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Iron oxide copper-gold deposits in the Tennant and Arunta regions

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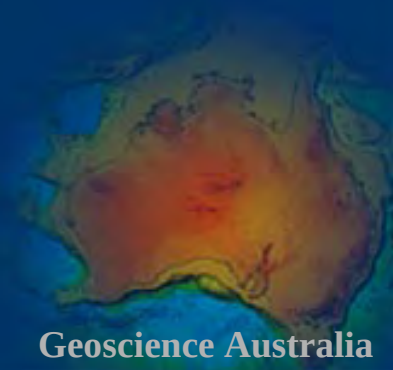
Northern Territory Geological Survey

NAP-wrap 2006



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Acknowledgments

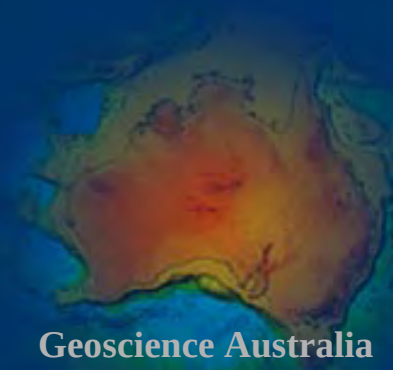
Jon Claoué-Long, Geoff Fraser, Julie Smith

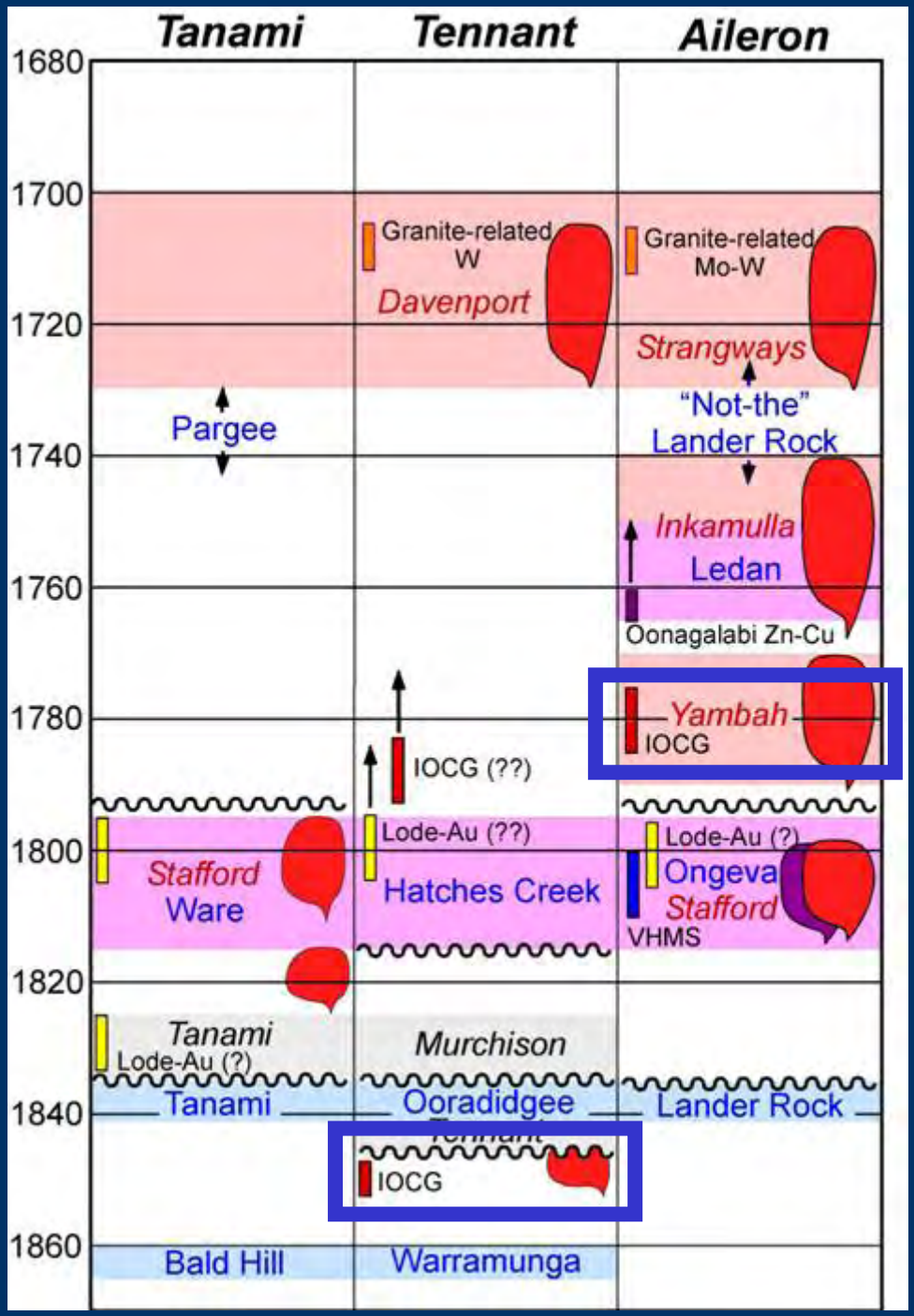
Shen-Su Sun

Ross Large

Roland Maas

Colleagues at GA and NTGS





Significant iron oxide-copper-gold mineralisation at:

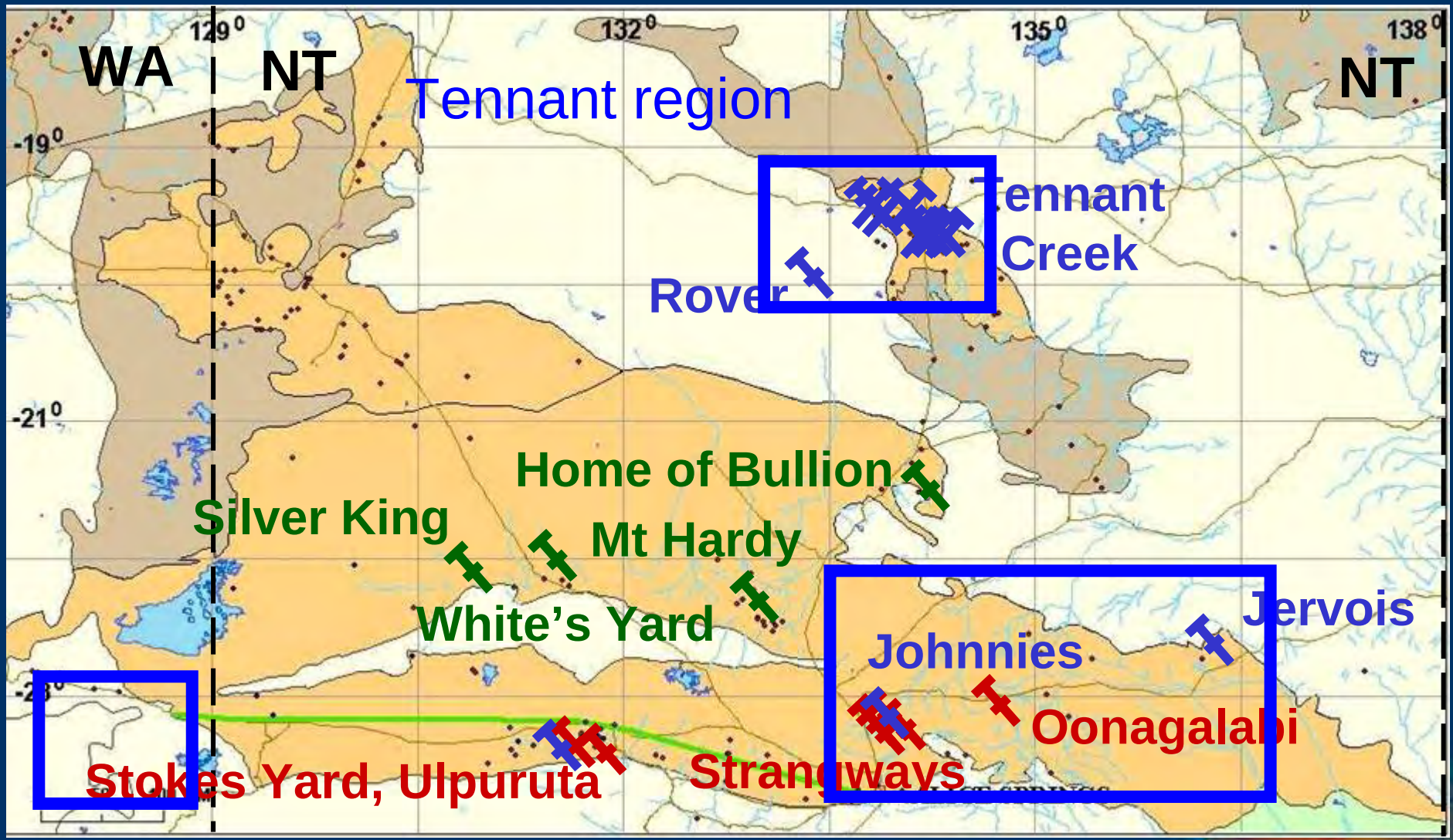
Tennant Creek
(>5 MOz Au + Cu-Bi-Se)

Potential for iron oxide-copper-gold mineralisation at:

SE Aileron Province

Western Warumpi Province (Mt Webb area)

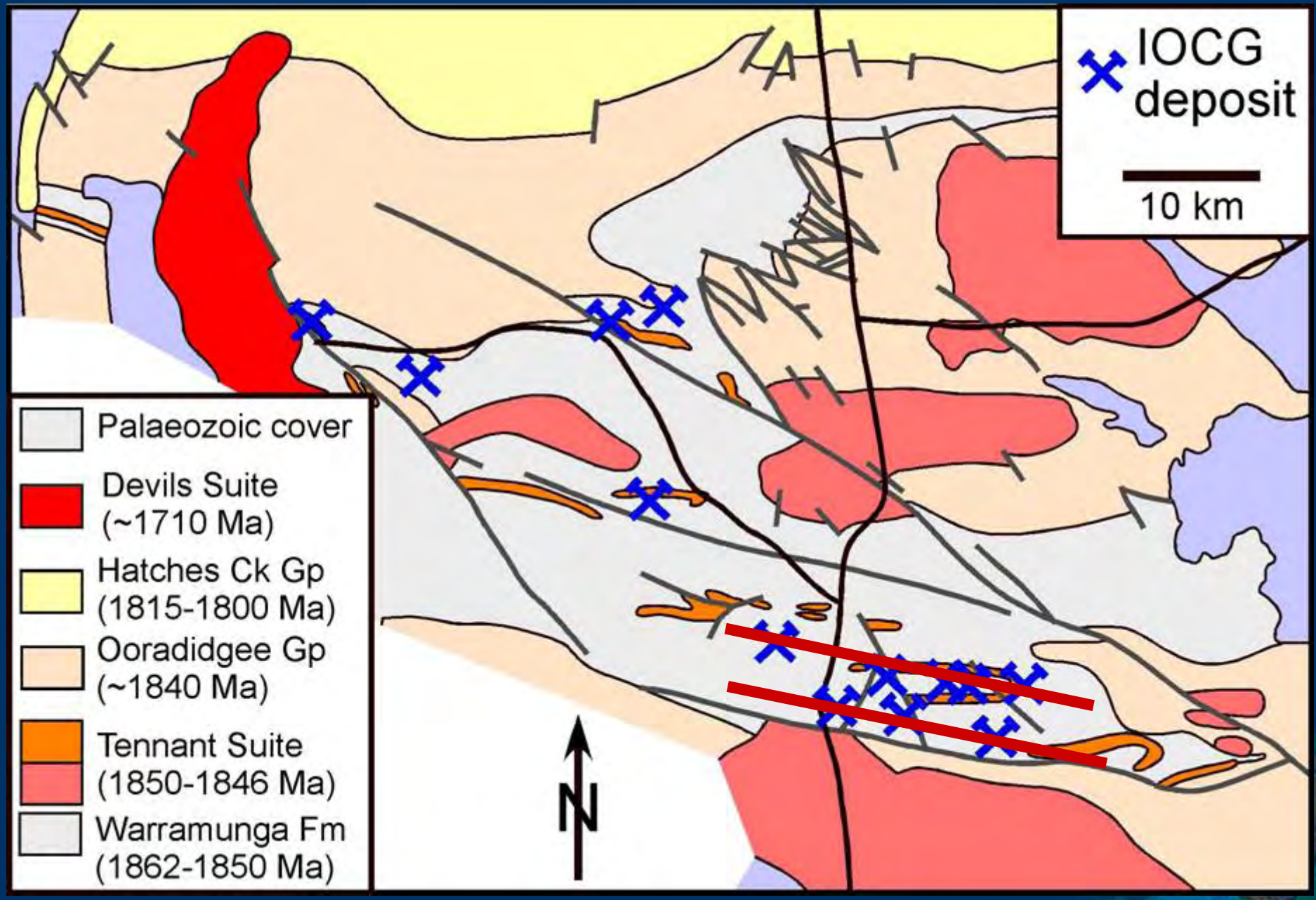
Zn-Cu & Cu-Au – Arunta-Tennant-Tanami



Mt Webb

Southeast Aileron

Iron oxide copper-gold deposits – Tennant region



Tennant Creek IOCG deposits – characteristics

Small high-grade deposits

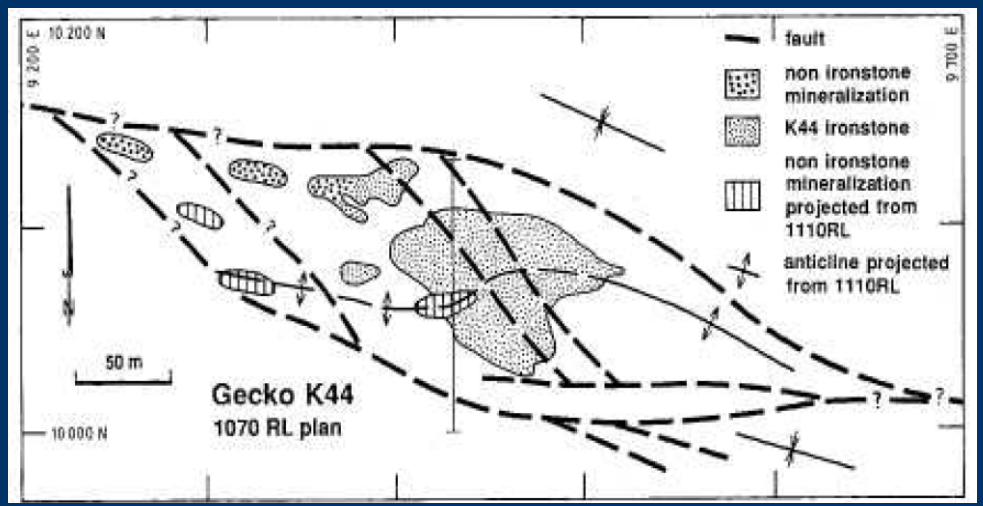
Juno: 0.45 Mt @ 56.1 g/t Au for 25.3 t Au (60 m x 30 m x 30 m)

Nobles Nob: 2 Mt @ 19.5 g/t Au for 39.0 t Au

Polymetallic: Au-Cu-Bi-Se + Pb-Zn-U-Mo-??; no As

Virtually all deposits closely associated with ironstones:

Magnetite-chlorite±hematite±talc rock

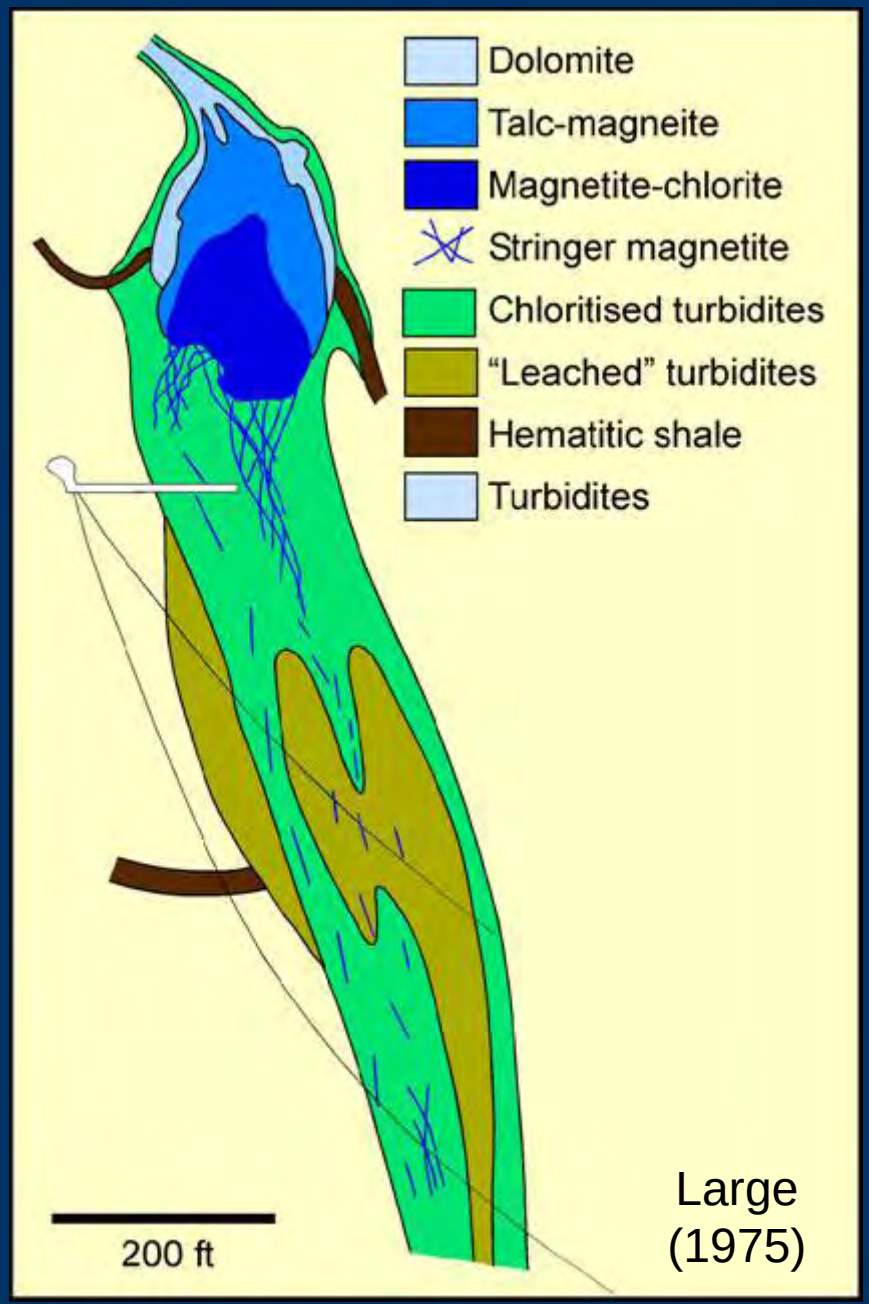


Structural controls: anticlinal hinges (over blind thrusts?), dilatant zones

Paragenesis: Ironstone → Au-Cu-Bi-Se

Three types of deposits: Juno-, Gecko- and Peko-types

Juno type deposits – geology



Ironstone localised along anticlinal hinge at "hematitic shale" contact

Ironstone: massive magnetite-chlorite and talc-magnetite

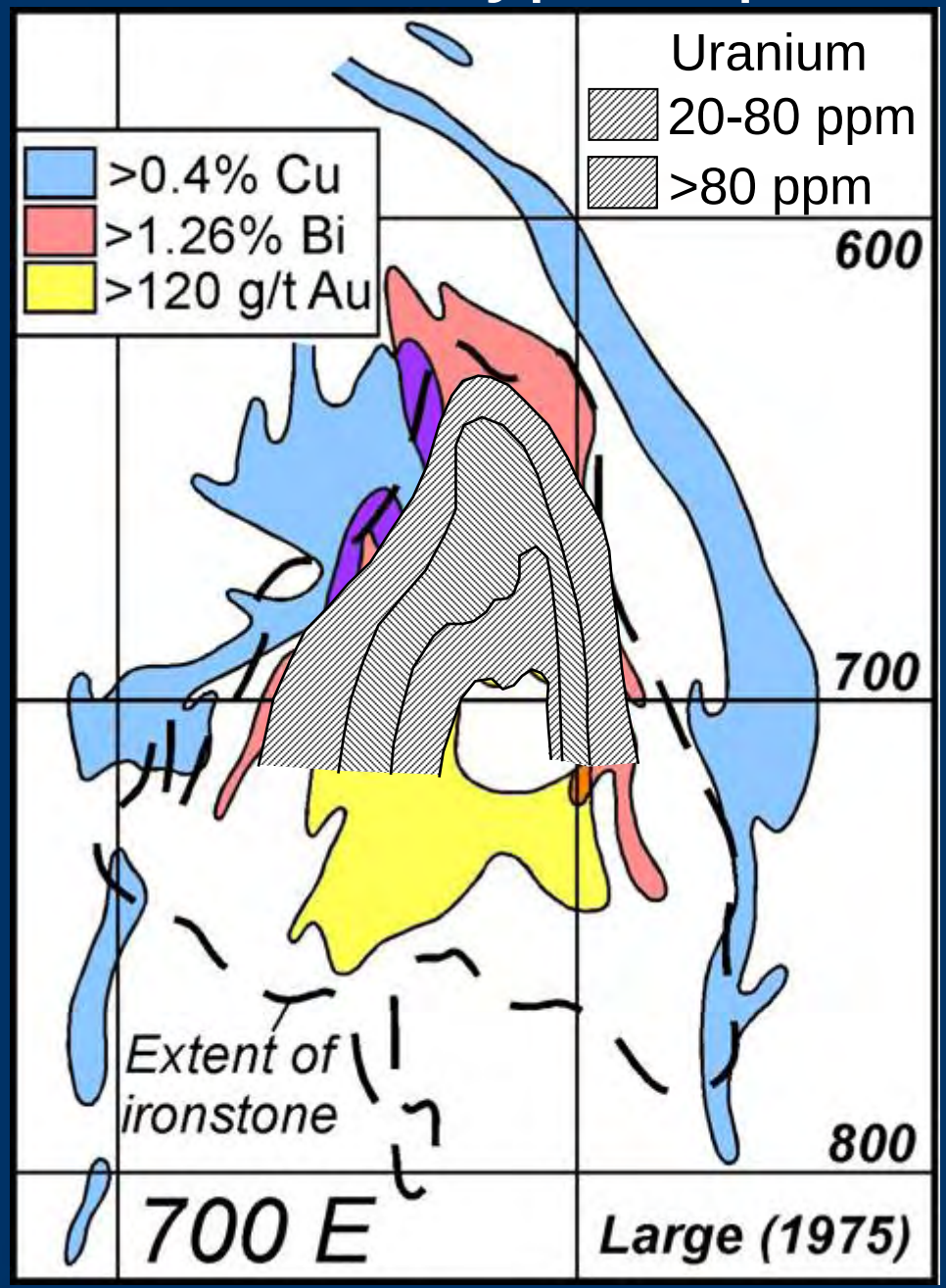
Ironstone localised above cross-cutting chloritic alteration zone with magnetite stringers

"Leached" turbidites at depth characterised by high Fe_2O_3/FeO

Small, but very high Au grades (< 1Mt; >15 g/t)

Other examples: Nobles Nob, White Devil, Chariot, Eldorado

Juno type deposits – metal zonation



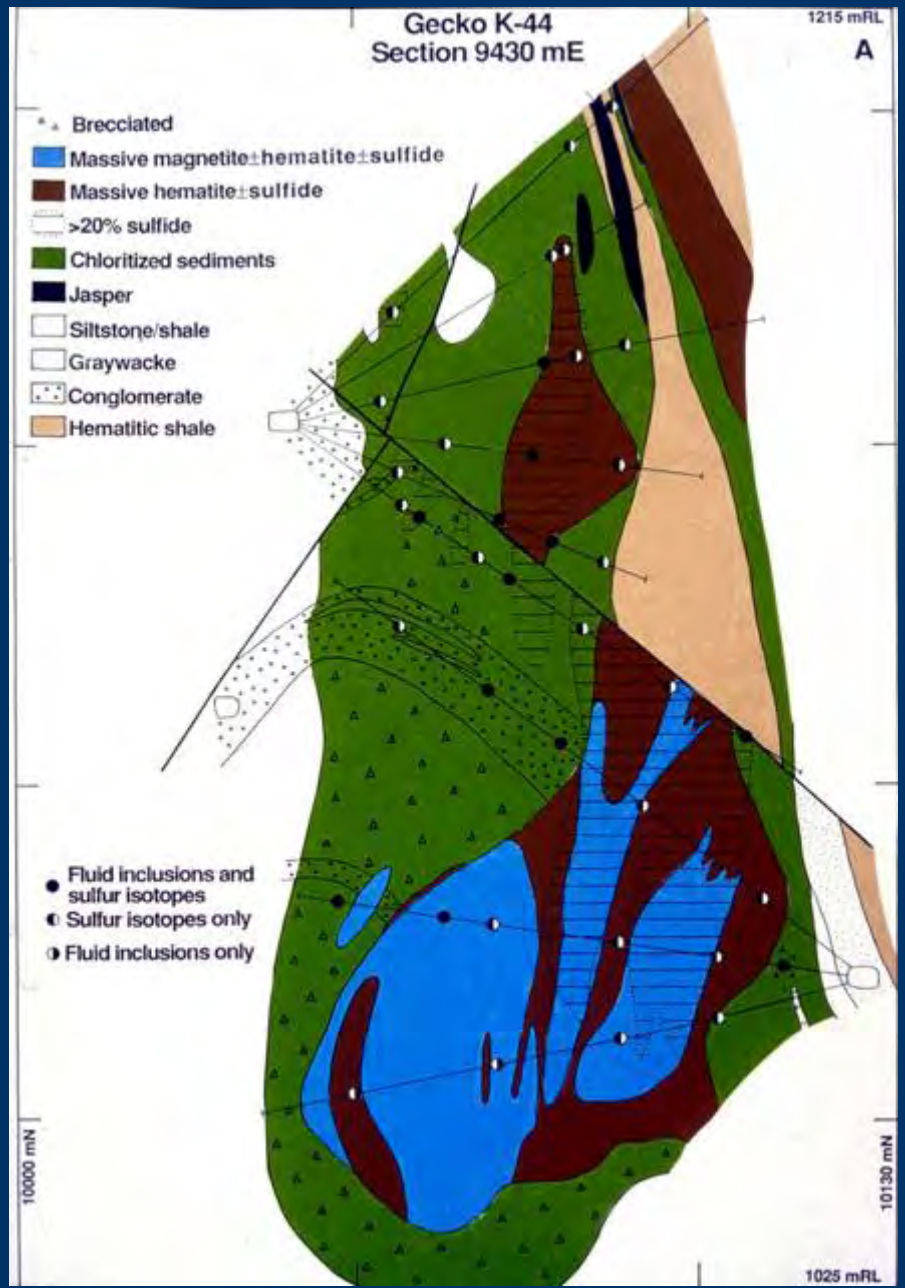
From bottom to top: Au → Bi-Pb-Se → Cu → pyrite

Gold commonly enriched at base of ironstone

Zonation present in many "Au-only" deposits (e.g. White Devil)

U enriched along contact between Au zone and Bi shell

Gecko type deposits – geology



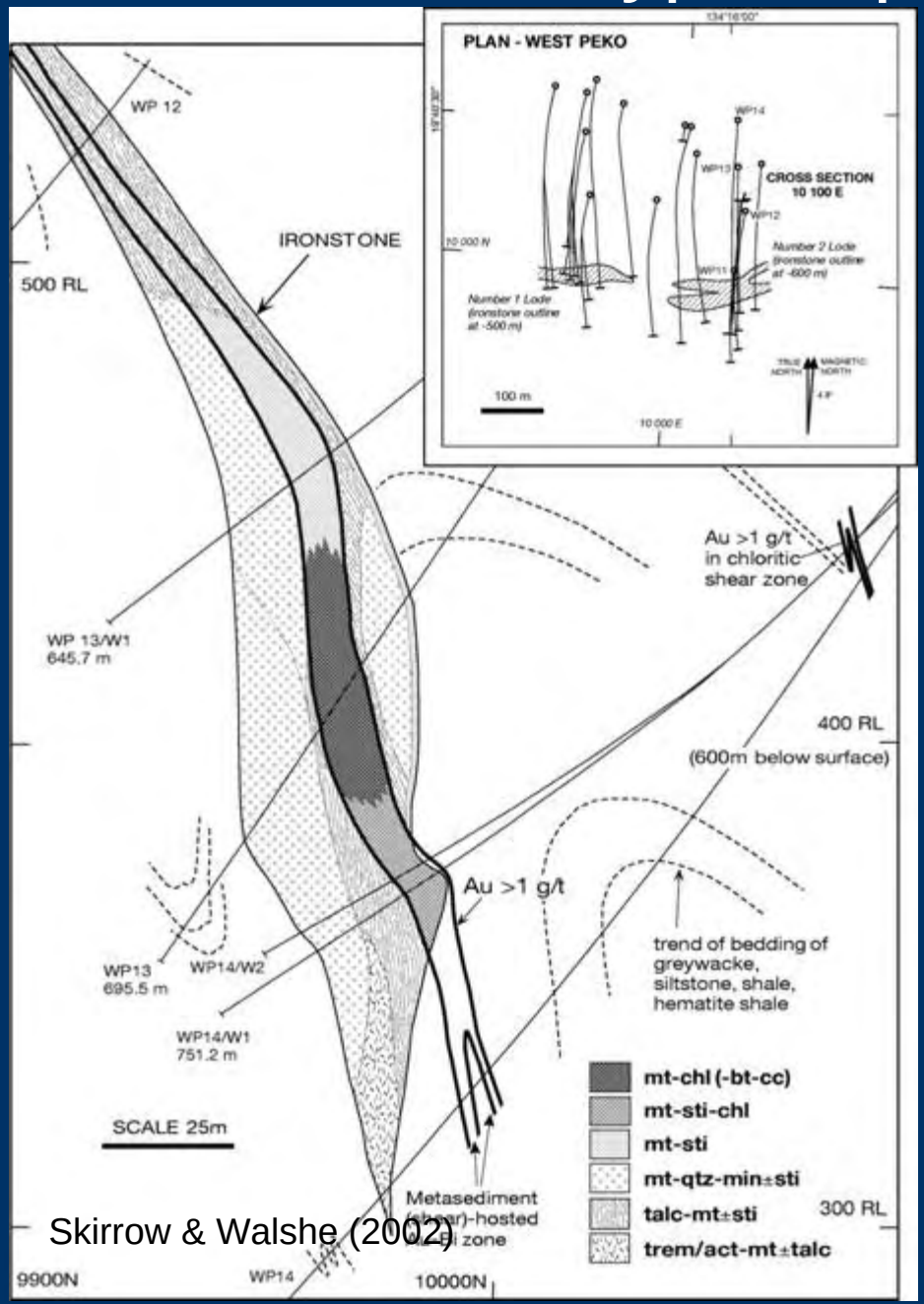
Hematite-rich ironstones near anticlinal closures

Unzoned (exception: K-44 sulphide tongue)

Larger size, high Cu, low Au: (Gecko: 4.9 Mt @ 3.8% Cu and 0.8 g/t Au)

Very abundant sulphide minerals: commonly >50% pyrite + chalcoprite

Peko type deposits – geology



Skirrow & Walshe (2002)

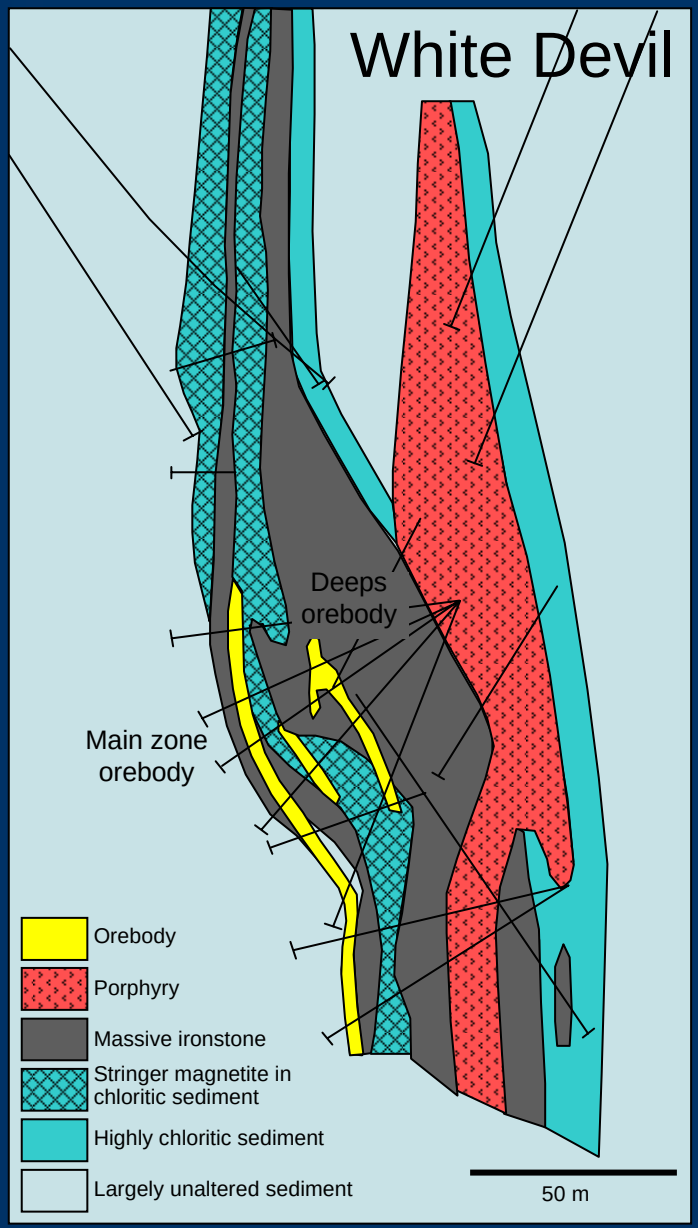
Hematite-poor ironstones; pyrrhotite common Fe-S mineral

Unzoned

Larger size, high Cu, moderate Au: Peko: 3.7 Mt @ 4.0% Cu, 3.5 g/t Au and 0.2% Bi

Abundant sulphide minerals: commonly >20% chalcopyrite + pyrrhotite

Tennant Creek IOCG deposits – a timing dilemma



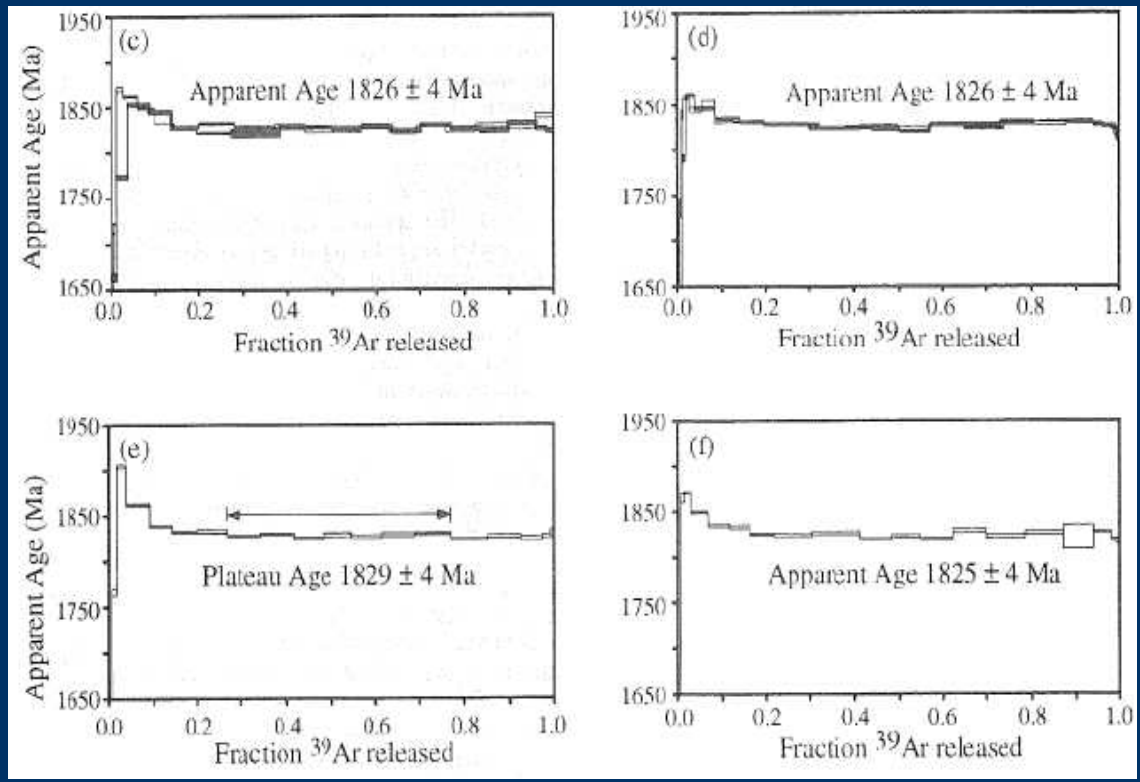
After Huston & Cozens (1994)

Porphyry dykes cut massive ironstone, but are themselves chlorite altered

Two types of chlorite (and muscovite): foliated, ironstone associated, and unfoliated Cu-Au-Bi associated

Maidment (2006) dated dyke at 1847 ± 3 Ma

Tennant Creek IOCG deposits – a timing dilemma



^{40}Ar-^{39}Ar dating of muscovite (Compston & McDougall, 1984)

Foliated *and* unfoliated muscovite yielded ages of 1825-1829 Ma

Dilemma: Age data in conflict with geology

Resolution (Fraser et al. 2006)

Recalculation of Compston & McDougall (1984) data using revised age for standard and decay constants gave age range of 1851-1847 Ma

Tennant Creek IOCG deposits – implications of new timing results

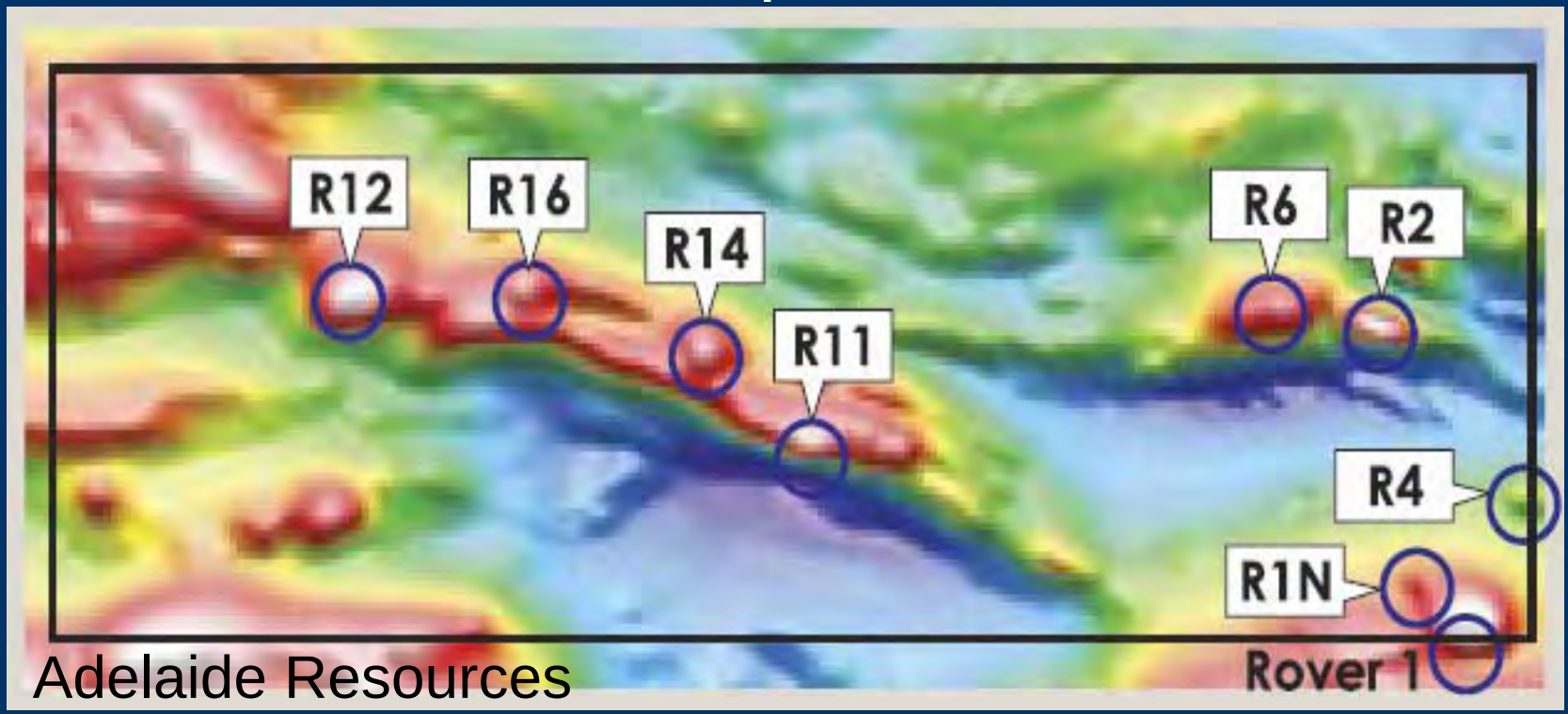
The Tennant Creek system evolved in a single event: no significant time gap between ironstone formation and Cu-Au-Bi mineralisation

Tennant Creek IOCG deposits temporally associated with 1850-1845 Ma Tennant Suite granites, not ~1820 Ma Treasure Suite granites

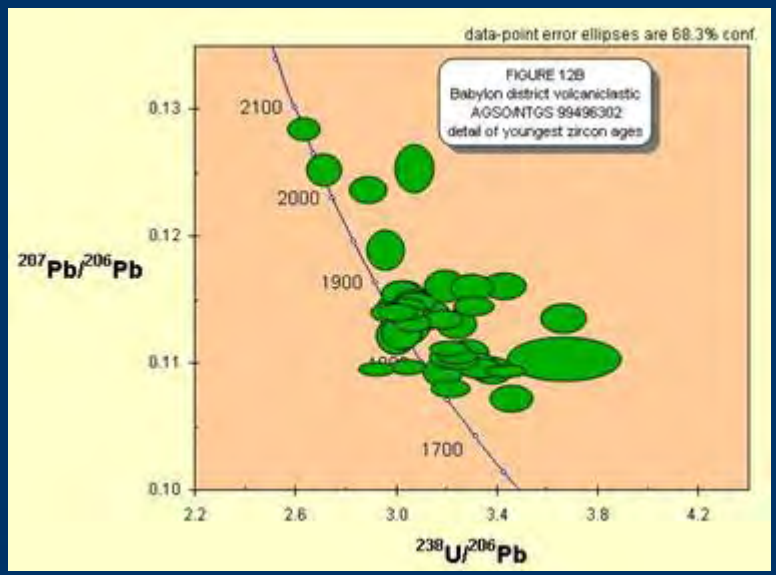
Transition from foliated (ironstone) to unfoliated (Cu-Au-Bi) phyllosilicates indicate mineralisation occurred syn- to post-Tennant Event

Tennant event constrained to 1850-1845 Ma

Tennant Ck IOCG deposits – the Rover field



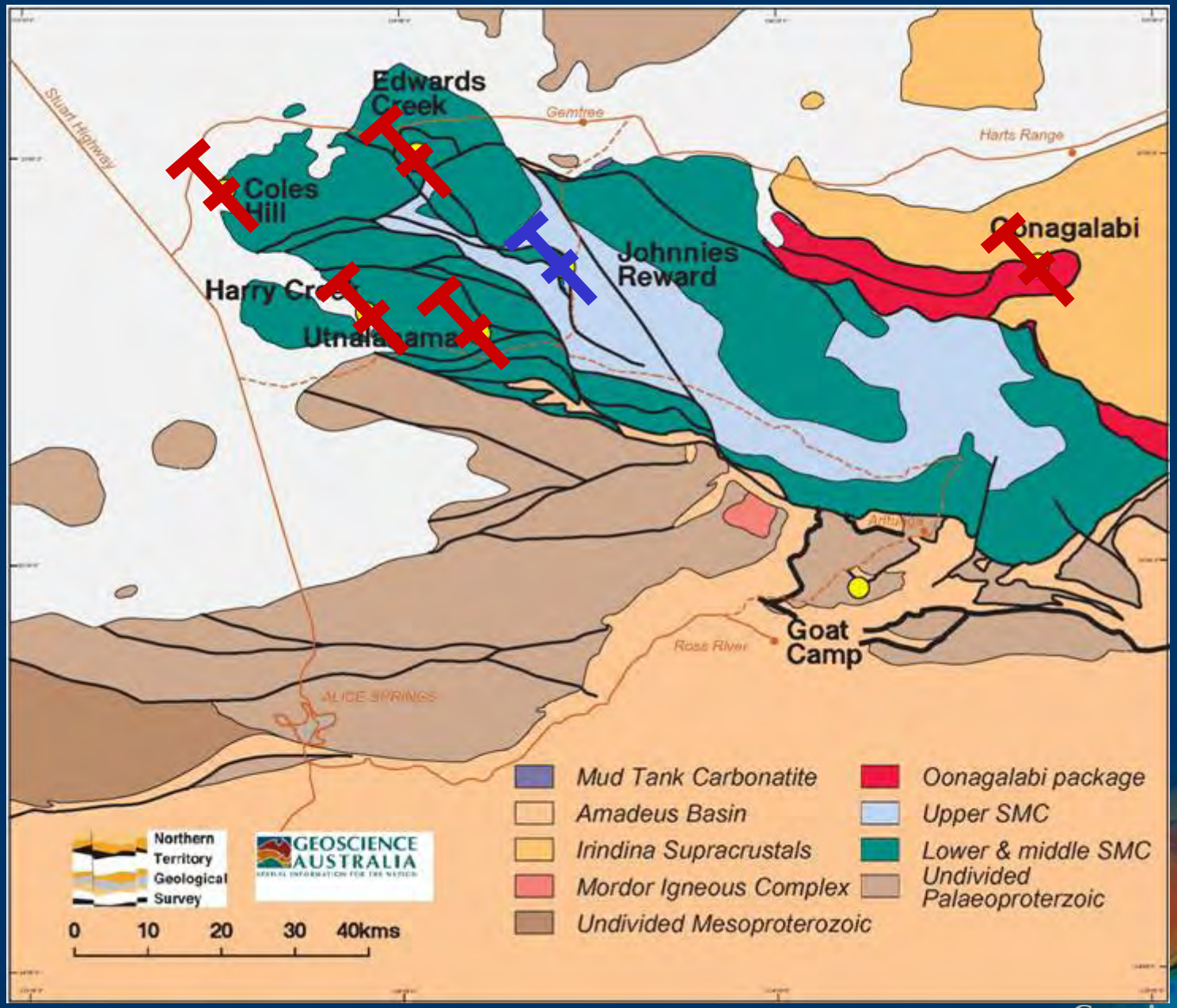
Adelaide Resources



Problem: Host rocks have maximum depositional age of 1796 5 Ma (younger than Tennant Creek mineralisation)

Resampled and re-analysed to test; results due in July-August

Zn-Cu & Cu-Au prospects – Strangways Range



Characteristics of Johnnies-type deposits

Mineralisation hosted by magnetite-rich rocks within the Ongeva package

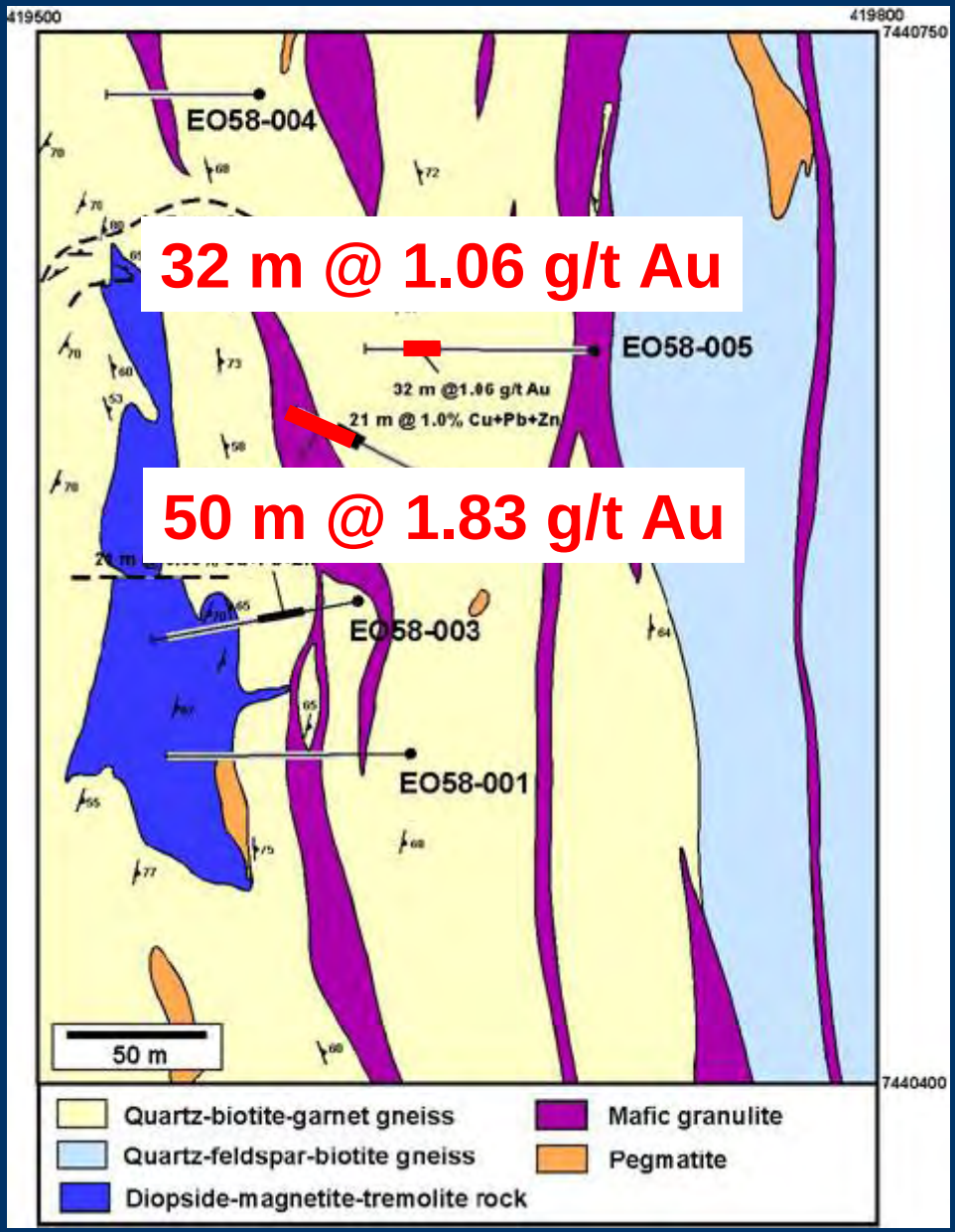
Age of host: 1810-1800 Ma (?)

Psammo-pelitic sequence

Size and grade of known deposits: not established

Dominant alteration assemblage: magnetite-tremolite-diopside rock after marble; garnetiferous quartzofeldspathic gneiss

Johnnie's-type (Johnnie's Reward) geology



After Chuck (1984)

Mineralisation associated with diopside-magnetite-tremolite rock that replaced carbonate lens

Proximal alteration not well developed

Increase in gt toward dp-mt-tr rock

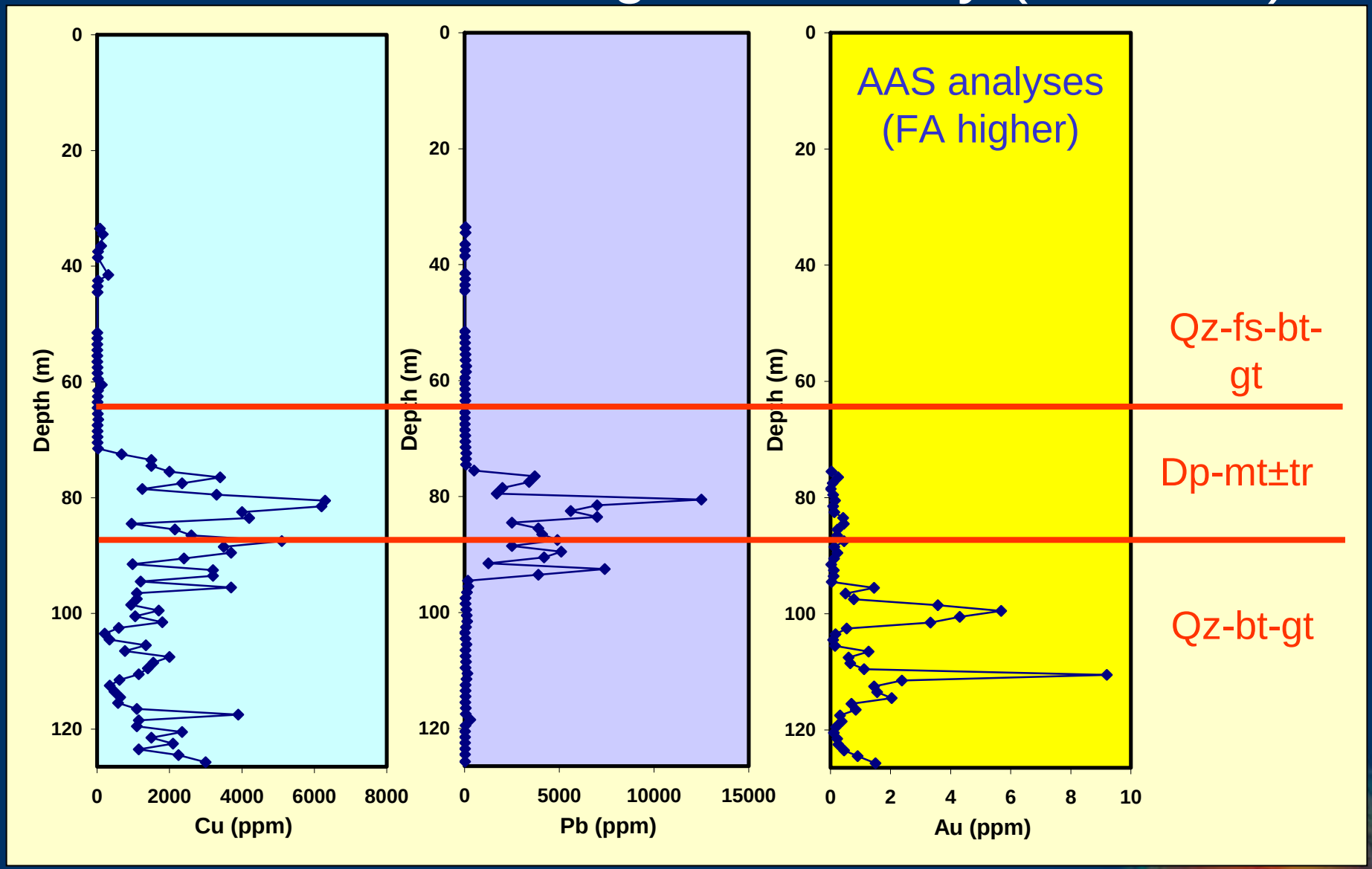
Feldspar destructive in structural footwall

Metal assemblages: Au(Cu-Mo-Bi) and Pb-Cu(Zn-Ag-Au)

Ore mineralogy: Mt > py ~ cp ~ gn~ sl > po ~ moly ~ scheel

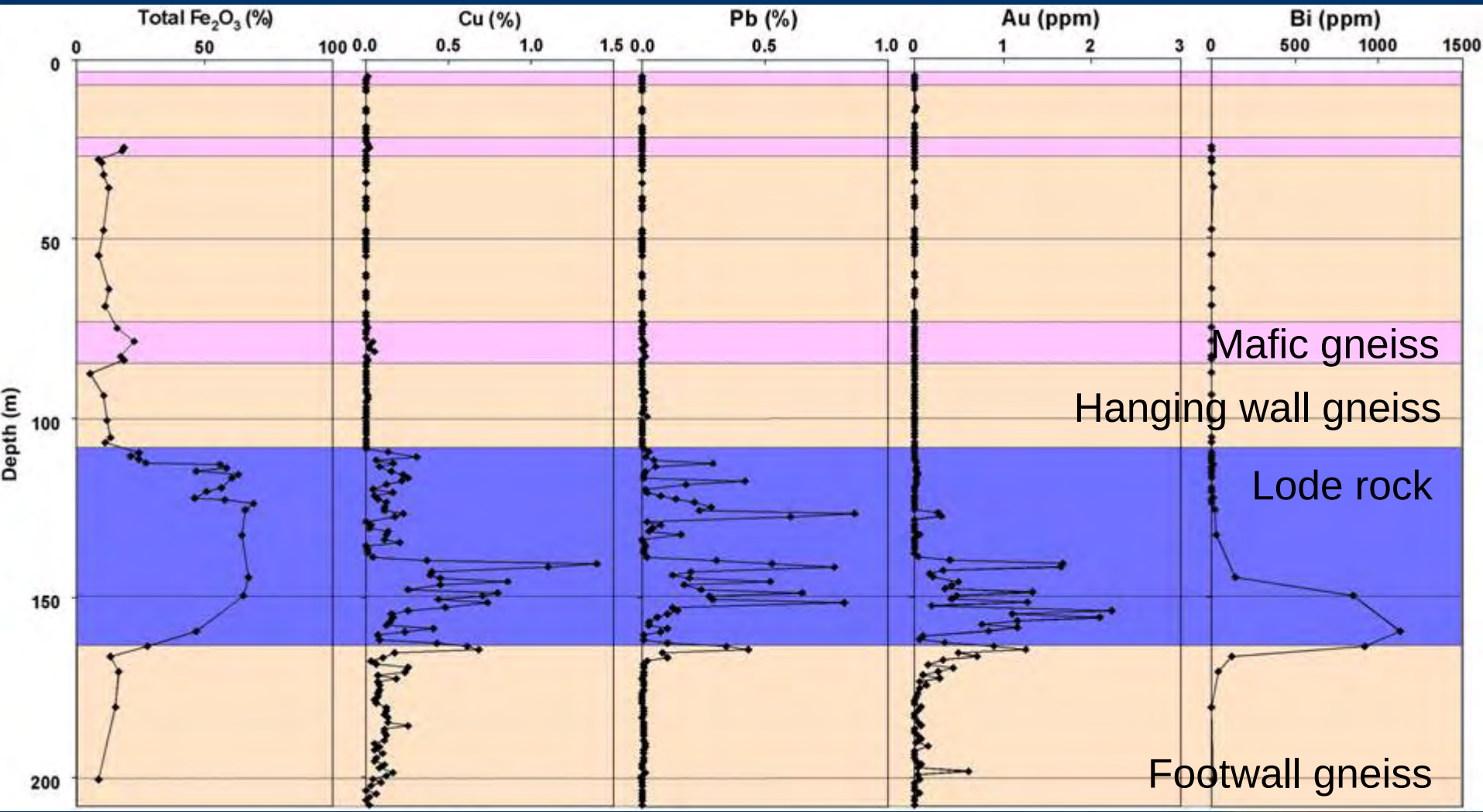
Late(?) hm-bn

Johnnie's Reward geochemistry (E58-002)



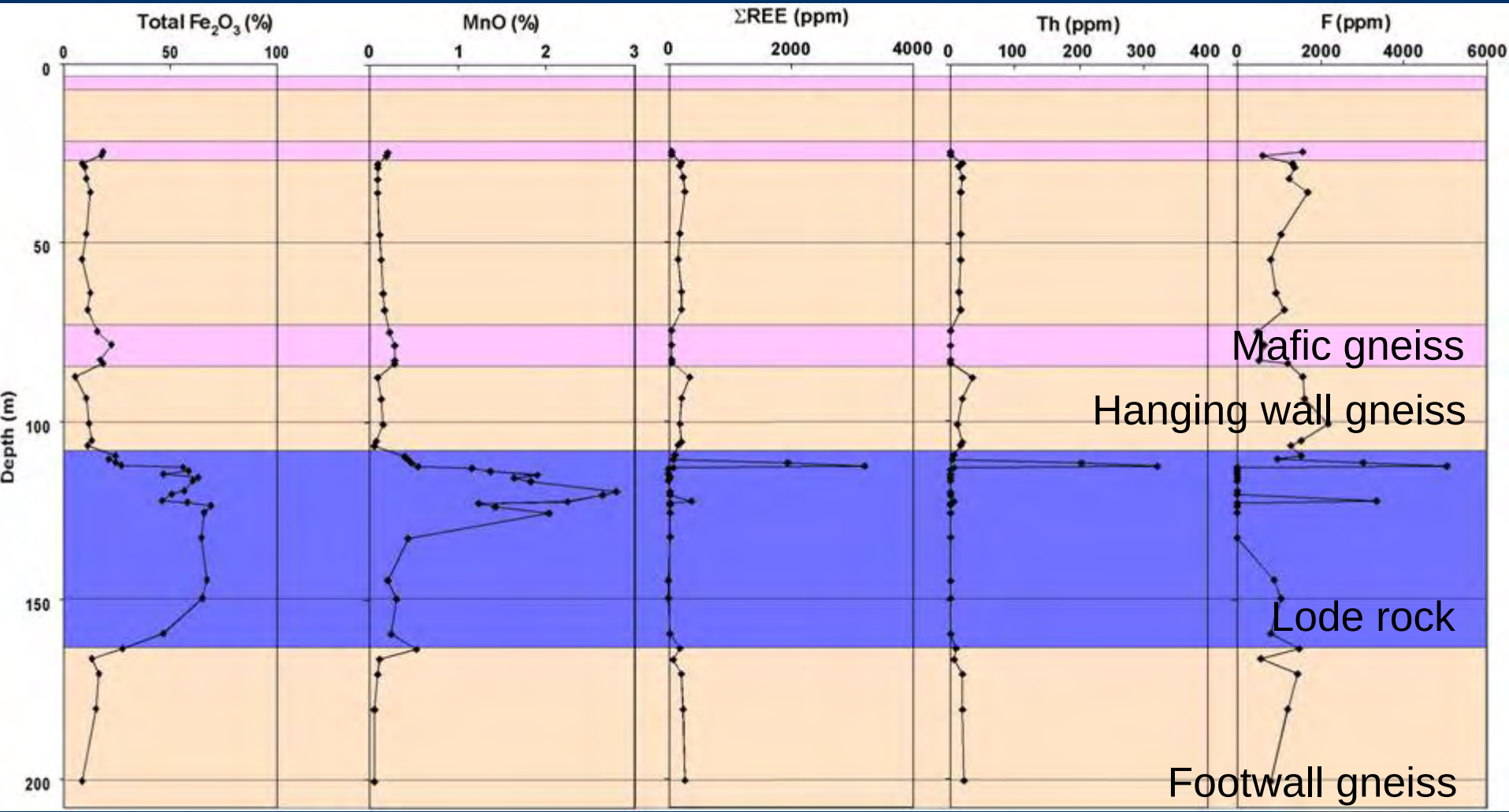
Gold in footwall quartz-biotite-garnet gneiss; separate from Cu-Pb-Zn and diopside-magnetite-tremolite rock

Johnnie's Reward geochemistry (E058-005)



Zonation: Au-Cu-Bi-Mo → Cu-Pb-Zn-Ag → Pb-Zn

Johnnie's Reward geochemistry (E058-005)



Zonation: Au-Cu-Bi-Mo → Cu-Pb-Zn-Ag → Pb-Zn → Mn

Local enrichment in REE, HFSE and F

Evidence for origin of Johnnies-type deposits

Association with magnetite-rich rocks

Metal association and ratios

Au-Cu-Zn-Pb-Bi-Mo-Mn-HFSE-REE

Pb/Zn > 1 (typically 2-3)

Metal zonation

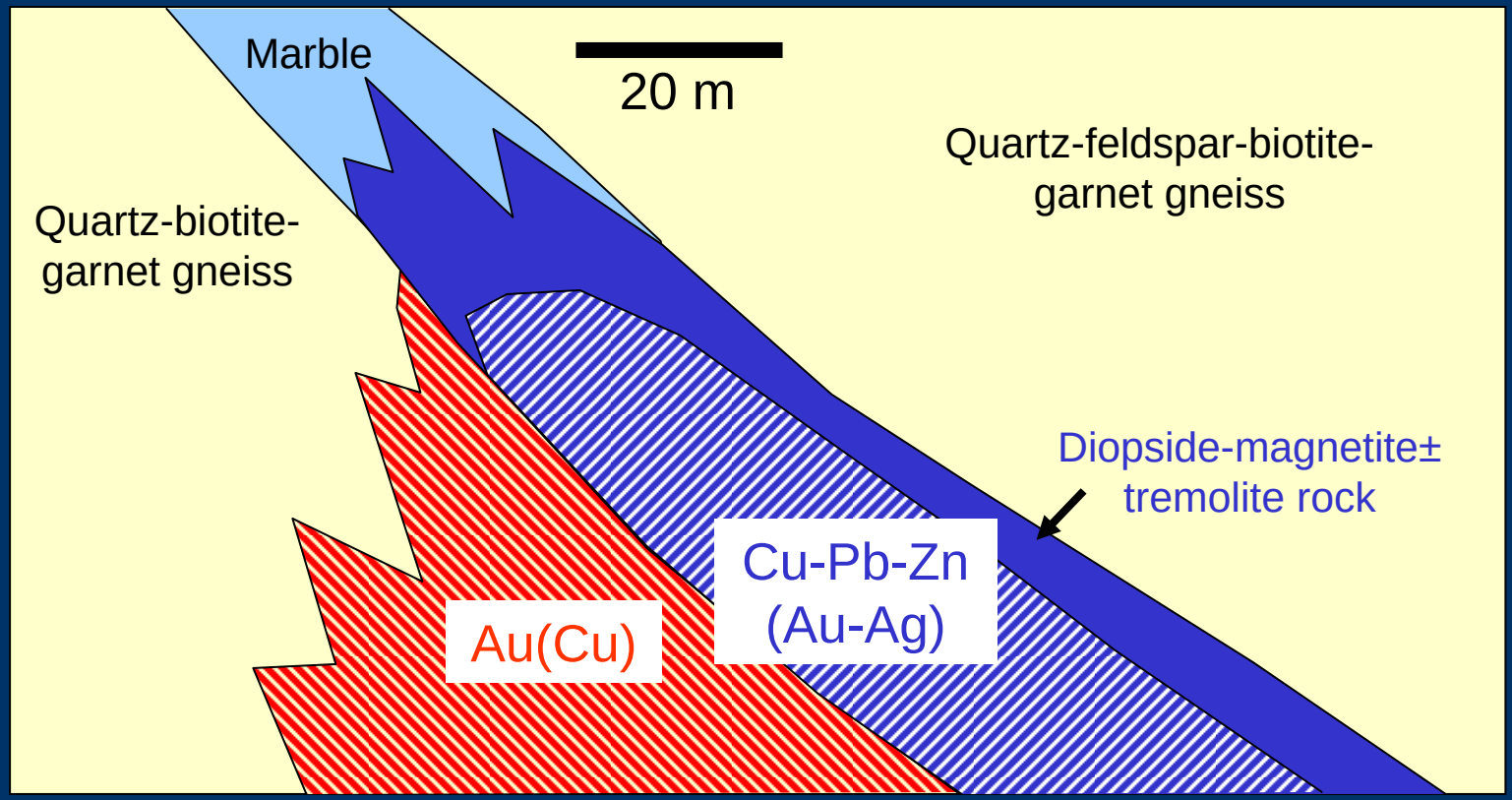
Au-Cu-Bi-S±Mo $\rightarrow$ Cu-Pb-S(Zn-Ag-Au) $\rightarrow$ Pb-Mn(Cu-S±Ca) $\rightarrow$ HFSE-REE (?) $\rightarrow$ Ca

Local bornite-hematite assemblages

Radiogenic (young) lead isotopes

Model ages: 1795-1770 Ma $\Rightarrow$ association with Yambah granites

Johnnies-type deposits – generalised model



Potential stratigraphy: Strangways and equivalents

Size: Unknown; potential for Au(Cu) and Cu-Pb-Zn(Au-Ag)

Host unit: Pelites & ironstones (replaced carbonate or BIF)

Alteration: Quartz-biotite-garnet

Associated with (margins of) magnetic anomalies

Mt Webb area, Warumpi Province
(Wyborne et al. 1998)

~1640 Ma granites and associated volcanic rocks

Granites strongly oxidised and fractionated

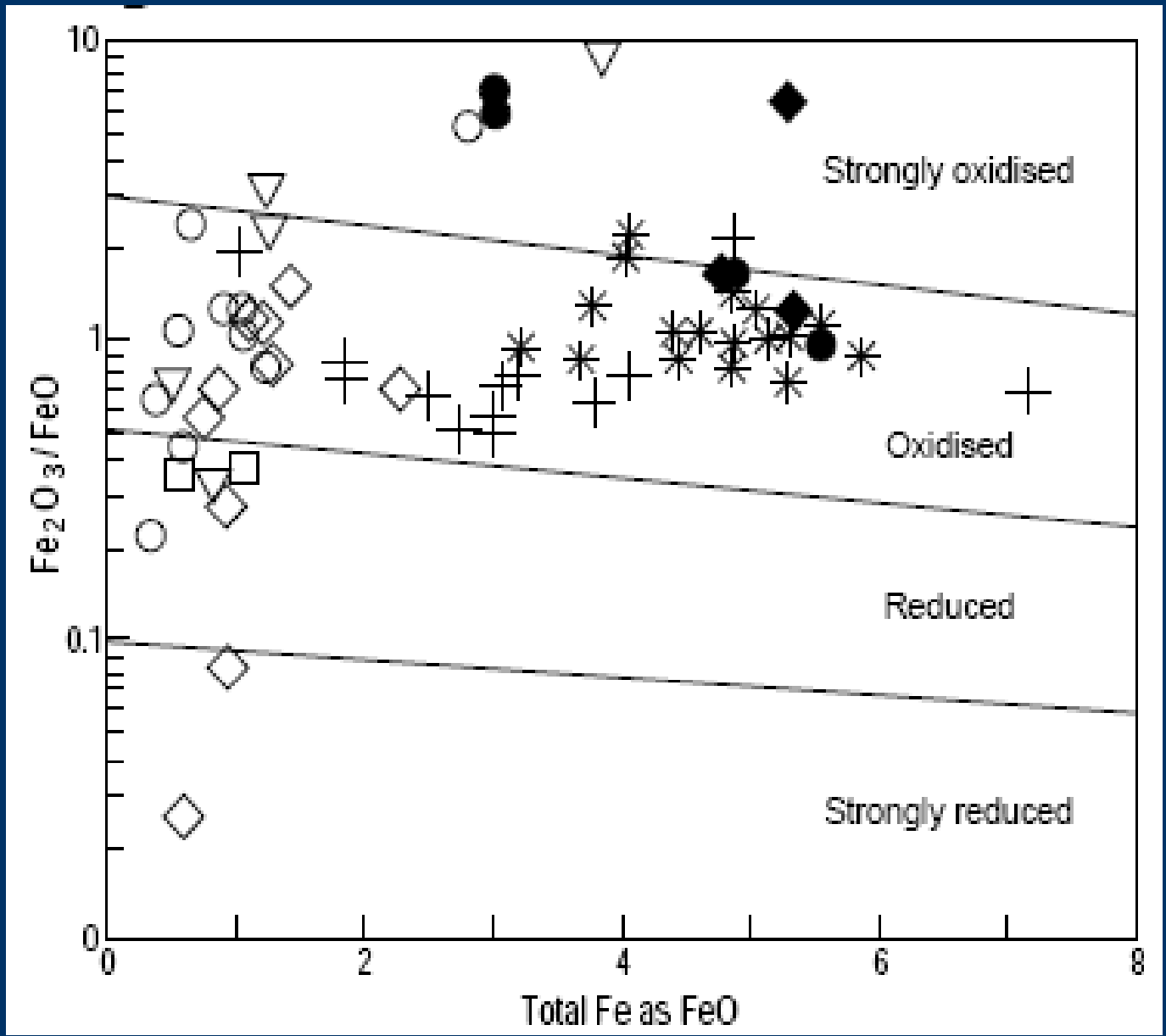
Sodic-calcic alteration assemblages in granite and volcanics

Hematitic assemblage in volcanics

Sericitic assemblage in granite

Sericitic granites have anomalous F, Cu, S, Pb and Mo

Mt Webb fractionation trends



- Granite - 'fresh'
- Granite - sericite
- Granite - sodic-calcic
- Aplite
- Volcanics - 'fresh'
- Volcanics - epidote
- Volcanics - hematite
- Veins

Wyborne et al. (1998)

Conclusions

Three styles and ages of (potential) IOCG in Arunta and Tennant regions

Tennant Creek: ~1850 Ma Au-Cu-Bi-Se associated with ironstone; contemporaneous with Tennant Event magmatism & deformation

Johnnies-type: ~1780 Ma Cu-Au(Pb-Zn-Bi-Mo) associated with magnetite-rich rock; possibly associated with Yambah magmatism

Mt Webb area: ~1640 Ma (?) sodic-calcic, sericitic & hematitic assemblages overprint Webb Suite granites; local Cu anomalism

Tennant Creek Event (deformation, magmatism and mineralisation) constrained to 1850-1845 Ma

Tennant Creek mineralisation: Multi-stage, single event