Gold in the Early Paleoproterozoic Birimian Shield, West Africa

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The Archean Breakup

After a long period of break-up, Archeons were surrounded by Early Paleoproterozoic (oxygenated) paleo-platform sequences (limestone, exhalites) and extensive BIFS superior type.

Tectonic drifting led to the creation of dozens of arc systems reflective of the true onset of modern (polycyclic) plate tectonics. Many arcs are Archean melts.

Certain arcs may have tapped into metasomatized (fertile?) Archean SCLM.

Extensive epiclastic sequences were formed within rifting and drifting basins tapping their sources mainly from the erosion of a variety of Arc Systems.

While the tectonic architecture was in the making, fluvial sedimentation mainly derived from Archean landmasses and (deformed) Arc sequences were shed within syn-tectonic basins.

The preexistence of Archean crust likely influenced the tectonic architecture and gold endowment that took place thereafter.
Simplified geodynamics of West Africa

Man Shield break-up 2.25 Ga

First Arcs 2.18 Ga

Second Arcs 2.14 Ga

Eburnean orogenesis 2.11 to 2.06 Ga

Modified from Delor et al. 2003
Protracting accretion/gold districts

1500 km of recycled crust added from 2195 Ma (SE Ghana) to 2067 Ma (W Mali)

Tectonic cyclicity created elaborate protracting structural network

1500 km of recycled crust added from 2195 Ma (SE Ghana) to 2067 Ma (W Mali)
Main gold settings

- **Mesothermal orogenic gold** along regional structures affecting mainly back arc belt-basin shear zones (Obuasi-Prestea, Akyem, Bibiani, Ahafo, Konkera);

- **Volcanic and shallow plutonic felsic bodies** along active strike-slip regional faults related to pull-apart basins (Angovia);

- **Early hydrothermal activity** and/or shallow plutonism along normal faults (Siguiri basin);

- **Paleoplacer** conglomerates in a possible orogenic foreland basin (Tarkwa).
West African Gold districts

Gold emplacement as magmatic-hydrothermal & orogenic deposits at the end of the Eburnean orogen

91 deposits > 10 t
> 4000 occurrences

Higher grade trends

Modified from Billa, 2011
Northern Districts (~100 Moz)

- Kenieba inlier
- Siguiri Basin
- Northern Domain
  - 250 mT+
  - 1000 mT+ Red Lake+
  - 500 mT+ Noranda
Southern Districts (~200 Moz)

6000 mT+
2.5 x Timmins
Perrouty et al., 2011

Southern Ashanti Belt

- Like the Archean Timiskaming it is an alluvial-fluvial sequence
- Delineates major “Breaks”
- Suture basins
Polyphase deformation Ashanti belt

Modified from Perrouty et al, 2011
Buesichem (SW Ashanti Belt)
Au Grade Thickness Long Section True Width

Buesichem

Left-lateral flexure
Bend dilation
South plunging shoots

Typical Ashanti shear ore

Grade Thickness
Au (g/t) m

- 175 to 500
- 125 to 175
- 75 to 125
- 50 to 75
- 40 to 50
- 20 to 40
- 10 to 20
- 0 to 10

Buesichem Grade Thickness

Courtesy M. Wasel, Golden Star Resources
Sefwi Belt

- Ahafo on north side of Sefwi greenstone belt on the east margin of the broad Comoe Basin filled primarily by epiclastics.
- Complex package of back-arc mafic volcanic rocks, sediments, and intrusive stocks (Birimian). Extreme rheological contrasts.
- Northwestly thrusting along Kenyasi fault with major offsets. Steep metamorphic gradients.
- Multiple ore shoot geometries that are generally shallow plunging.
- Bibiani and Chirano deposits about 50km south in similar setting.
- Meta-sediments (carbonaceous shales) and volcanics to north (footwall) with intrusives south (hangingwall)

- **Hangingwall splays are important for localizing higher grade**

- Multiple shoot directions require detailed mapping

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**Ahafo South Structure**

(Schematic Block Diagram)

- Meta-sediments (carbonaceous shales) and volcanics to north (footwall) with intrusives south (hangingwall)

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**Feybesse et al. 2006**

Courtesy D. Finn, Newmont
Konkera, (Boromo Belt) SW Burkina

*Ampella Mining Ltd

Metelka et al., 2011

42.6mt @ 1.9 g/t = 2,6 Moz Au
**Imbricate Thrust system**

**Essakane (Burkina Faso, Northern Domain)**

Main gold bearing unit: Fresh Arenite (35% kspar-diss Tm)

Higher vein density = more (coarse) Au

Pohl, 1995
Common thrust styles*

- Fault propagation folds
- Anticlinal hanginwall folds
- Imbricated thrust systems
- Thrust duplexes (simple, complex)
- Shear couple systems (C-S type geometry)
- Single shear

* Most settings have comparable geometries in regional map view. 3D geometry is usually resolved by detailed mapping and generally conditioned by rheology of lithostratigraphic assemblages as well as by regional and local state of strain.
Common themes

- All mesothermal orogenic gold settings are proximal to major first order breaks with protracting structural histories.
- Most settings are affected by thrust geometries conditioned by deep-seated basement conditions as well as local stratigraphic components.
- A large number of mesothermal gold settings are hosted in clastic sediments.
- Volcanic hosted settings and much less frequent than in the Archean.
- Gold grades are generally diluted in clastic rocks with an average grade of 1.1gpt Au in the fresh rock.
- Gold events protracted through time across the entire shield.
- Gold is mostly late but early gold is clearly present.
- Carbonaceous shales are recurrent in a majority of settings.
At least 14 arcs identified to date with arc and back-arc signatures.

Granitoids are generally poorly understood.

Modified from Bardoux et al. 1998
U-Pb zircons Eastern Guiana Shield

Modified from Bardoux et al. 1998
Archean Greenstones in SE Guiana Shield

Modified after Ricci et al. 2003
TransAmazonian Tectonic Framework

French Guiana (supracrustals)

- Conglomerates
- Epiclastics
- Arc volcanics
- Gabbros
- Ultramafics
- Granitoids-gneisses
- Main Au deposits
- Major Breaks
- Archean
- 3.3 Ga detrital Zr

French Guiana

Brazil
Primary Gold Occurrences, Guiana Shield

Modified from Voicu et al., 2001

More than 700 gold occurrences

1-2 gpt/Au

Rosebel

Stock-Million onces
- 1.0 - 2.0
- 2.0 - 3.0
- 3.0 - 6.0
- 6.0- 21.4
Rosebel Geological Cross-section

Volcanism between North and South domains recorded a change in tectonic context from a backarc extensional basin to subduction dominated environments.

- Regional synclinorial (bridging) basin
- Major reverse shear in the South Domain
- Major dextral slip faulting in North Domain
- Late normal movement
- 2 phases of ductile deformation (pre- and syn-Au)

13 Moz +

Courtesy of C. Daoust and G. Voicu, Iamgold
From *dwarfs* to *Giants*

More than 120 significant ore bodies

- Broad range of settings
- Emerging new districts
- Persistent Exploration
Early Paleoproterozoic orogens of Africa and South America

- **Reguibat** (2.25 to 2.05 Ga (Rhyacian))
- **Birimian**
- **Guiana**
- **Ogoué-Sao Francisco** (2.2 to 2.0 Ga)
- **Western Amazon** (2.0 to 1.7 Ga)
- **Ubendian** (2.175 to 1.750 Ga)

Modified from Billa 2011
Obrigado, Thanks, Merci

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