Australian Government

Geoscience Australia

Geochemical and stratigraphic tools for exploration undercover:

Tanami region, Northern Australia

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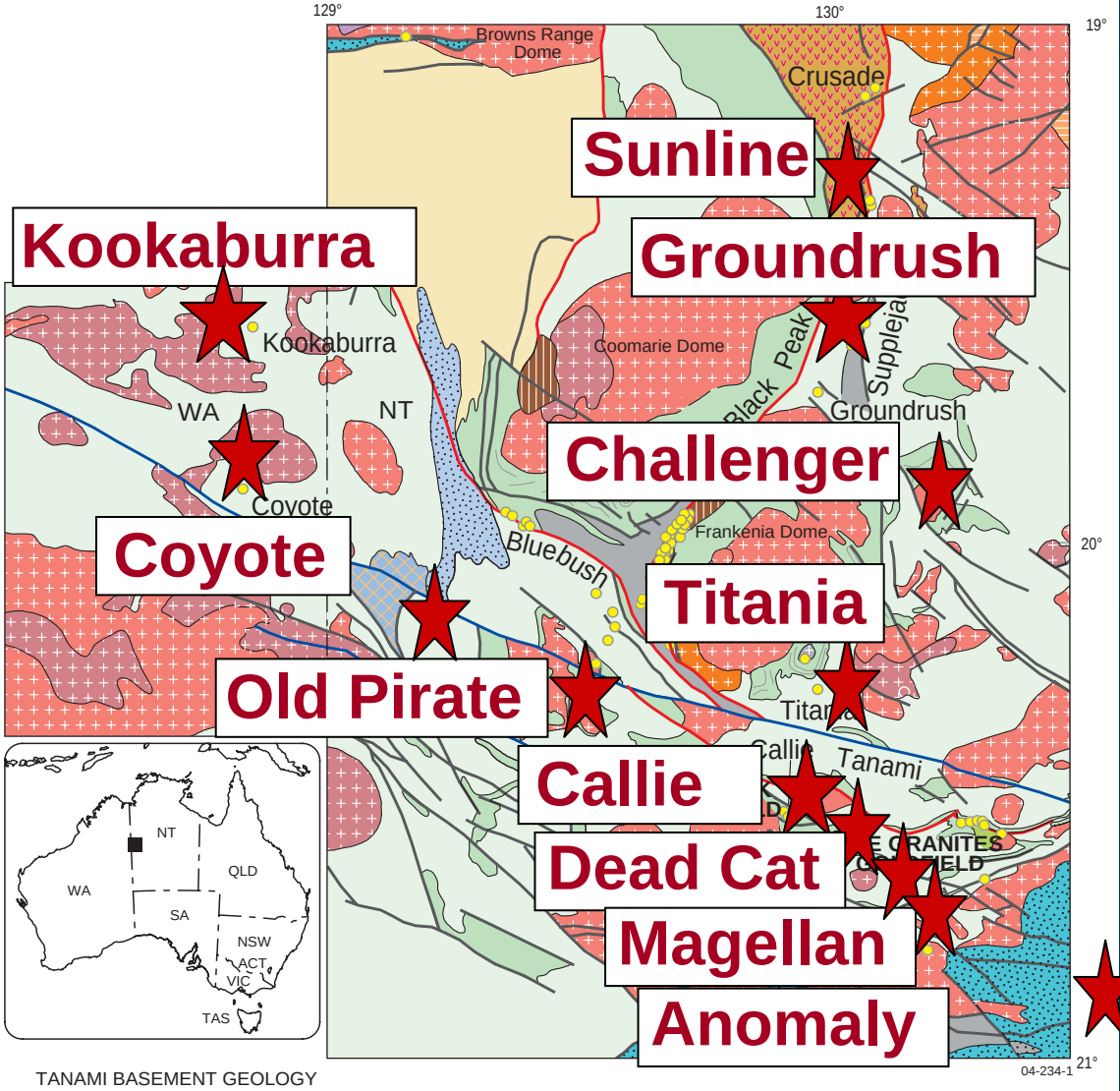
Overview:

Gold-hosting units in the Tanami region have been geochemically fingerprinted and placed in a stratigraphic model which has important implications for regional exploration

Geology of north-central Australia

Tanami Region

A Proterozoic Basin



{ Cashel 39km east of Anomaly in undifferentiated Tanami Group }

★ Drill or outcrop logs

Gold in the Tanami occurs in:

- **Shallow level, epizonal mineralisation**

- **Deep level, meso-thermal mineralisation, hosted by:**
  - **iron formations**
  - **metamorphosed mafic sill**
  - **turbidites**
  - **hosted by decarbonised siltstone, World-Class Callie deposit (> 6 MOz)**

75% of gold in the Tanami occurs in siltstone or fine greywackes

Evolution of Tanami basin Geochronology results

- Pargee Sst. < 1760 Ma.
- Mt Charles Formation.
- Ware Group < 1820 Ma.
- Killi Killi Formation 1840 Ma. Maximum depositional age
- Dead Bullock Formation 1838 ± 6 Ma. Depositional age
- Bald Hill 1864 ± 3 Ma. Magmatic crystallisation age

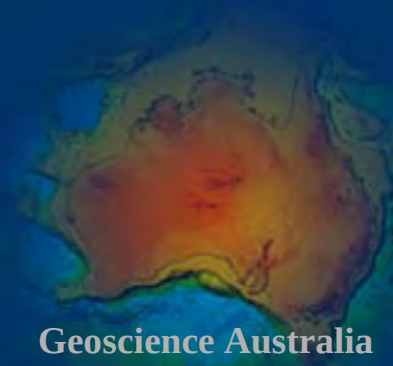
Need to use geochronology in conjunction with geochemistry to help elucidate the full story

Stratigraphic distribution of gold

Regional Stratigraphy	Au* (tonnes)
Pargee Sandstone	Nil
Mt Charles Formation	50.6
Ware Group	2.3
Killi Killi Formation	27.4
Dead Bullock Formation	270
Bald Hill Sequence	3.5

Tanami Group containing Callie stratigraphy

Au* tonnage calculated as a sum of gold resources, production and stockpile



Obstacles to Overcome

- Lack of outcrop in the Tanami
- Rocks that do outcrop are generally fine-grained greywackes or black shales
- Relatively shallow exploration holes
- Relating mine stratigraphy nomenclature to regional stratigraphy

Approach

- Downhole geochemistry to distinguish gold-bearing lithologies

- Use Th/Sc combined with Cr values to define the gold-bearing lithologies
  - High Cr indicative of a mafic provenance
  - High Th/Sc indicative of a felsic provenance

- Build composite cores of Dead Bullock & Mt Charles Formations

- Dead Bullock & Mt Charles Formations which contain in excess of 320 tonnes of gold combined

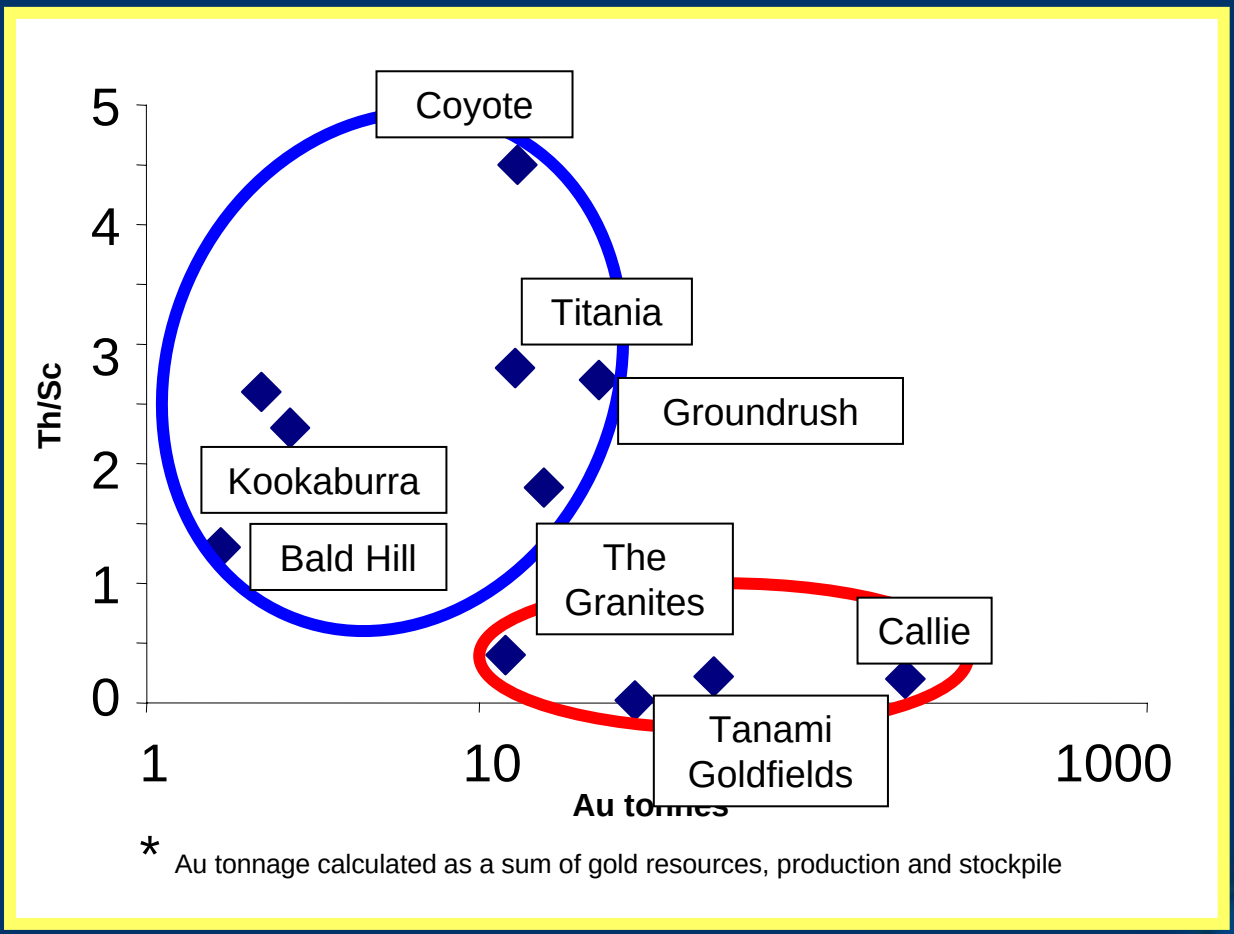
Approach

- Use isotopic data to differentiate between Dead Bullock & Mt. Charles Formations

- Log grain size and sedimentary features from diamond drill cores & limited outcrop logs

- Use Sequence stratigraphy to predict where we can find possible gold-bearing fine-grained greywackes and black shales within the Tanami

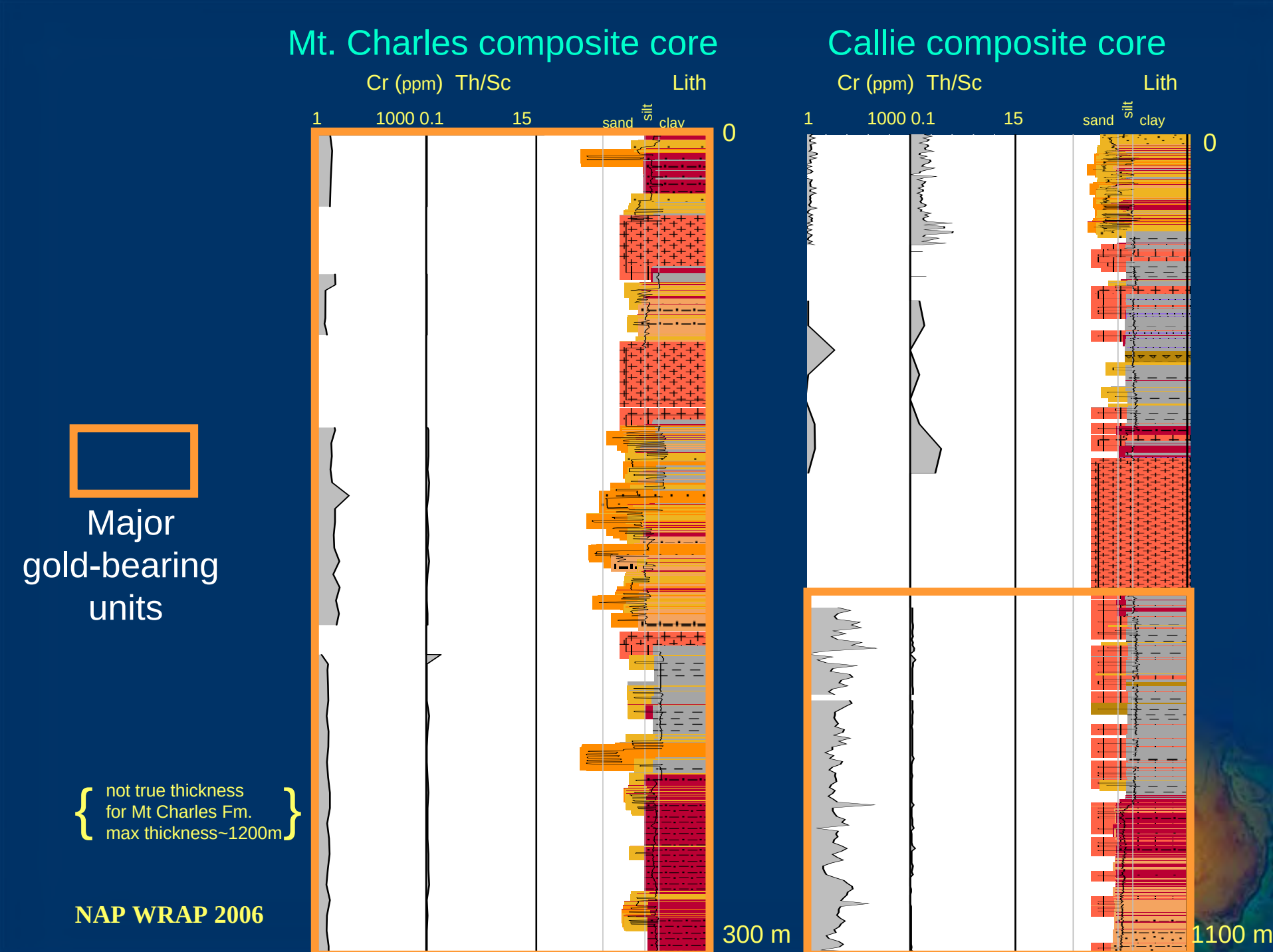
Th/Sc vs. Au Tonnes



Regional framework

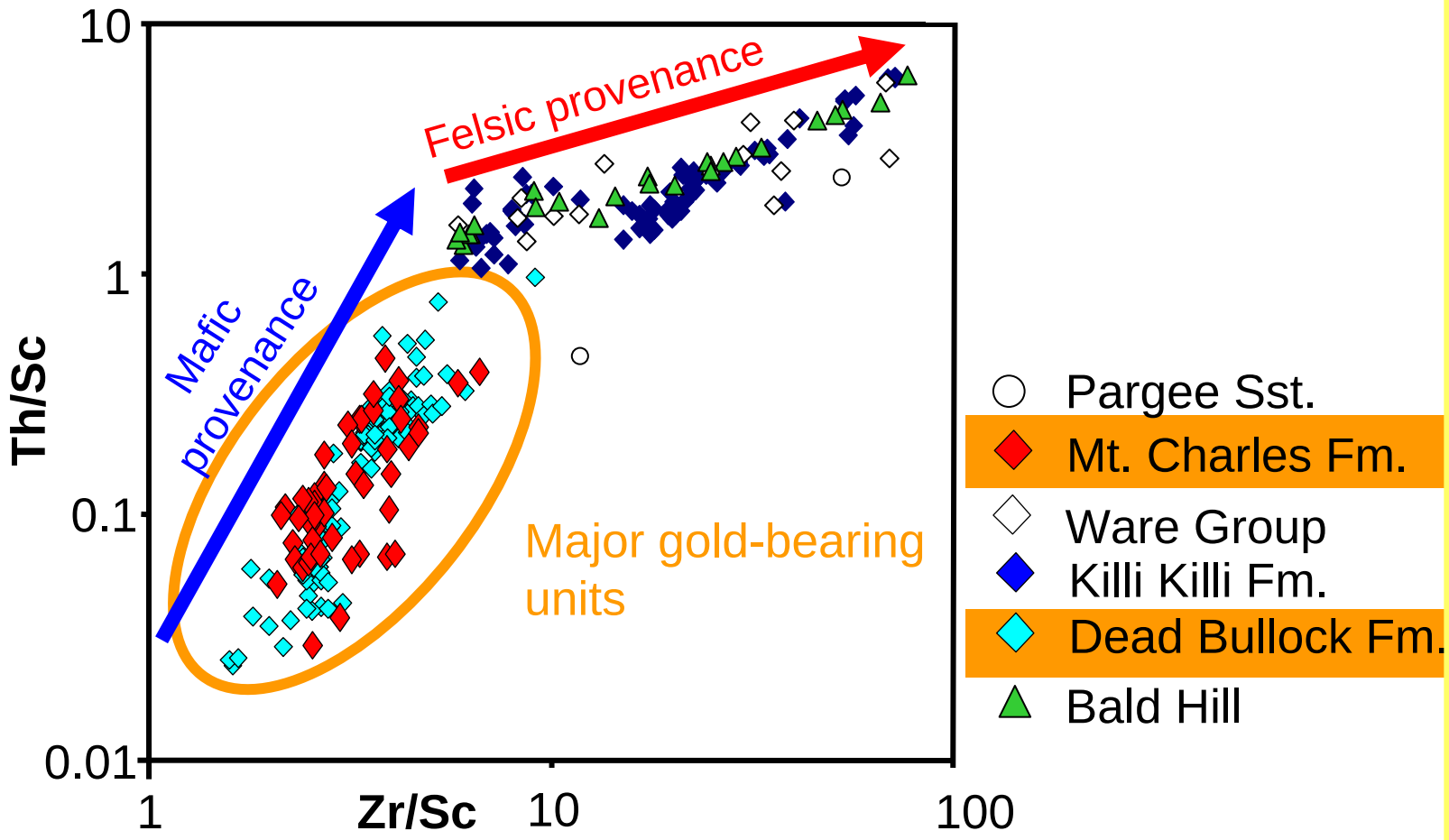
- How do the composite drill holes at Callie and Tanami Gold fields relate to the regional stratigraphy?

- Can we use whole-rock and isotope geochemistry to distinguish the regional stratigraphy in relation to the Callie and Mt Charles stratigraphy?


Mt. Charles composite core
Cr (ppm)
Th/Sc
Lith
1
1000 0.1
15
sand
silt
clay
0
300 m
Callie composite core
Cr (ppm)
Th/Sc
Lith
1
1000 0.1
15
sand
silt
clay
0
1100 m
Major gold-bearing units
not true thickness for Mt Charles Fm. max thickness~1200m
NAP WRAP 2006

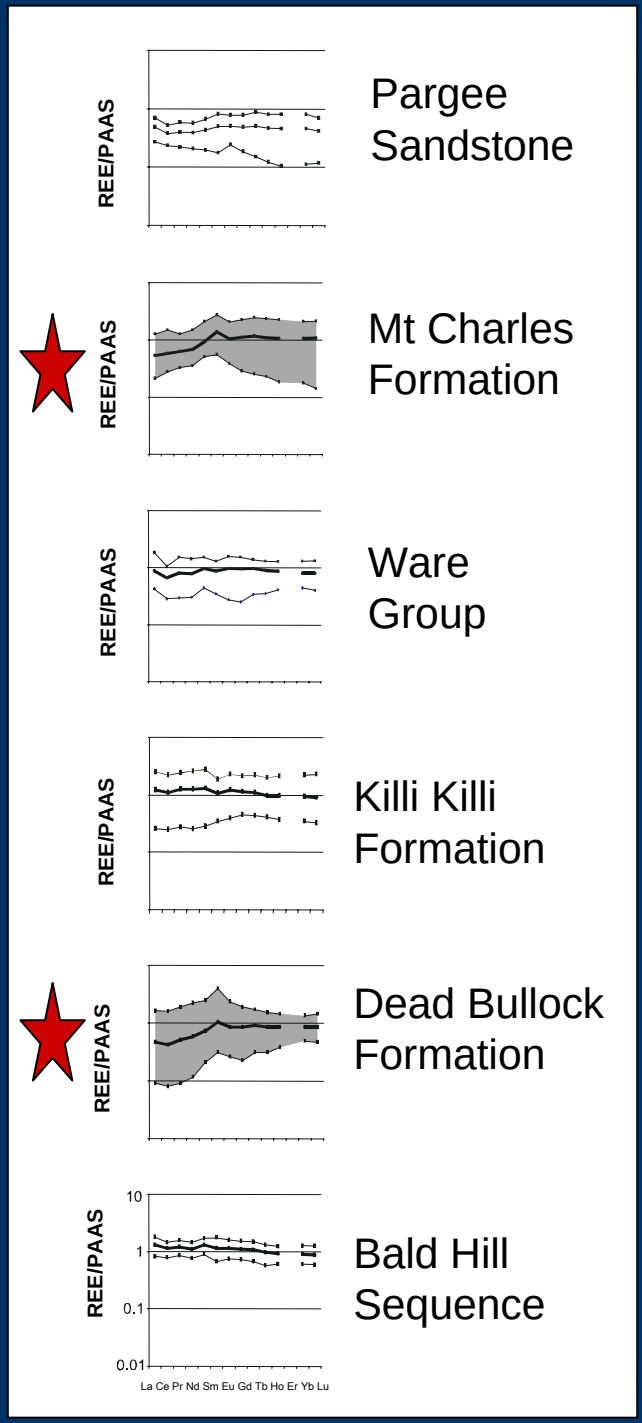
A kinked continuum

Compositional variations due to change in provenance



Regional Stratigraphy:

Rare earth element traces



- Maximum
- Average
- Minimum

Felsic sediments
Au tonnes (Nil)
n = 2

Mafic sediments
Au tonnes (56.6)
n = 57

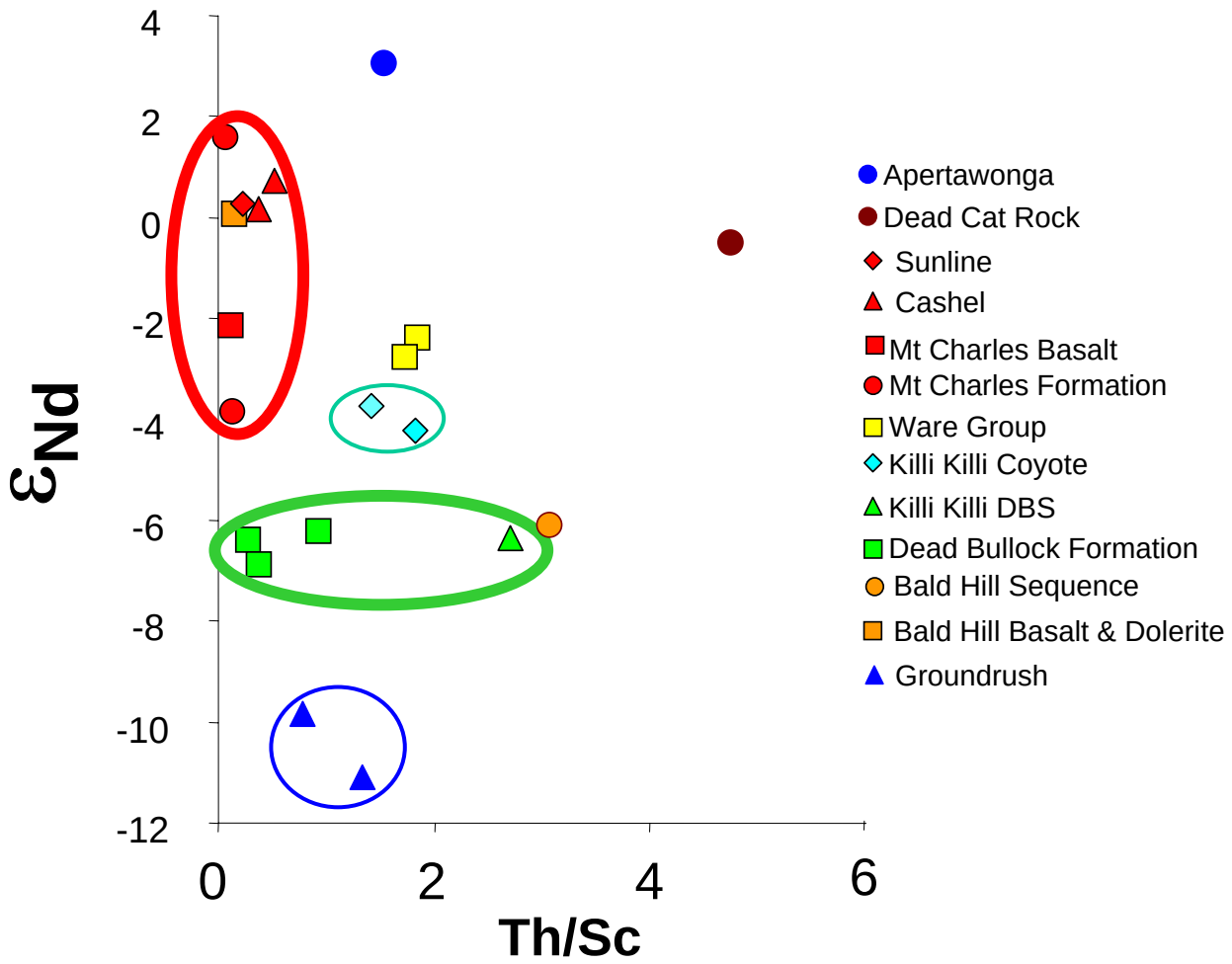
Felsic sediments
Au tonnes (2.3)
n = 6

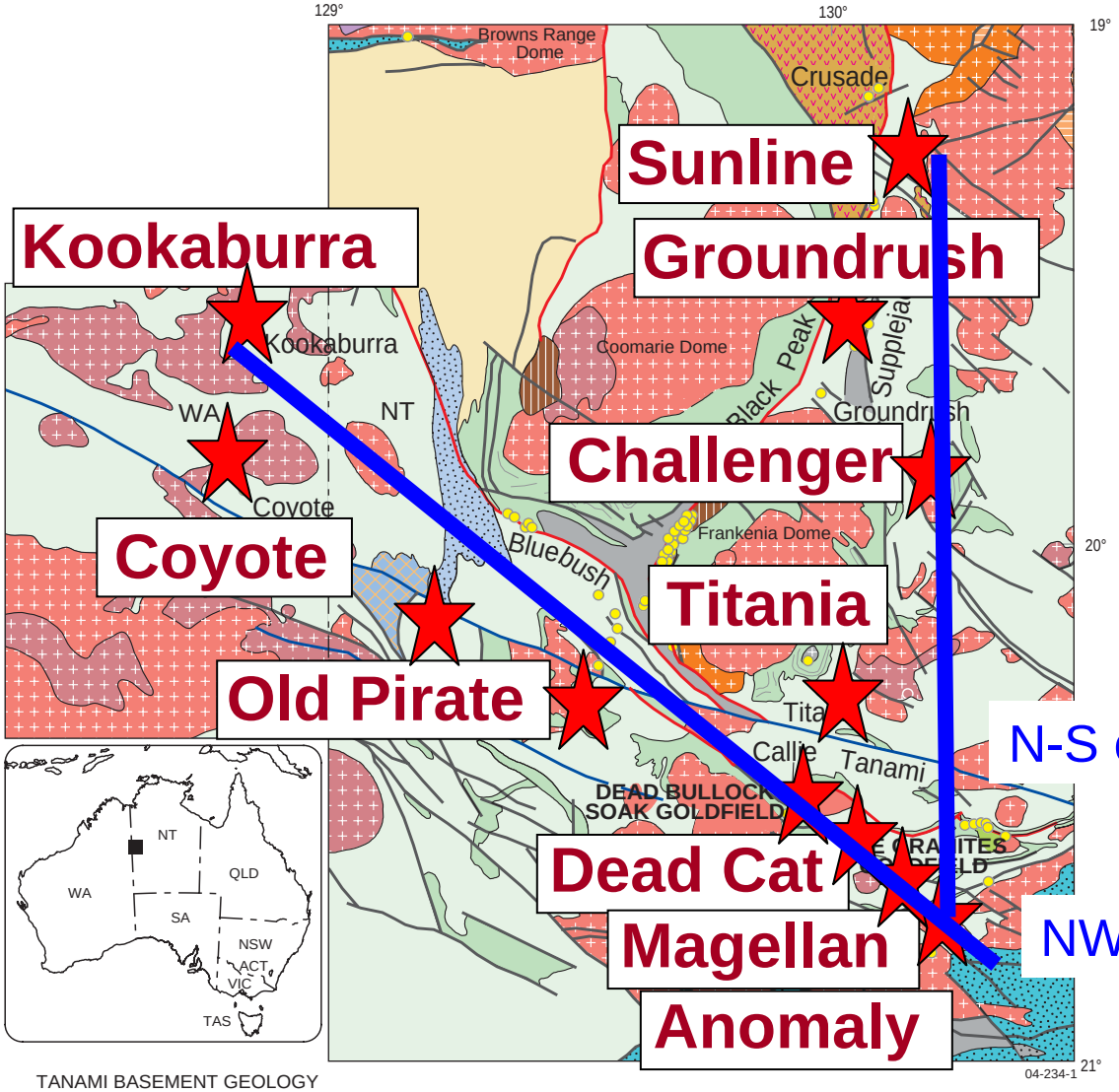
Felsic sediments
Au tonnes (27.4)
n = 76

Mafic sediments
Au tonnes (270)
n = 102

Felsic sediments
Au tonnes (3.5)
n = 29

ε_{Nd} values





Cross-sections constructed using whole-rock and isotope geochemistry

N-S cross-section

NW-SE cross-section

Drill or outcrop logs

North south Tanami transect

Sediments above this line are interpreted as Killi Killi Formation

N

Sunline

Jasper Hills

Challenger Trig

Titania

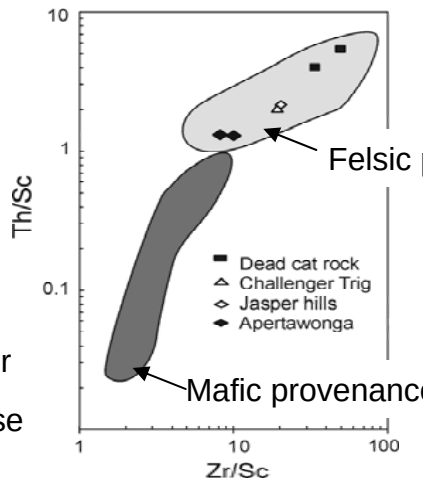
Callie

Dead Cat Rock

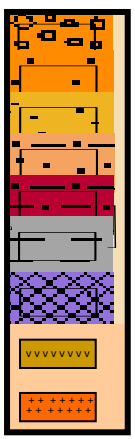
S

Sediments below this line are interpreted as Dead Bullock Formation

Outcrop samples



Ferdies Lower Callie Sequence



Conglomerate granule to boulder

Sandstone medium to very coarse

Sandstone very fine to fine

Sandy siltstone

Siltstone

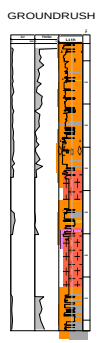
Shale

Chert

Fault Breccia

Dolerite

Groundrush



Metres ?

Groundrush is interpreted by the NTGS to be stratigraphically below Callie however, the stratigraphic distance separating the units is not known.

North west – south east Tanami transect

Black shales can occur in the Killi Killi Formation, felsic geochemistry

Coyote

Old Pirate

Callie

Cr Th/Sc

Anomaly

Magellan

Cashel

Apertawonga

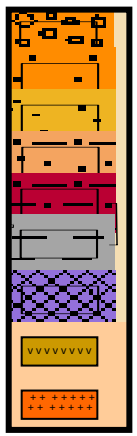
Dead Cat Rock

Sediments above this line are interpreted as Killi Killi Formation

NW

SE

Sediments below this line are interpreted as Dead Bullock Formation



Conglomerate granule to boulder

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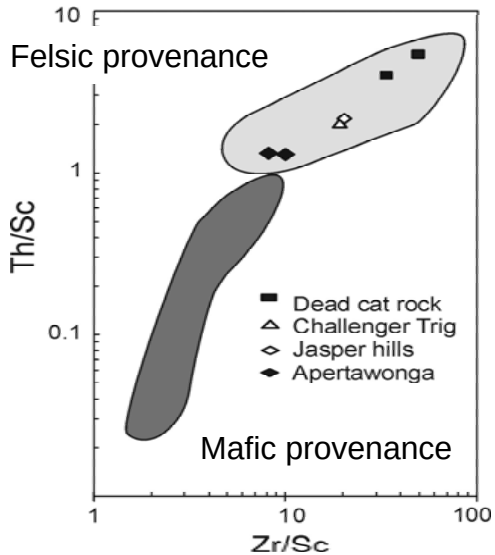
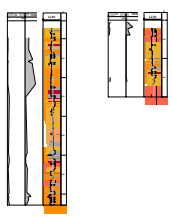
Outcrop samples



Bald Hill

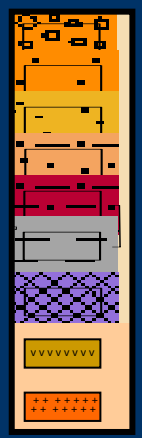
Kookaburra



The Bald Hill Sequence has a depositional age That is older than Callie but the distance separating the units is not known.

Callie composite core

Callie composite core displays supersequence scale stratigraphy



Conglomerate granule to boulder

Sandstone medium to very coarse
Sandstone very fine to fine

Sandy siltstone
Siltstone
Shale

Chert

Fault Breccia

Dolerite

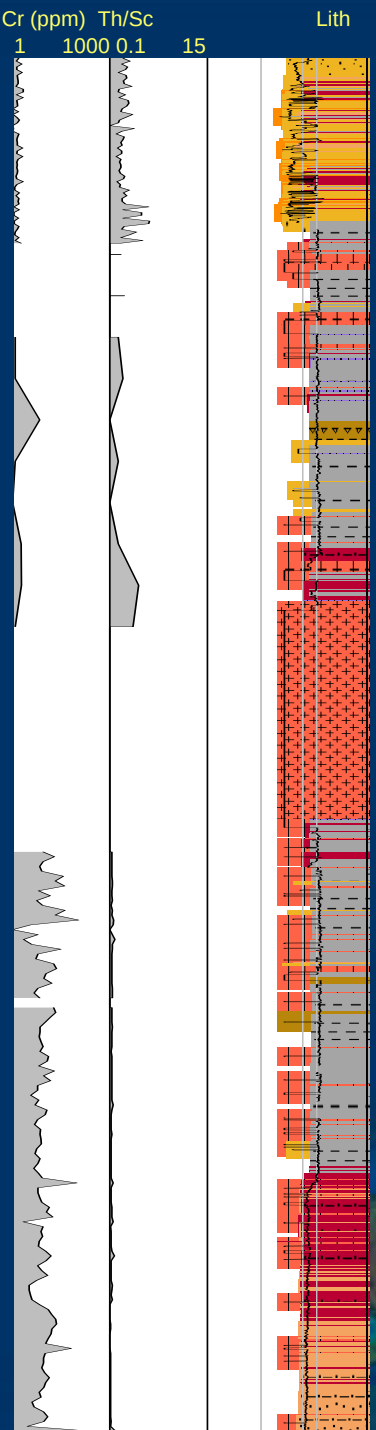
NAP WRAP 2006

Progradation

Aggradation

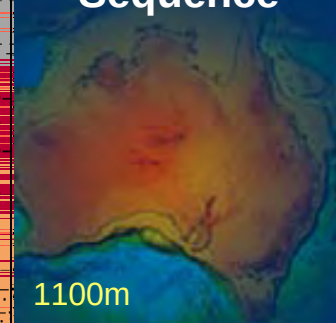
World class deposit

Transgression

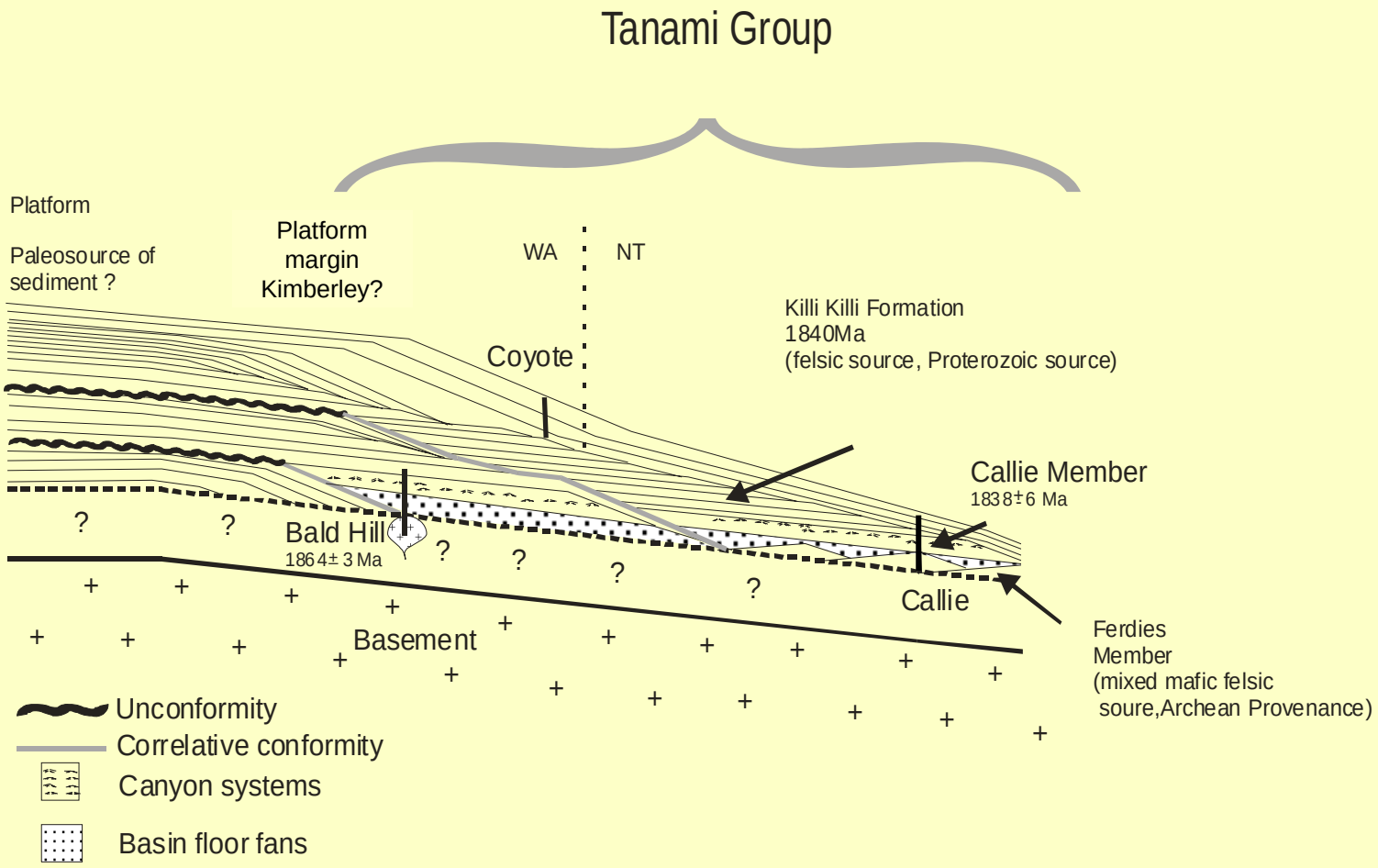


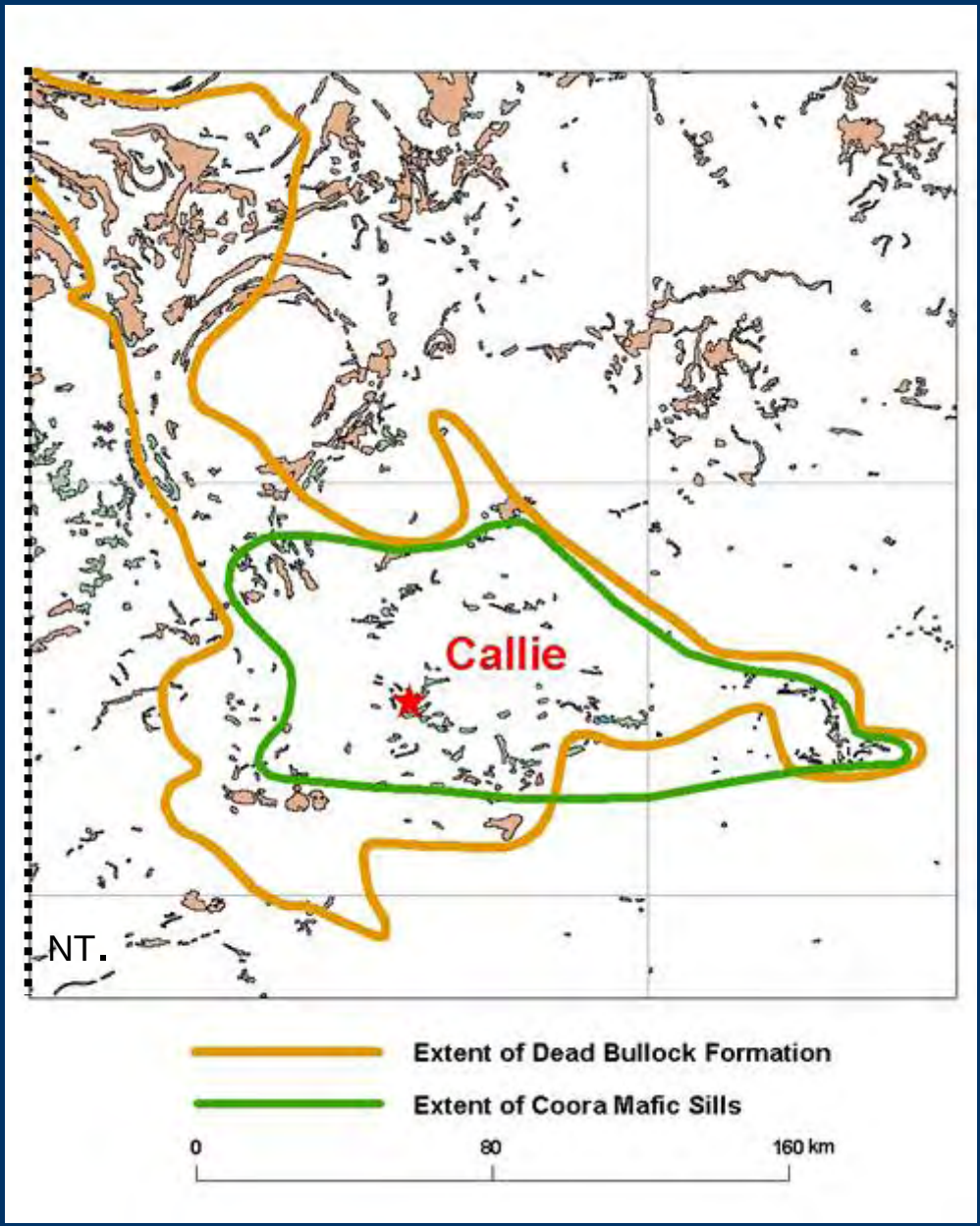
Killi Killi Formation

Ferdies Lower Callie Sequence



Stratigraphic model for Tanami region





Black shale distribution

- Suggests Dead Bullock Formation (black shales) largely restricted to NT

Conclusions

Geochemistry:

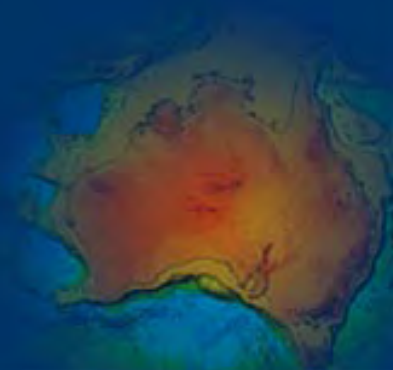
Effective discriminators define the strongly mineralised mafic group:

- ✓ High Cr values
- ✓ Low Th/Sc values
- ✓Light REE depletion
- ✓ Low ε_{Nd} values

Conclusions

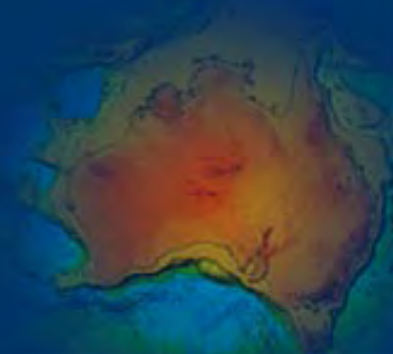
Stratigraphic Model for the Tanami Region:

- ✓ The Killi Killi Formation may represent a series of Low Stand prograding diachronous turbiditic packages.
- ✓ Ferdies Lower Callie Sequence represents a sediment-starved, deep water environment distal to land.
- ✓ The Bald Hill Sequence could form part of these earlier diachronous packages or it could be part of a unit not recognized in the Northern Territory.



Questions that remain?

- Correlating logs over a large area?
- We only have a very basic basin structure
- Can only identify super sequence scale packages
- This technique only works where end members of the Stratigraphy are of different compositions



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Jim Anderson (Tanami Gold)

NEWMONT AUSTRALIA

Northern Territory Geological Survey

TANAMI GOLD NL

Samarium and Neodymium dating

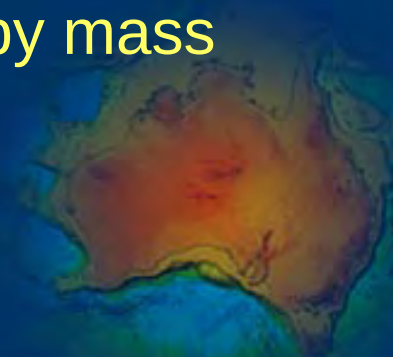
What is it and how do we measure it?

•Samarium (^{147} Sm) is radioactive and decays to neodymium (^{143}Nd).

• Decay process is very slow as the half life of ^{147}Sm is 106 billion years.

• Over geologic time, the decay of ^{147}Sm to ^{143}Nd results in changes in the abundance of ^{143}Nd relative to the other Nd isotopes.

• These small variations are measured precisely by mass spectrometers.

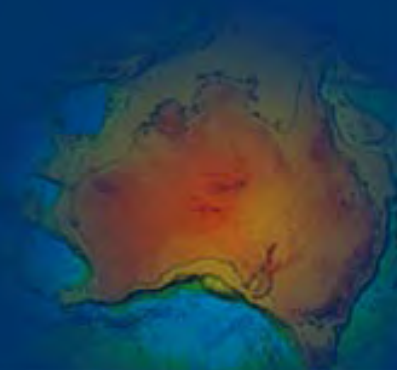


Sedimentary Rocks

Studies show that Nd isotopic characteristics are a good indicator of Sediment provenance, and that the information is complementary to that provided by other methods of provenance determination.

Studies also show confirm that interlayed coarse-grained beds and fine grained beds give the same isotopic results. Important because it is almost Impossible to determine provenance of fine grained sediments petrographically

Mixing is a special process in that isotopic ratios in the endmember compositions of a mixture may be different, so in the process of mixing one component into an other, shifts the isotopic ratio as well as shifts chemical composition



Downhole geochemistry of Callie composite core

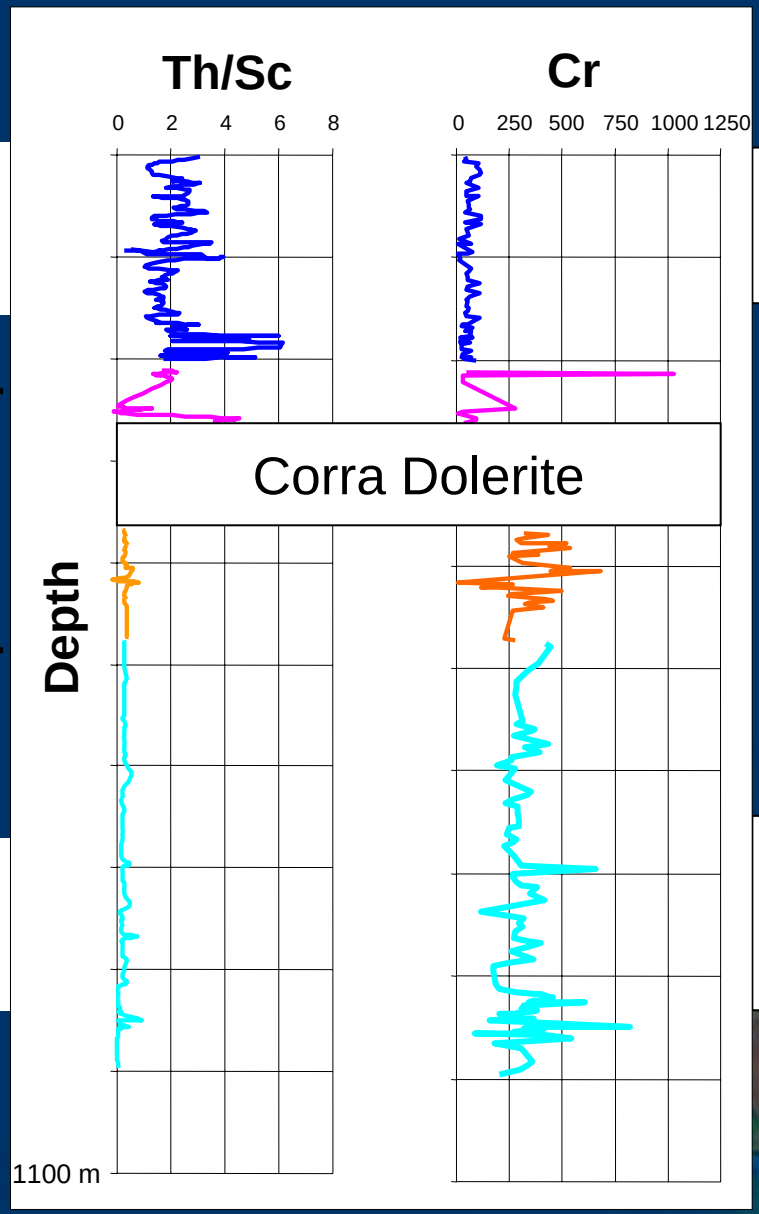
High Th/Sc indicative of a felsic provenance

Felsic Provenance

Intermixing
between provenances

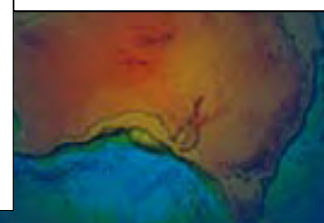
High Cr indicative of a mafic provenance

Mafic Provenance



Killi Killi Formation

Dead Bullock Formation



Geology of north-central Australia

Tanami Region