Tanami Regional Geochemistry and Sequen Tools for Future Exploration

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

Occurrence of Gold in the Tanami

- Shallow-level epizonal mineralization
- Deep-level mesothermal mineralization hosted by:
  - Iron formation
  - Metamorphosed mafic sill
  - Turbidites
  - Decarbonized siltstone, e.g., Callie deposit (>6 Moz)
- 75% of gold in the Tanami occurs in siltstone or fine greywackes

Regional Stratigraphy	Au (tonnes)*	
Pargee Sandstone	Nil	
Mt. Charles Formation	50.6	
Ware Group	2.3	
Killi Killi Formation	27.4	} Tanami Group containing Callie stratigraphy
Dead Bullock Formation	270	} Tanami Group containing Callie stratigraphy
Bald Hill Sequence	3.5	
Archean	Nil	

*Tonnage calculated as a sum of gold, resource, 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
- Dead Bullock Formation and Mt. Charles Formations which contain in excess of 320 tonnes of gold combined
- Use isotopic data to differentiate between Dead Bullock and Mt. Charles Formations
- Log grain size and sedimentary features from diamond drill cores and limited outcrop logs

Callie Mine stratigraphy: World-class gold mine within the Tanami Group

Callie mine stratigraphy was simplified and divided into four distinctive groups listed below. The formalized names of the Northern Territory Geological Survey have been used for this study.

Mine Stratigraphy Nomenclature	Regional Stratigraphy Name (NTGS)	
Madigan Beds	Killi Killi Formation	
Seldom Seen Schist		} Upper Callie Member (UCM)
Manganiferous Cherts		} Upper Callie Member (UCM)
Colgate Schist		} Upper Callie Member (UCM)
Schist hills Iron Member		} Upper Callie Member (UCM)
Dead Bullock Member		} Upper Callie Member (UCM)
Coora Dolerite		
Upper Orac Schist		} Middle Callie Member (MCM)
Upper Orac Chert		} Middle Callie Member (MCM)
Mid Orac Schist		} Middle Callie Member (MCM)
Lower Orac Chert		} Middle Callie Member (MCM)
Lower Orac Schist		} Middle Callie Member (MCM)
Federation Member		} Middle Callie Member (MCM)
Orac Boudin Chert		} Middle Callie Member (MCM)
Upper Blake Beds		} Ferdies Lower Callie Sequence (FLCS) / Contains world-class Callie Deposit
Pip Schist		} Ferdies Lower Callie Sequence (FLCS) / Contains world-class Callie Deposit
Callie Boudin Chert		} Ferdies Lower Callie Sequence (FLCS) / Contains world-class Callie Deposit
End it all Dolerite		} Ferdies Lower Callie Sequence (FLCS) / Contains world-class Callie Deposit
Magpie Schist		} Ferdies Lower Callie Sequence (FLCS) / Contains world-class Callie Deposit
Magpie Schist Transition		} Ferdies Lower Callie Sequence (FLCS) / Contains world-class Callie Deposit
Callie Laminated Beds		} Ferdies Lower Callie Sequence (FLCS) / Contains world-class Callie Deposit
Lower Blake Beds		} Ferdies Lower Callie Sequence (FLCS) / Contains world-class Callie Deposit
Lower Blake Laminations		} Ferdies Lower Callie Sequence (FLCS) / Contains world-class Callie Deposit

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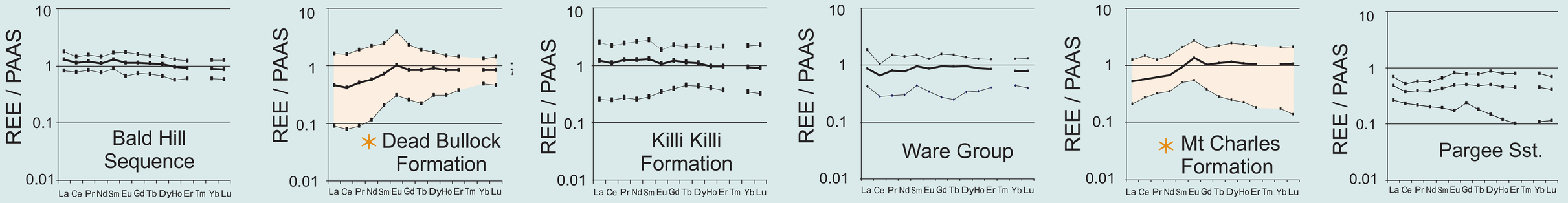
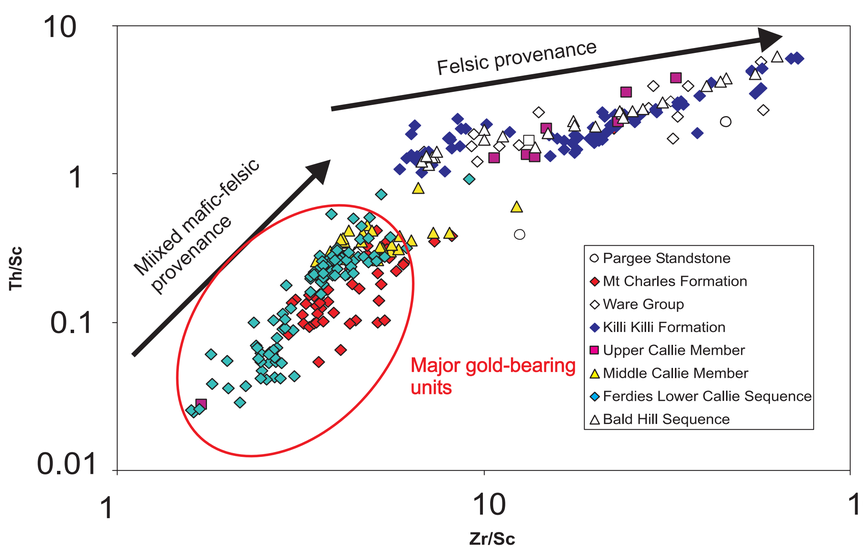
ce Stratigraphic Interpretation:



Geochemistry

The main gold-bearing units (✳) when normalized to Post Archean Australian Shale (PAAS) have distinctive Rare earth element patterns (depleted in light REEs)

Sedimentary provenance indicators in Callie composite core help to define major gold-hosing units

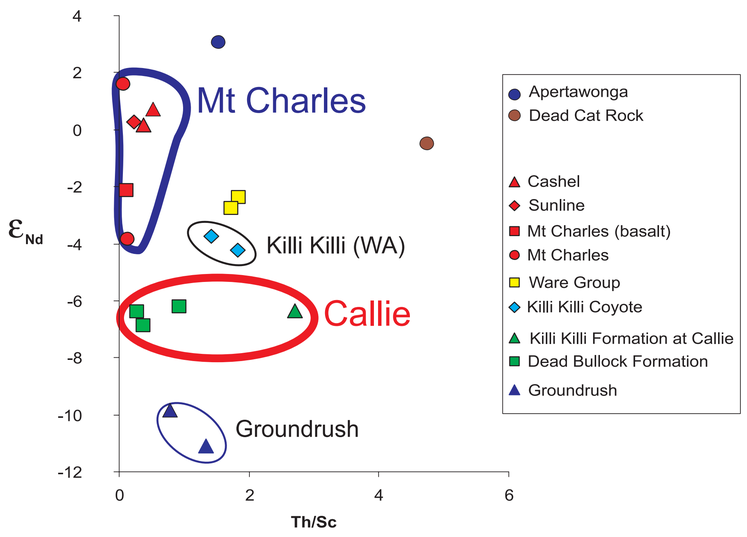


A Kinked Continuum:

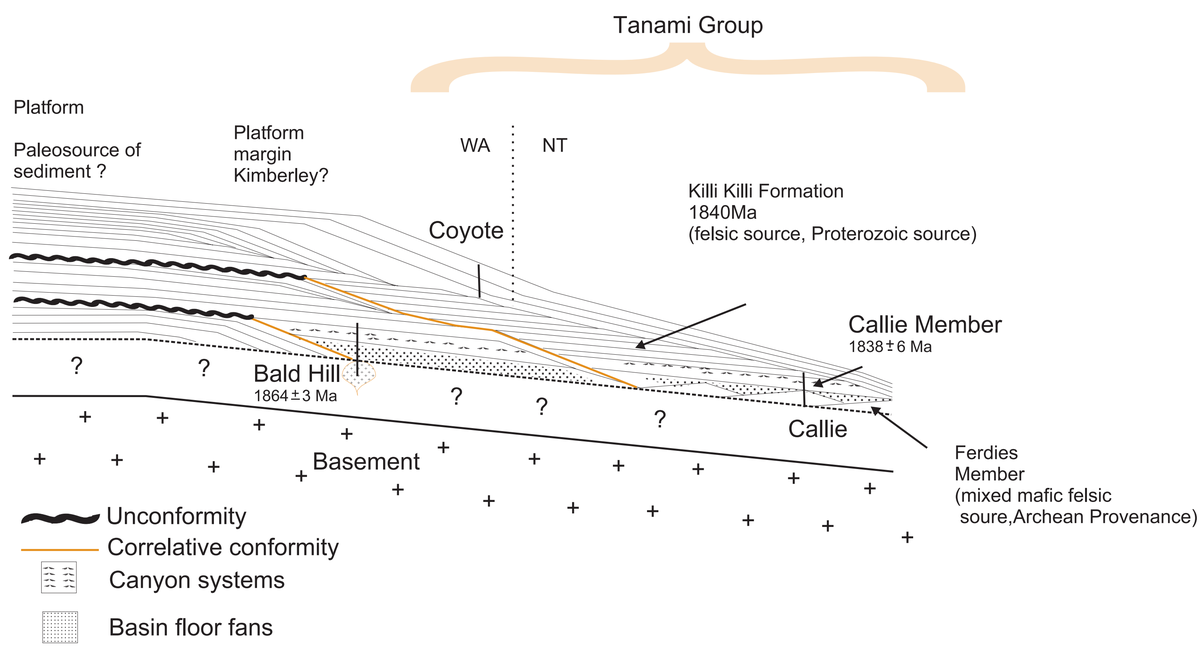
Compositional variations due to change in provenance

- Th/Sc and Zr/Sc are used to distinguish the provenance of sedimentary rocks. This technique has the added benefit that all of these elements are generally immobile, and use of ratios eliminates potential problems associated with mass change during hydrothermal alteration.
- The Th/Sc vs. Zr/Sc plot above uses data from Dead Bullock Soak goldfield as a template to overlie the regional geochemistry. The data from Dead Bullock Formation and Killi Killi Formation show a bipartite distribution. The gold-bearing Dead Bullock and Mt. Charles Formations have substantially lower Th/Sc and Zr/Sc values than the Bald Hill Sequence, Killi Killi Formation, Ware Group, and Pargee Sandstone.
- The Ferdies Lower Callie Sequence contains the world-class Callie gold deposit. The Th/Sc vs. Zr/Sc plot can be used as an exploration tool to recognize favourable parts of the stratigraphy and hence help to identify additional world-class gold deposits in the Tanami region.

Nd-isotopes can distinguish between the two main gold-bearing units



Stratigraphic Model for the Tanami Region



Using a supersequence model the composite section at Dead Bullock Soak goldfield represents a transgressive/regressive suite with four distinctive geochemical units.

We interpret the Ferdies and Callie Members, which host the Dead Bullock Soak deposit, to be a relatively deep water (below storm wave base marine transgressive-aggradational package with multiple higher order condensed sections.

Higher order condensed sections contain the ore zones within black carbonaceous shales and iron formations.

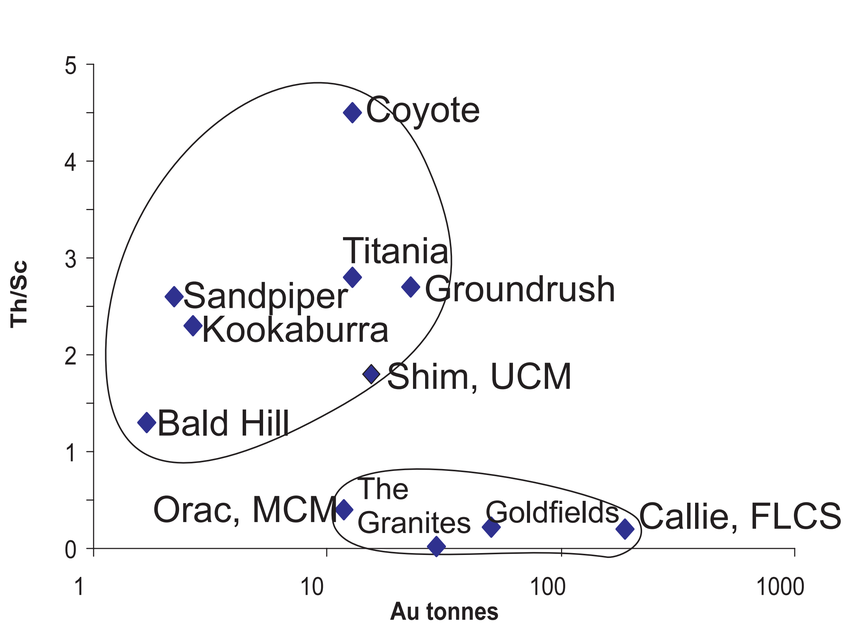
The Killi Killi Formation may represent a series of Low Stands prograding diachronous turbiditic packages.

We interpret the Ferdies Lower Callie Sequence to represent a sediment-starved, deep water environment distal to land. Minor occurrences of silt rip-up clasts within a silt matrix and coarser greywackes probably represent the distal toes of infrequent higher energy turbidites.

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.

Th/Sc plotted to gold tonnage

This graph demonstrates that low Th/Sc ratios define the most productive gold mines.



Tanami north south cross-section displaying downhole lithology and Cr and Th/Sc compositions

World-class gold-bearing Callie Stratigraphy is highlighted by high Cr (100-800 ppm) and low Th/Sc values (<2)

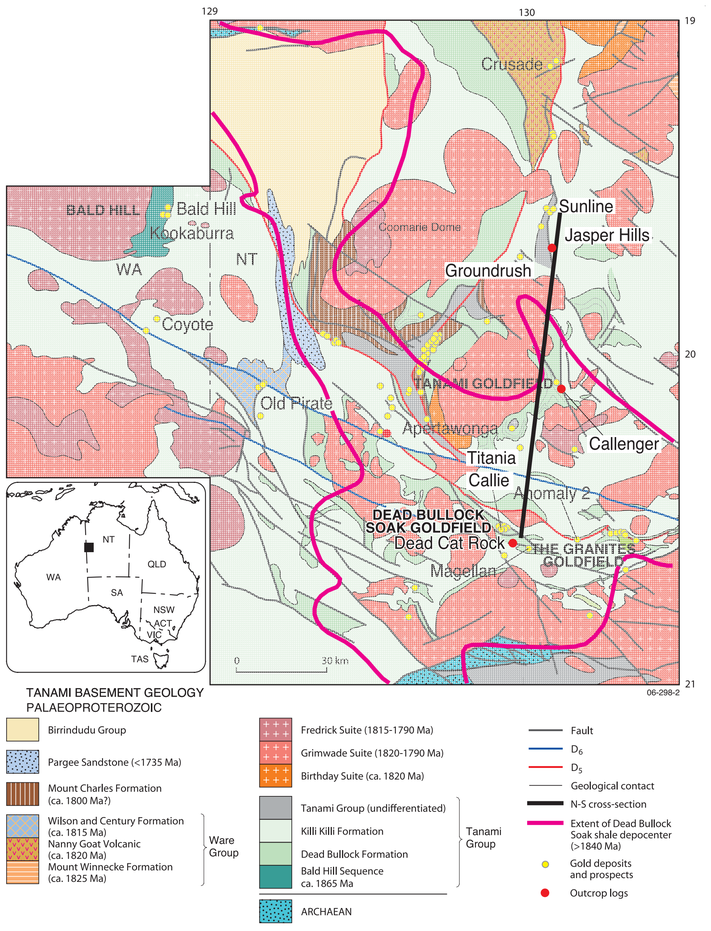
Construction of the Callie composite core

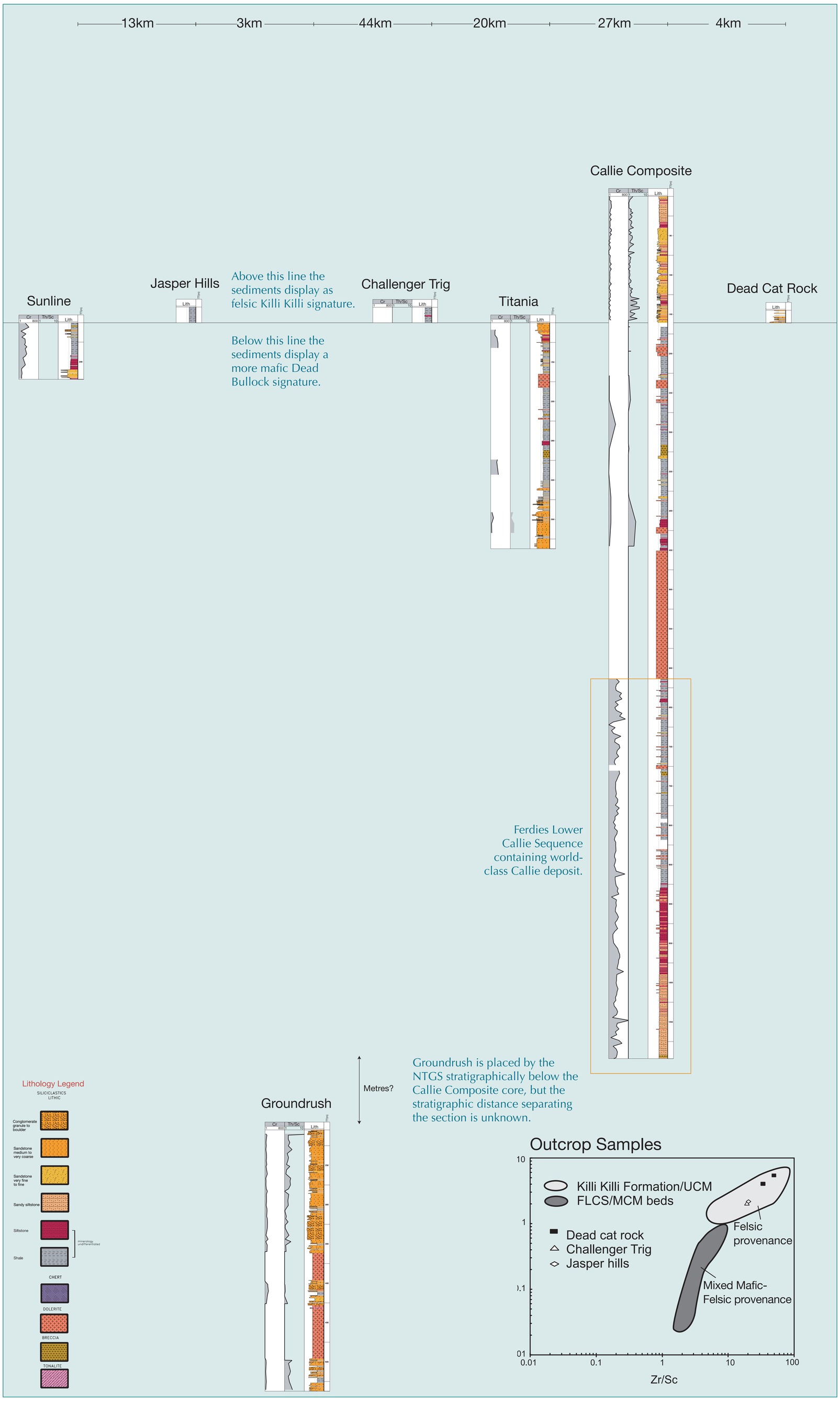
- A Callie composite log was constructed to use as a baseline for more regional studies
- Cores from three diamond drill holes; DBD434, DBDX885_2088 and DBD378 were selected for logging and sample collection from the Dead Bullock Soak goldfield.
- These drill cores were selected in consultation with Newmont mine geologists to cover the full stratigraphic succession and avoid structural complications.
- Data from these cores were combined produce a composite section which was used as a regional template for geochemical and stratigraphic work as shown in panel 3 and 4.

Outcrop samples are shown on the Th/Sc vs. Zr/Sc plot as shown on panel 2. All the outcrop samples in this study plot within the less mineralized Killi Killi Formation.

Interpretation of Sunline

Based on Cr and Th/Sc compositions the Sunline prospect resembles the geochemistry of the Ferdies Lower Callie Sequence. However, Nd isotope data indicates that Sunline is more similar to Mt. Charles geochemistry (refer to ε_{Nd} vs. Th/Sc plot on panel 2).





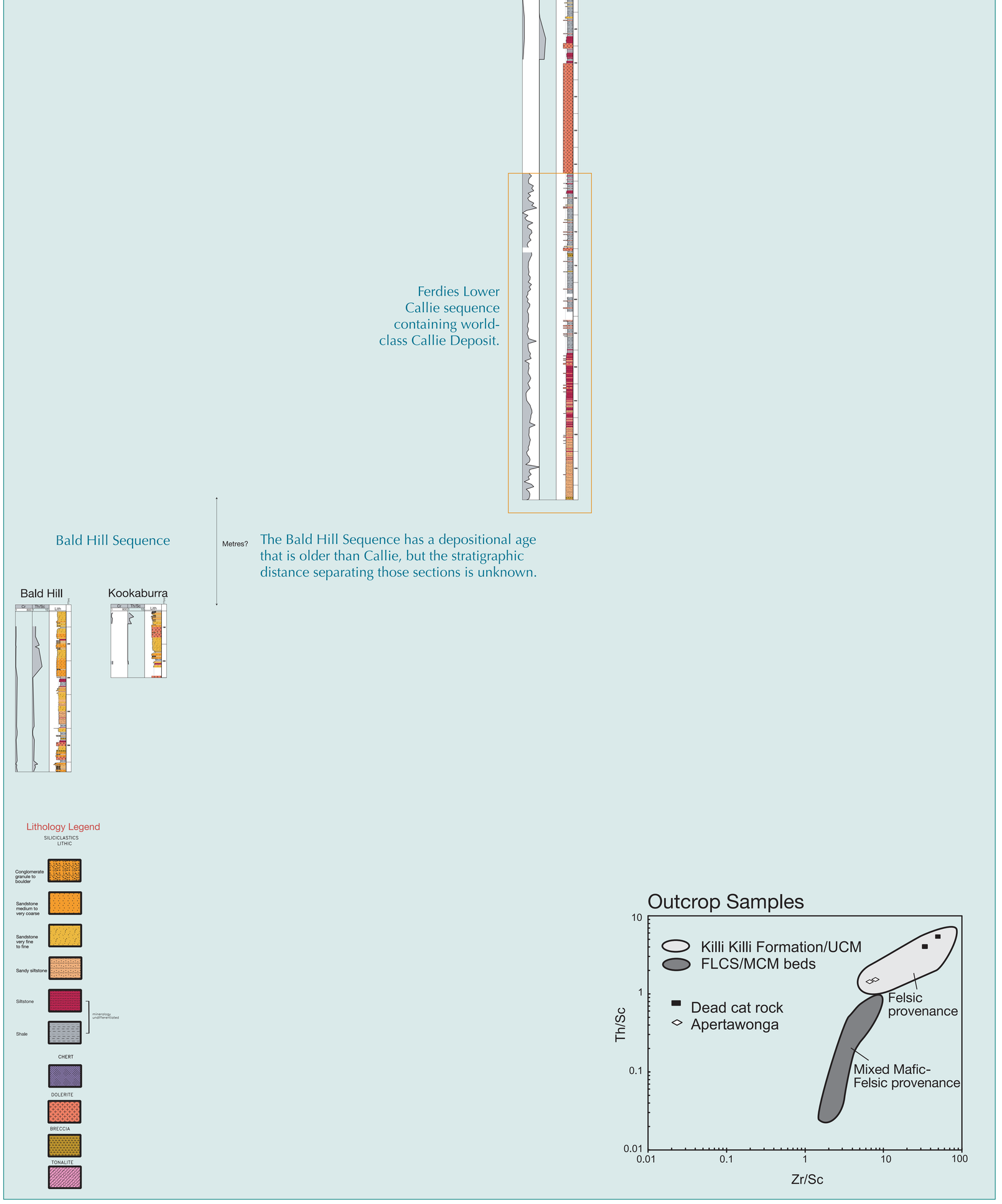
Tanami north-west south-east cross-section displaying downhole lithology and Cr and Th/Sc compositions

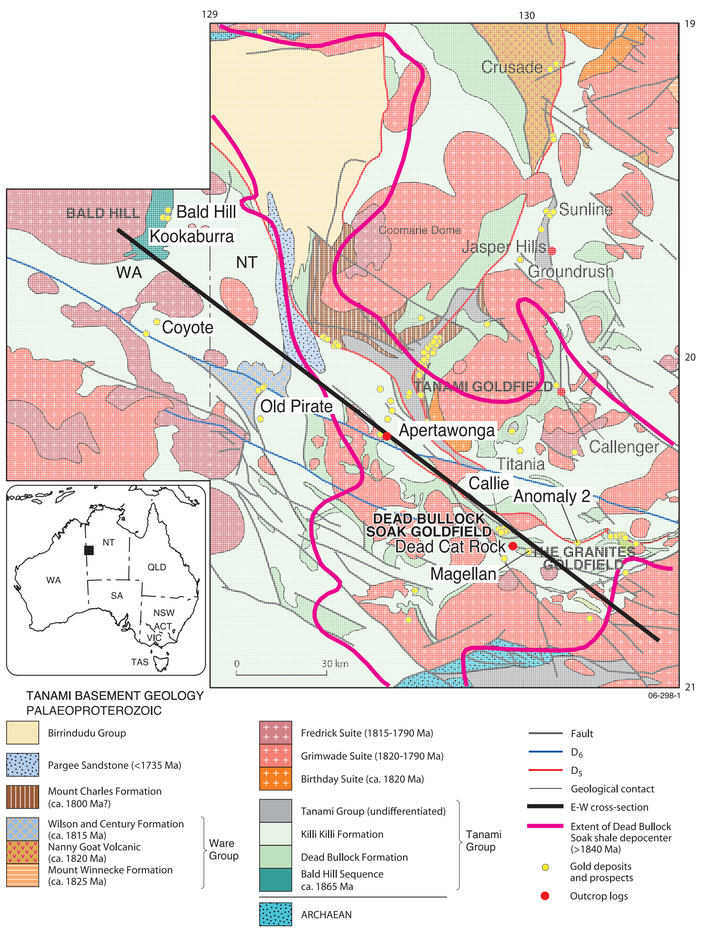
World-class gold-bearing Callie Stratigraphy is highlighted by high Cr (100-800 ppm) and low Th/Sc values (<2)

Outcrop samples are shown on the Th/Sc vs. Zr/Sc plot as shown on panel 2. All the outcrop samples in this study plot within the less mineralized Killi Killi Formation.

Interpretation of Cashel

Based on Cr and Th/Sc compositions the Cashel prospect resembles the geochemistry of the Ferdies Lower Callie Sequence. However, ε_{Nd} isotope data indicates that Cashel is more similar to Mt. Charles geochemistry (refer to ε_{Nd} vs. Th/Sc plot on panel 2).





*Cashel is 39km east of Anomaly 2 in undifferentiated Tanami Group.