

# Tectonic setting and metallogenesis in the South-Eastern Kédougou-Kéniéba Inlier: Our current understanding

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RESOURCES

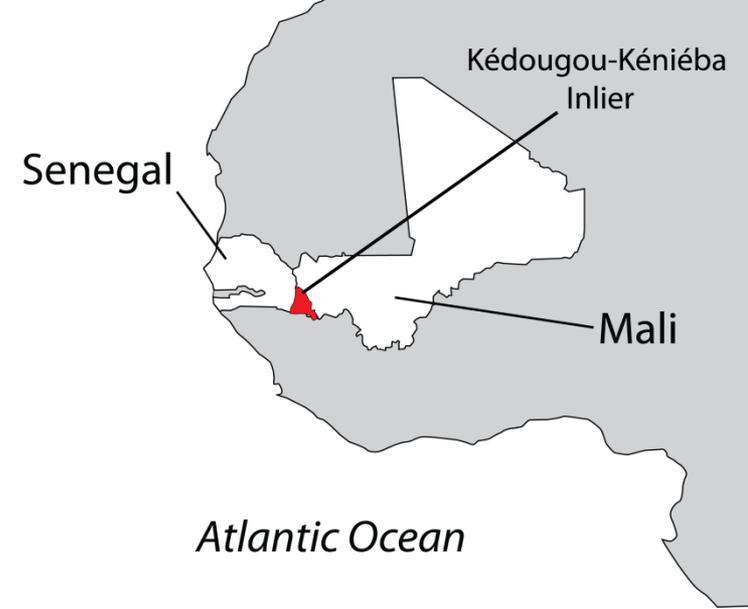
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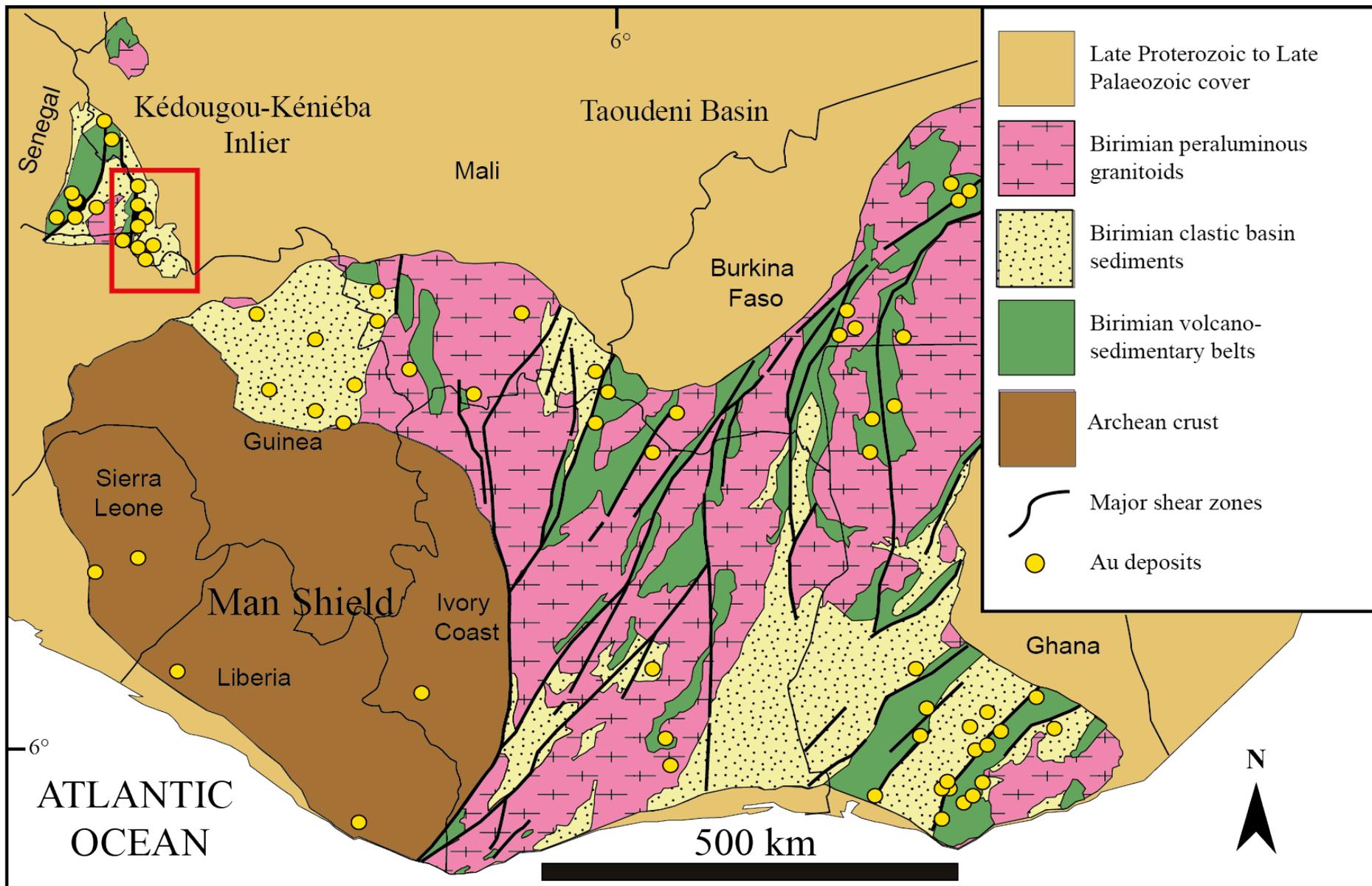
# Introduction

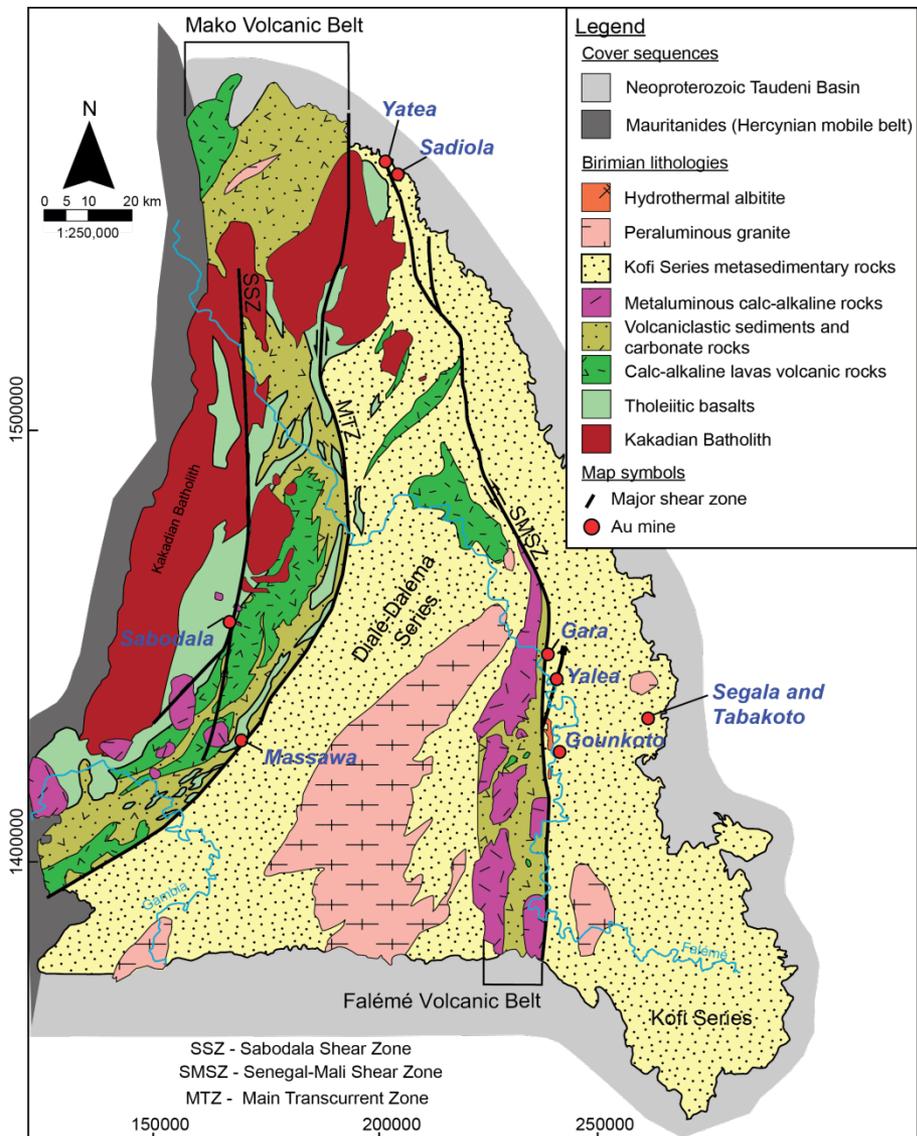
- The Senegal-Mali Shear Zone: a major crustal scale terrane boundary, hosts combined Au ~27 Moz.
- KU and RRL have been working together in the region for the past ~7 years.

## Research aims:

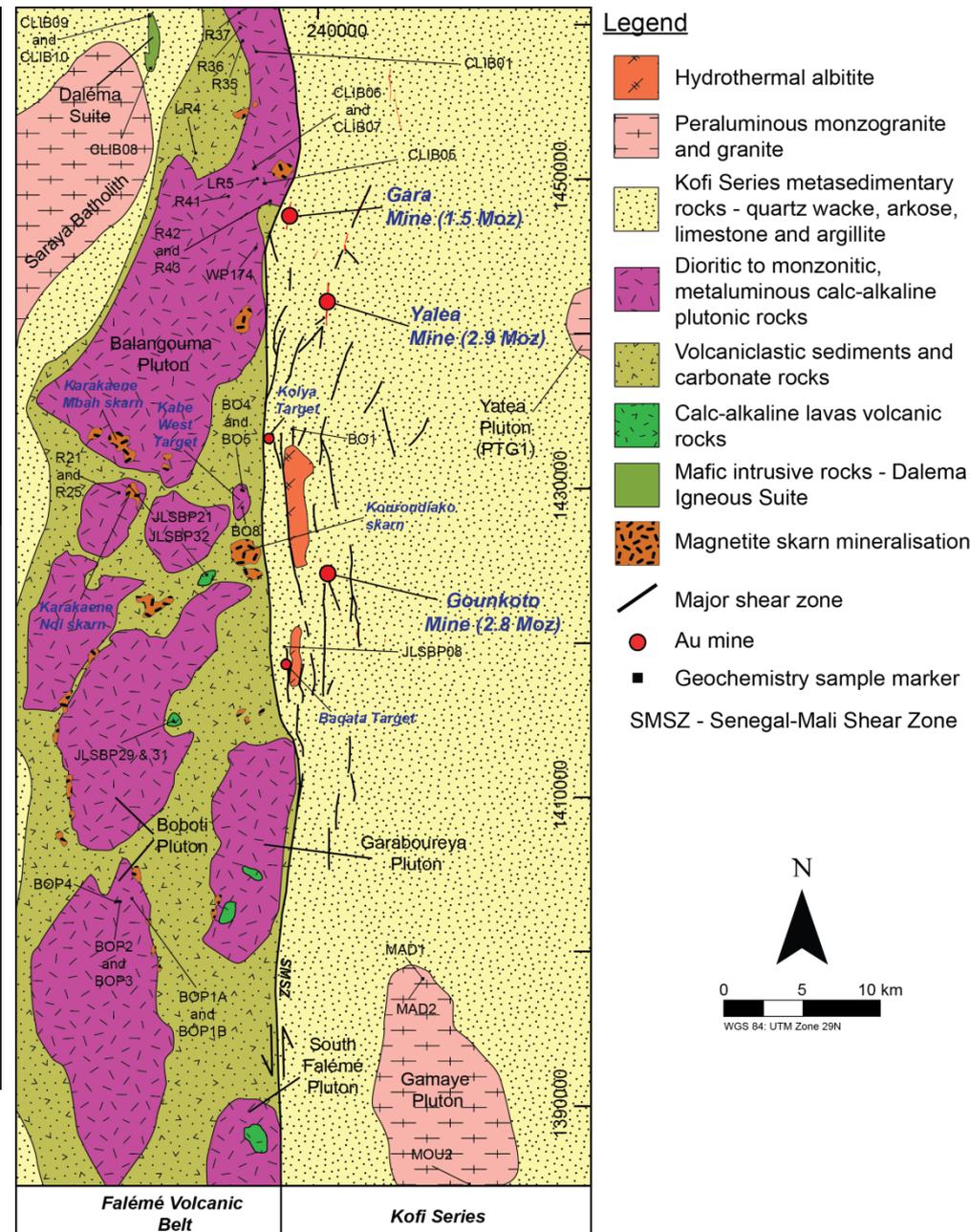
- To improve understanding of the geological, structural and tectonic setting of the KKI.
- To characterise orogenic gold deposits in the region and investigate their genesis.
- To feed findings into exploration strategies.

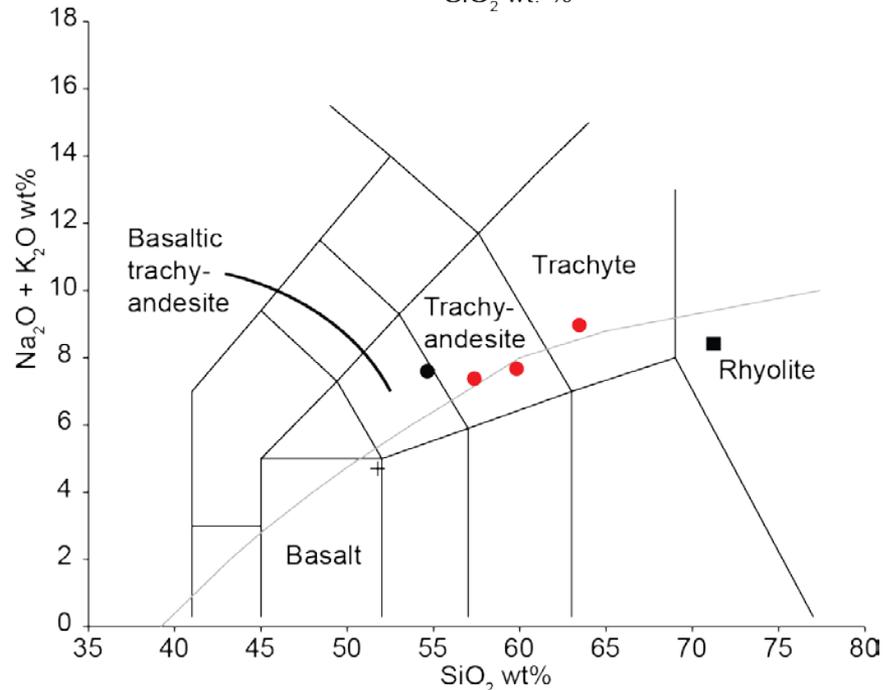
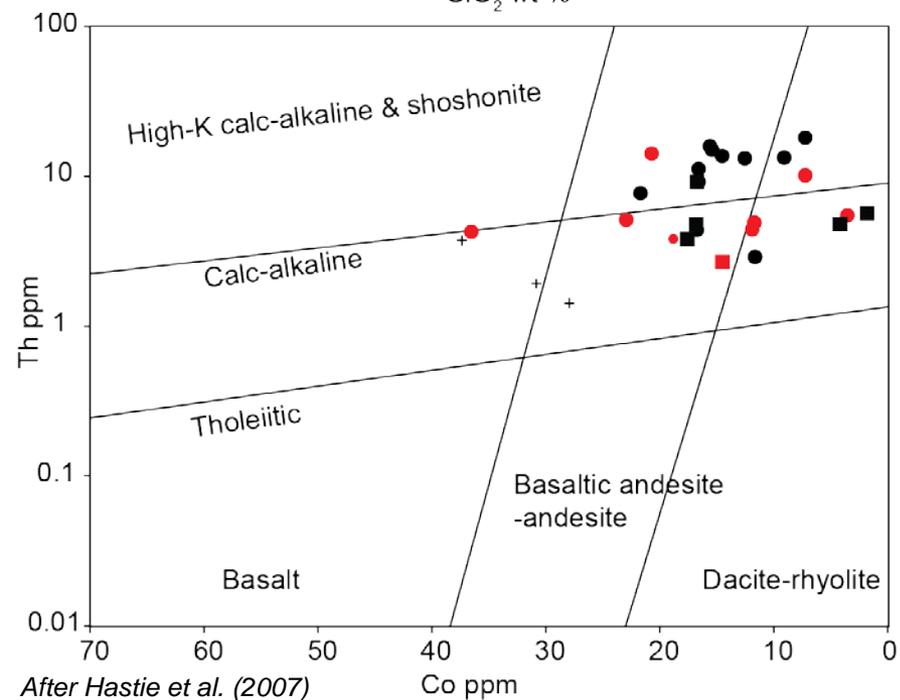
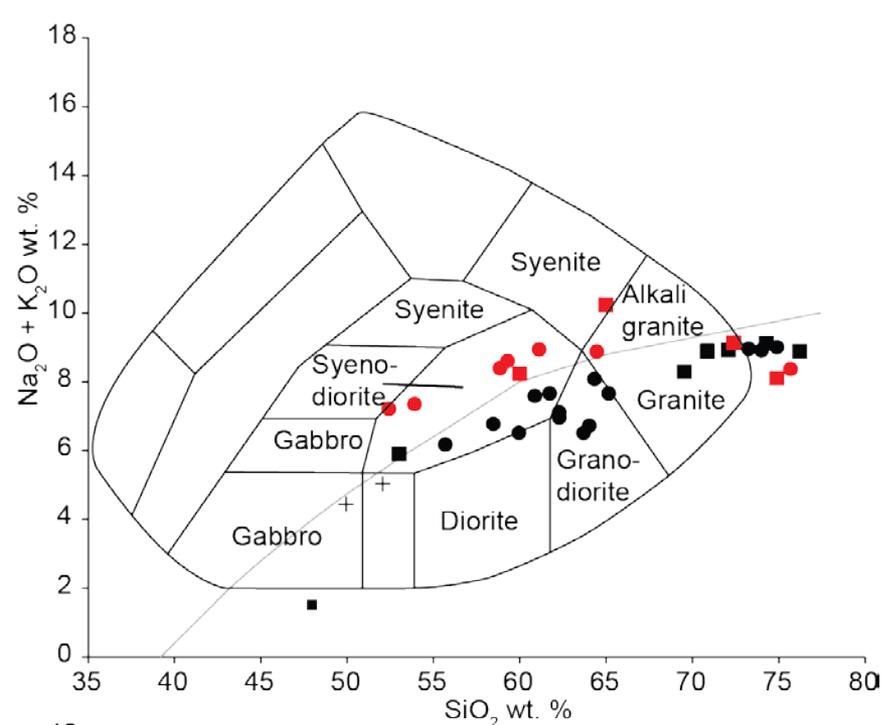
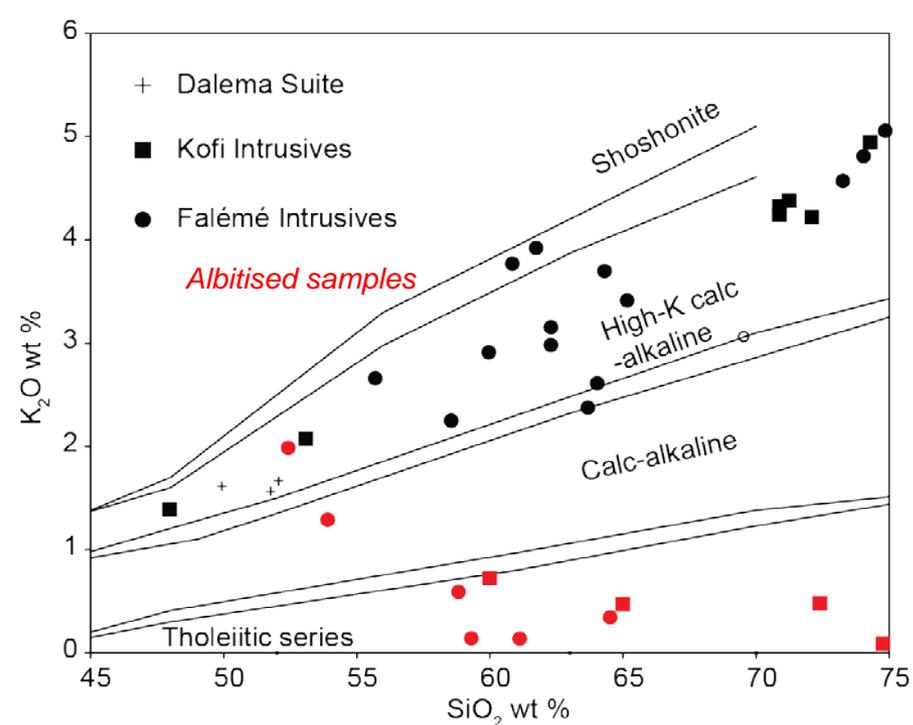




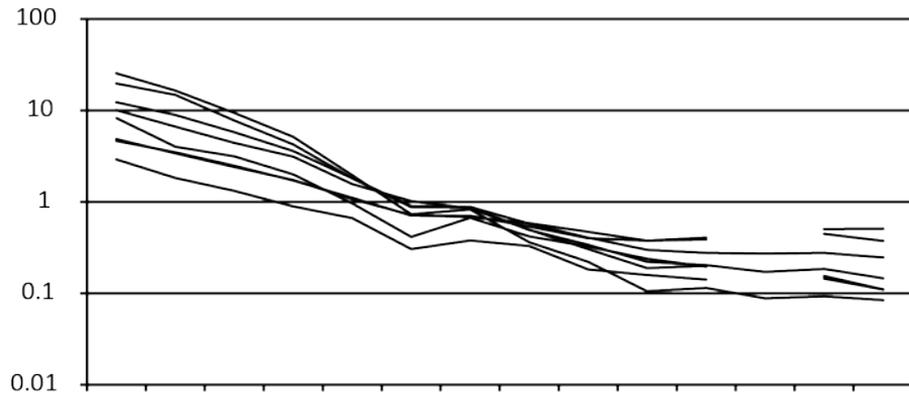


Metaluminous plutons ~2115 Ma to 2080 Ma;  
 peraluminous plutons <2080, but poorly  
 constrained; parts of the Kofi Series are <2090 Ma  
 (Boher et al., 1992).

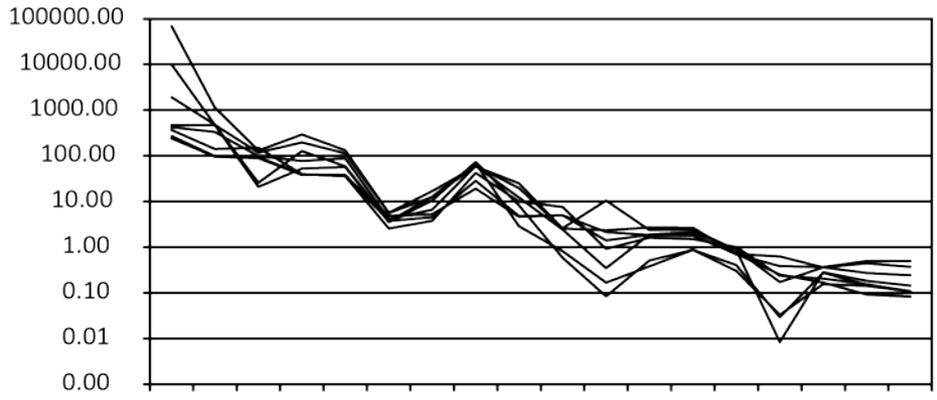




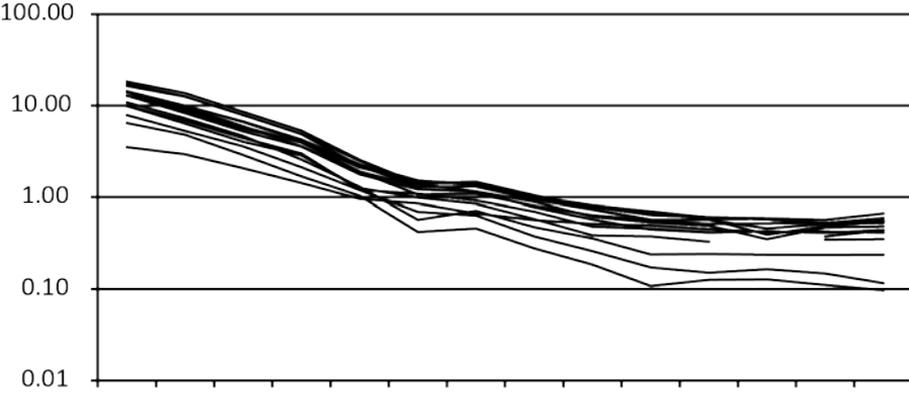
# Rock/N-MORB



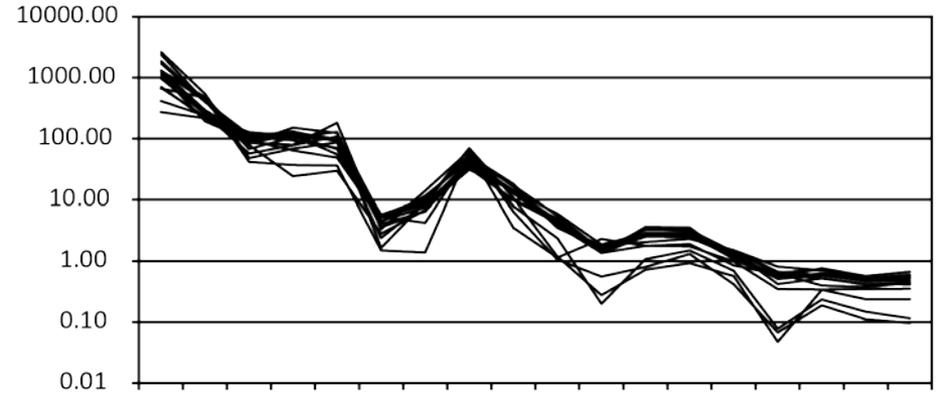
# Kofi Series



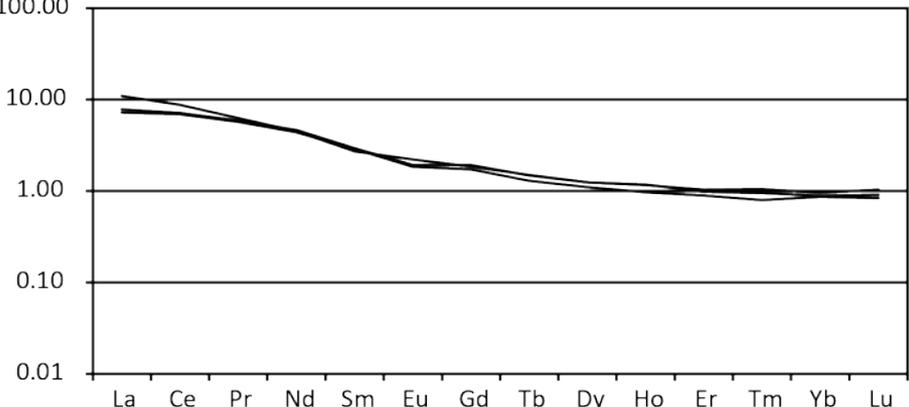
# Falémé Belt



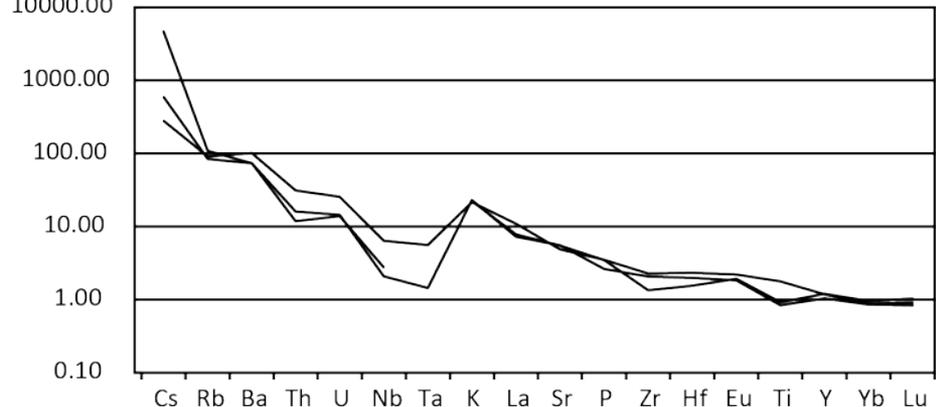
# Falémé Belt

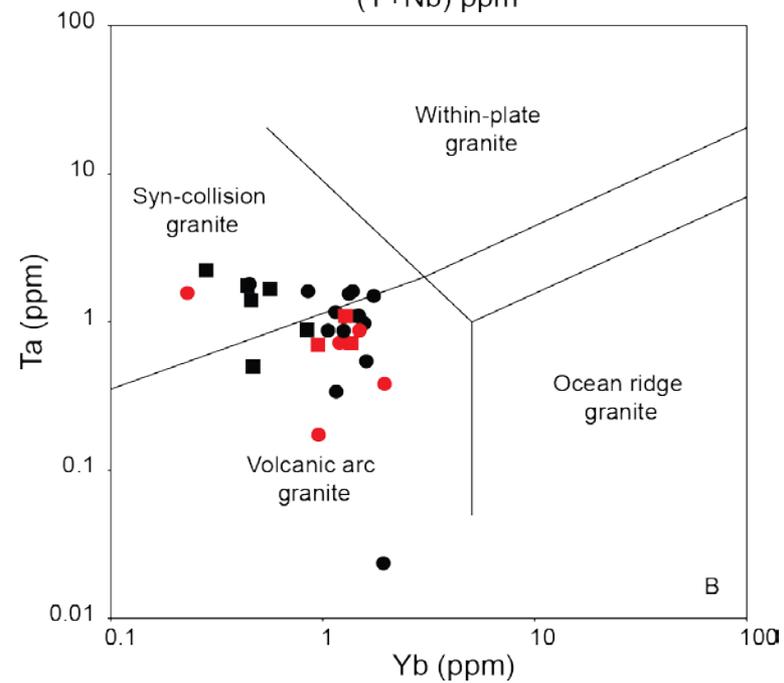
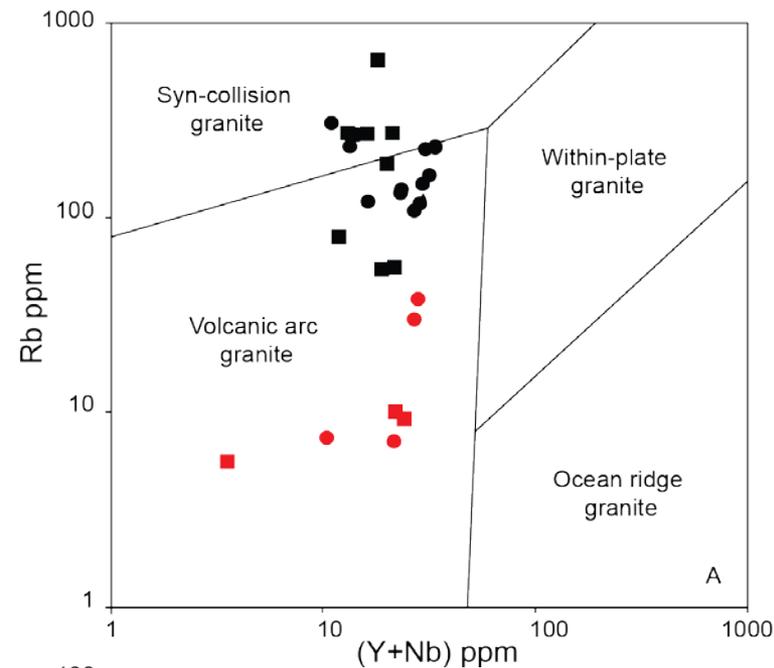


# Dalema Igneous Rocks

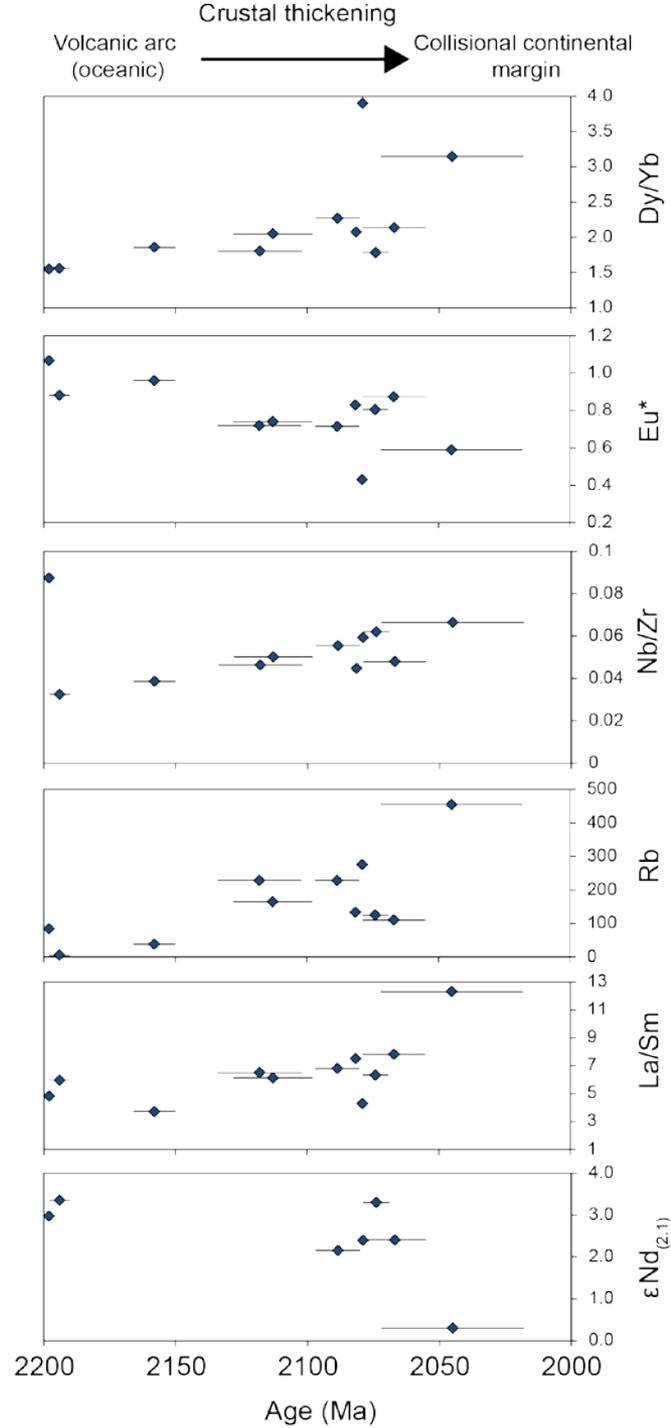


# Dalema Igneous Rocks





Right - Data from Boher et al., (1992), Pawlig et al., (2006), Dioh et al., (2006) Bassot and Caen-Vachette (1984); Dia et al. (1997); Hirdes and Davis (2002); Gueye et al. (2007) – for whole KKI.



- Units in the eastern KKI are all  $\leq 2100$  Ma; corresponding to the Birimian ME3 and 4.
- They generally fit with the trend in the Birimian of magmatism becoming more peraluminous with time, reflecting the change from VAG to collisional magmatism.
- Do not see older high Sr/Y, K-rich granites.
- No tholeiitic component.

# Structural setting

- Sinistral strike-slip dominated (D2-3) – ore deposit architecture
- D1 structures (thrusts) are somewhat cryptic, though early bedding parallel foliation may also be D1.

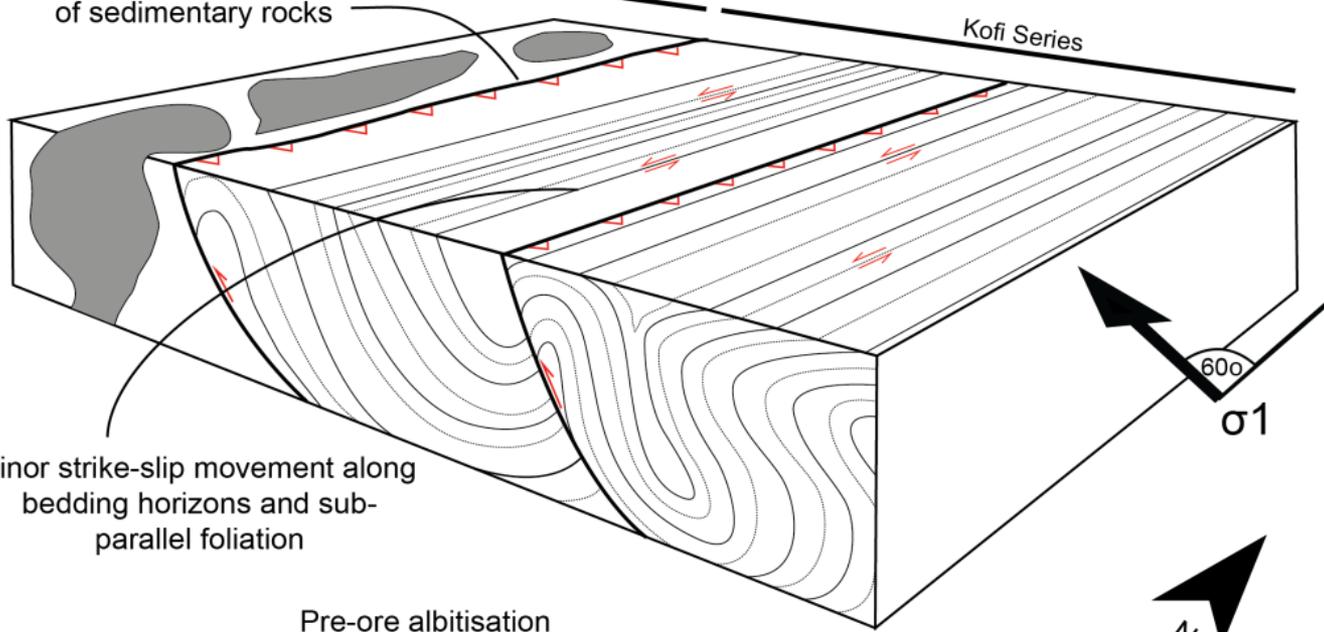


**A**

Thrust stacking and folding of sedimentary rocks

Falémé Volcanic Belt

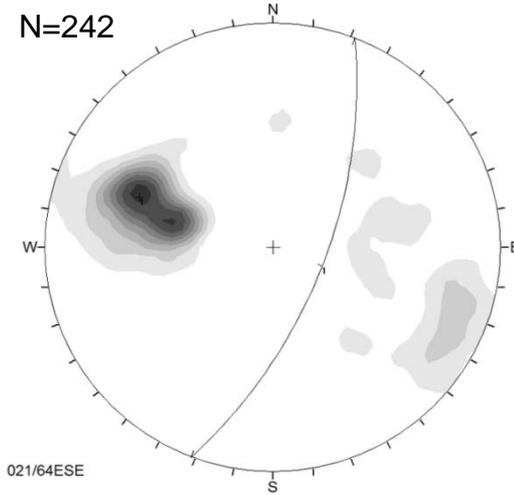
Kofi Series



Minor strike-slip movement along bedding horizons and sub-parallel foliation

 $\sigma_1$   
60°**D1**

N=242



021/64ESE

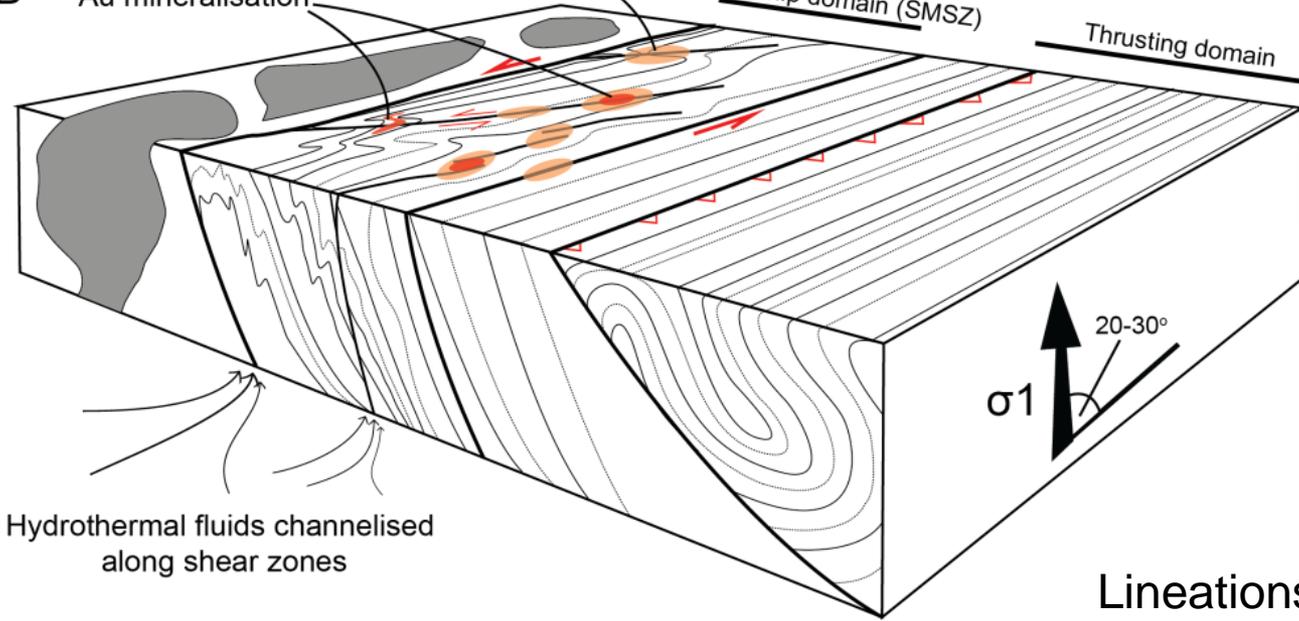
**B**

Au mineralisation

Pre-ore albitisation of host rocks

Strike-slip domain (SMSZ)

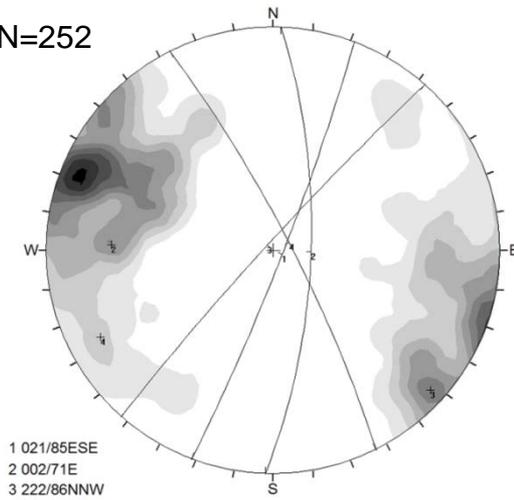
Thrusting domain



Hydrothermal fluids channelled along shear zones

 $\sigma_1$   
20-30°**D2**

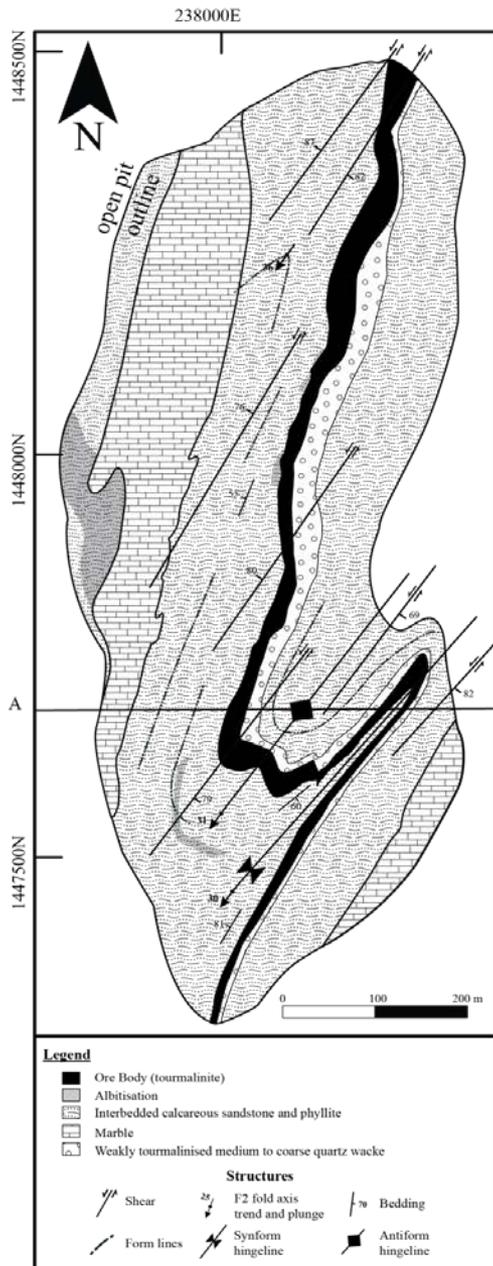
N=252



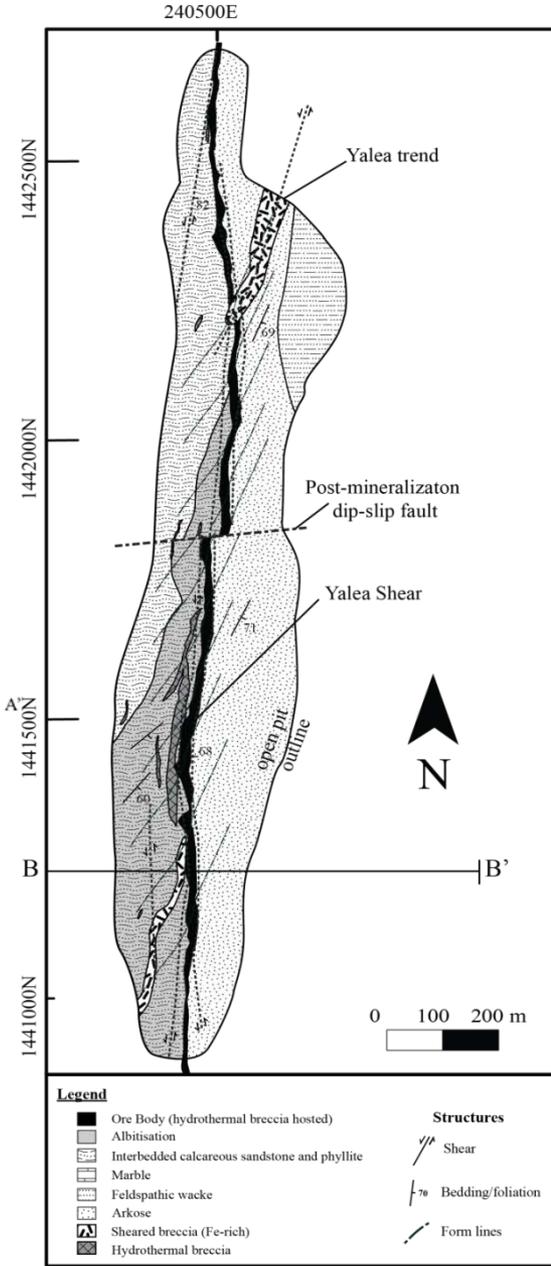
1 021/85ESE  
 2 002/71E  
 3 222/86NNW  
 4 333/81NE

Lineations plunge 9° toward 193°

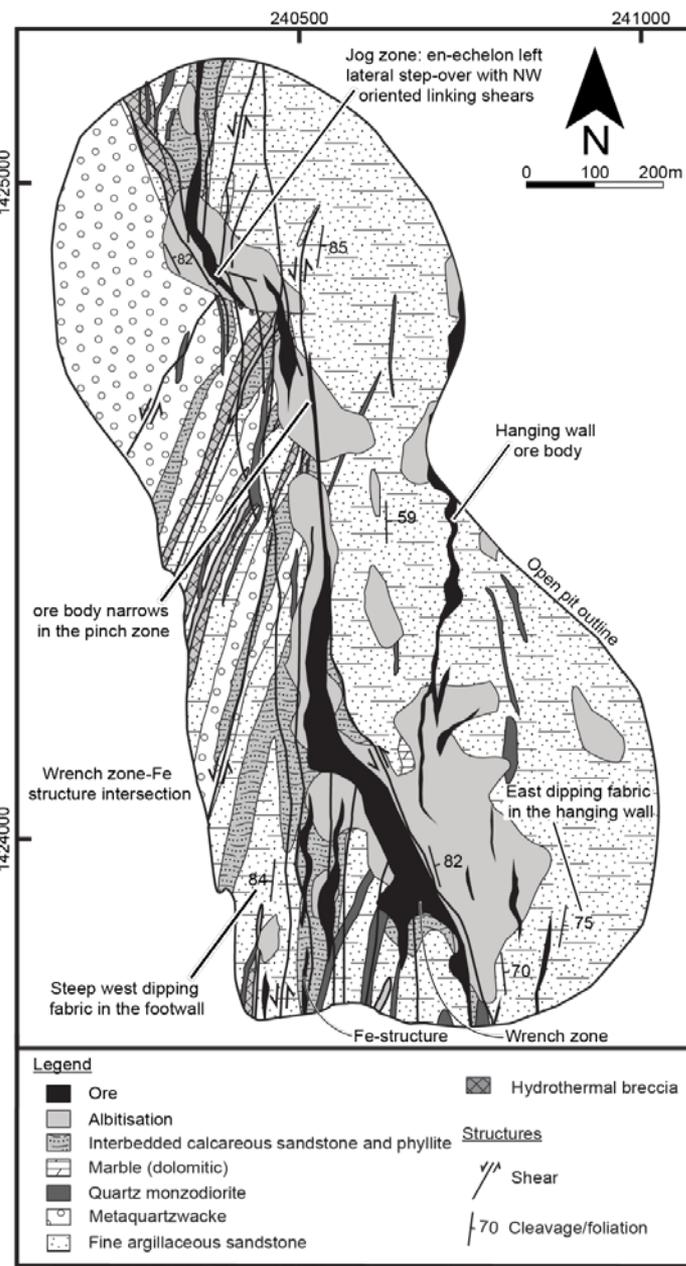
# Gara

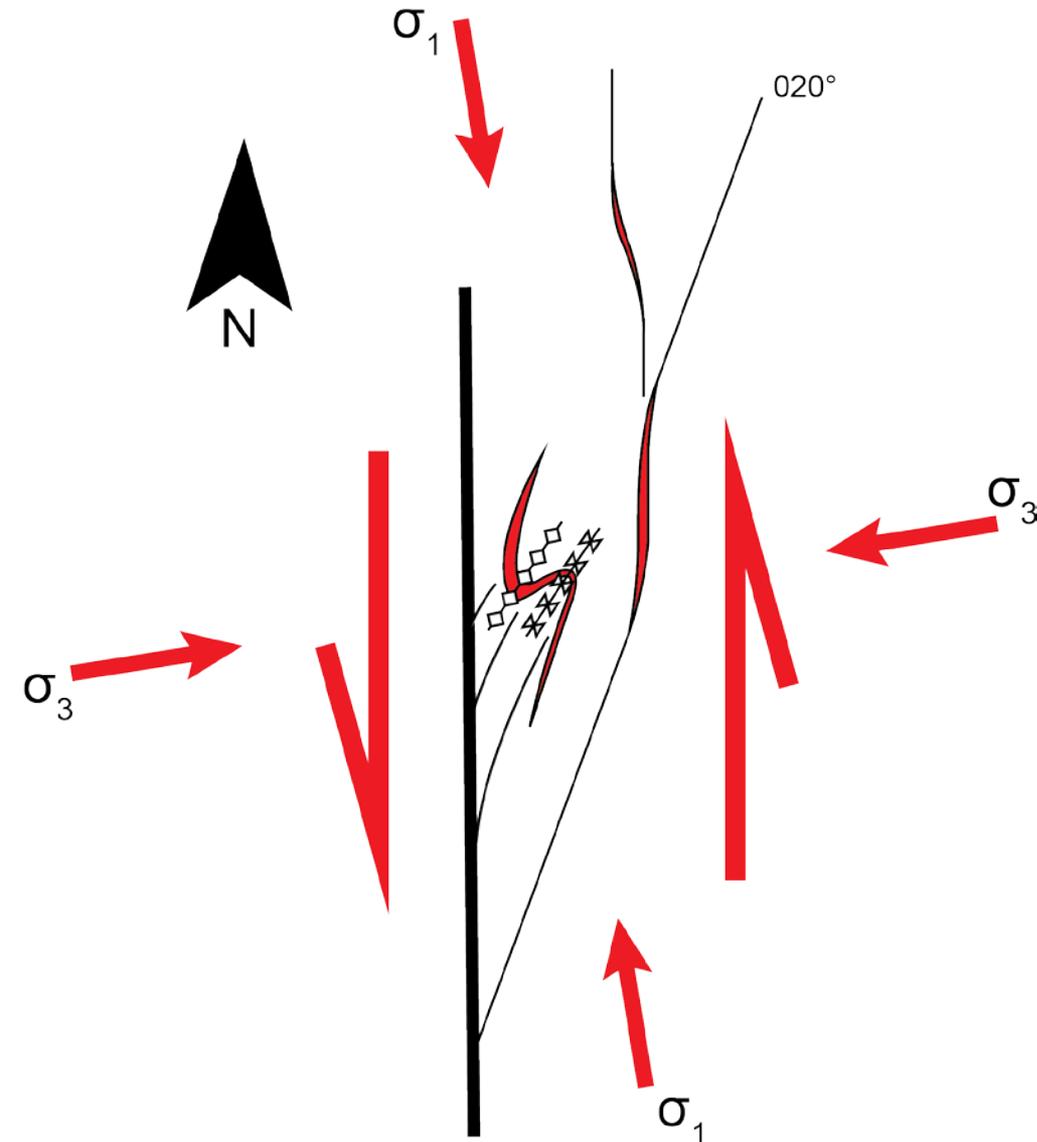


# Yalea



# Gouunkoto

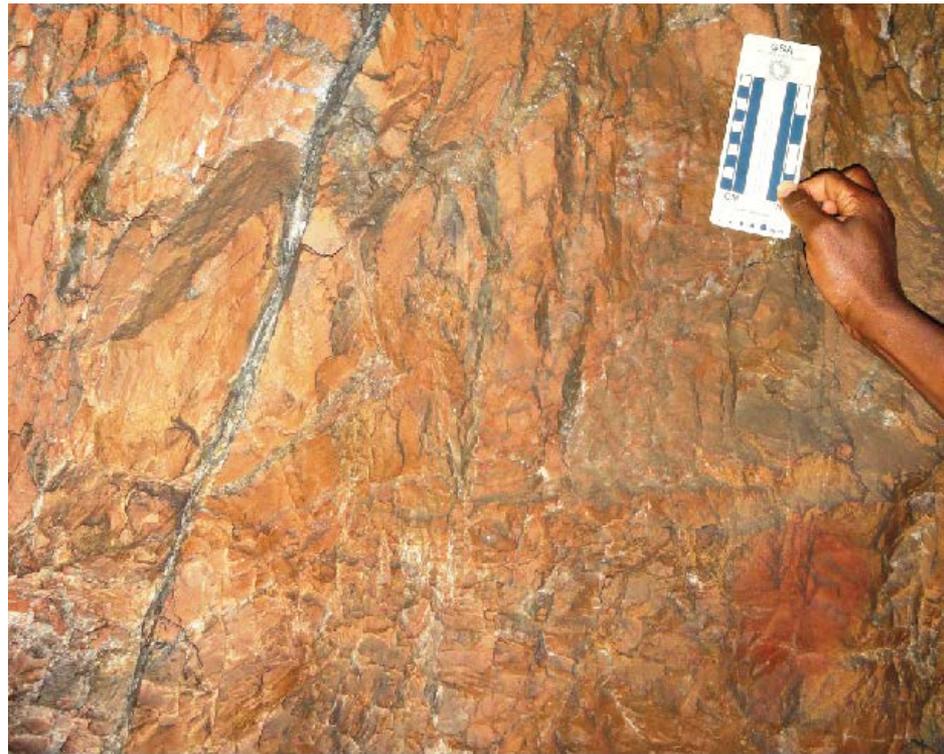
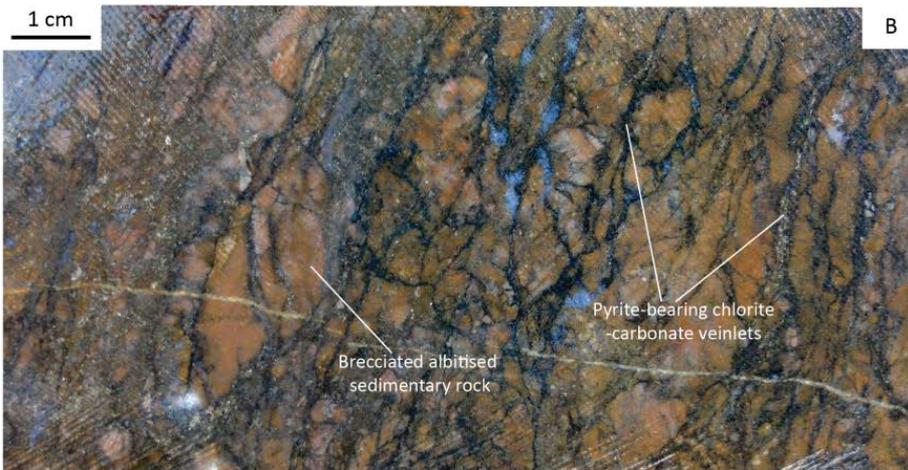




Why do we get ore deposits in apparently different orientations?

- Localised transtension within an overall transpressional regime – throughout D2-3.
- Most deposits appear to sit along left steps in the system.
- Also some signs of a late dextral reactivation, regionally (also reported by Dabo and Aifa, 2011)

- What we see in the Loulo-Gouunkoto area correlates with local WAXI studies at Sadiola (Masurel et al., in press):
  - D1s - recumbent folding (F1).
  - D2s - 10-30° SSW-plunging upright folds (F2)
  - D3s - strike-slip faulting.
- In terms of the regional structural framework:
  - All the deformation in the South-Eastern KKI corresponds (probably) to the WAXI D4-5.



**Gara**      **Yalea**      **Goukoto**

**Sulphides**

|              |             |             |             |
|--------------|-------------|-------------|-------------|
| pyrite       | Major       | Major       | Major       |
| arsenopyrite | Trace       | Major       | Trace       |
| Ni±Co pyrite | Accessory   | Not present | Accessory   |
| As-pyrite    | Not present | Major       | Accessory   |
| chalcopyrite | Trace       | Major       | Trace       |
| pyrrhotite   | Trace       | Major       | Not present |
| cobaltite    | Not present | Trace       | Trace       |
| galena       | Not present | Trace       | Trace       |
| gersdorffite | Accessory   | Not present | Not present |
| jamiesonite  | Not present | Trace       | Not present |
| millerite    | Not present | Trace       | Trace       |
| molybdenite  | Trace       | Not present | Not present |
| polydymite   | Not present | Major       | Trace       |
| pentlandite  | Accessory   | Trace       | Trace       |
| Ullmannite   | Not present | Trace       | Not present |
| tenantite    | Not present | Trace       | Trace       |

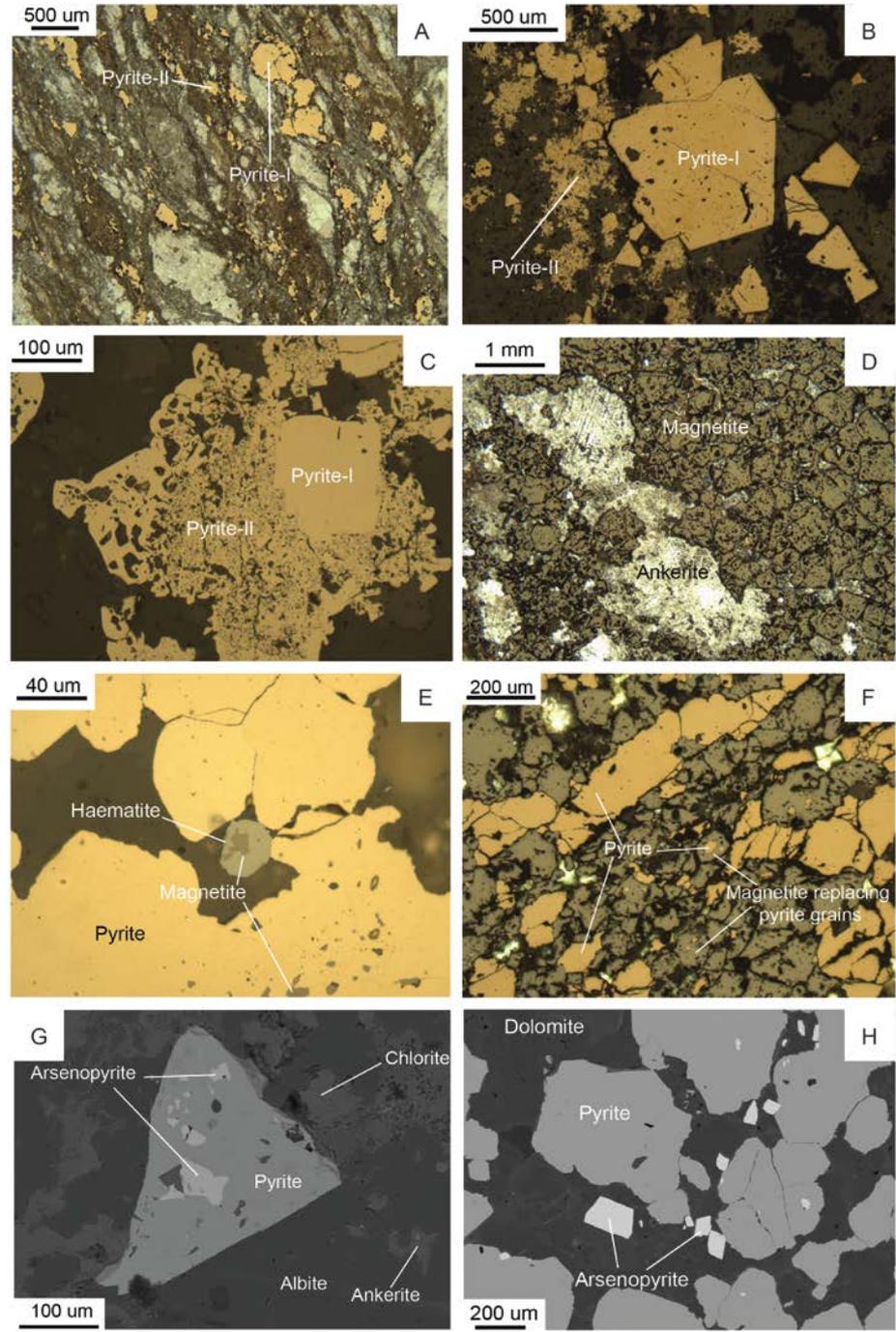
**Non-sulphide ore phases**

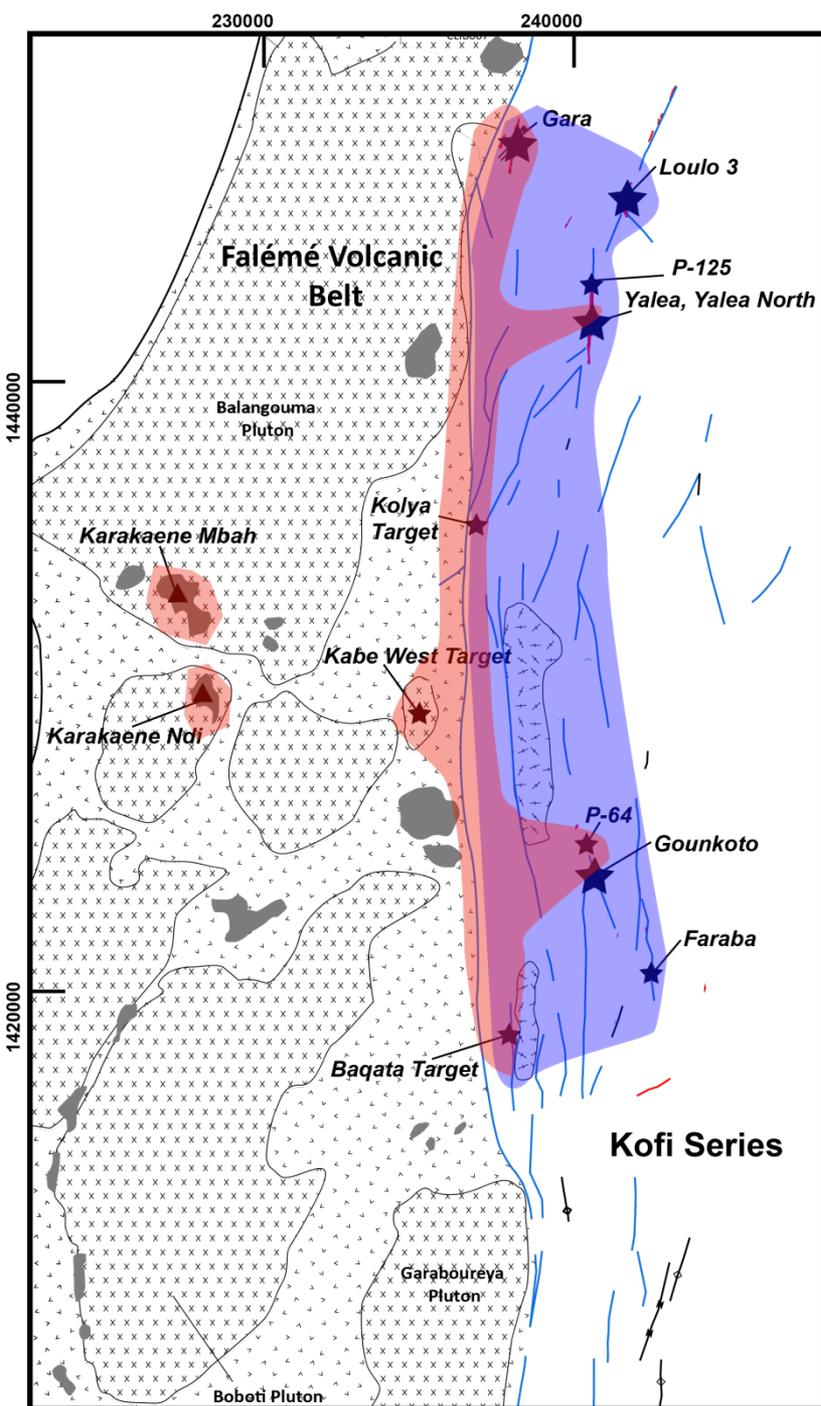
|           |             |             |             |
|-----------|-------------|-------------|-------------|
| magnetite | Not present | Major       | Major       |
| monazite  | Accessory   | Not present | Accessory   |
| haematite | Not present | Trace       | Trace       |
| scheelite | Accessory   | Trace       | Trace       |
| xenotime  | Trace       | Not present | Not present |

**Au and related phases**

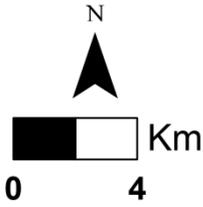
|                |             |             |           |
|----------------|-------------|-------------|-----------|
| gold           | Accessory   | Accessory   | Accessory |
| altaite        | Not present | Not present | Trace     |
| calaverite     | Not present | Not present | Trace     |
| clausenthalite | Not present | Not present | Trace     |
| tellurium      | Not present | Not present | Trace     |

Major      Trace  
Accessory      Not present

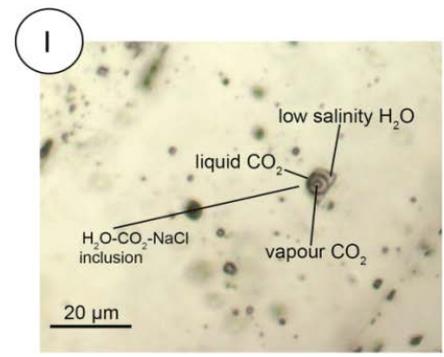




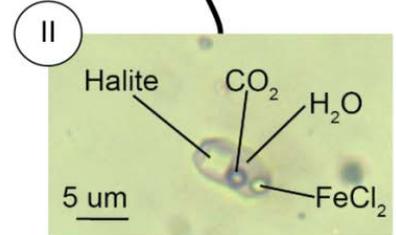
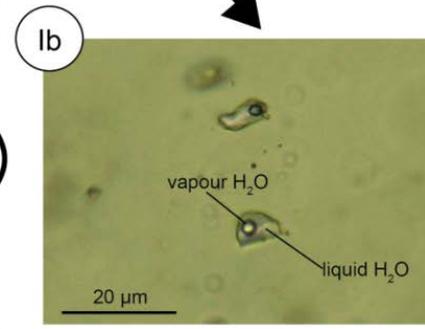
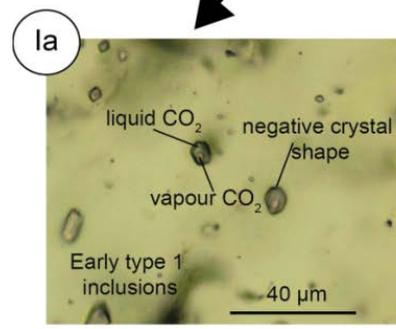
- Legend**
- Albitite
  - Granite
  - Volcanic series
  - Calc-alkaline plutons
  - Metasediments
  - Magnetite skarn
  - Au ore body
  - Major shear
  - Low salinity fluid
  - Hypersaline fluid
  - Zone of mixing



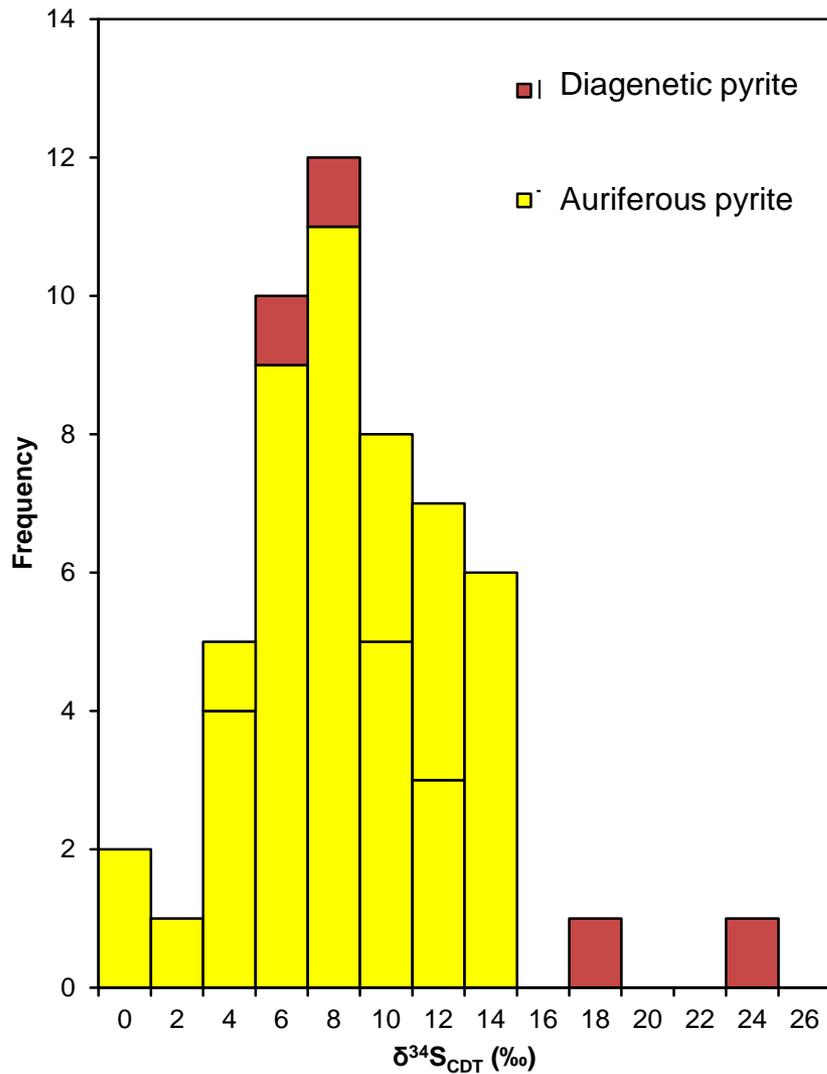
- Volumetrically subordinate, but widely distributed
- Linked to alteration facies



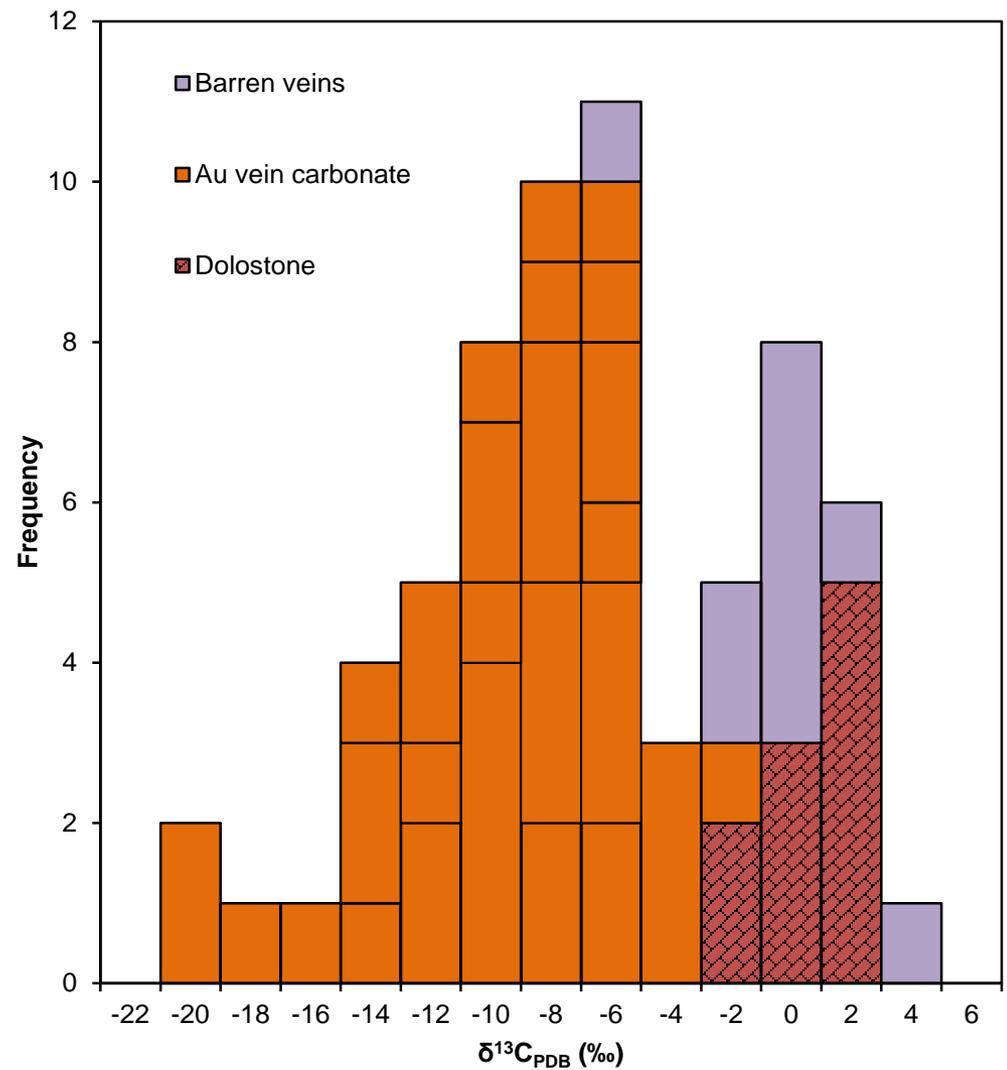
Phase separation as a result of pressure fluctuation (fault-valve action c.f. Sibson, 2004), enhanced by partial mixing with a high salinity fluid, expanding the two-phase field



# Stable isotopes

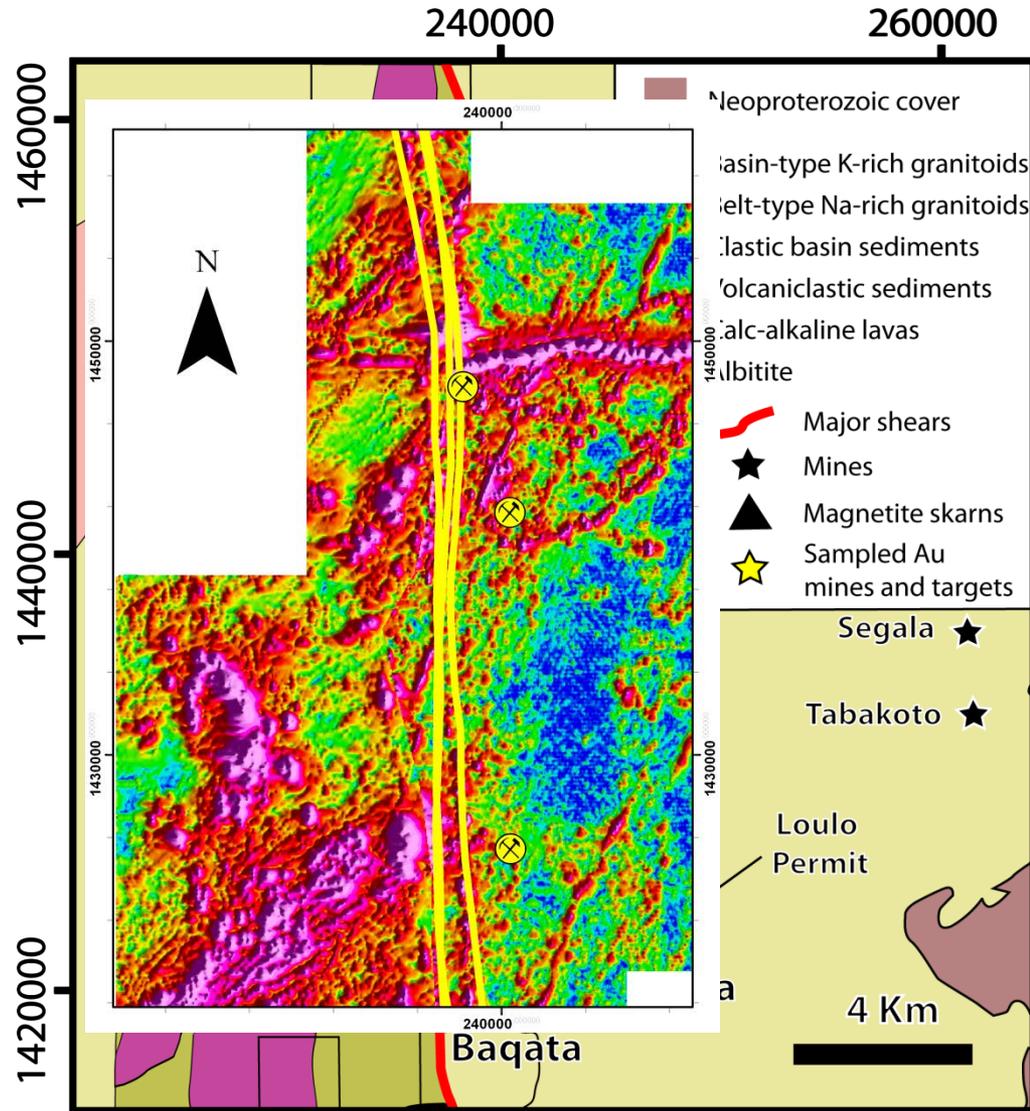


Data from Lawrence et al. (2013b) and Lambert-Smith et al. (In Press)

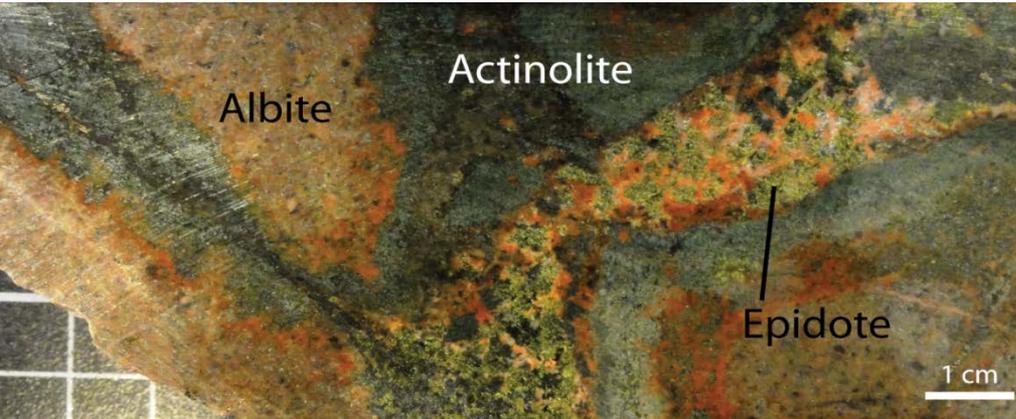


# Falémé Iron District

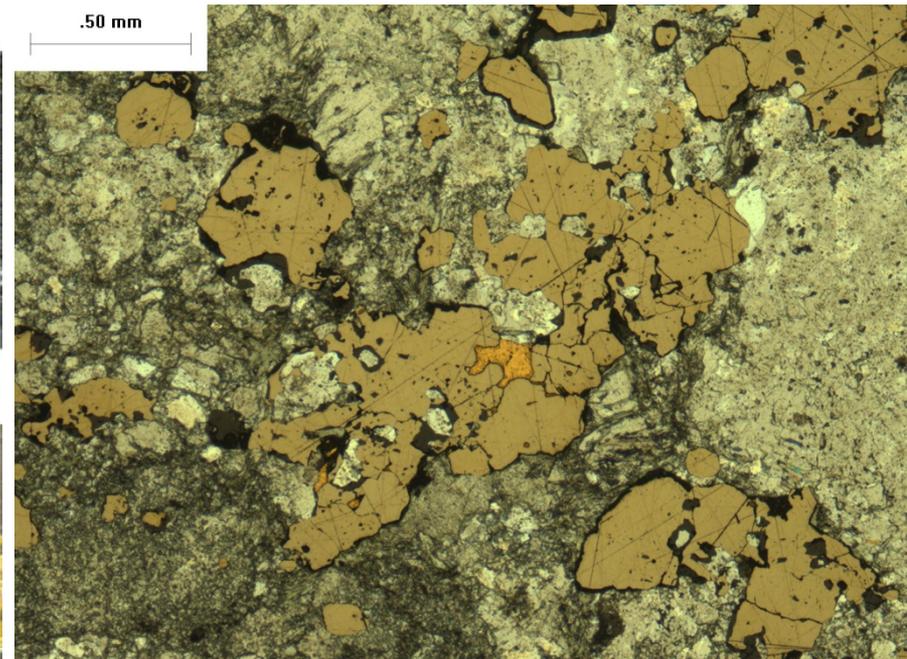
- Falémé Volcanic belt to the west of the SMSZ.
- Hosts ~630 Mt of Fe ore (Schwartz and Melcher, 2004).
- A group of exo- and endo-skarn ore bodies, with potential affinities to IOCG deposits.
- Locally bears Au grade (~2 g/t), though not economic.



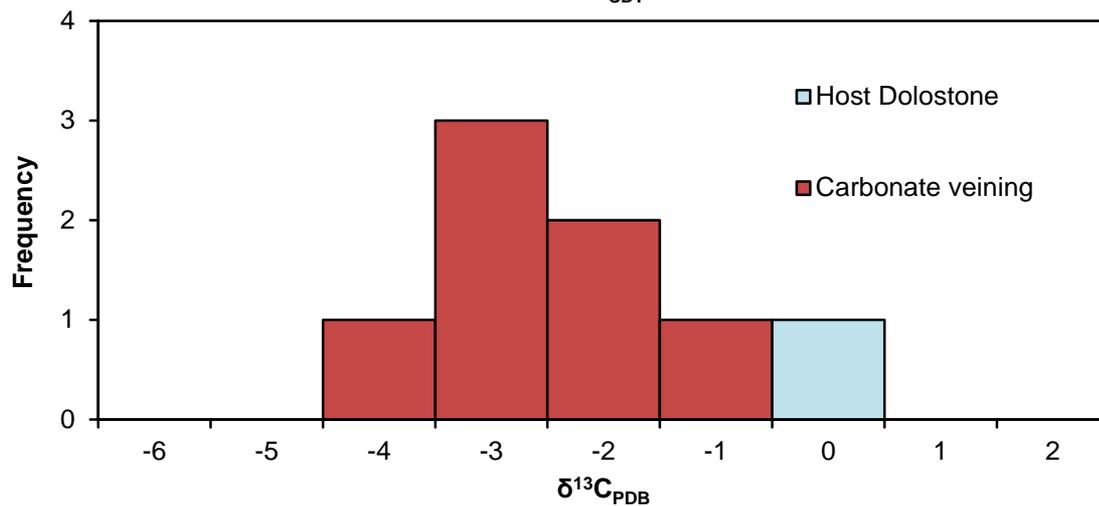
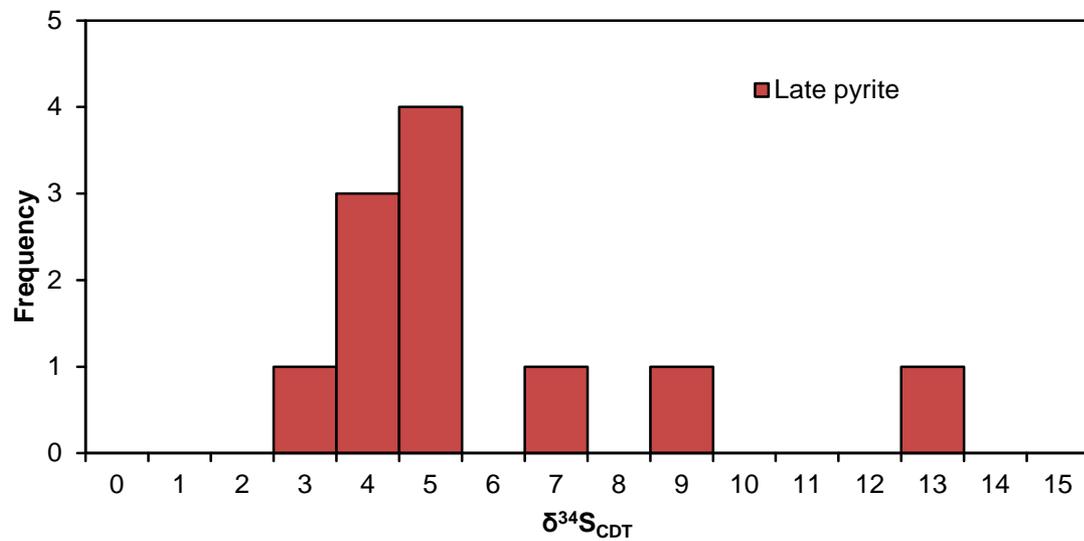
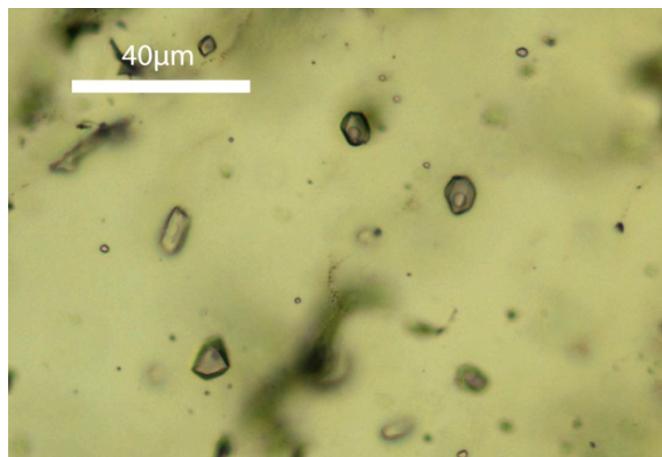
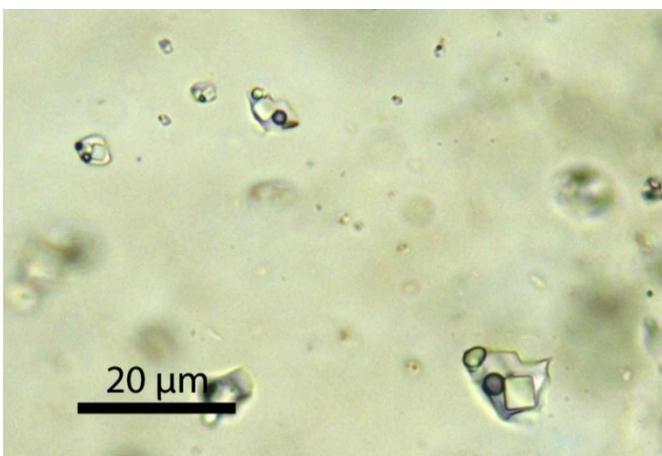
# Falémé Iron District



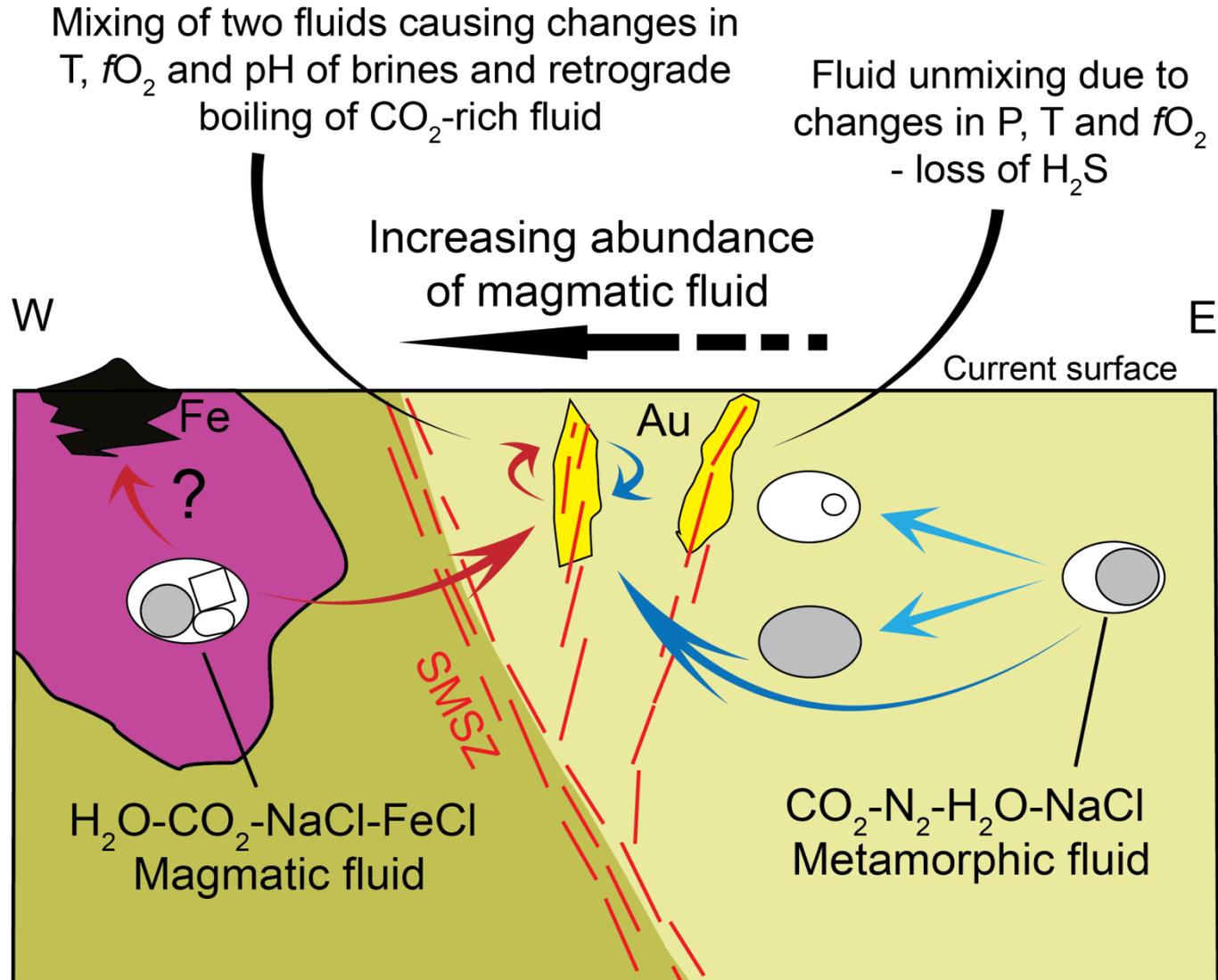
- Zonal alteration followed by massive magnetite mineralisation and overprinting auriferous sulphides

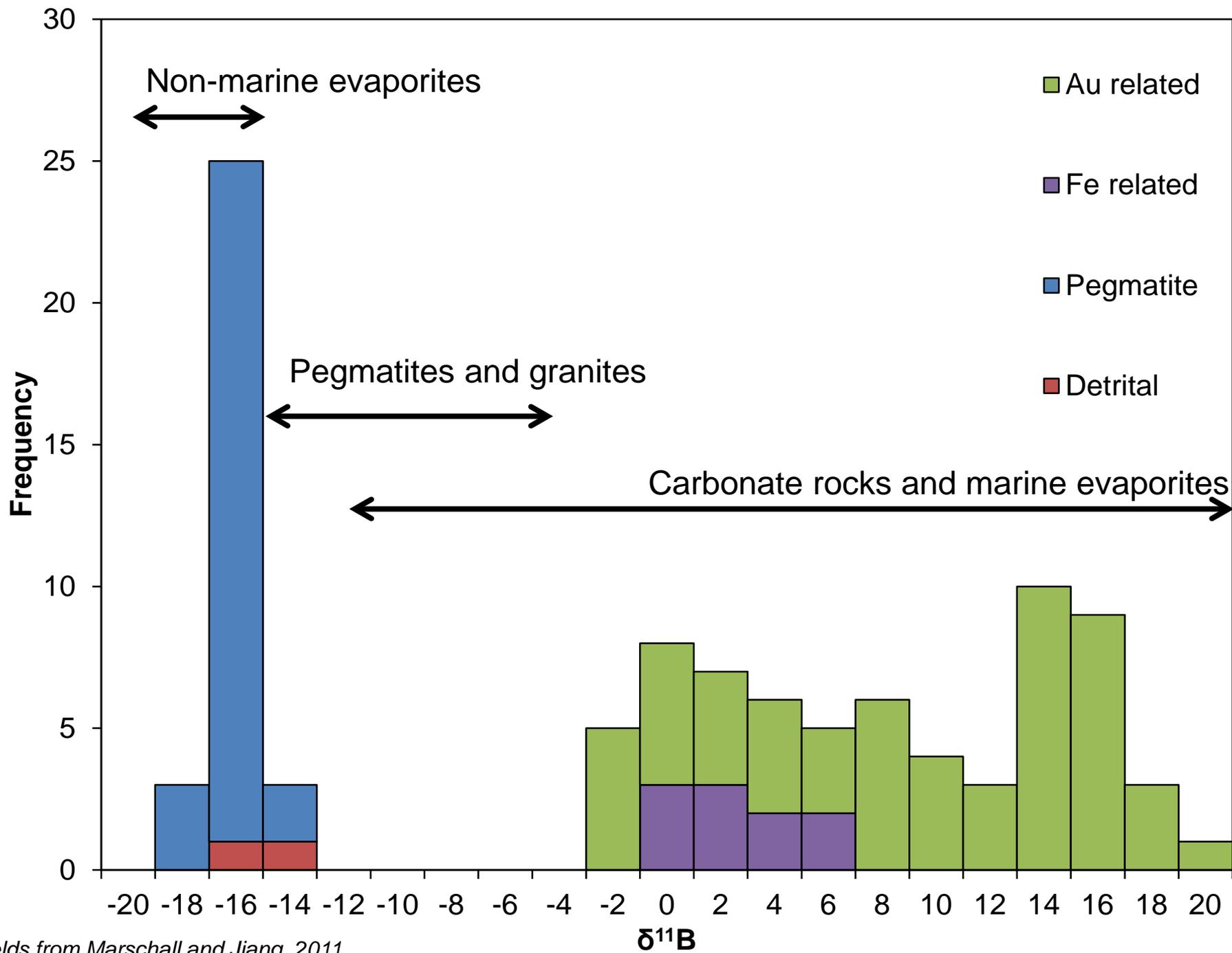


# Falémé Iron District: Stable Isotopes and fluid inclusions



# Conclusions?





# Implications and outstanding issues

- All the isotopic evidence points to evaporite sources for the hyper-salinity of the brine BUT this does not explain the high homogenisation and decrepitation temperatures ( $>400$  °C).
- Could still be potential for involvement of magmatic systems (FID skarns), perhaps as a heat source?
- Dating of both deposit types is now needed to unravel these issues.