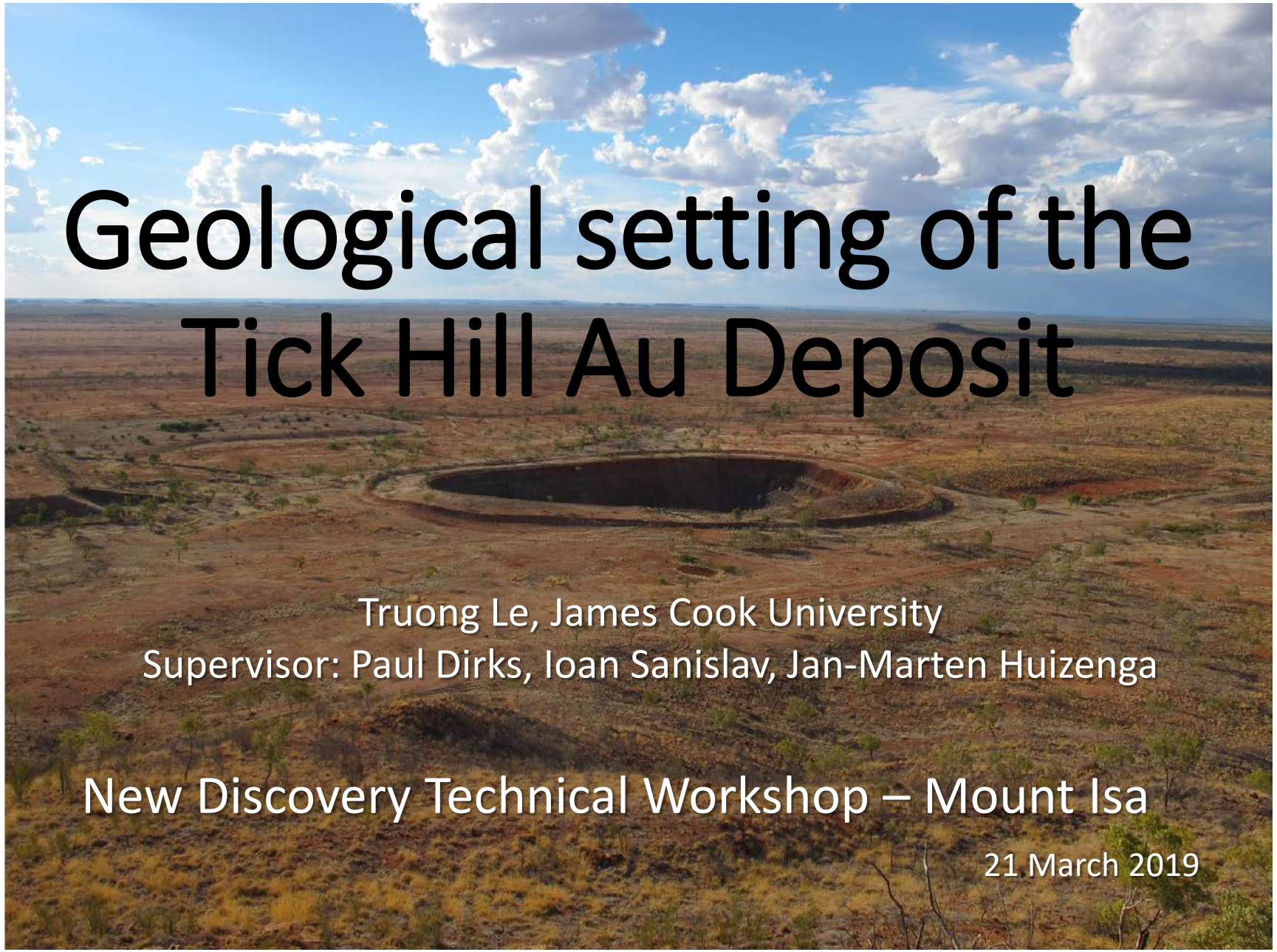

Geological setting of the Tick Hill Au Deposit

Truong Le, James Cook University
Supervisor: Paul Dirks, Ioan Sanislav, Jan-Marten Huizenga

New Discovery Technical Workshop – Mount Isa

21 March 2019

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Outline

1. Background
2. Geological setting
3. Structural setting
4. Metamorphic controls
5. Geophysics
6. Mineralisation
7. Summary

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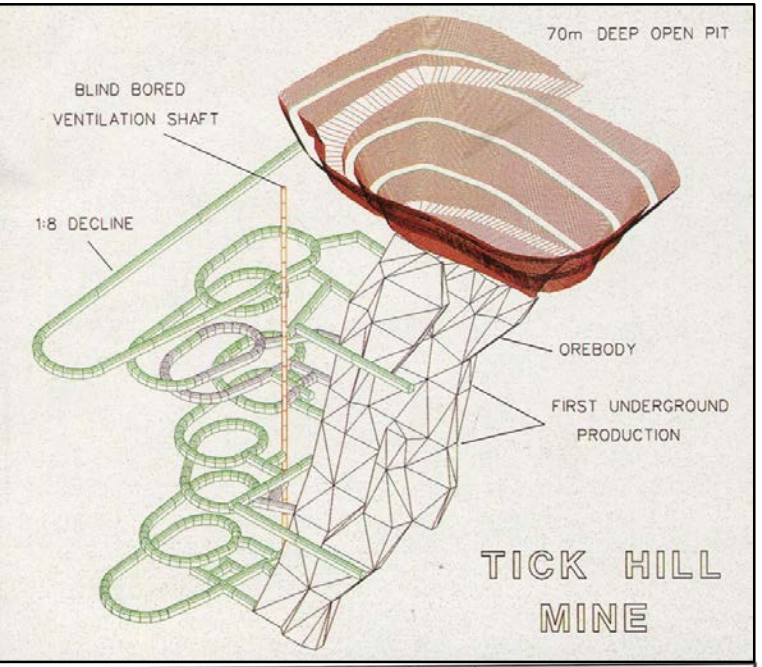
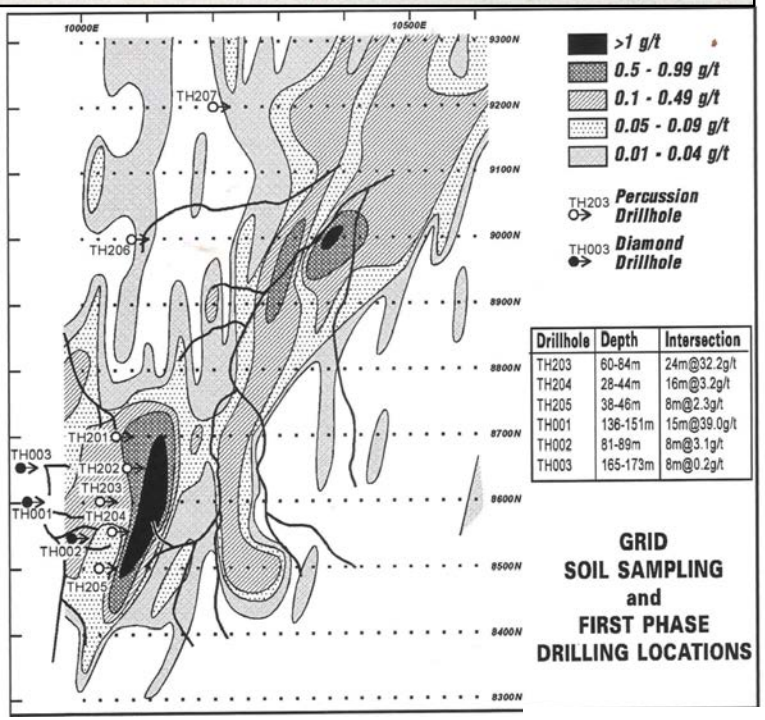
Background

Tick Hill Au Deposit:



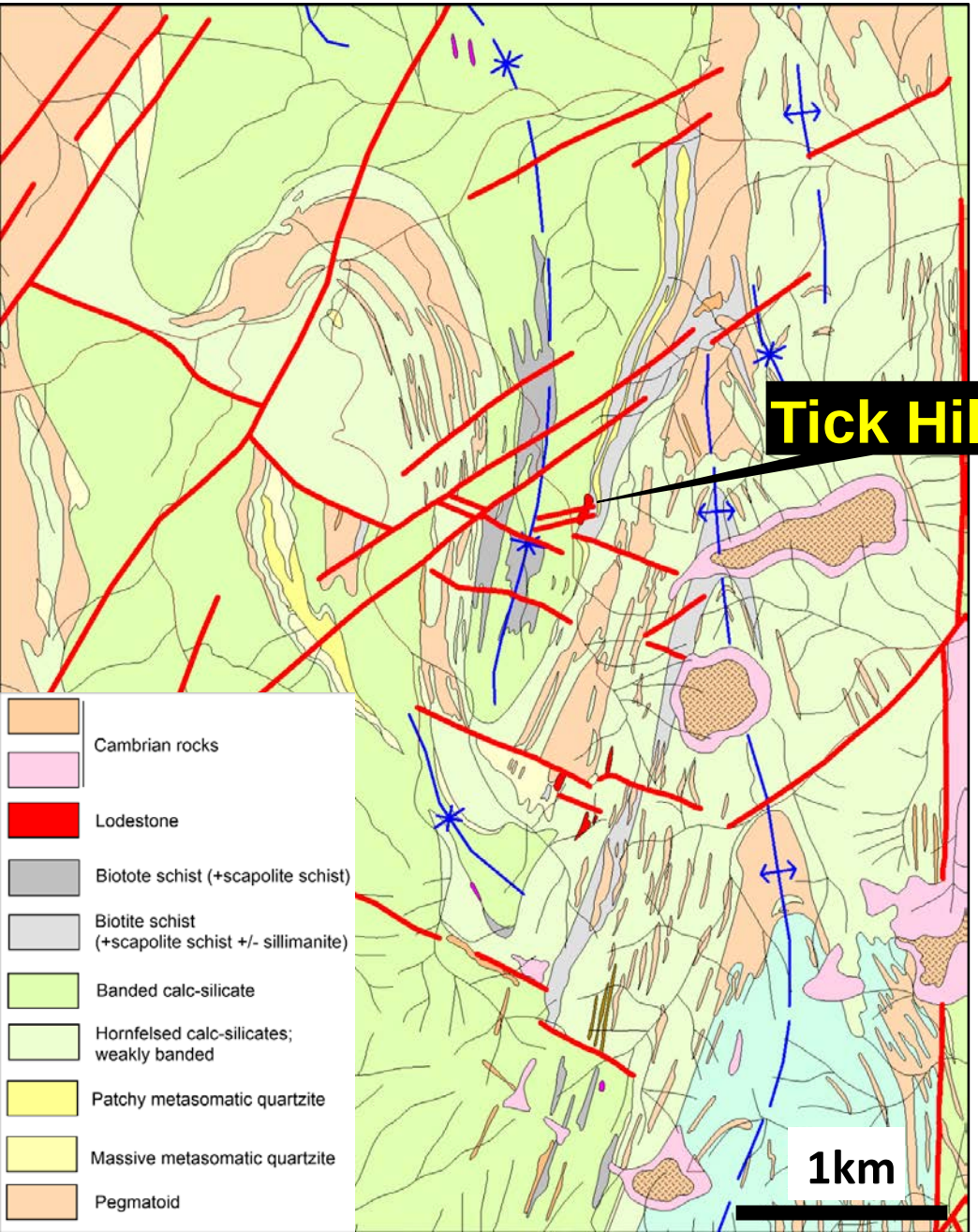


Perkins (1999)

- Located in S part of Mary Kathleen Domain
- Discovered by stream geochemistry
- Mined between 1991 - 1994 by Carpentaria Gold
- 706 000 tons @ 22.52g/t. = 511 000 ounces
- The ore body:
  - 140m long,
  - 1-30m wide
  - Mined to 240m below surface
- Native Au with little Ag and minor Cu+Co
- Project difficulties:
  - Limited cores access
  - Limited samples
  - No published information

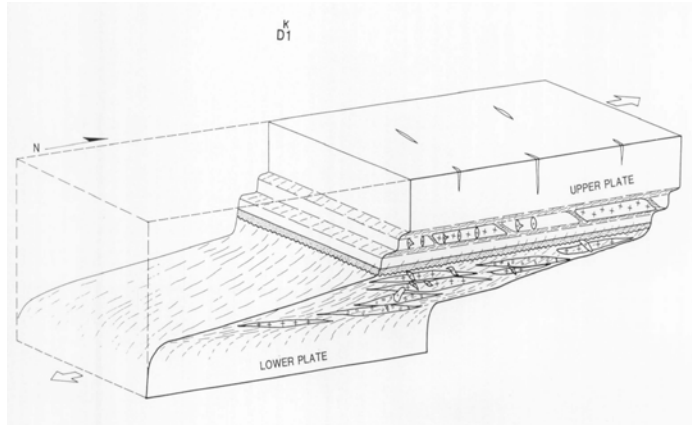
Geological setting

Tectonic interpretation:



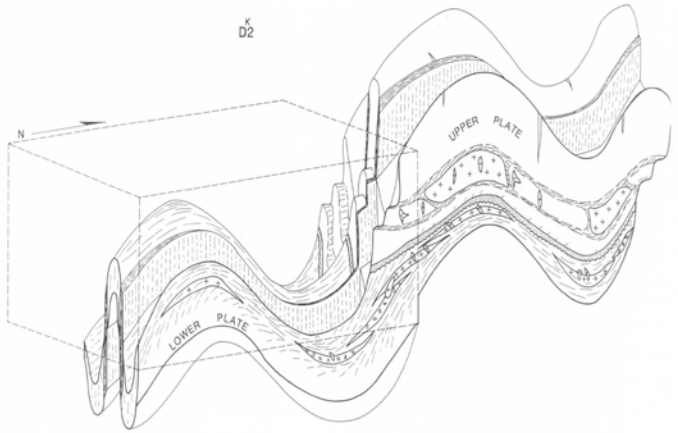
Early mylonitic fabric

Interpretation after
Holcombe & Oliver (1992)



Mid-Crustal detachment (~1740Ma)

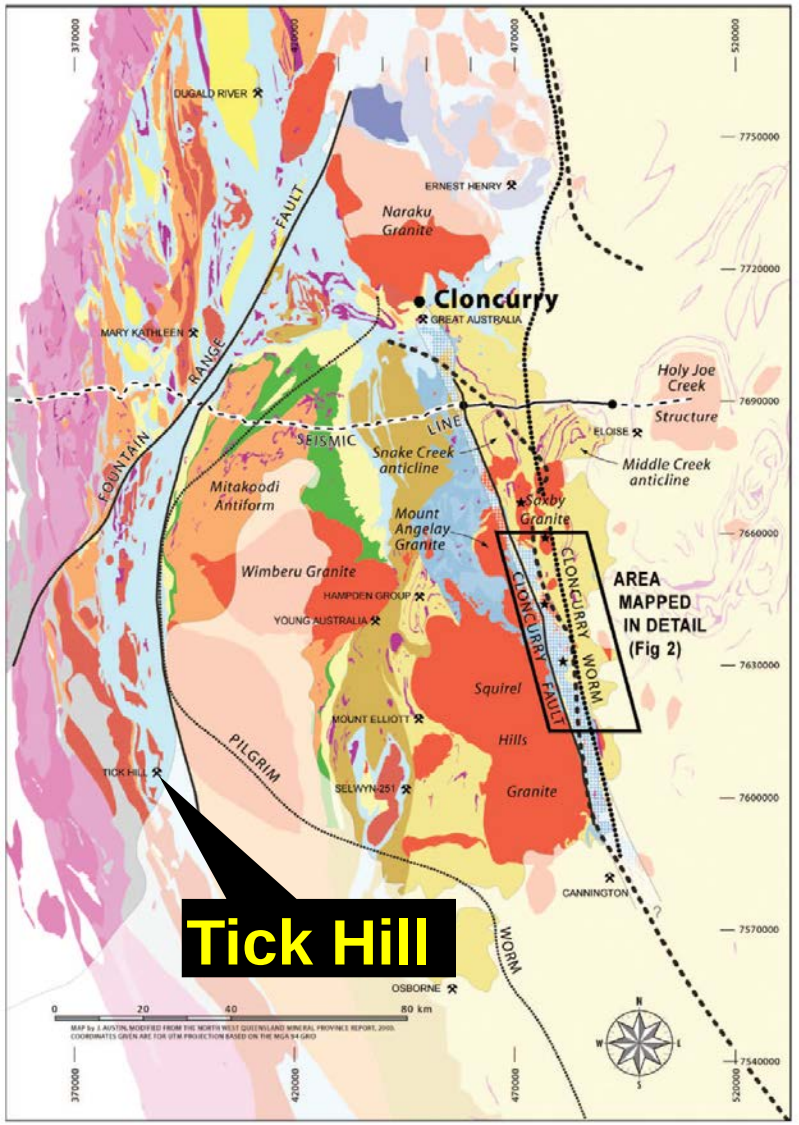
Upright folding



Upright folding (~1550Ma)

Geological setting

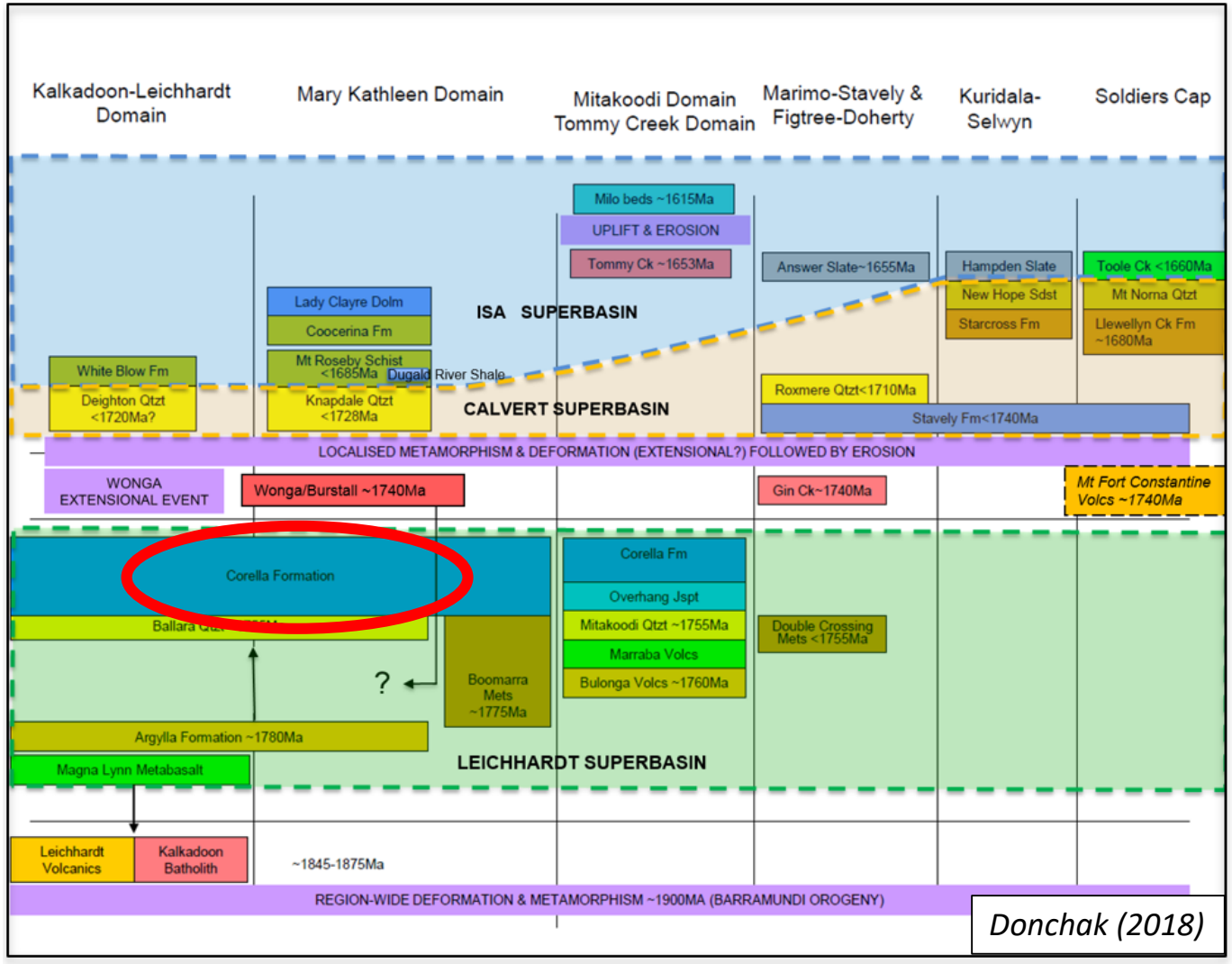
Current stratigraphy Interpretation:



Legend

- High Level Magnetic Worm
- High Level Gravity Worm
- Major Mineral Deposit
- Cloncurry Fault Zone
- Williams Batholith
- Mt Fort Constantine Volcanics
- Ernest Henry Diorite
- Dolerite Dykes and Sills
- Wonga Batholith
- Mount Albert Group
- Young Australia Group
- Soldiers Cap Group
- Doherty Formation
- Corella Formation
- Ballara-Mitakoodi Quartzite
- Marraba Volcanics
- Argylla Formation
- Kalkadoon/Leichhardt
- Basement

Austin and Blenkinsop (2010)



Donchak (2018)

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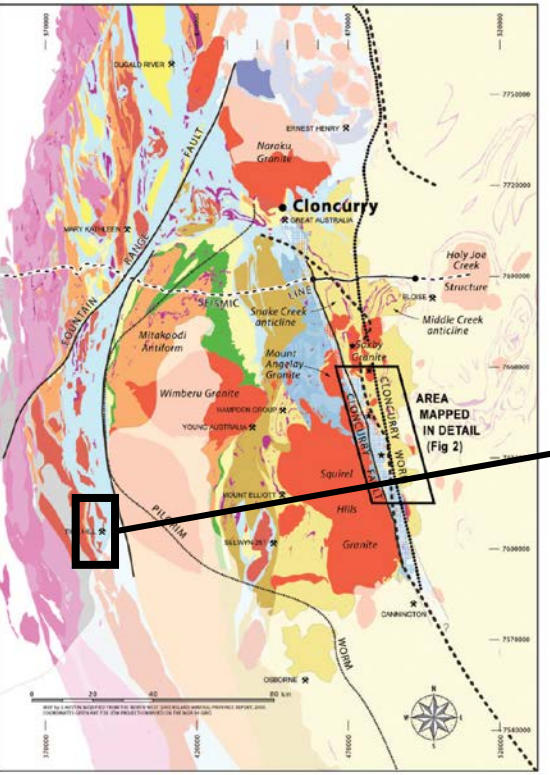
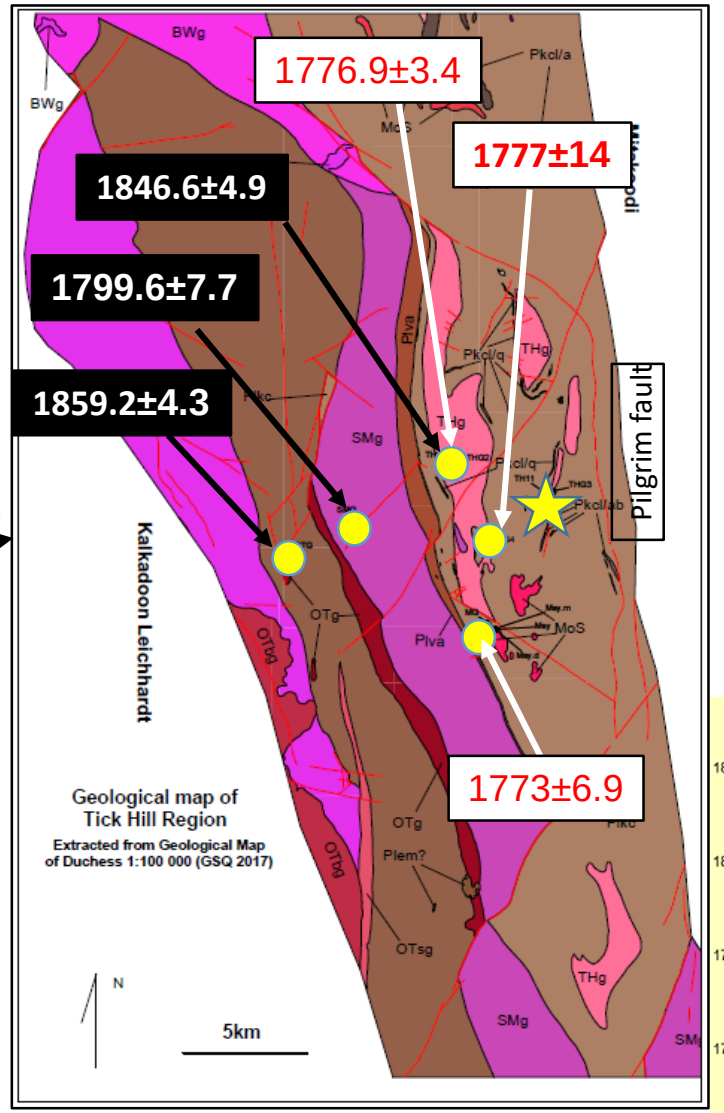
Geological setting



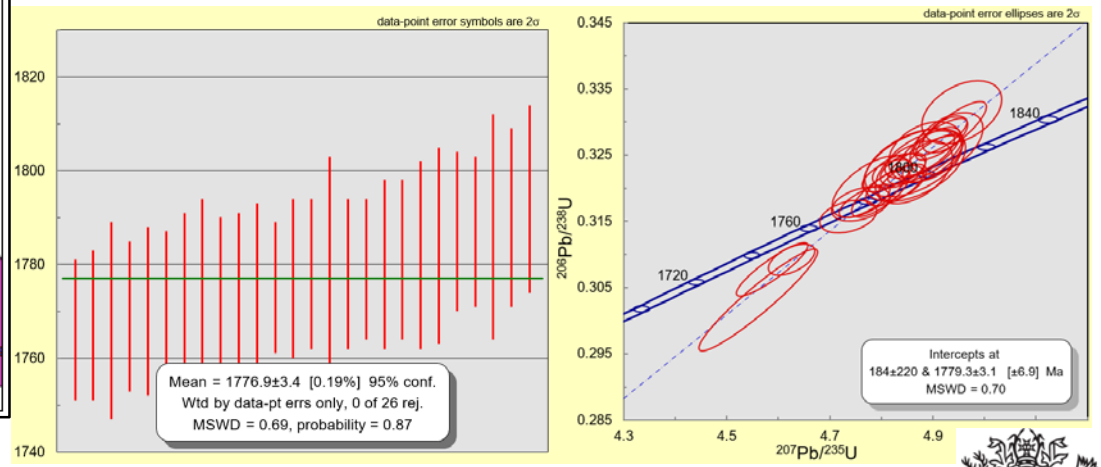
Austin and Blenkinsop (2010)



New age constraints:

- **Syn- to late tectonic Granite ~1775 Ma**
- **Host rocks > 1775 Ma:**
  - calc-silicate, scapolite, calcite
  - metapelite
  - amphibolite

  Previously interpreted as Corella Fm
  (e.g. Foster and Austin, 2008)
- **Basement Gr. > 1800 Ma**



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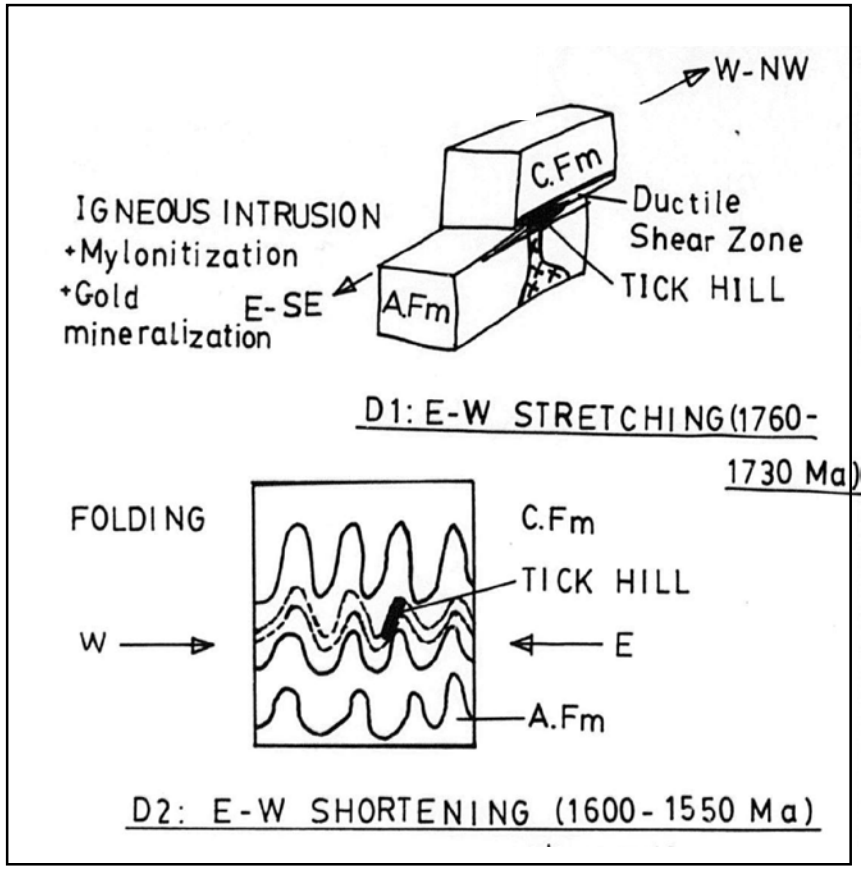
Geological setting



Choy (1995)

Past Models:

1. Gold is early

- Syn-sedimentary
- Epi-thermal
- Incorporated in D1 detachment zones (~1750 Ma)
- Remobilized during Isan Orogeny (~1530 Ma)

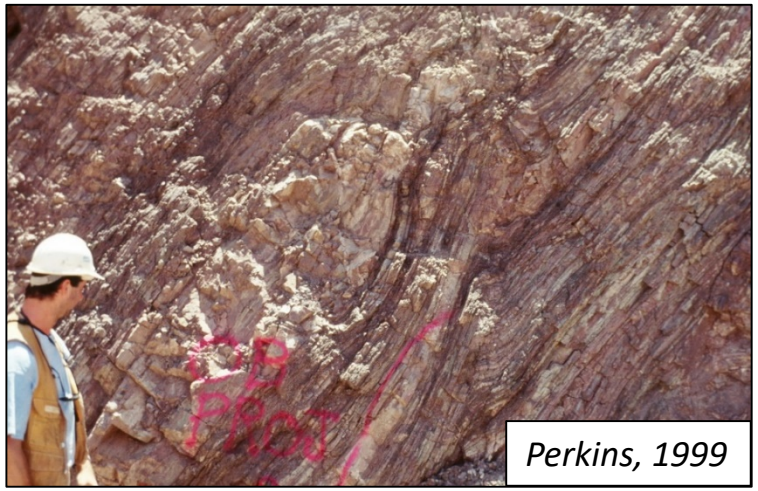
2. Gold is late

- End-member IOCG ?
- Intrusion related ?
- Formed during Isan Orogeny (~1530 Ma)
- Orogenic

- **Origin of the Tick Hill deposit is unclear**
- **Unique mineralization style in Mt Isa Block**

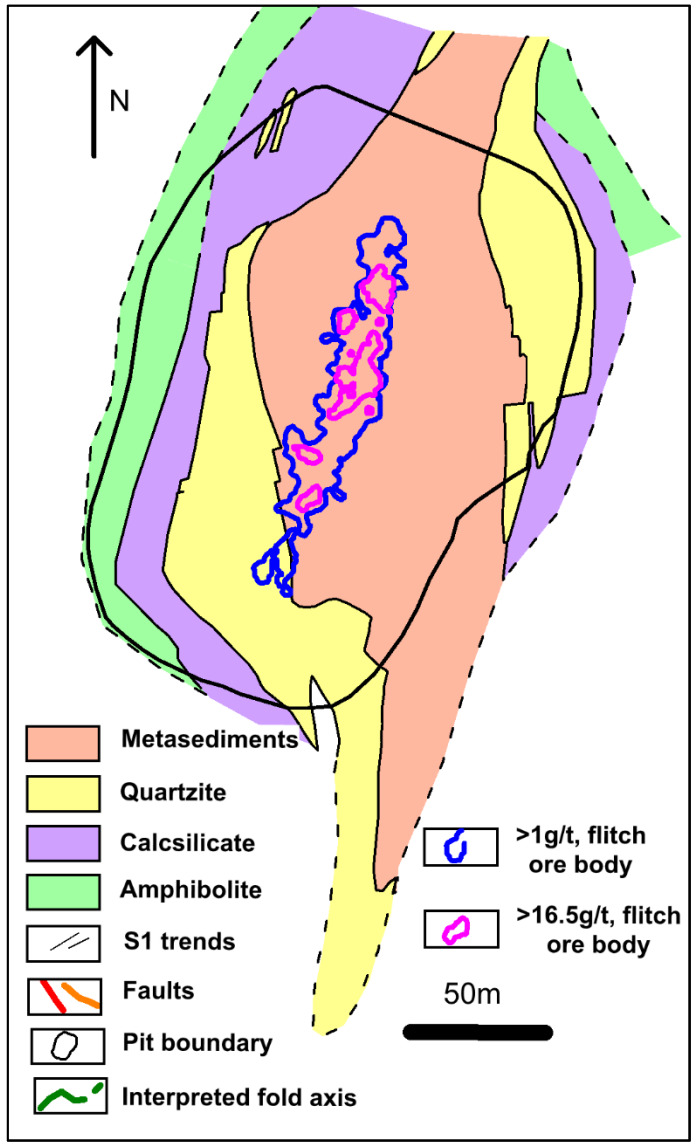
Geological setting

Deposit geology:



1. Host rocks to Tick Hill:
   - **calc-silicate** containing scapolite, calcite
   - metapelite
   - **amphibolite**

2. Hosted by **mylonitic gneiss** at upper amphibolite facies
3. Syn- and Post-tectonic intrusions occur
4. Gold envelope is **linear** and constrained to small area



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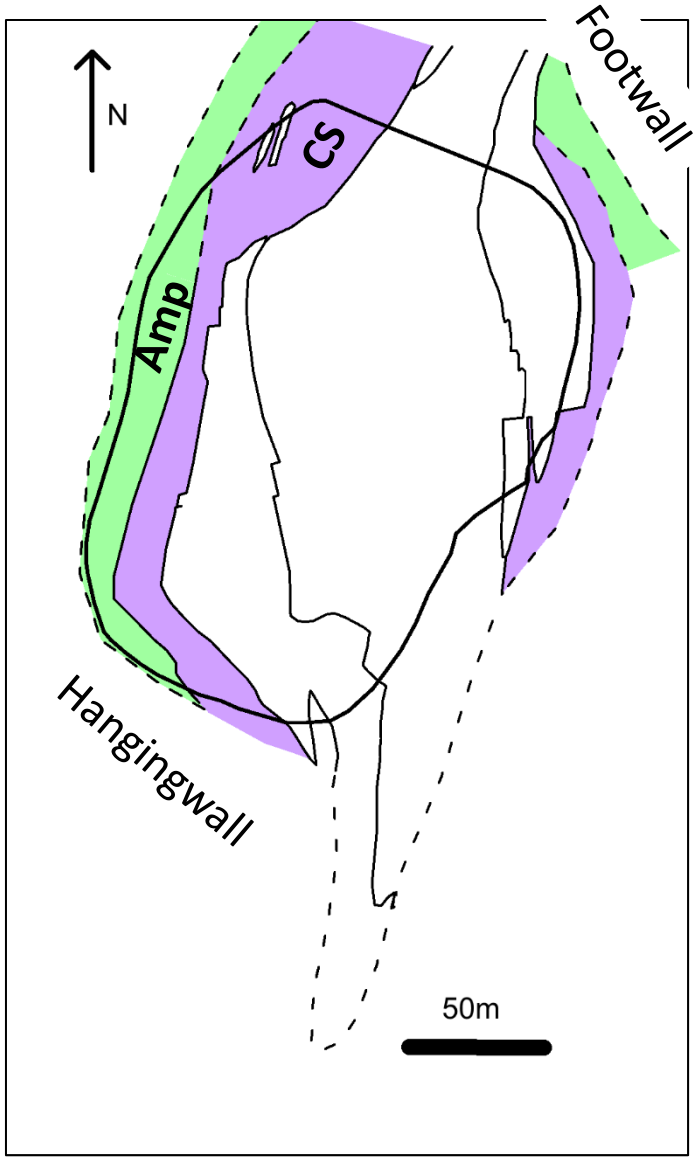
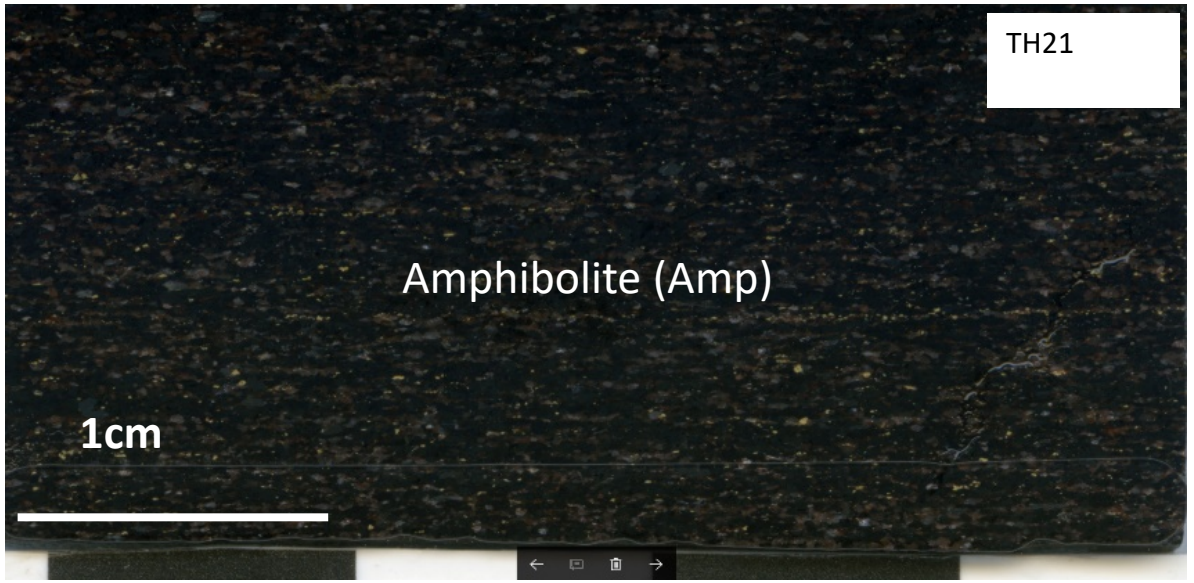
Geological setting

Deposit geology:





Hangingwall & footwall sequences

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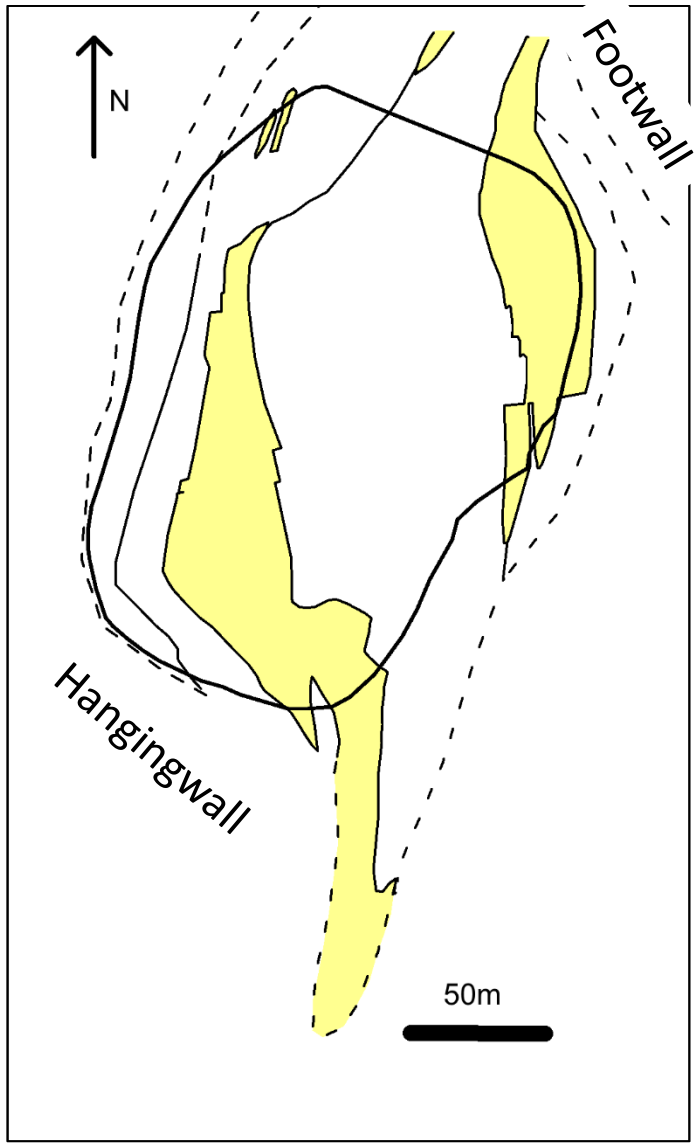
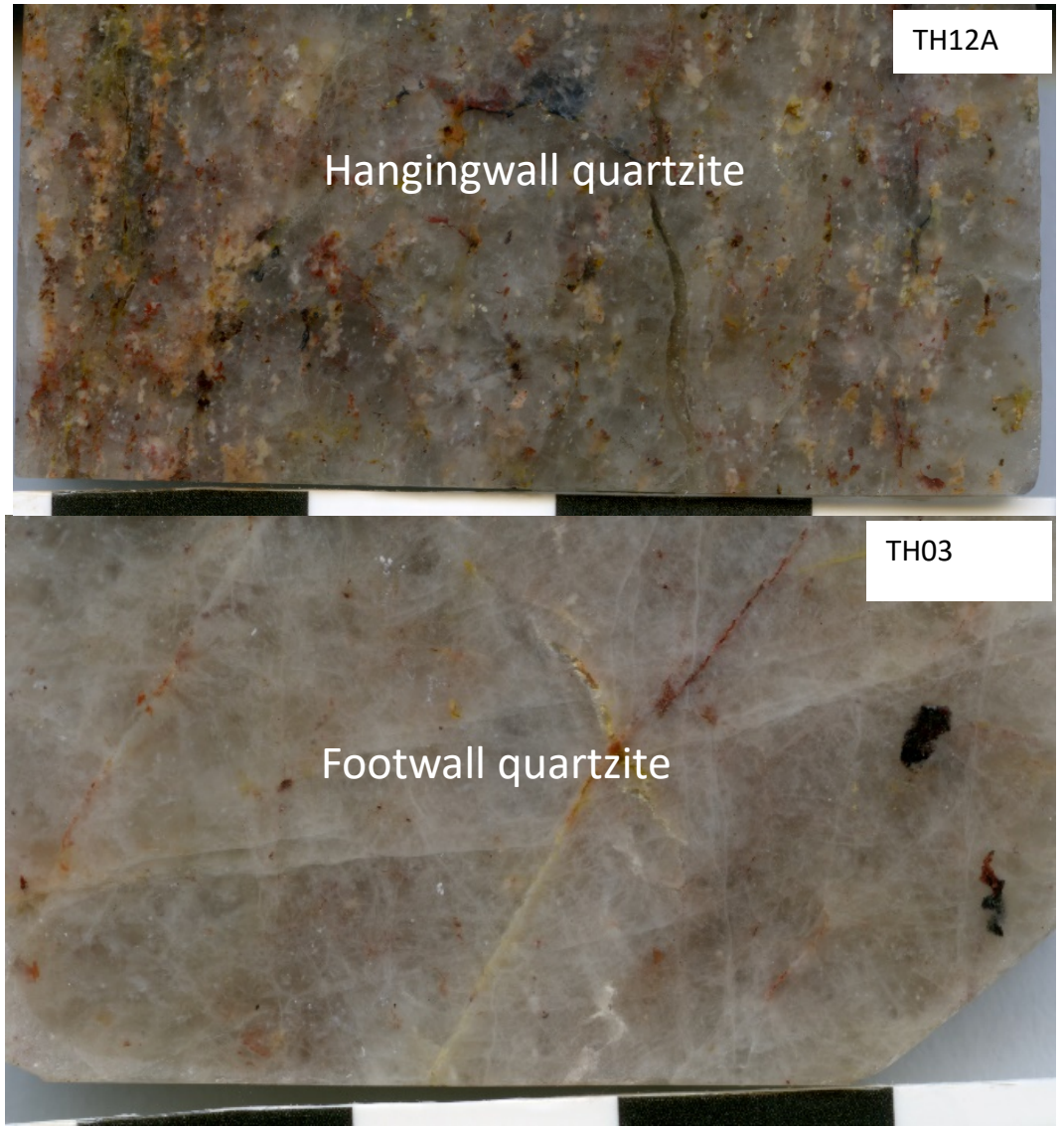
Geological setting

Deposit geology:





Hangingwall & footwall quartzites

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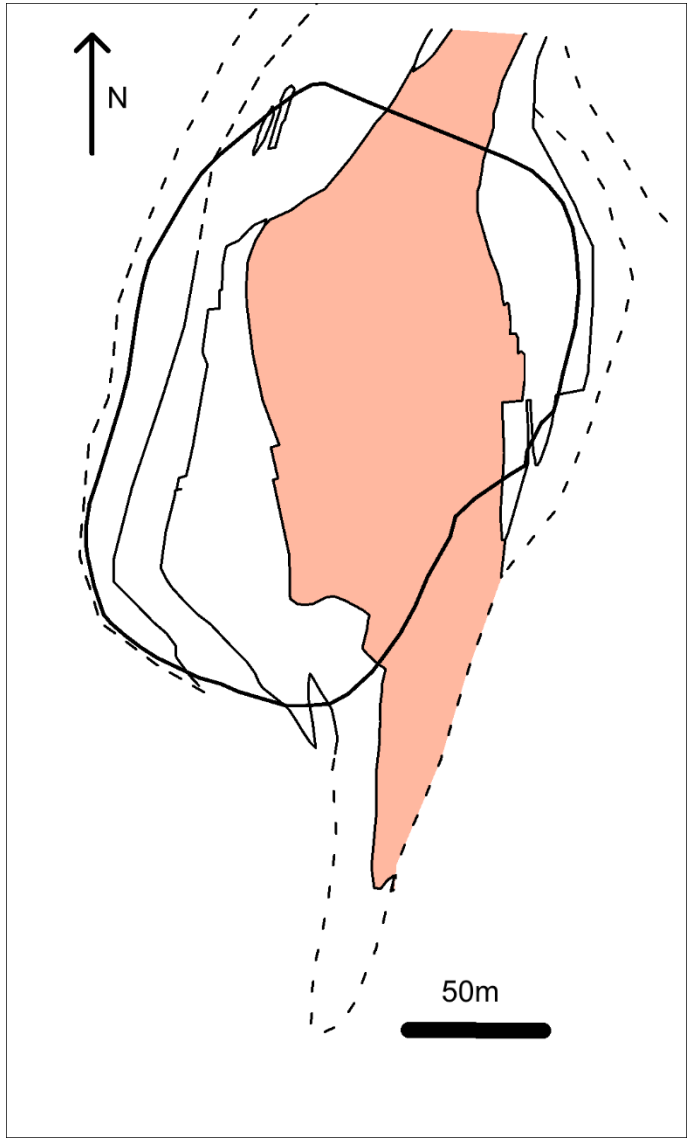
Geological setting

Deposit geology:



interbedded metapelite-metapsammite-calcsilicate-amphibolite and qtz-fsp mylonite/ gneiss

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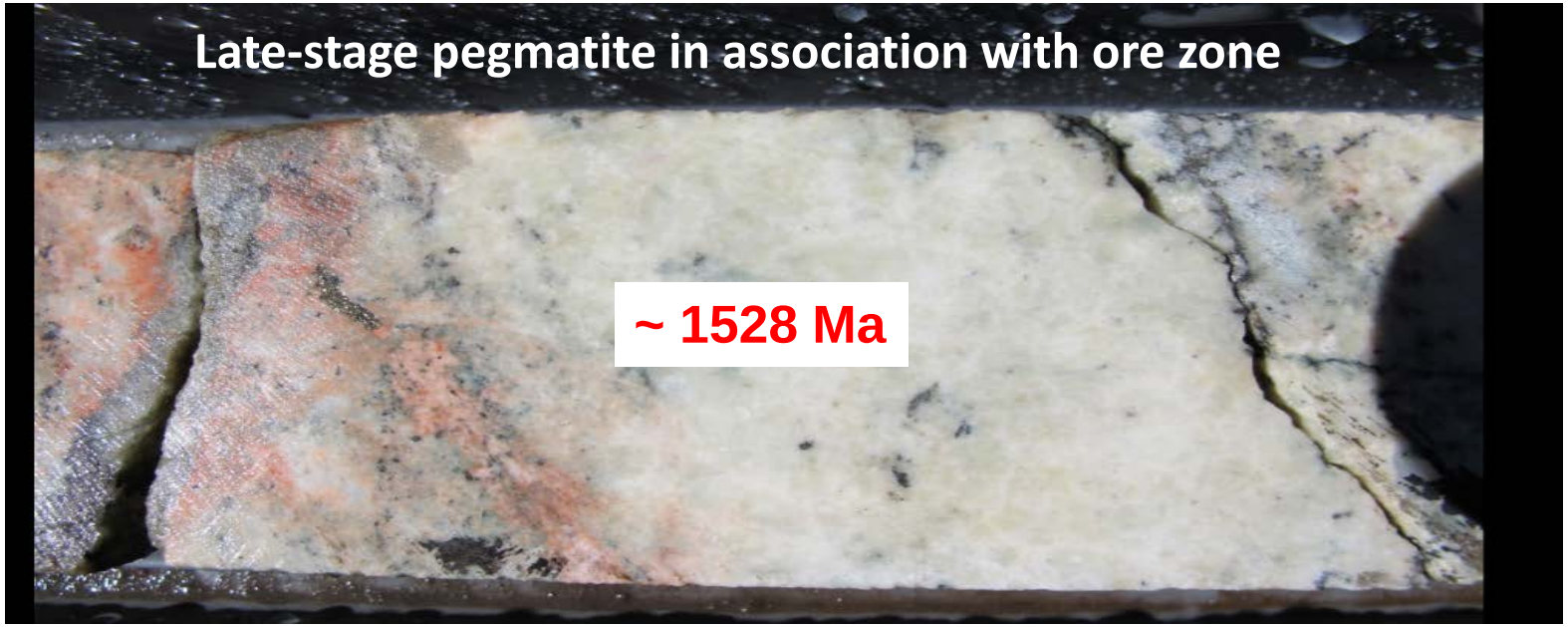
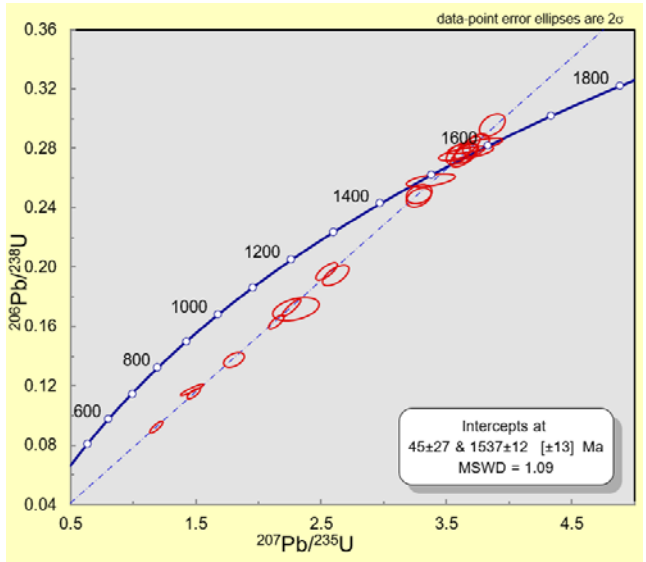
Geological setting

Intrusions:





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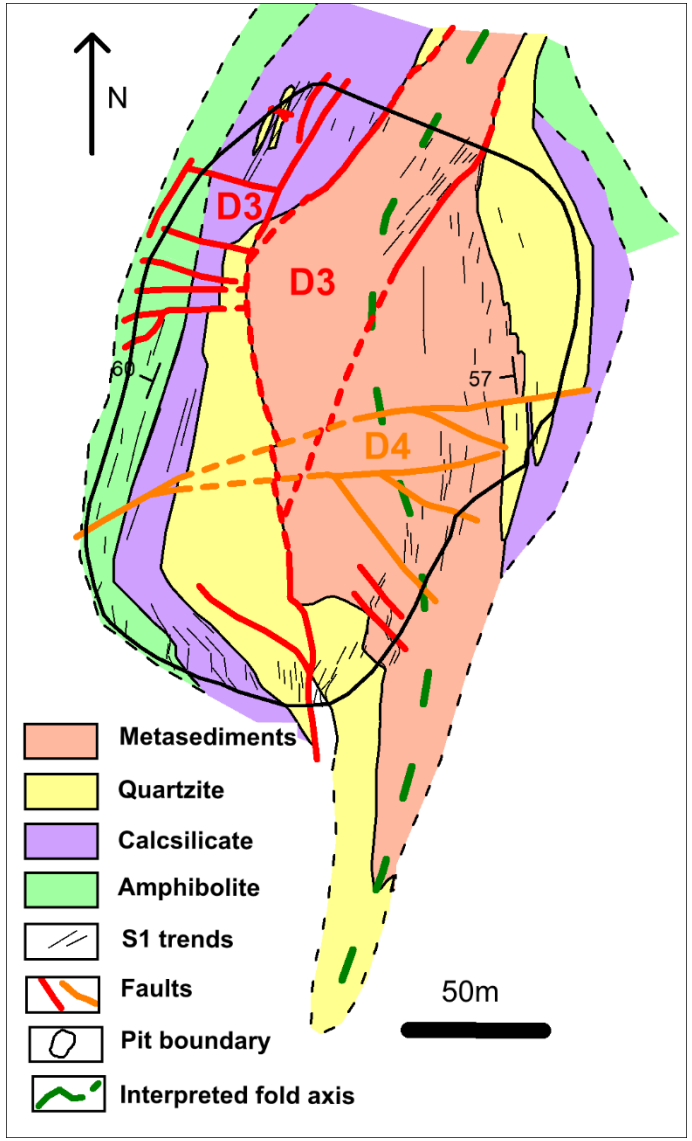
Structural setting



Summary:

4 deformations events:

1. D_1 mylonite and tight folding
2. D_2 upright folding of S_1
3. D_3 normal faulting
4. D_4 strike-slip faulting

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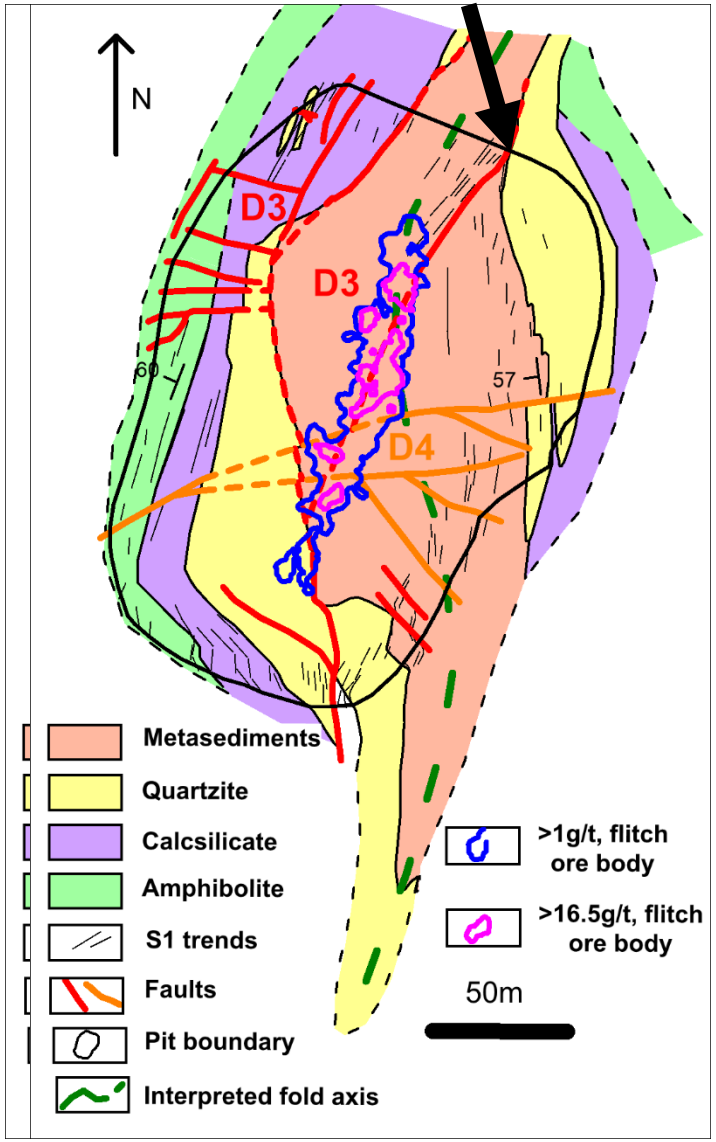
Structural setting



Summary:

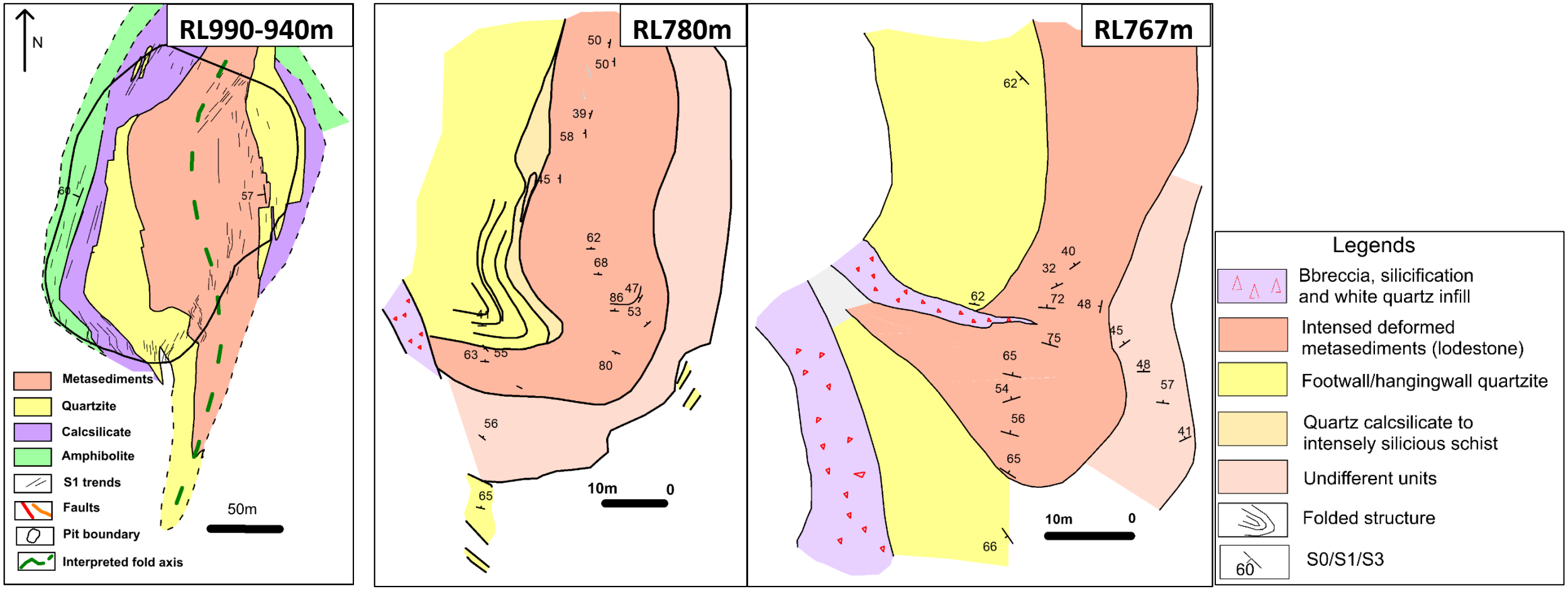
1. Geology at T.H. pit appears to be tightly folded (D_1)
   - HW sequence is similar to foot wall sequence

2. D_3 shear zone reactivates the S_1 foliation truncation plane

3. The ore zone displays a close spatial association with D_3 shear zones

4. The ore envelope transects lithological boundaries
   i.e. the ore envelope overprints the S1 fabric

Structural setting

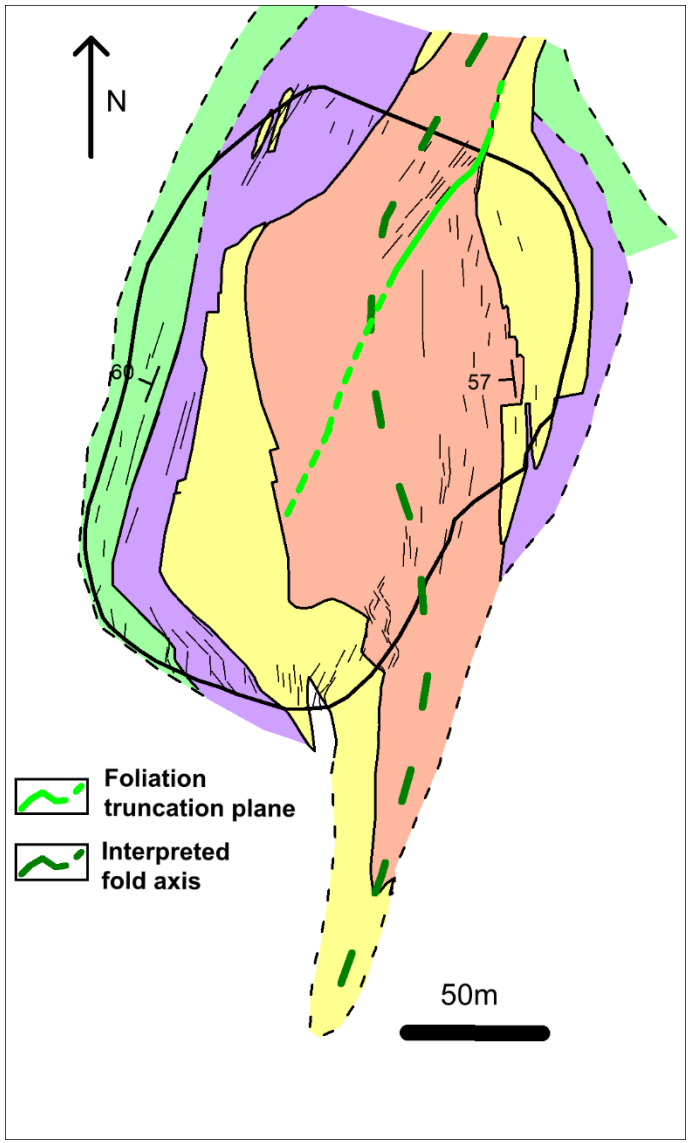


Compiled from MIM (2000)

Summary:

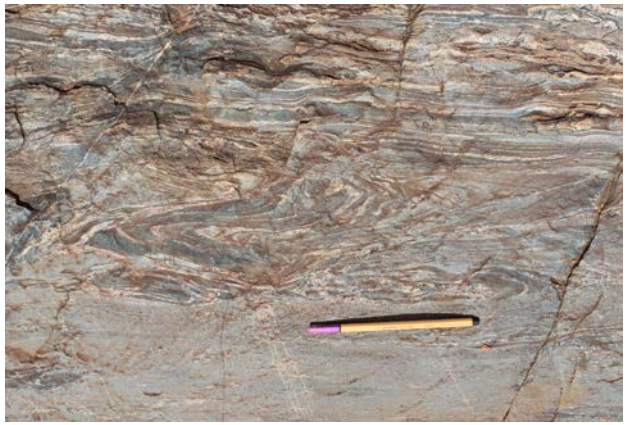
- **Host lithologies are folded at depth**
- **At depth: ore near E-W breccia**

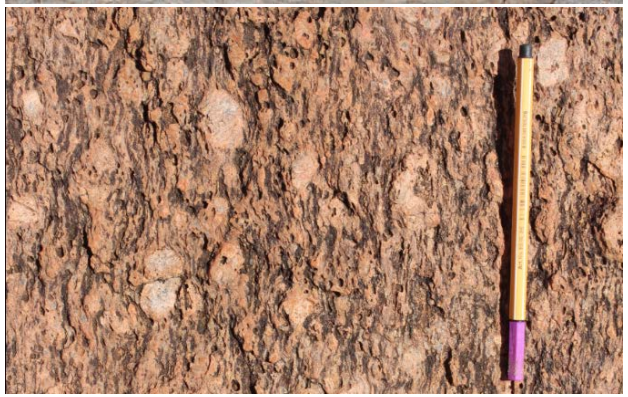
Structural setting



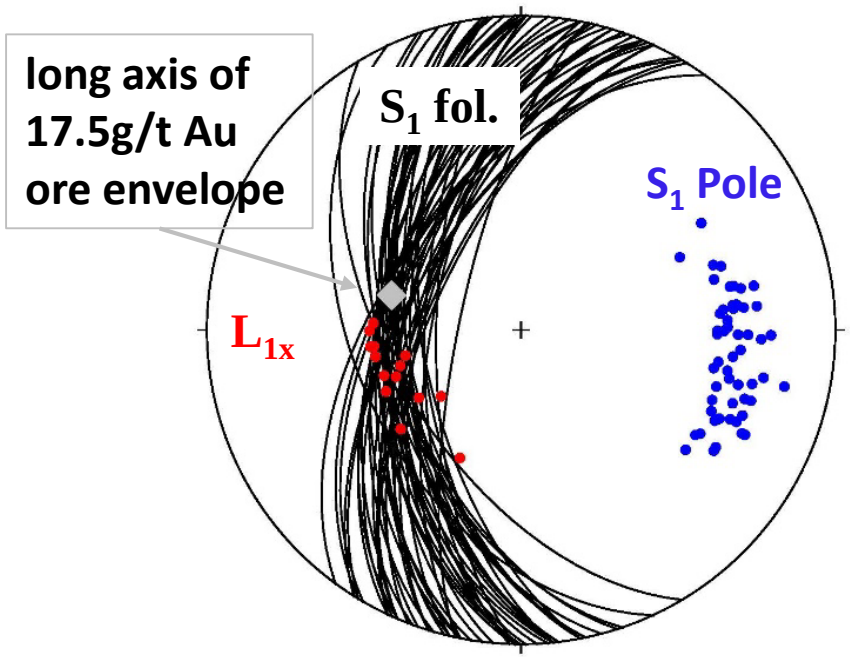
D_1: Intense shearing

- tight folding
- sheath folds





Deformation: D_1



S_1 foliation (2 clusters)

- 305/65
- 250/50

L_1 ~ 250/55 (// D_1 fold axis)

- Ore axis (~285/55) is **not** parallel to L_{1x}

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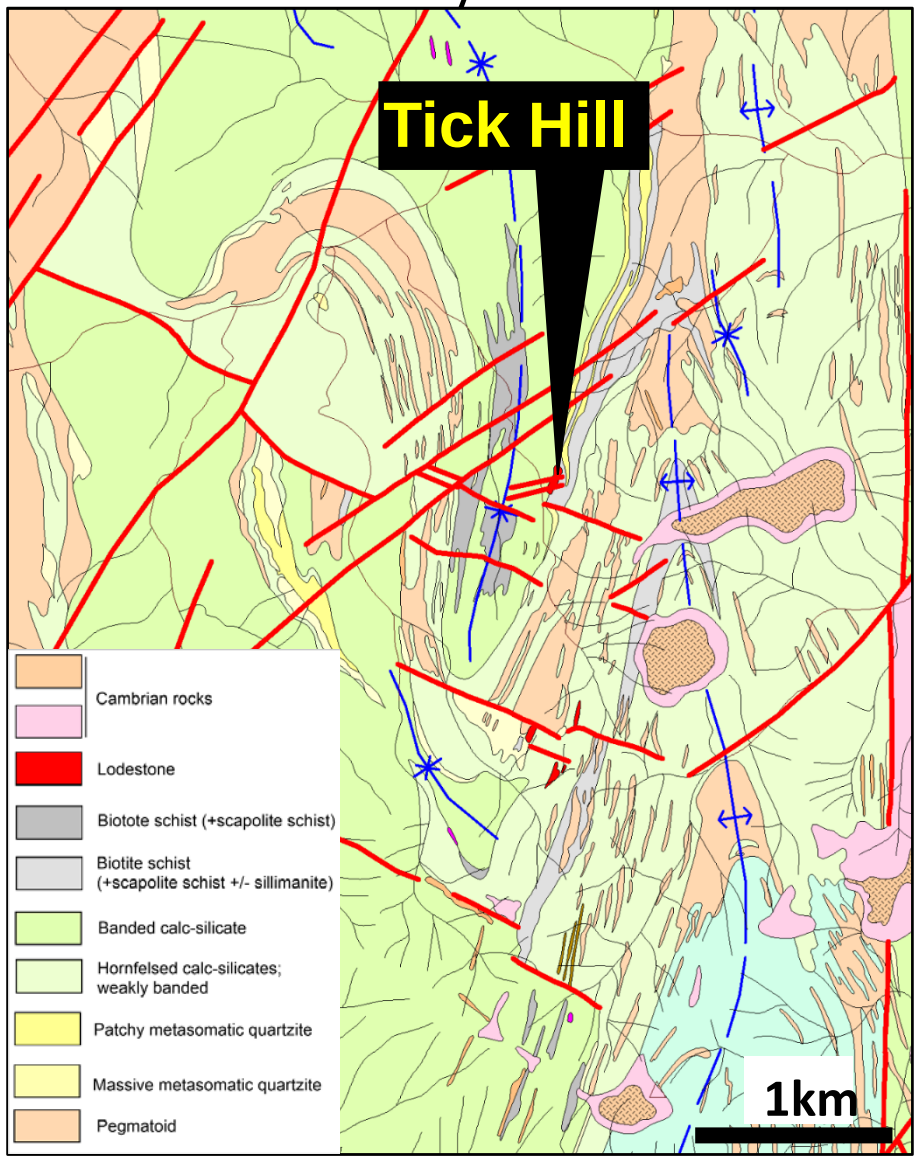
Structural setting

Tick Hill Synform



Coughlin 1993

Deformation: D_2

- **Open to close upright folds**
- **Folding of S_1 fabric => ~ N-S trending axial plane**
- **Tick Hill synform formed during D_2**

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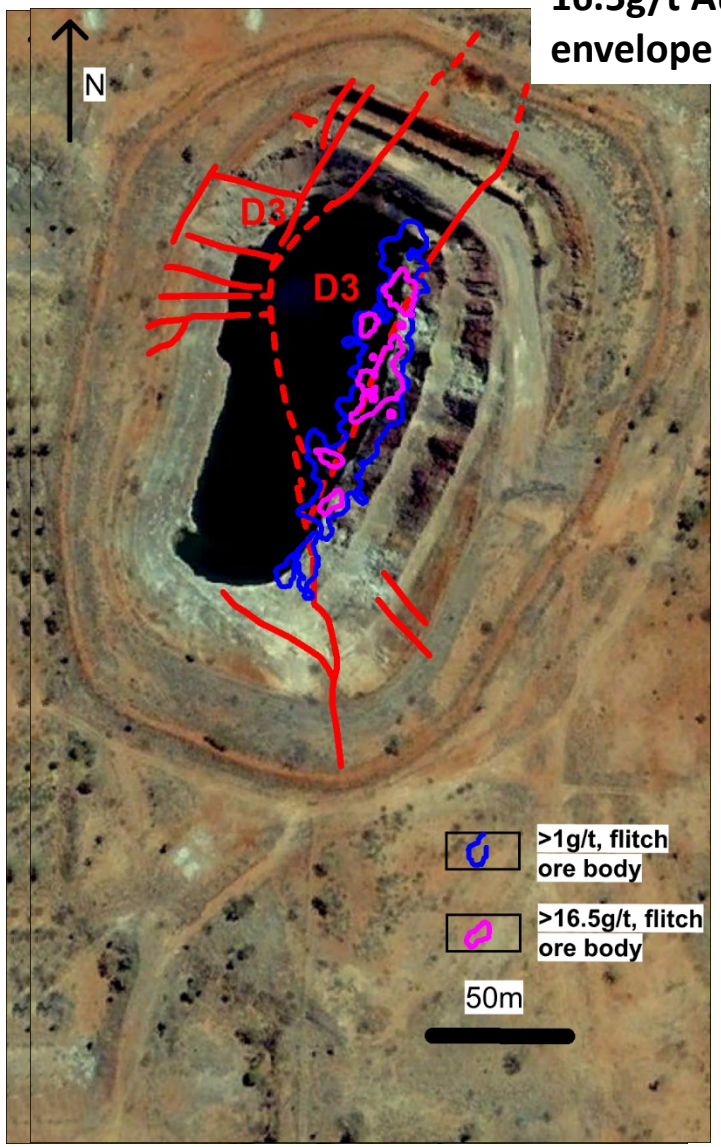
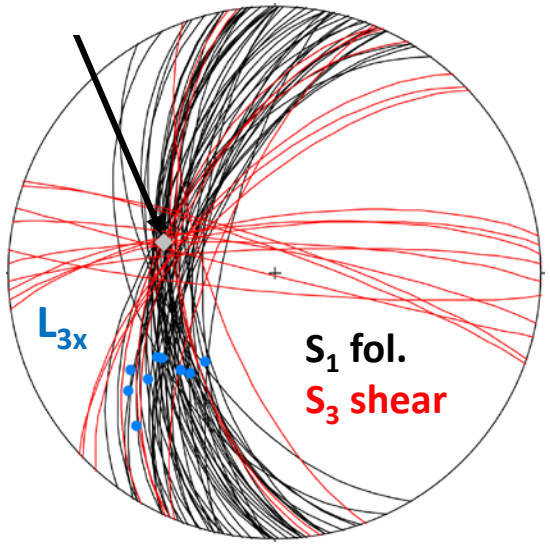
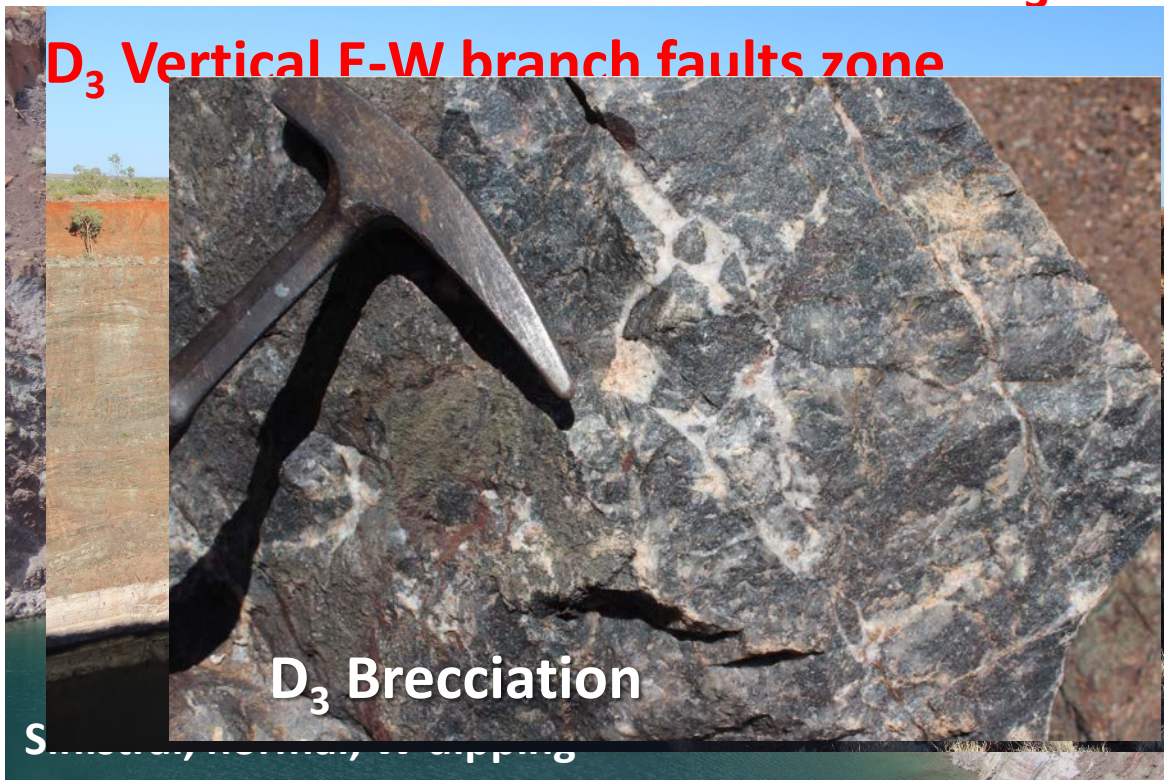
Structural setting



long axis of 16.5g/t Au ore envelope



Deformation: D_3



- D_3 shear and faults: 2 main groups
  1. Parallel to D_1 foliation truncation plane
  2. E-W vertical faults
- L_3 ~230/40
- Ore envelope // intersection lineation between S_1 and D_3 shears

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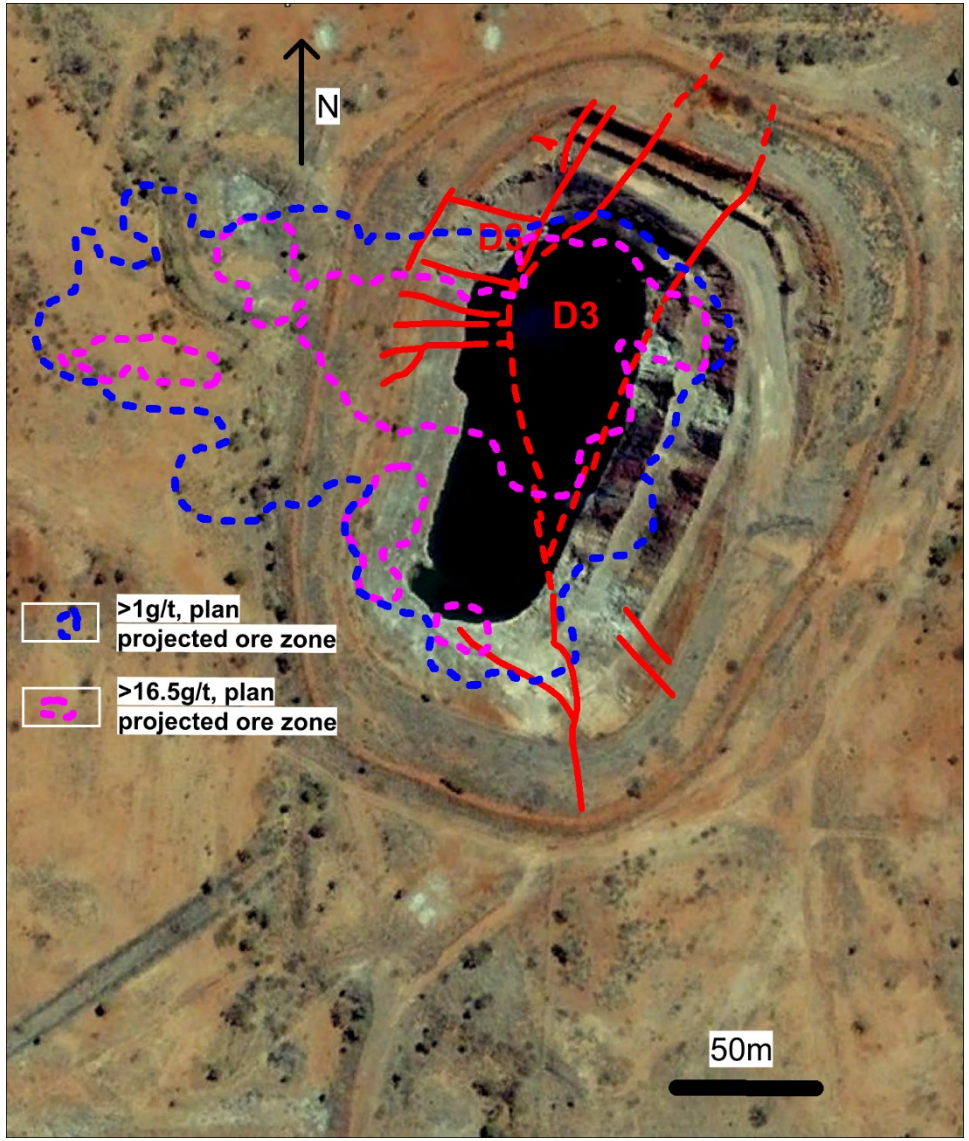
Structural setting

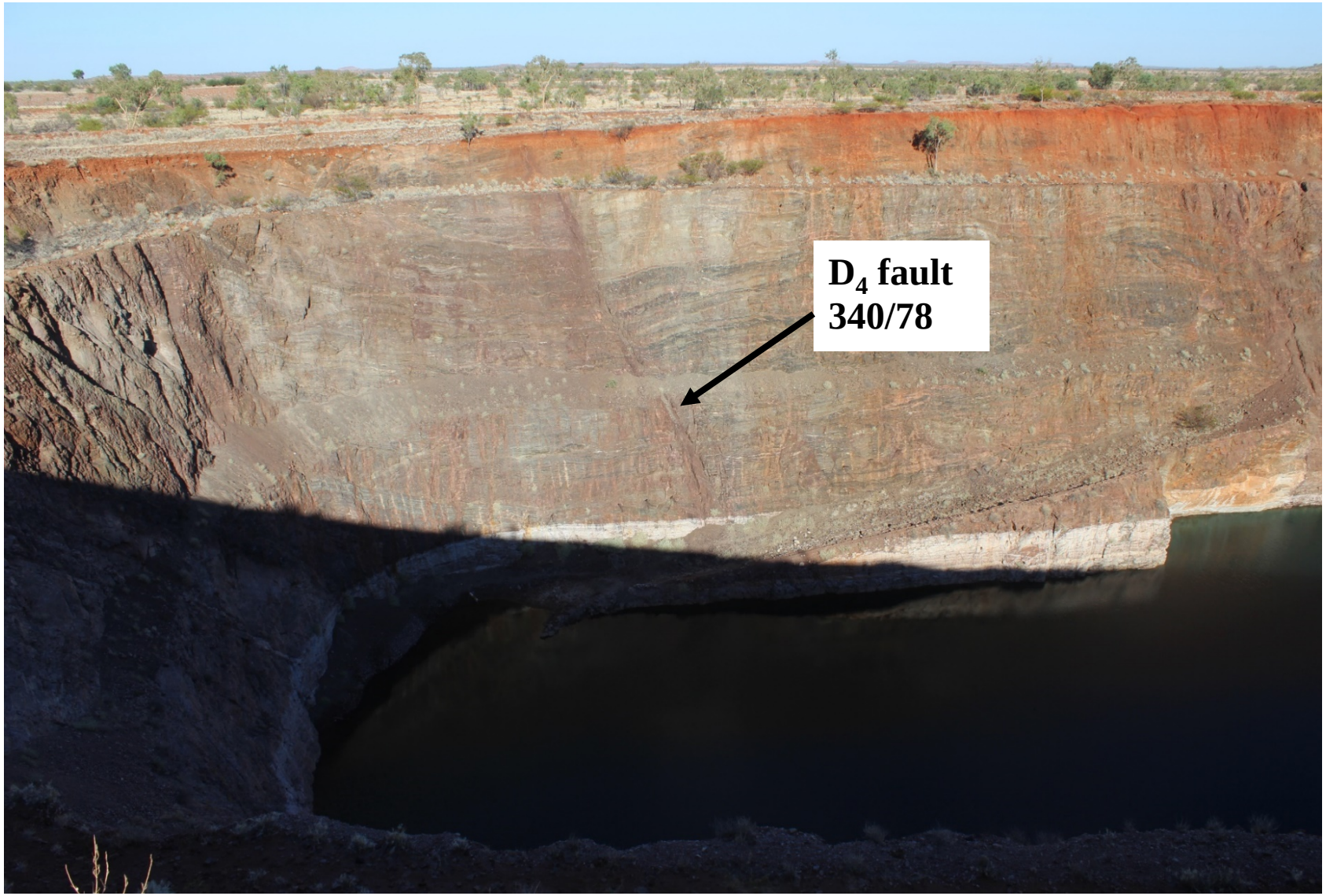
Deformation: D_3



- **Projected ore body in plan view:**
  - **Ore body trends ~ E-W**
  - **Coincides with D_3 E-W faults and breccia zones**

Structural setting

Deformation: D_4



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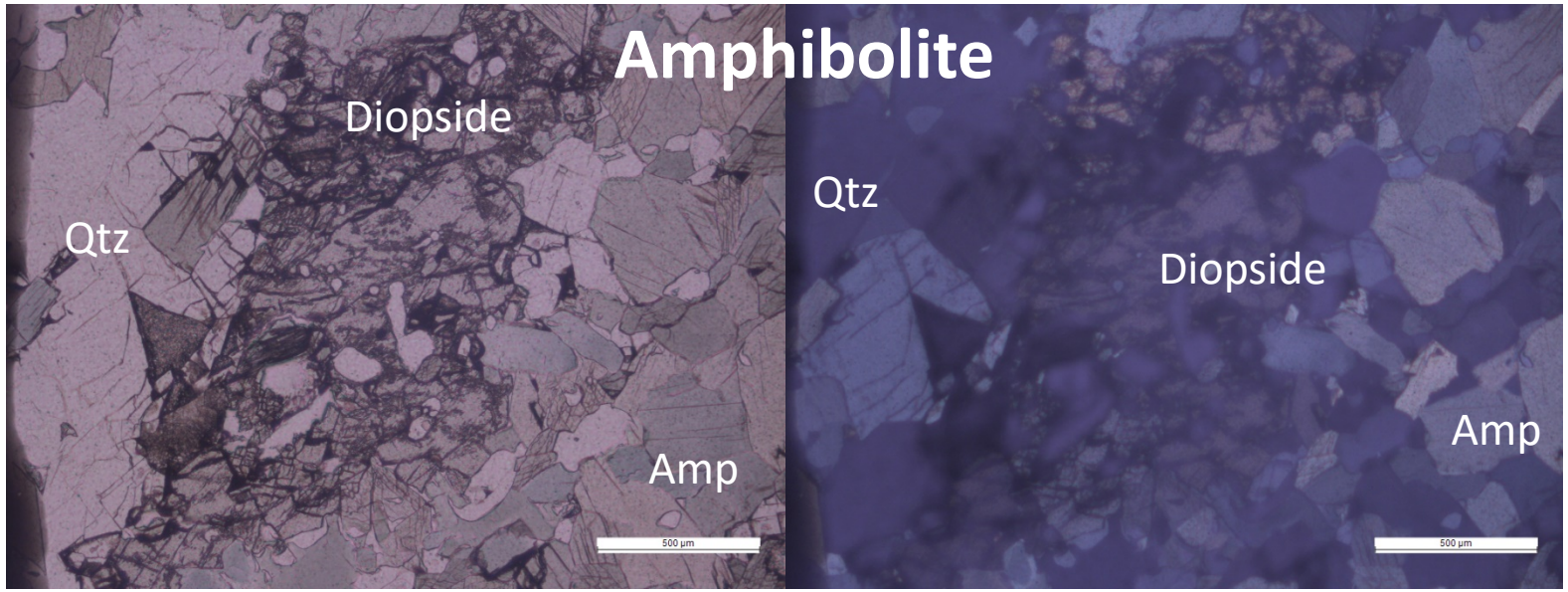
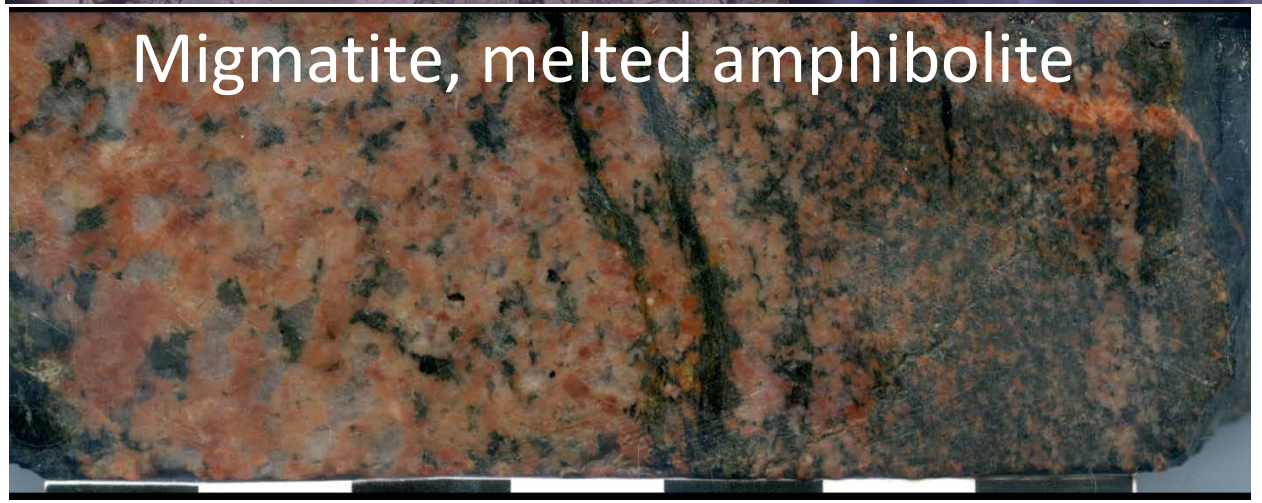
Metamorphism

2 phase: D_1 and D_2





D_1: upper amphibolite to granulite facies

D_2: upper amphibolite facies

Au locally contained in peak-assemblage

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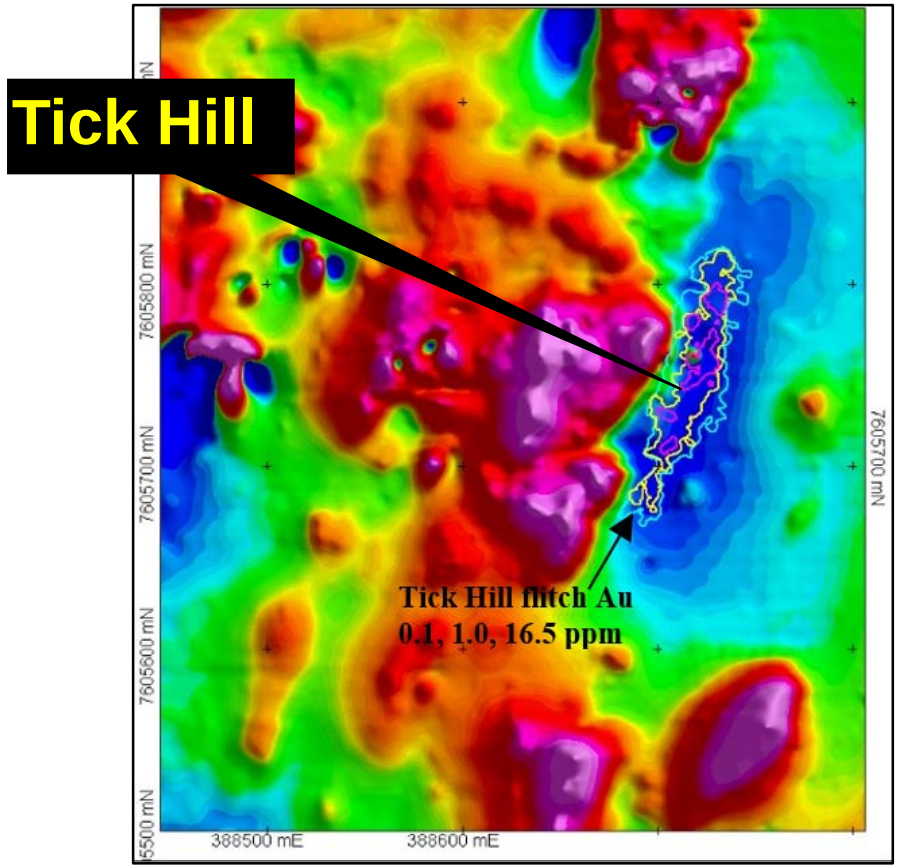
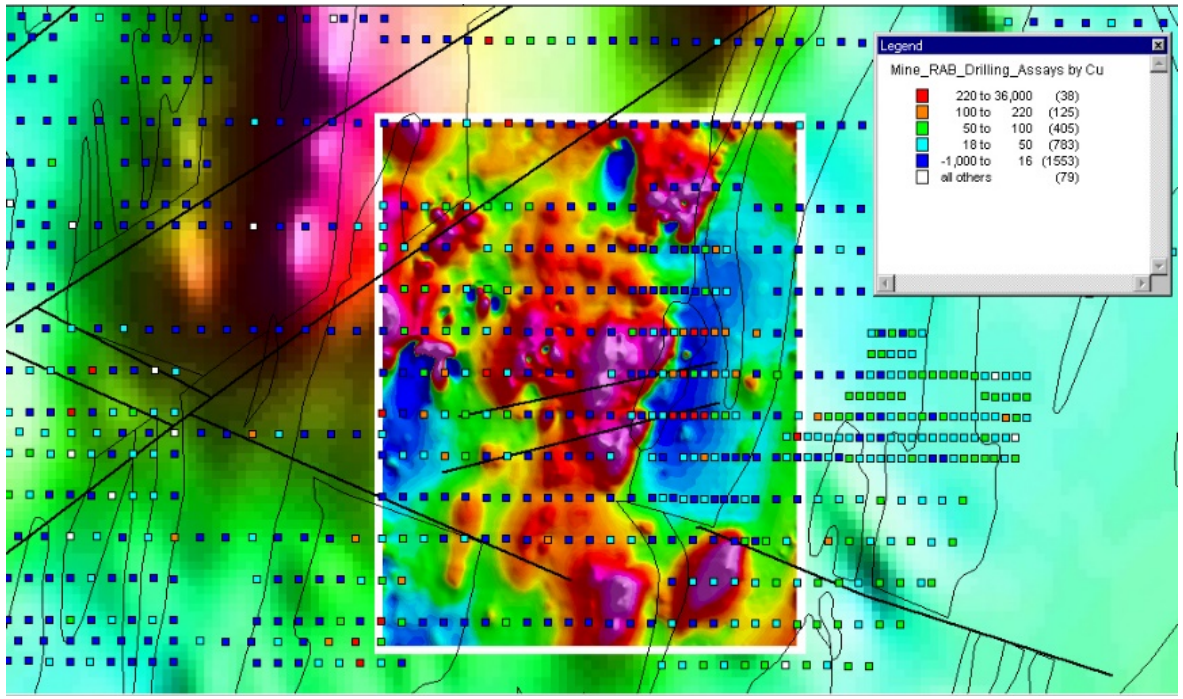
Geophysics



Au mineralisation coincides with magnetic low (magnetite replaced by hematite)



MIM (1999)

Cu soil anomaly coincided with magnetic low

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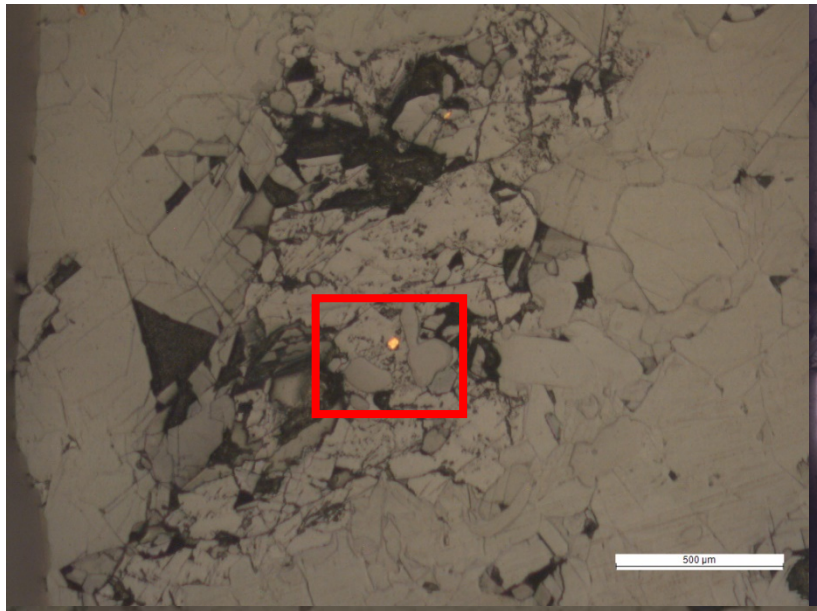
Mineralisation

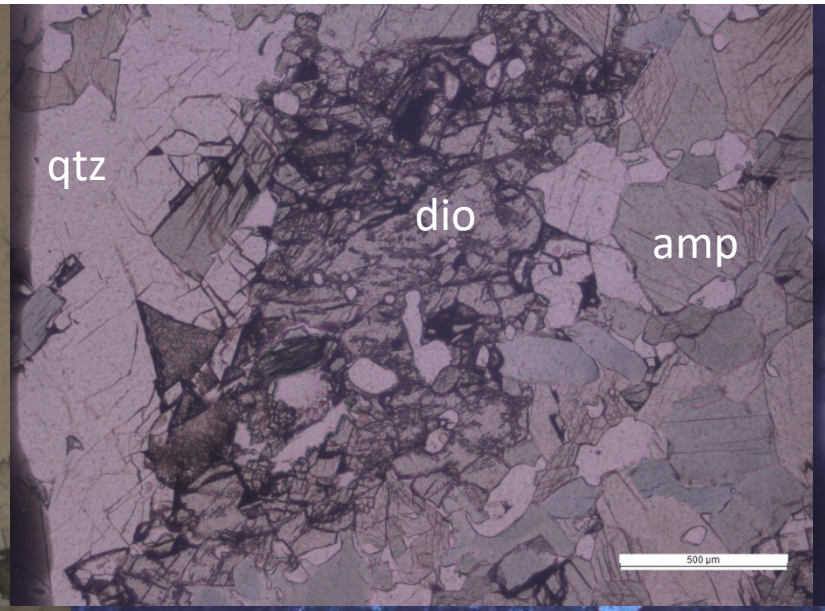
Paragenesis – Alteration:

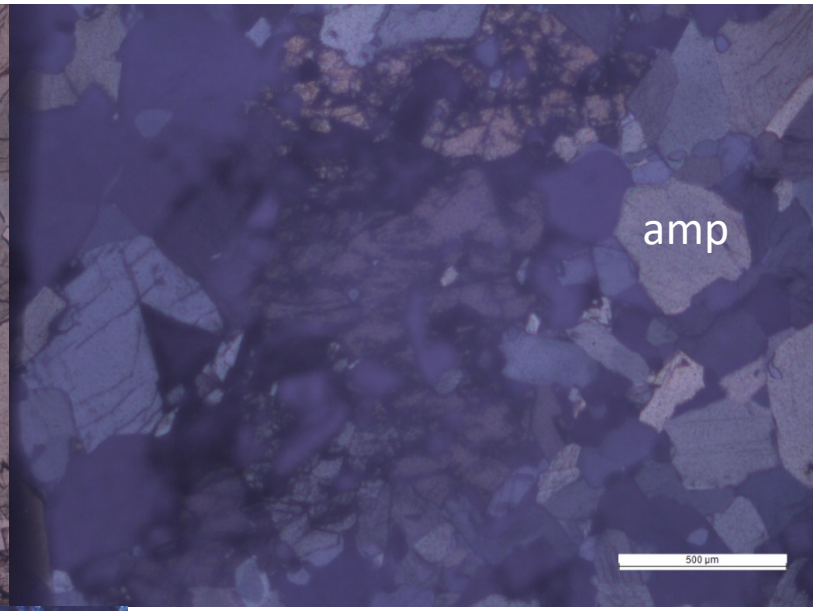
Deformation event - stage	Description	Ore mineral	Alteration minerals
D_1	• peak metamorphism, mylonite fabric	• magnetite, early Au (?)	• Peak metamorphic assemblage
D_3 - stage 1 (pre Au)	• Qtz-Fsp-Mt sheeted veins	• magnetite	• quartz • biotite • hematite
D_3- stage 2 (main Au)	• **white to pink, Au-bearing annealed quartz and feldspar (Qtz-Fsp metasomatism)**	• **Au – chalcopyrite – bornite – chalcocite – pyrrhotite – arsenopyrite - pyrite (trace)**	• **quartz** • **hematite (proximal)** • **biotite (proximal)** • **clay minerals (distal)**
D_3 - stage 3 (minor Au)	• red rock alteration	• Au – pyrite – chalcopyrite – bornite –pyrrhotite – pyrite	• quartz • chlorite + epidote • hematite • albite • clay minerals
D_3 - stage 4 (post Au)	• pale pink Qtz-Fsp flooding	• magnetite	• quartz
D_3 - stage 5	• late Epi-Chl-Qtz veins		• chlorite (+ epidote)
D_3 - stage 6	• late veins, brecciation	• pyrite	• quartz • clay minerals

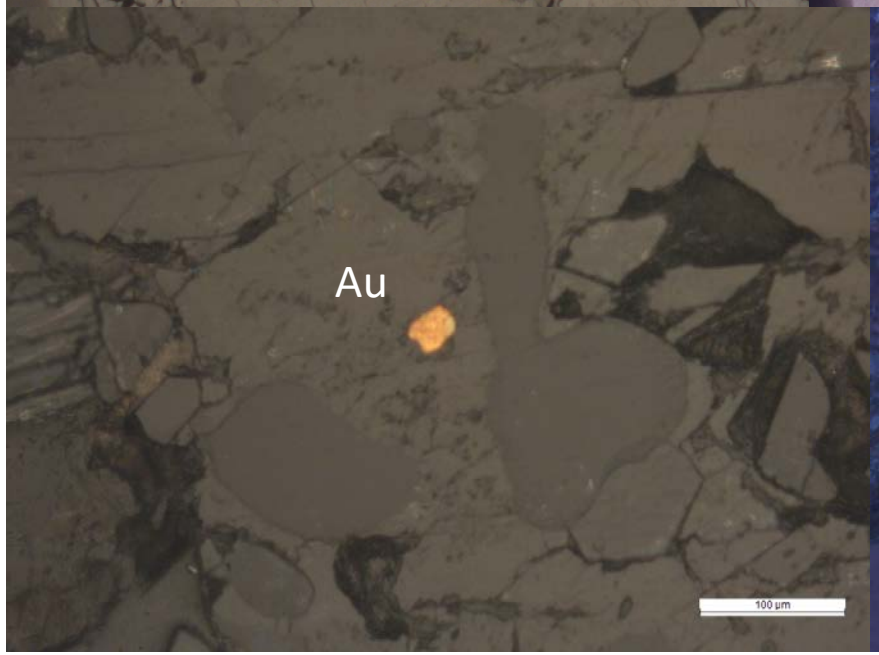
Mineralisation

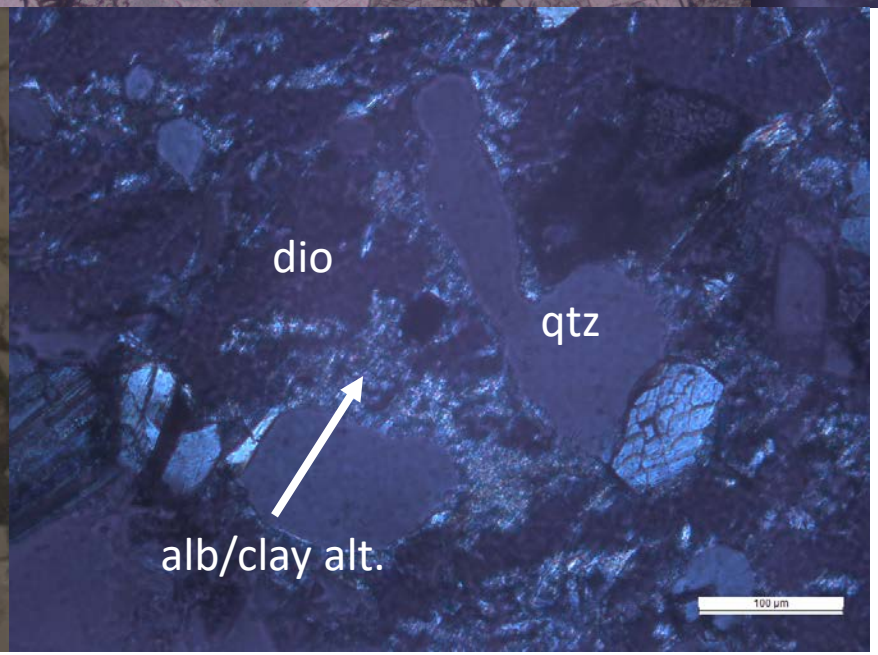
Paragenesis: D_1







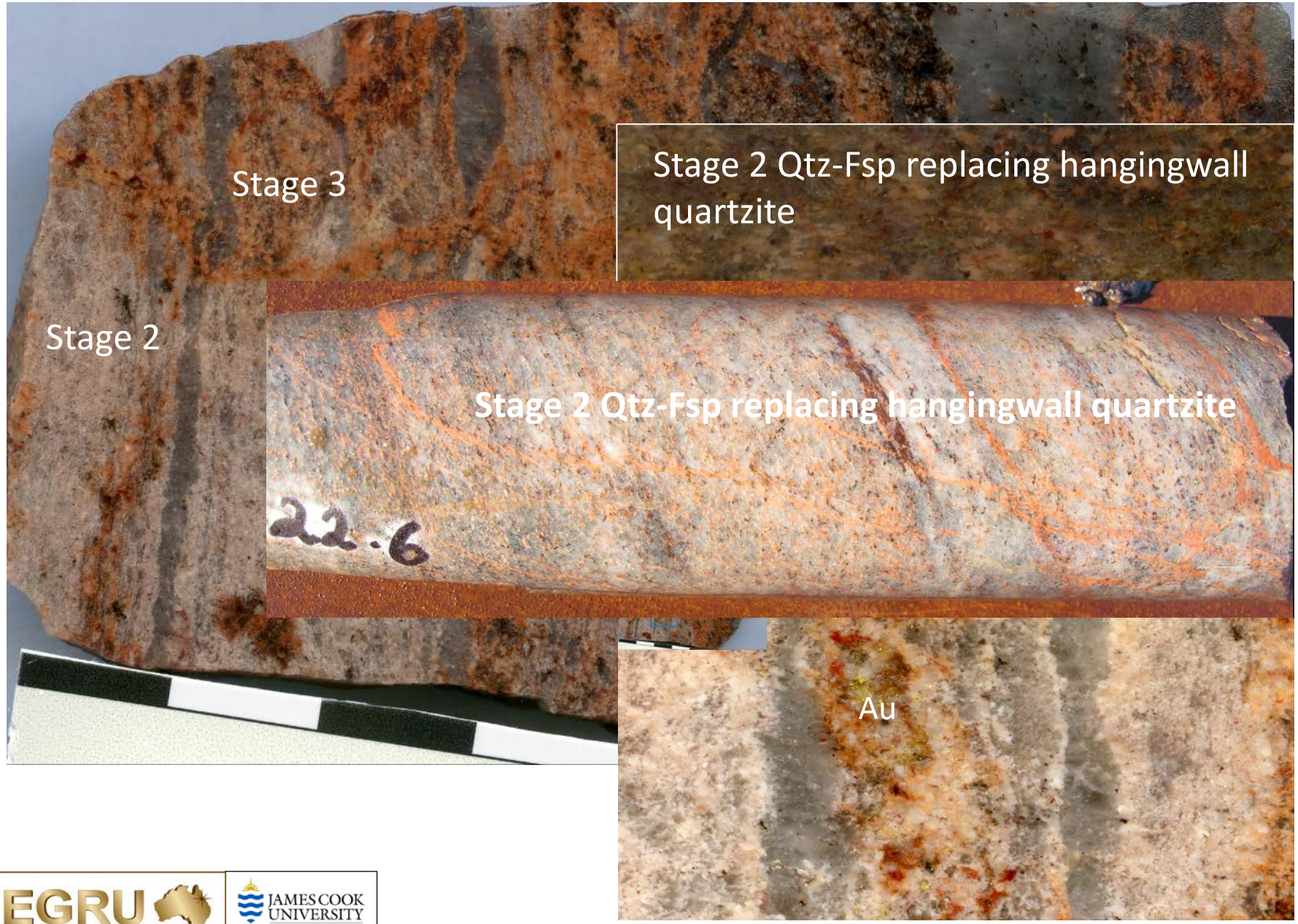




- Au in deformed and altered D_1 diopside
- D_1 or D_3 Au ? (further studies required)

Mineralisation

Paragenesis: D_2 & D_3



- D_3 - stage 2:

  annealed Au-bearing quartz-feldspar

- D_3- stage 3

  Red rock alteration overprinting stage 2

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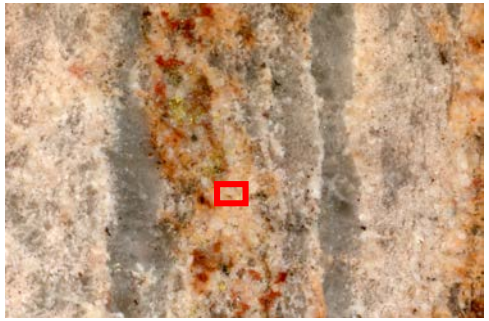
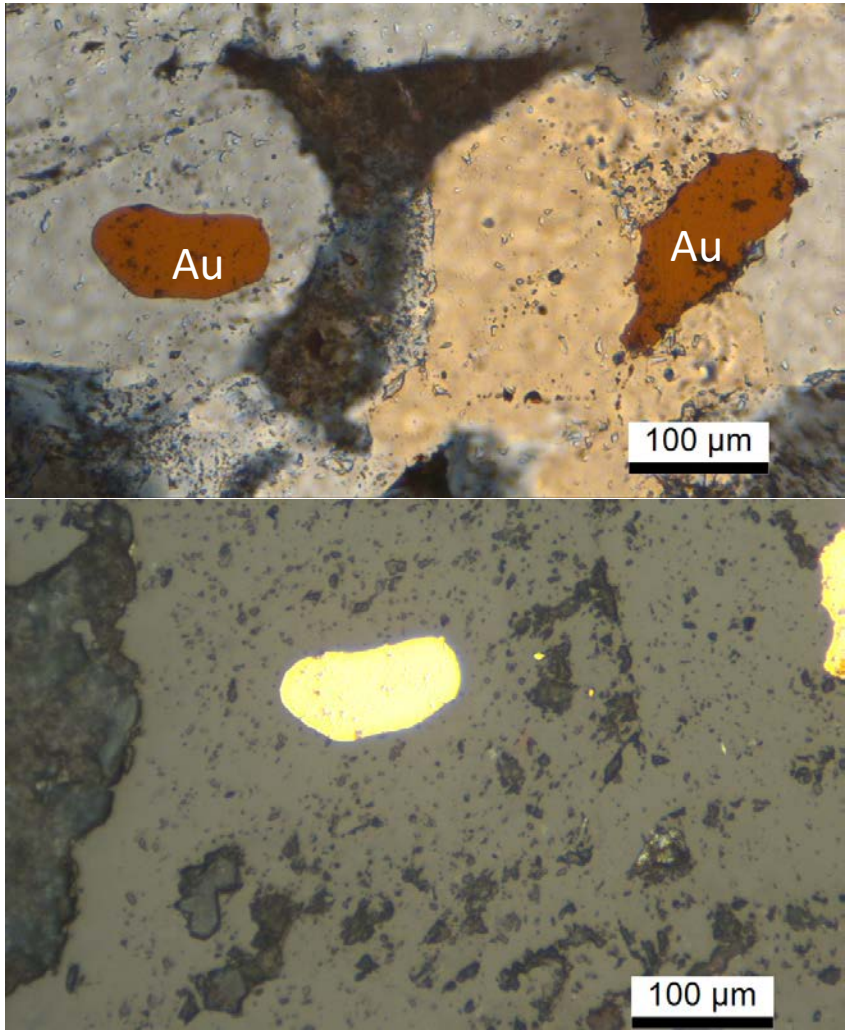
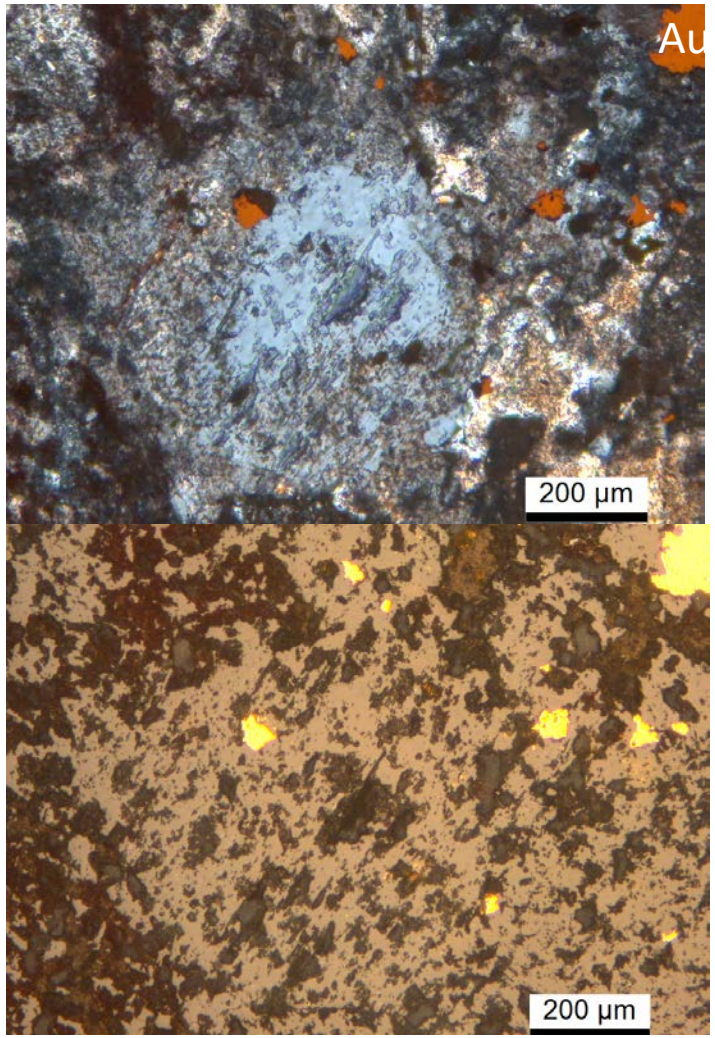
Mineralisation

Paragenesis – Alteration: D_2&D_3





D_3 - stage 2: Au in annealed quartz and feldspar



D_3 - stage 3: Au with sericite-albite-chlorite-clay alteration

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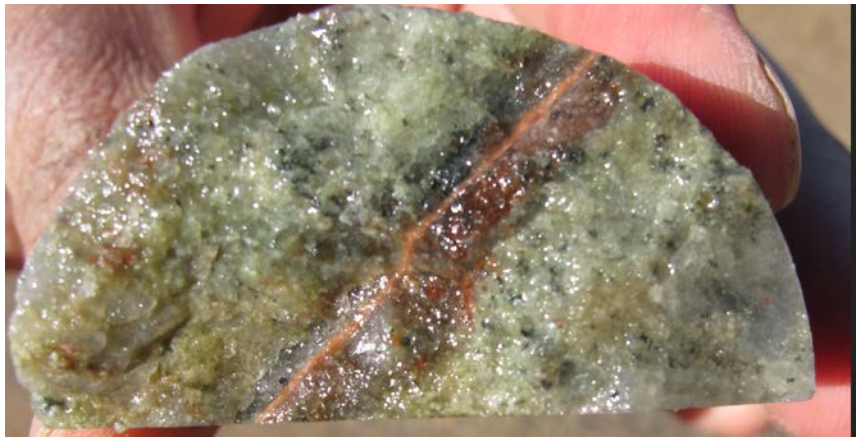
Mineralisation

Main Au-stage alteration zonation:

Pit wall



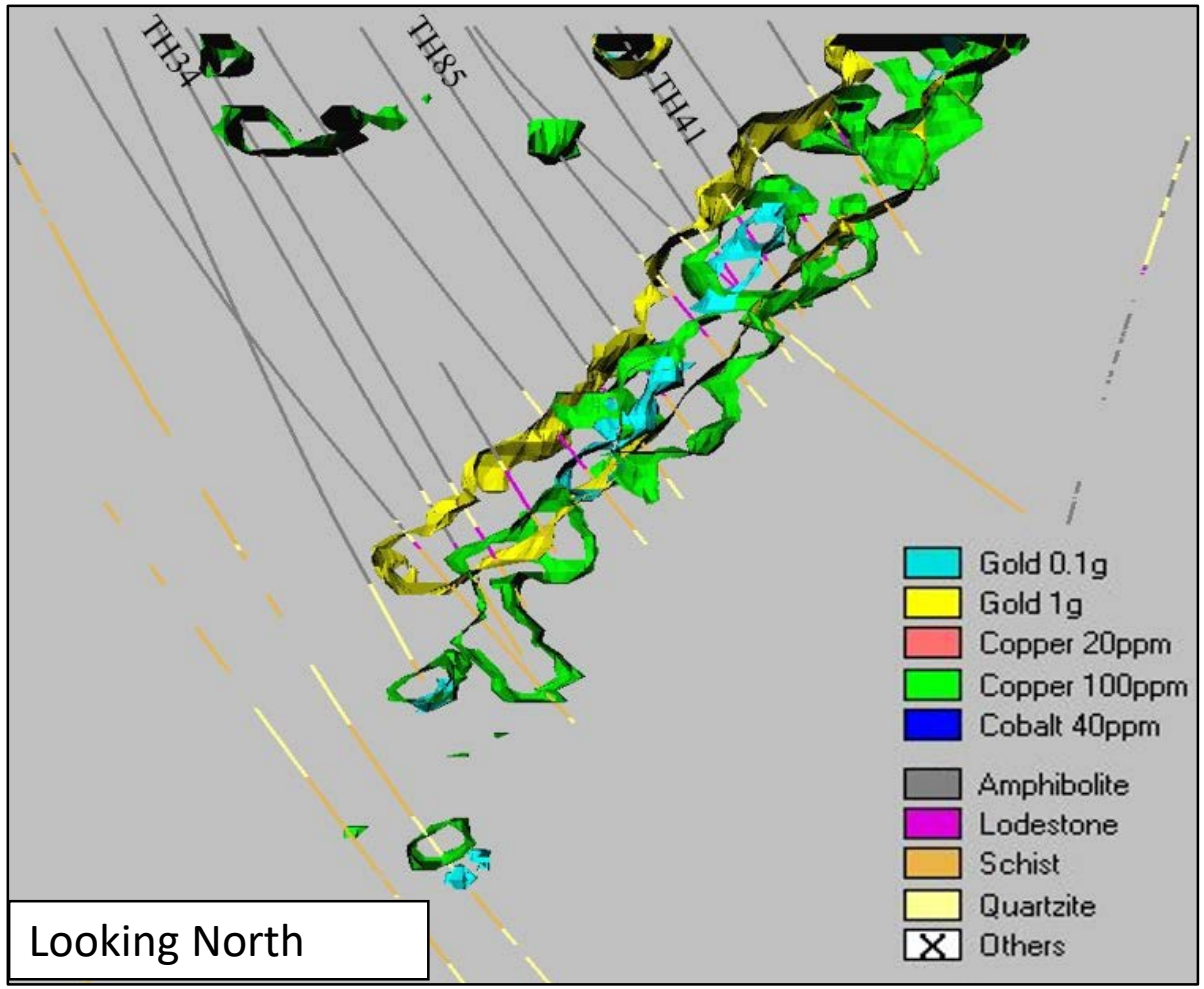
40m from the ore zone

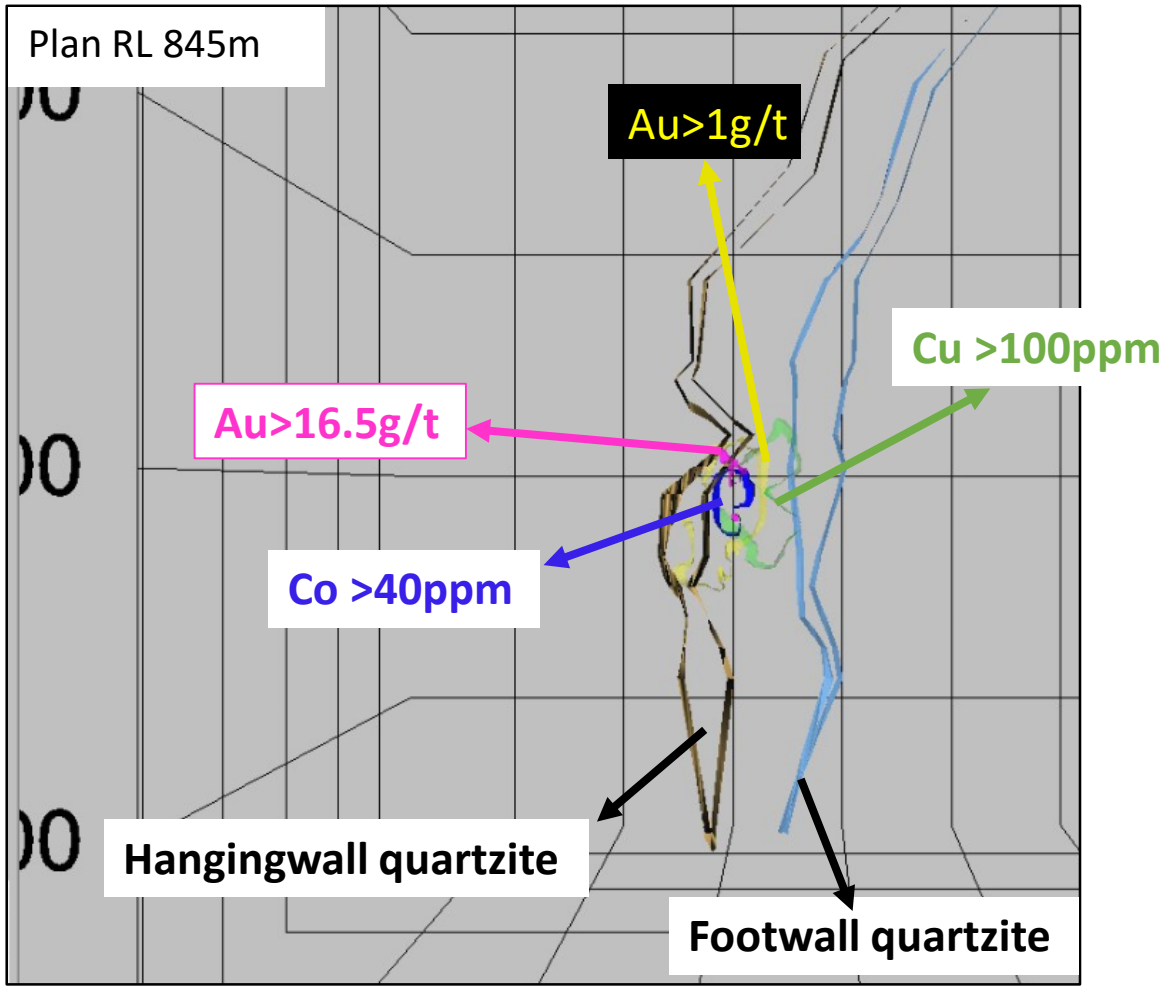
Stage 2:

- Proximal:
  Silicification + hematite + biotite
- Distal:
  Green clay minerals

D_3- stage 2 alteration (overprinted by stage 3 red rock alteration)

Mineralisation





Au associated with Cu and Co

MIM (1999)

Summary

Geology:

- Basement rock >1800Ma
- Syn-D_1 intrusions ~ 1772-1777Ma, Late pegmatite ~1517-1528Ma
- Host rocks: calcsilicate, biotite schist, amphibolite, quartzite
- Ore zone transects lithological contacts
- Au mostly hosted in annealed quartz-feldspar mylonite
- Au also in calcsilicate, horblende-plagioclase-quartz mylonite and quartzite

Structure

- Ore shoots lie in the F_1 hinge zone of Tick Hill tight fold
- Ore occurs along late (D_3) shear zone, along foliation truncation plane
- Ore shoots // to intersection lineation between S_1 and S_3 shears

Summary

Metamorphism

- Upper amphibolite to granulite facies

Other

- Ore shoots (+ Cu, Co) occurs in the magnetite-depleted zone
- Au associated with minor Cu and Co

Mineralisation and alteration

- Main syn-Au stages: D_3 - stage 2

  Ore: Au – chalcopyrite – bornite – chalcocite – pyrhotite – pyrite (trace)

  Alteration: quartz- hematite – biotite (proximal) and clay minerals (distal)

- Early Au?: Au with quartz – feldspar – amphibole

What is it ?:
End-member IOCG which formed ~ 1528-1530 Ma; possibly with some early gold

Acknowledgement

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