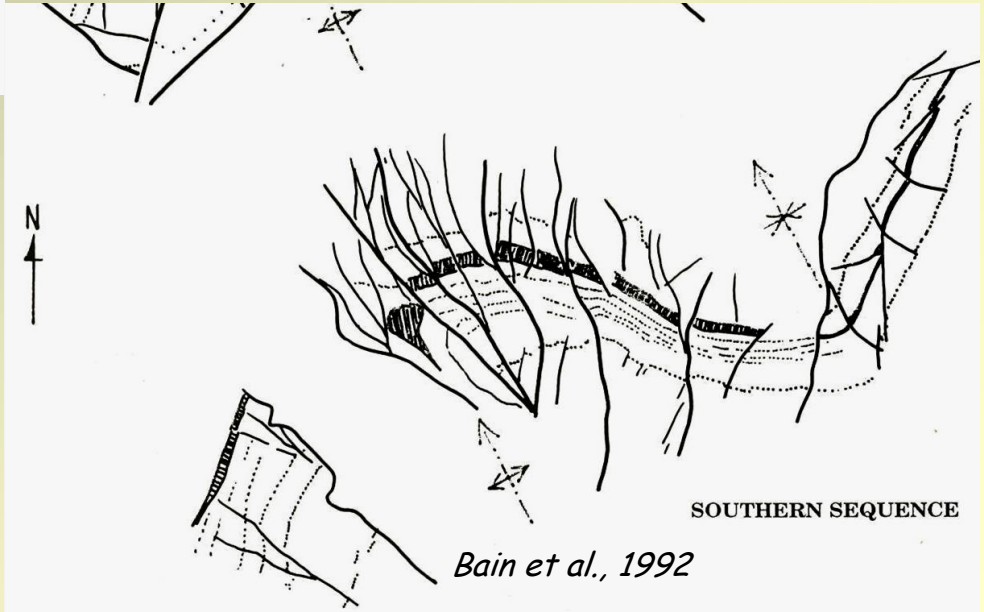
Betts & Lister, 2002

Unravelling inversion – remove the effects of D3 wrenching



From this. . . .

. . . to this

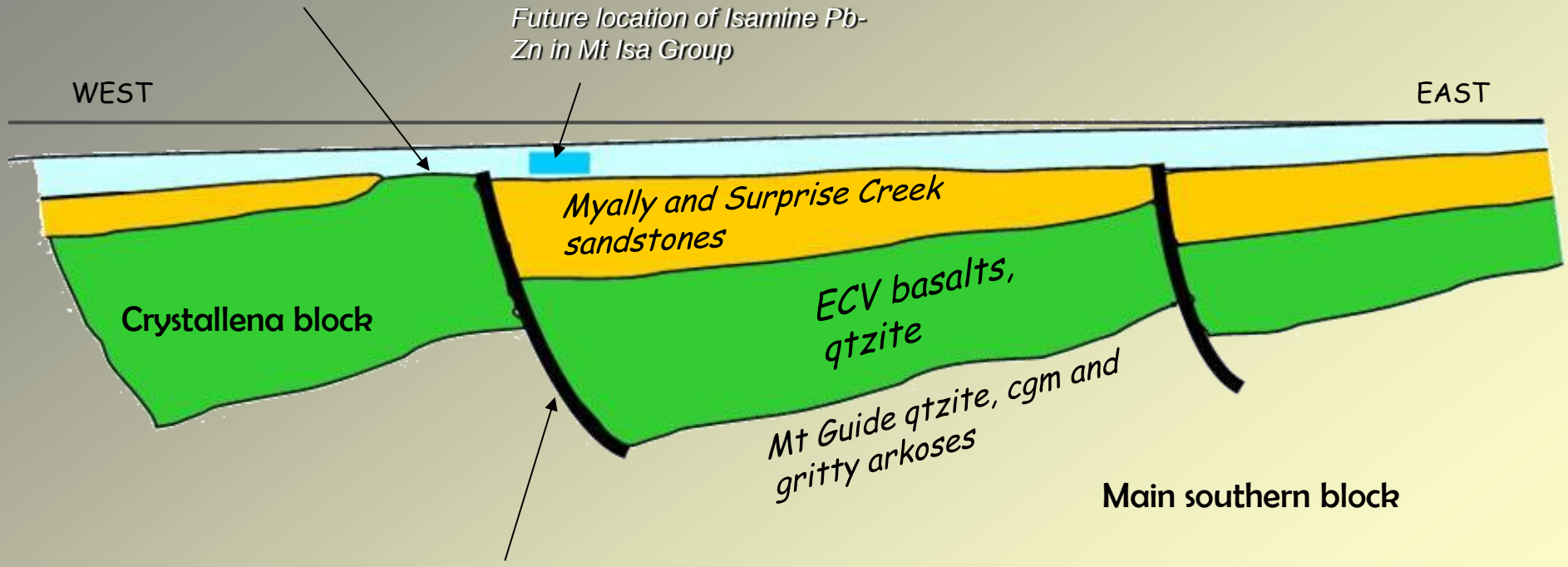


Bain et al., 1992

A simple east-tapering half-graben sequence of Eastern Creek Volcanics

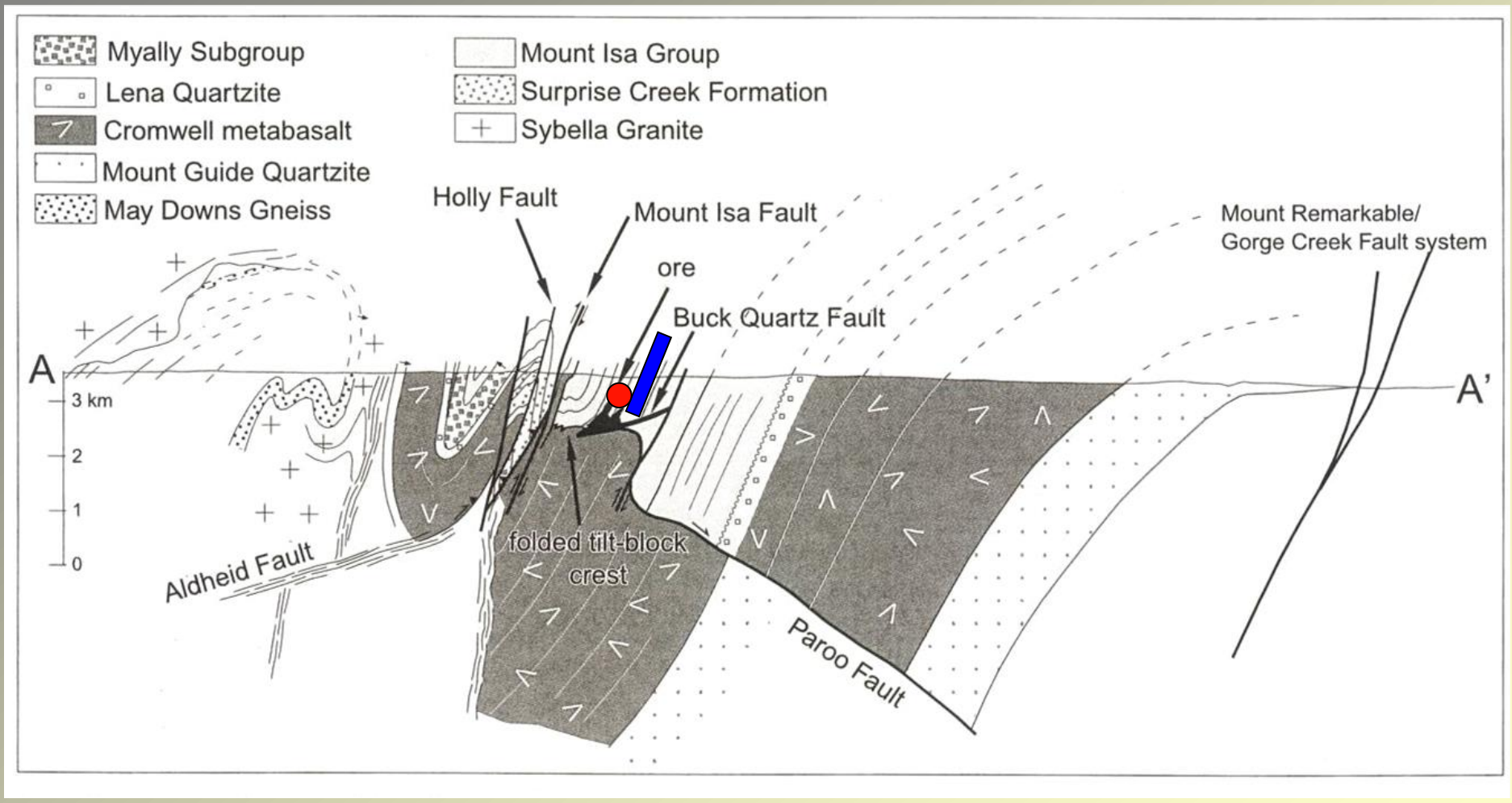
Simple West-East section pre-Mt Isa Group time

Note erosion and unconformities on tips of rotated fault blocks



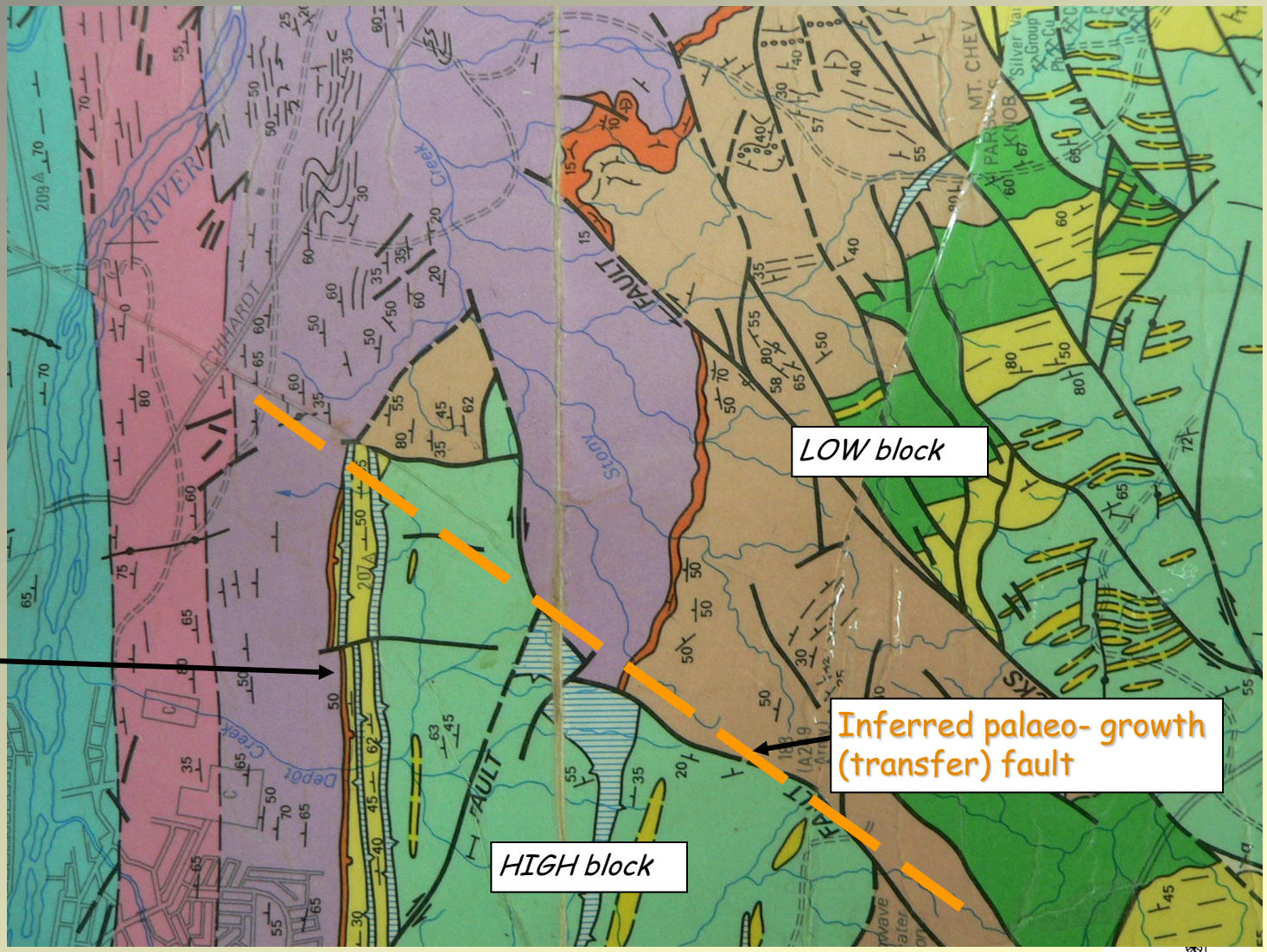
Crystallena or Paroo (normal) Fault and east-tapering half-graben

Then D2-D3 inversion (after Betts et al)



Unravelling inversion - the basic rift elements 2- TRANSFER STRUCTURES

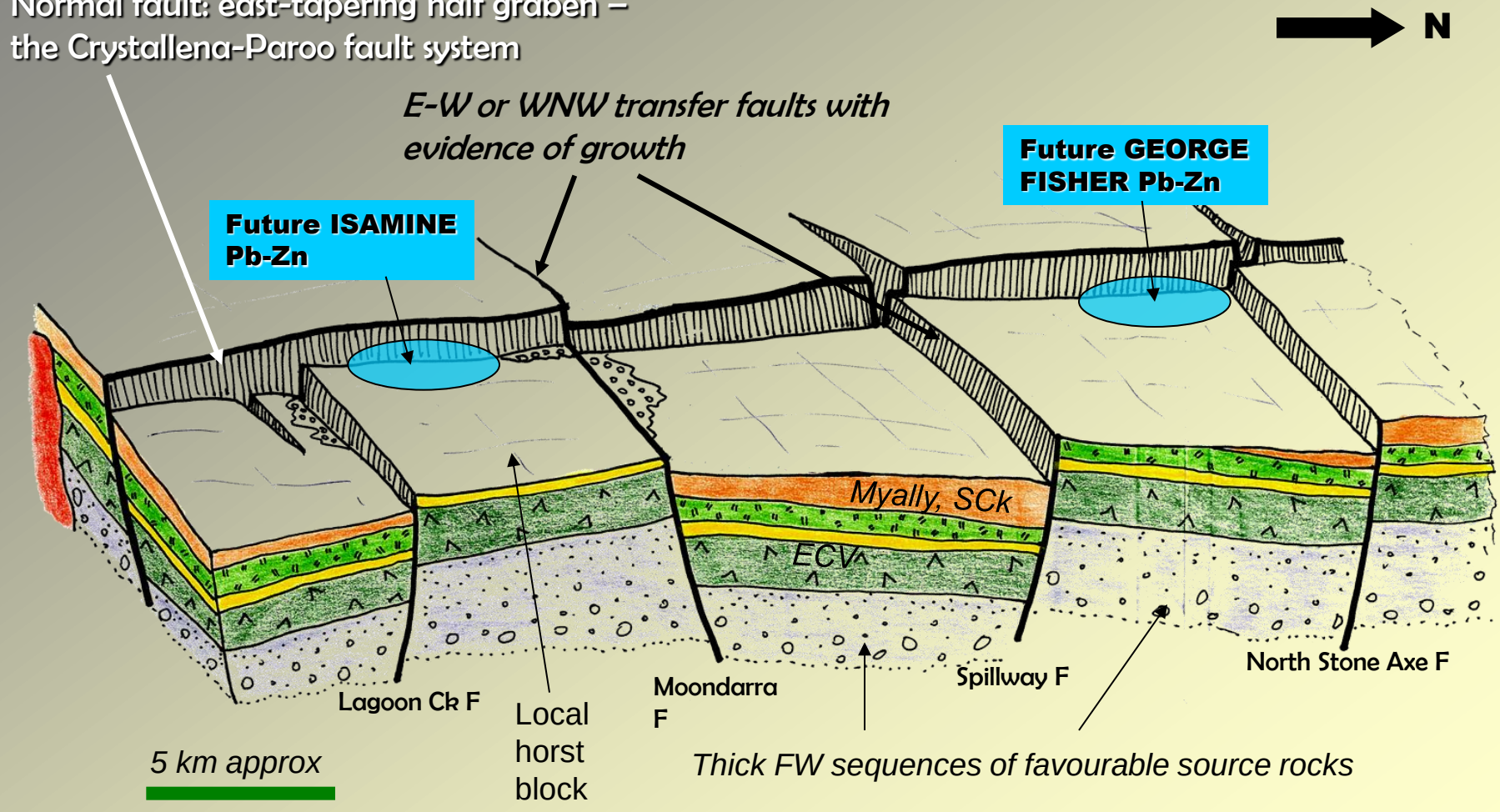
Local horst blocks exist east of Mt Isa, with evidence of growth fault activity in pre-Mt Isa Group time at 1700-1680Ma; note loss of section between high and low blocks



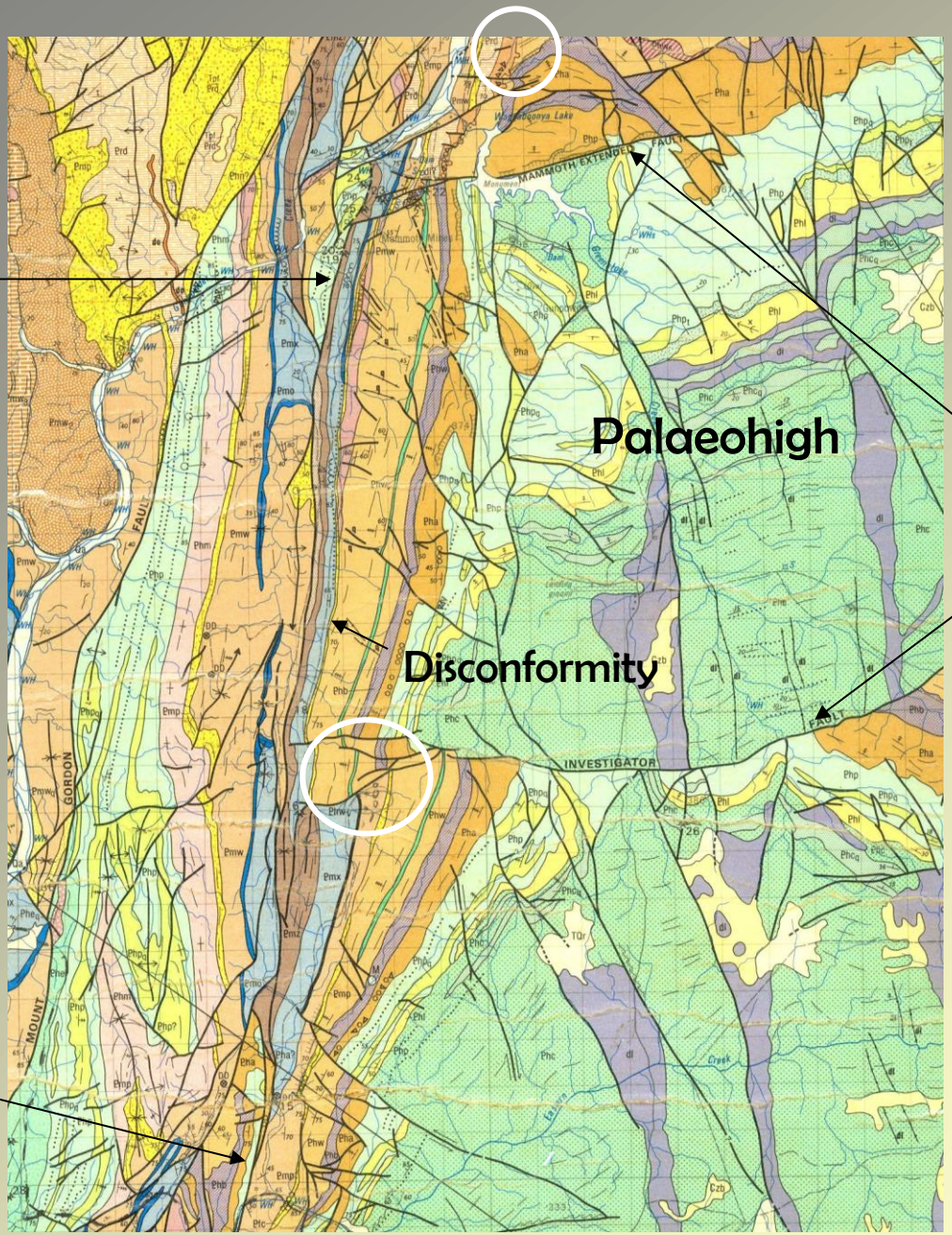
Mt Isa Group basal cgm (1670Ma?) rests disconformably on Lena Qtzite (1770Ma)

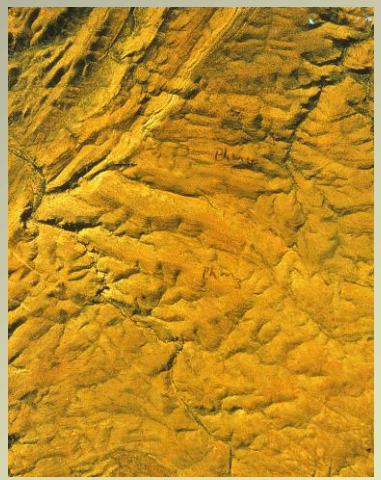
A 3D SUMMARY – possible basin morphology at 1670Ma

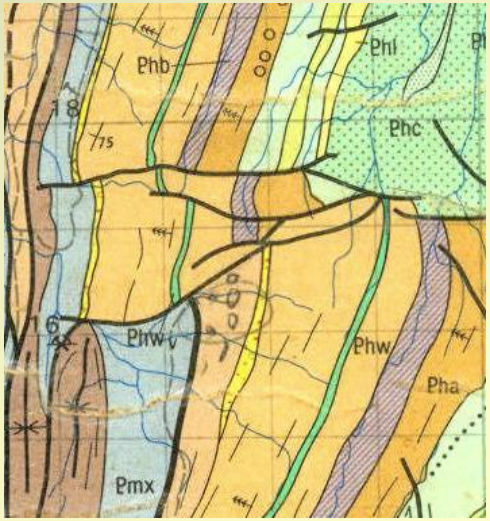
- Multiple early rift events
- Growth faulting
- Template for 3rd order basins
- Immature arkosic source rocks



Fault setting of Paroo Fault equivalent



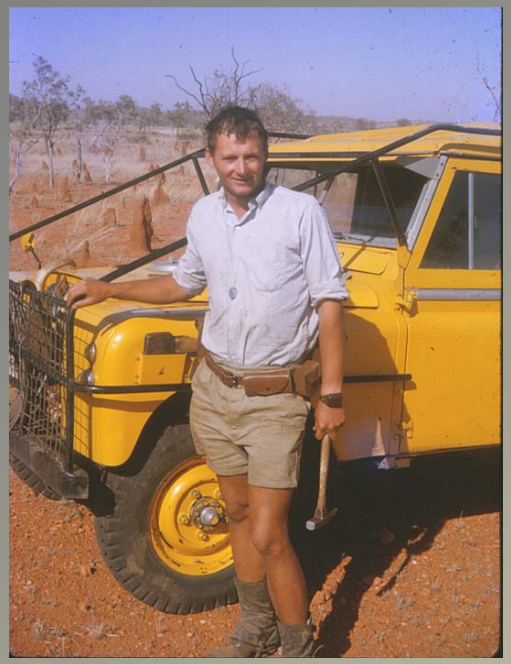




Fault setting of Paroo Fault equivalent

GO BACK !!!

Best footprint of all is to
GO FOR GROWTH



1964

2007

Many thanks to Tony Webster and CODES for the opportunity to present and share this data, and thanks to you all for your attention