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Summary:

Exploration characteristics of IOCG systems in the Gawler Craton

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IOCG Workshop

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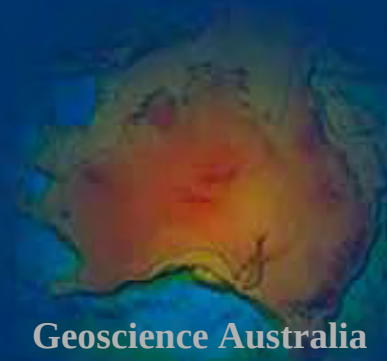

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Outline

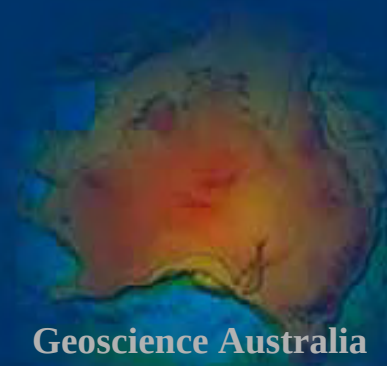
Part 1

- 'Essential ingredients' as they relate to exploration for mineralised IOCG systems
- A model for the Olympic Dam region

Part 2

- Map of IOCG Potential

Questions

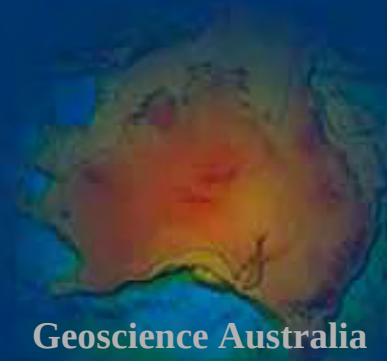


Part 1

‘Essential ingredients’

(i.e., key geological characteristics and processes required to form major IOCG systems, focussing on mappable features)

and IOCG model

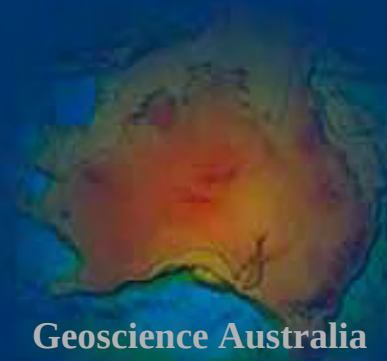


Tectonic / thermal ingredients

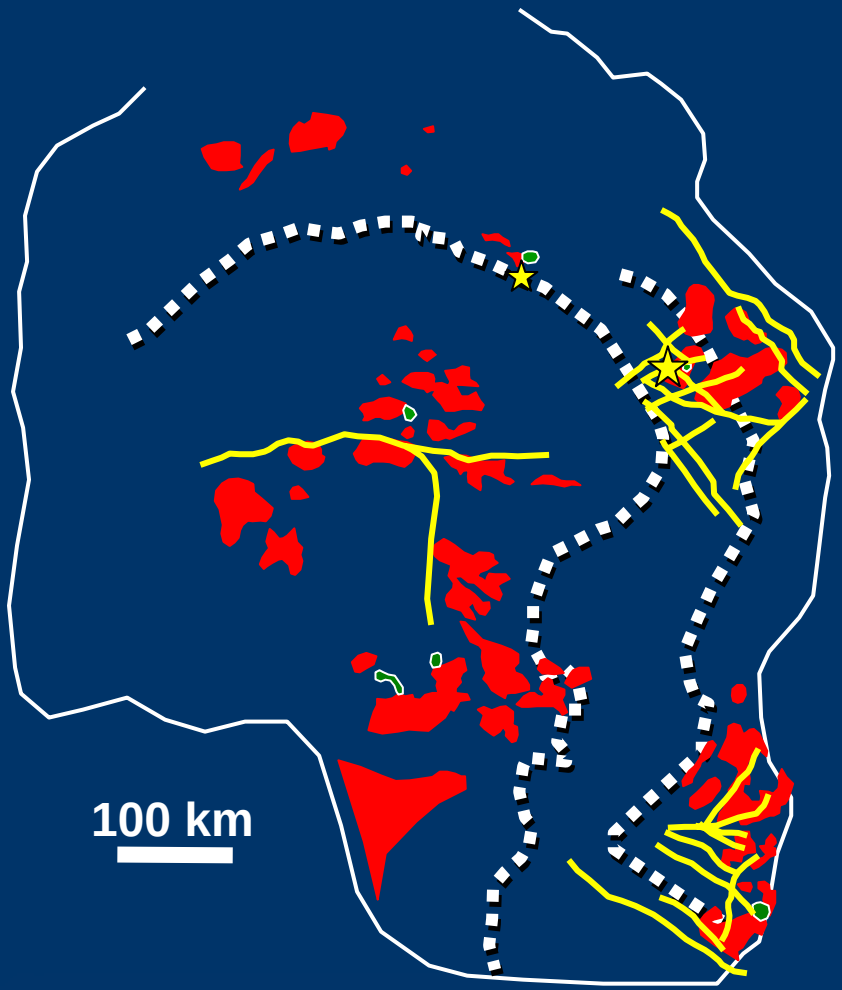
1. ‘Plumbing’ - major Mesoprot IOCG systems in re-activated Palaeoprot orogenic belts at margins of Archaean ‘core’; not anorogenic, but geodynamic settings still unclear.

2. Timing - Iron oxide Cu-Au (±U) in eastern Gawler, and Au in central Gawler, all at ~1575-1595 Ma:– broadly coeval and spatially associated with *some* Hiltaba-GRV magmatism.

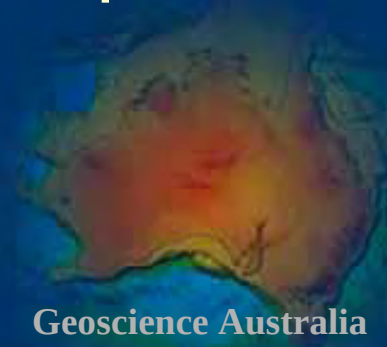
3. Heat - IOCG districts developed where very high heat flow at 1575-1595 Ma (represented by A-type high-T magmas, mafics, and Fe-oxide alteration).



Tectonic / thermal ingredients



- *1. PLUMBING+SOURCE* - Palaeoprot orogenic belt(s) at margin of Archaean, + metased basins, + NW/NE faults
- 2. *TIMING* – broadly coeval with Hiltaba-GRV
- *3. HEAT* – manifest in 1575-1595 Ma mafic & high-temp granitoid complexes & volcs
- Major IOCGs in overlaps

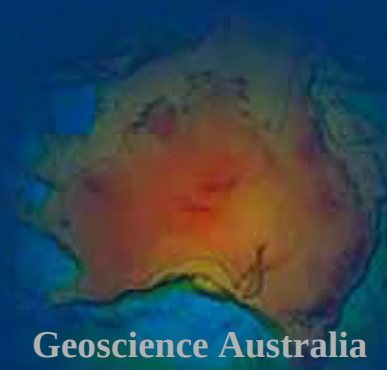


Lithological / stratigraphic ingredients

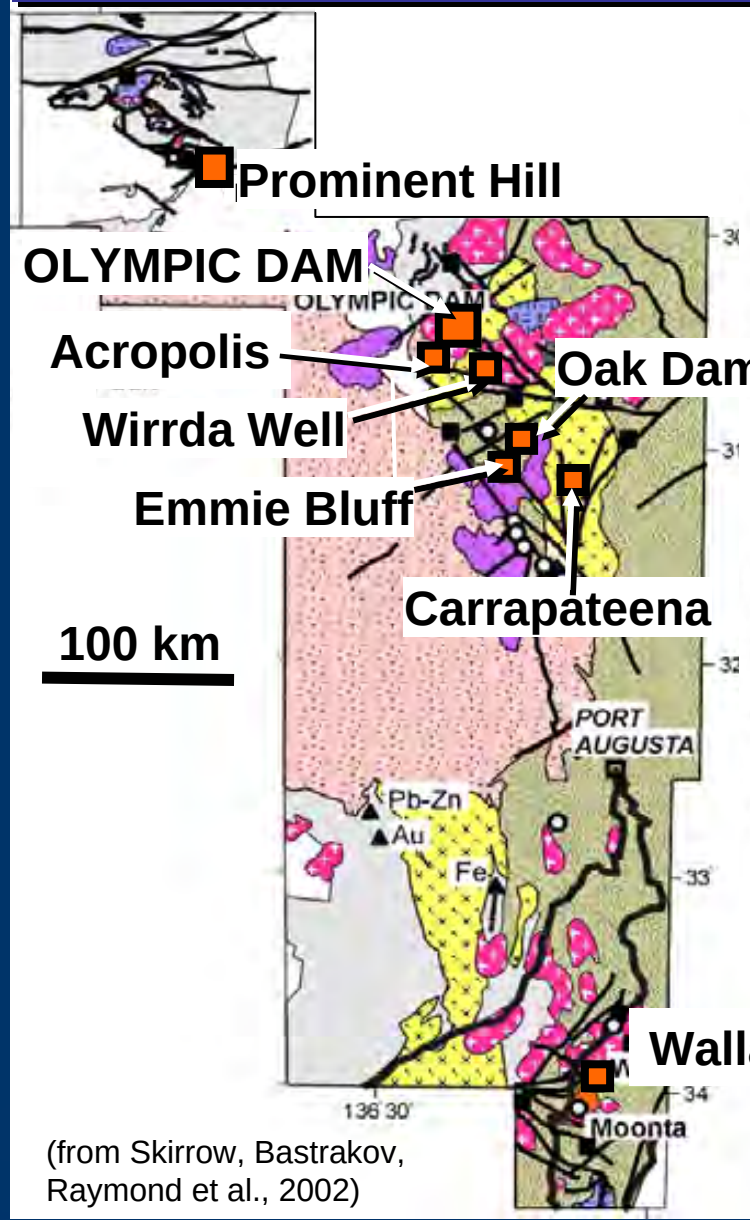
4. Fluid / metal / sulfur 'sources' – Palaeoprot meta-sedimentary basins (with ex-evaporites?), Fe-rich but not too reduced (e.g., Wallaroo Gp; Willyama SG equivalents?)

5. Metal / sulfur 'sources' – IOCG districts have 1575-1595 Ma mafic intrusions, ± felsic / mafic volcanic centres

6. Favourable 'trap' rocks – not critical except for U-rich IOCGs (A-type granitic host may be essential)



Lithological / stratigraphic ingredients



(from Skirrow, Bastrakov, Raymond et al., 2002)

Structural ingredients

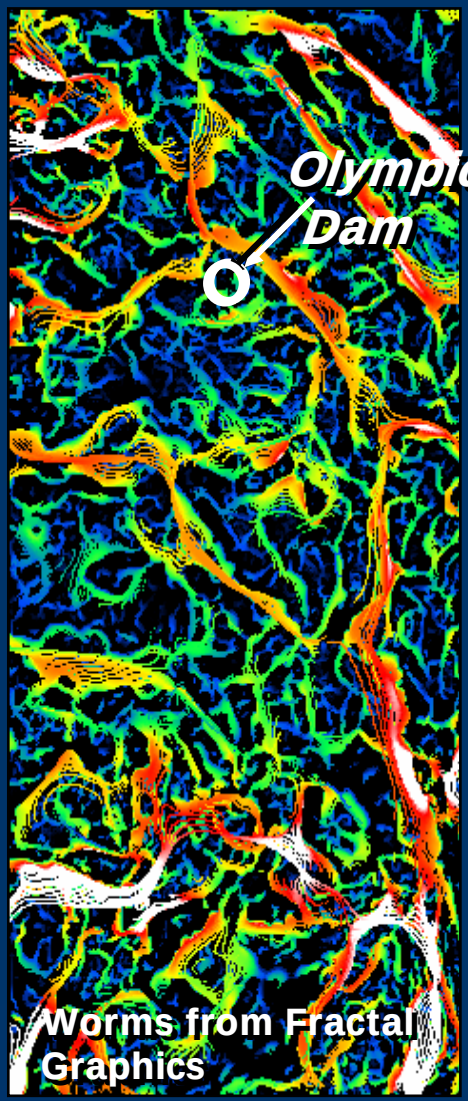
7. Crust-scale fluid pathways – e.g. terrane boundaries, + upper-crustal major fault complexes active at 1575-1595 Ma (extension and/or compression?)

8. District-scale fluid pathways – NW-trending regional and district transpressive(?) fault/shear zones, AND district- to deposit-scale NE-trending ?conjugate faults/shears (OD region at least)

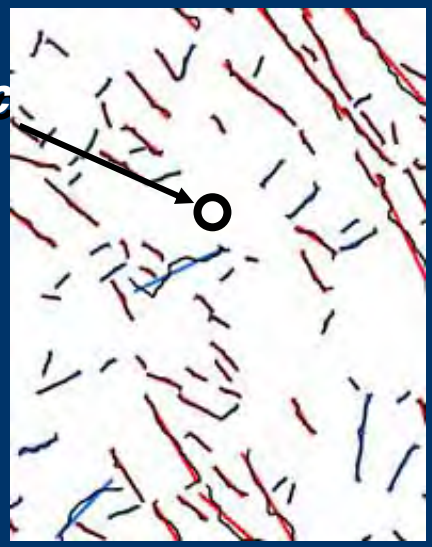
9. Local fluid pathways – localised extension(?) (e.g. dilatent jogs) during IOCG mineralisation; *breccias* are a product of the structural-magmatic-hydrothermal settings

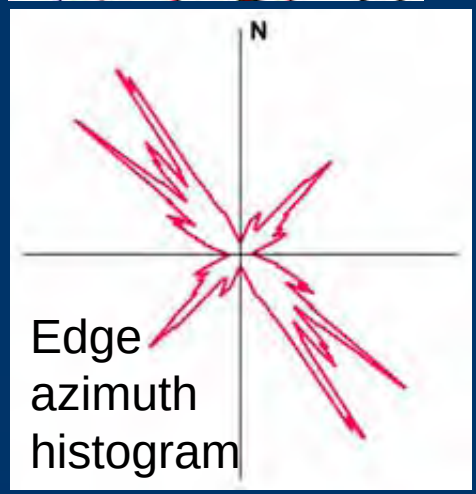
Crust- to deposit-scale fault/shear zones

Edges or 'worms'

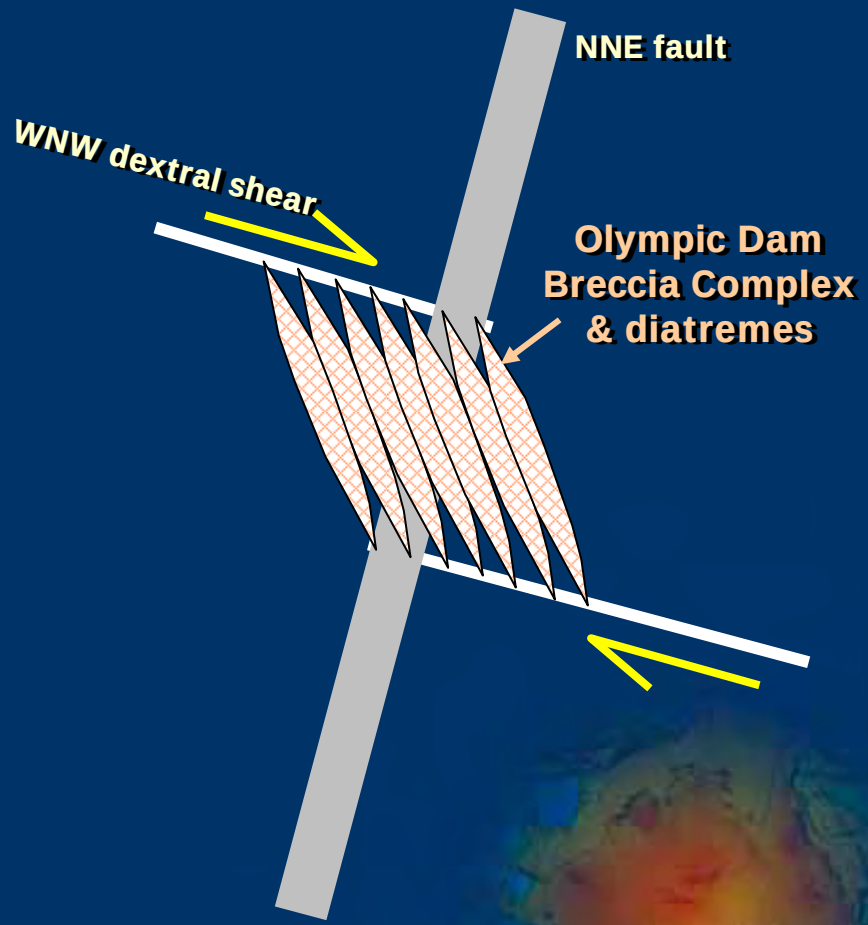


Conjugate NW & NE worm=fault? network





Regional- to deposit-scale structure



Mineralogical / geochemical ingredients

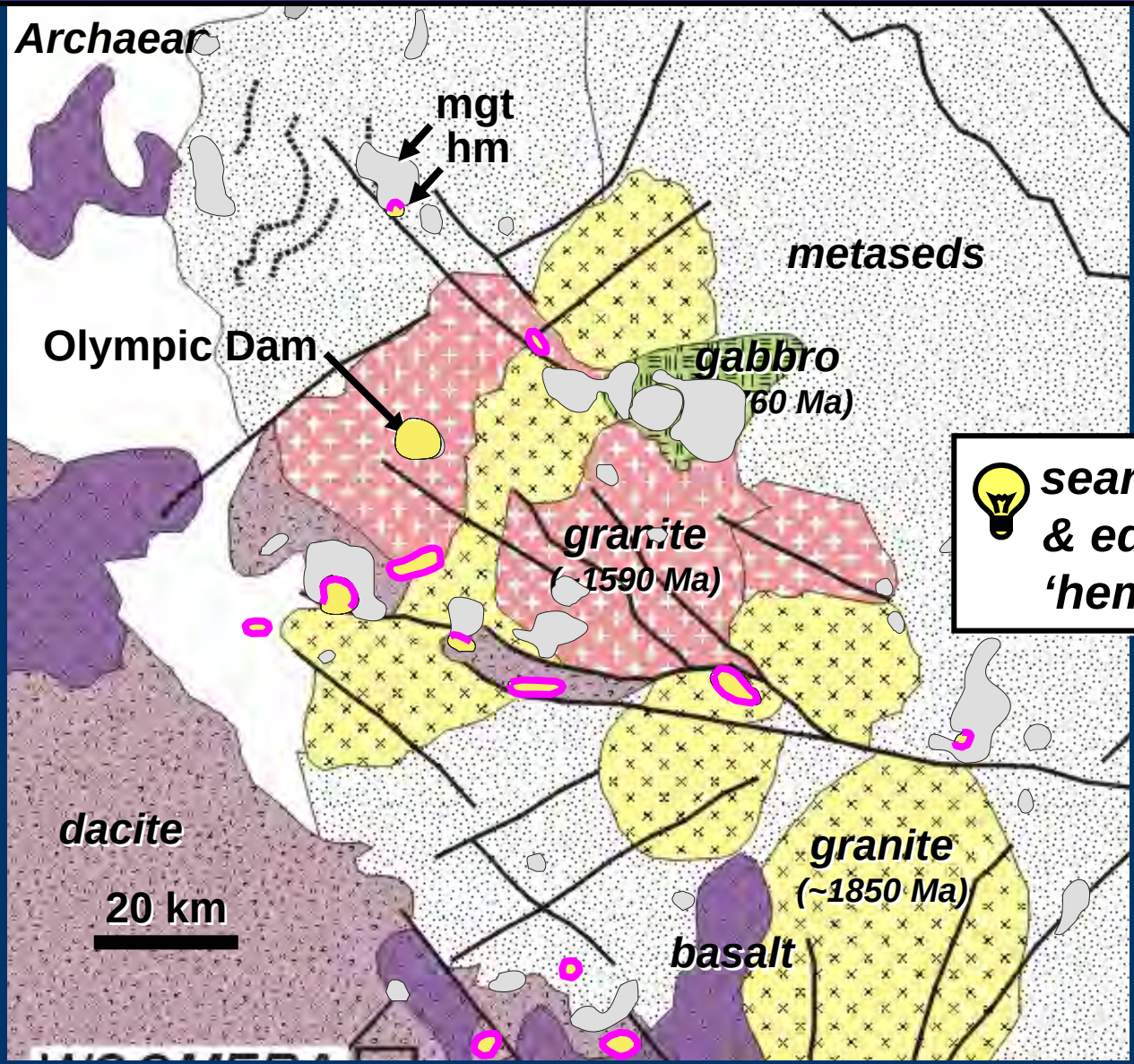
10. Regional alteration – magnetite – calsilicate (amphibole, cpx) – Kfeldspar / albite and / or magnetite – biotite alteration ± minor Cu-Au-LREE (high-T hypersaline fluids did this!)

11. District to local alteration – high-level Cu-Au (-U) has hematite-sericite-chlorite-carbonate; deeper Cloncurry style IOCGs may resemble regional alt'n

12. Geochemistry – Cu, Au, Ag, U, LREE, Ba, F, P, Co; high epsilon-Nd and low delta-34-S values are good

13. Zoning – laterally or vertically from LREE to Au to Cu-Au within hematitic breccias; if magnetite present, tends to be deeper and with chalcopyrite-pyrite; phengite a vector(?)

Regional-, district- and deposit-scale alteration mapped undercover using inversion of potential field data



Basement geology

Anomalous magnetite (> ~2% vol.)

Anomalous hematite (> ~2%)

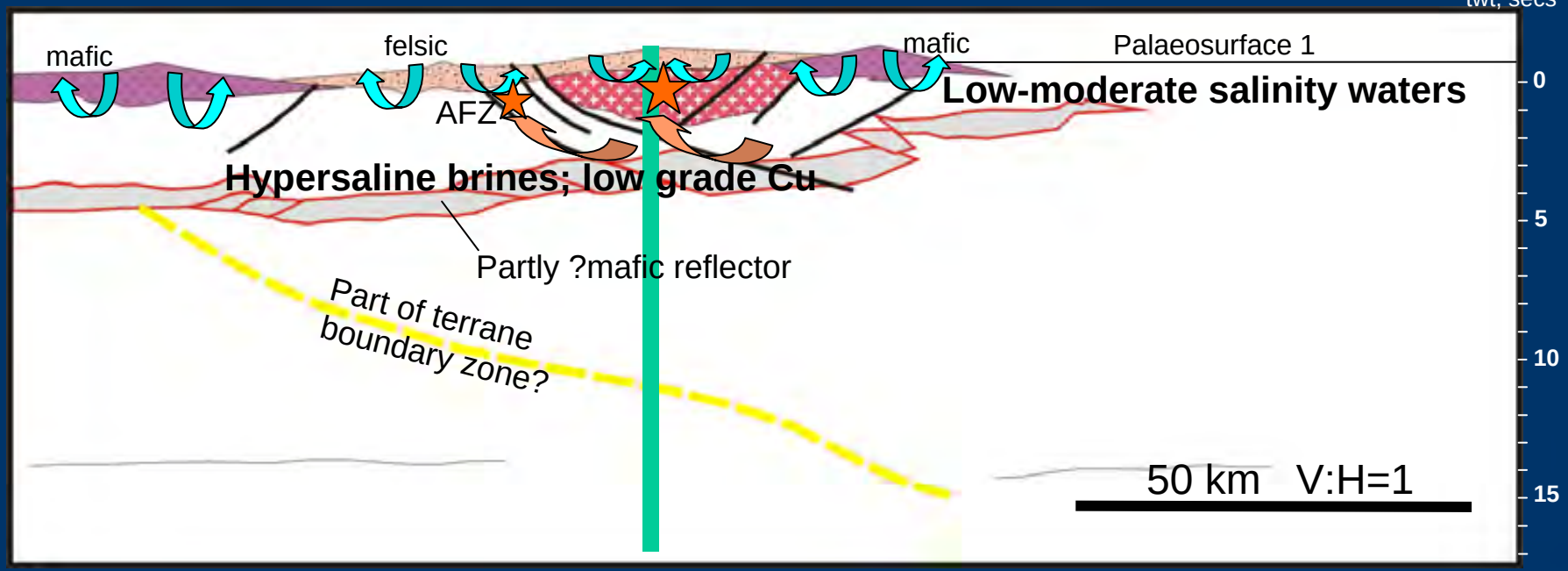
search contacts & edges of 'hematite' zones

A model for the Olympic Dam region

1575-1595 Ma: granite, unroofing, volcanics, Cu-U-Au where coincidence of ingredients

S

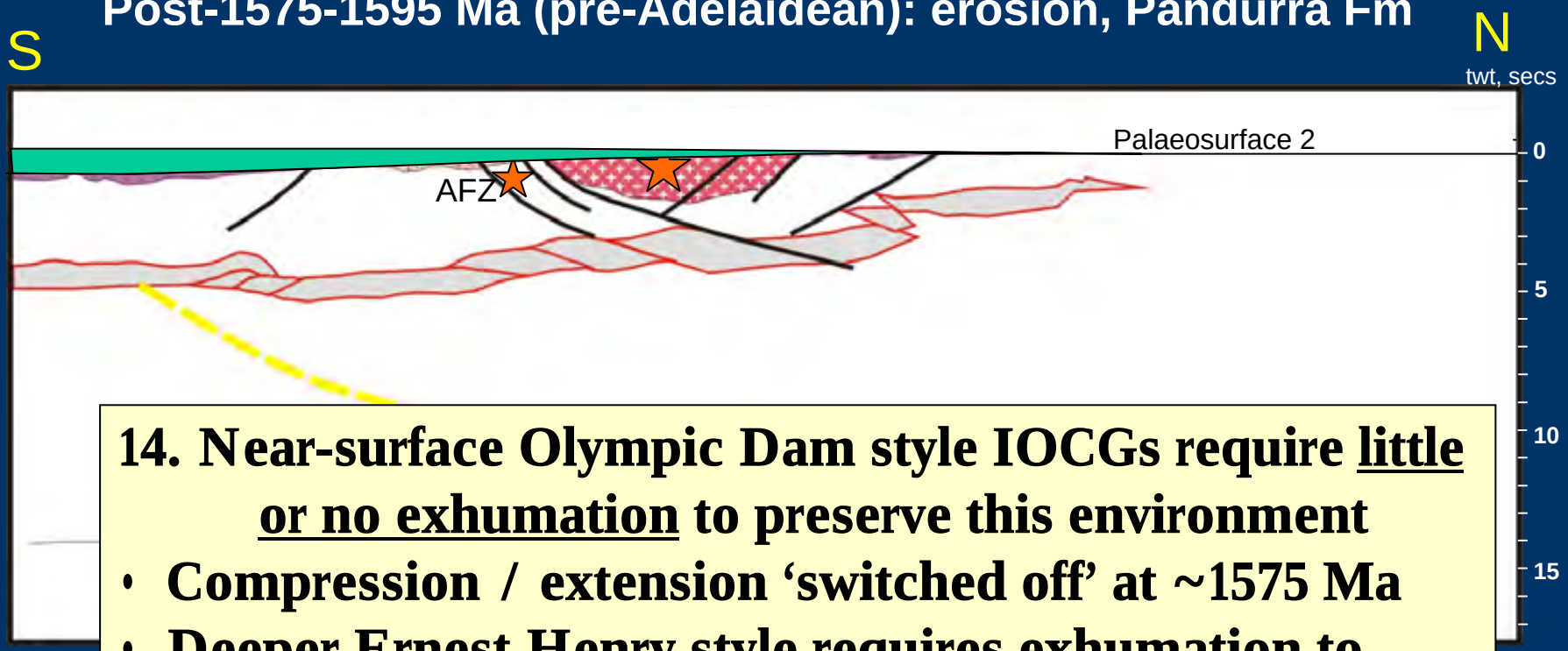
N



Modified from Skirrow et al. (submitted)

Preservation of IOCG systems

Post-1575-1595 Ma (pre-Adelaidean): erosion, Pandurra Fm



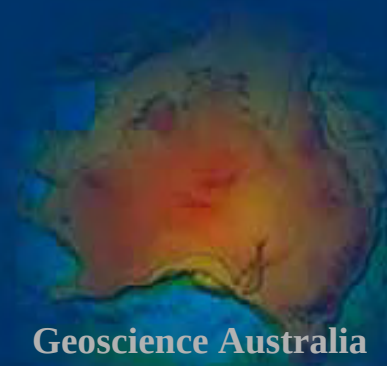
14. Near-surface Olympic Dam style IOCGs require <u>little or no exhumation</u> to preserve this environment

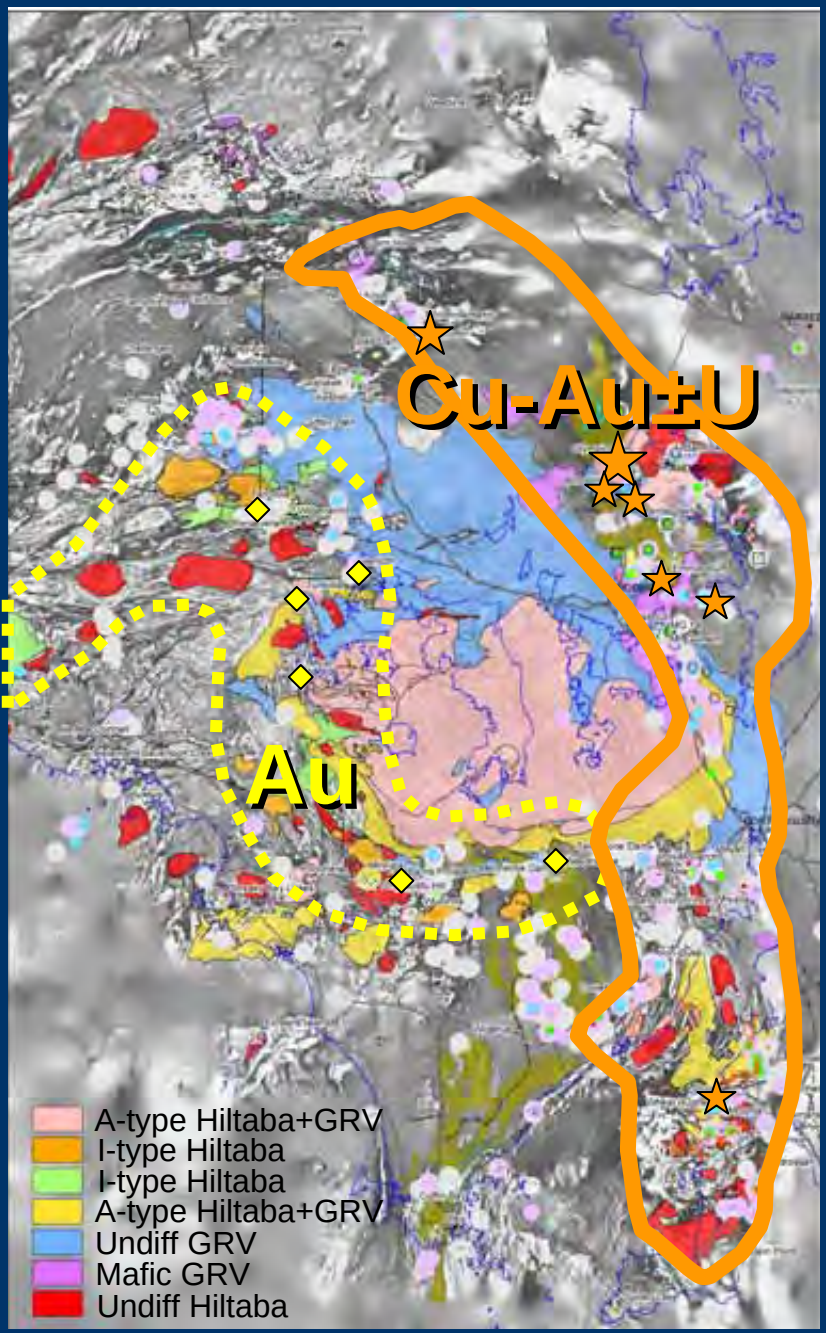
- **Compression / extension 'switched off' at ~1575 Ma**
- **Deeper Ernest Henry style <u>requires exhumation</u> to be detectable by 'shallow' exploration methods**

Part 2

Map of IOCG Potential of the Gawler Craton

(preliminary edition)

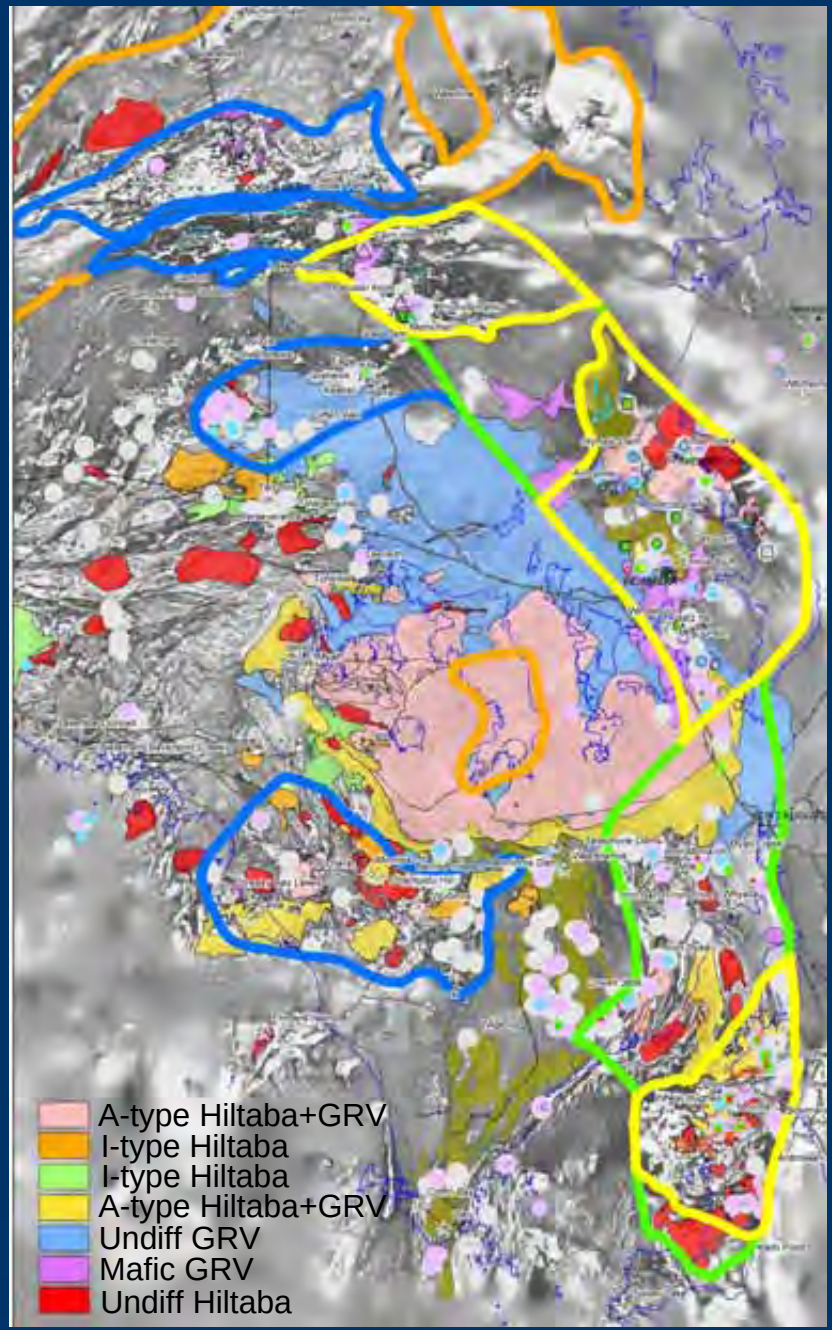




IOCG Potential Map coverages

- Greyscale background: "1.5vd" magnetics (TMI + 1st vertical derivative)
- Key metased units
- Hiltaba-GRV classification (Budd, 2006)
- Faults active at 1575-1595 Ma
- Anomalous Cu (>200ppm) from drillholes & surface
- IOCG alteration assemblages from drill hole logging
- IOCG alteration zones from geophysical interp / modelling
- Geochronology & Sm-Nd

IOCG Potential Map



- Areas ranked by potential, based on presence of 'essential ingredients'
- Specific IOCG deposit targets not identified – use district- to deposit-scale targeting criteria

1 – high potential
2
3
4 - moderate

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Questions?

ESSENTIAL INGREDIENT	MAPPING TOOLS/METHODS
*High palaeogeothermal gradients at time of IOCGs	Metamorphic petrology & geochron; granite geochem as a guide to PT; broad-band seismic & MT as a guide to lithospheric structure?
*High-temperature K-rich A-type to I-type granites; 2.50-2.60 Ga, 1.5-1.6 Ga, 0.1 Ga may be favourable periods	Field mapping / hole logging; granite geochem; geochron; radiometrics to map high K-contents of A-types
*Mafic/ultramafic intrusive rocks (K-rich?), coeval with granitoids	Field mapping / hole logging; geochem; geochron; seismic reflection and refraction data
Pre-IOCG orogenic belts at margins of older cratons; *crustal domain boundaries	Synthesis of geophysical (incl. seismic, MT), geological, geochemical/isotopic (incl. Sm-Nd), geochron data; Moho depth; Skippy datasets
Networks of crustal-scale faults/shears	Field mapping; conventional interp and worming and inversion of potential field data; seismic reflection data

ESSENTIAL INGREDIENT	MAPPING TOOLS/METHODS
Metasedimentary-metavolcanic basin sequences older than syn-IOCG magmatism; not too reduced, with meta-evaporites?	Field mapping / hole logging; sequence strat; aeromags may detect redox gradients
*Regional-scale (1-10km) Na (± Ca ± Fe) alteration (albite, actinolite, ± magnetite)	Field mapping; geochem; geochron; magnetics & gravity (e.g. inversions); radiometrics (e.g., low K/Th ratios); hyperspectral mapping?
*Regional- to local-scale K-Fe ± carbonate alteration and Cu-Au mineralisation (biotite, K-feldspar, ± magnetite, Cu-Fe sulfides)	Field mapping / hole logging; geochem; geochron; magnetics & gravity (e.g. inversions); radiometrics (e.g., high K/Th); hyperspectral mapping?
*Local-scale hematitic alteration & Cu-Au±U mineralisation (hematite, sericite, chlorite, carbonate)	Field mapping / hole logging; geochem; geochron; magnetics & gravity (e.g. inversions); radiometrics (e.g., high U; high K/Th); hyperspectral mapping?

ESSENTIAL INGREDIENT	MAPPING TOOLS/METHODS
Hypersaline high-temp brines (associated with magnetite alteration) + lower salinity lower temp brines ± CO_2	Fluid inclusion studies incl. microanalysis to detect Cu-bearing fluids
Fe, Cu, Au, U, LREE, Ag, Ba, F, CO_3, P, Co, Mo	Geochemistry (e.g., compilations of exploration drillhole data), basic mineralogy
Brittle-ductile shear zones with jogs (EH style) with syn-IOCG timing	Field mapping; interp & worming of potential-field data; geochron of minerals in shear fabrics
Brittle deformation structures (OD style) with syn-IOCG timing	Field mapping; interp & worming of potential-field data; geochron of minerals in structures
Volcanic maar/diatreme settings (OD style)	Field mapping / hole logging; interp & worming of potential-field data
*Preservation of near-palaeosurface setting (OD style)	Field mapping/ hole logging to detect presence of volcanics, epizonal alteration mineralogy, palaeo-weathering zones, etc
Exhumation of mesothermal environment (EH style)	Field mapping/ hole logging to identify metamorphic assemblages & PT conditions; Ar-Ar dating for thermal history & exhumation