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

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with: D. M. Lawrence, A. Rocholl, W. Müller, A. Boyce & P. J. Treloar
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.
The diagram illustrates the geological features of the region, including the Kédougou-Kéniéba Inlier, Taoudeni Basin, and the Man Shield. It highlights Late Proterozoic to Late Palaeozoic cover, Birimian peraluminous granitoids, Birimian clastic basin sediments, Birimian volcano-sedimentary belts, Archean crust, and major shear zones. Yellow markers represent Au deposits.
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).
After Hastie et al. (2007)

- Dalema Suite
- Kofi Intrusives
- Falémé Intrusives

Albitised samples
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.

Albitised samples
• Units in the eastern KKI are all ≤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

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

B. Pre-ore albition of host rocks

Au mineralisation

Strike-slip domain (SMSZ)

Thrusting domain

Hydrothermal fluids channelised along shear zones

Lineations plunge 9° toward 193°
Lawrence et al. (In Press); Lambert-Smith et al. (In Press)
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-Gounkoto 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.
Pyrite stringers within chlorinised and sheared host rock.

Brecciated albitted sedimentary rock.

Pyrite-bearing chlorite-carbonate veinlets.

Albitised wall rock with Fe-rich carbonate overprint.
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<th>Mineral</th>
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<th>Yalea</th>
<th>Gounkoto</th>
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**Notes:**
- Major
- Trace
- Accessory
- Not present
- **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

- Stable Isotopes
  - $\delta^{34}\text{S}_{CDT}$
    - Late pyrite
  - $\delta^{13}\text{C}_{PDB}$
    - Host Dolostone
    - Carbonate veining

Microscopy images with scale bars:
- 20 µm
- 40 µm
Conclusions?

Mixing of two fluids causing changes in T, fO₂ and pH of brines and retrograde boiling of CO₂-rich fluid

Fluid unmixing due to changes in P, T and fO₂ - loss of H₂S

Increasing abundance of magmatic fluid

W

E

Fe

? Fe

H₂O-CO₂-NaCl-FeCl

Magmatic fluid

SMSZ

Au

CO₂-N₂-H₂O-NaCl

Metamorphic fluid

Current surface
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.