



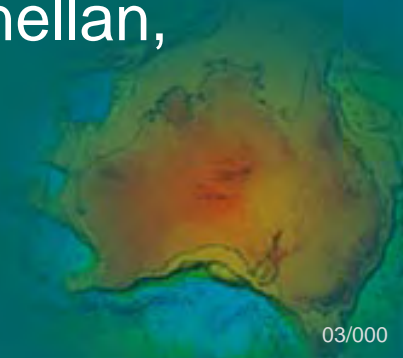
Australian Government

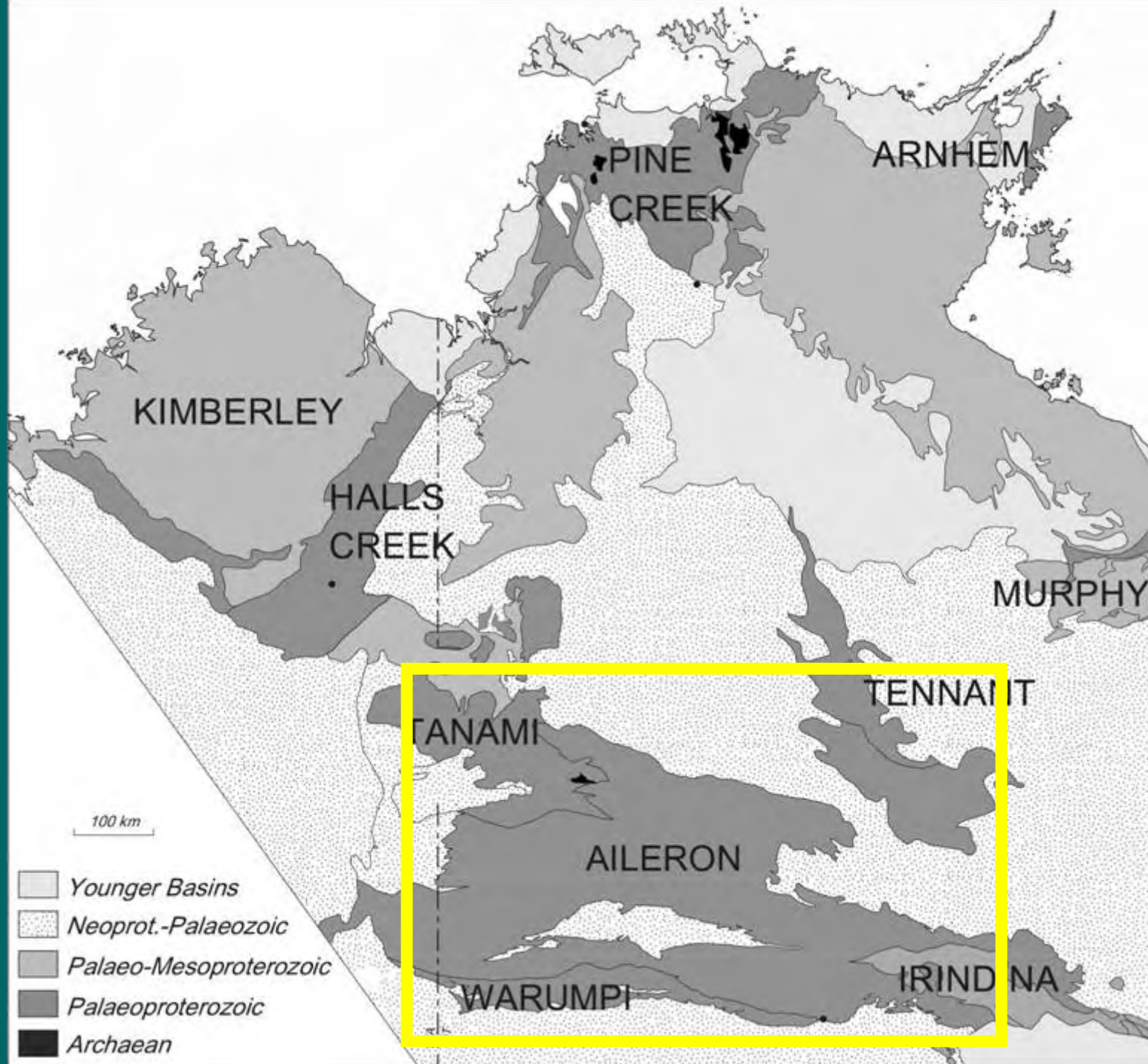
Geoscience Australia

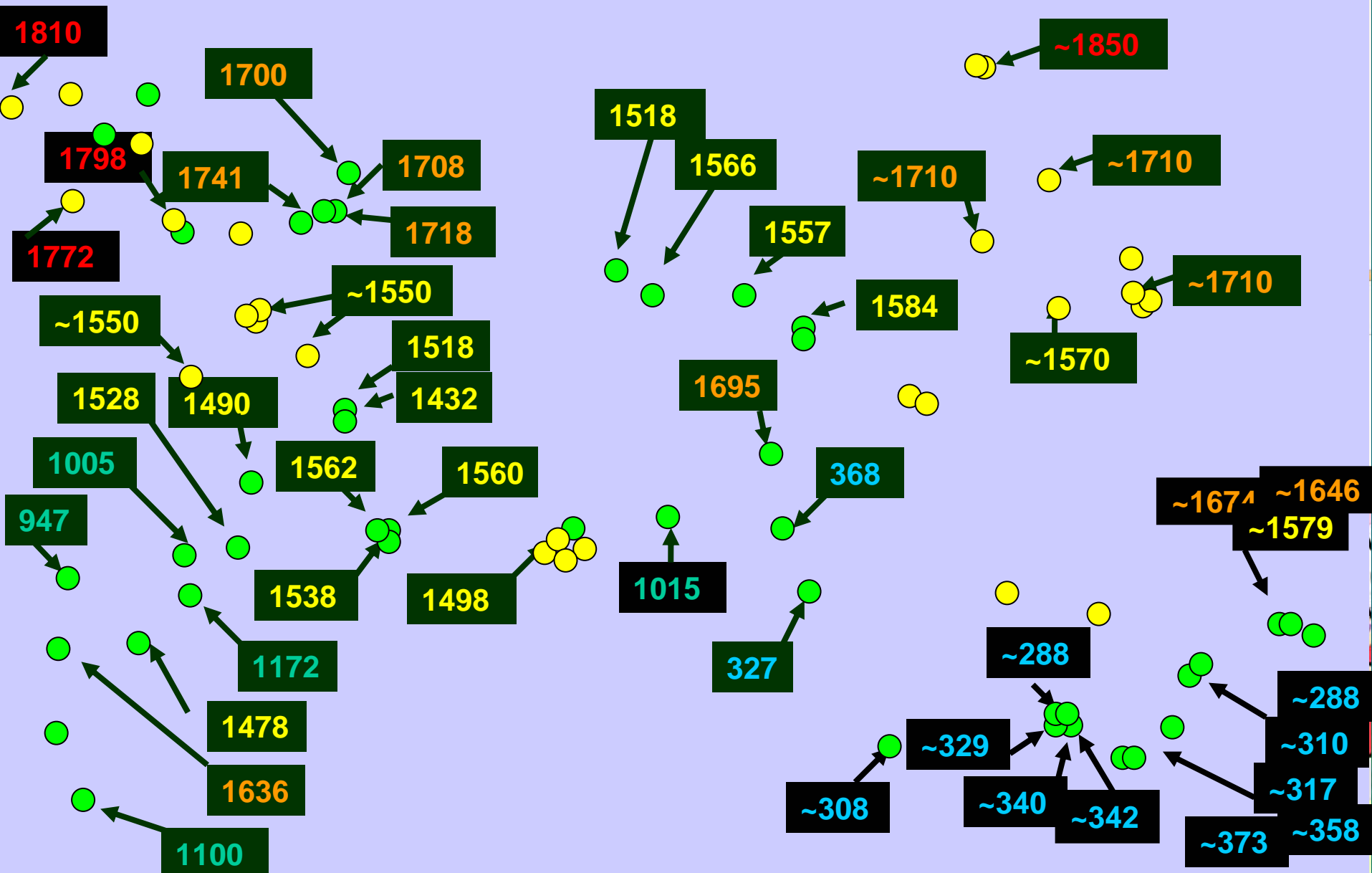
$^{40}\text{Ar}/^{39}\text{Ar}$ constraints on the episodic history of mineralization and tectonism in the southern North Australian Craton

Geoff Fraser, David Huston, Leon Bagas, Kelvin Hussey, Jon Claoue-Long, David Maidment, Andrew Cross, Leon Vandenburg, Andrew Wygralak, Nigel Donnellan, Andrew Crispe

GA, NTGS, GSWA





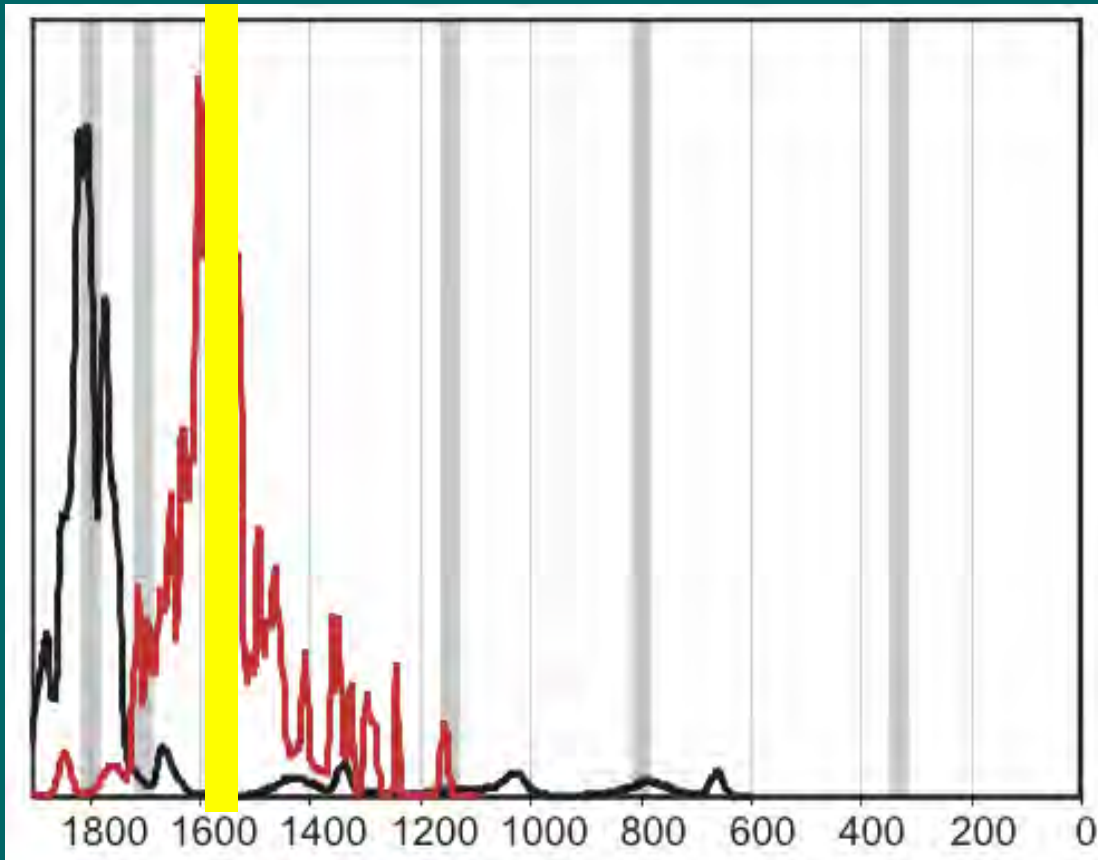


Frequency distributions of argon ages

Stafford
Strangways
Chewing

Teapot

ASO

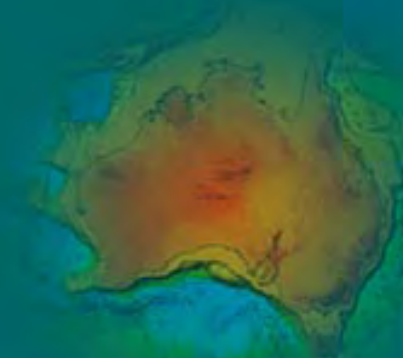


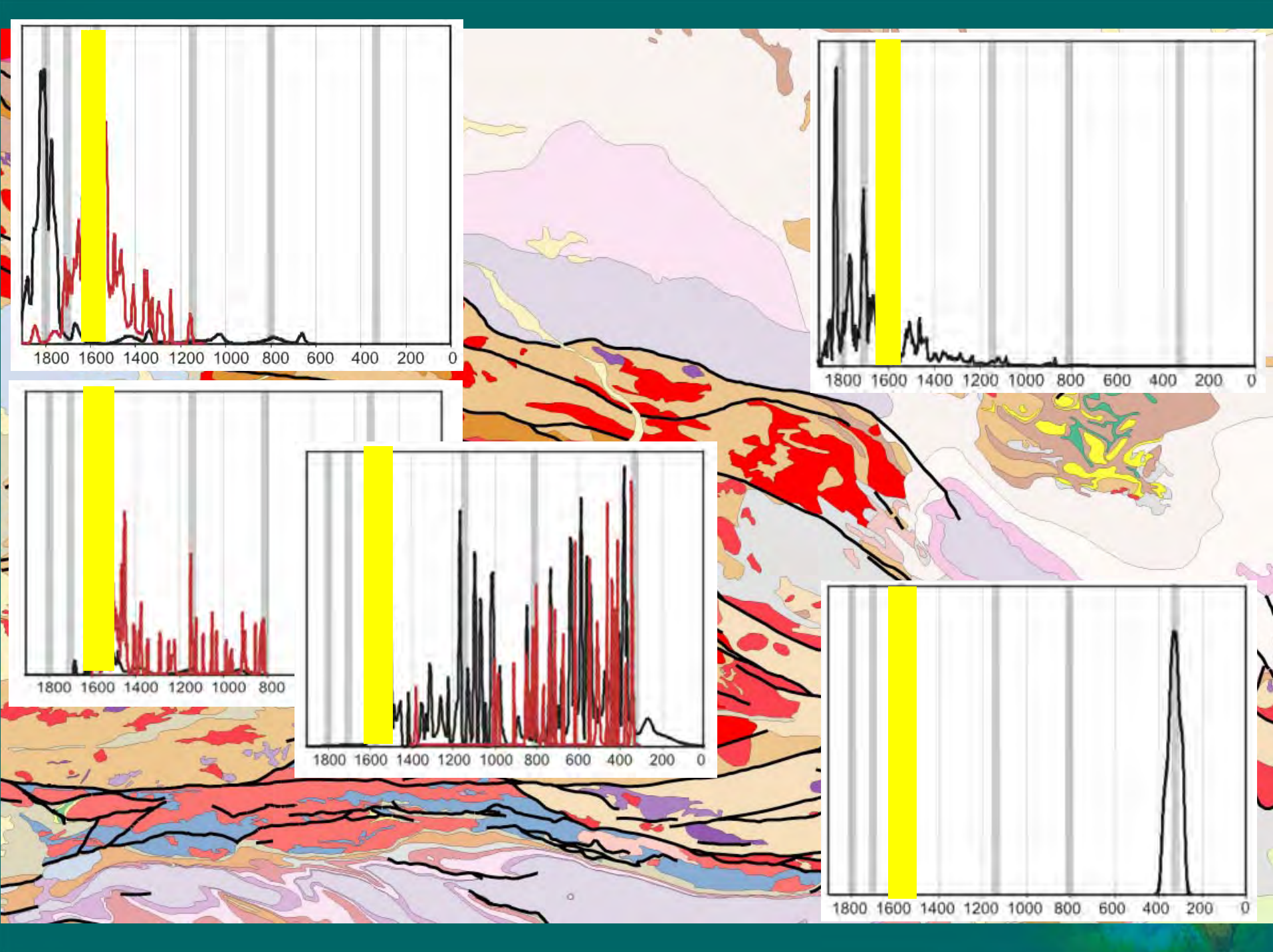
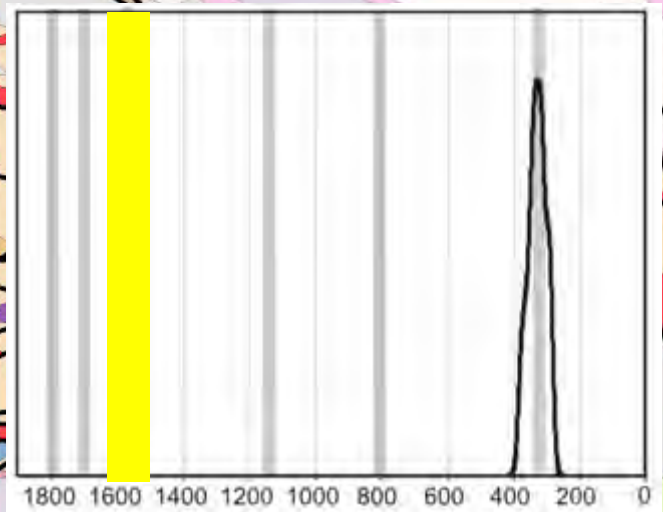
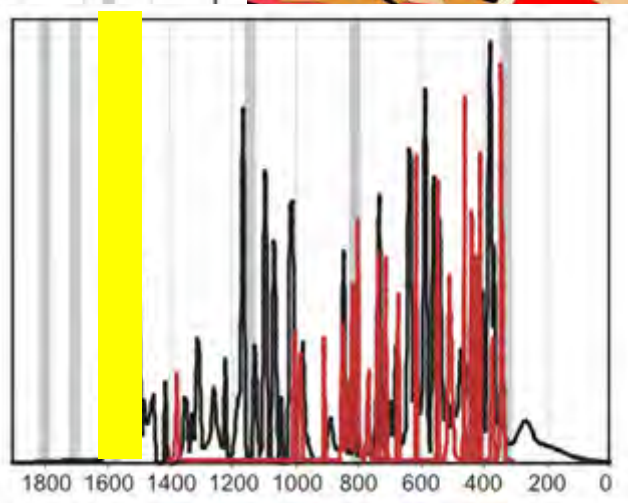
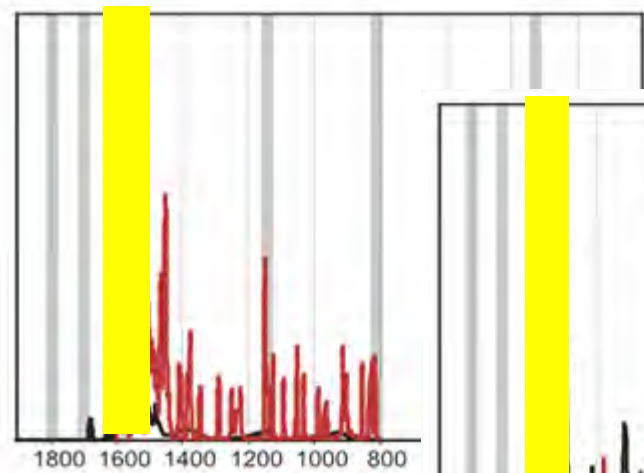
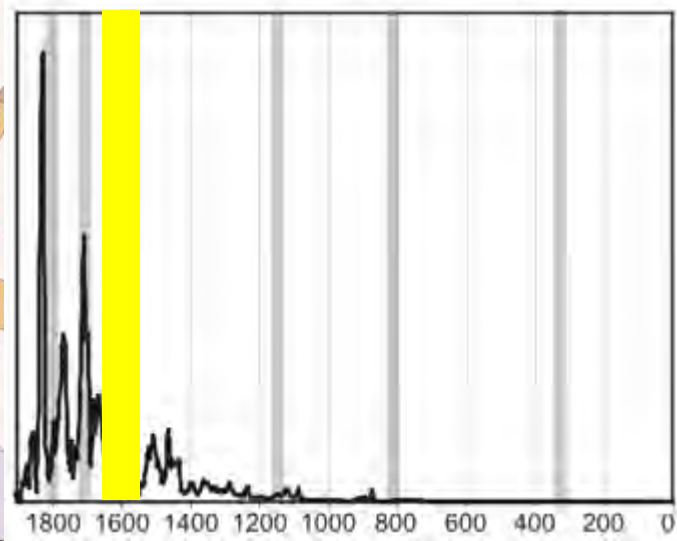
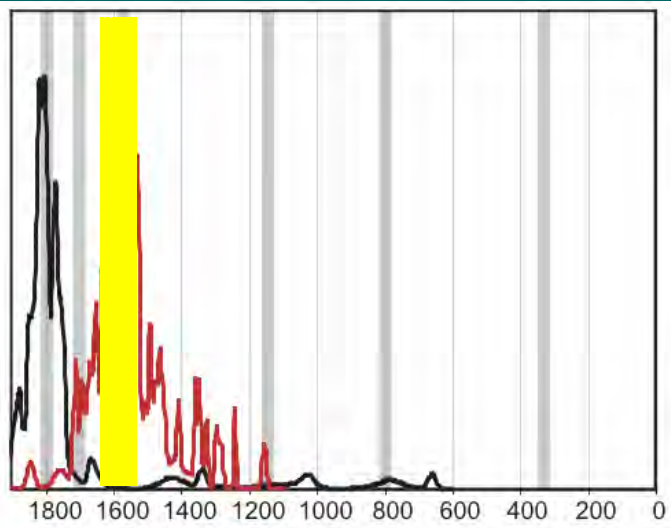
Black = micas

T_c ~400-300°C

Red = K-feldspar

T_c ~250-200°C





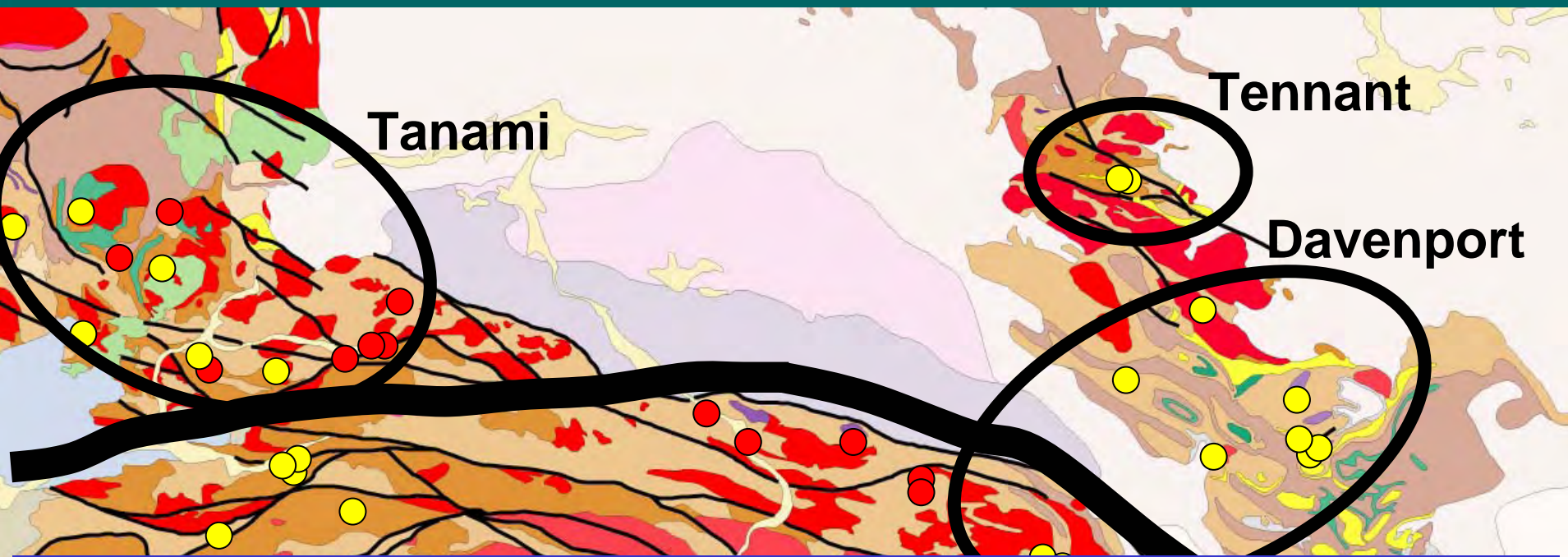
Palaeoprot. >1700 Ma

Mesoprot. <1580 Ma

Neoprot. <1150 Ma

Warumpi

Palaeozoic

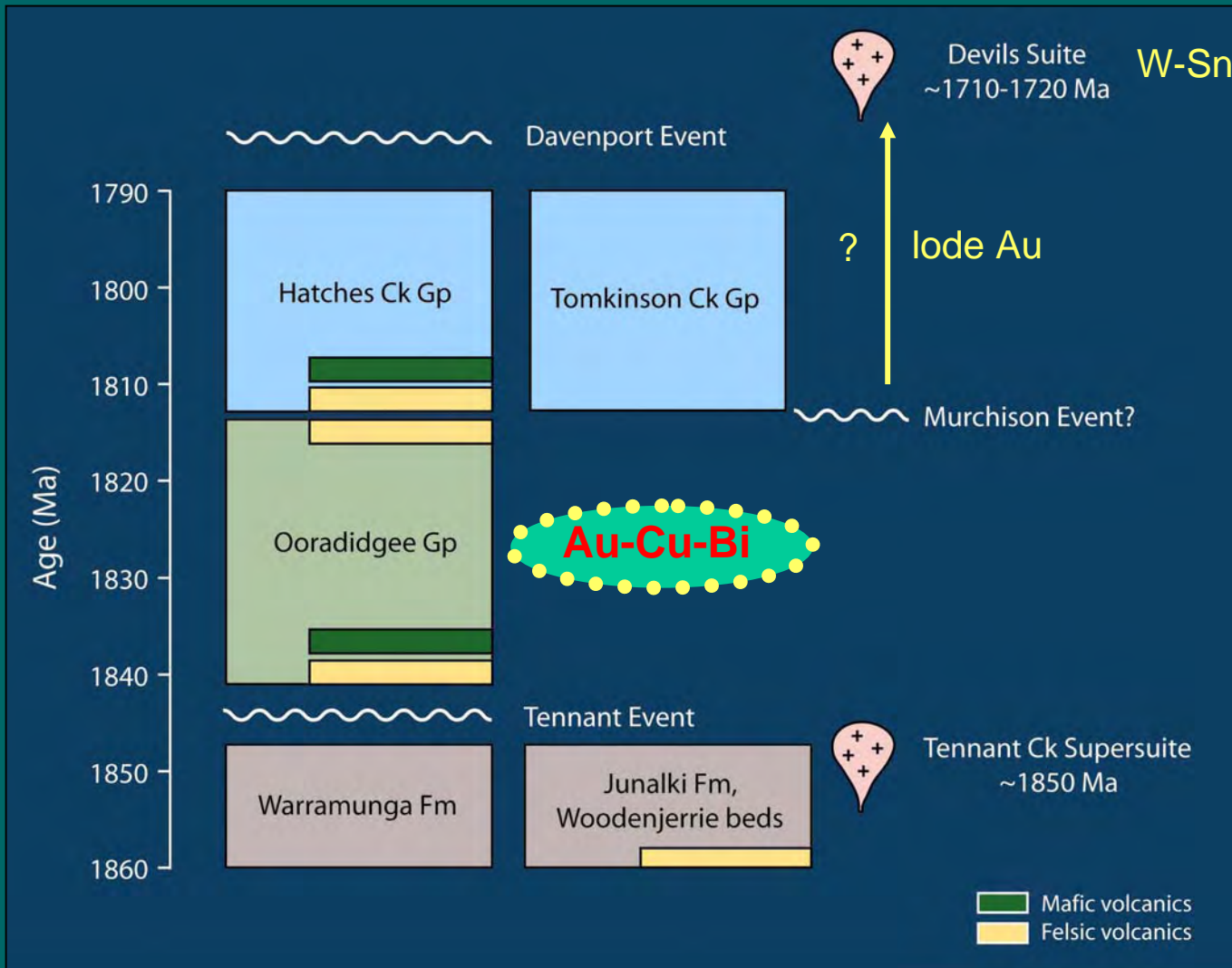


Now consider mineralization history within the interior of craton

- Tennant
- Davenport Ranges
- Tanami

Argon geochronology of limited use for Palaeoproterozoic mineralization towards southern margin, due to overprinting effects

Tennant Creek



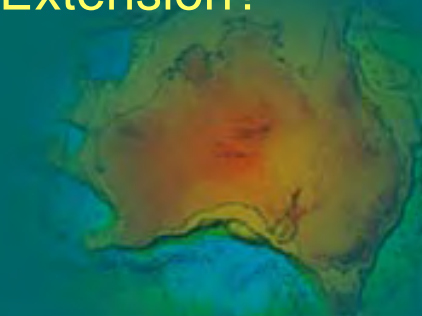
Extension

Extension

Convergence

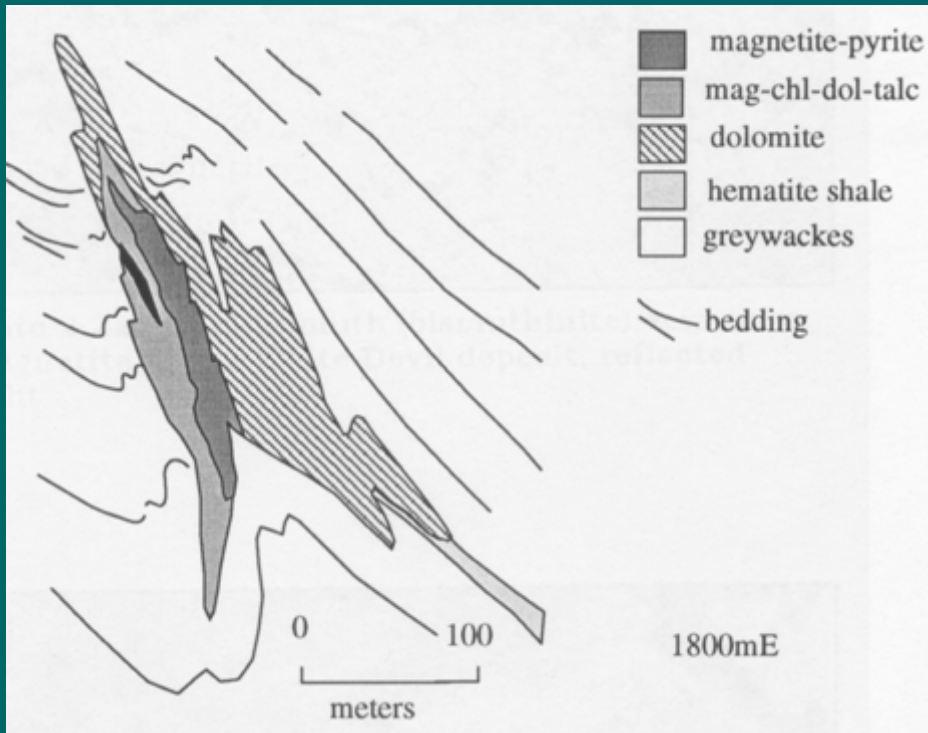
Extension?

from Maidment et al, 2006

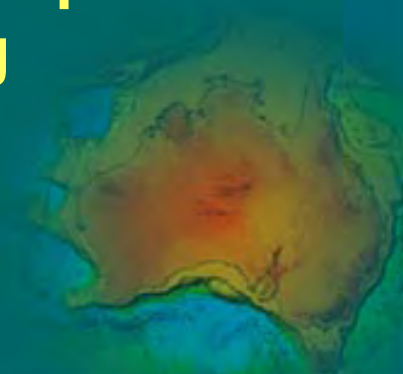


Tennant Creek: Cu-Au-Bi age constraints

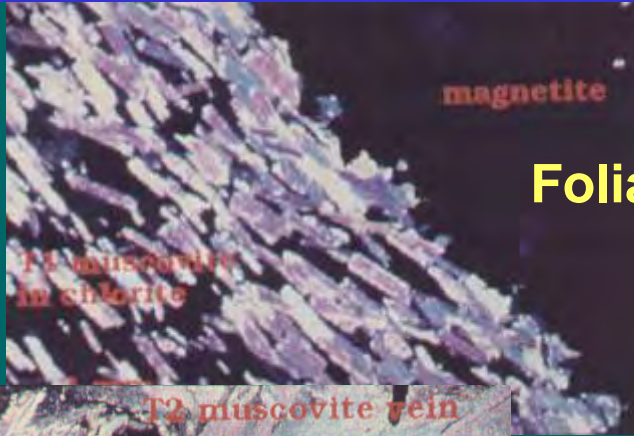
$^{40}\text{Ar}/^{39}\text{Ar}$ muscovite data from D. Compston PhD thesis
(Compston & McDougall, 1994, AJES)



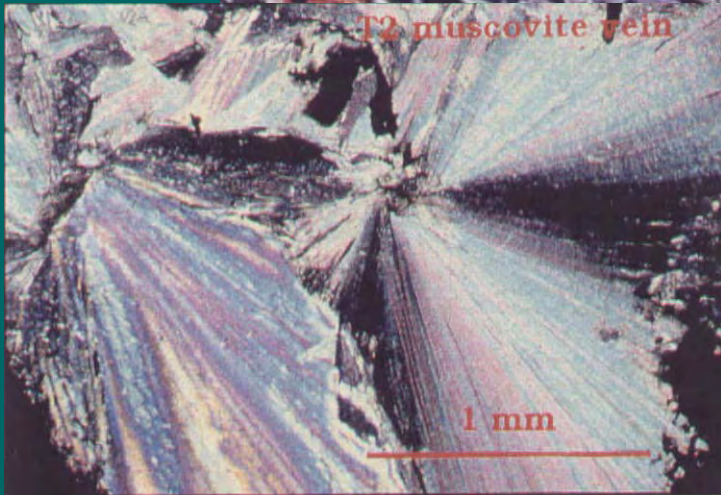
- Ironstones in hinges of D1 folds in Warramunga Formation
- Ironstone overprinted by zoned Cu-Au-Bi mineralization
- Mineralization post-dates folding



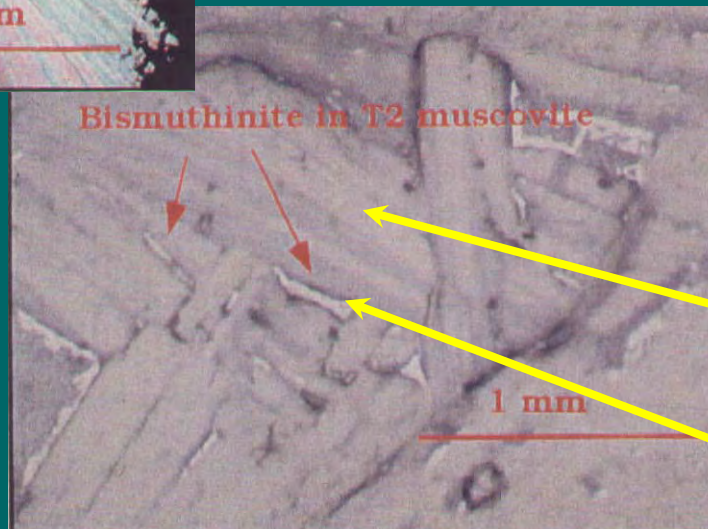
Muscovite and Mineralization relationships, Tennant Creek



Foliated muscovite in ironstone: TYPE 1



Vein muscovite in undeformed, radial splays: TYPE 2



Muscovite intergrown with bismuthinite
ie. syn-mineralization

from D.Compston
PhD thesis, 1994

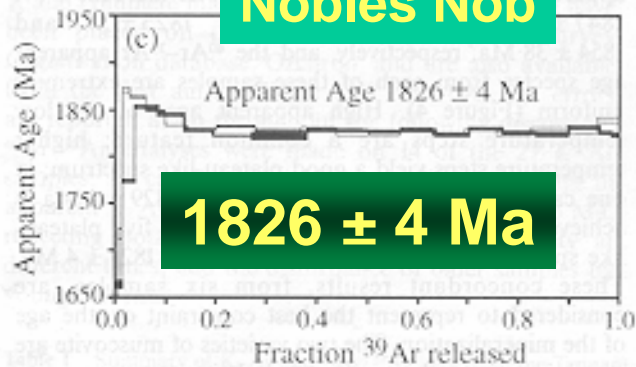
muscovite

bismuthinite

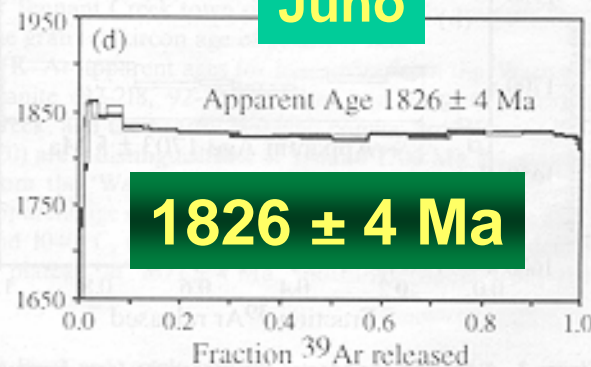
Muscovite syn-Cu-Au-Bi, Tennant Creek

➤ Reproducible $^{40}\text{Ar}/^{39}\text{Ar}$ plateau ages 1825 to 1829 Ma

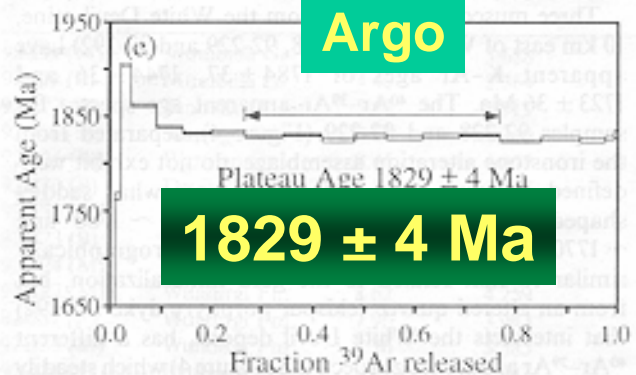
Nobles Nob



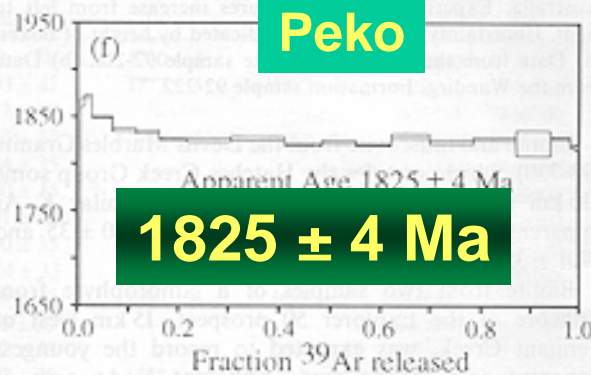
Juno



Argo



Peko



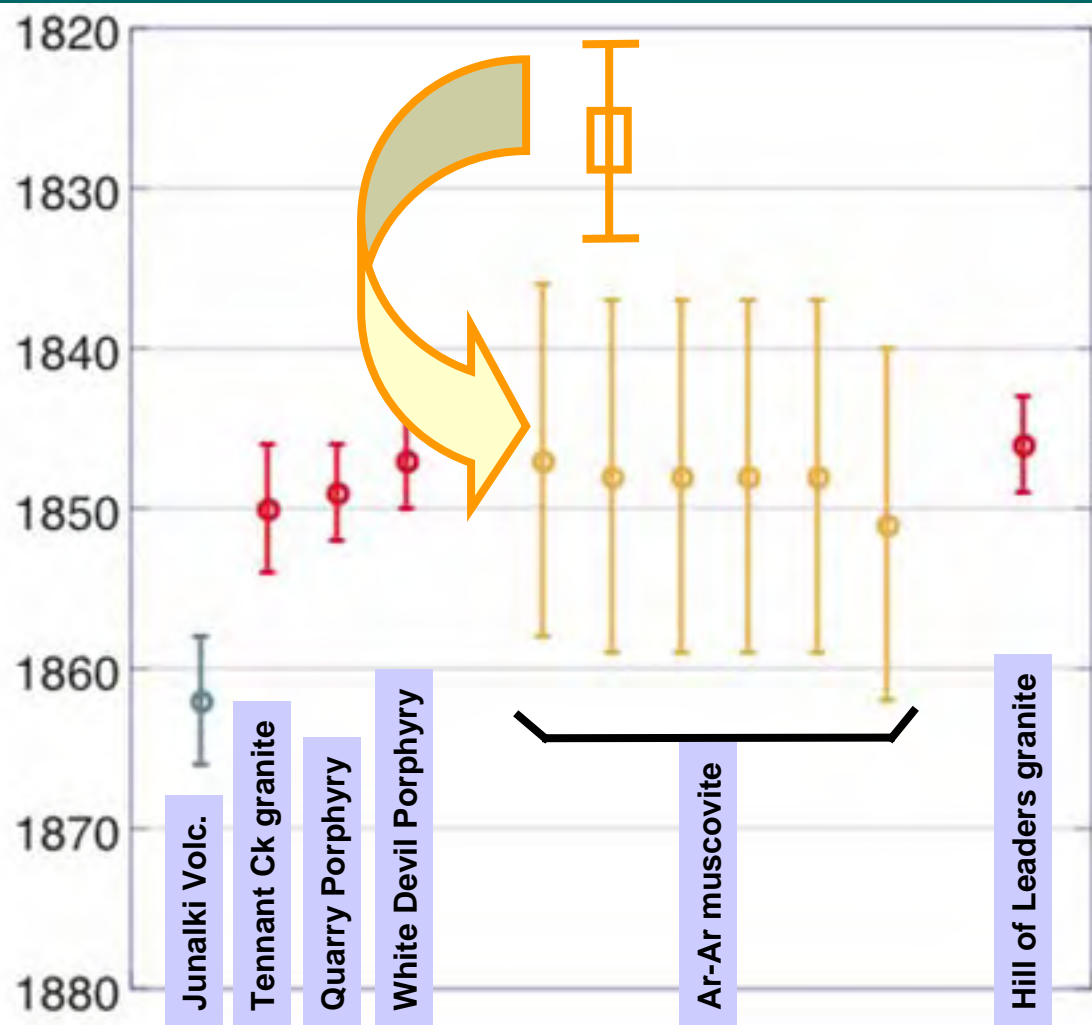
Since early 1990's

1. Revised age of standard
2. Revised value for decay constant, λ

Compston & McDougall, 1994, AJES



Summary of Tennant Event age constraints



- ✓ Deposition
- ✓ Deformation
- ✓ Magmatism
- ✓ Mineralization

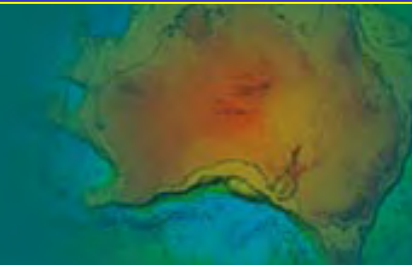
between:

~1860 to 1845 Ma

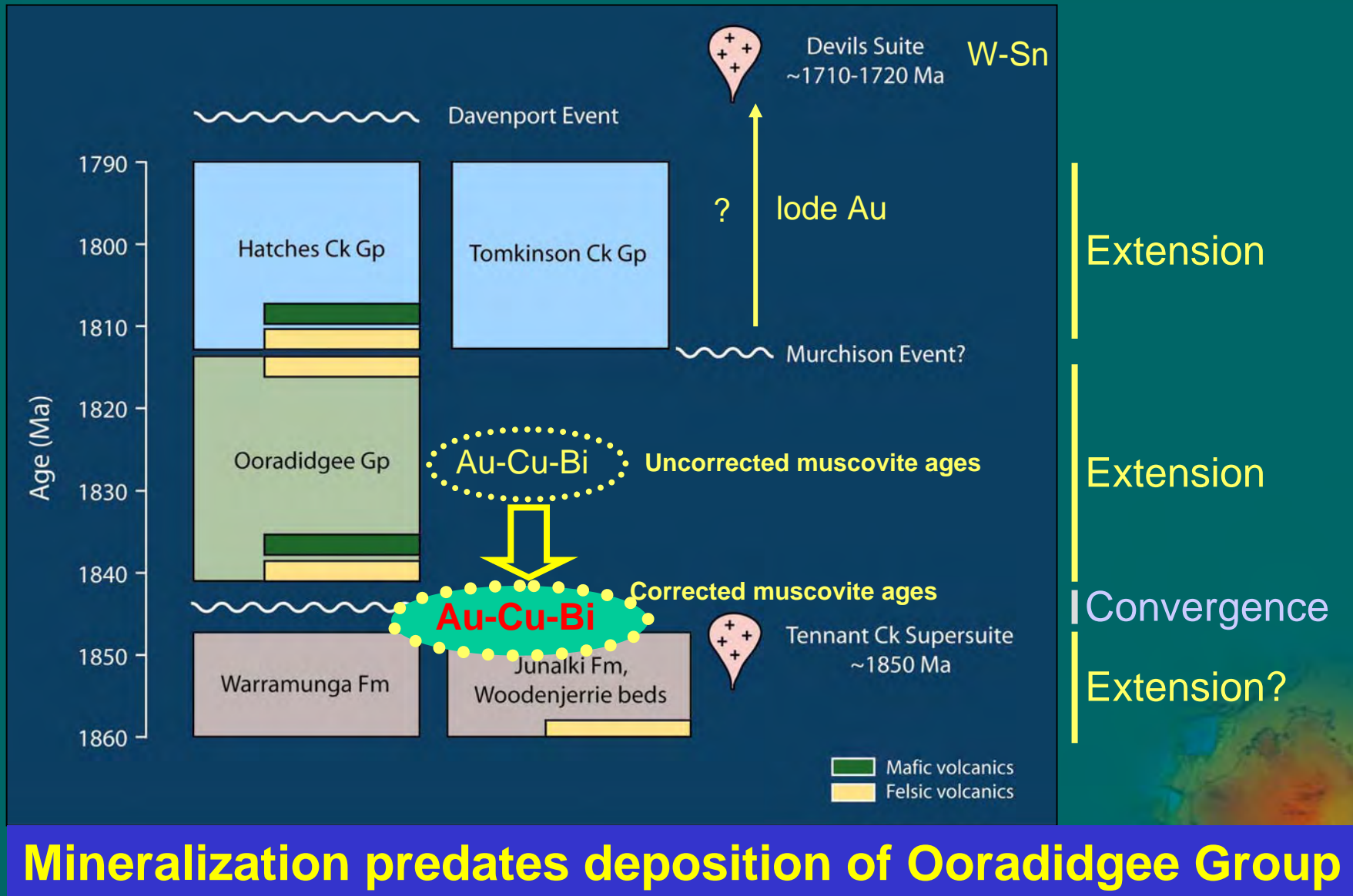
Cu-Au-Bi more probably
syn-felsic-
magmatism at:

~1850 to 1845 Ma

Data sources: Compston & McDougall, 1994;
Maidment et al., 2006; Smith, 2000



Tennant Ck mineralization: revised age



Davenport Ranges

Warrego

Hill of

Devils Suite Granites

~1720 - 1700 Ma

Wauchope - W

Devils Marbles

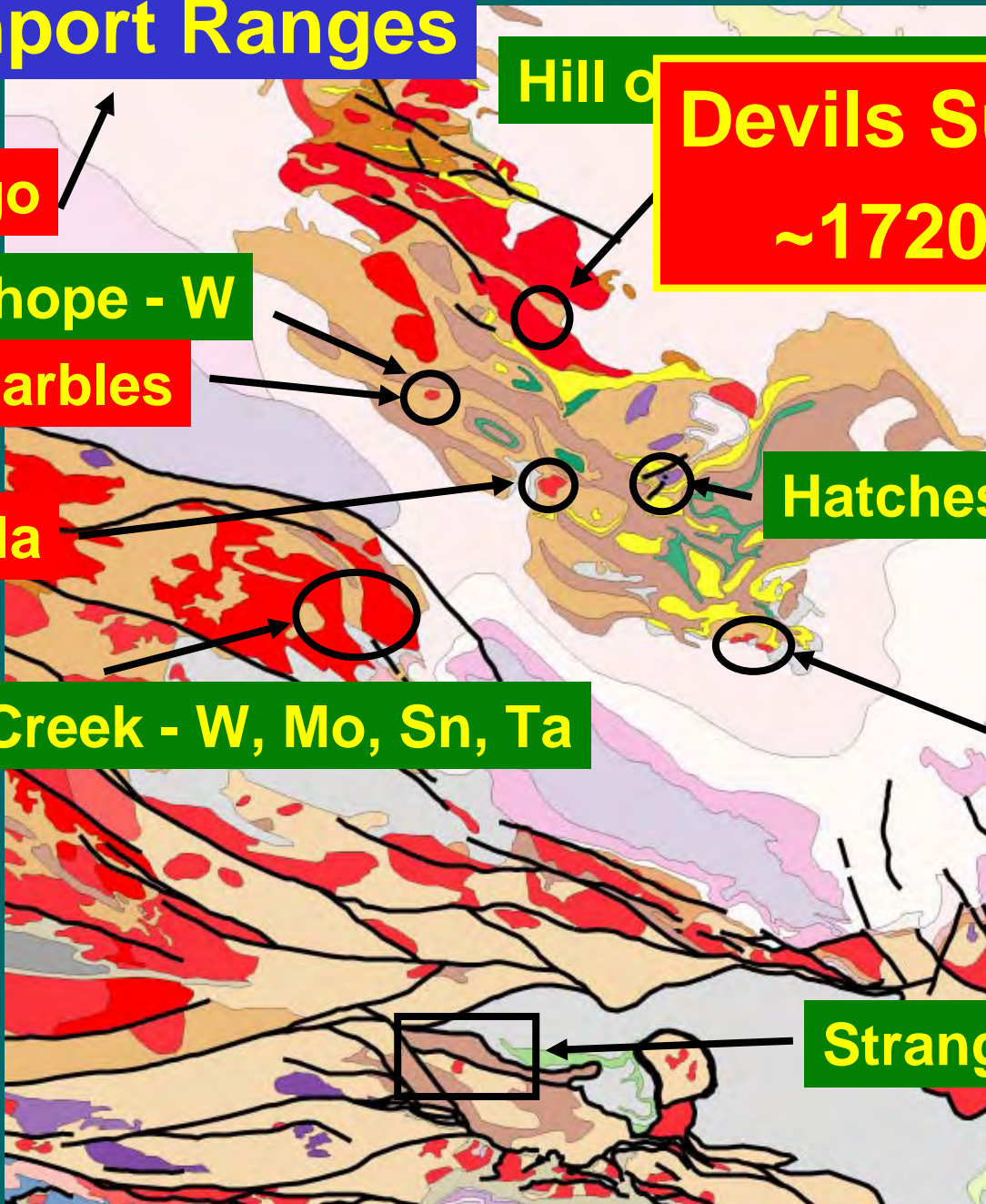
Kaidwalla

Hatches - W, Cu, Mo, Au

Barrow Creek - W, Mo, Sn, Ta

Elkedra

Strangways Range



Warramunga Group

Ooradidgee Group

Hatches Ck Group

Devils Suite
granites & lamprophyres

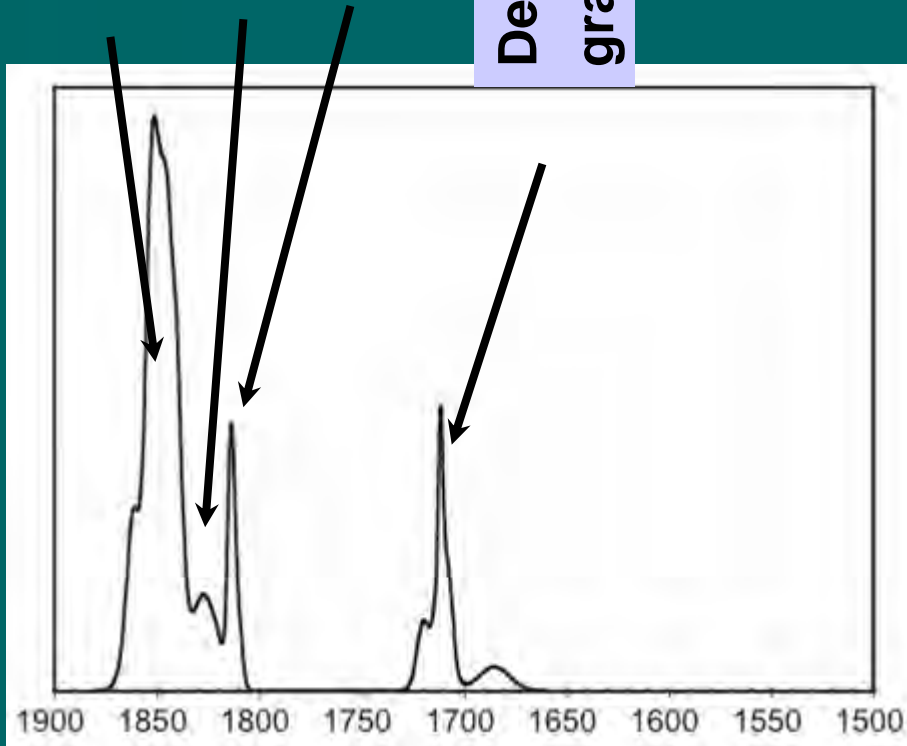
Late granites

- Devil's Marbles
- Elkedra
- Gosse River East
- Kaidwalla
- Lamprophyre dyke

U-Pb zircon

1711 ± 4 Ma²
1720 ± 6 Ma²
1712 ± 5 Ma¹
1707 ± 4 Ma³
1711 ± 2 Ma³

Sources: ¹Compston, 1995; ²Page, 1995;
³Maidment et al. 2006



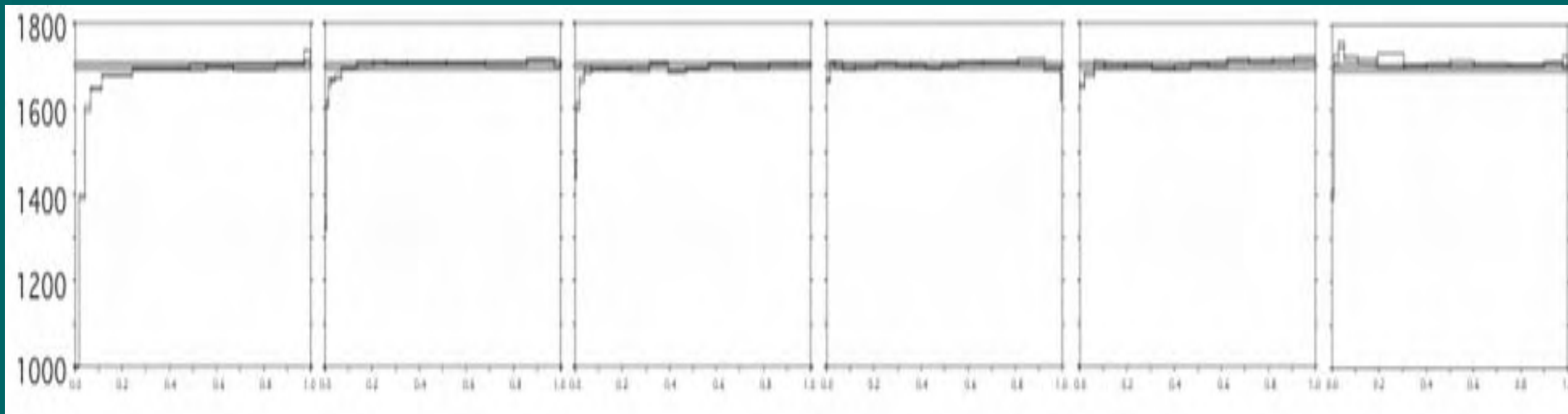
Tennant U-Pb zircon ages



Muscovite selvage

$^{40}\text{Ar}/^{39}\text{Ar}$ muscovite age spectra for W-Sn-Mo-mineralization and related rocks

- ~1700 Ma ages reproducible over wide area
- No hint of partial resetting from prior to ~1700 Ma
- Minor argon loss post ~1700 Ma



The Cu Show
Hatches

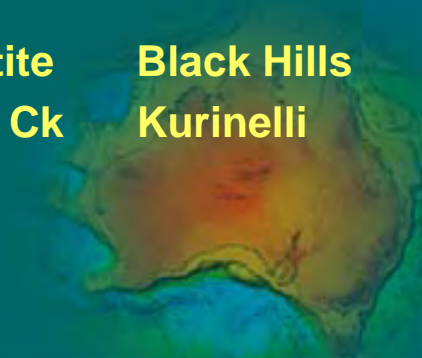
Green Diamond
Hatches

Bonanza
Hatches

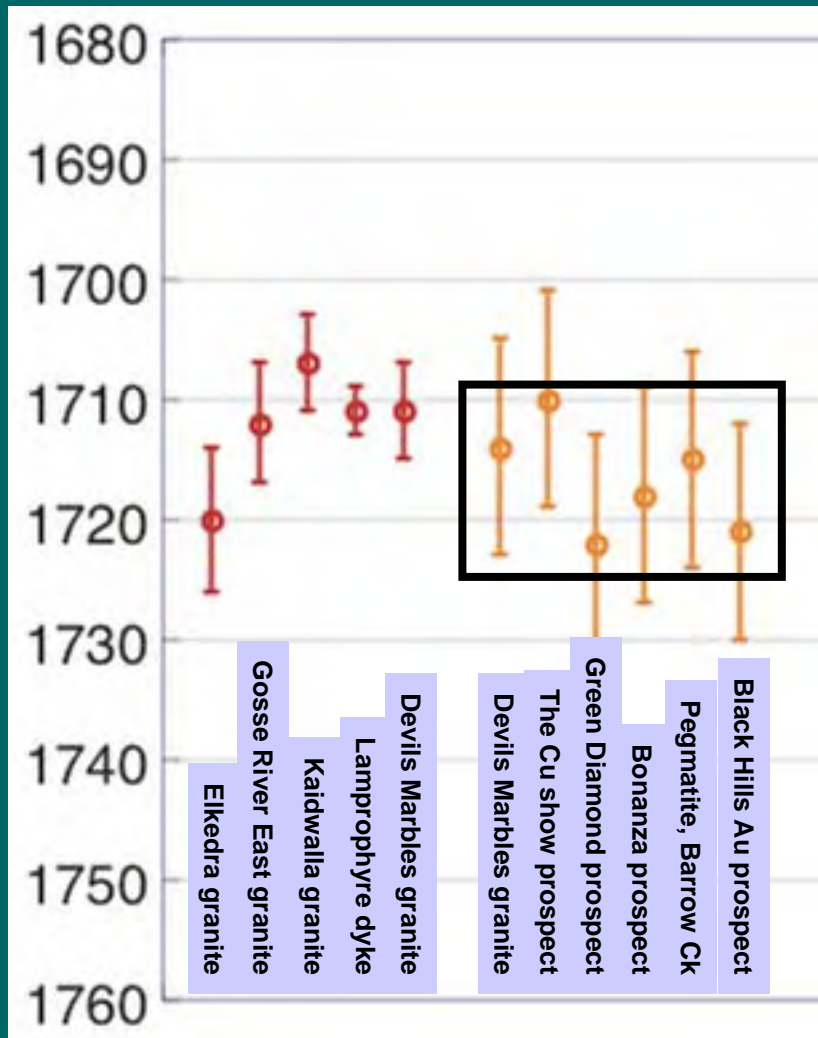
Devils Marbles

Pegmatite
Barrow Ck

Black Hills
Kurinelli

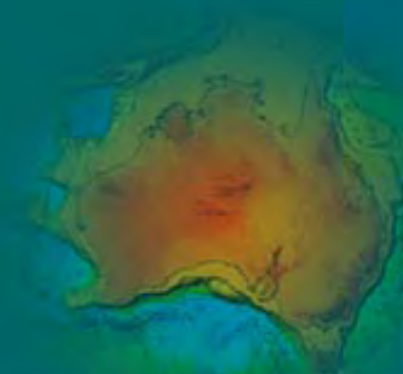


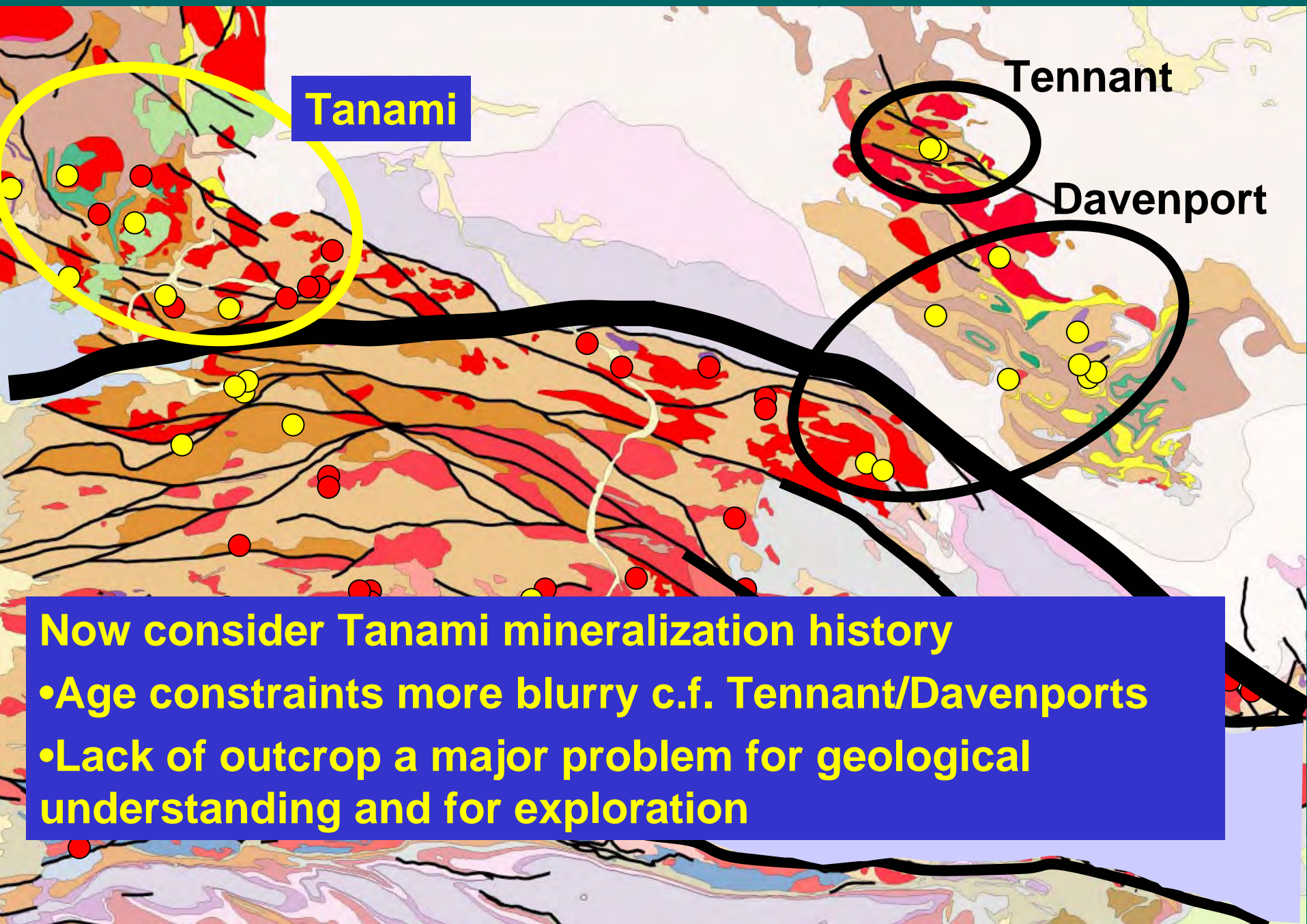
Timing of W-Sn-Mo Mineralization in Davenports/Barrow Ck mineralization syn-Devils Suite intrusives, 1720 - 1710 Ma



Cratonwide event at ~1710 Ma

- Granites, pegmatites
- W-Sn-Mo (up to Pine Creek, Bynoe pegmatite field)
- Strangways metamorphics
- Bend in APWP





Tanami

Tennant

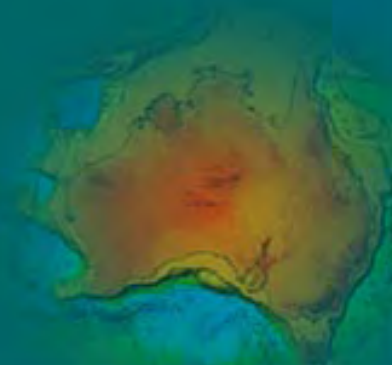
Davenport

Now consider Tanami mineralization history

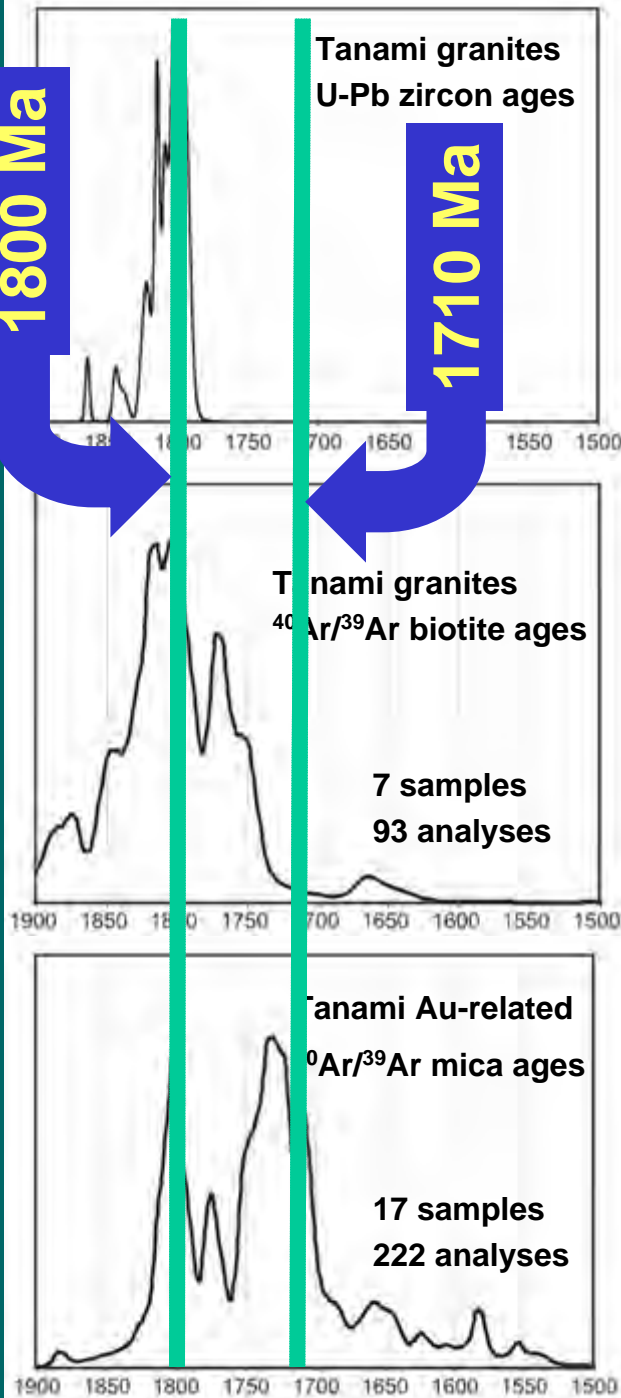
- Age constraints more blurry c.f. Tennant/Davenports
- Lack of outcrop a major problem for geological understanding and for exploration

Timing of Tanami lode-Au

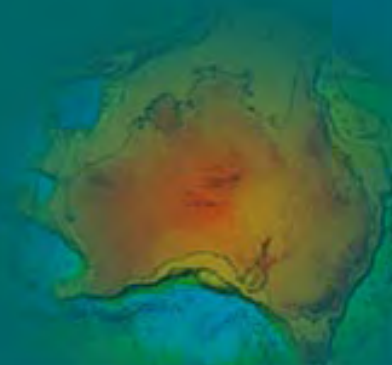
- Best “direct” age constraints from U-Pb xenotime ~1800 Ma
 - 1803 ± 19 Ma - Callie (Cross et al., 2005)
 - 1801 ± 5 Ma - Coyote (Armstrong, 2002)
- ~synchronous with major pulse of regional granites
- Argon geochronology has been less successful in constraining age of mineralisation
- Considerable evidence for isotopic disturbance at ~1710 Ma. Spatially variable



A ~1710 Ma event in the Tanami?



- Variable argon isotopic resetting of micas at Callie and The Granites at ~1720 - 1710 Ma
- Contrasts with older biotite ages from regional granites
- Possible local reactivation of structures/fluids or heat input at ~1720 - 1710 Ma
- Local expression of cratonwide event at ~1720 - 1710 Ma



TANAMI

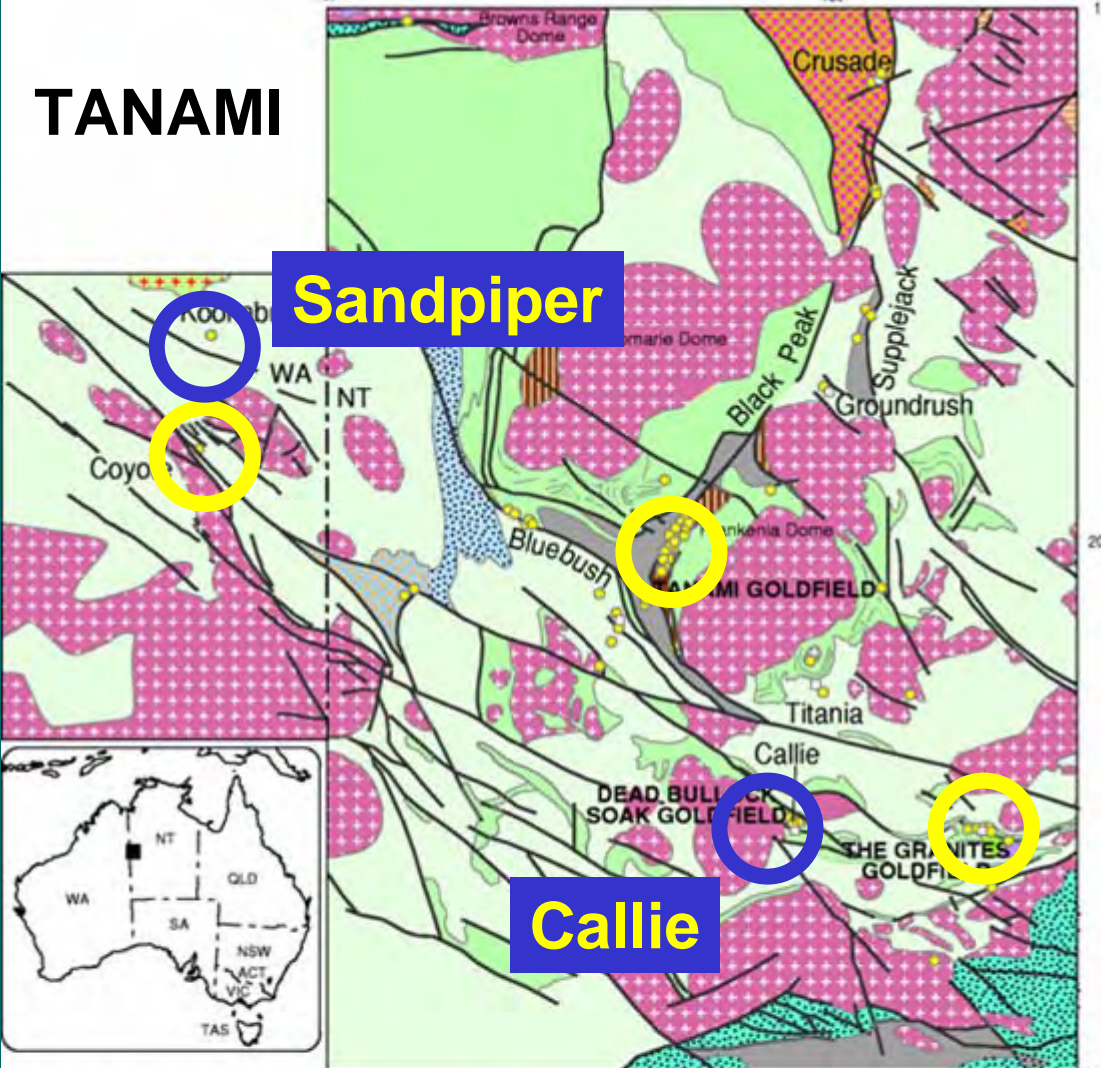
Sandpiper

Callie

Two new $^{40}\text{Ar}/^{39}\text{Ar}$ muscovite ages

1. Callie
2. Sandpiper

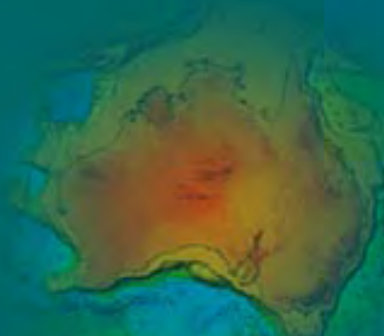
Both pre-date the ~1710 Ma event



TANAMI BASEMENT GEOLOGY



Gold field or prospect



Callie



**Qtz vein
with
muscovite
selvage**

Previous studies

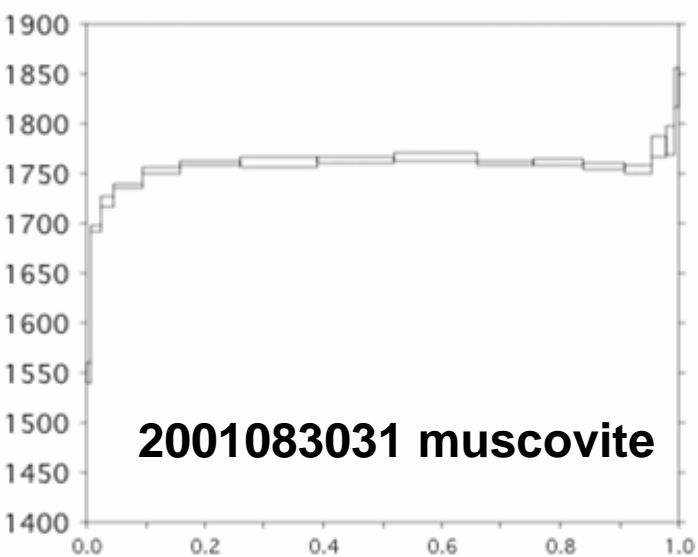
4 styles of veins present

1. Folded pre-ore qtz-carb

2. sheeted Au-bearing qtz veins with biotite & chlorite selvages

3. Qtz-pyr veins without alteration selvages

4. Qtz±carb veins with sericitic selvages



Plateau Age

1776 ± 5 Ma (1σ)

Minimum age for mineralization

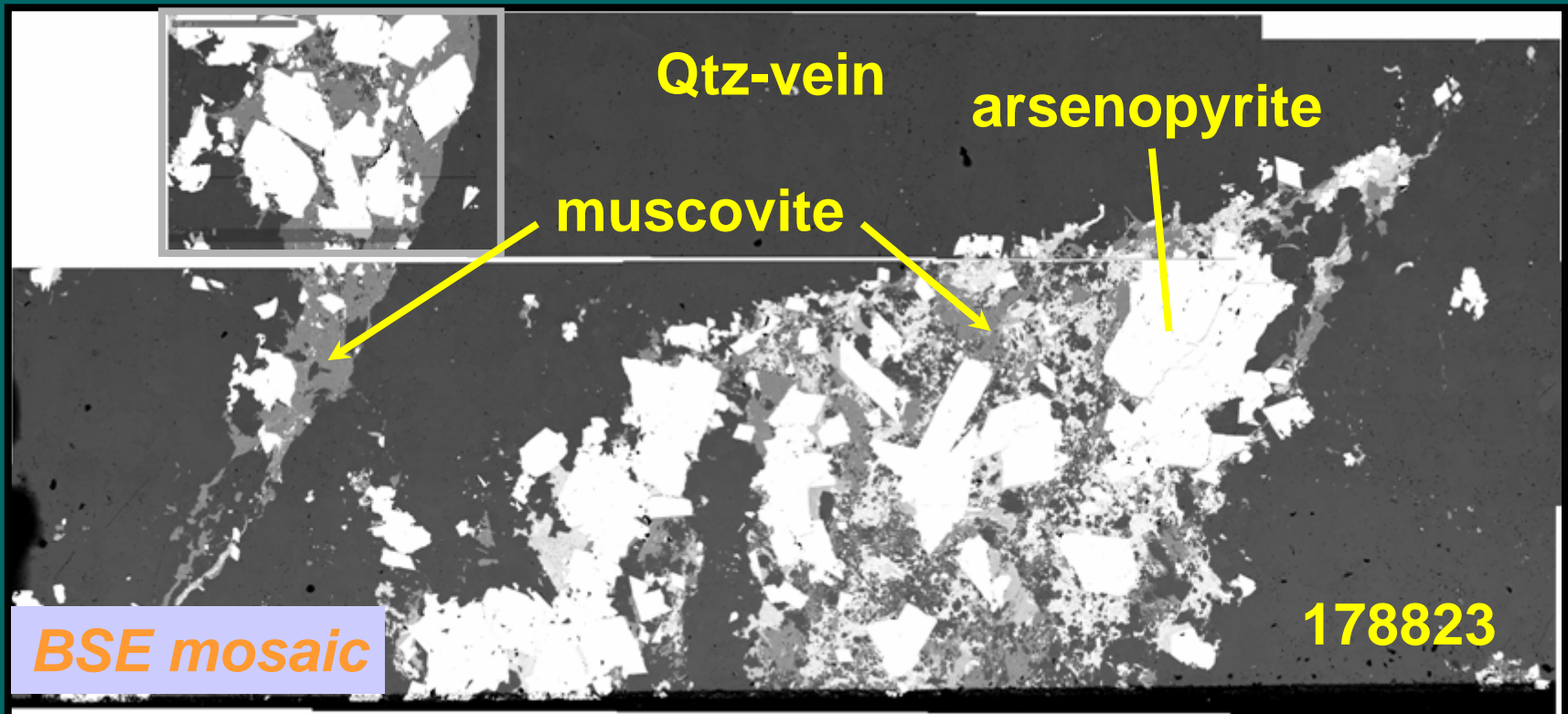
Consistent with:

**Xenotime U-Pb age 1803 ± 19 Ma
(Cross et al., 2005)**

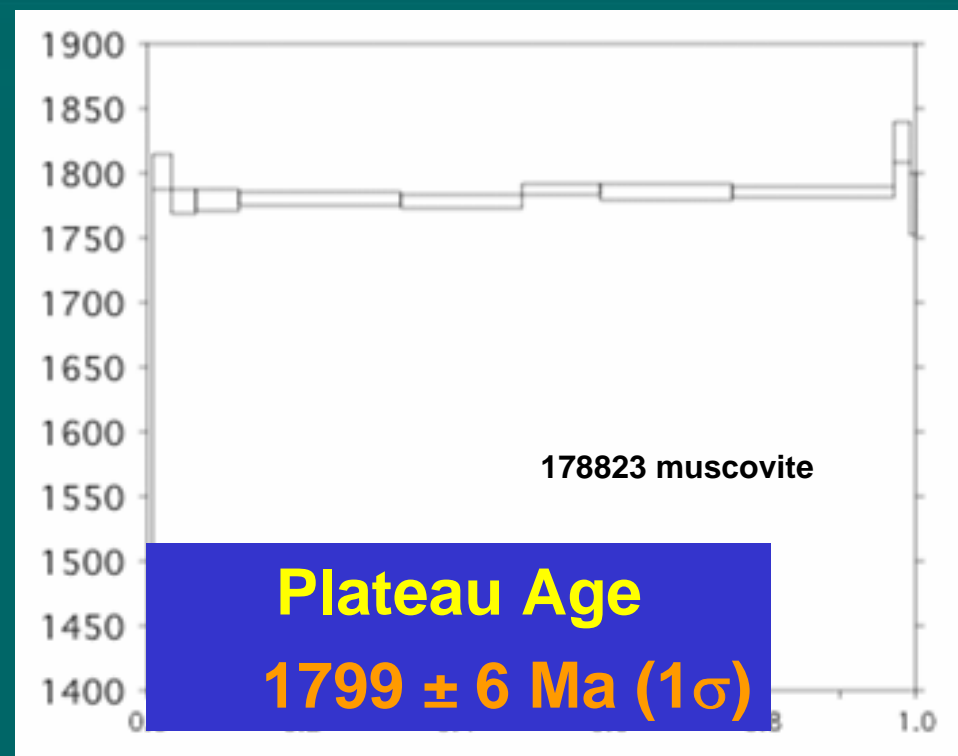
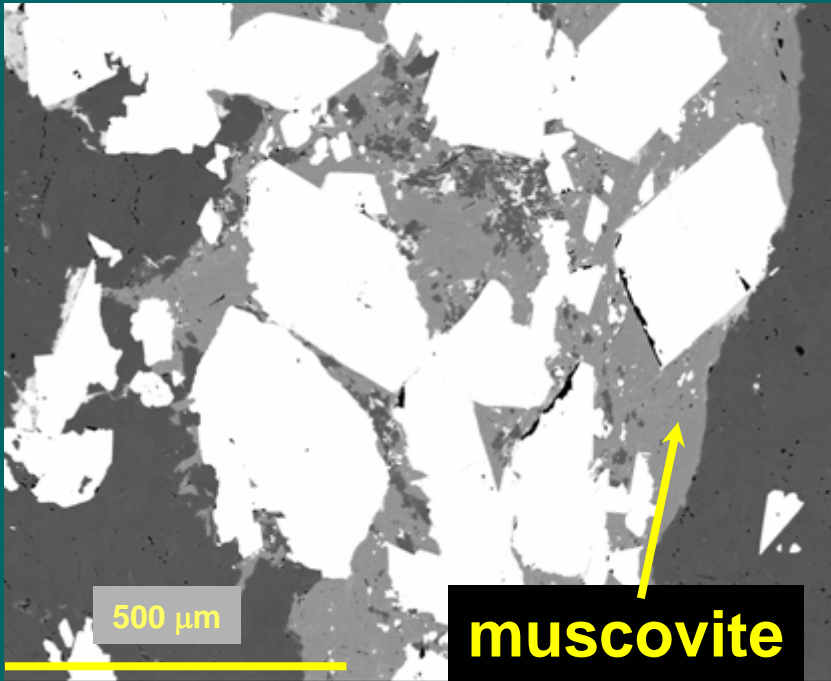
Sandpiper prospect

Muscovite intergrown with arsenopyrite in quartz veins and breccias

- muscovite syn-gold mineralization



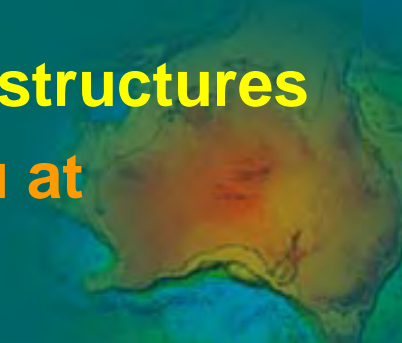
Sandpiper prospect



Consistent with U-Pb xenotime ages from Callie and Coyote
But Au hosted in the older Bald Hill sequence

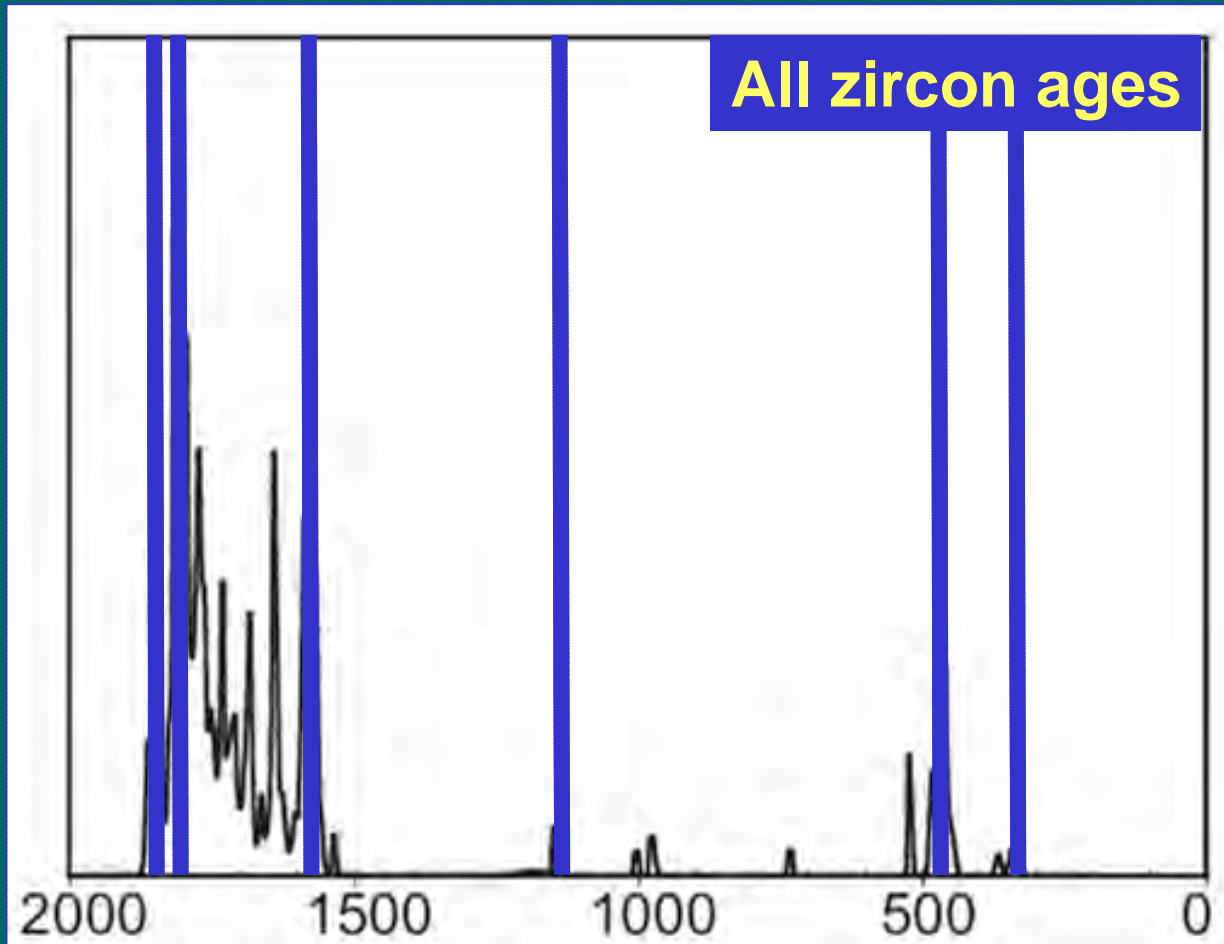
Field interpretation: Au associated with “early” structures

Argon age of ~1800 Ma is a minimum age for Au at Sandpiper

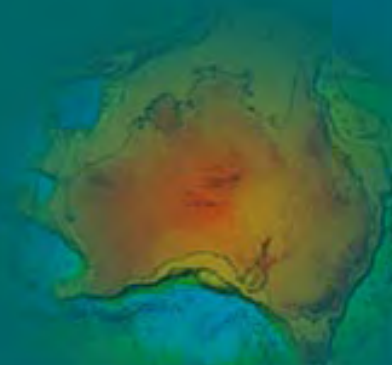


Conclusions - part 1

Much improved “event framework” for Tennant-Tanami-Arunta



- Stratigraphy
- Unconformities
- Deformation
- Magmatism



Conclusions - part 2

Much improved understanding of distribution and intensity of successive geological events

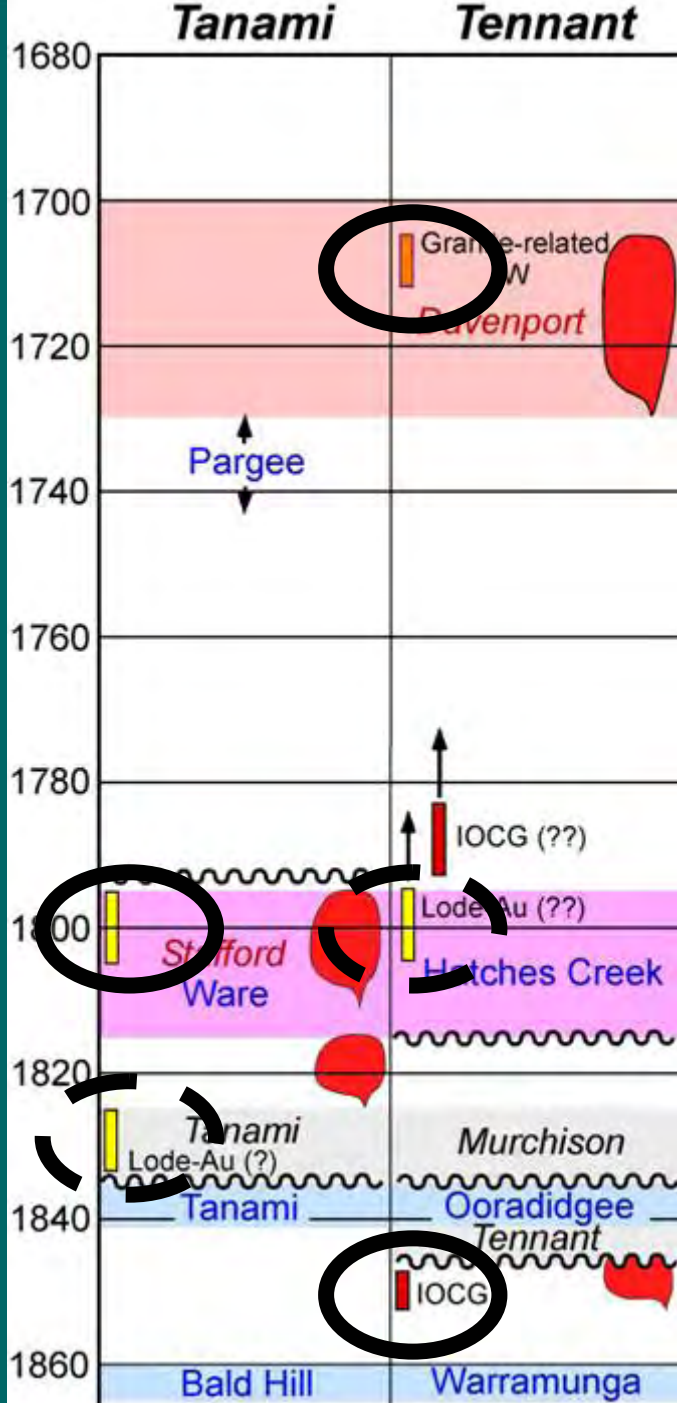
- Variety of complementary methods - consistent trends

Mesoprot. <1580 Ma

Neoprot. <1150 Ma

Warumpi

Palaeozoic



Conclusions - part 3

Improved constraints on:

- Geology
- Correlated regional “events”

Timing of mineralization

- Episodic

Better understanding of relationships between regional geology & mineralization

- Guides to exploration

