The geophysical Signatures of the West African Craton

Mark Jessell CET, UWA
Graham Begg, MTI
Meghan Miller, USC

WAXI - West African Exploration Initiative
IXOA - L’Initiative d’ Exploration Ouest Africaine
Project Broker & Coordinator

Research Partners

Sponsors in kind (Geological Surveys)

Liberia  Mali  Niger
Mauritania  Guinea  Burkina Faso
Senegal  Ghana  Togo

Sponsors: Research Program

Sponsor: Capacity Building
Craton Margin Models of Mineralisation

Nickel

Begg et al., 2010

Cassidy & Champion, 2007
McCuaig et al., 2010

Nd model ages
Are there clear geophysical signatures defining the lithospheric scales structures of the West African Craton?

When the signals are not clear, what types of data do we need to collect?

What is their relationship to mineralisation?
Mesozoic & Cenozoic sedimentary basins
Phanerozoic sediments
Mesoproterozoic sediments
Palaeoproterozoic
Archaen
Four Scales of Geophysical Analysis in WAXI

- Lithosphere
- Crust
- Surface Geology
- Regolith
Data from Grant, 2011
Reprocessed by Begg
Jessell et al., 2015, PR
Lithosphere-Asthenosphere Boundary (LAB)
Fishwick & Bastow - Lithosphere-Asthenosphere Boundary

500km wavelength Gravity

Depth km

500km wavelength
cutoff Bouguer gravity

<-130 0 >115
mgal
Receiver function data

Jessell et al., 2015
Lithosphere-Asthenosphere Boundary

3 different LAB Models

LAB Models vs receiver function data
Zircon ages vs longitude

Parra 2015
8 different Moho Models

Moho Models vs receiver function data

- Nataf & Ricard
- B & S
- Laske et al
- Reguzzoni et al
- Pasyanos et al
- P & N
- Tugume et al
- Tedla et al
- Average

R² = 0.0523

R² = 0.0445
Seismic Anisotropy

- Seismic anisotropy in the mantle at three depths: 80, 180 & 280 km
- 4° resolution map for Africa
- Length of lines proportional to strength of anisotropy
- Based on Surface wave (Rayleigh and Love) seismic tomography

Seismic Anisotropy (Vs fast direction)


WAC Mafic Dykes
Jessell et al., 2015, JAES
Four Scales of Geophysical Analysis

Lithosphere

Crust

Surface Geology

Regolith
Interpretation of 30km wavelength coincident grav-mag features

Legend:
- Archean
- Eburnean
- Rift
- Panafrican
- Atlantic
- Atlas/Tethys
- Unknown

Less-certain attributions are dashed
Possible Eburnian Features vs $\delta V_s$ at 180 km

Seismic Anisotropy at 180 km vs $\delta V_s$ at 175-250km

Schaeffer & Lebedev, 2013

Vs Anisotropy 180 km (Sebai et al., 2006)
3D Model of SW Burkina Faso

Metelka, 2015
Volume: 160*160*15 km
Resolution: 200 m

Perouty et al., OGR, 2014
3D Correlation between mineralisation and stratigraphy

Number deposits less than 1500 m from each horizon

Stratigraphic Depth

Distance

Perrouty et al., OGR, 2014
Geophysics Training

Structural geophysics courses

• Accra 2010
• Dakar 2011
• Ouagadougou 2012
• Abidjan Dec 2015

Sefwi Belt
Summary

• The West African Craton has a double root of faster Vs material that we interpret to be a remnant of an early assembly event.

• The craton shows a layered seismic anisotropy, with 80 km depth fast Vs orientations possibly related to mafic dykes.

• A large amount of uncertainty remains with respect to both the short wavelength structure and depth of the WAC Moho.

• Intermediate-wavelength gravity and magnetic anomalies have been interpreted in terms of their age and suggest the possible continuity of Archean basement of the Reguibat rise beneath the northern Taoudeni basin, and across the current limit of the Western Margin of the WAC.