The geophysical Signatures of the West African Craton

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WAXI - West African Exploration Initiative

IXOA - L'Initiative d'Exploration Ouest Africaine

Project Broker& Coordinator

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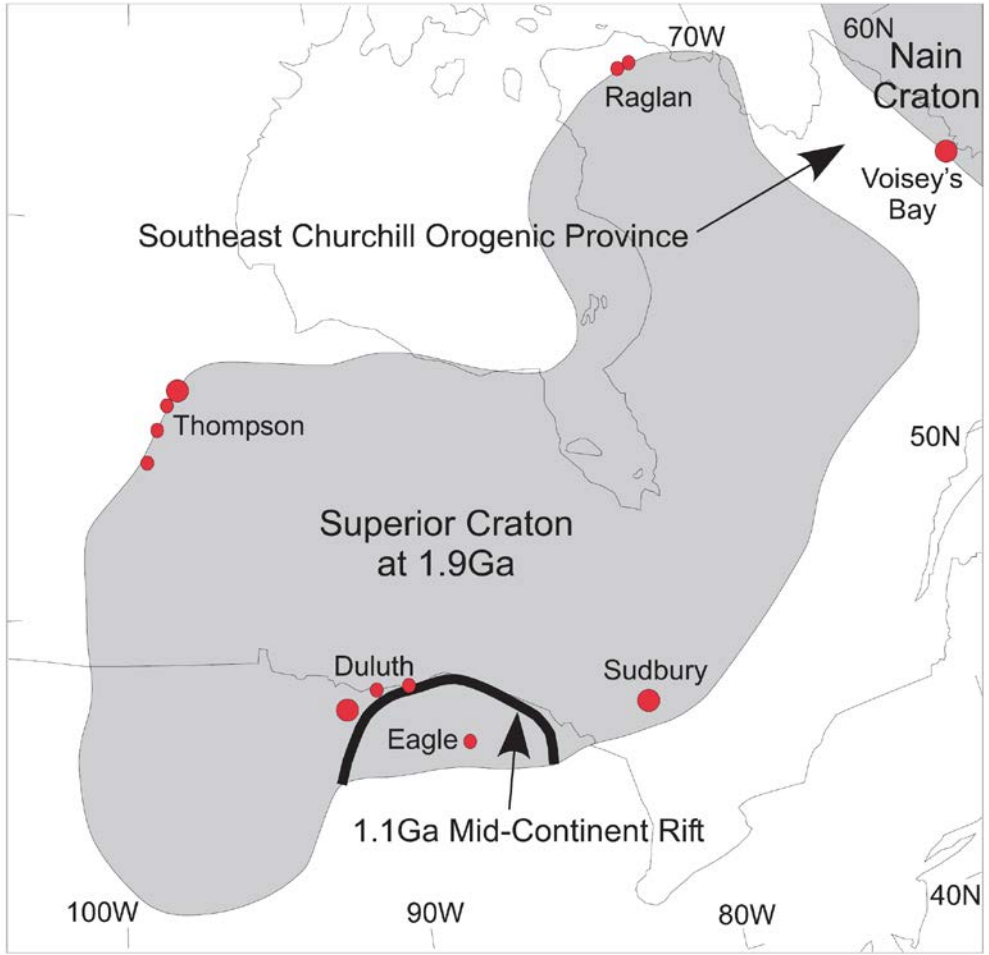
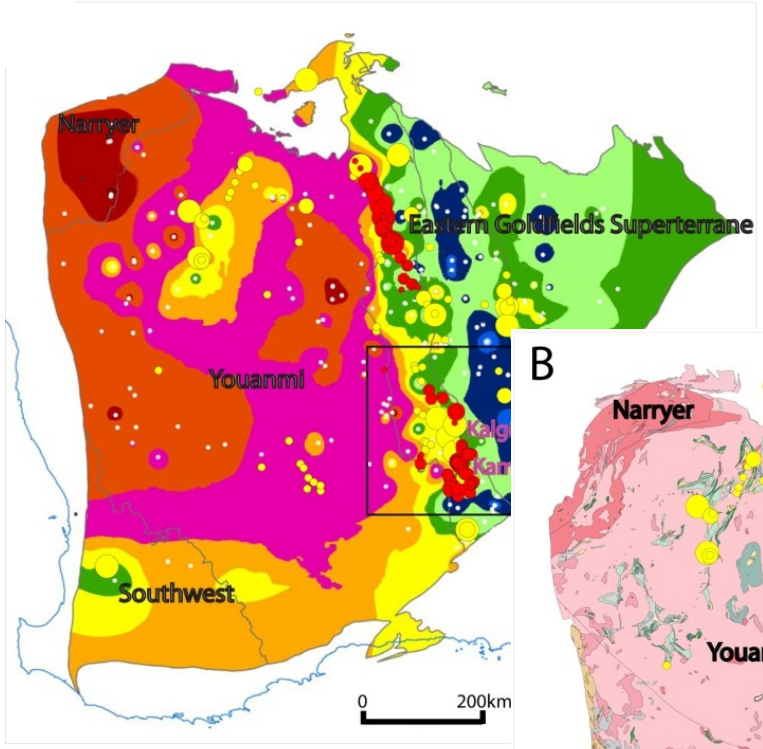
Craton Margin Models of Mineralisation

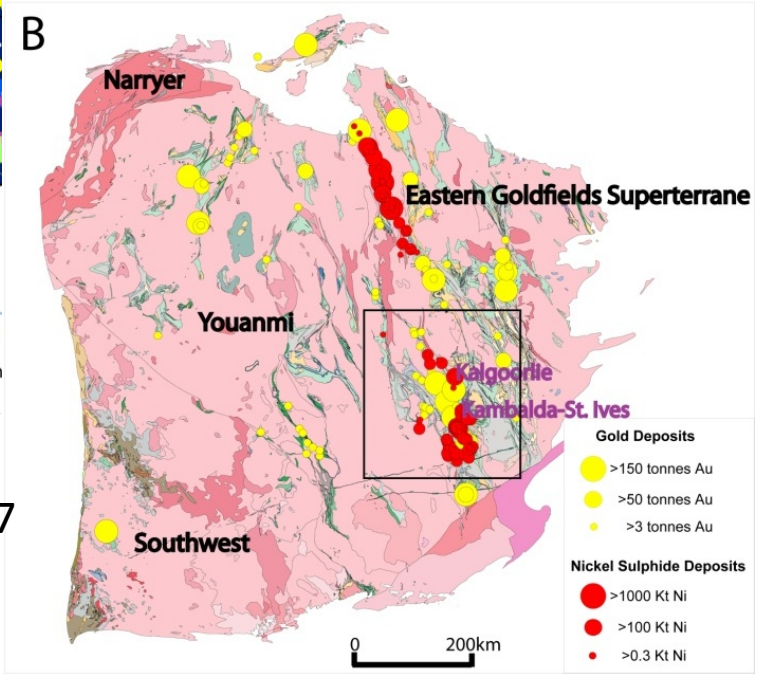


Begg et al., 2010

Nickel

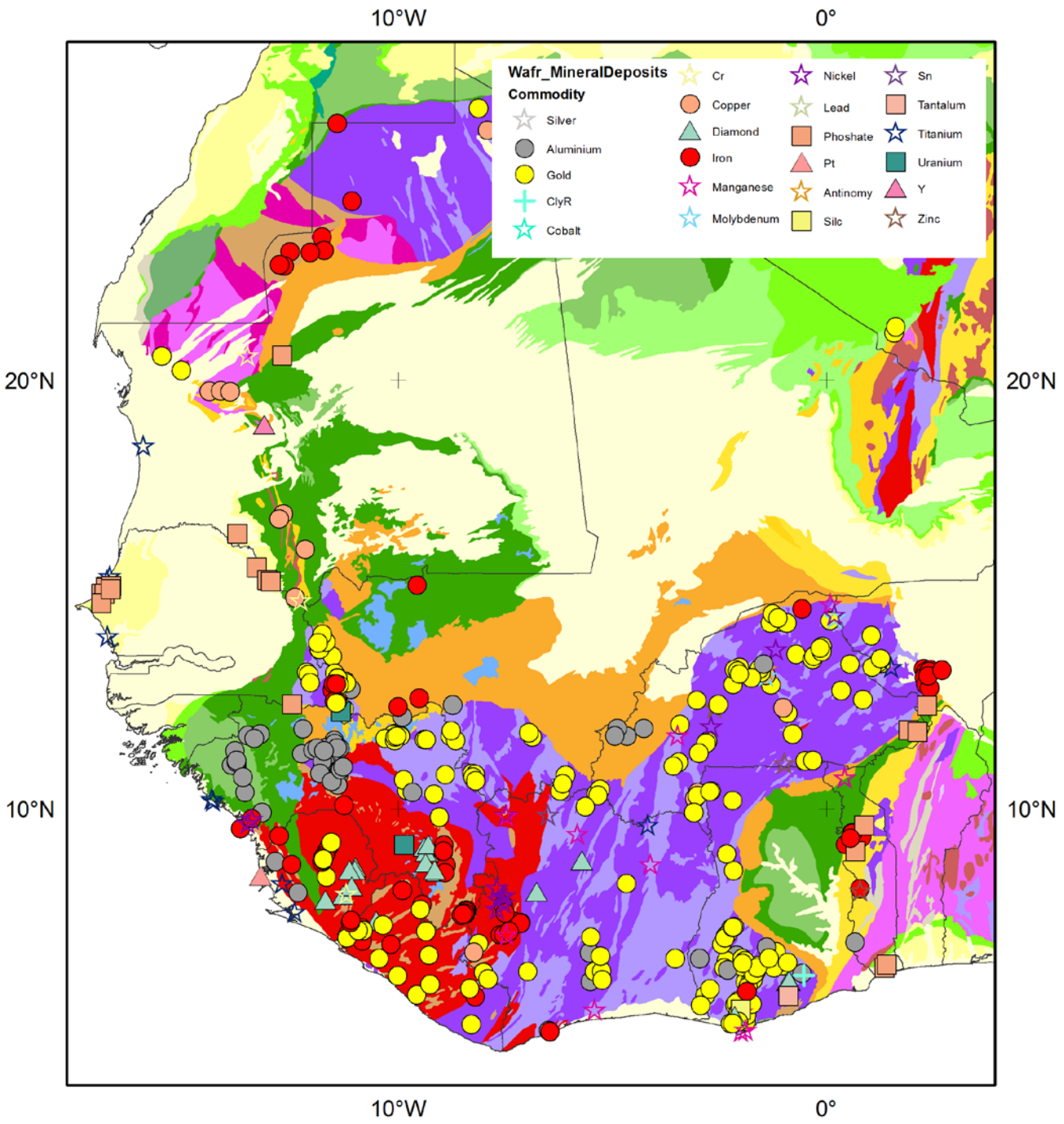


Nd model ages



Cassidy & Champion, 2007
McCuaig et al., 2010

Nickel ● & Gold ●

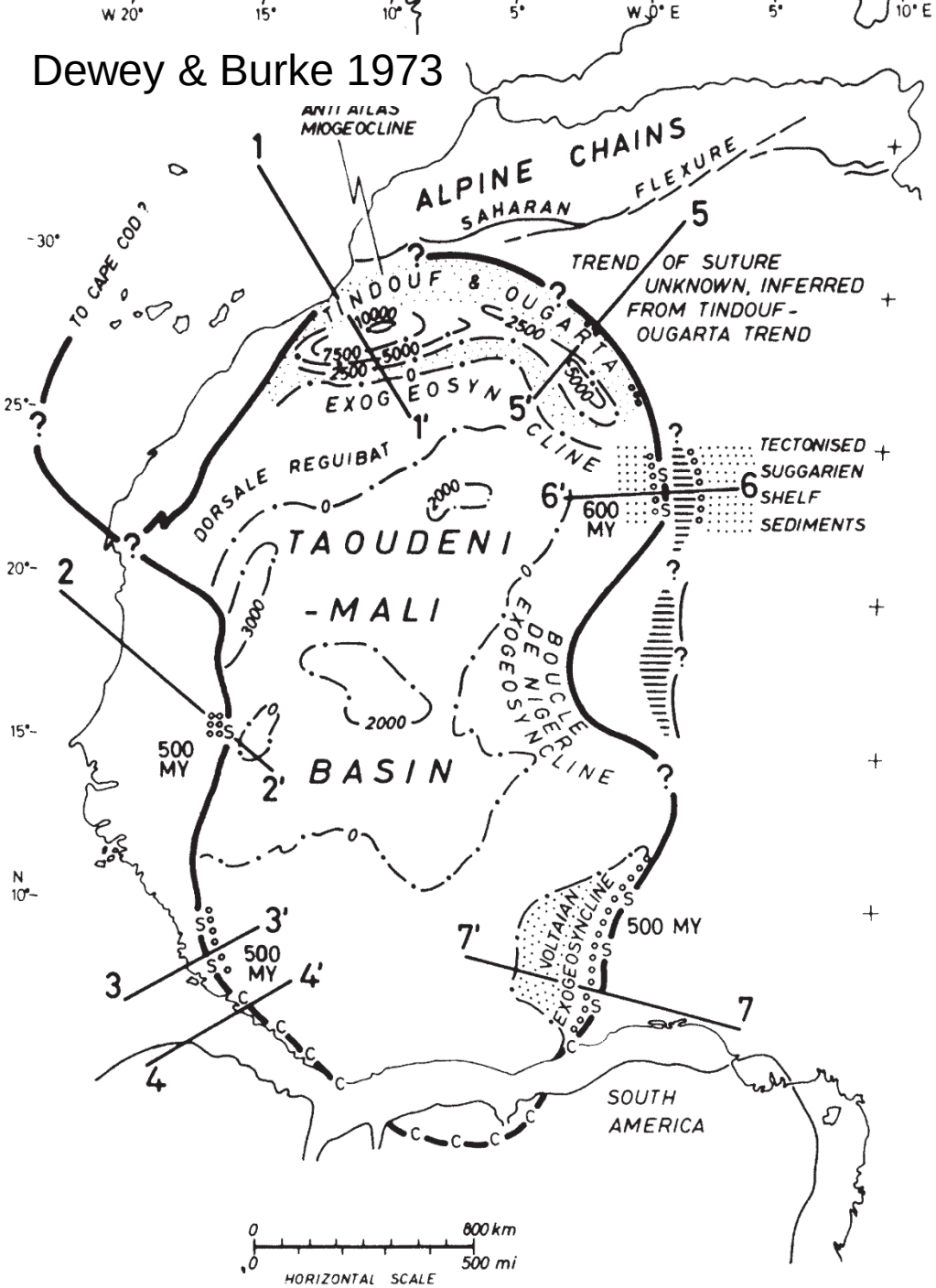


Are there clear geophysical signatures defining the lithospheric scales structures of the West African Craton?

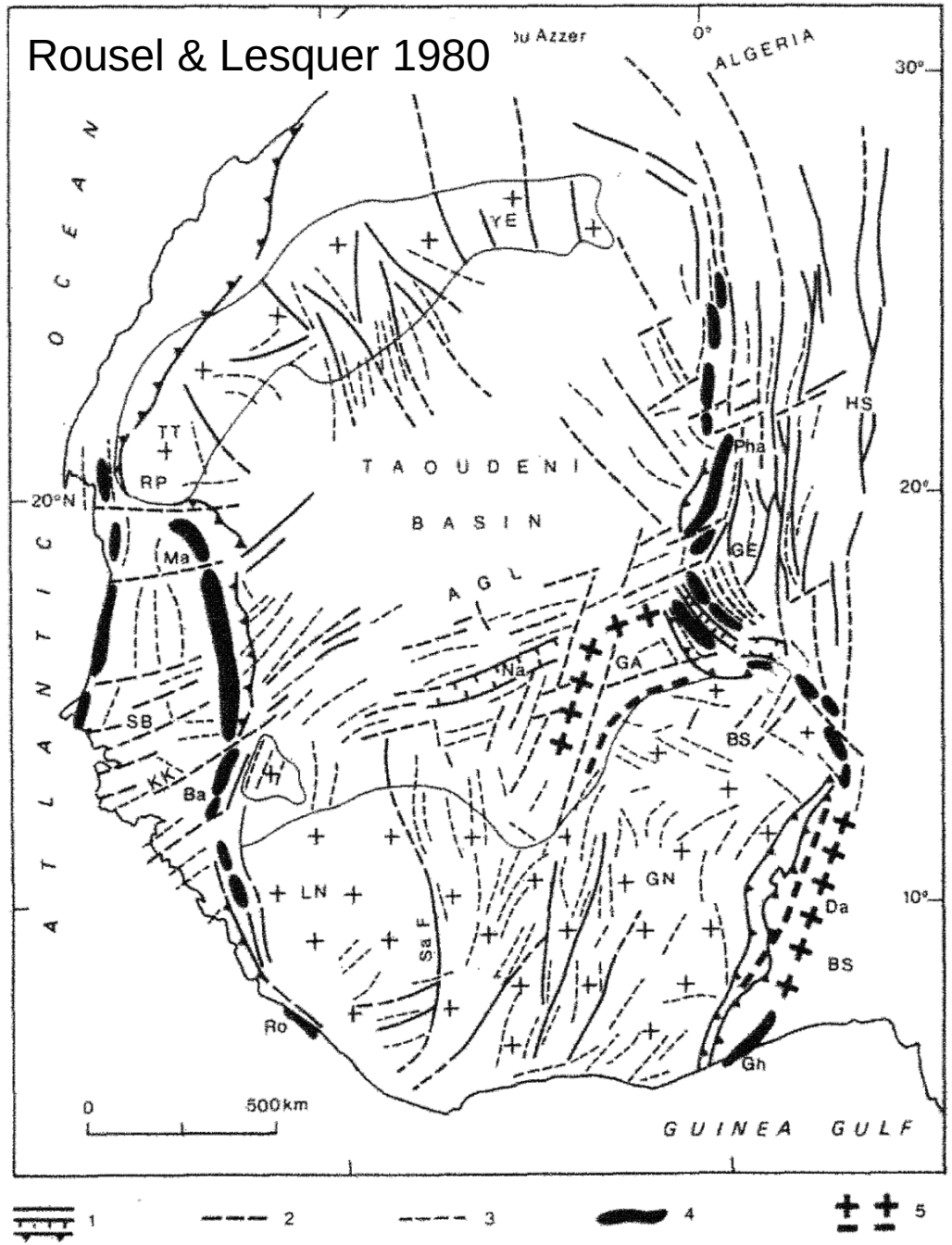
When the signals are not clear, what types of data do we need to collect?

What is their relationship to mineralisation?

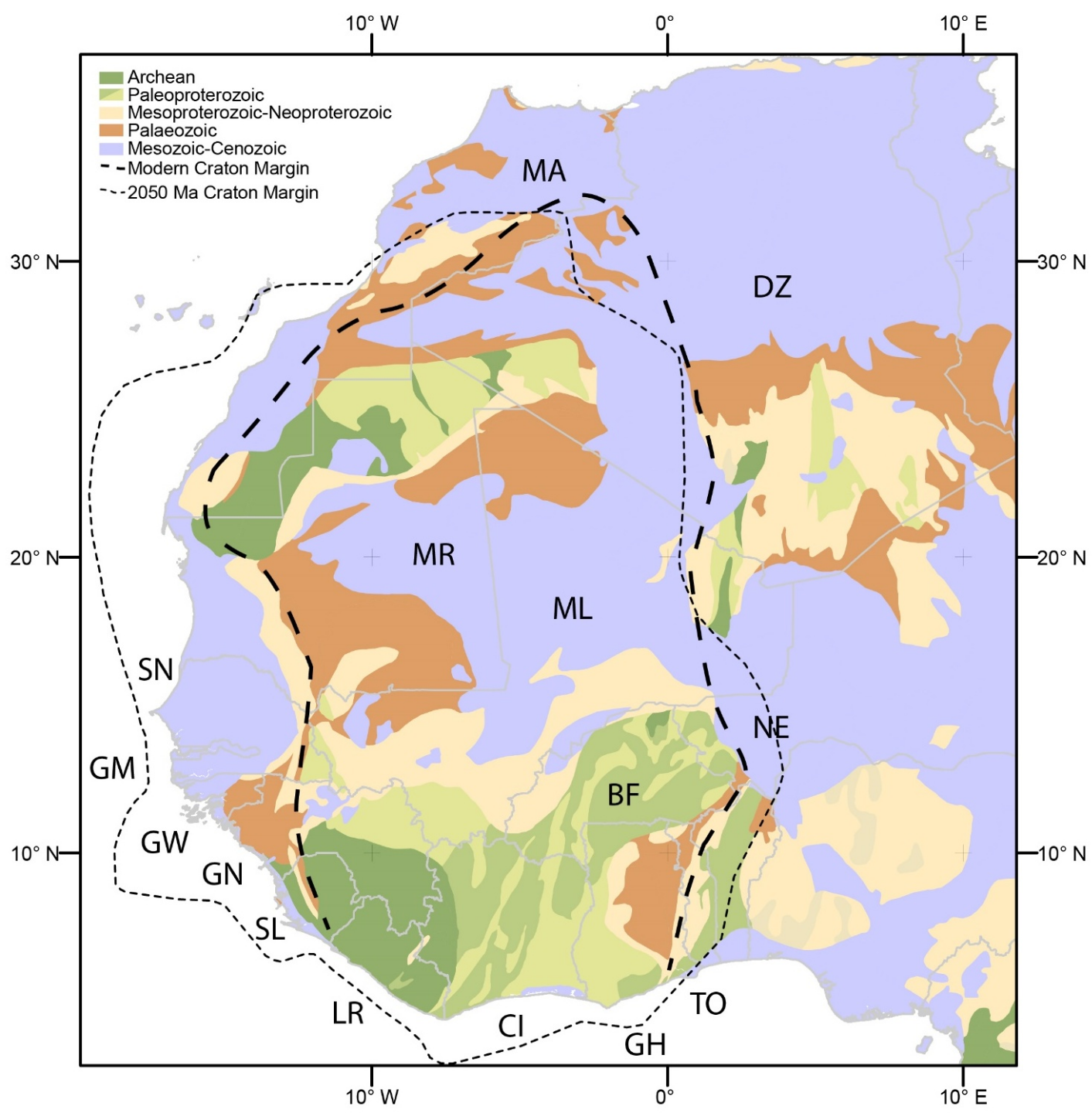
Dewey & Burke 1973



Rousel & Lesquer 1980



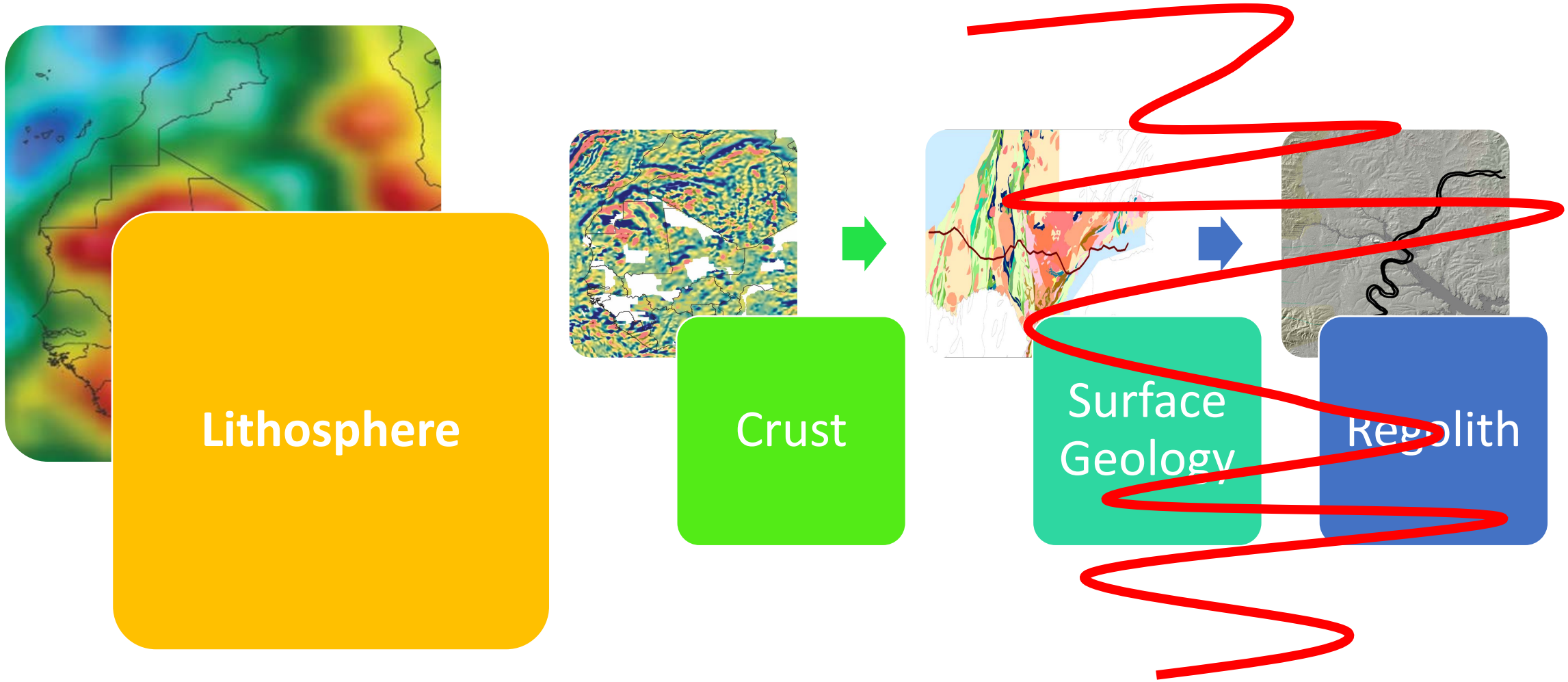
Faults ● Fault/discontinuity ● Gravity trend ● Gravity high ● Paired gravity anomalies



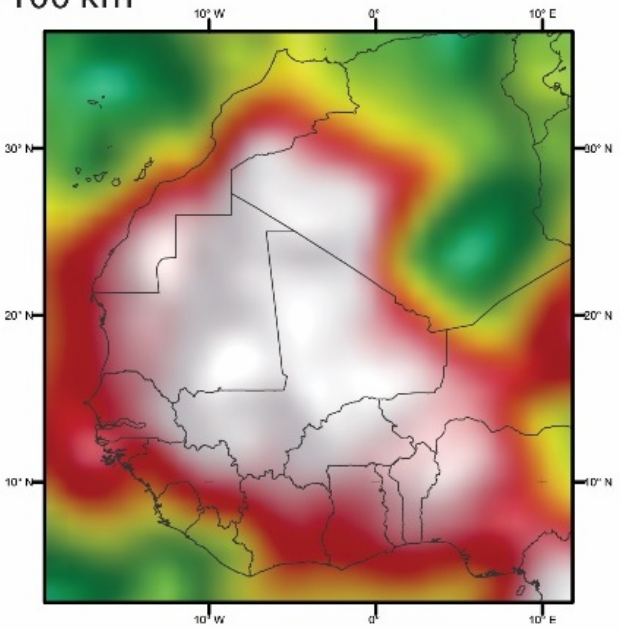
Context

- Mesozoic & Cenozoic sedimentary basins
- Phanerozoic sediments
- Mesoproterozoic sediments
- Palaeoproterozoic
- Archaen

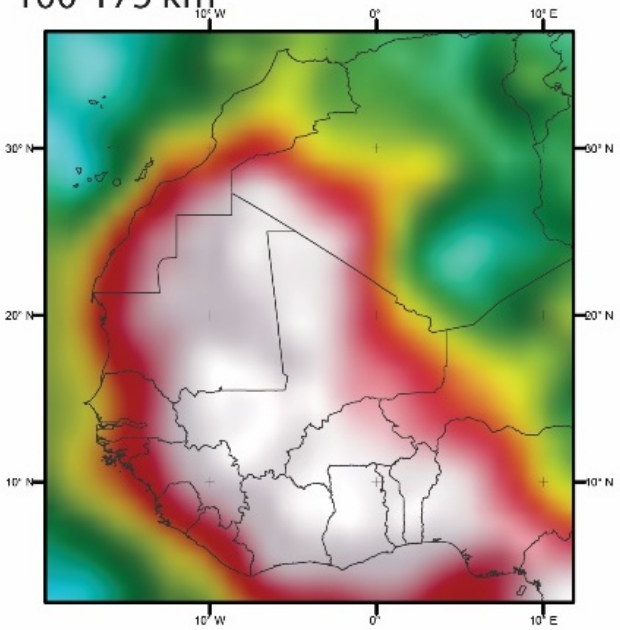
Four Scales of Geophysical Analysis in WAXI

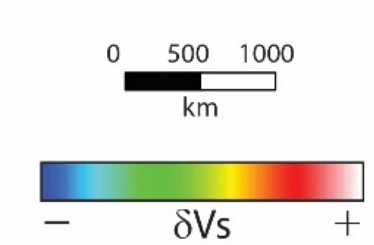


0-100 km

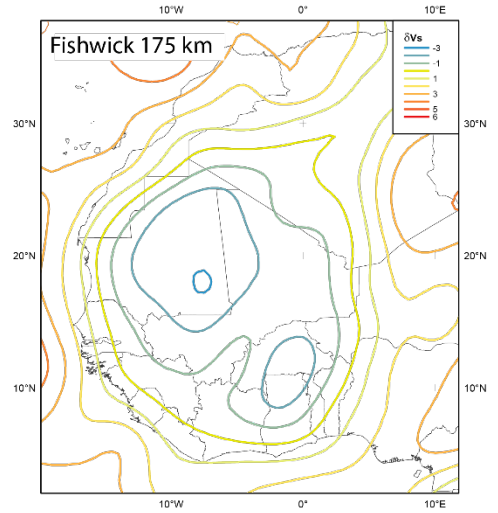


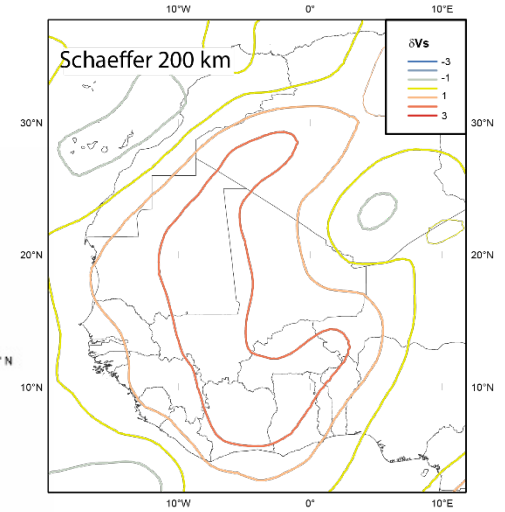
100-175 km



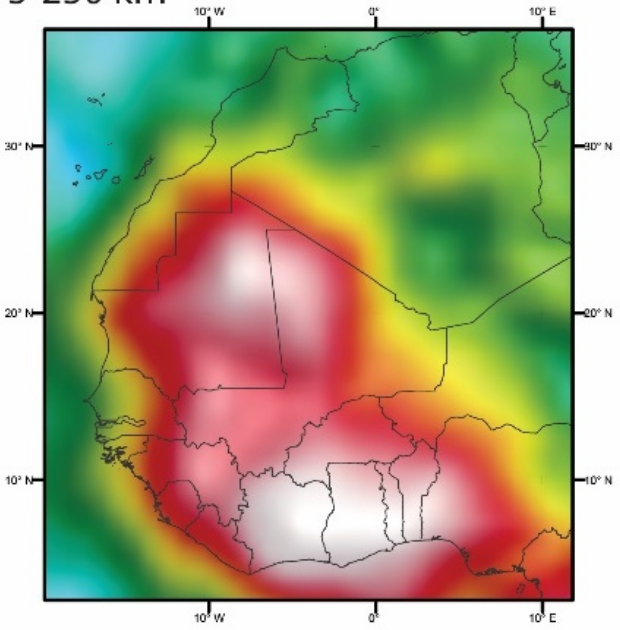


Data from Grant, 2011
Reprocessed by Begg
Jessell et al., 2015, PR

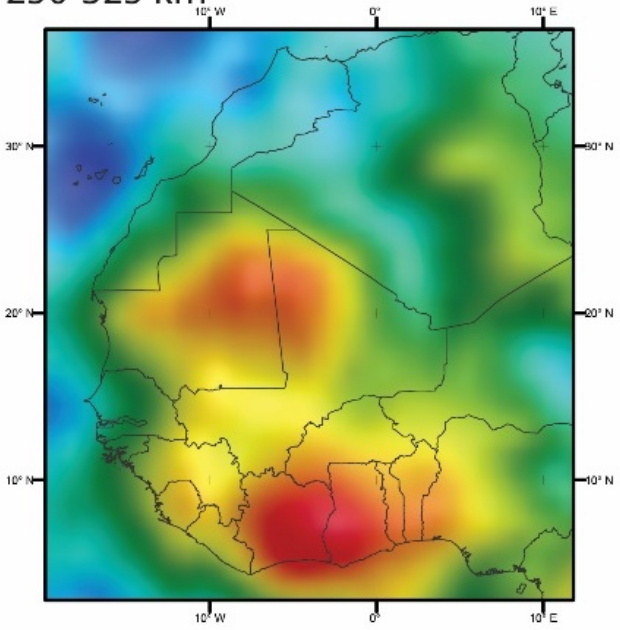




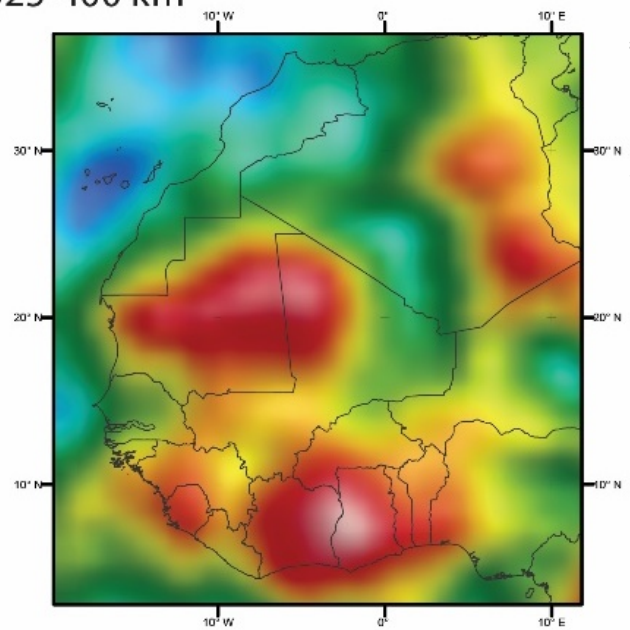
175-250 km

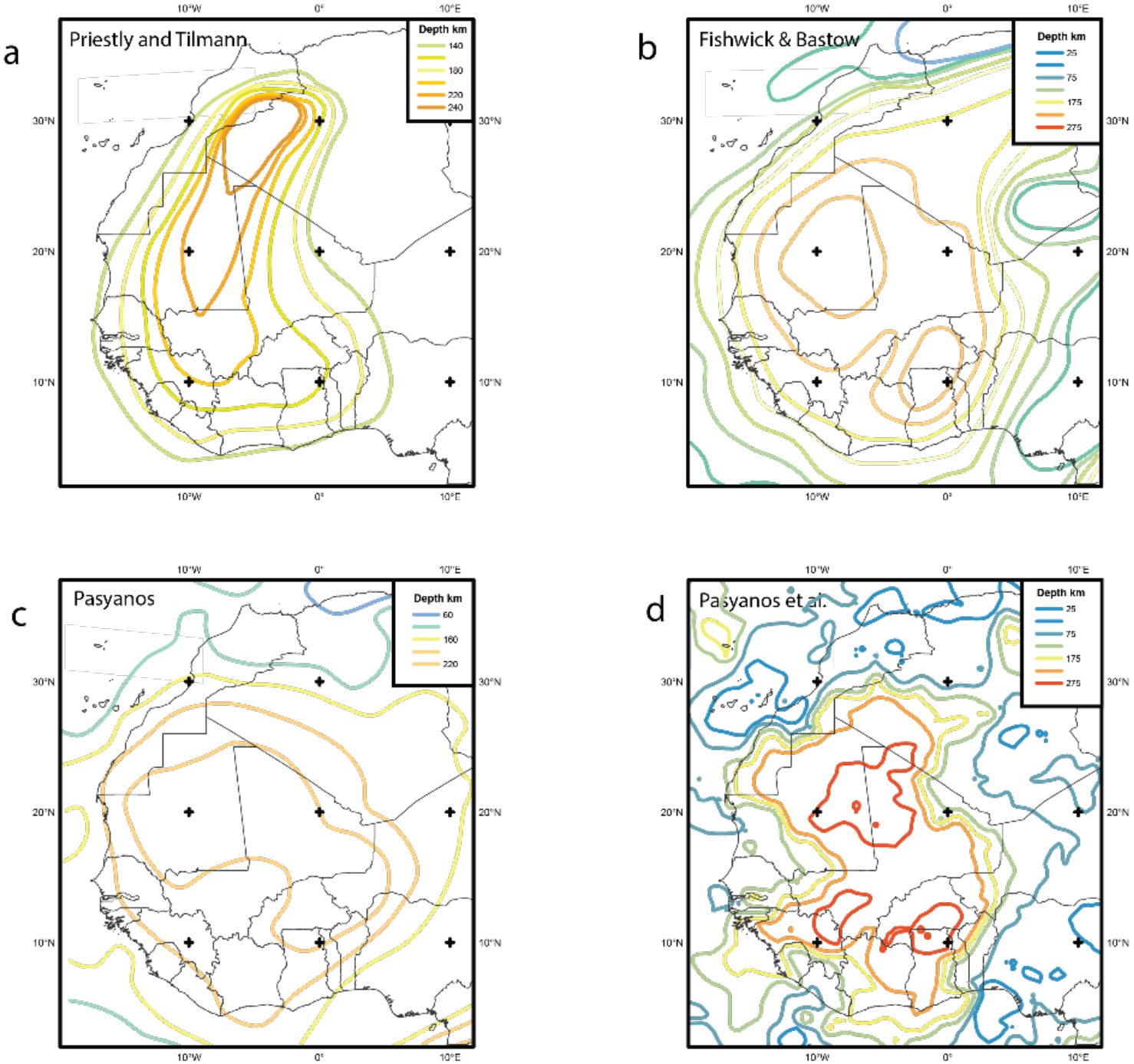


250-325 km

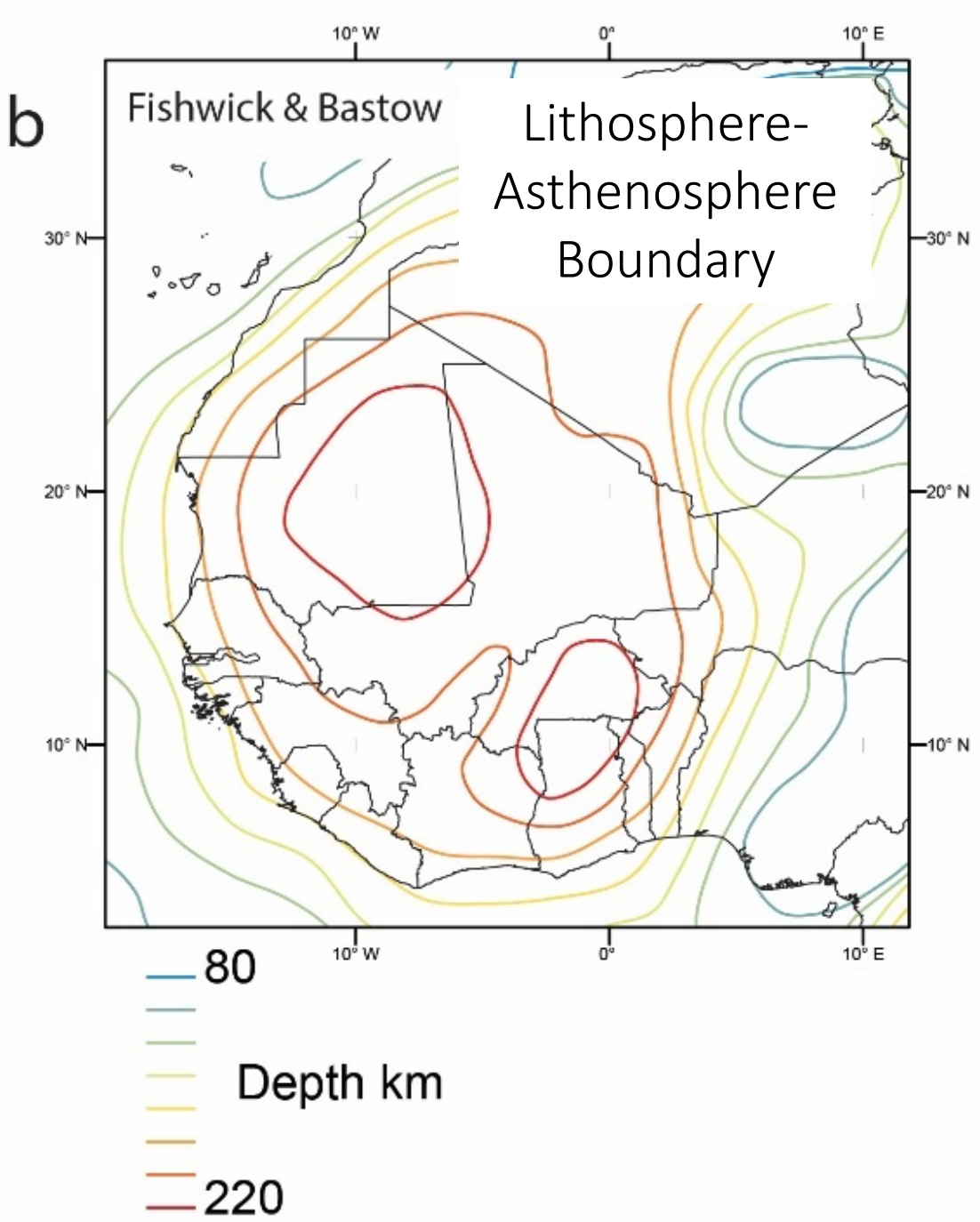


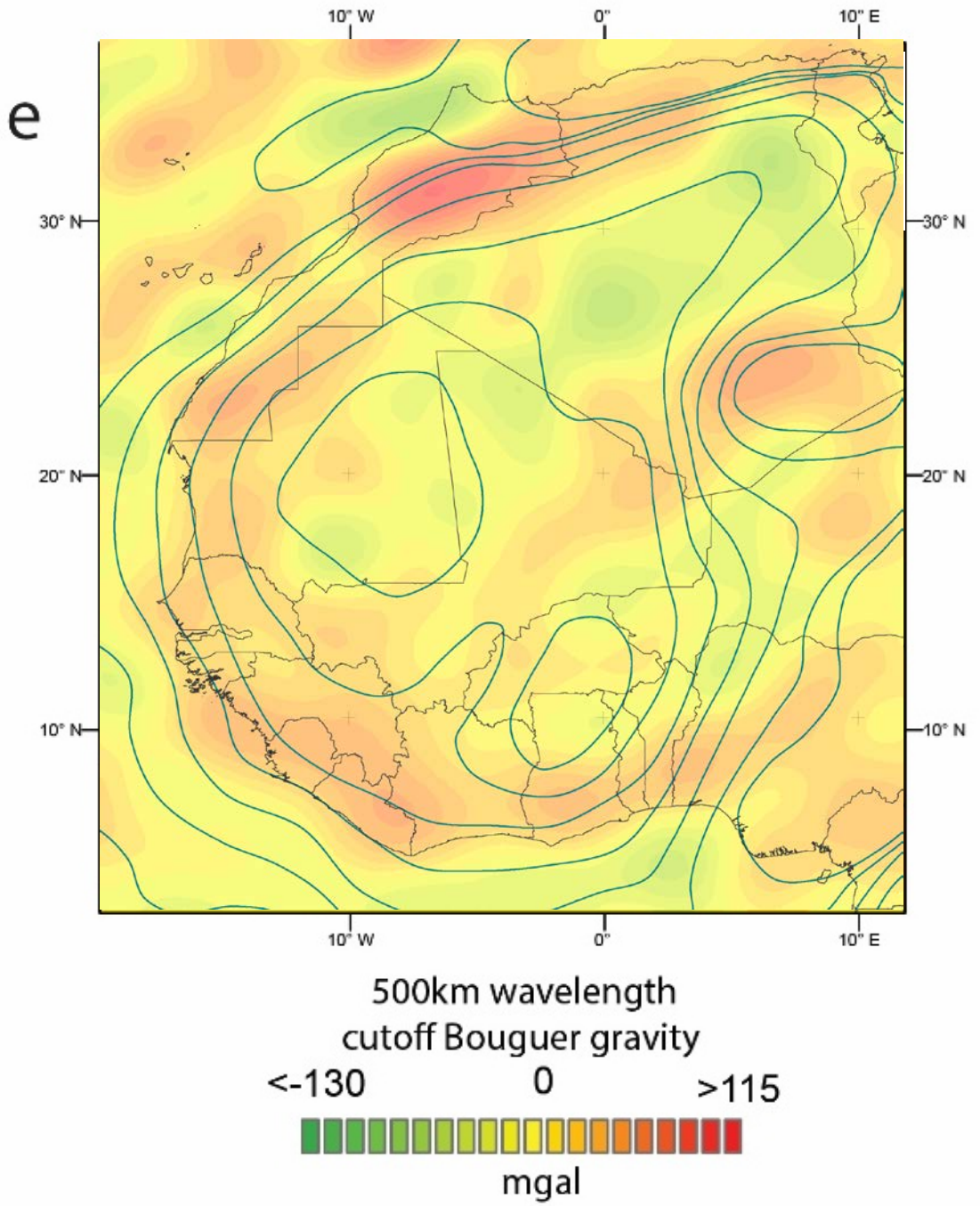
325-400 km

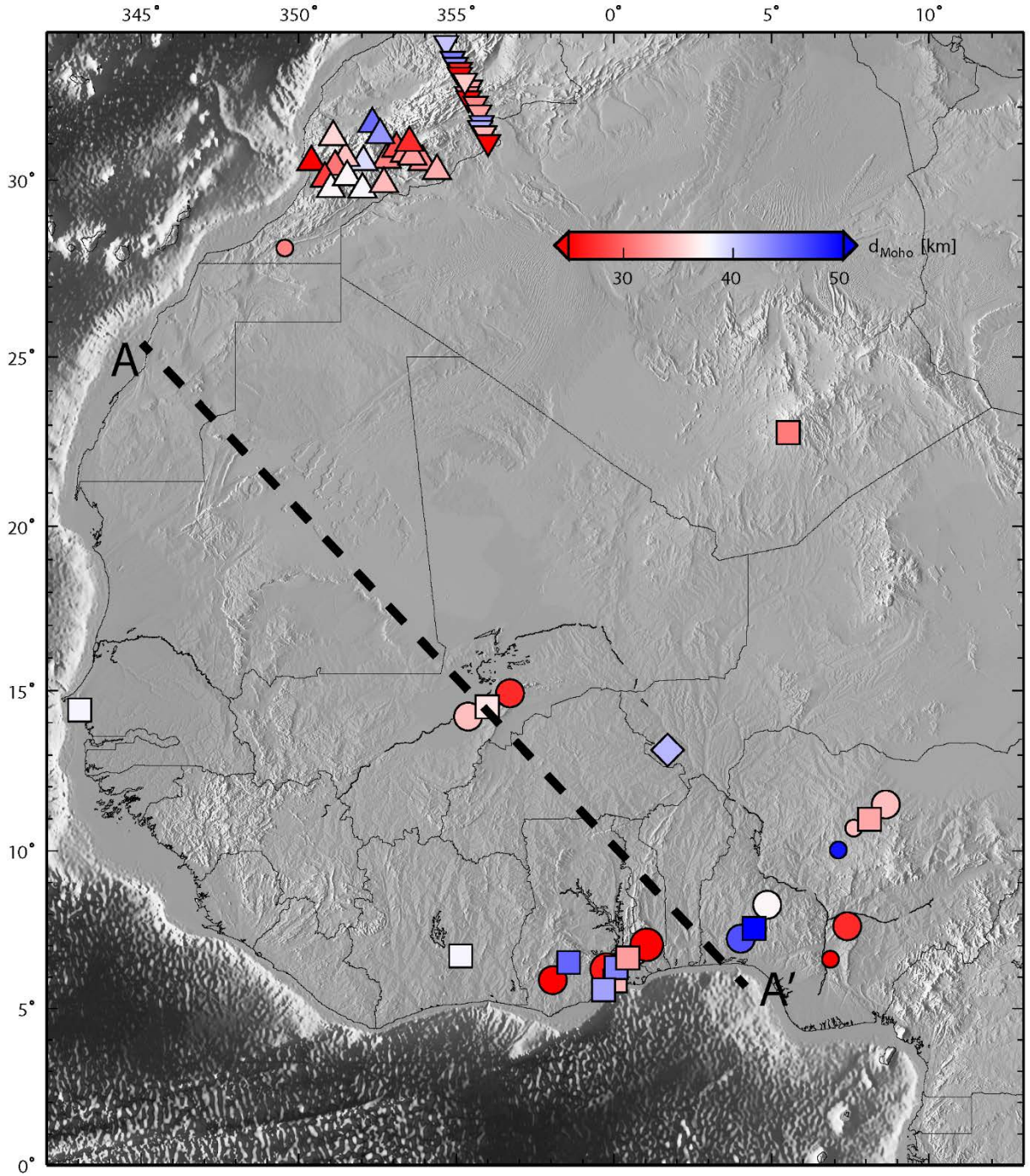




Lithosphere-Asthenosphere Boundary (LAB)


b
Fishwick & Bastow
Lithosphere-Asthenosphere Boundary
10° W
0°
10° E
30° N
20° N
10° N
80
Depth km
220

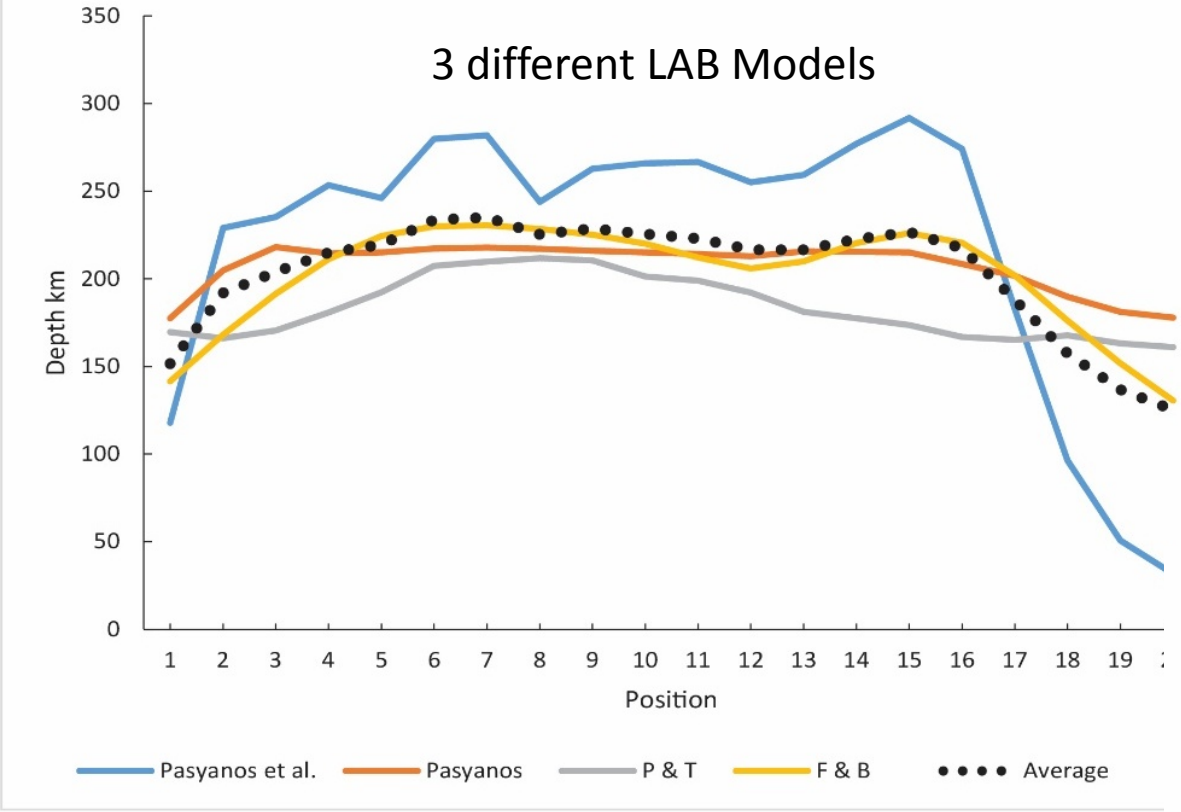

e
10° W
0°
10° E
30° N
20° N
10° N
500km wavelength
cutoff Bouguer gravity
<-130
0
>115
mgal



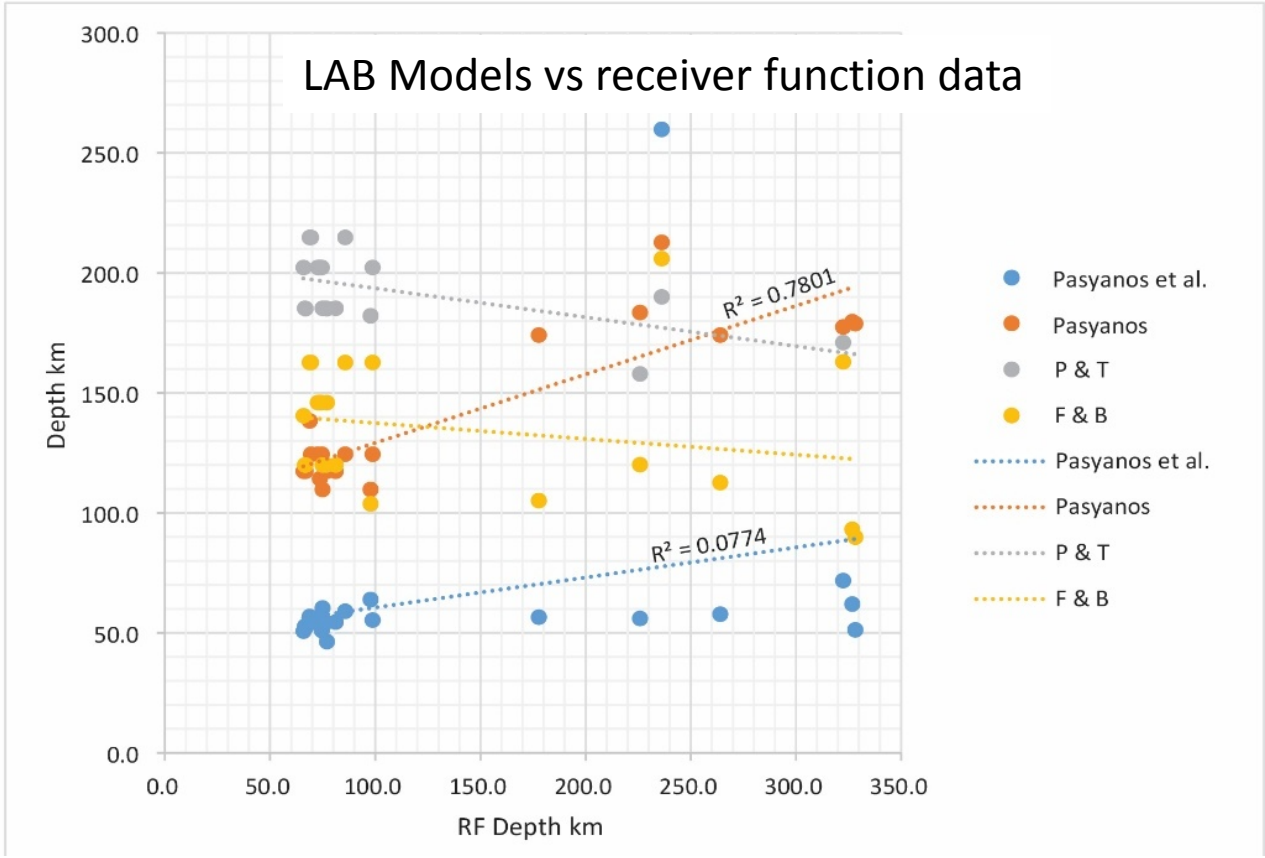
Receiver function data

- Cooper and Miller PRF
- Cooper and Miller SRF
- Spieker et al. PRF
- Di Leo et al. PRF
- Miller & Becker PRF
- Comparative Profile

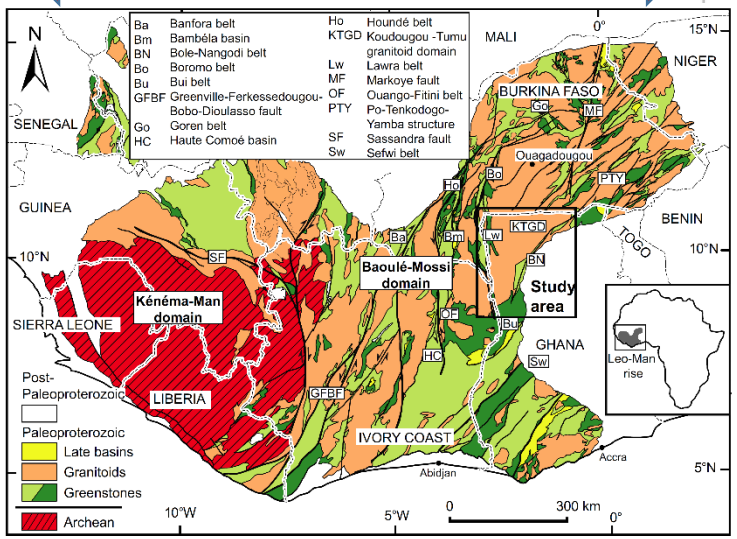
Jessell et al., 2015

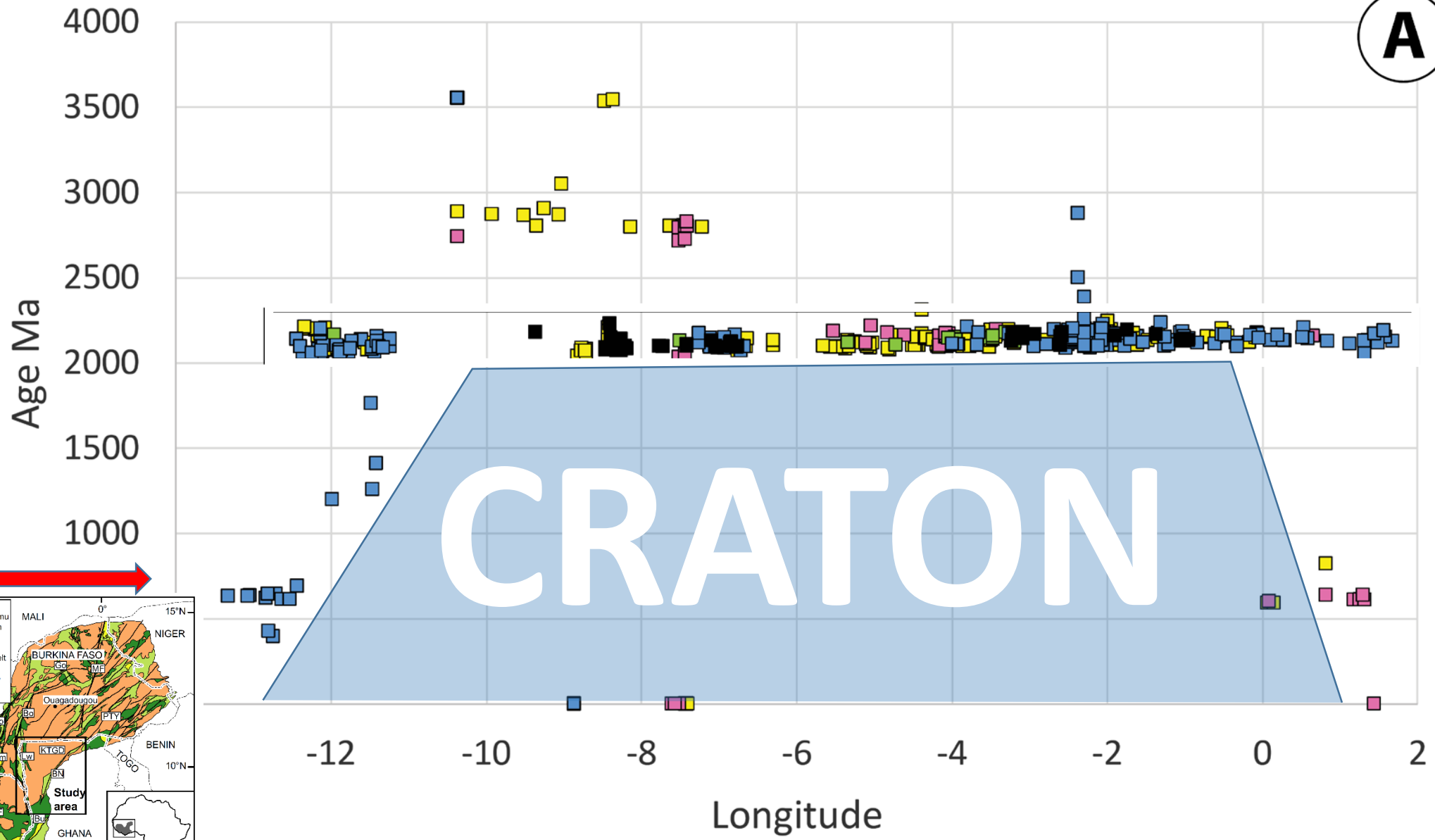


Lithosphere-Asthenosphere Boundary



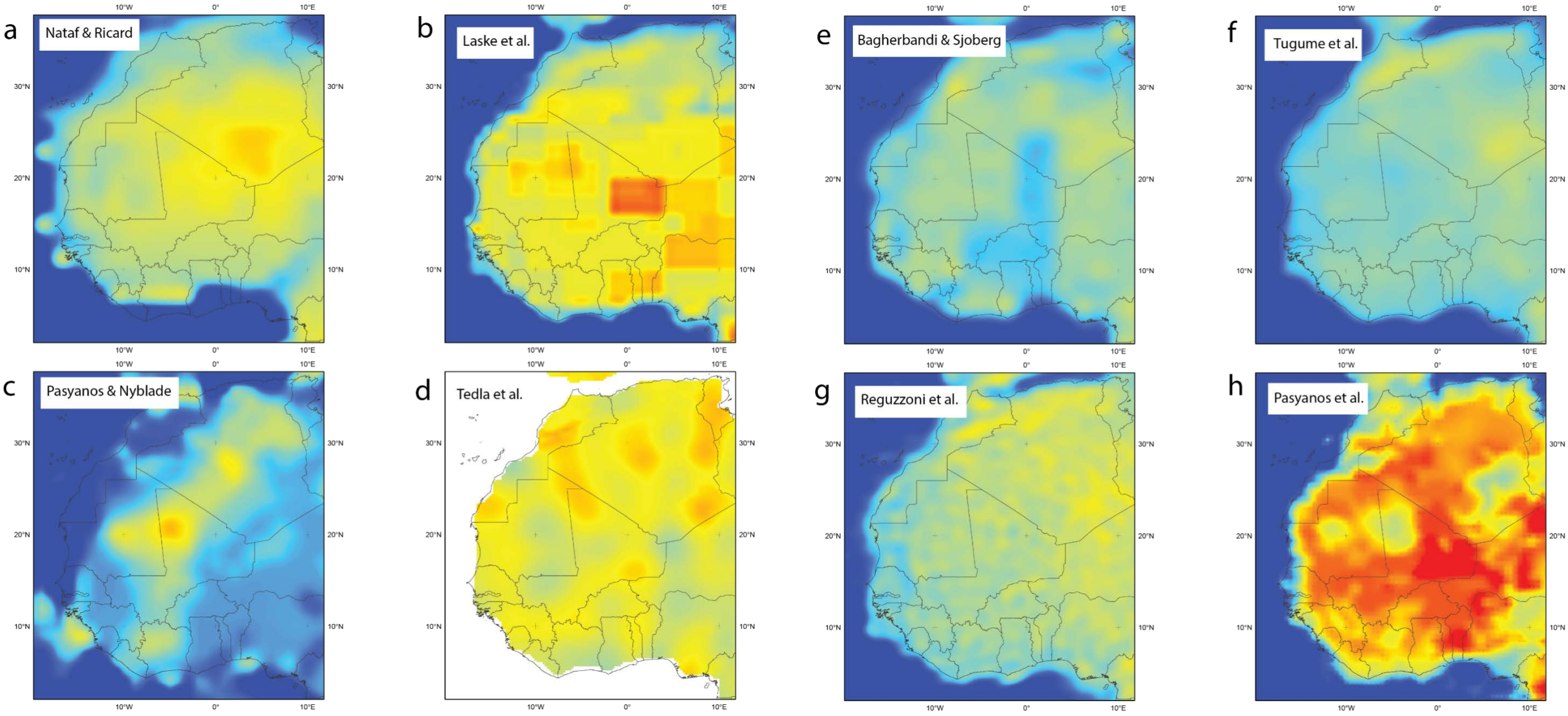
Zircon ages vs longitude



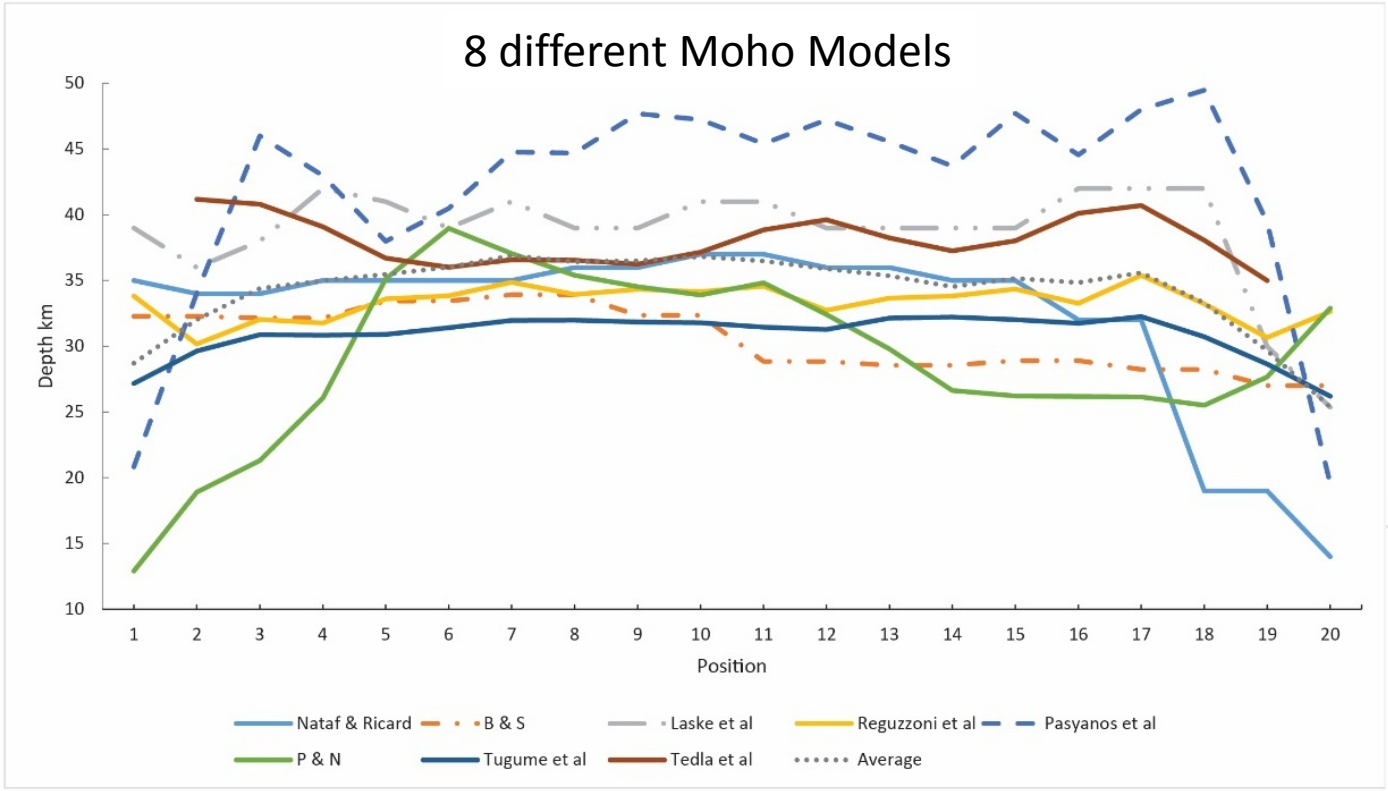


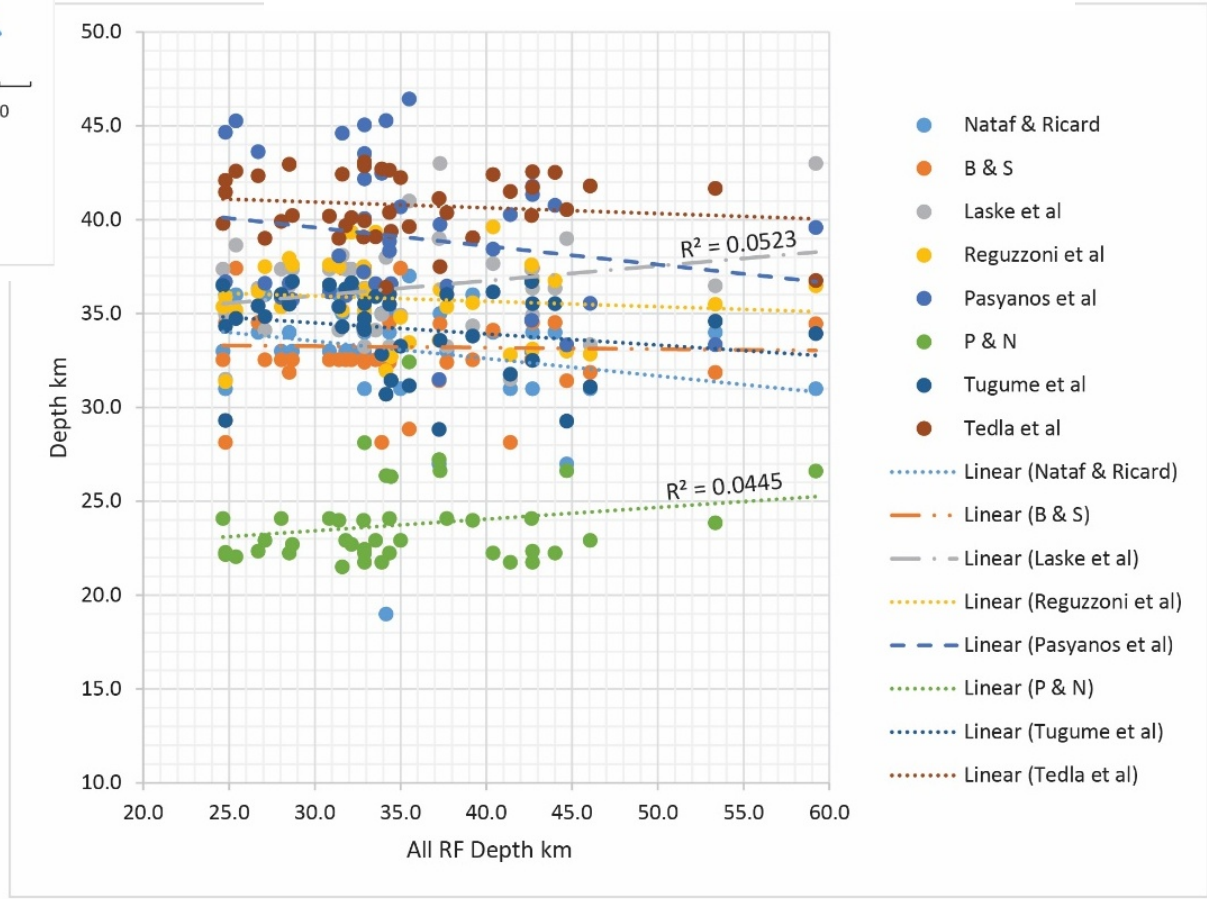
Parra 2015

Moho


a
Nataf & Ricard
b
Laske et al.
e
Bagherbandi & Sjoberg
f
Tugume et al.
c
Pasyanos & Nyblade
d
Tedla et al.
g
Reguzzoni et al.
h
Pasyanos et al.
10°W
0°
10°E
30°N
20°N
10°N
50
Depth to Moho km
20

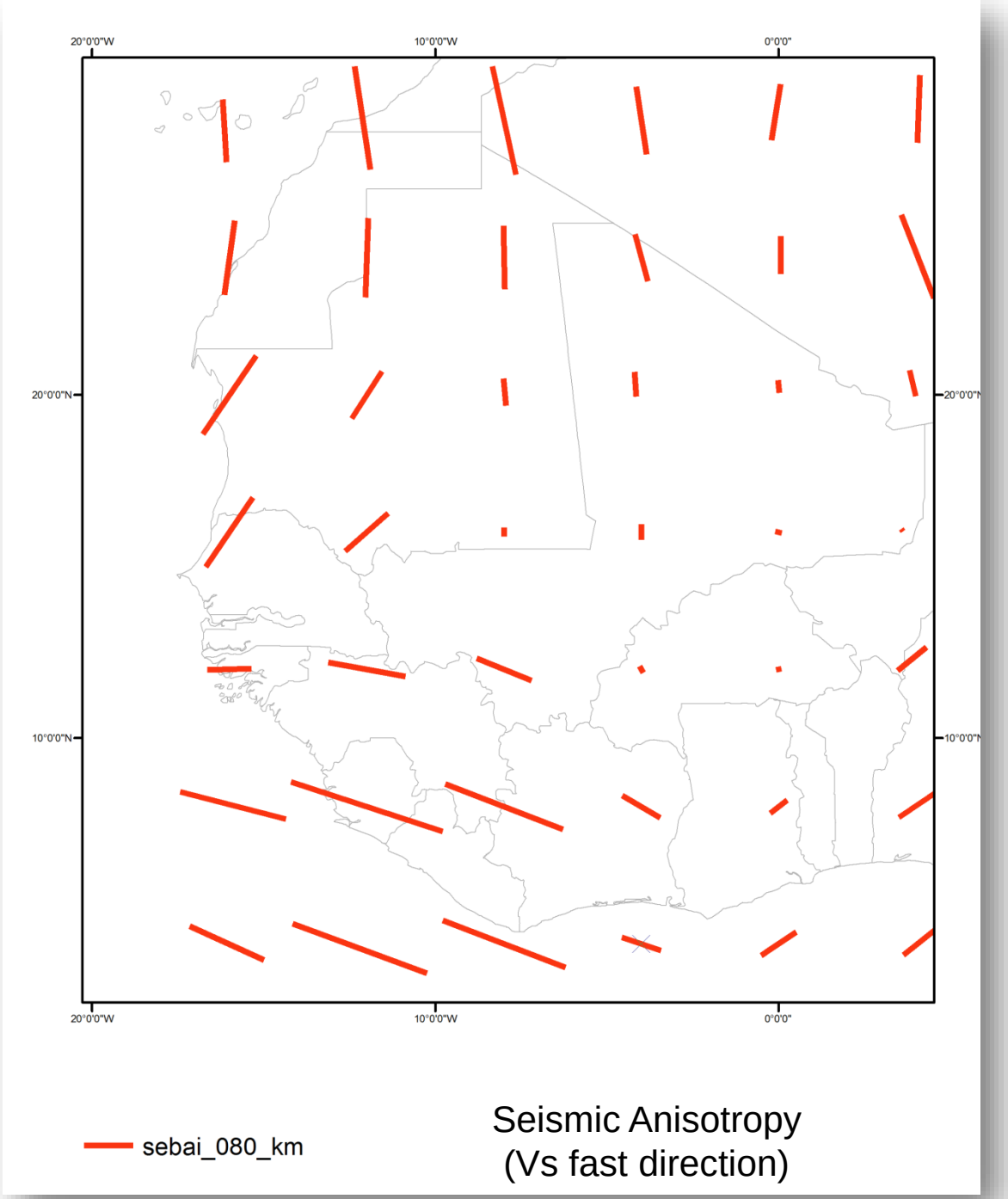
Moho


8 different Moho Models
Depth km
Position
Nataf & Ricard
B & S
Laske et al
Reguzzoni et al
Pasyanos et al
P & N
Tugume et al
Tedla et al
Average

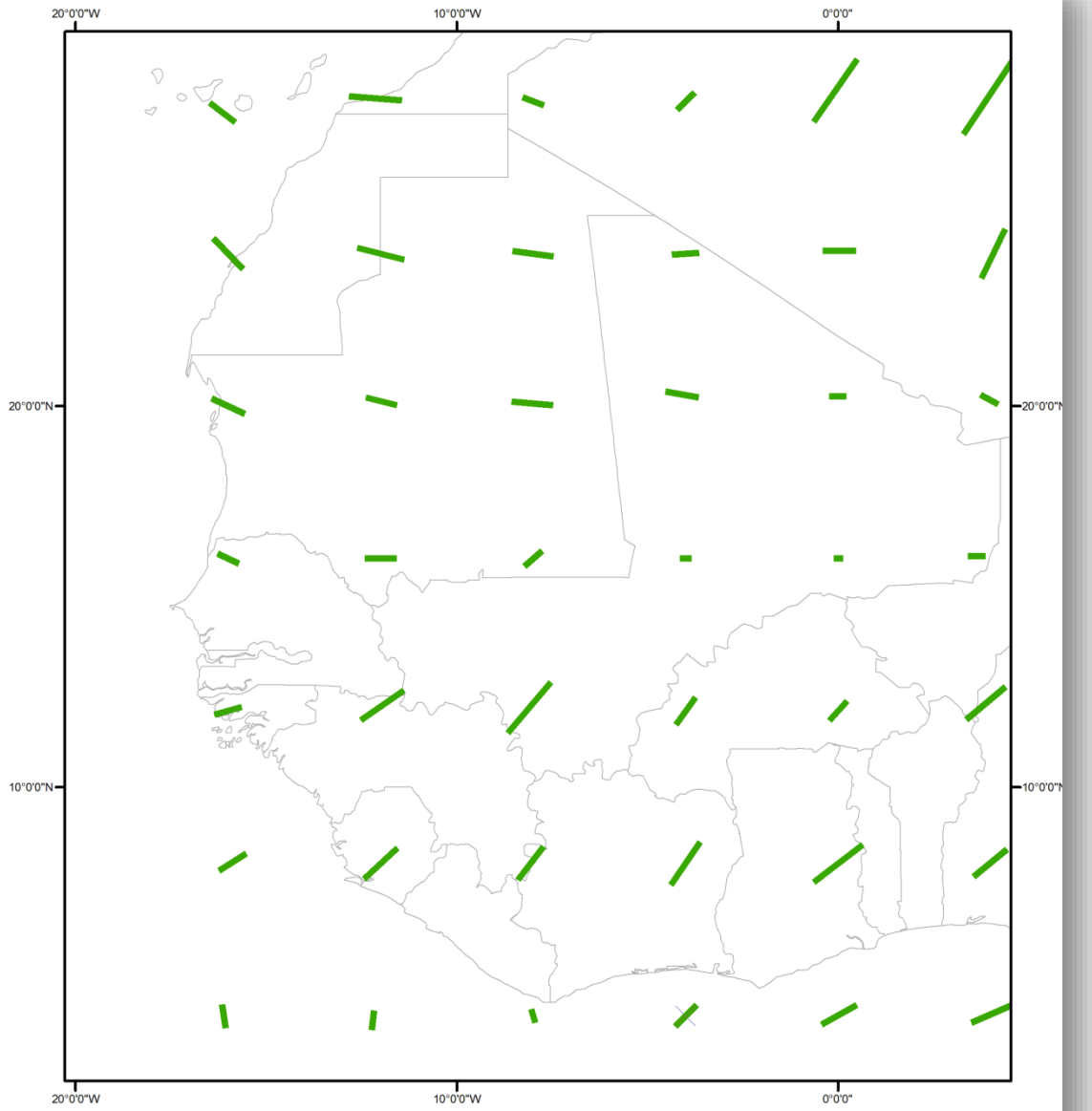

Moho Models vs receiver function data
Depth km
All RF Depth km
R² = 0.0523
R² = 0.0445
Nataf & Ricard
B & S
Laske et al
Reguzzoni et al
Pasyanos et al
P & N
Tugume et al
Tedla et al
Linear (Nataf & Ricard)
Linear (B & S)
Linear (Laske et al)
Linear (Reguzzoni et al)
Linear (Pasyanos et al)
Linear (P & N)
Linear (Tugume et al)
Linear (Tedla et al)

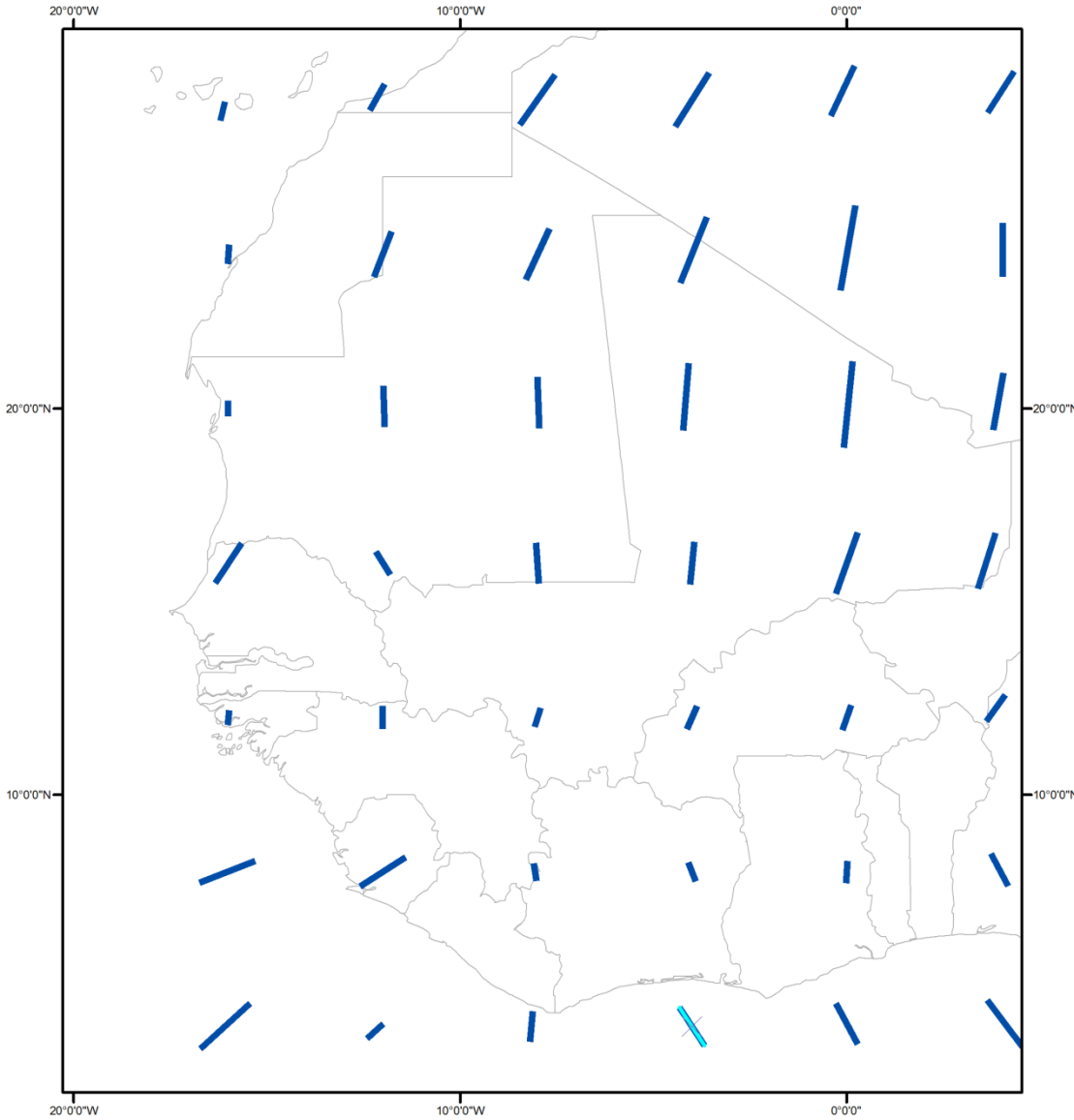
Seismic Anisotropy

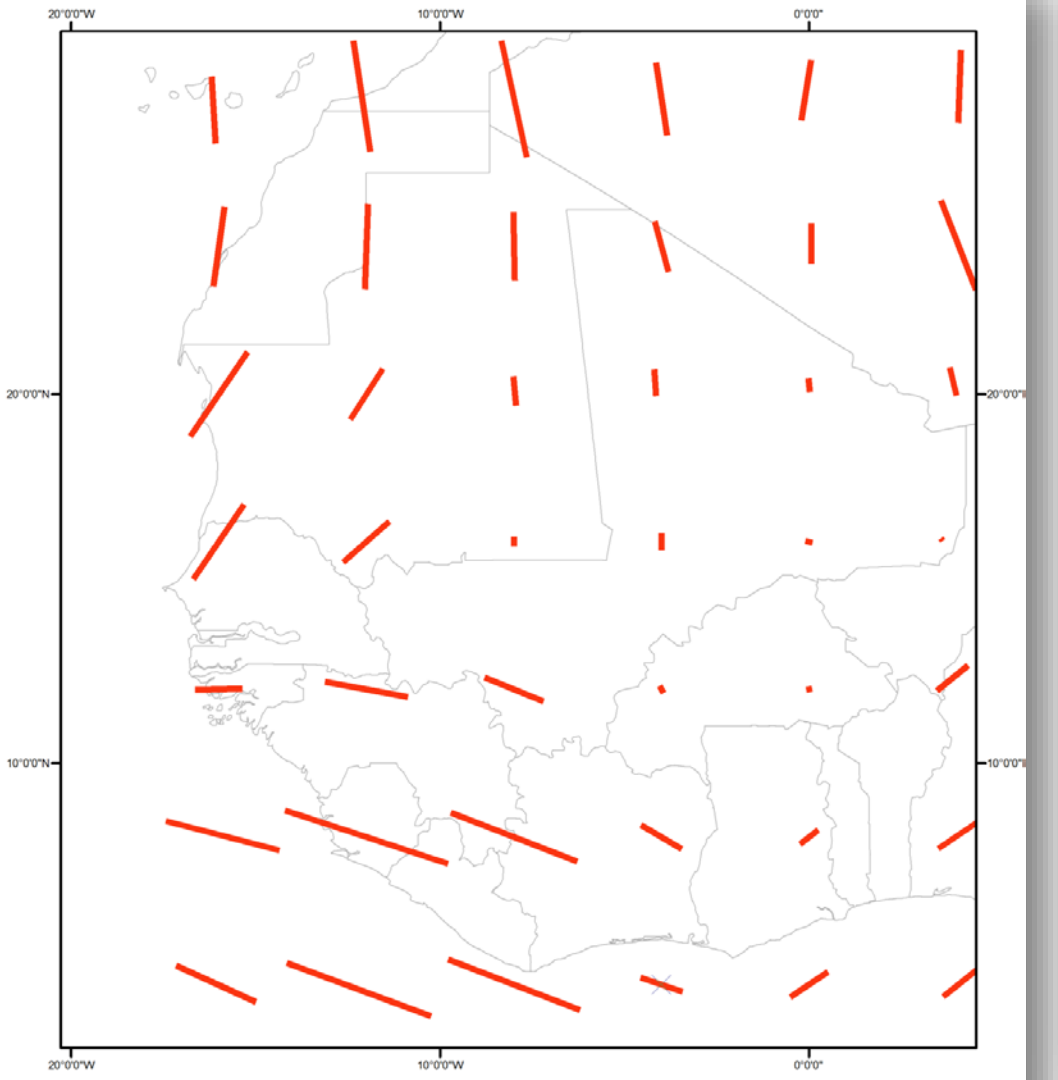
- Seismic anisotropy in the mantle at three depths: 80, 180 & 280 km
- 4° resolution map for Africa
- Length of lines proportional to strength of anisotropy
- Based on Surface wave (Rayleigh and Love) seismic tomography



Sebai, A., Stutzmann, E., Montagner, J.-P., Sicilia, D. & Beucler, E. 2006. Anisotropic structure of the African upper mantle from Rayleigh and Love wave tomography. Physics of the Earth and Planetary Interiors, 155, 48–62.

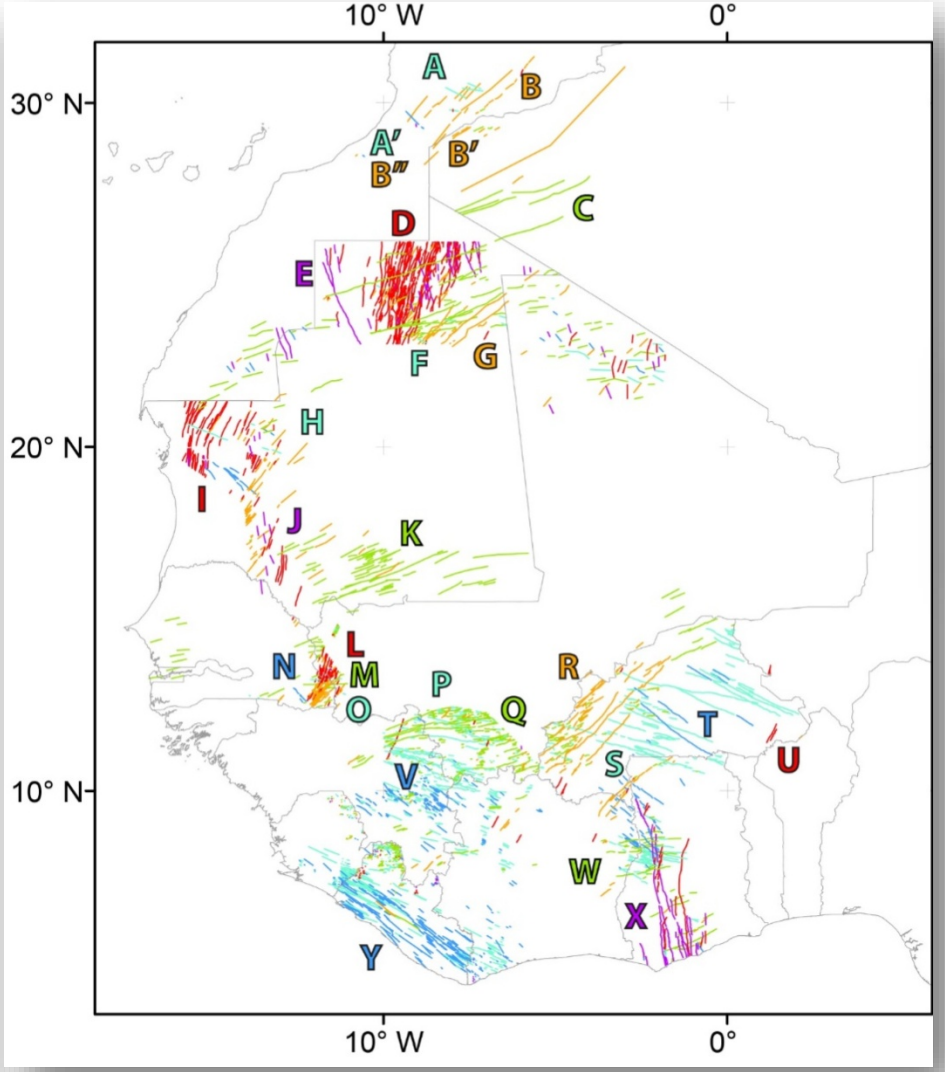

20°0'0"W
10°0'0"W
0°0'0"
20°0'0"N
10°0'0"N
sebai_180_km

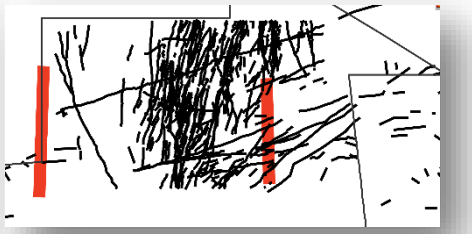

20°0'0"W
10°0'0"W
0°0'0"
20°0'0"N
10°0'0"N
sebai_280_km

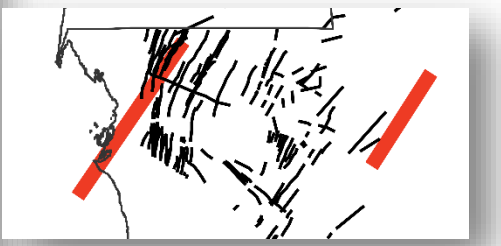


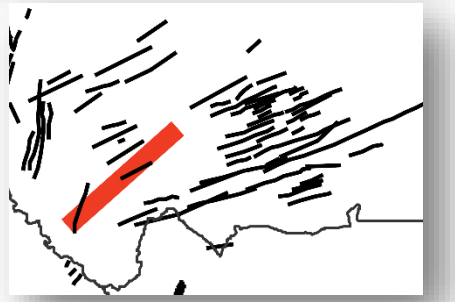
Seismic Anisotropy (Vs fast direction)

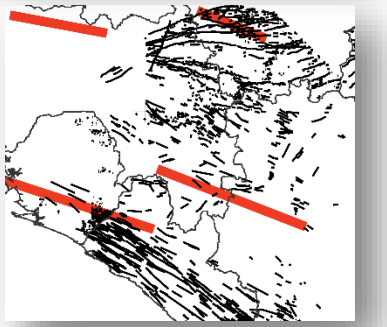
Sebai et al. 2006. Physics of the Earth and Planetary Interiors, 155, 48–62.







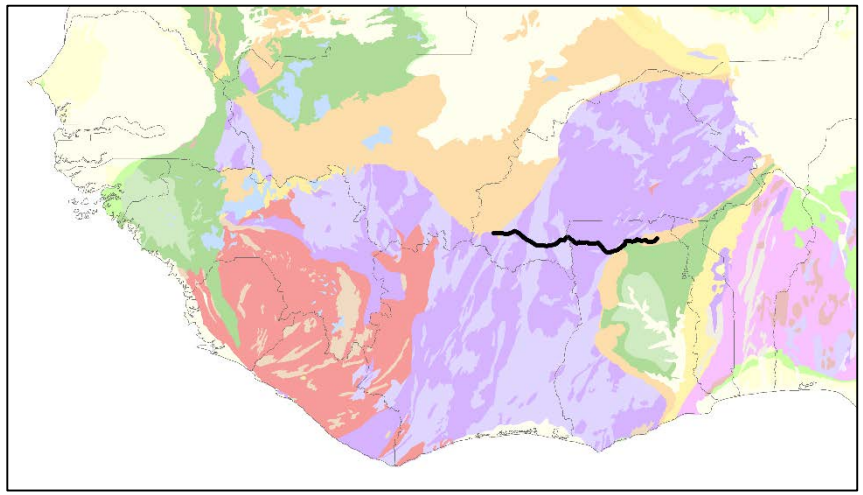


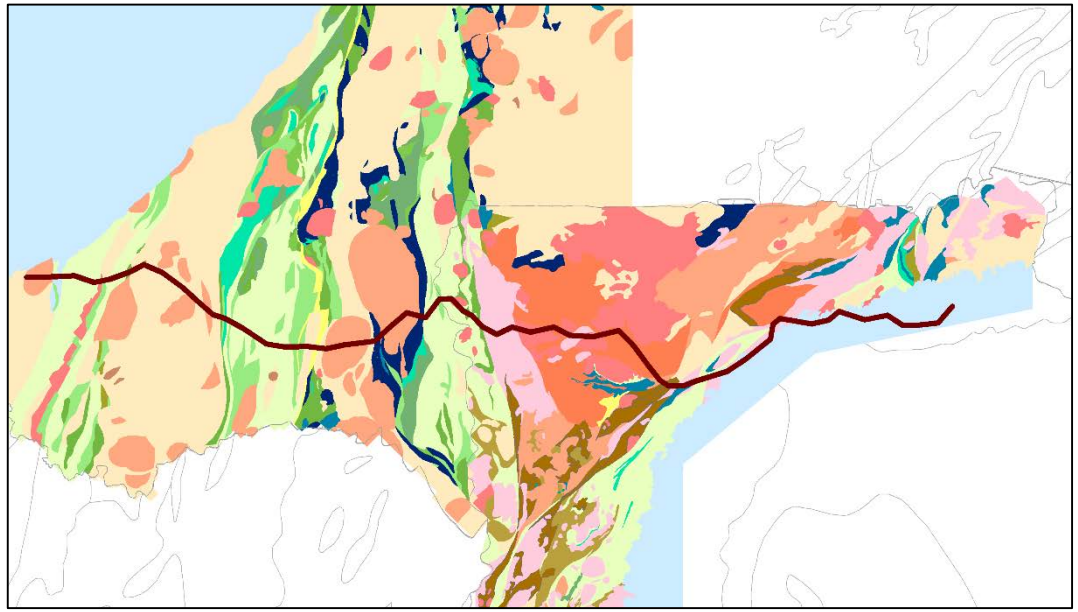


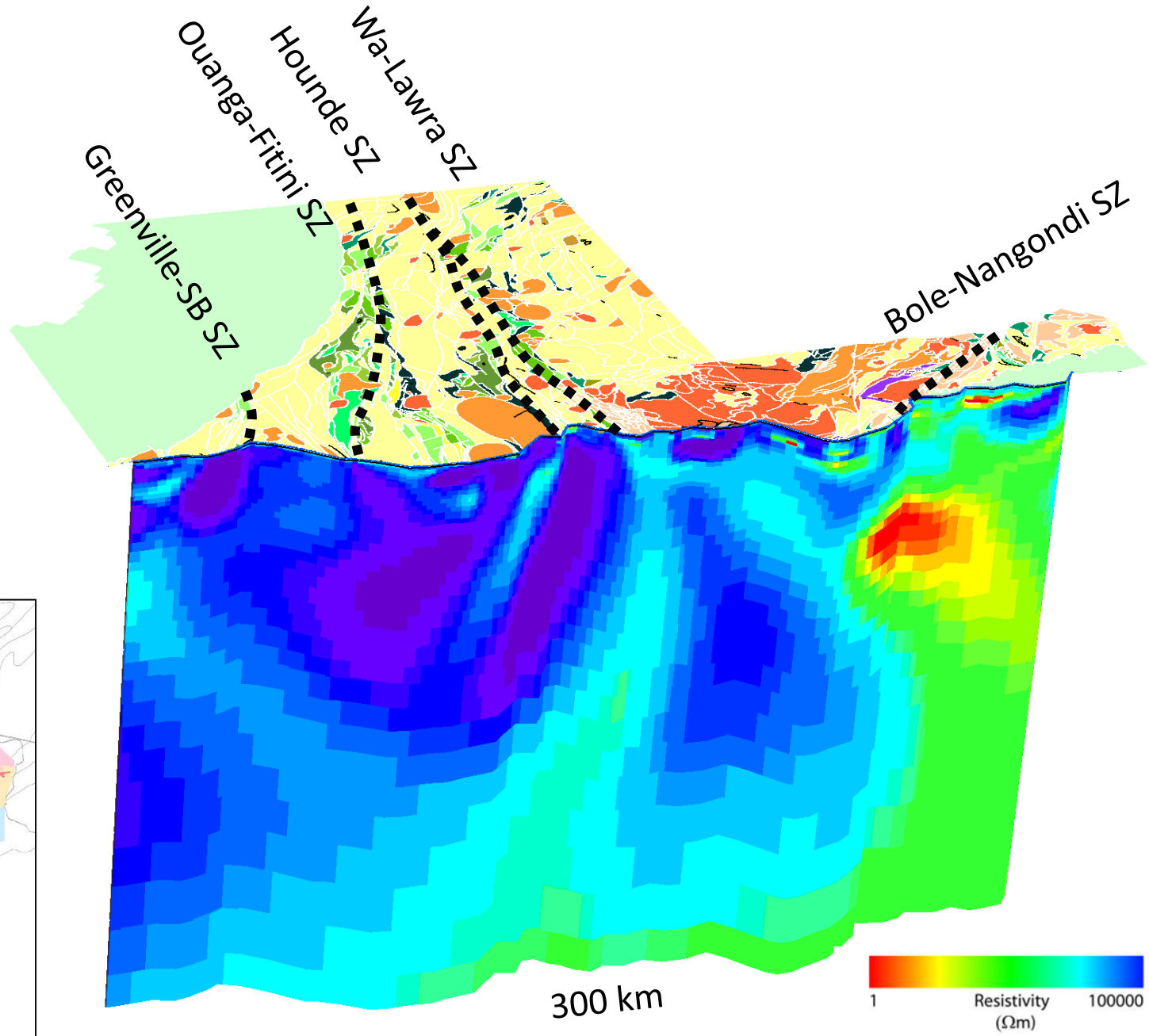
WAC Mafic Dykes

Jessell et al., 2015, JAES

MT traverse

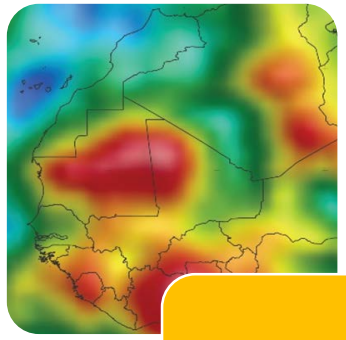




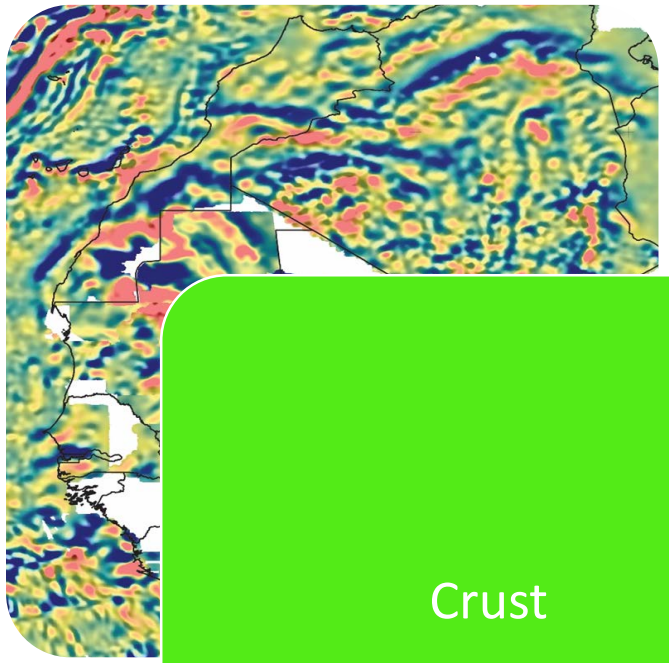


Le Pape et al., in prep, 2015

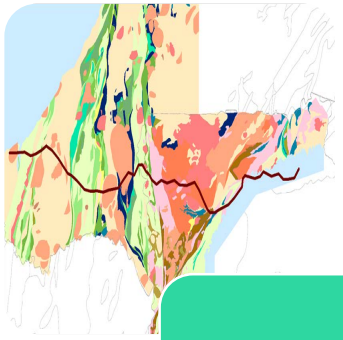
Four Scales of Geophysical Analysis



Lithosphere

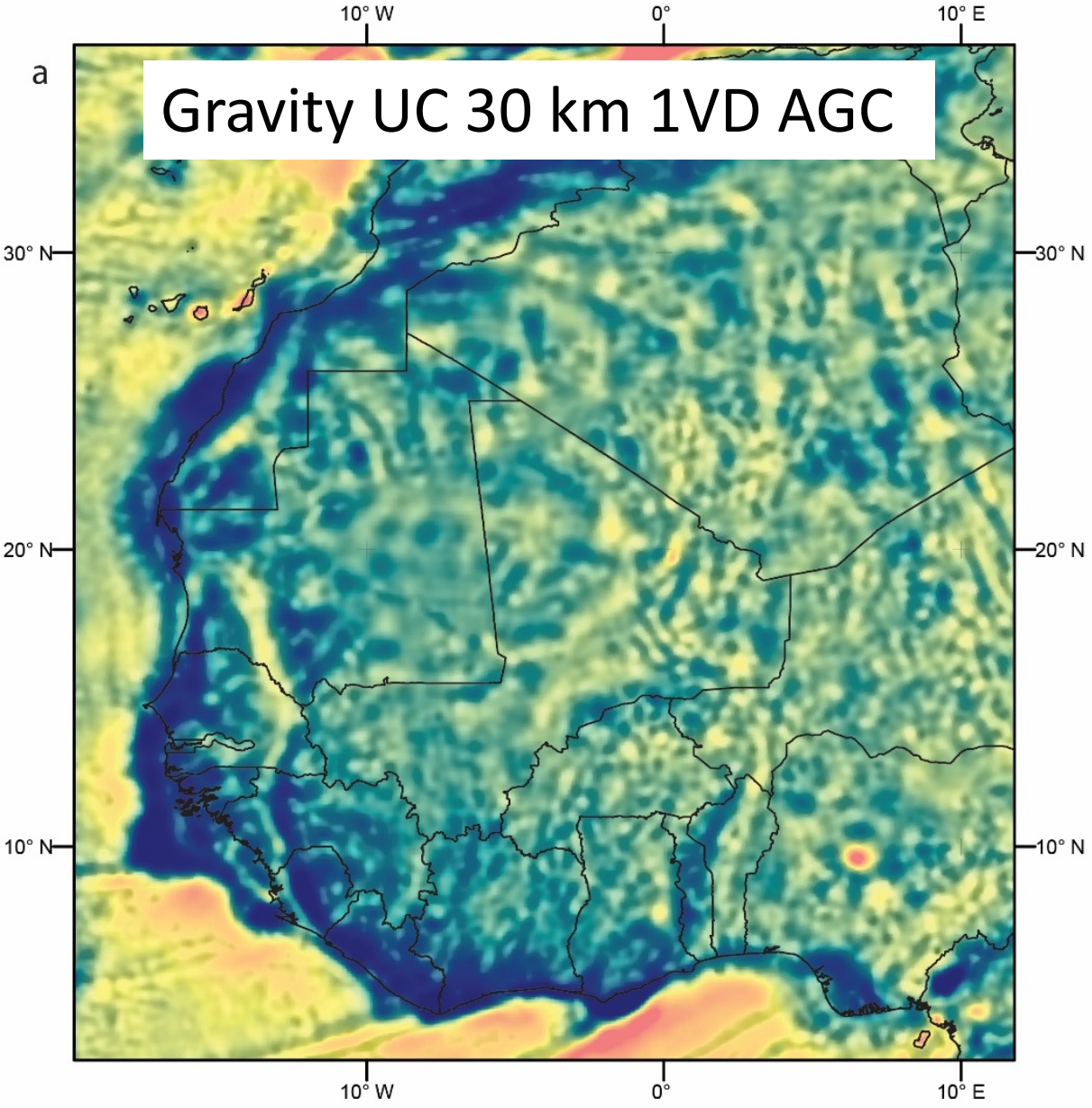


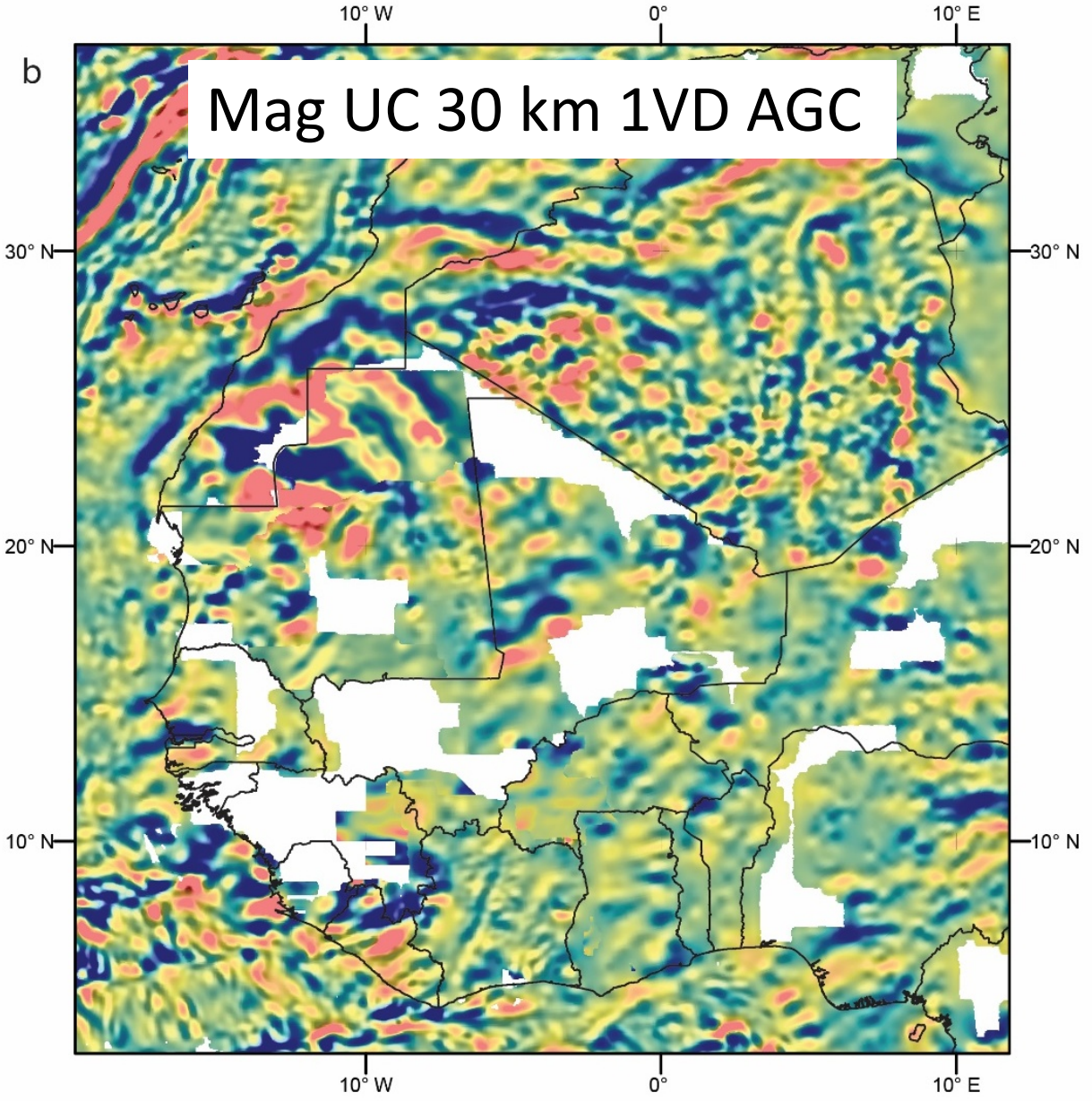
Crust



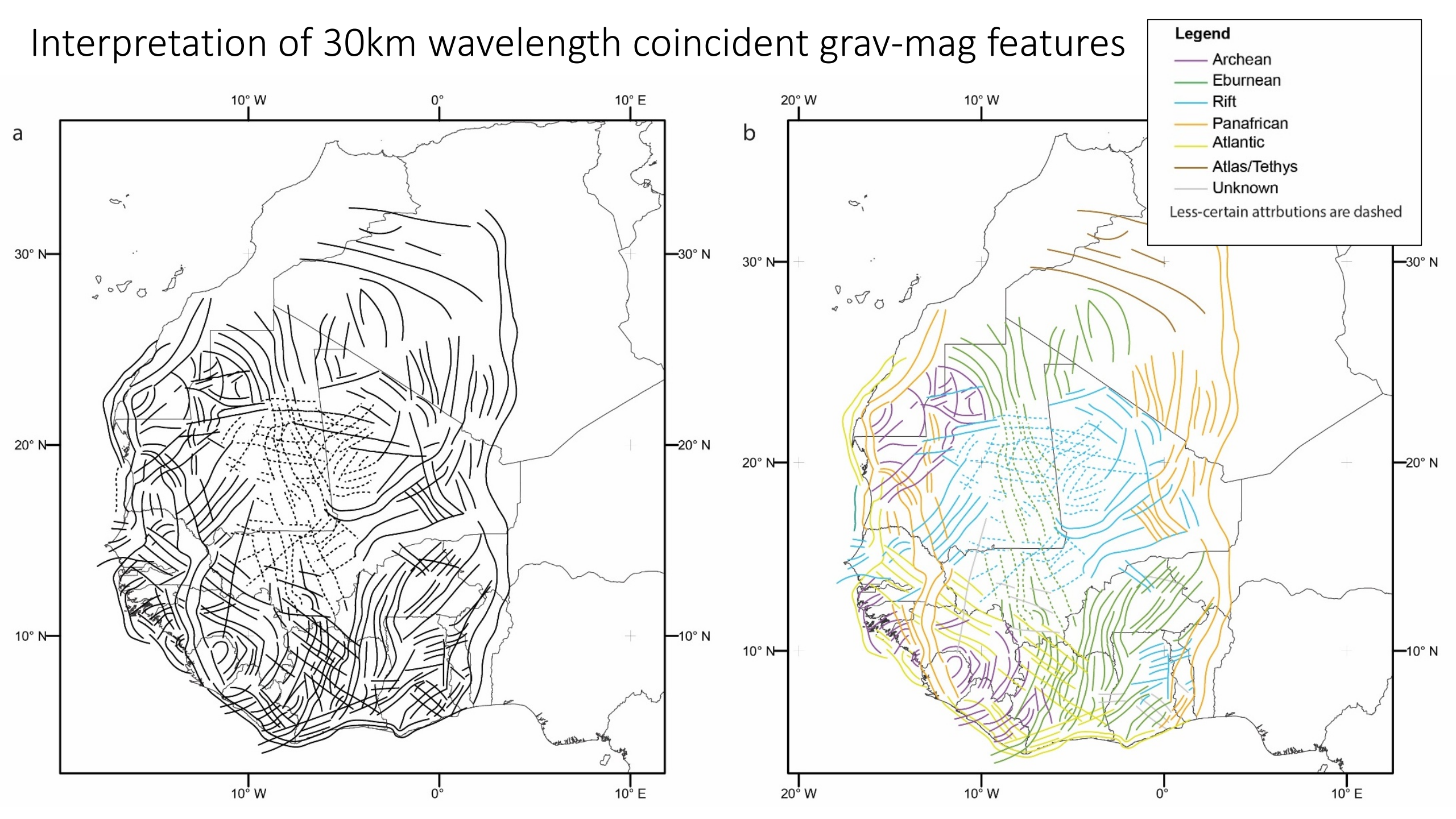
Surface Geology

Regolith

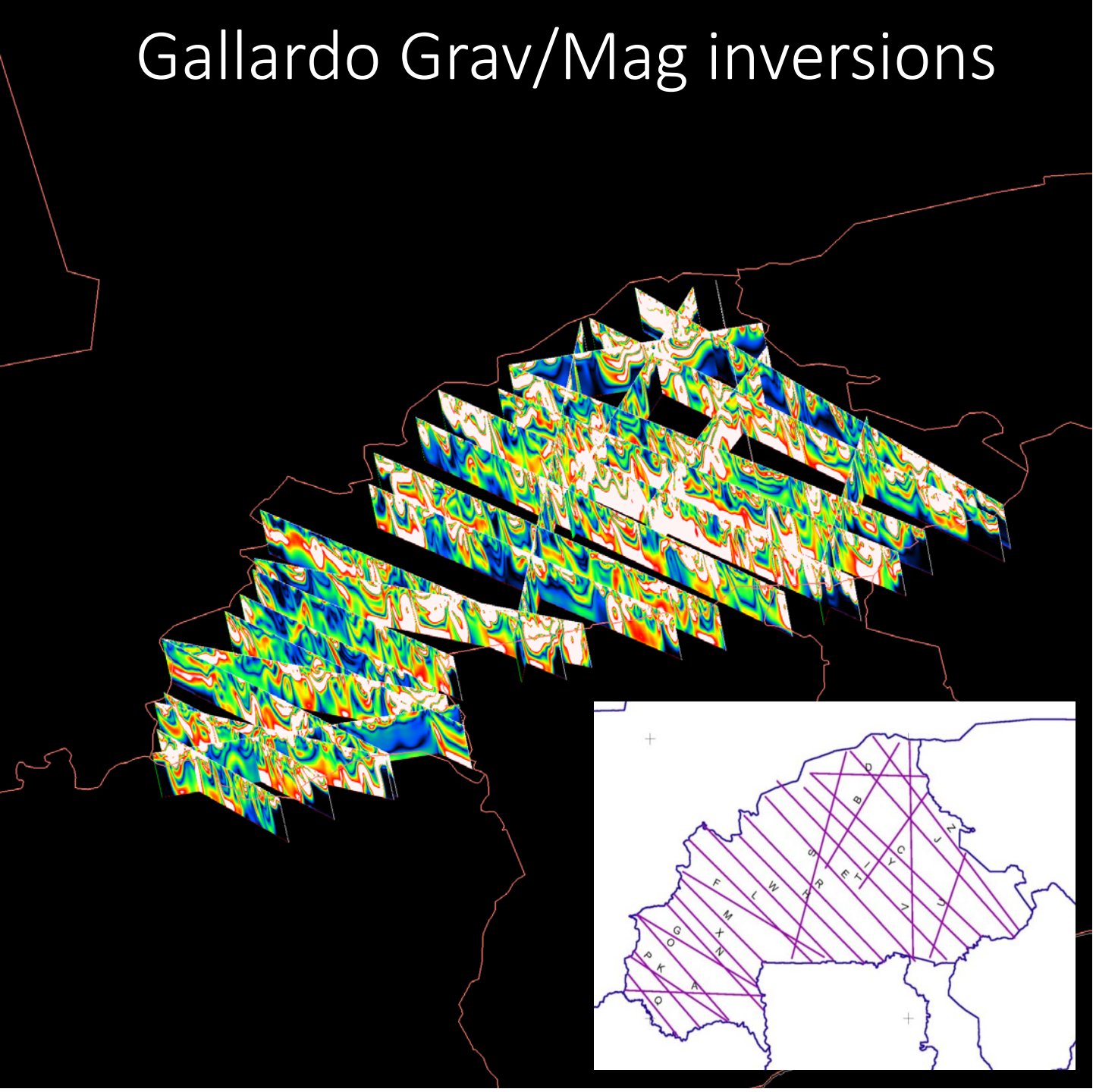

a
Gravity UC 30 km 1VD AGC
10° W
0°
10° E
30° N
20° N
10° N

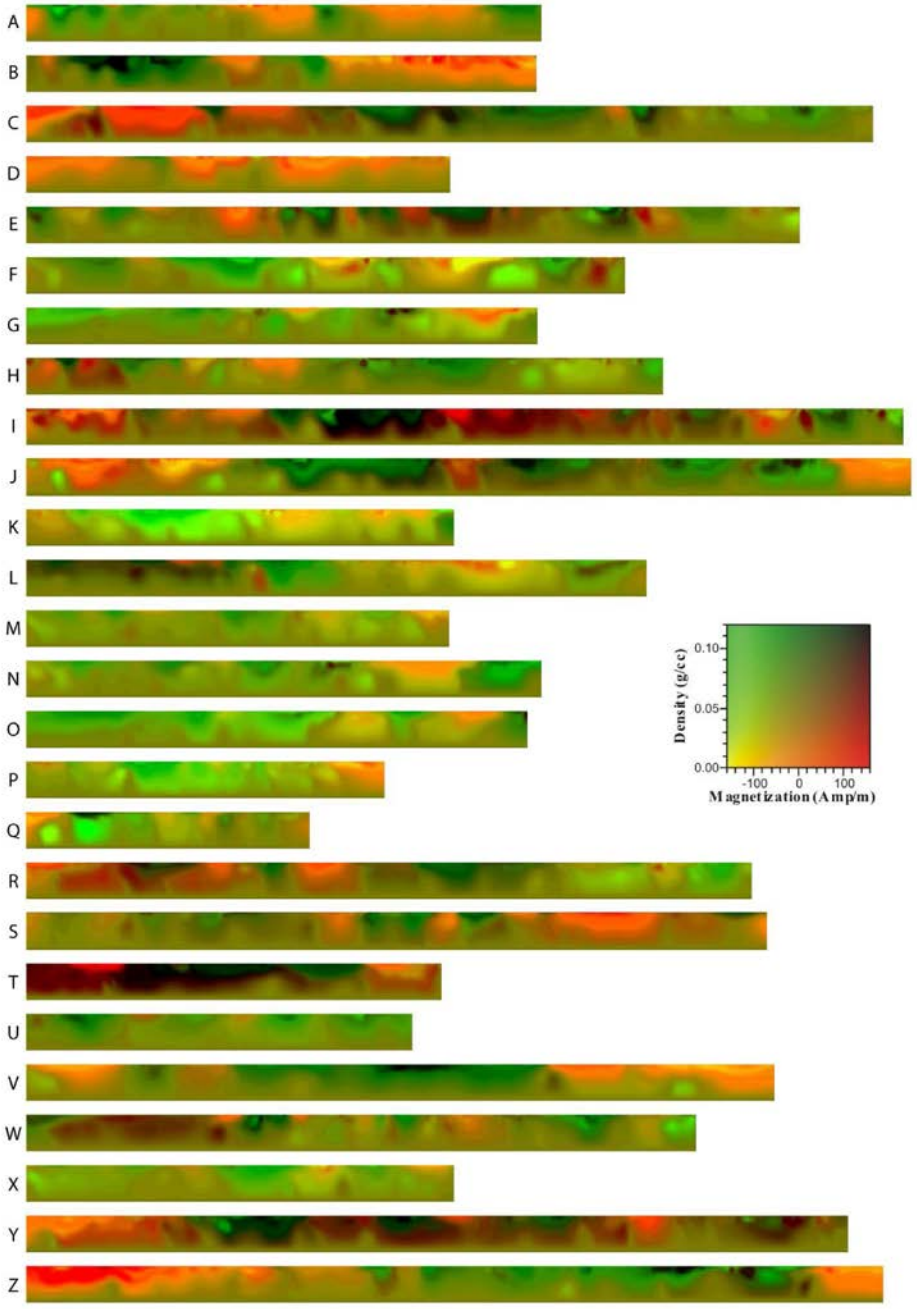

b
Mag UC 30 km 1VD AGC
10° W
0°
10° E
30° N
20° N
10° N

Interpretation of 30km wavelength coincident grav-mag features

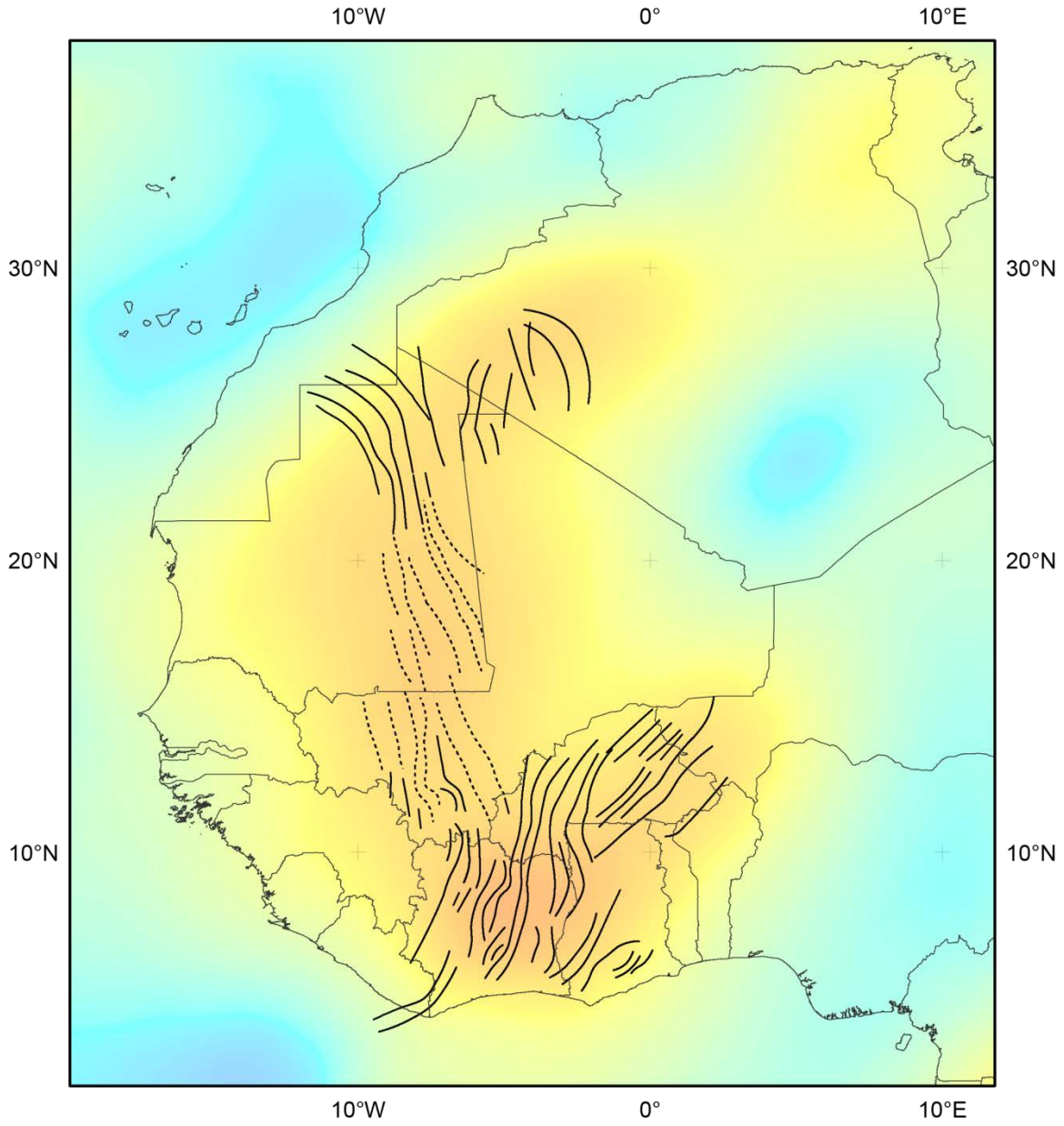


Gallardo Grav/Mag inversions



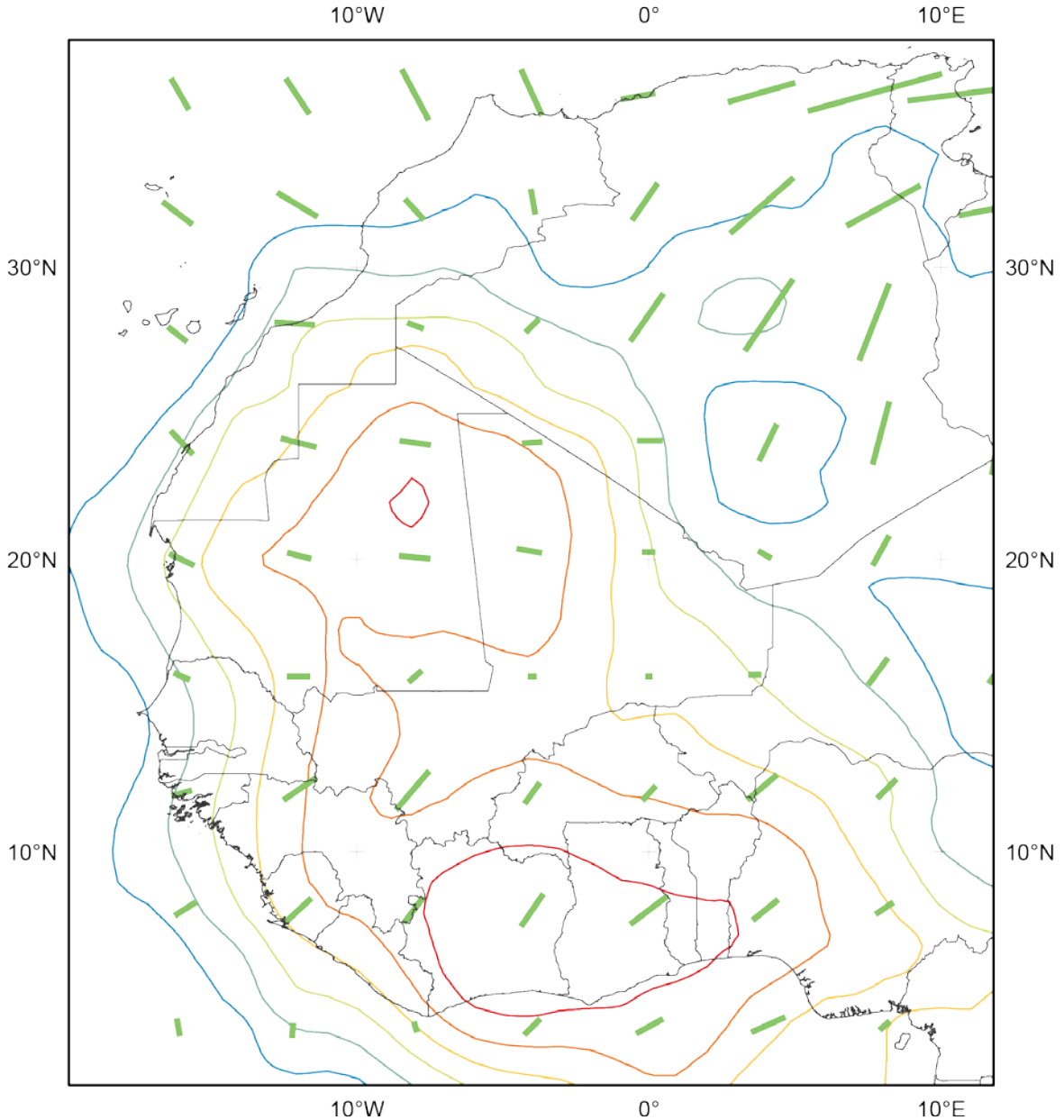


Possible Eburnian Features vs δVs at 180 km



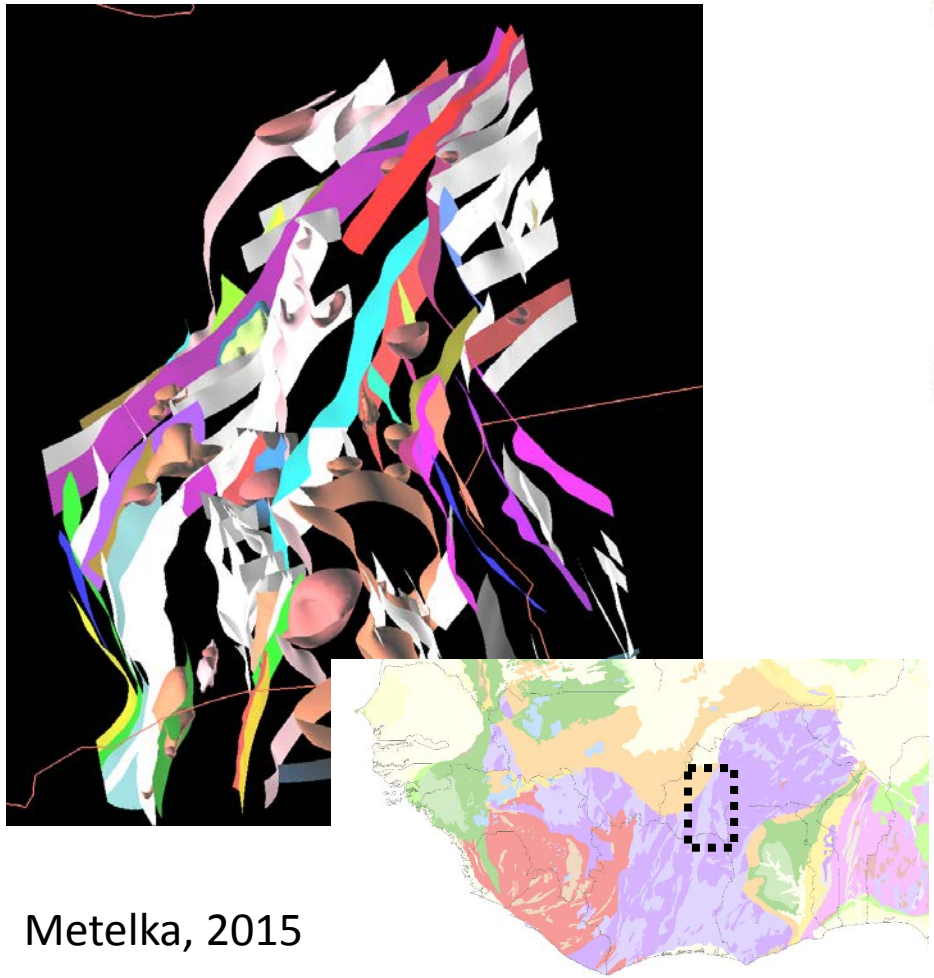
Schaeffer & Lebedev, 2013

Seismic Anisotropy at 180 km vs δVs at 175-250km

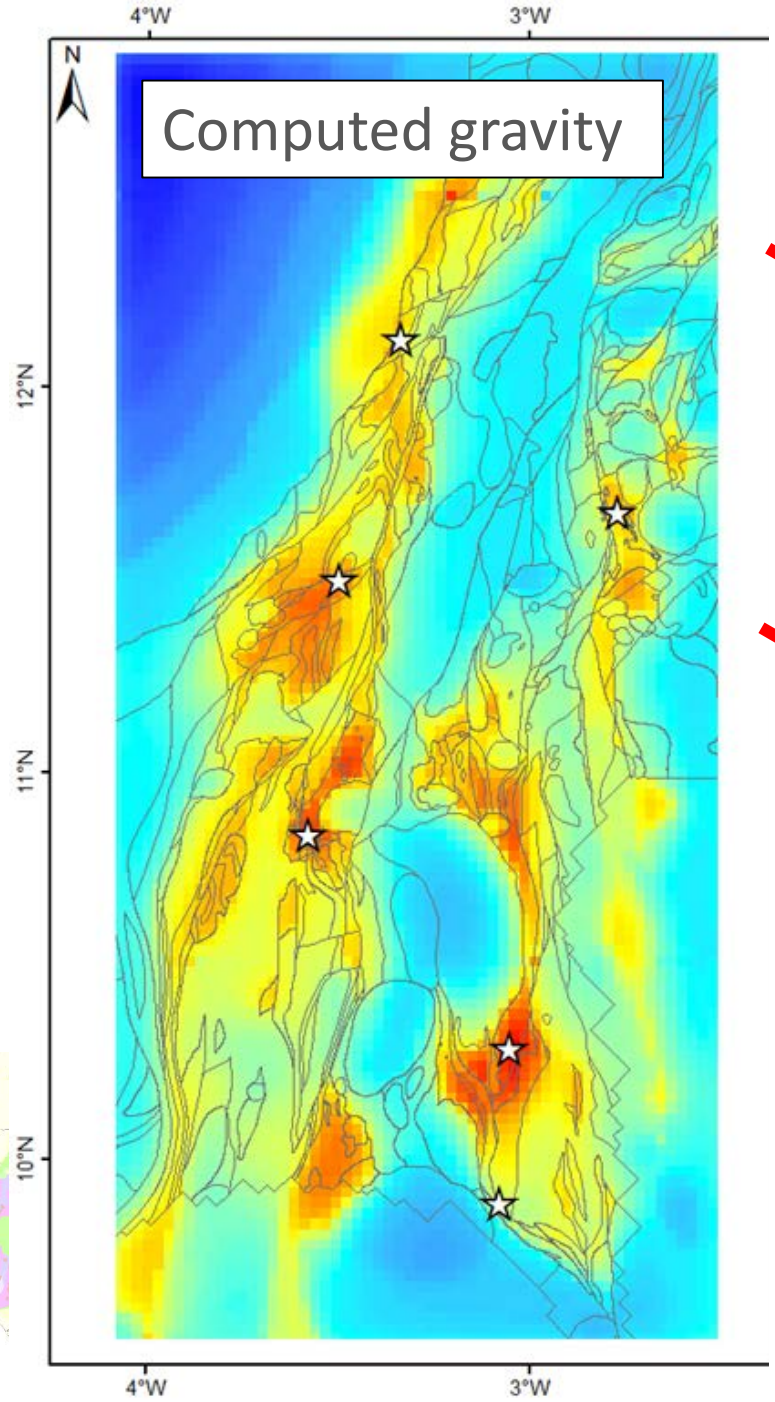


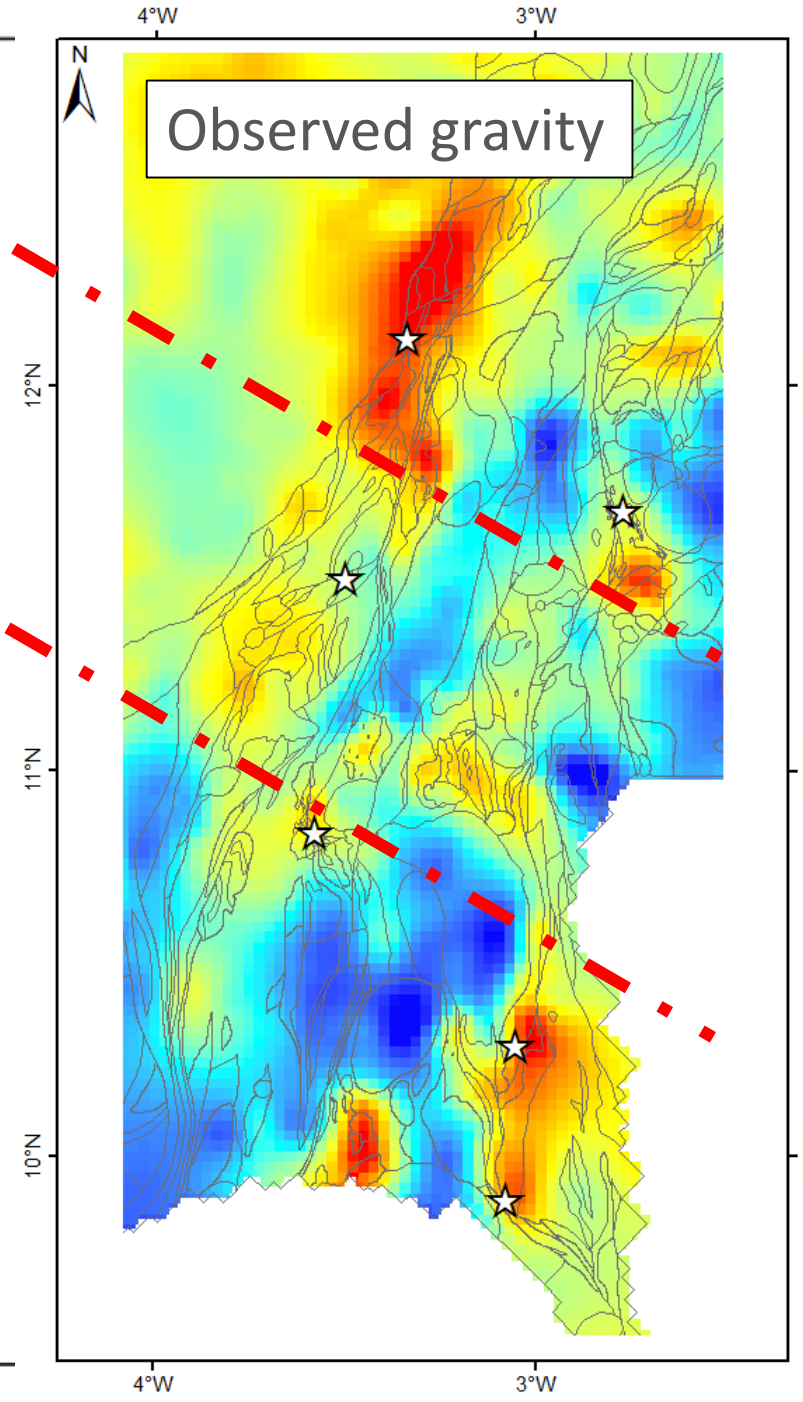
Vs Anisotropy 180 km (Sebai et al., 2006)

3D Model of SW Burkina Faso



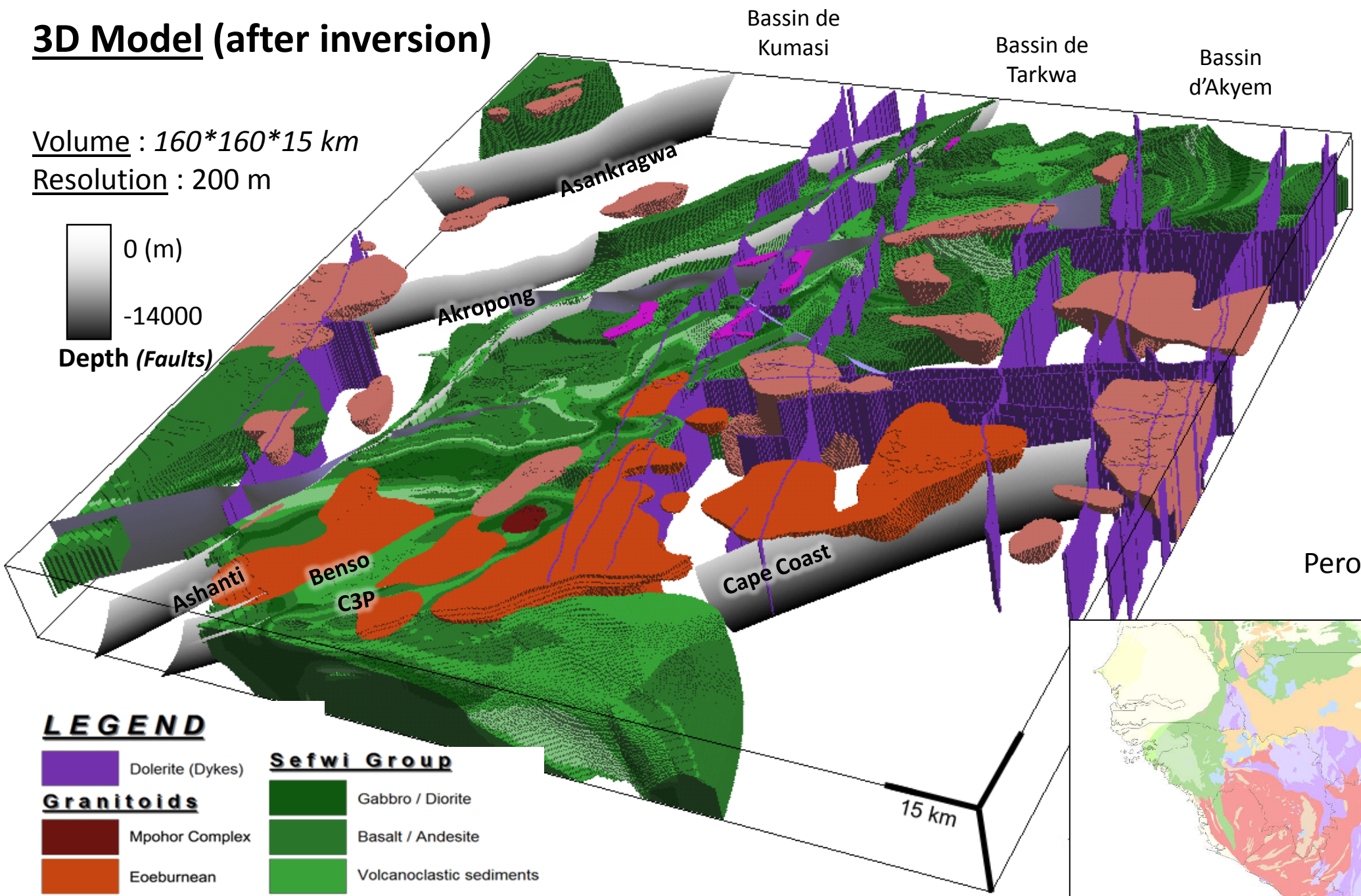
Metelka, 2015



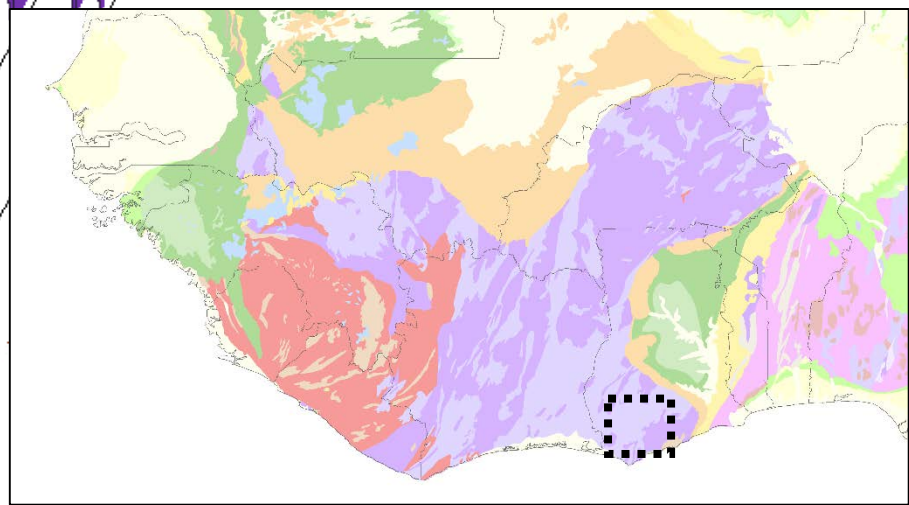


3D Model (after inversion)

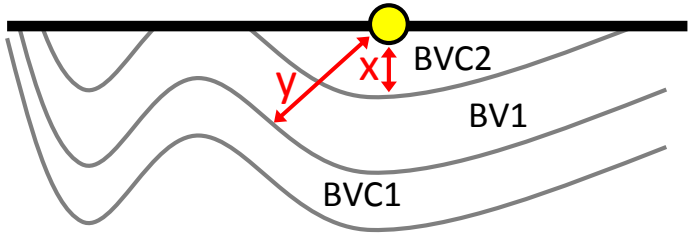
Volume : *160*160*15 km*
Resolution : 200 m



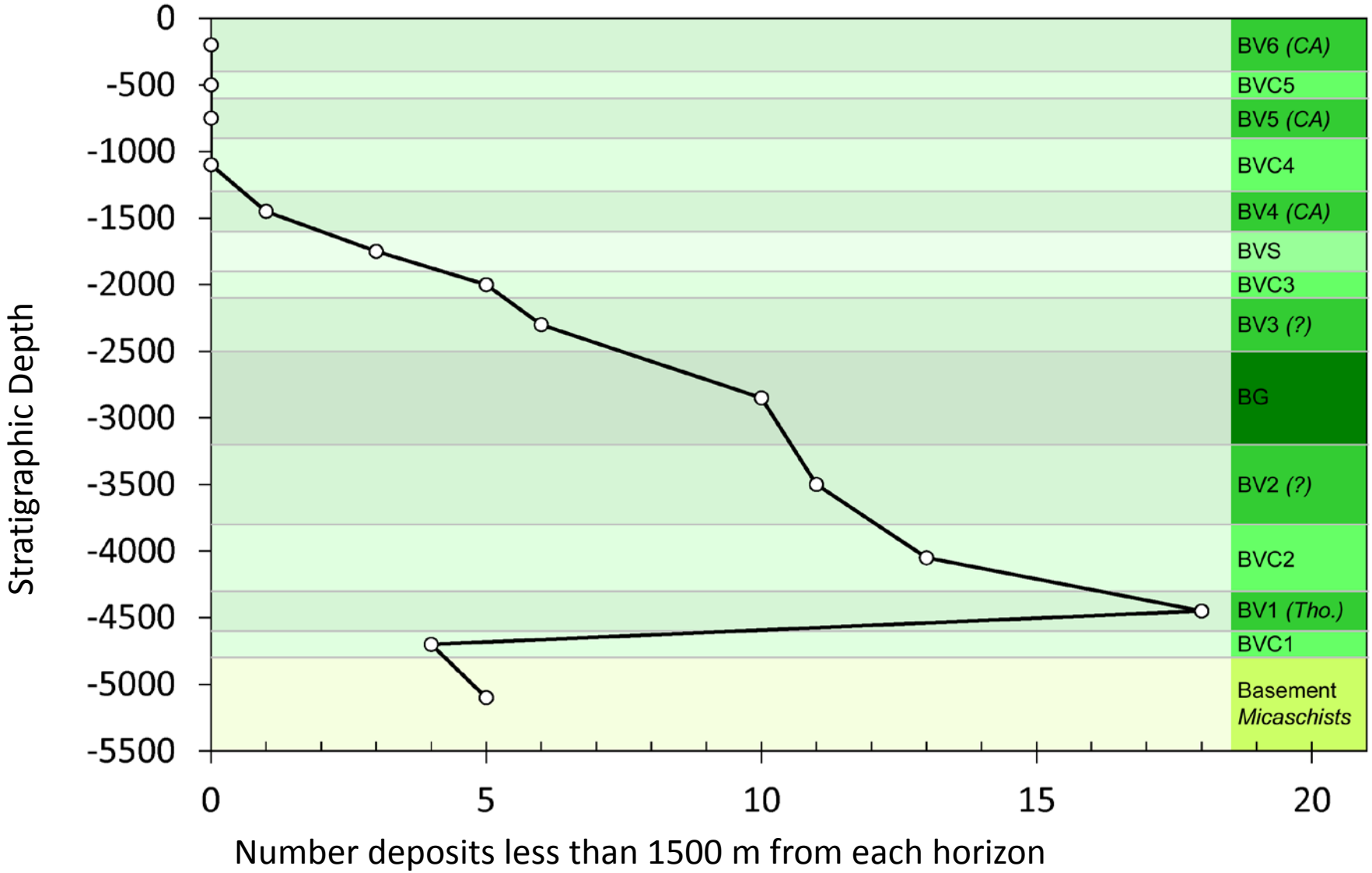
Perouty et al., OGR, 2014



3D Correlation between mineralisation and stratigraphy

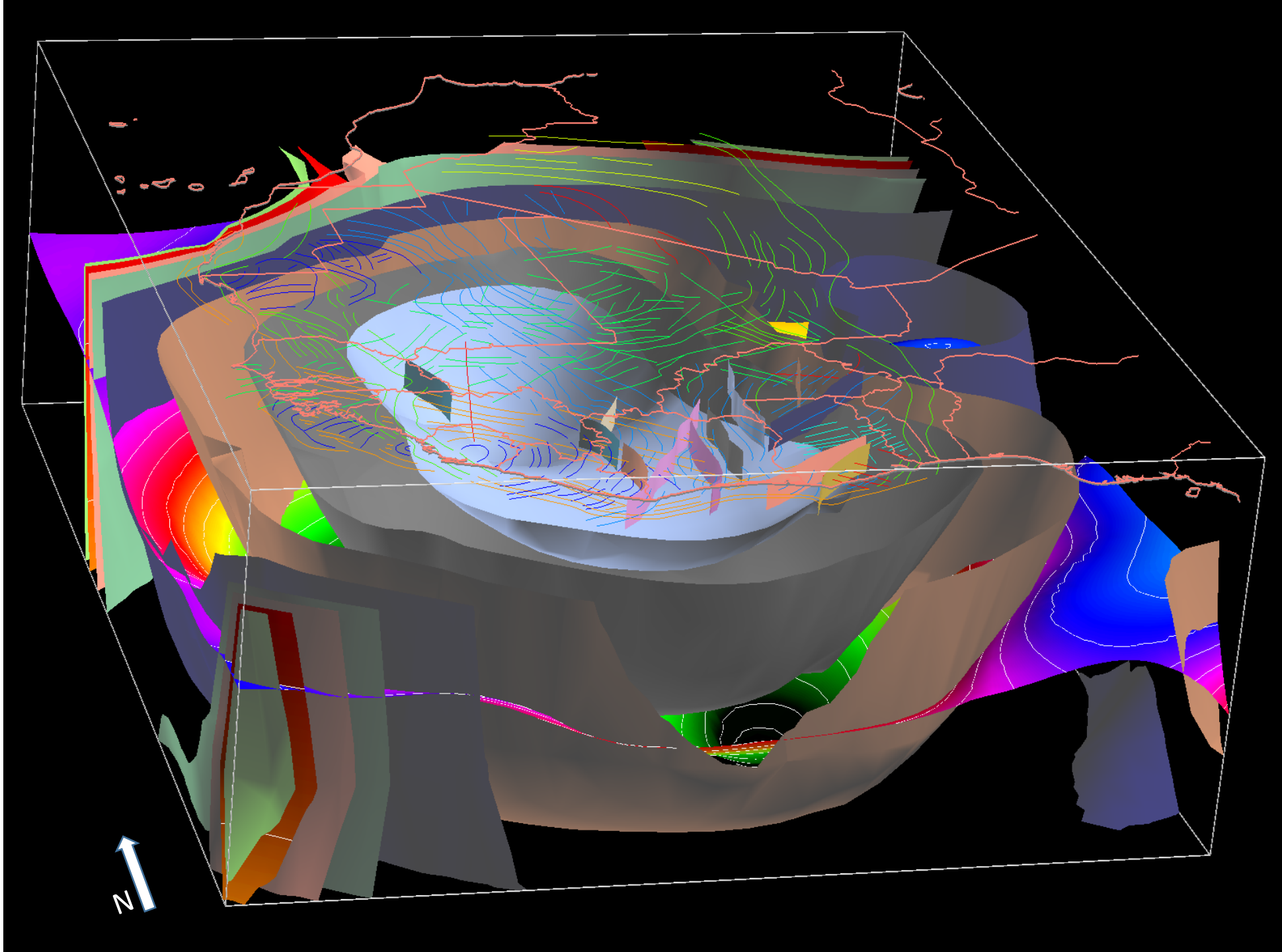


	BVC2	BV1	BVC1
Distance	*0 m*	*x*	*y*



Perrouty et al., OGR, 2014

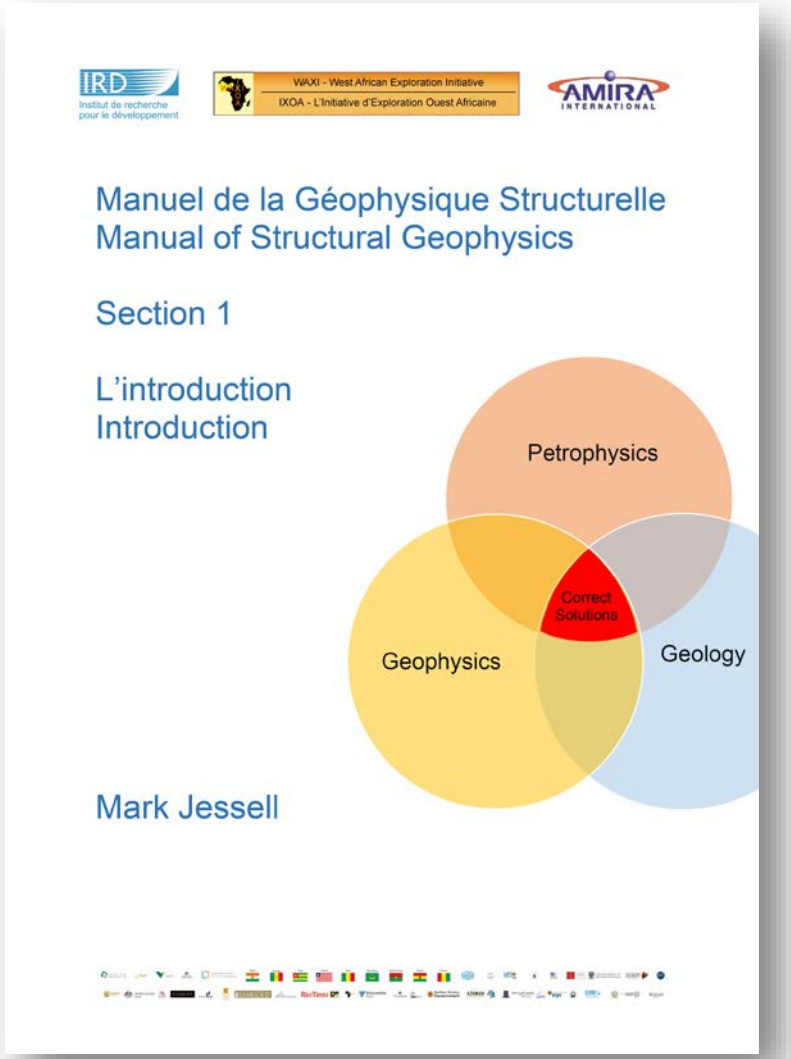
3D Model(s) of Craton

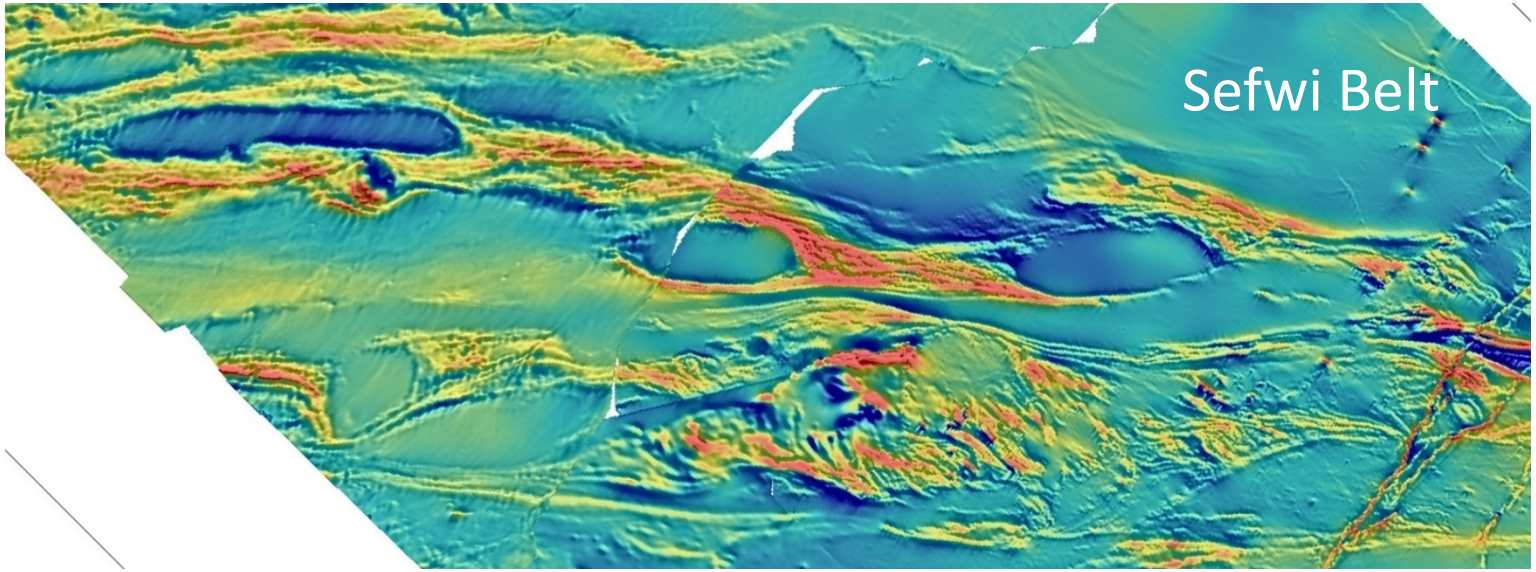


Geophysics Training

Structural geophysics courses

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





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.