IGGC12
Georgetown

What do we know about the positioning of West Africa and the Guiana Shield during the Rhyacian Period?

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CET UWA

SAXI South American Exploration Initiative

THE UNIVERSITY OF WESTERN AUSTRALIA

Centre for EXPLORATION TARGETING

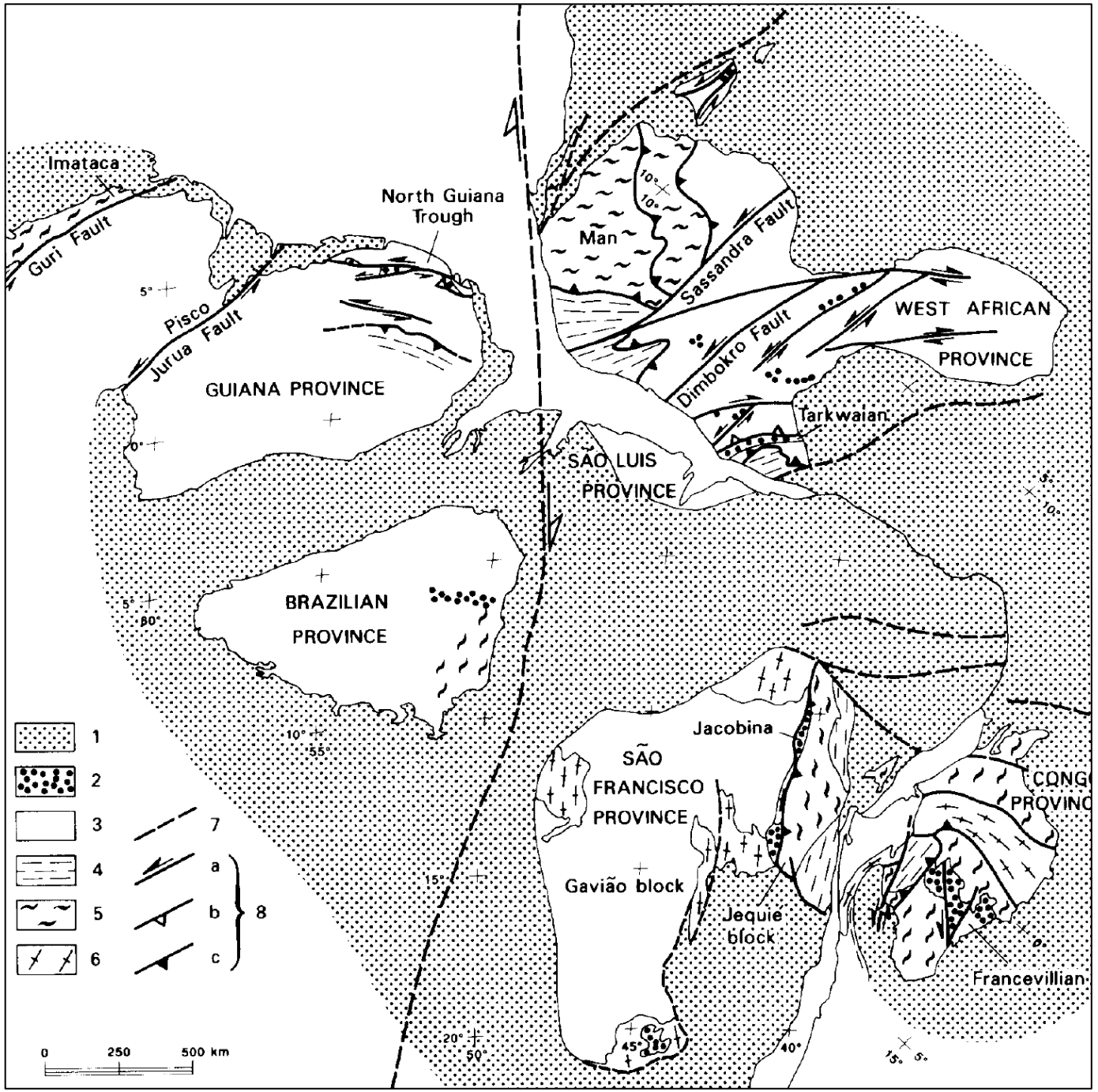
WAXI West African Exploration Initiative

Proposed Reconstructions

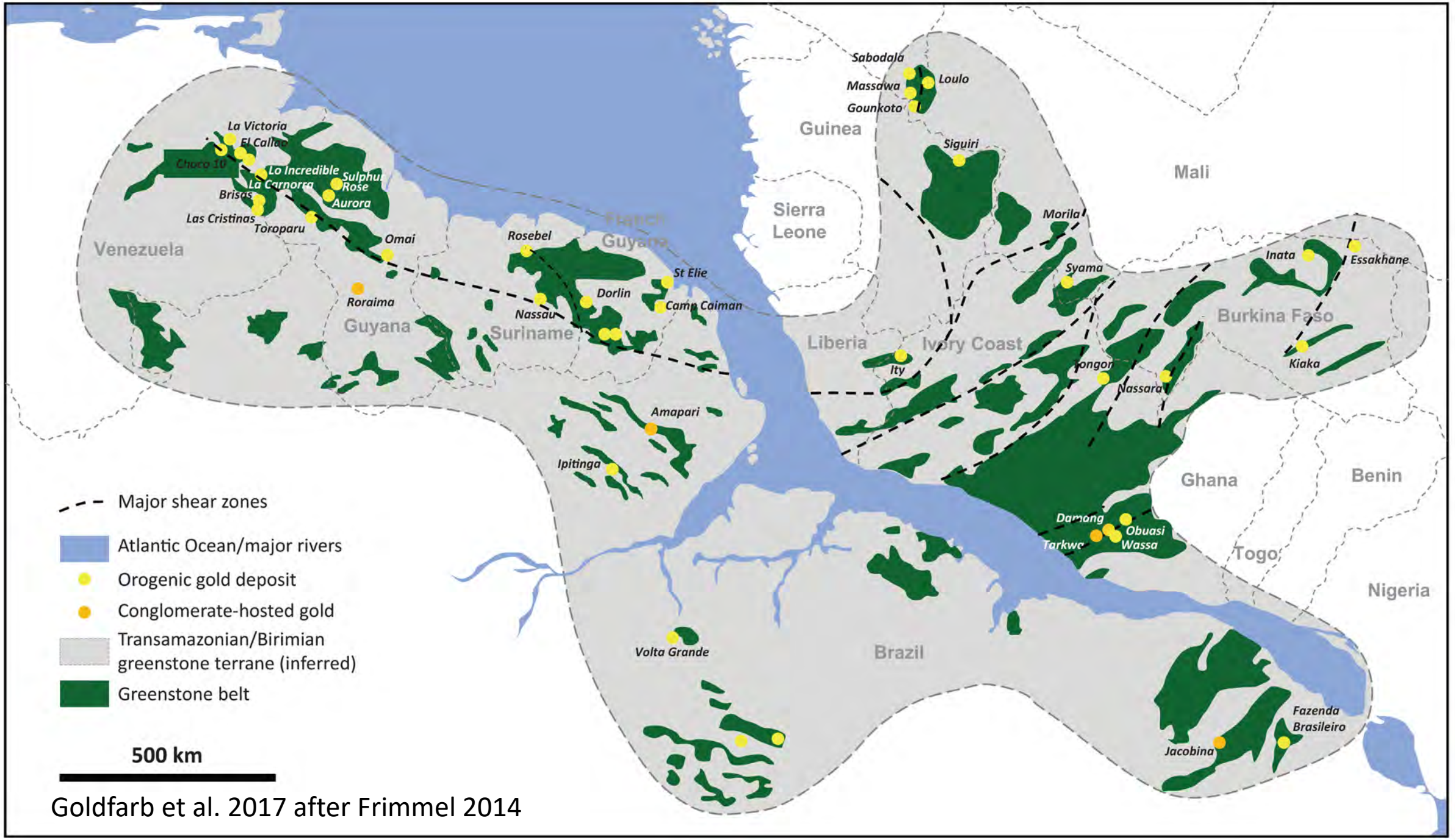
Available Constraints

- Paleomag
- Geochron/Isotopes
- LIPS
- Structure/Metamorphism
- Stratigraphy
- Lithosphere

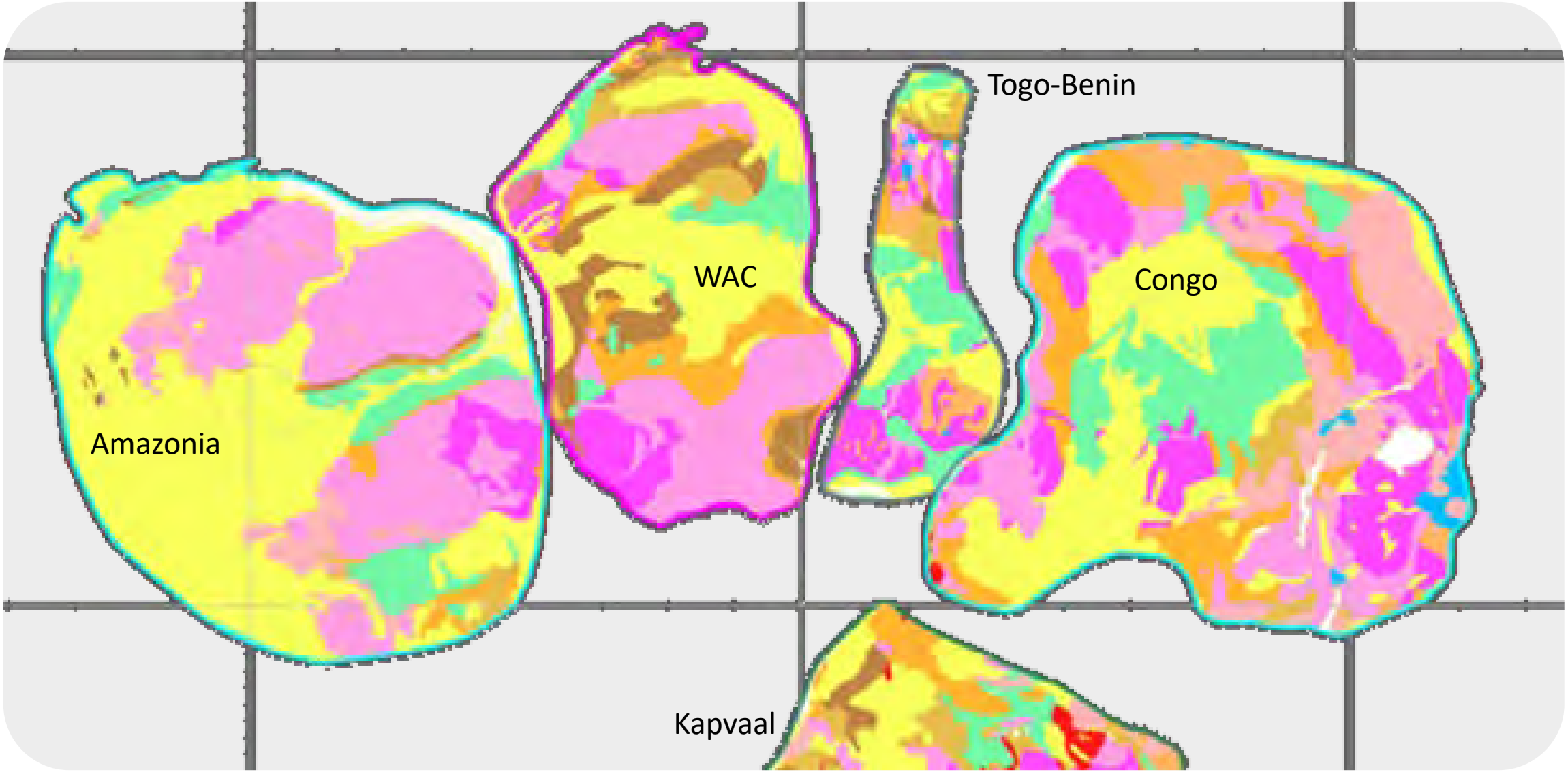
Proposed Reconstructions



Ledru et al., 1994
Vanderhaeghe et al., 1998
Delor et al., 2003



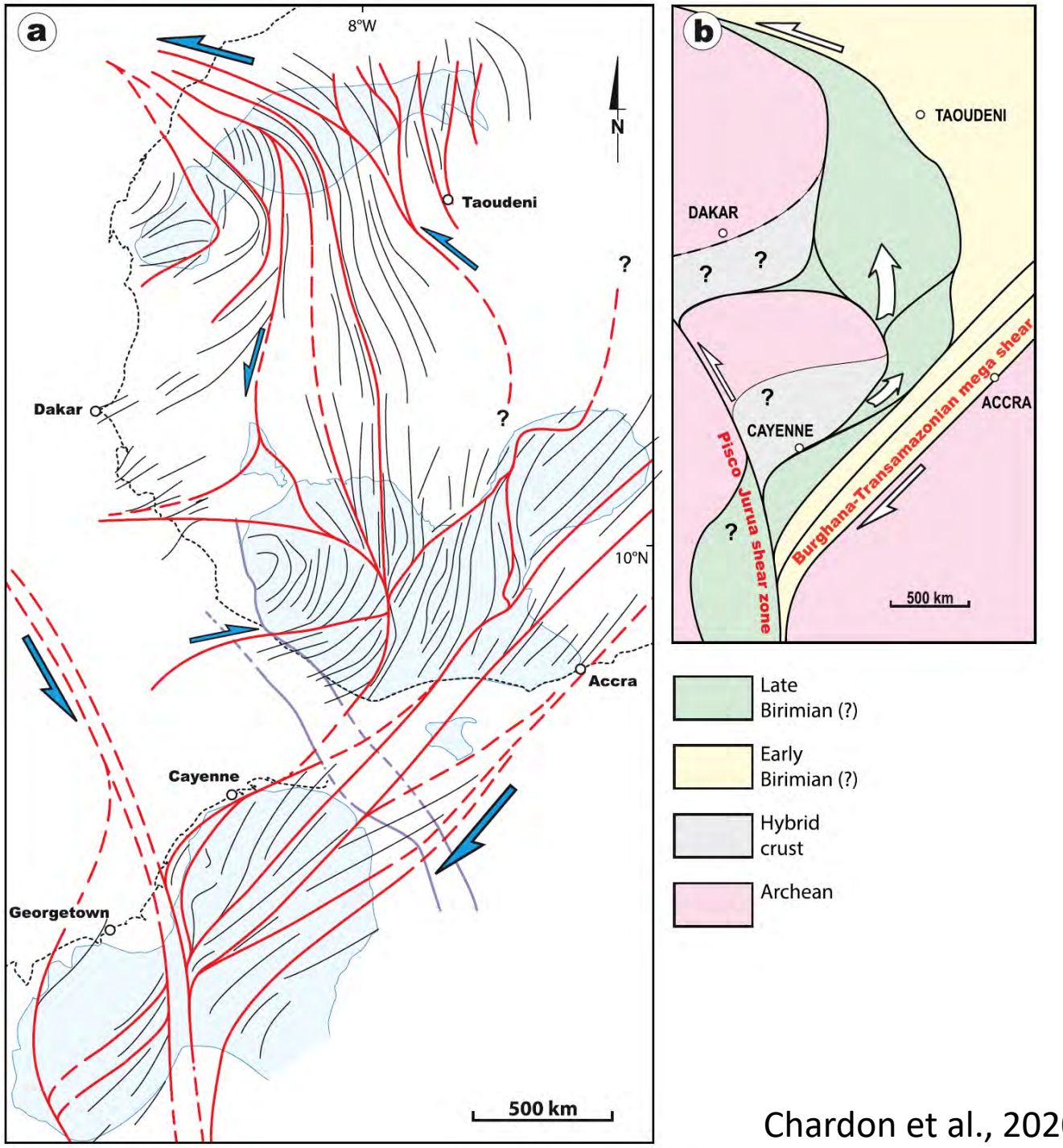
Goldfarb et al. 2017 after Frimmel 2014



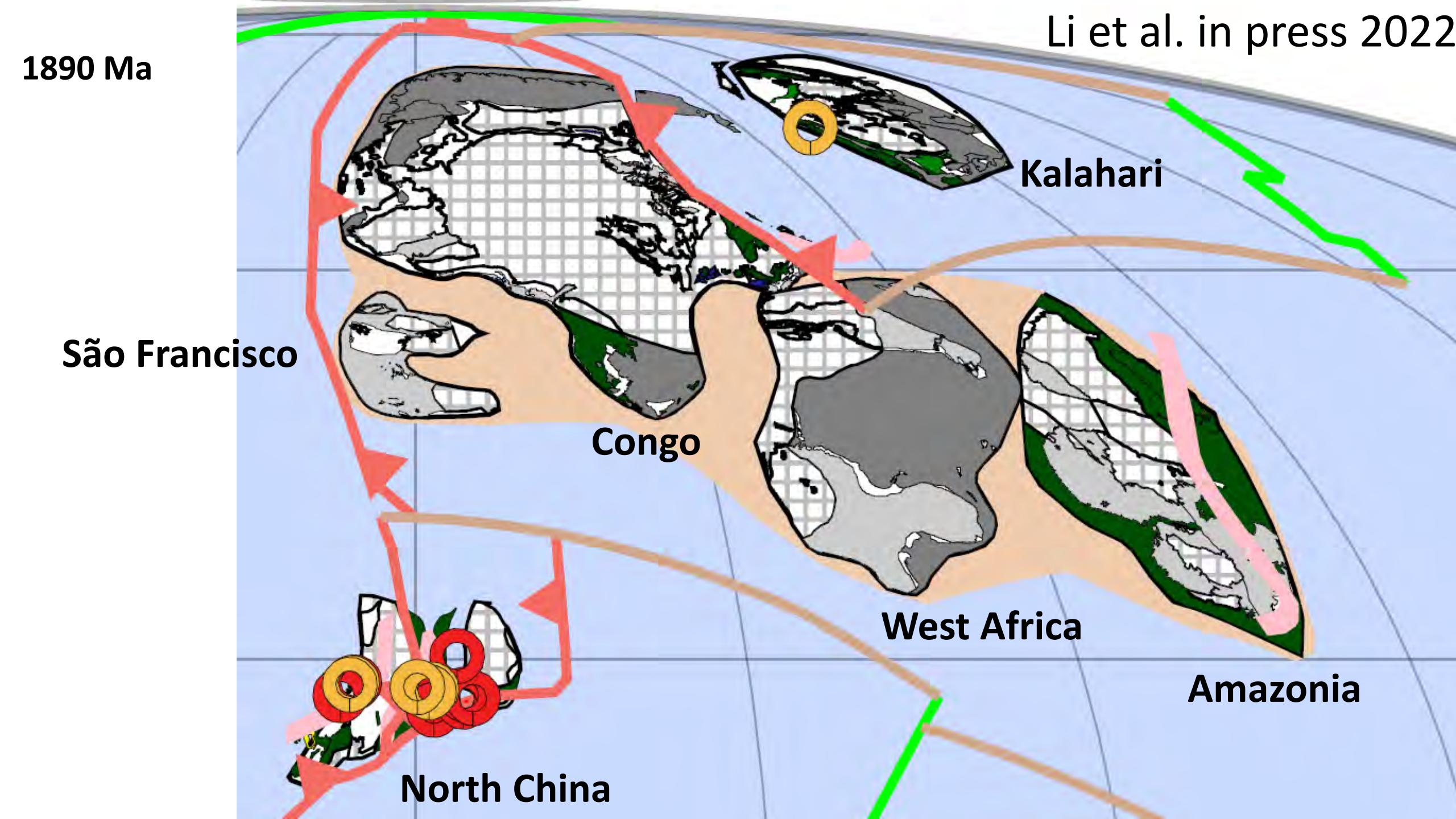
2000 Ma

Davis 2013, Unpublished Hons. Thesis
Pehrsson et al. 2015

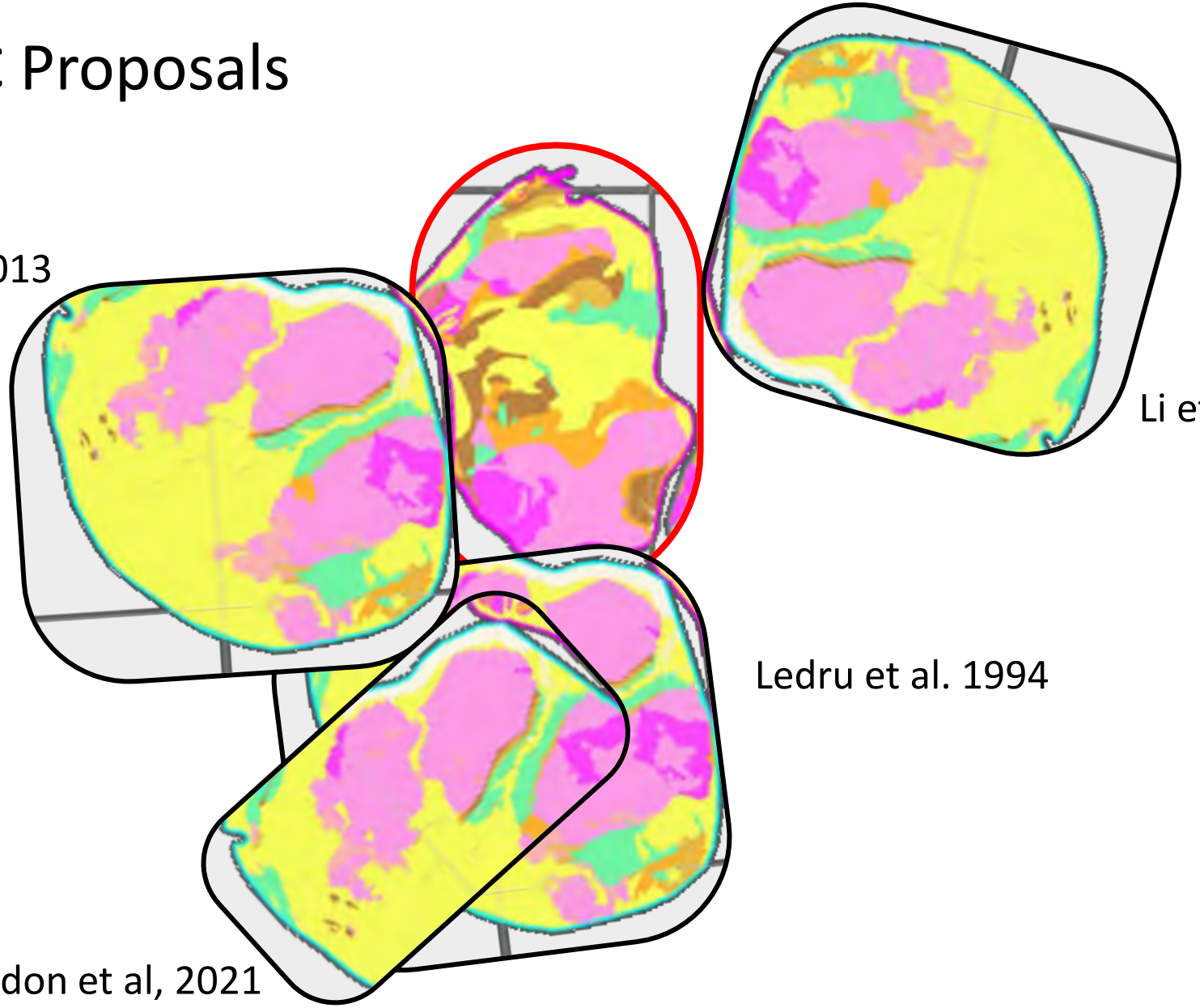
Relative orientation based on structural pattern of the Eburnean-Transamazonian orogen.



Chardon et al., 2020


1890 Ma
Li et al. in press 2022
São Francisco
Kalahari
Congo
West Africa
Amazonia
North China

AM/WAC Proposals



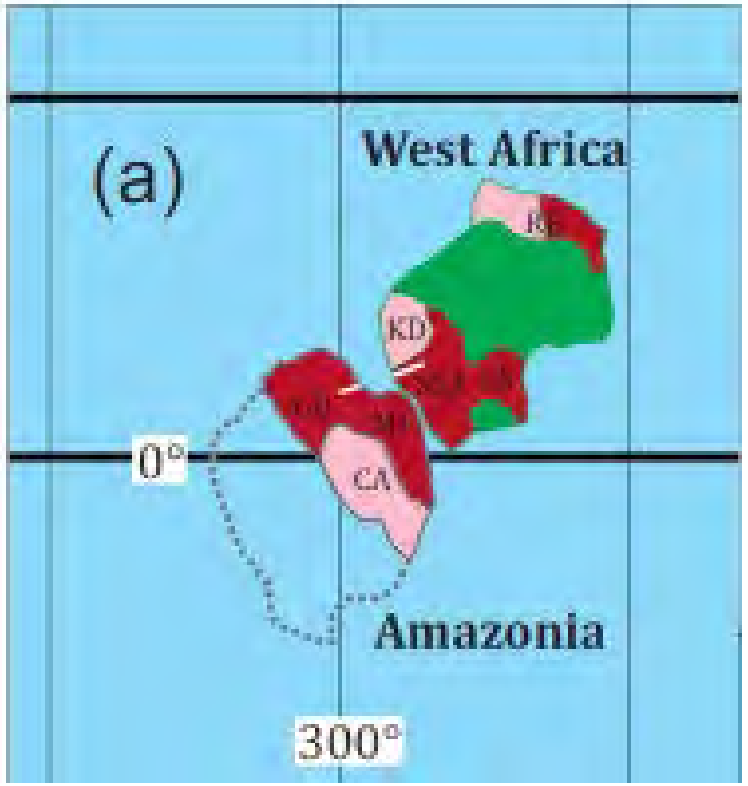
Davis 2013

Li et al, 2022 in press

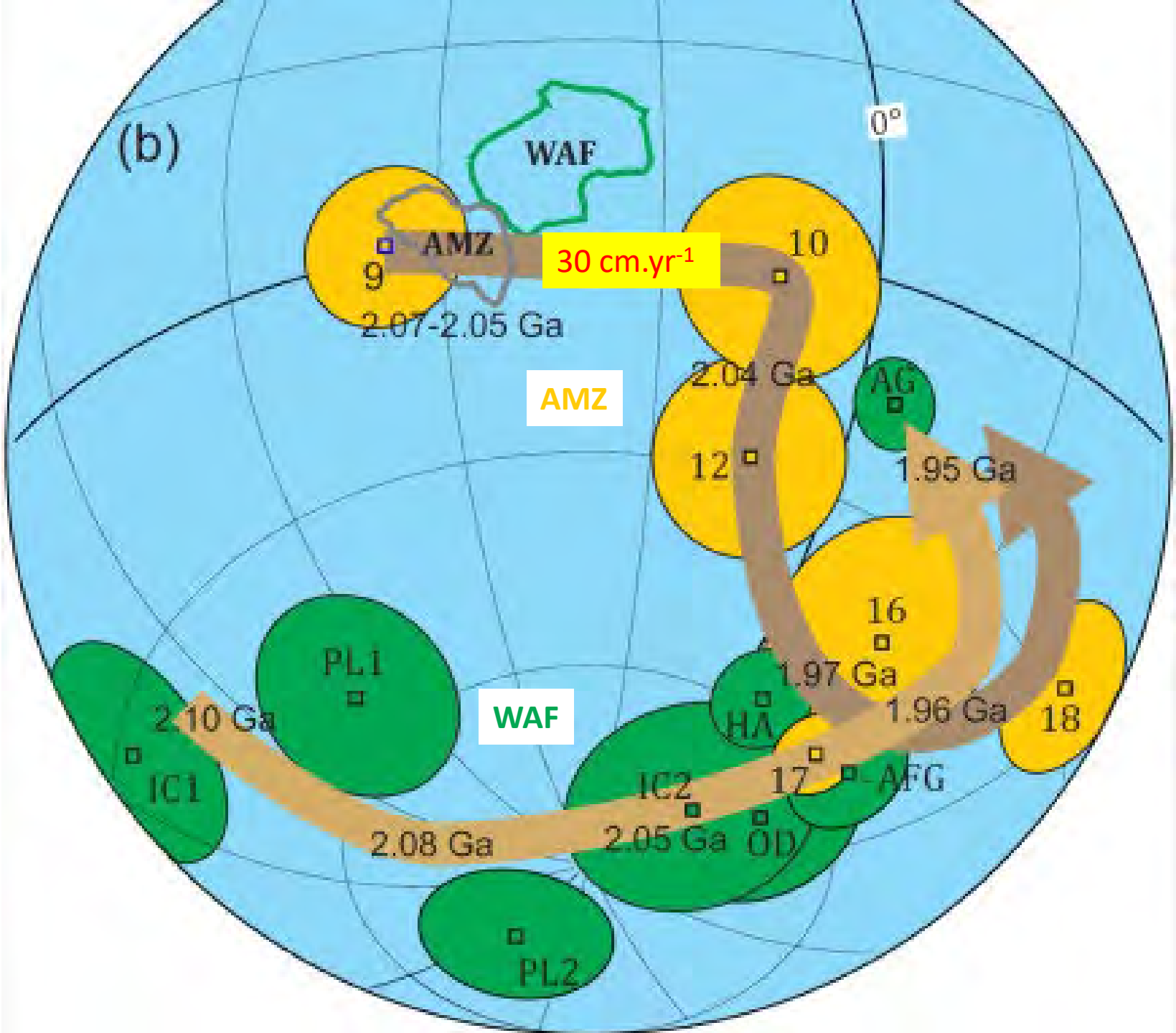
Ledru et al. 1994

Chardon et al, 2021

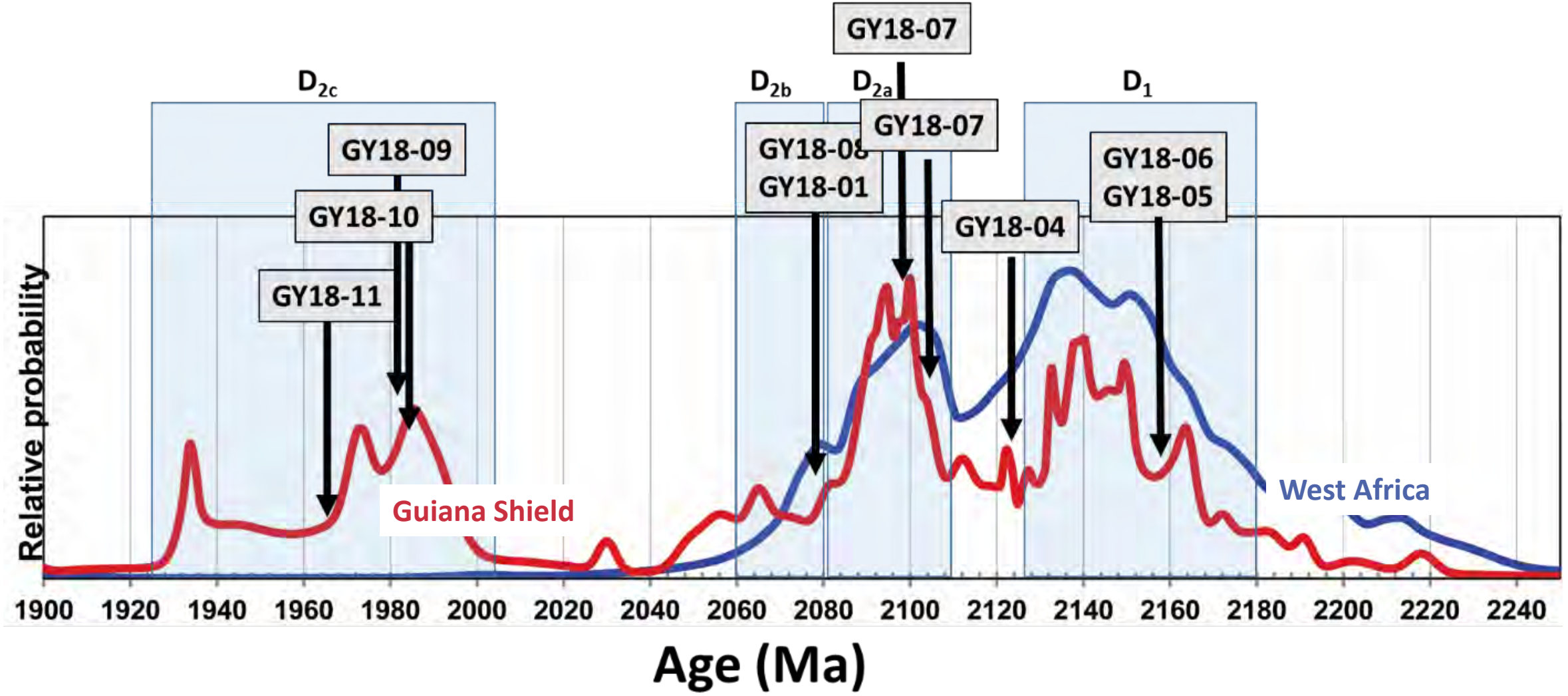
Paleomagnetism



D'Agrella-Filho et al., 2021

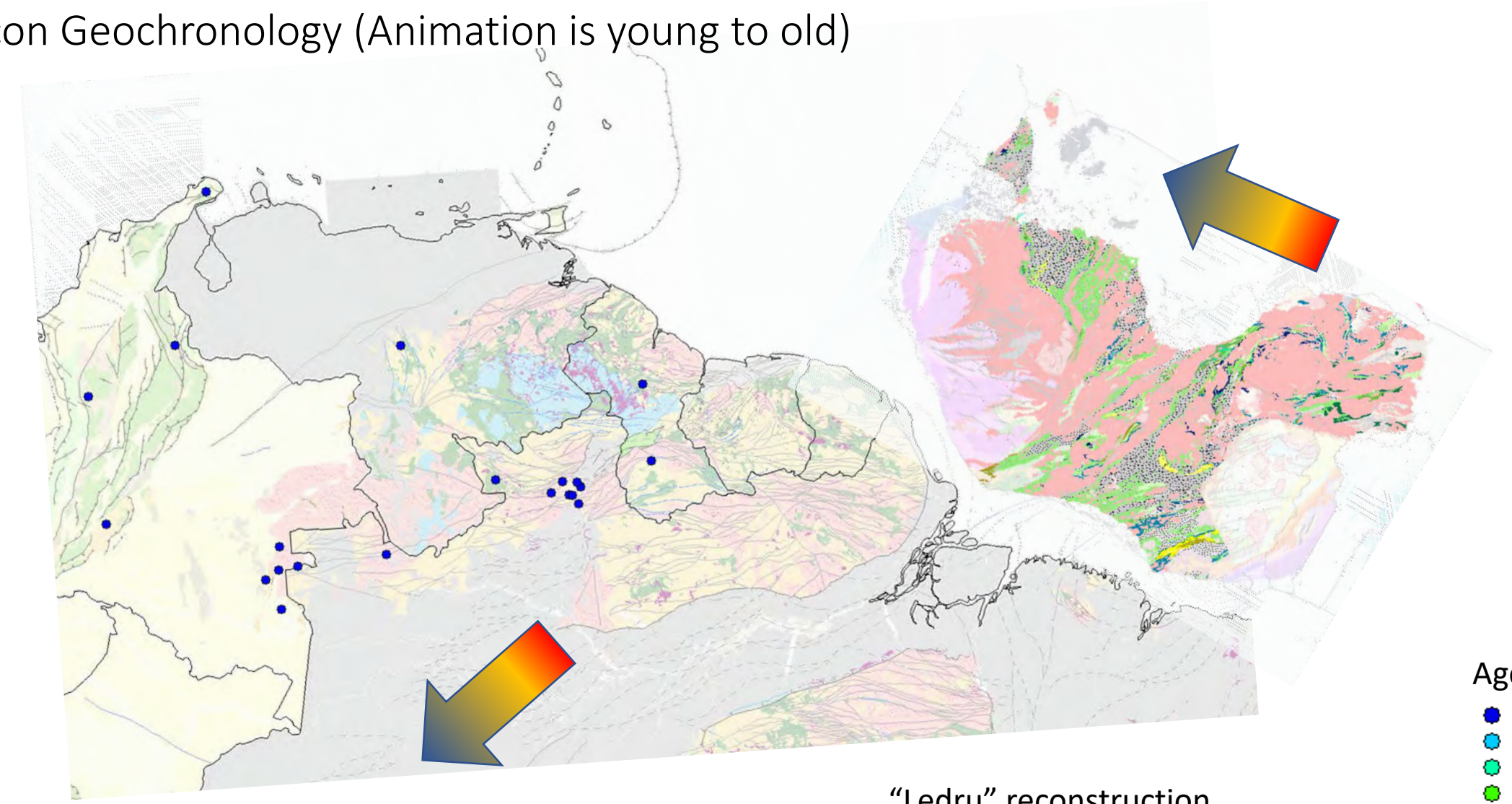


Geochronology/Isotopes



Probability diagram of a compilation of U-Pb zircon geochronology from the Guiana Shield (Tedeschi et al., 2020) with the interpreted orogenic stages (Delor et al., 2003) and results of this study.

Zircon Geochronology (Animation is young to old)

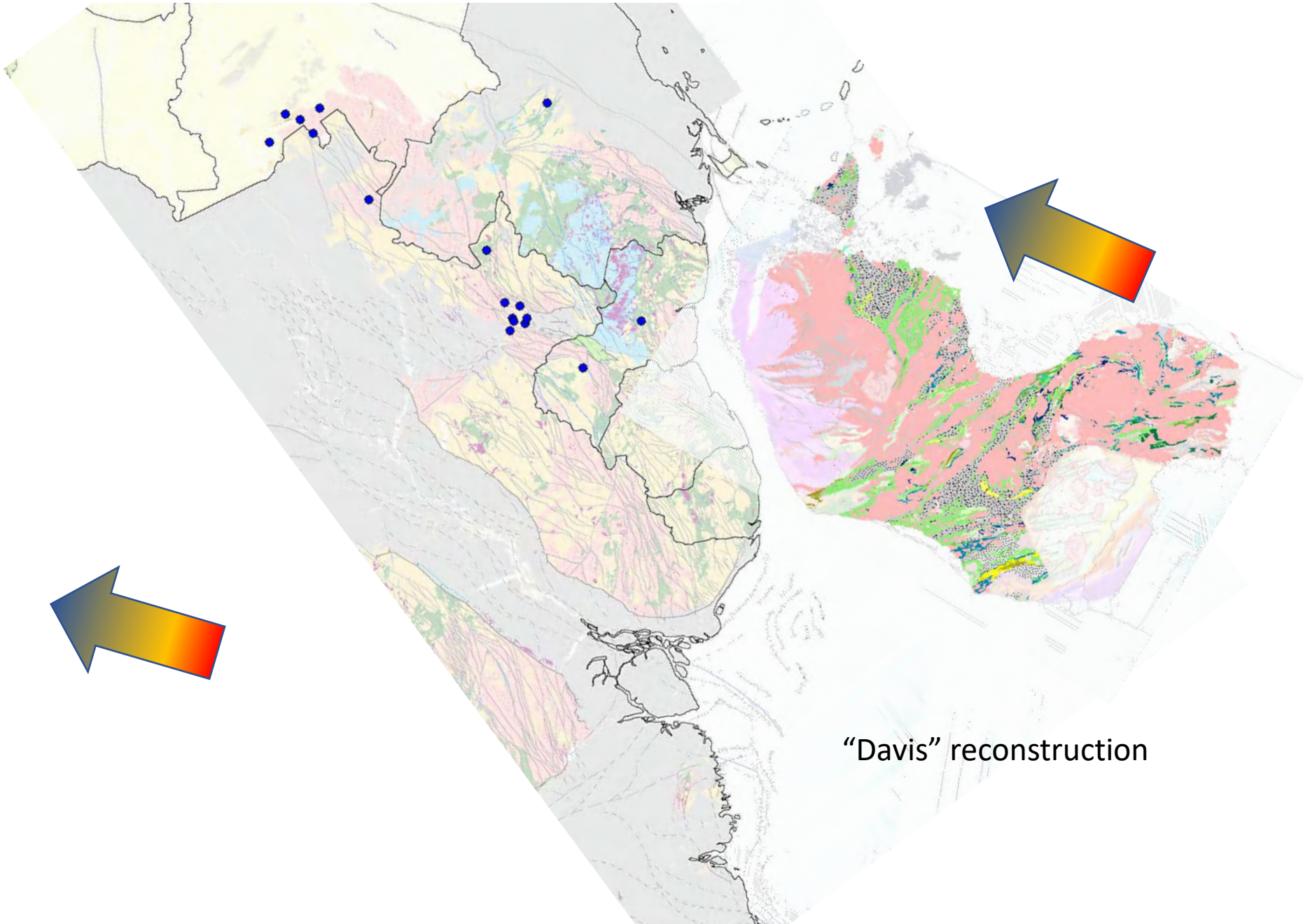


"Ledru" reconstruction

Age (Ma)

- 1508 - 1574
- 1574 - 1660
- 1660 - 1757
- 1757 - 1841
- 1841 - 1911
- 1911 - 1965
- 1965 - 2020
- 2020 - 2081
- 2081 - 2133
- 2133 - 2191

Zircon Geochronology (Animation is young to old)

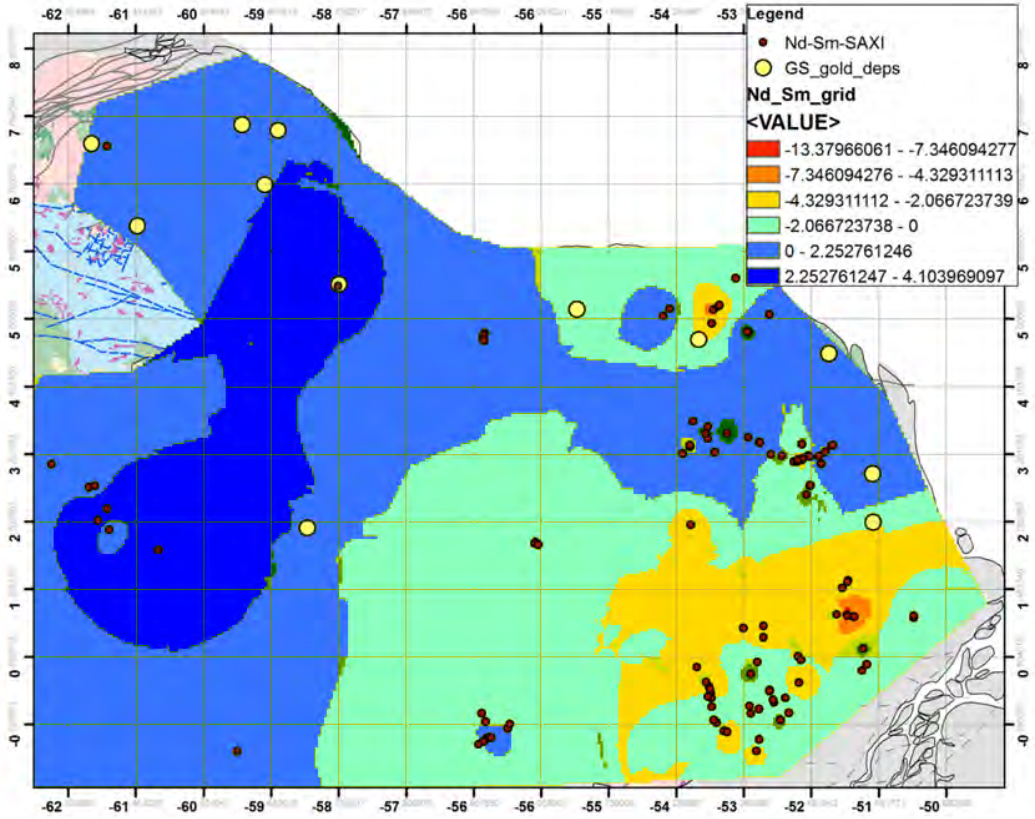


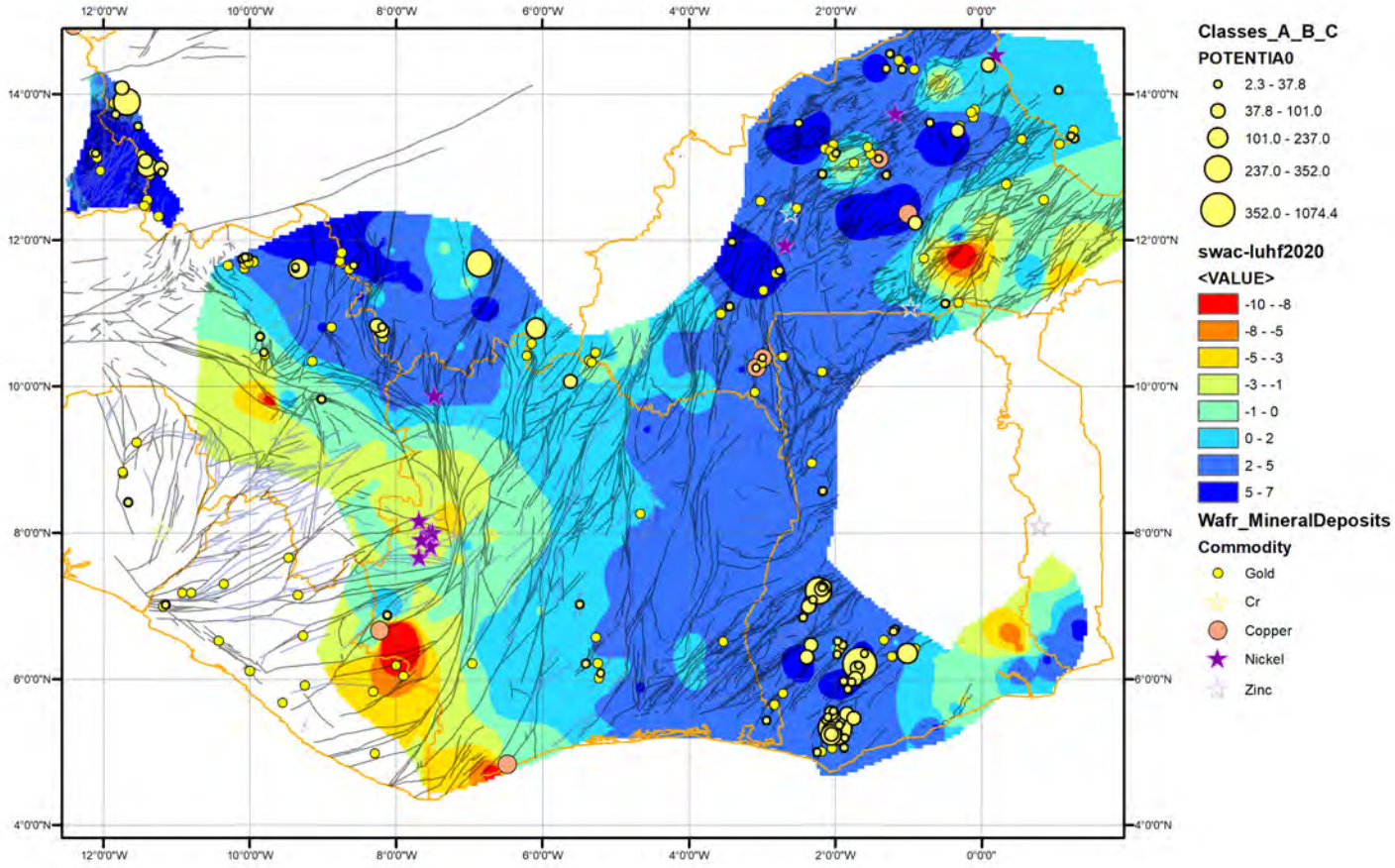
“Davis” reconstruction

Age (Ma)

- 1508 - 1574
- 1574 - 1660
- 1660 - 1757
- 1757 - 1841
- 1841 - 1911
- 1911 - 1965
- 1965 - 2020
- 2020 - 2081
- 2081 - 2133
- 2133 - 2191

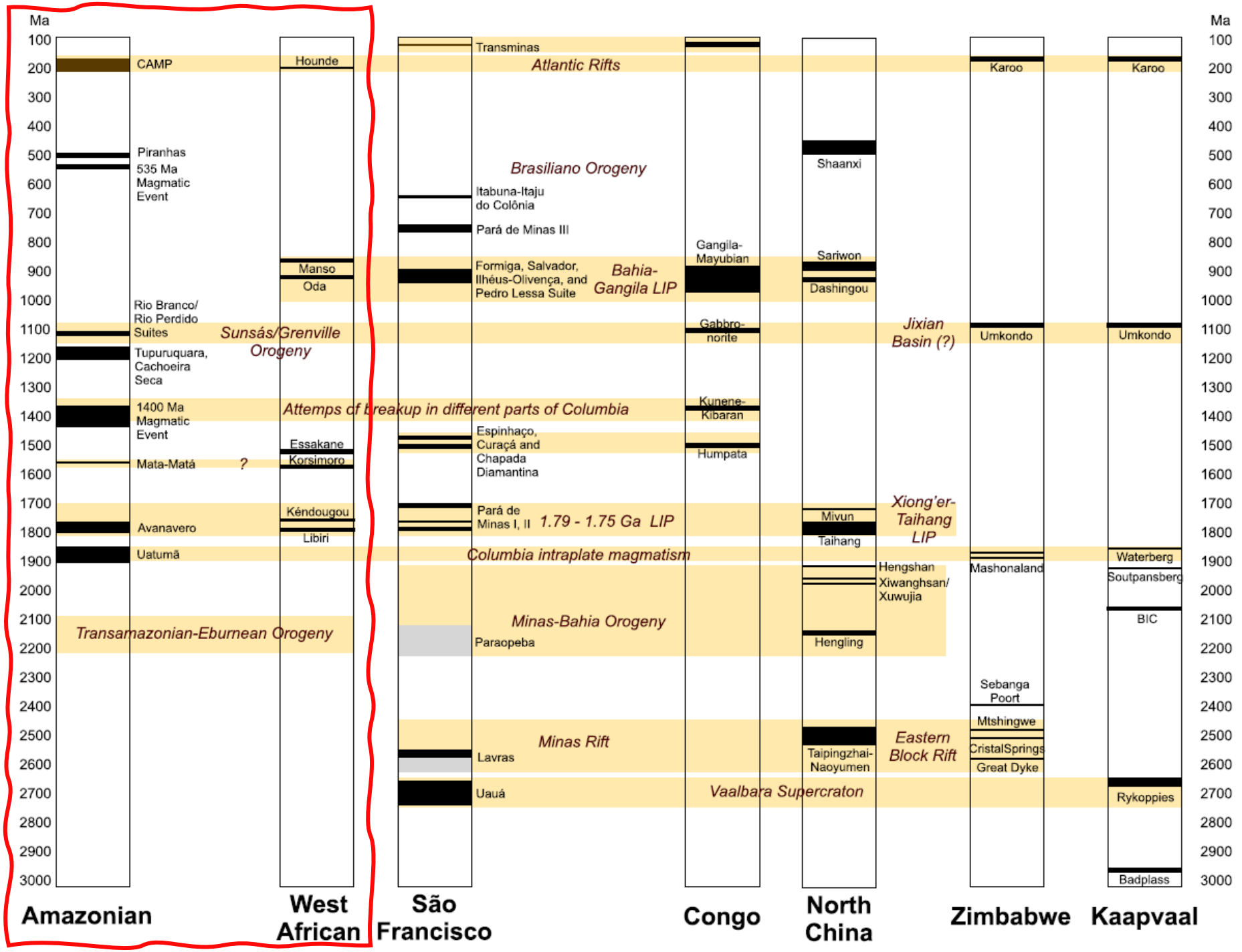
NdSm Thebaud unpublished SAXI 1 final report





LuHf Thebaud unpublished WAXI 3 final report

Large Igneous Province Data

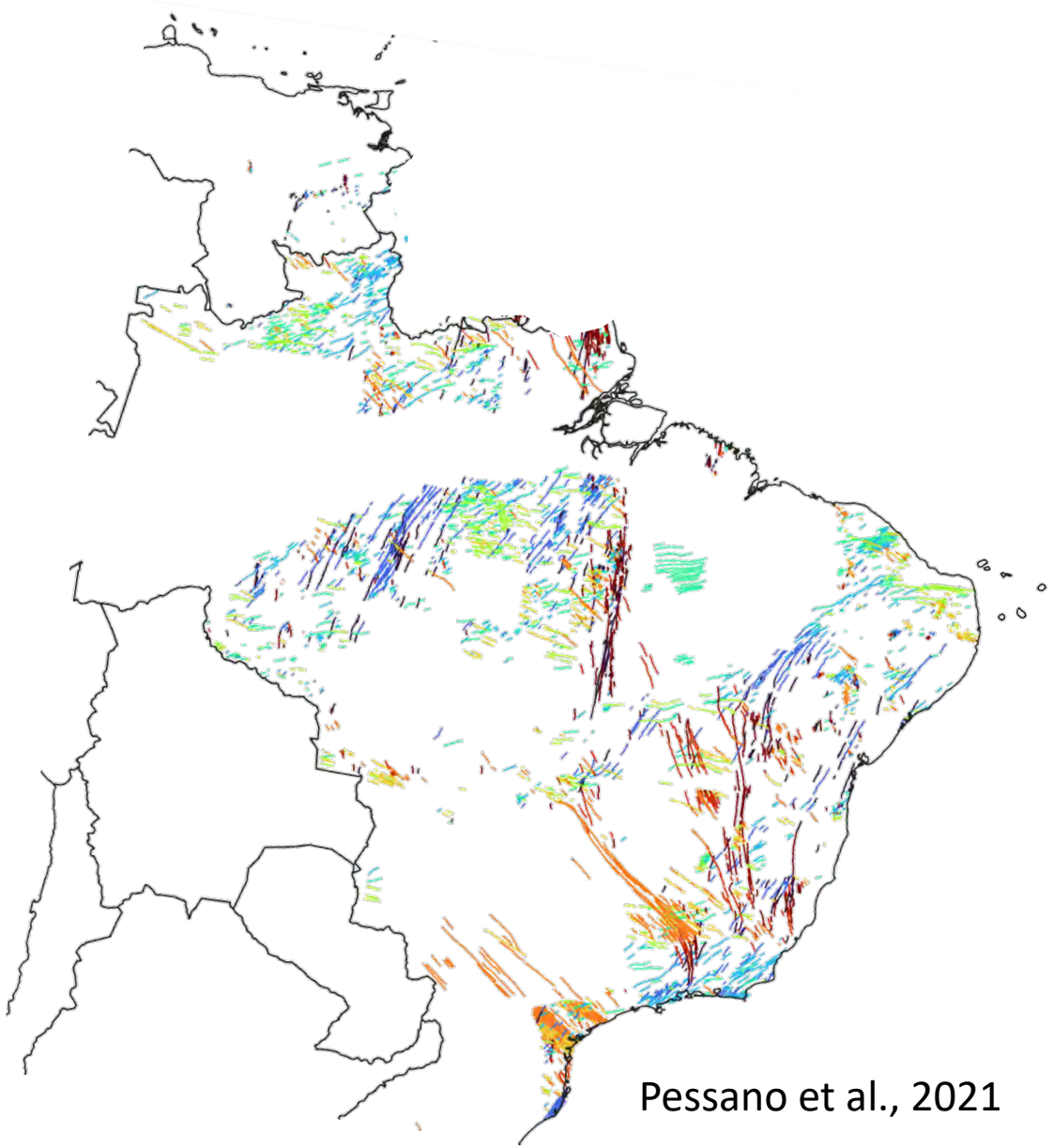


Jessell et al., 2015

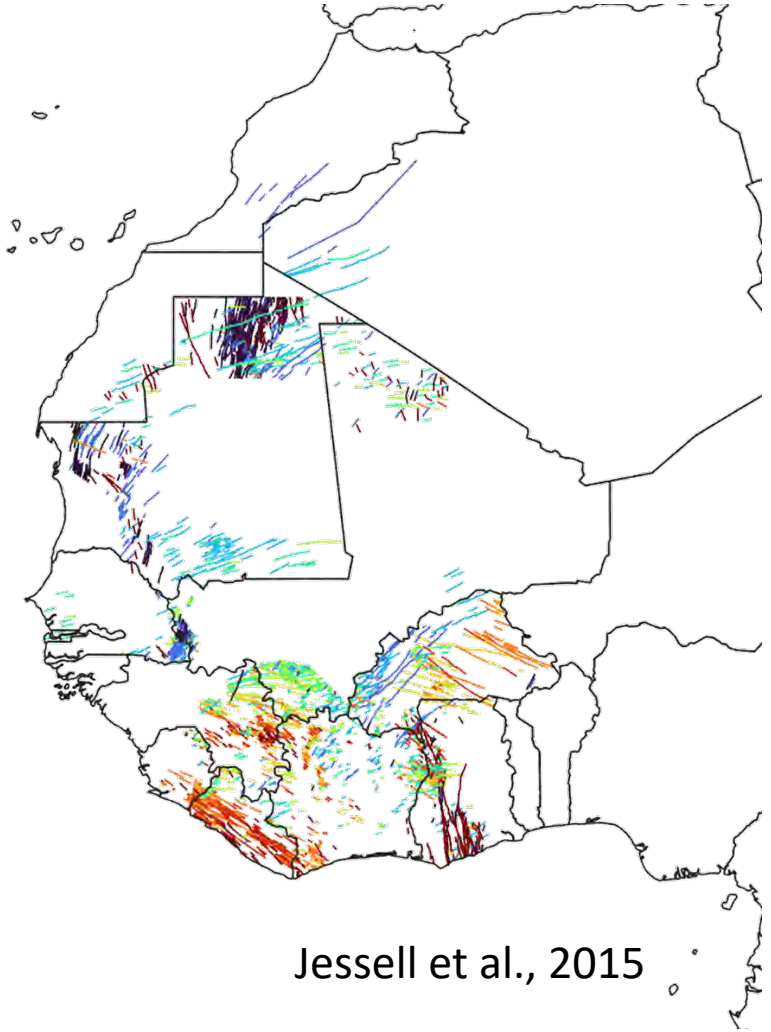
Baratoux et al., 2019

Pessano et al., 2021

Mafic dyke coloured by orientations

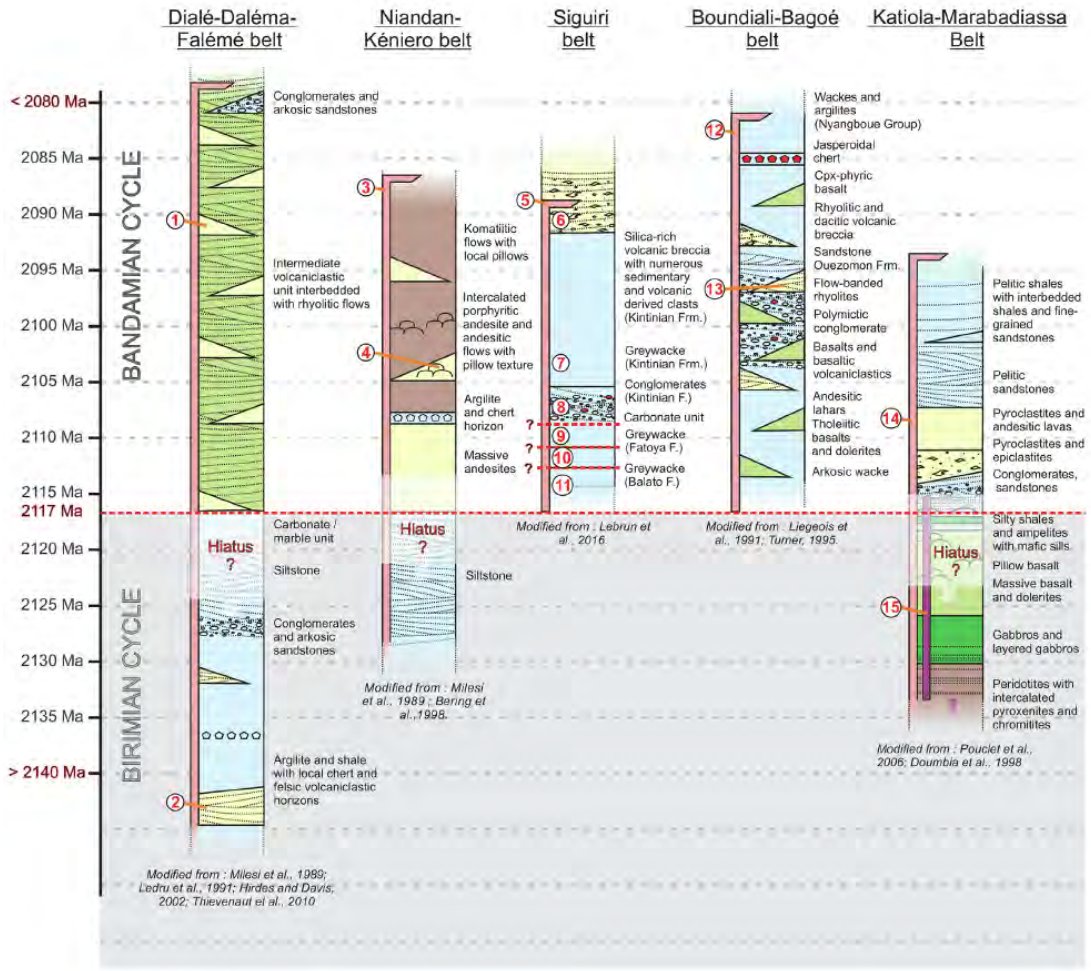


Pessano et al., 2021

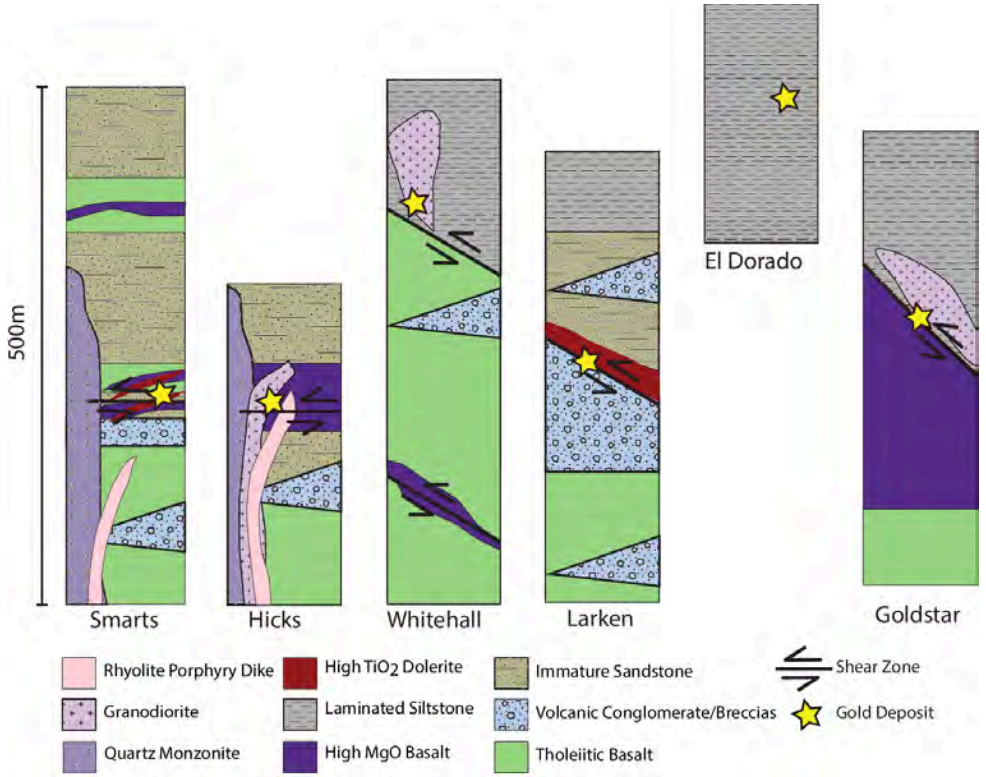


Jessell et al., 2015

Stratigraphy

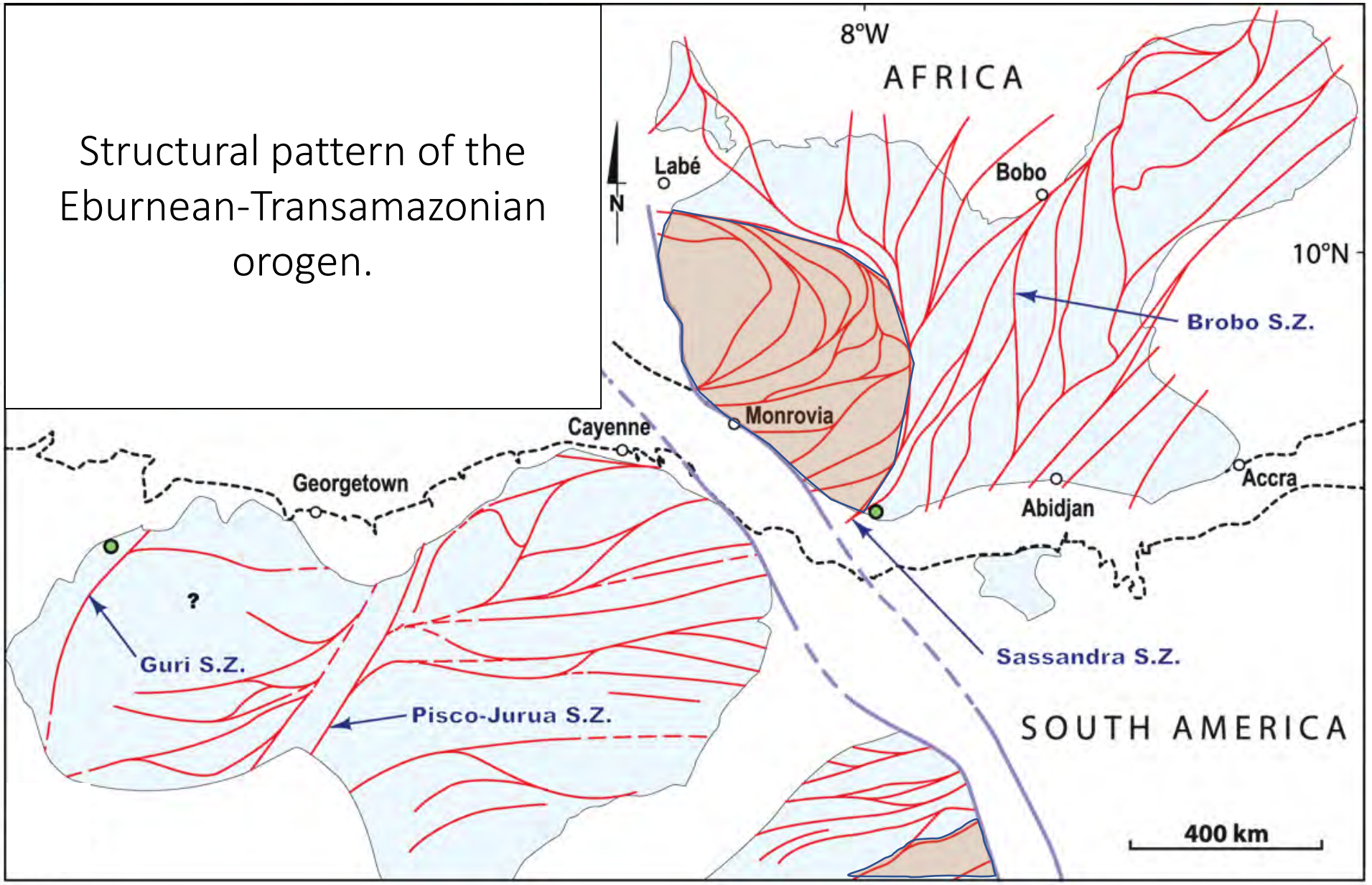


Stratigraphic Synthesis of western Cote d'Ivoire
Meriaud et al. 2020



Stratigraphic columns from across the Karouni camp showing the location and position of gold deposits within each prospect
Tedeschi 2018

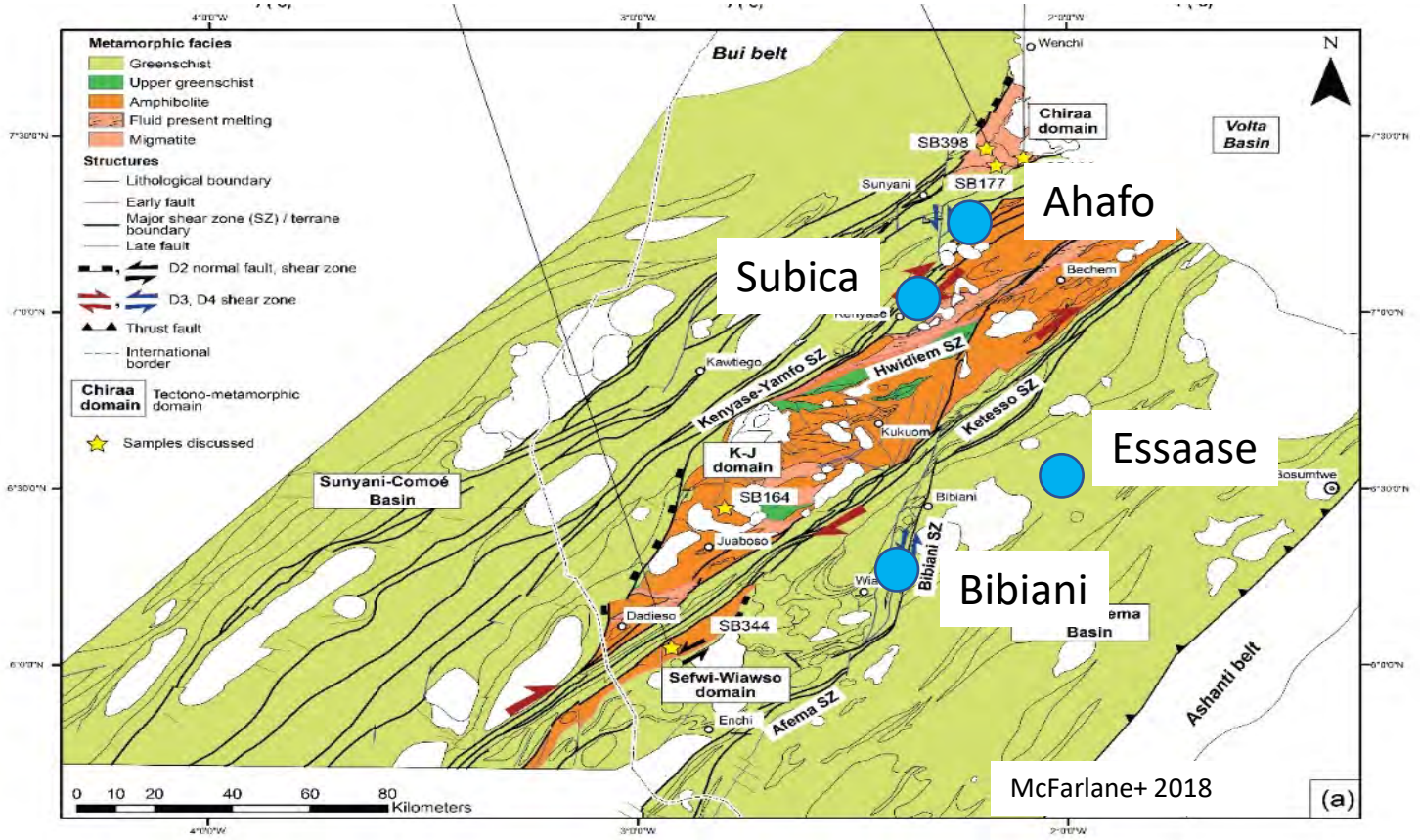
Structure/Metamorphism



after Chardon et al., 2020

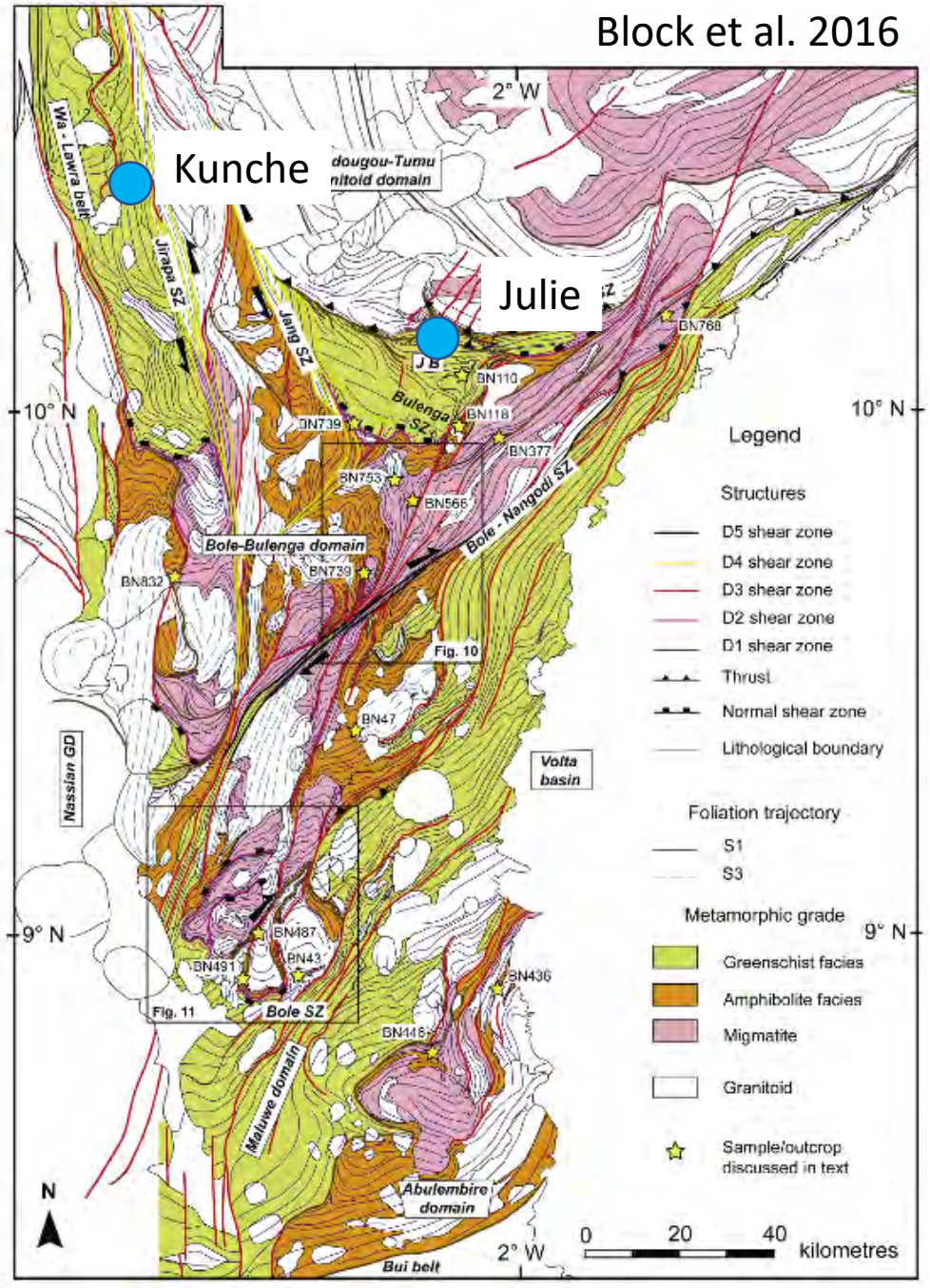
West Africa: Metamorphic Mapping: major extensional episodes and breaks in metamorphic grade

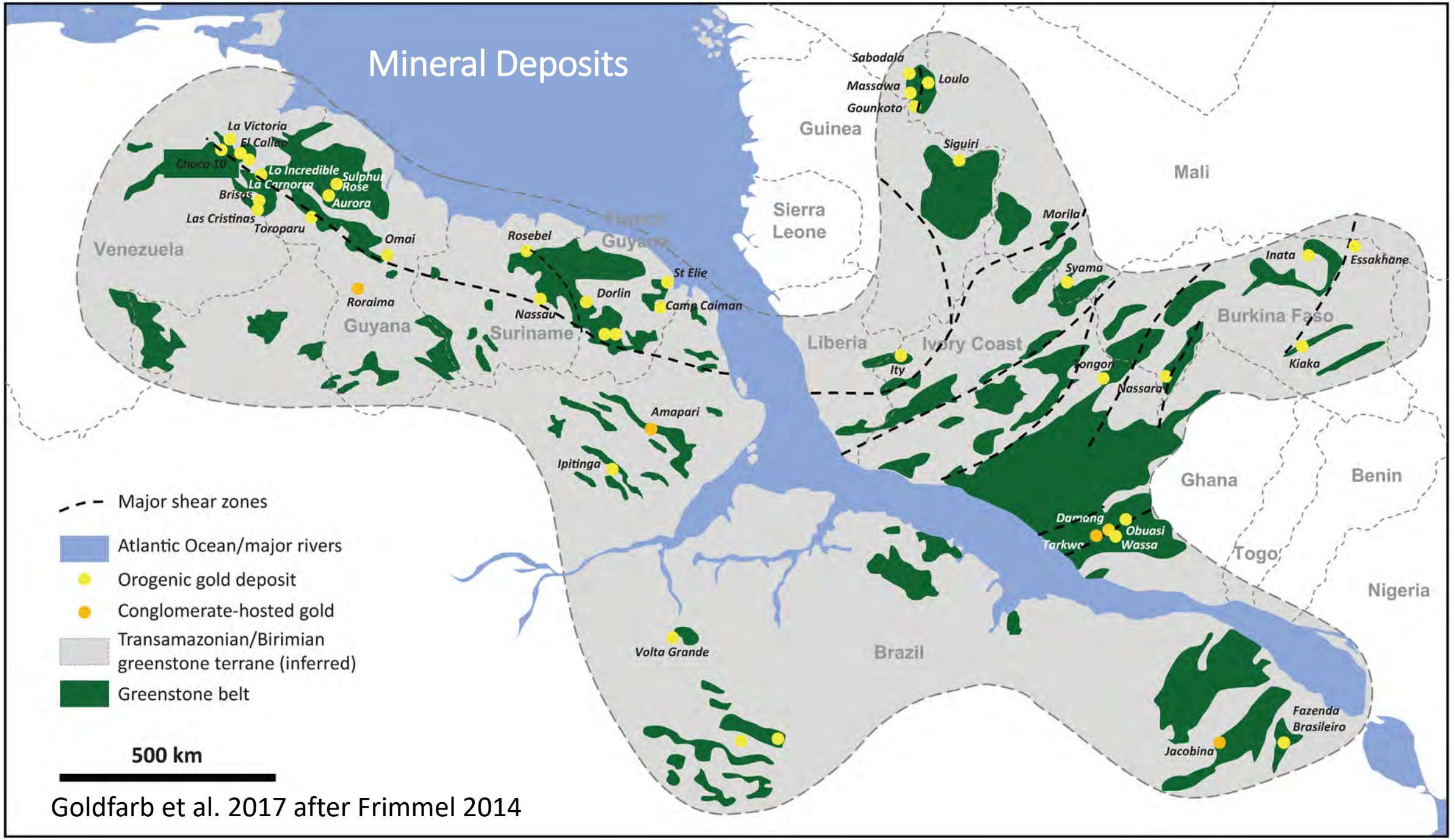
McFarlane et al. 2019



McFarlane+ 2018

Block et al. 2016

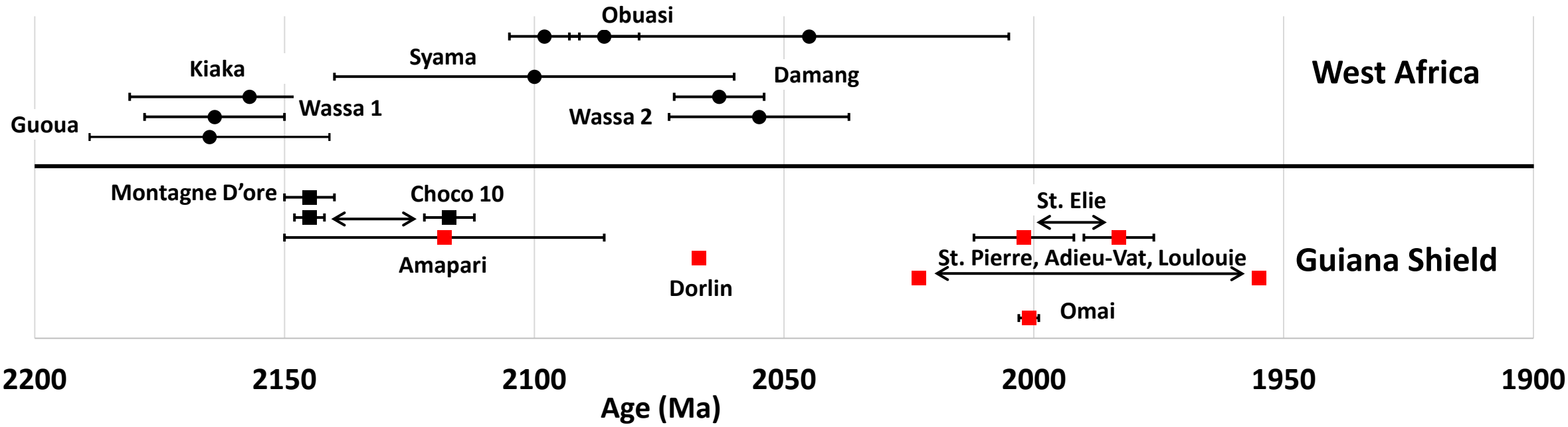




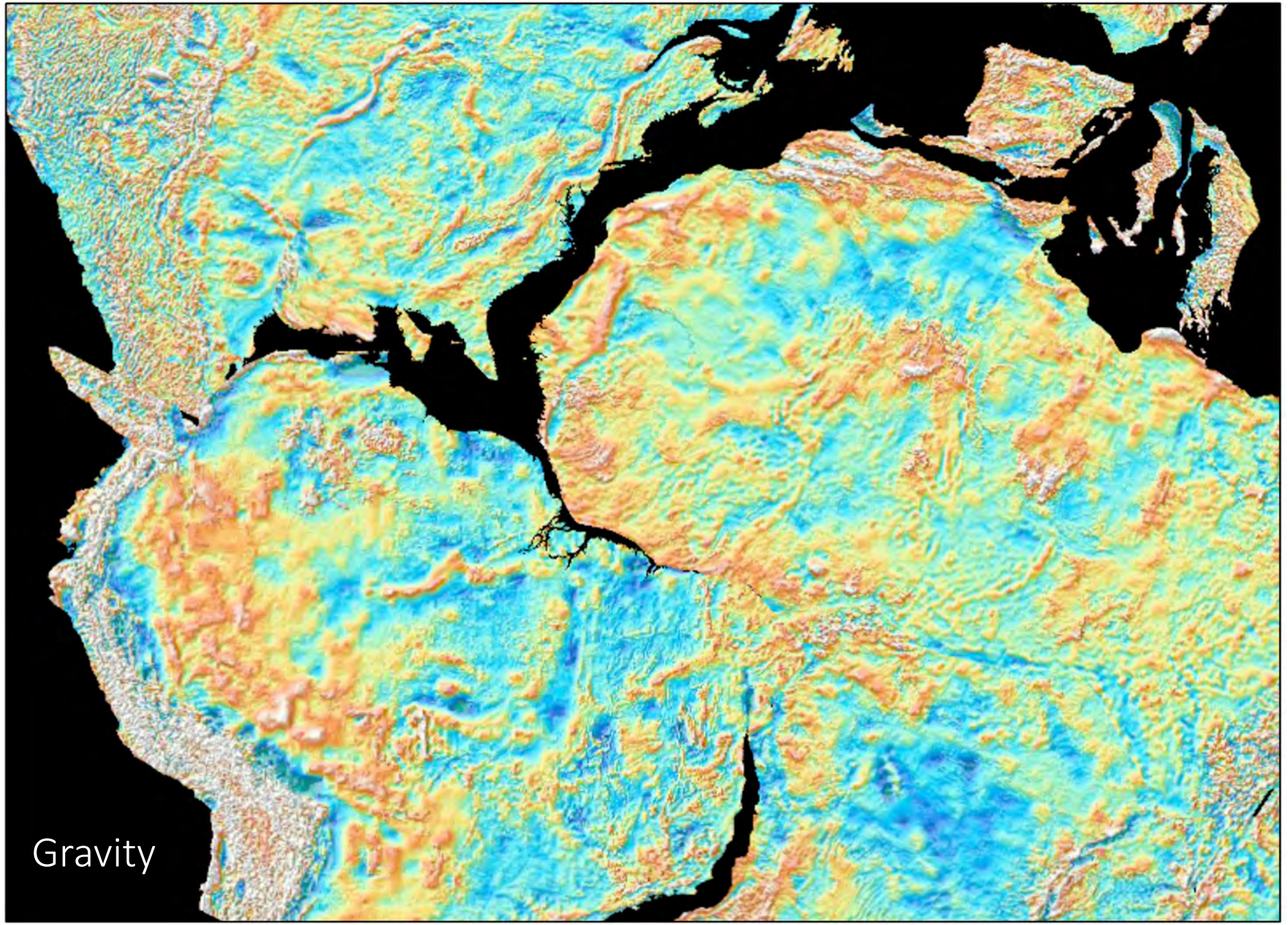
Goldfarb et al. 2017 after Frimmel 2014

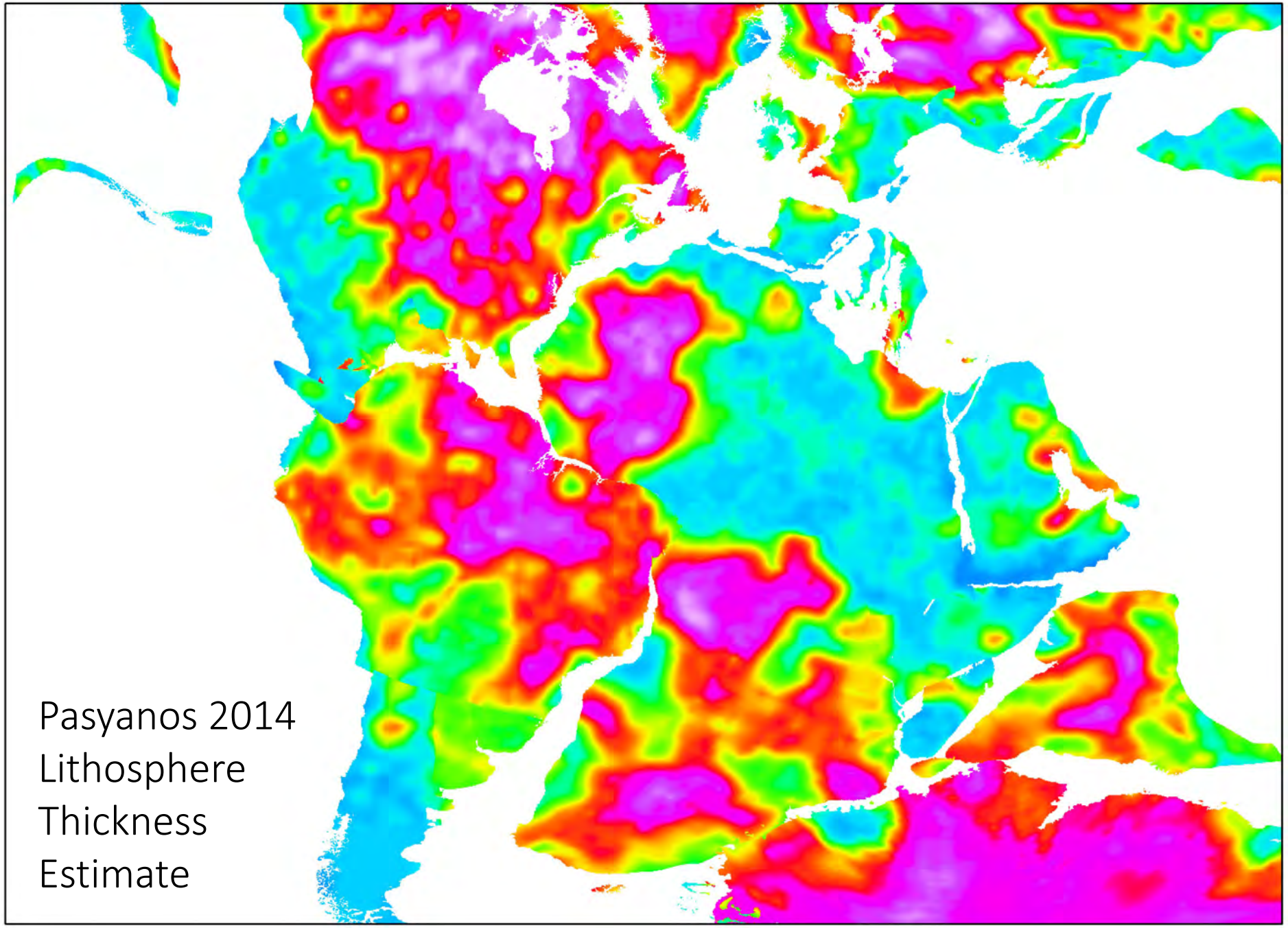
Timing of Gold Mineralization

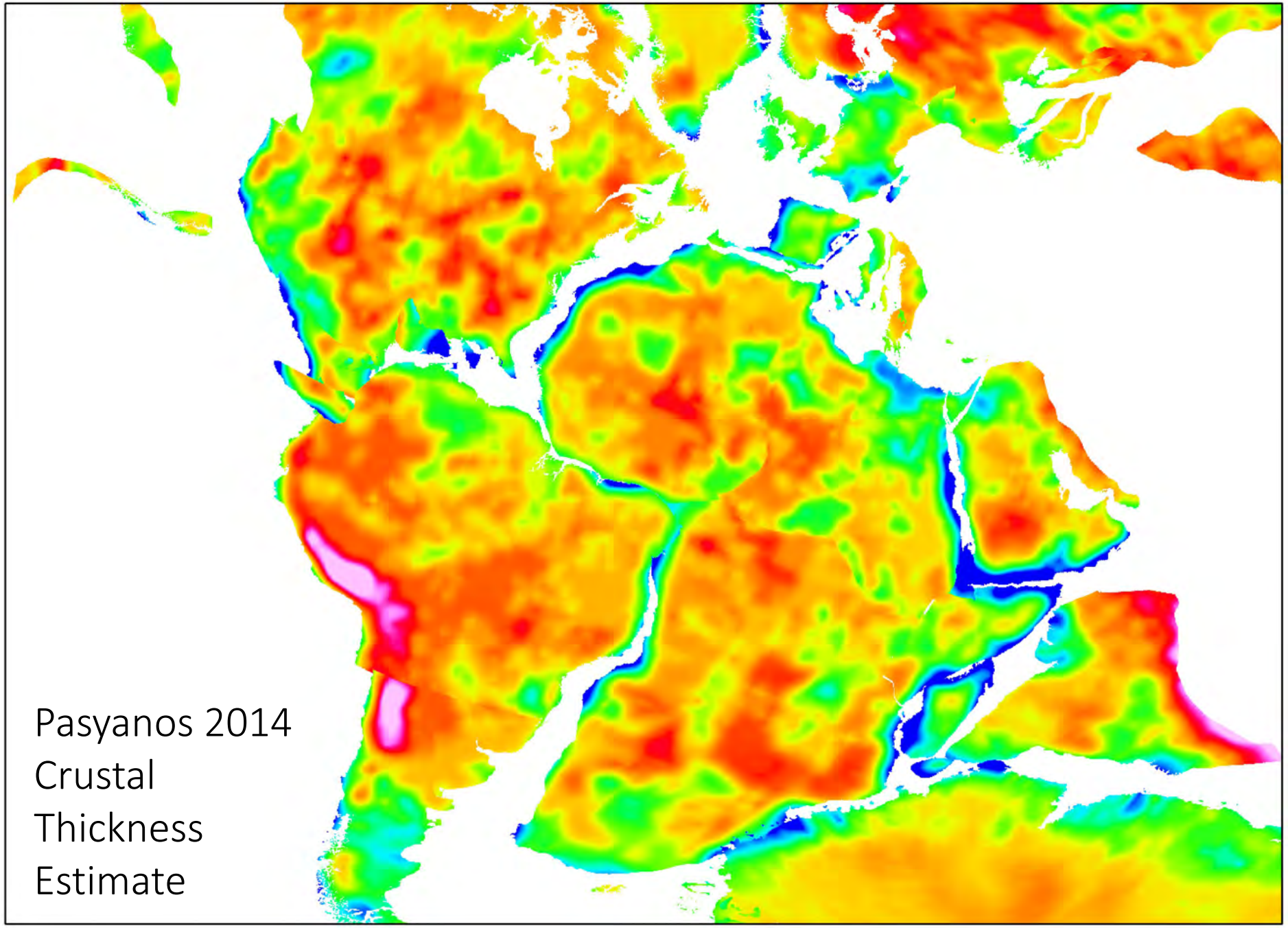
- Younger ages in Guiana Shield
- Few dated deposits, fewer precise ages
- Dating methods (Pb-Pb model ages, Ar-Ar), lack of petrographic relationships to Au
- Late thermal overprint (2.0-1.90 Ga)



Lithospheric Architecture

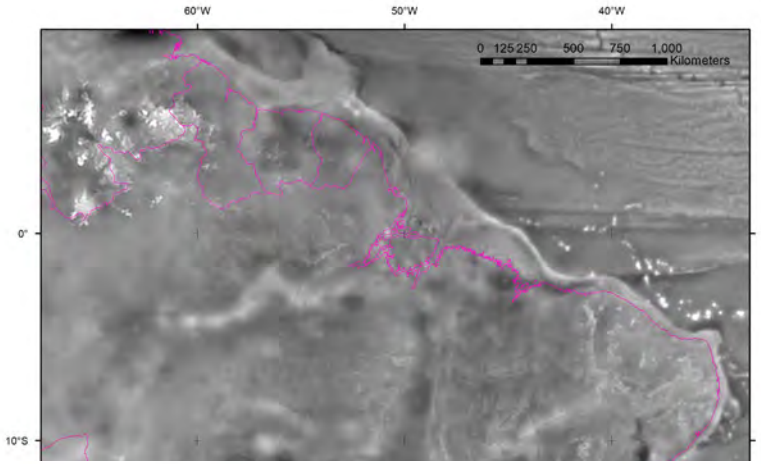


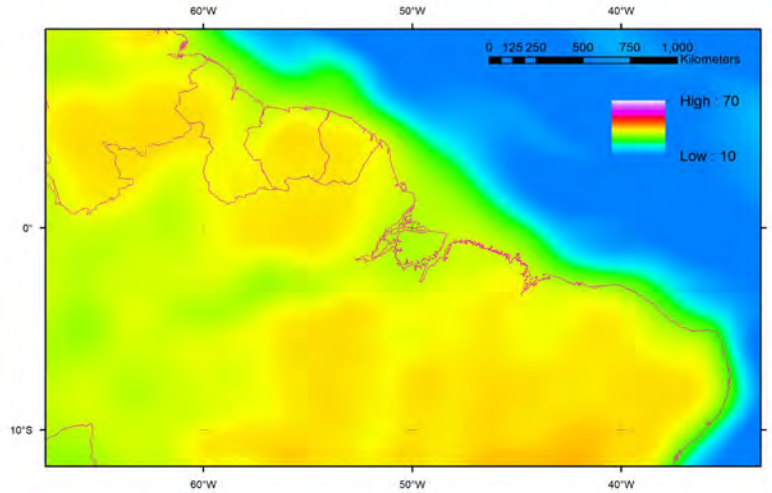

Pasyanos 2014
Lithosphere
Thickness
Estimate


Pasyanos 2014
Crustal
Thickness
Estimate

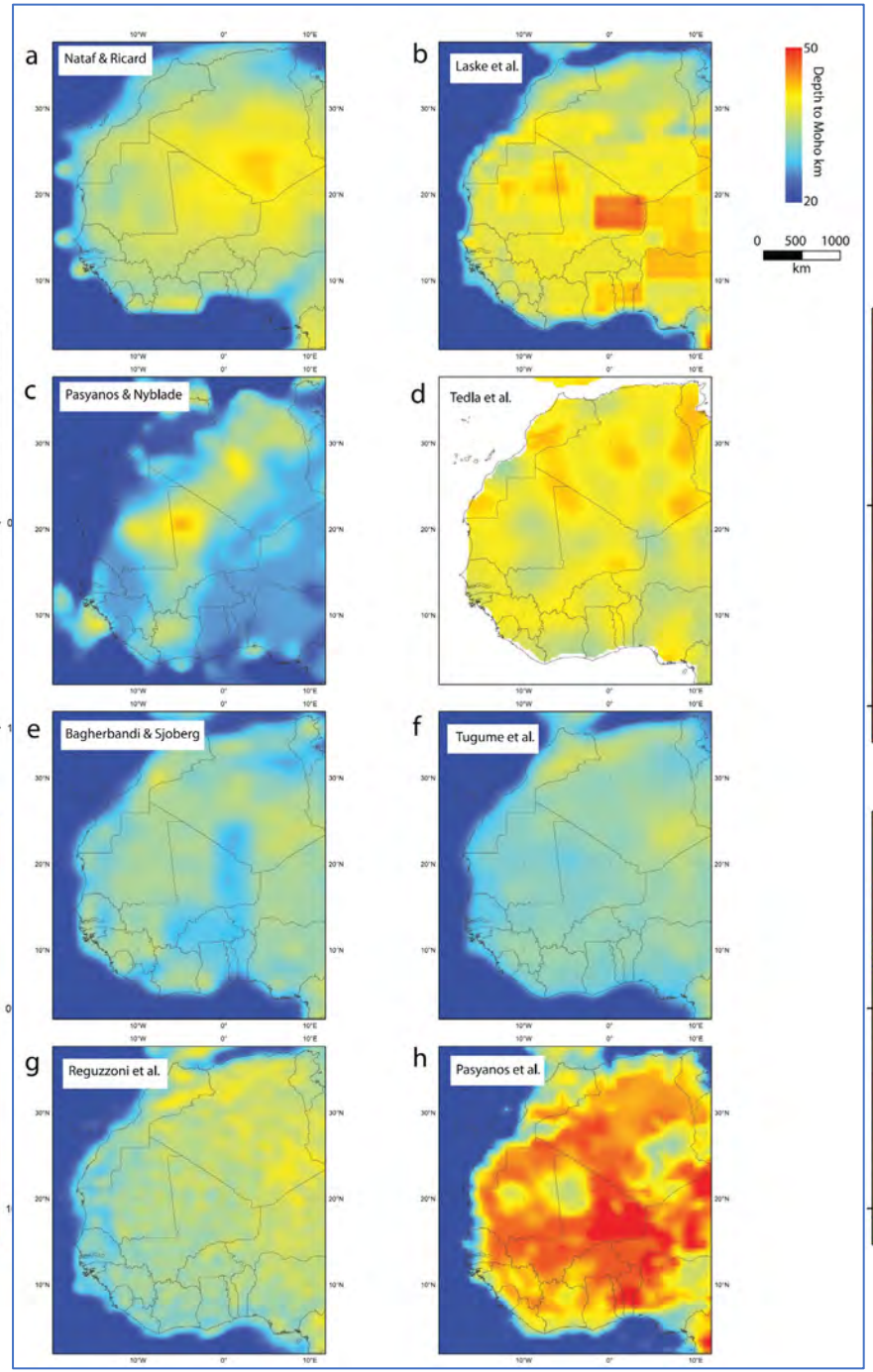
Crustal thickness estimates

Bouguer Gravity

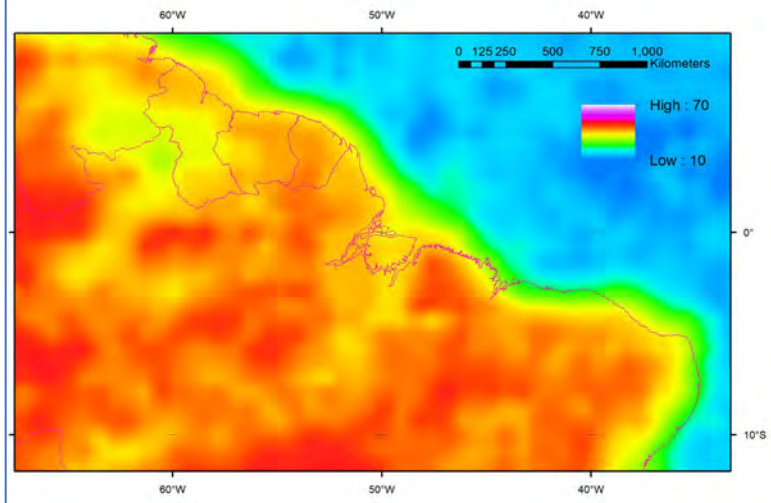


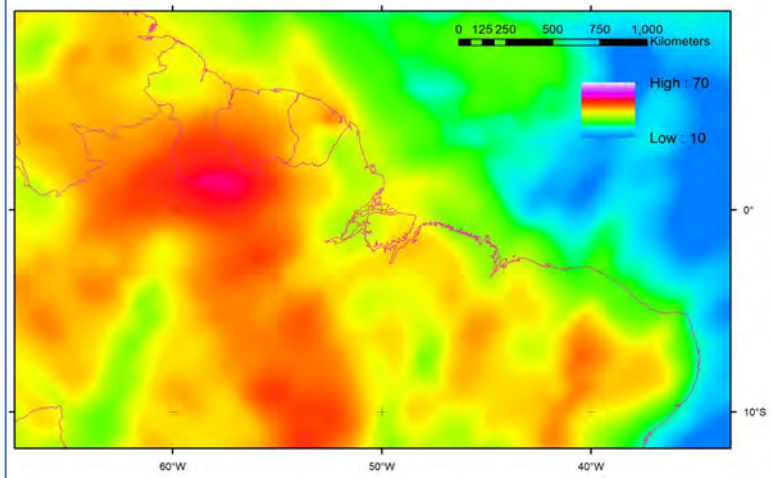


Meijde 2013



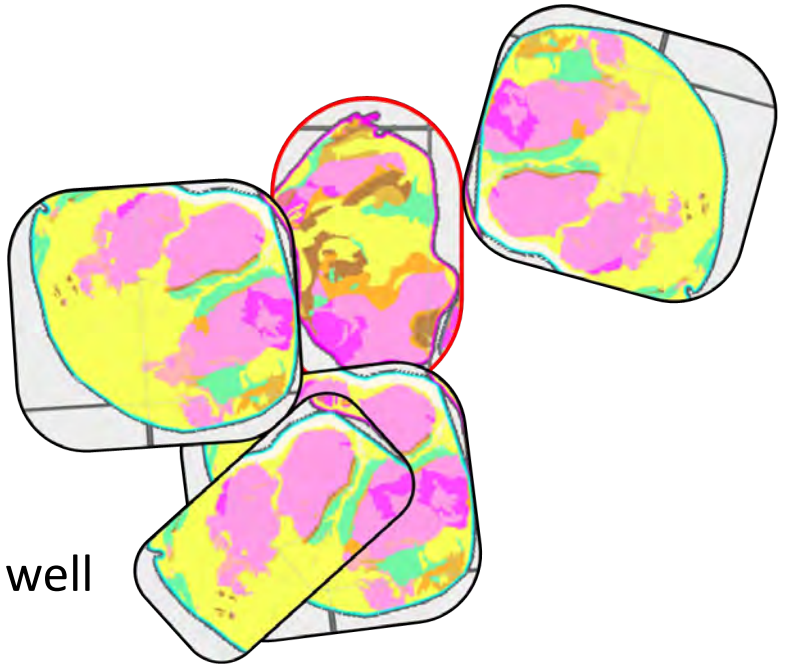
Pasyanos 2014





Lloyd 2010

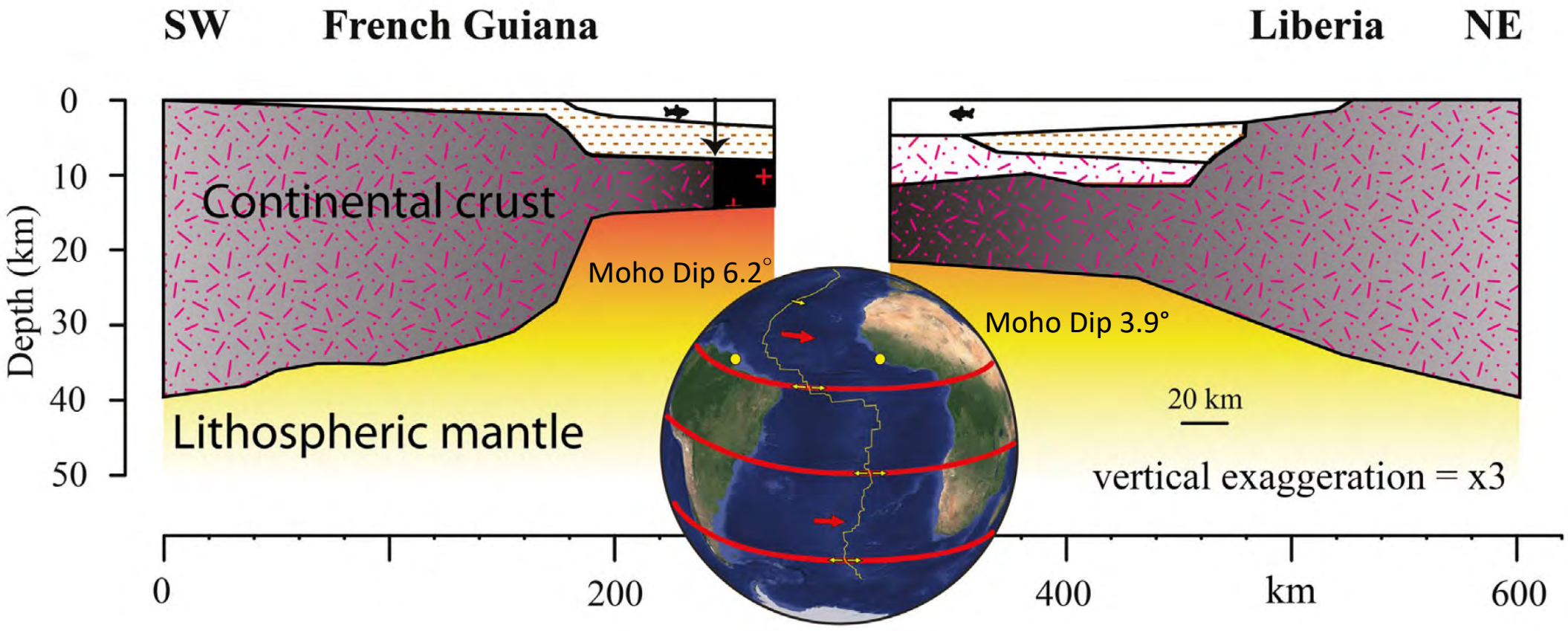
Conclusions

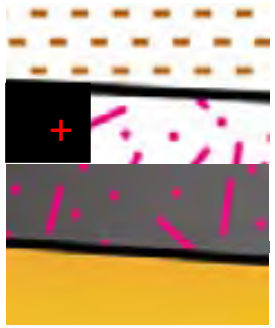


- Existing data are permissive of many configurations
- Collision at 2Ga seems reasonable, but geometry of this collision less well constrained
- Increased availability of 2D spatial analysis:
  - felsic geochronology
  - mafic dykes
  - isotopic mapping
  - major structures

- New research programs needed to better constrain 2.2-1.0 Ga (co-?)evolution of Amazonia and West Africa

(Another Caveat) Continental Margins





Sedimentary Cover

Oceanic Crust

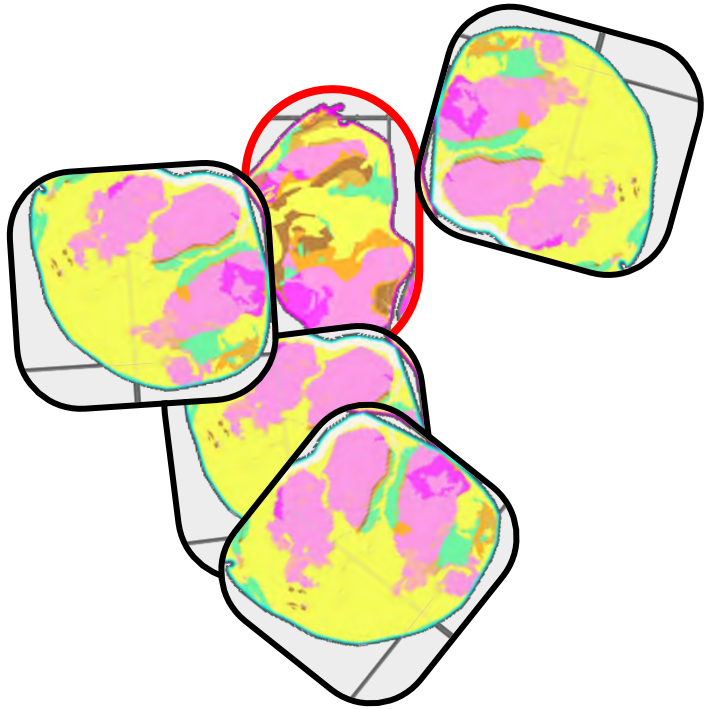
Continental Crust

Lithospheric Mantle

Vangone & Doglioni 2021

WAC & Amazonia before Gondwana

Australian Research Council Linkage Proposal



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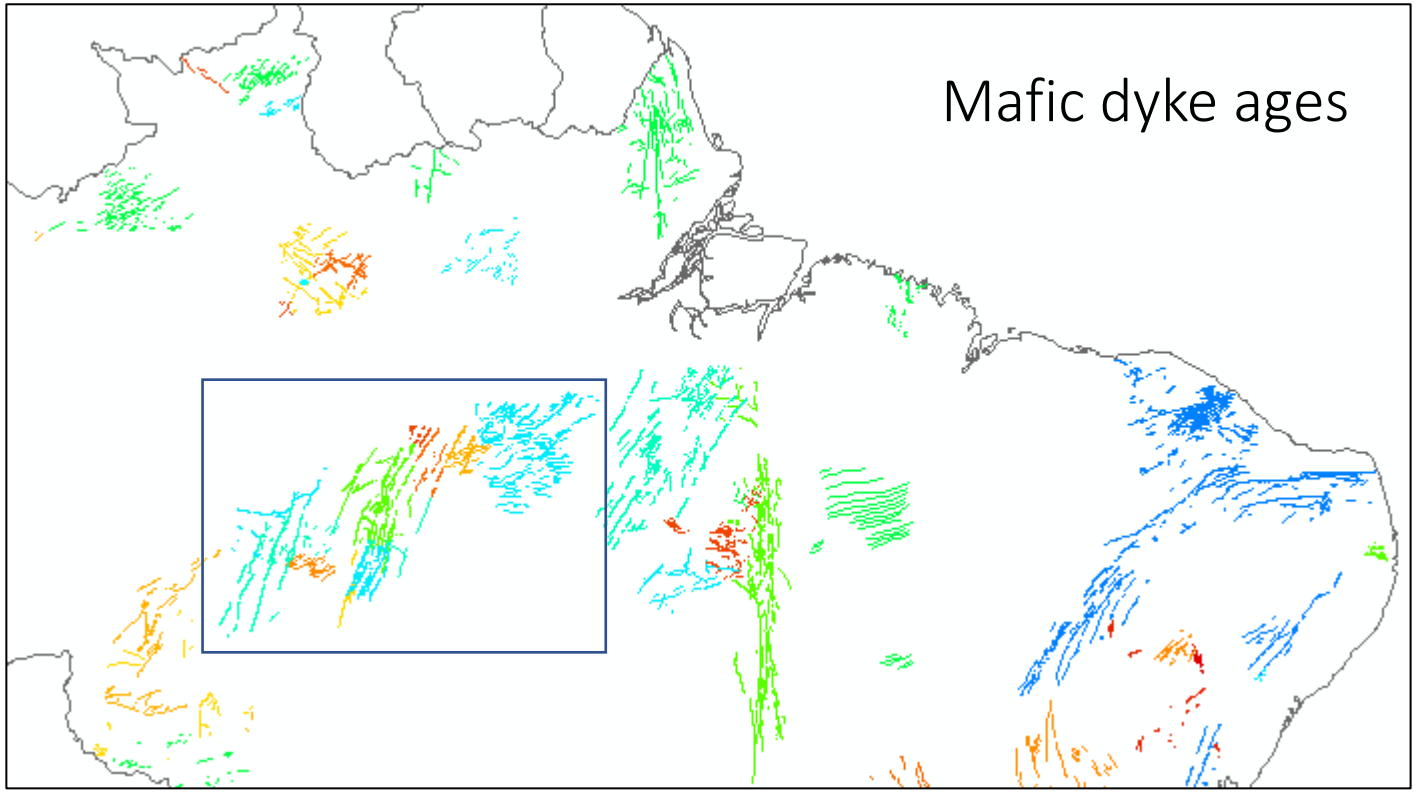
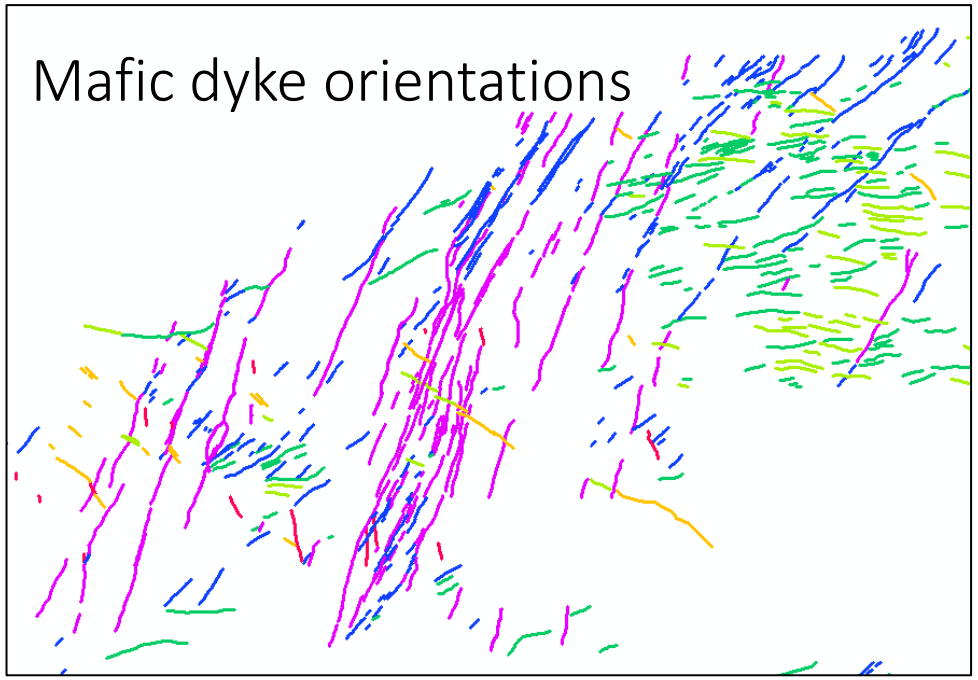
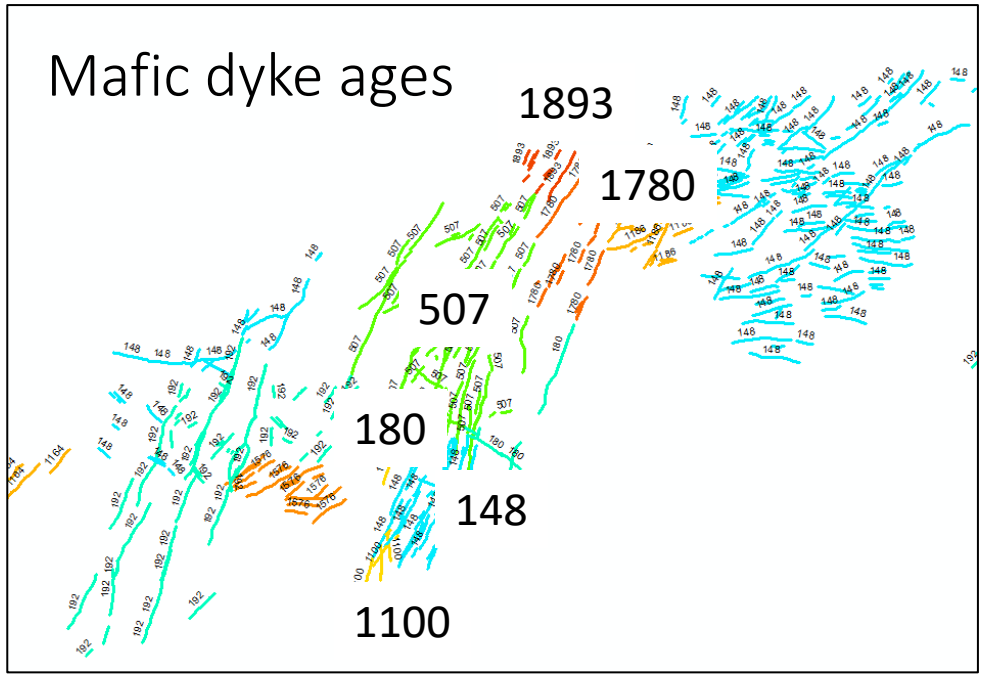
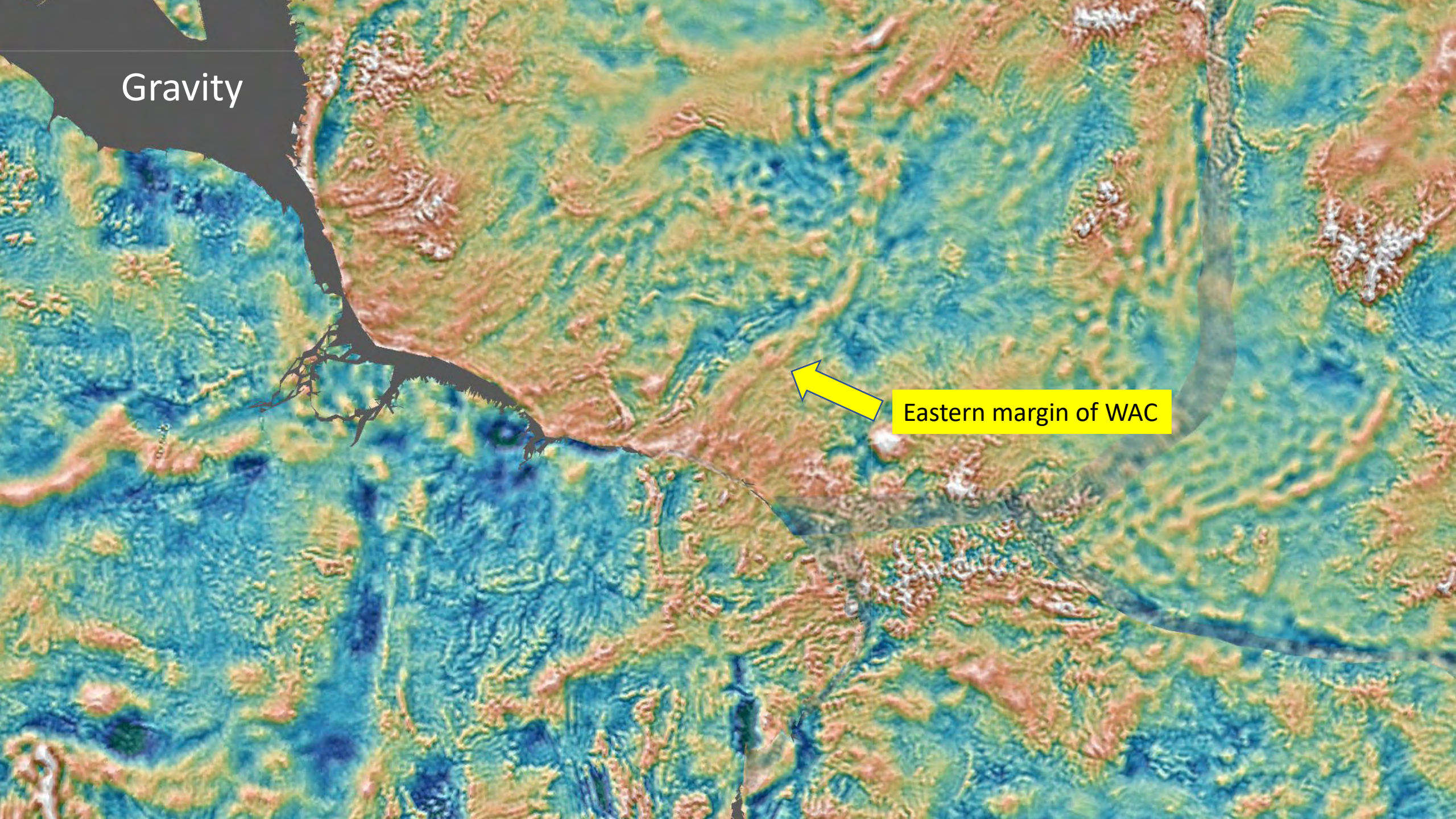
Richard Enrst
Carlton University

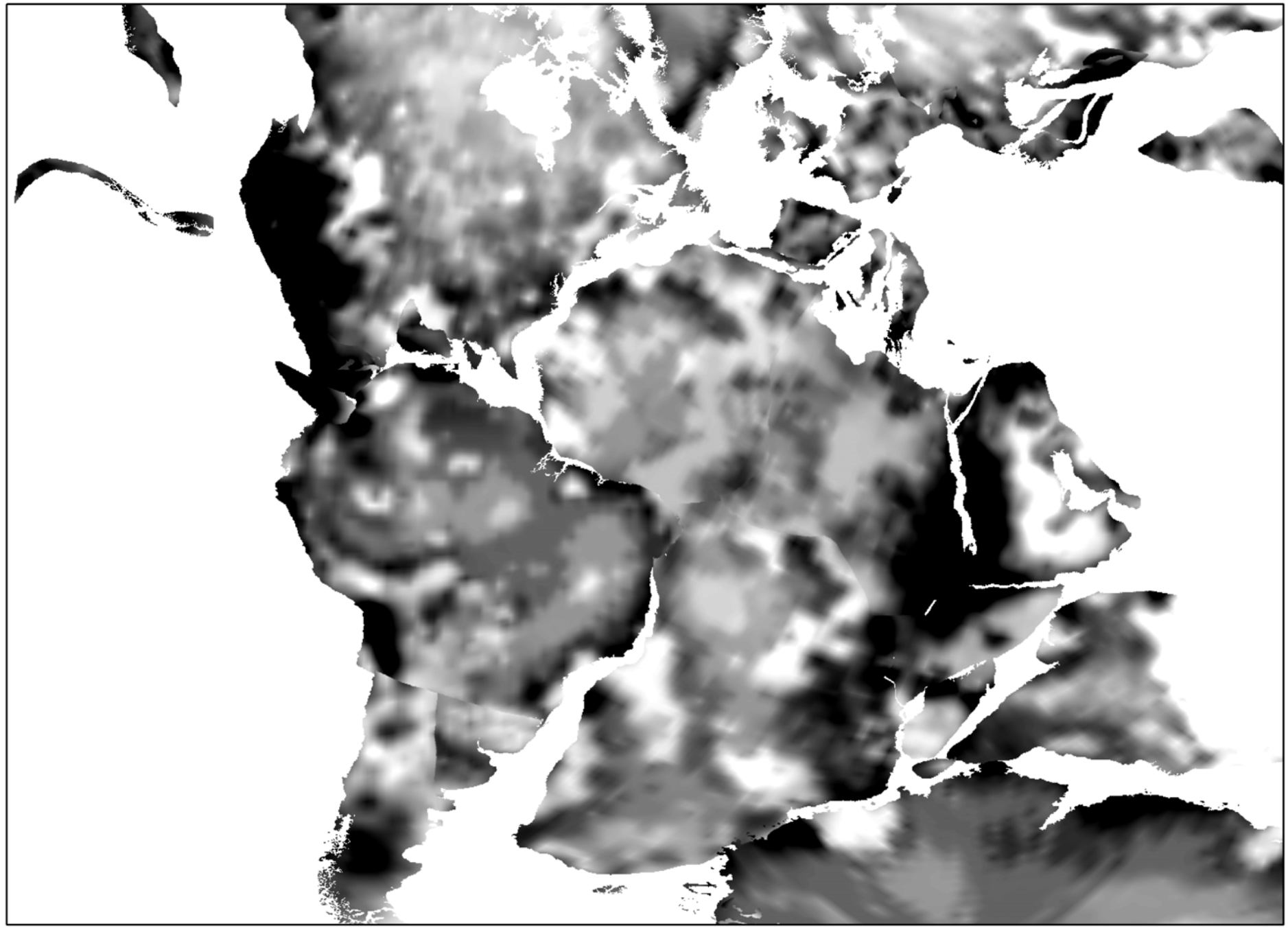


Pessano et al., 2021

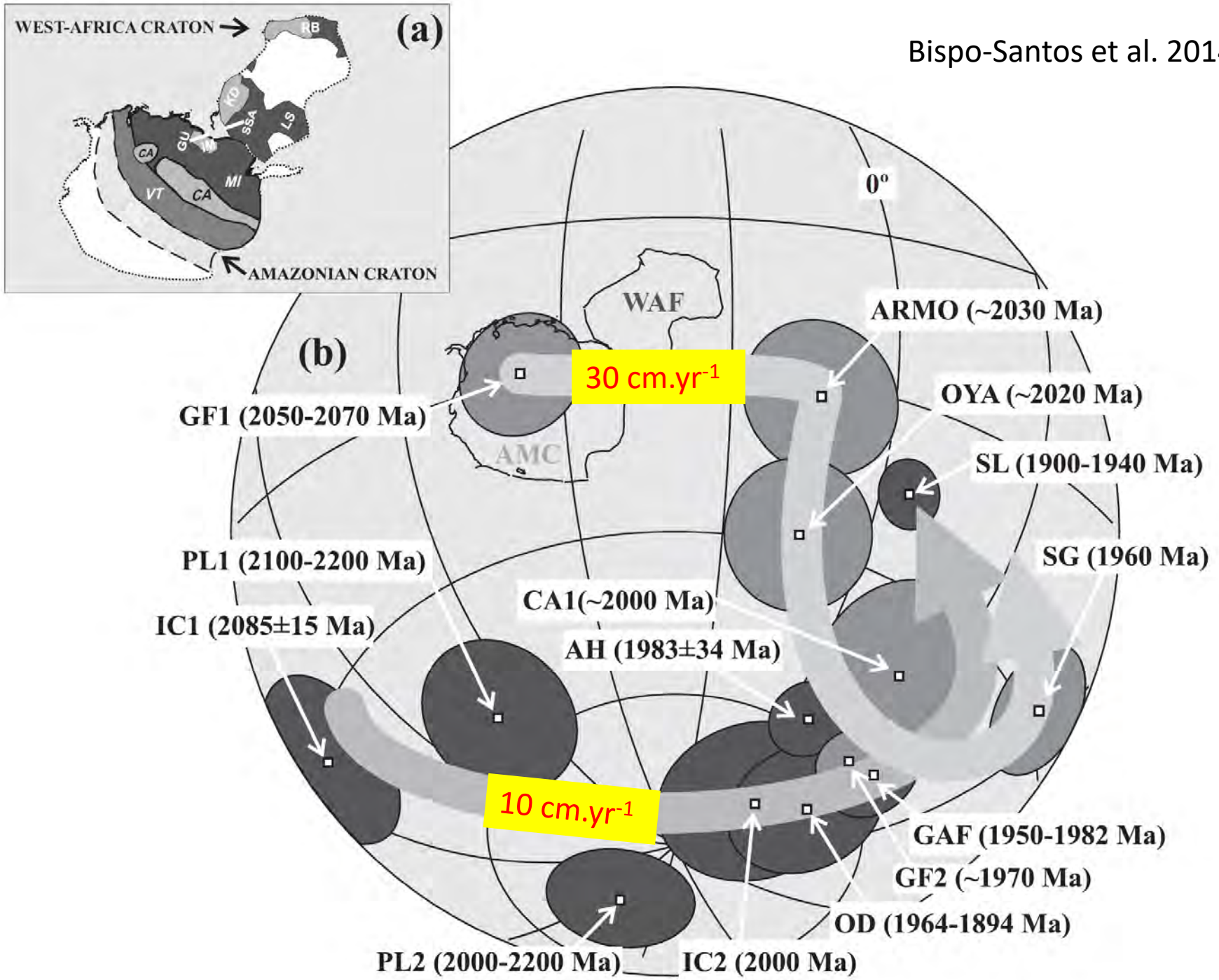


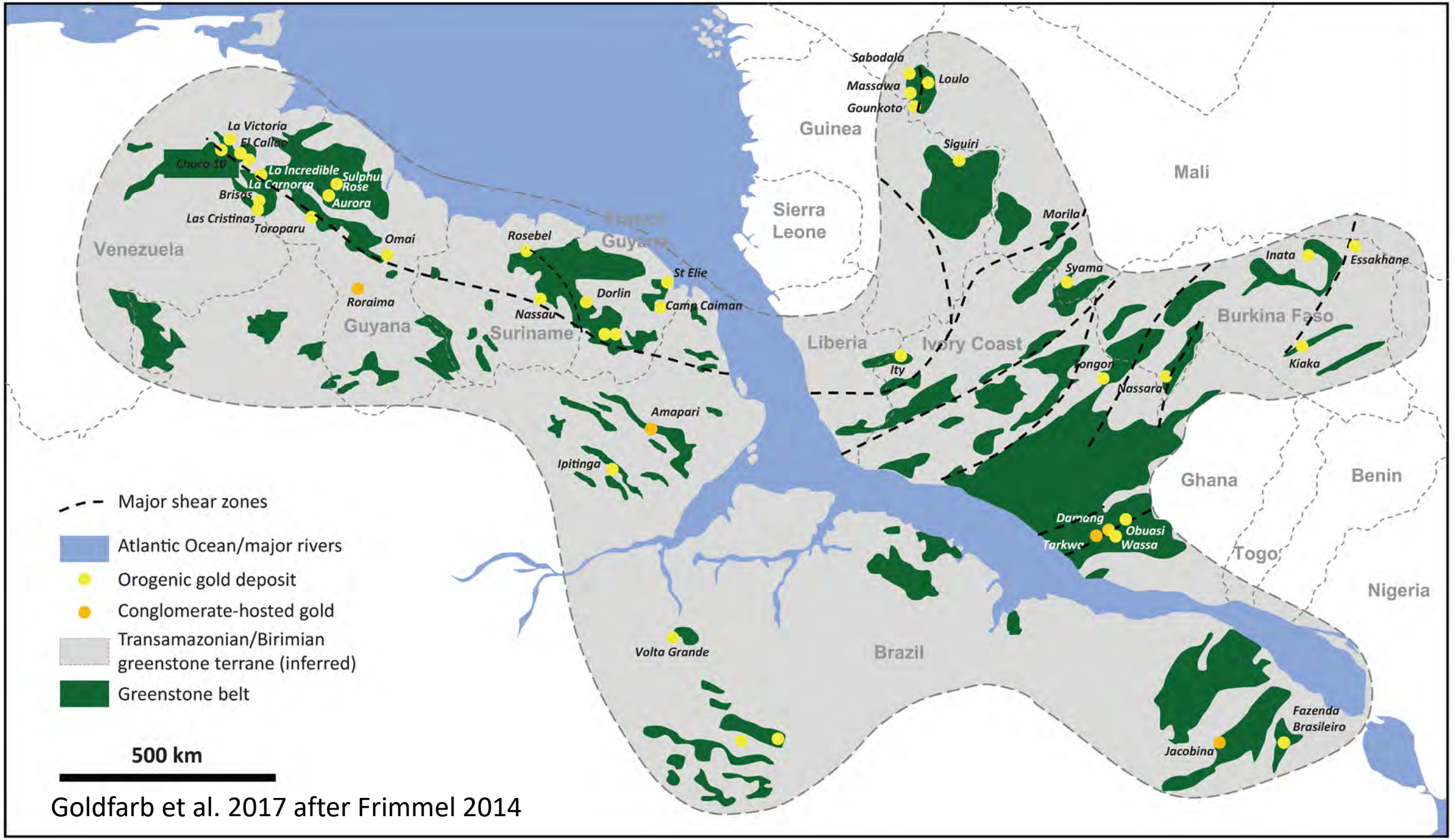



Gravity
Eastern margin of WAC

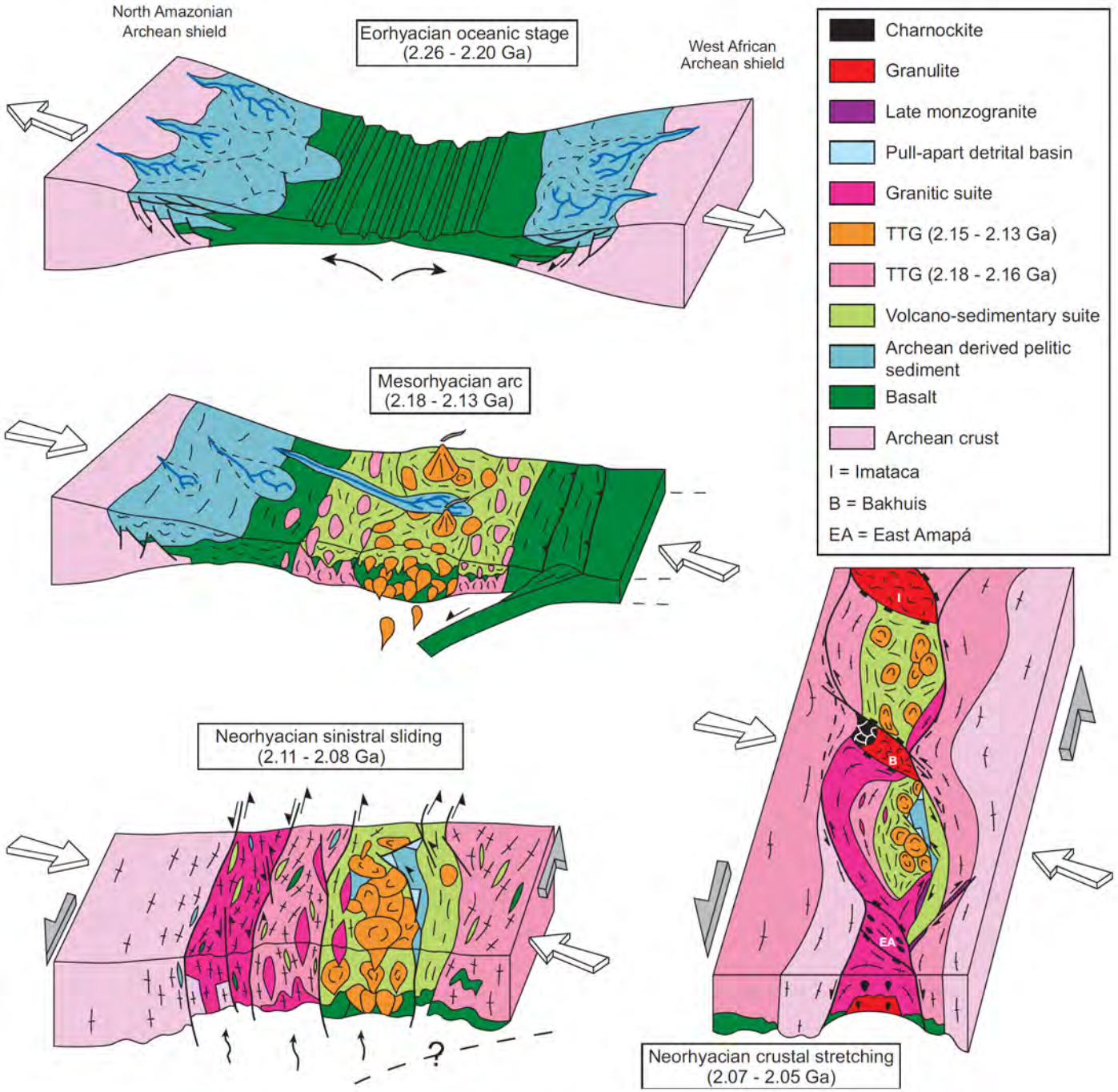


Bispo-Santos et al. 2014



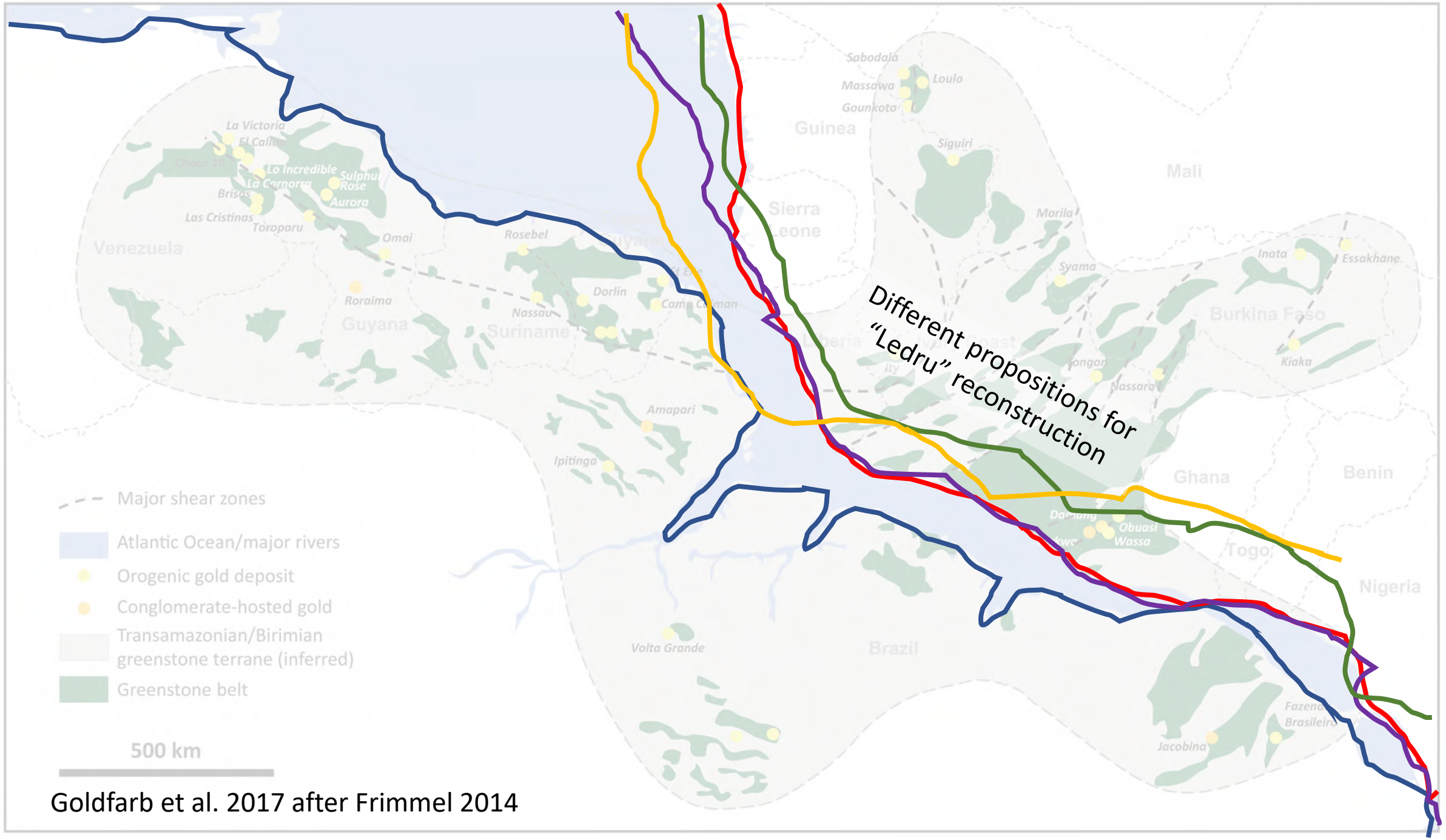


Goldfarb et al. 2017 after Frimmel 2014



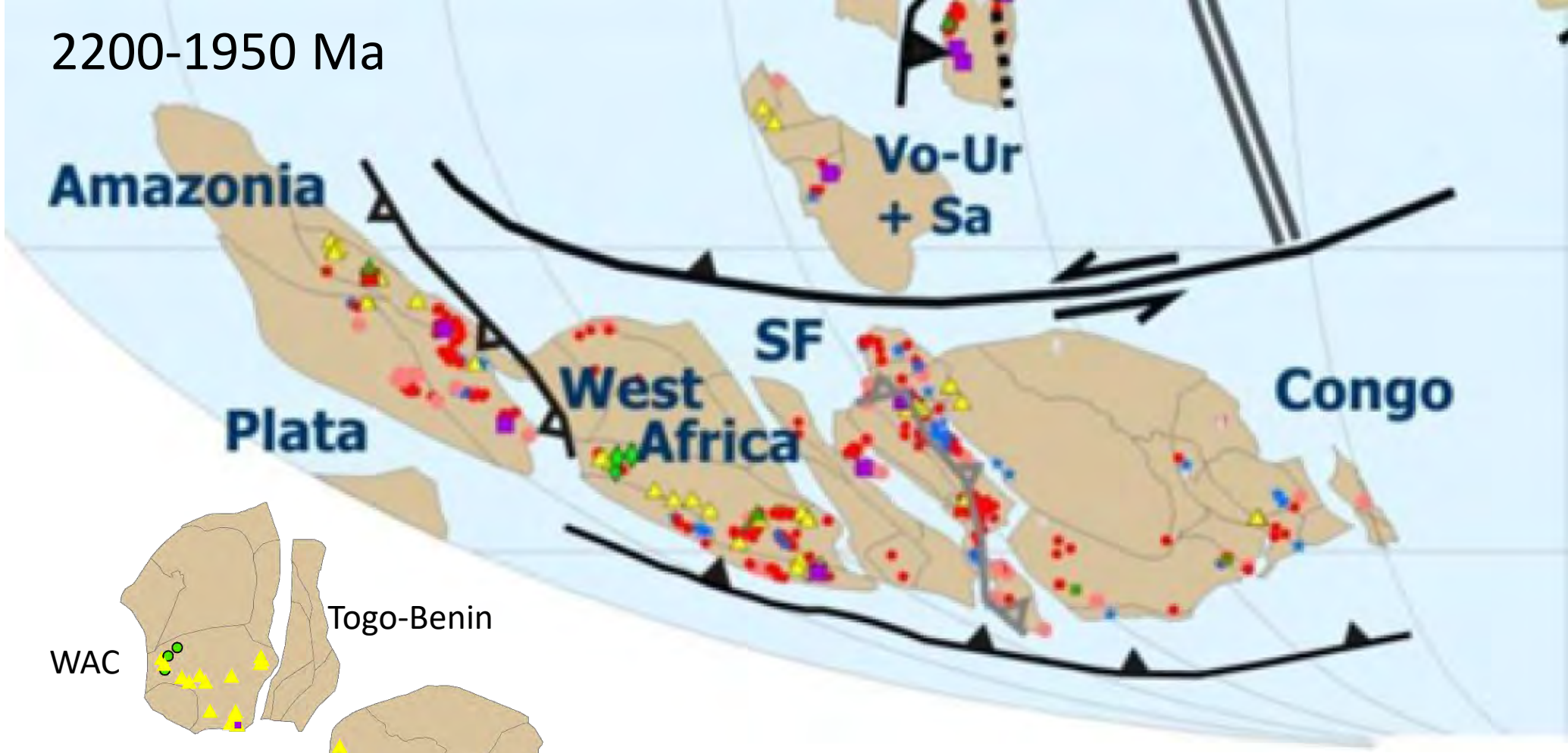
Passive margin formation then collision of two Archean Blocks

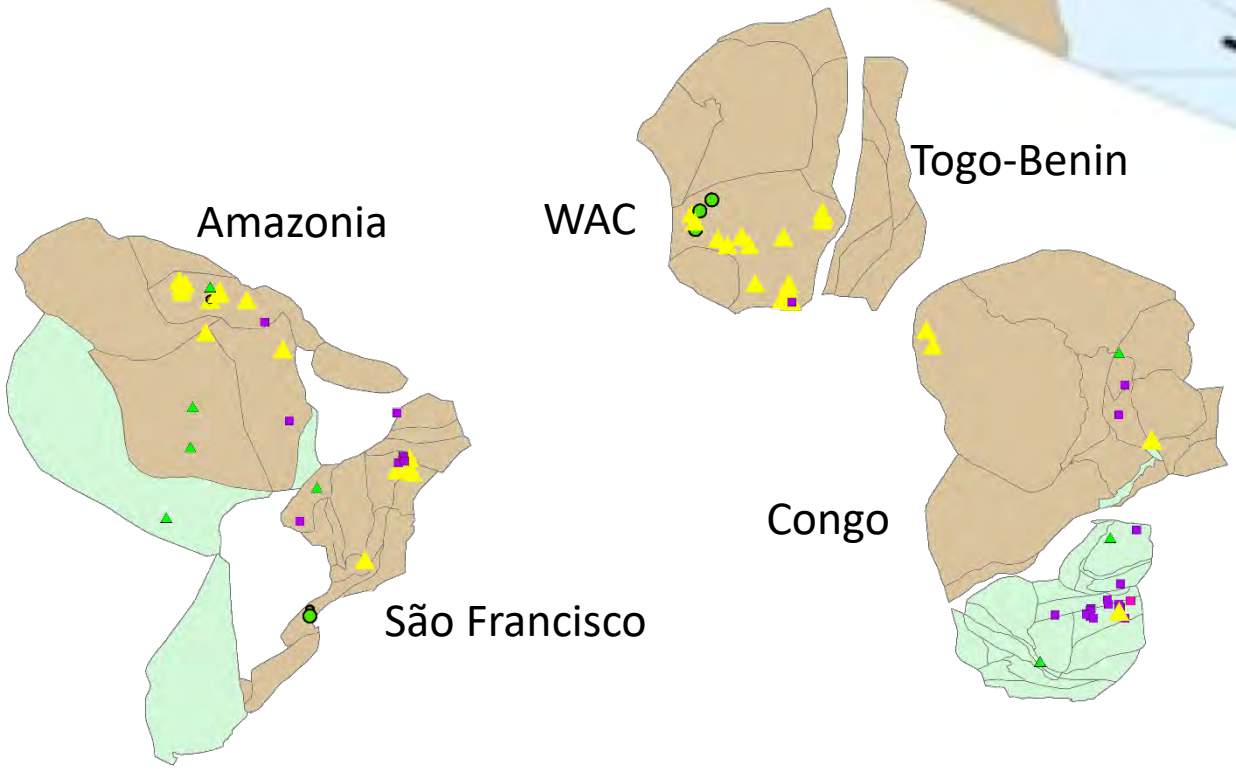
Delor+ 2003



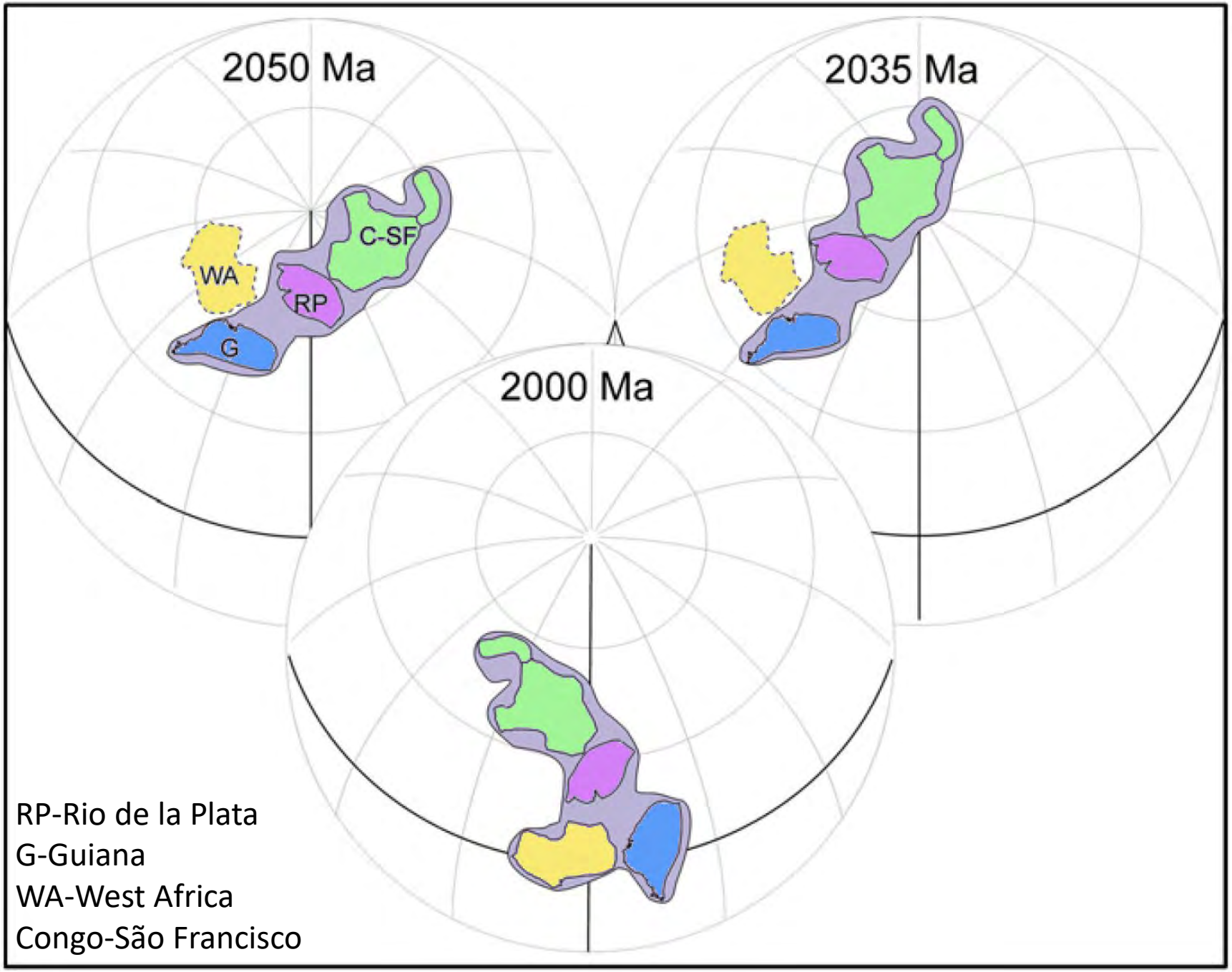
Goldfarb et al. 2017 after Frimmel 2014

Pehrsson et al 2015





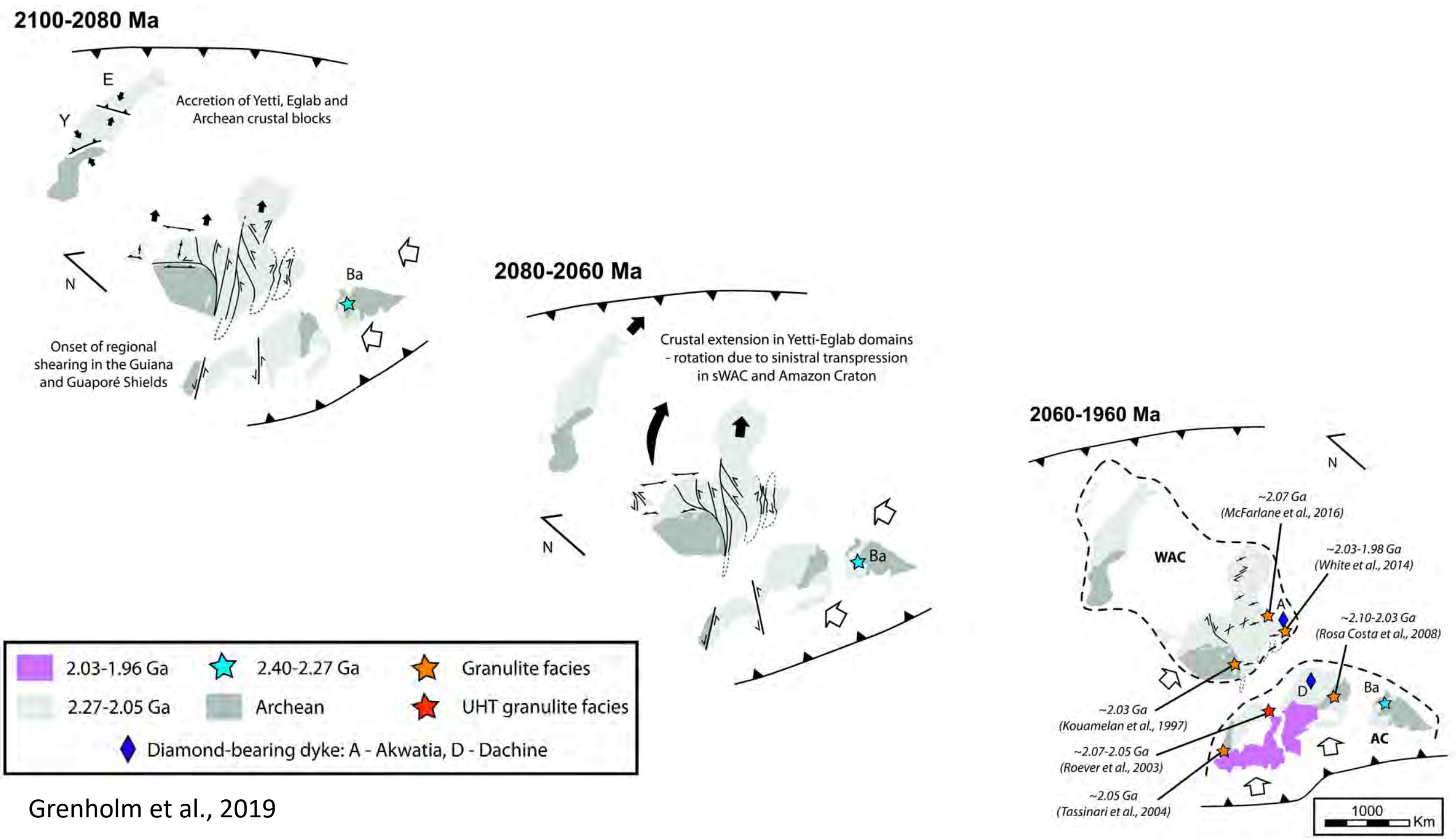
Rapalini et al. 2015



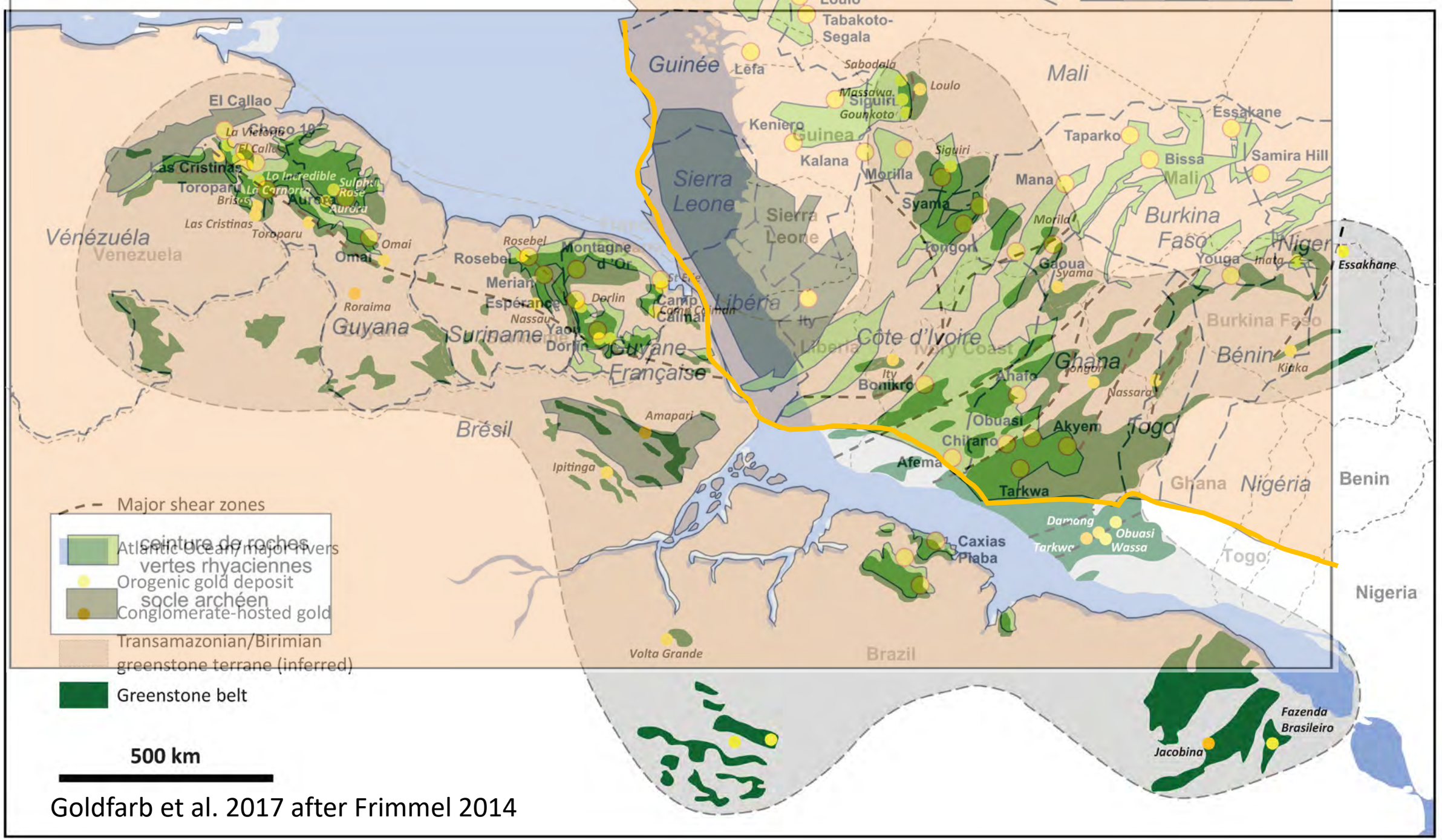
Paleomagnetically controlled paleogeographic reconstruction of the proposed Atlantica continent at 2.05, 2.035 and 2.0 Ga.

No paleomagnetic constraint on West Africa's position is available.

Comparison with coeval poles from the Guiana, Congo–São Francisco and West African cratons indicates that **a configuration of Atlantica that resembles their Western Gondwana fit is not supported by paleomagnetic data.**



Grenholm et al., 2019



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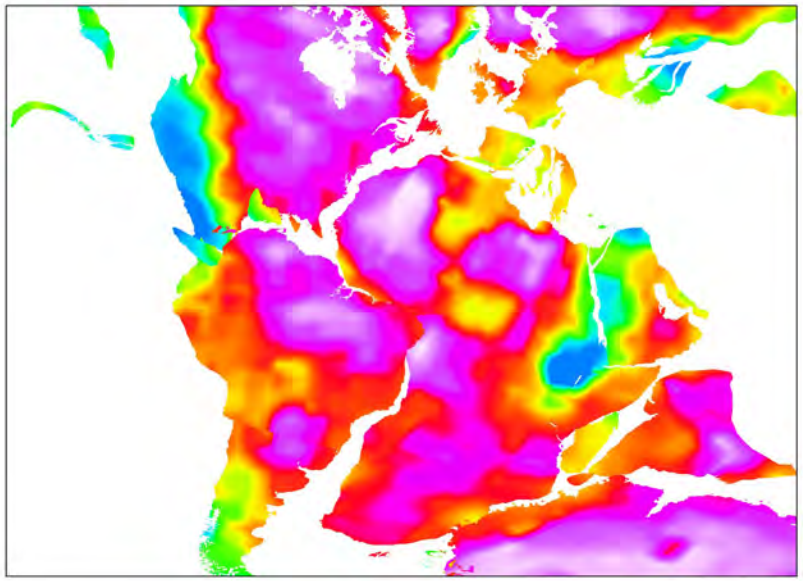
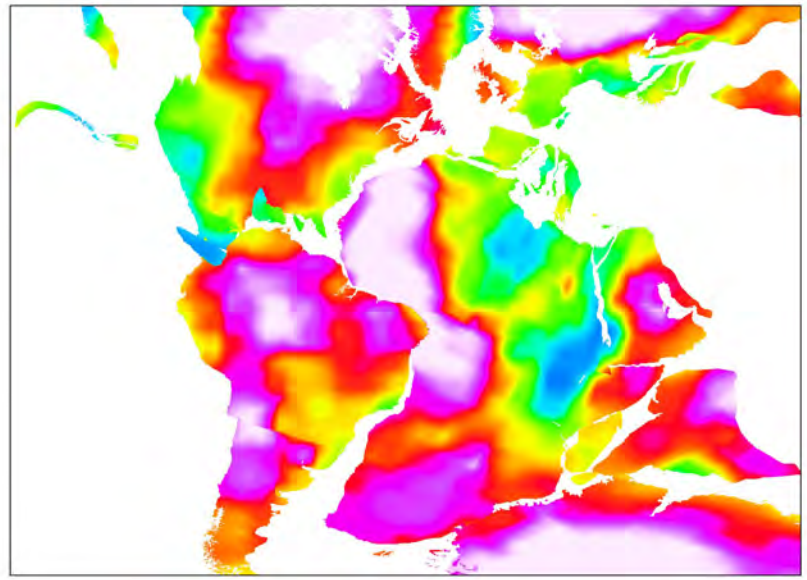
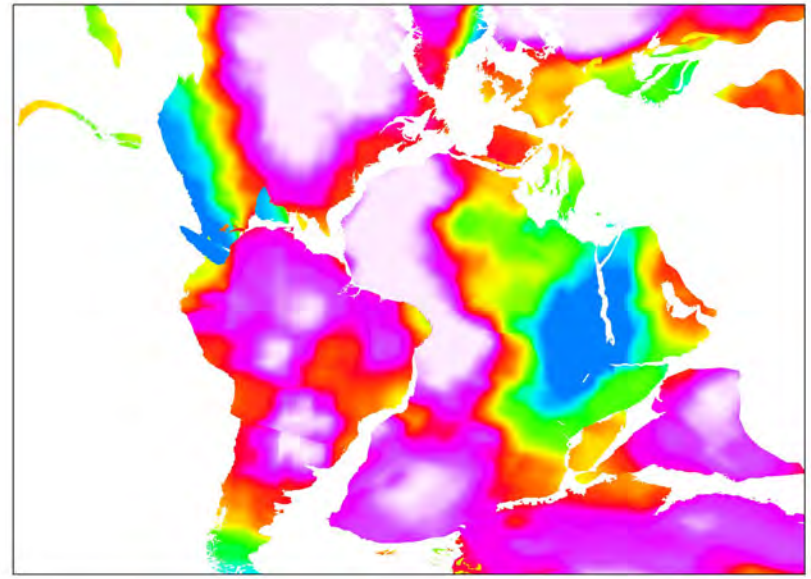
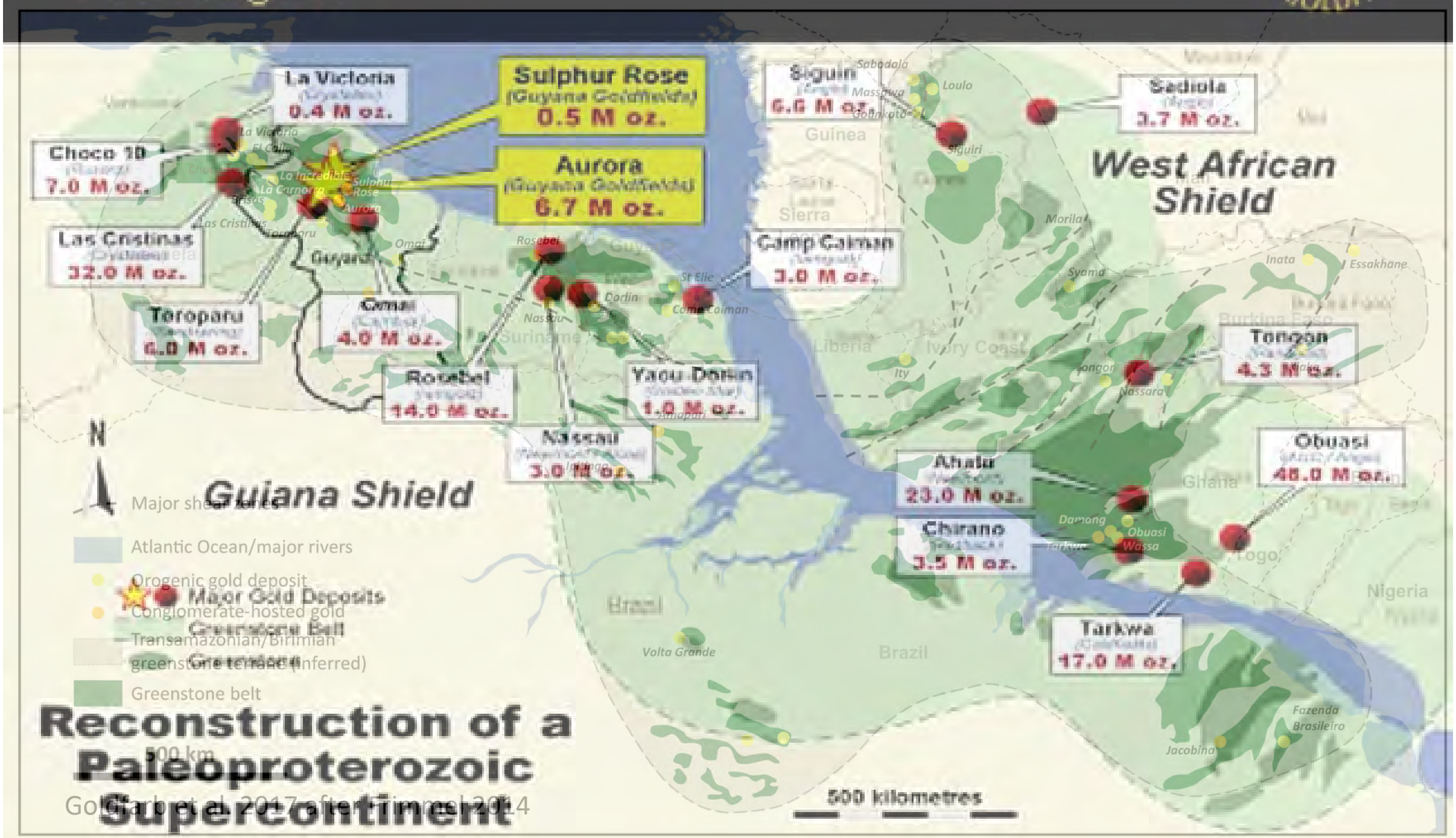
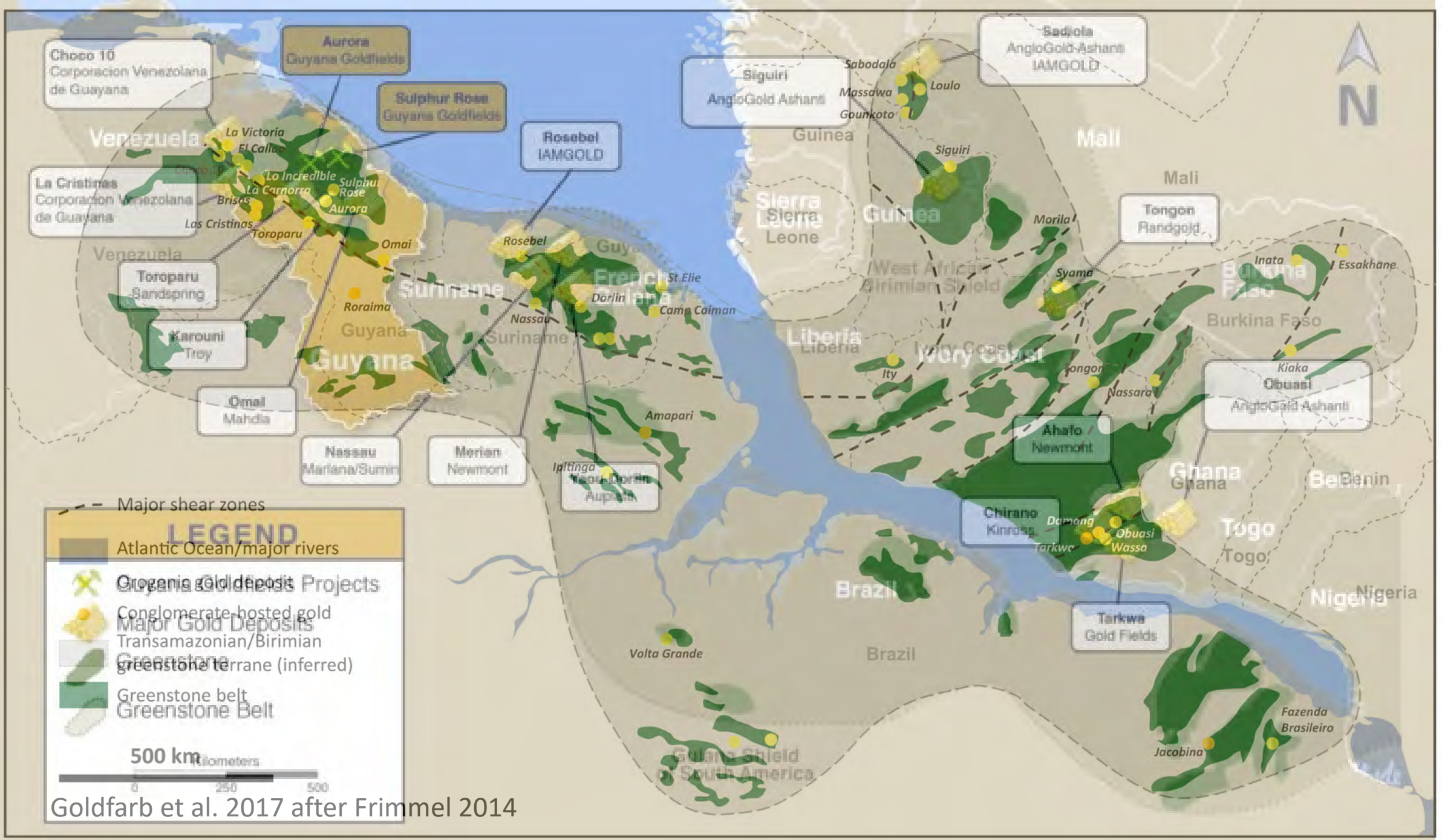


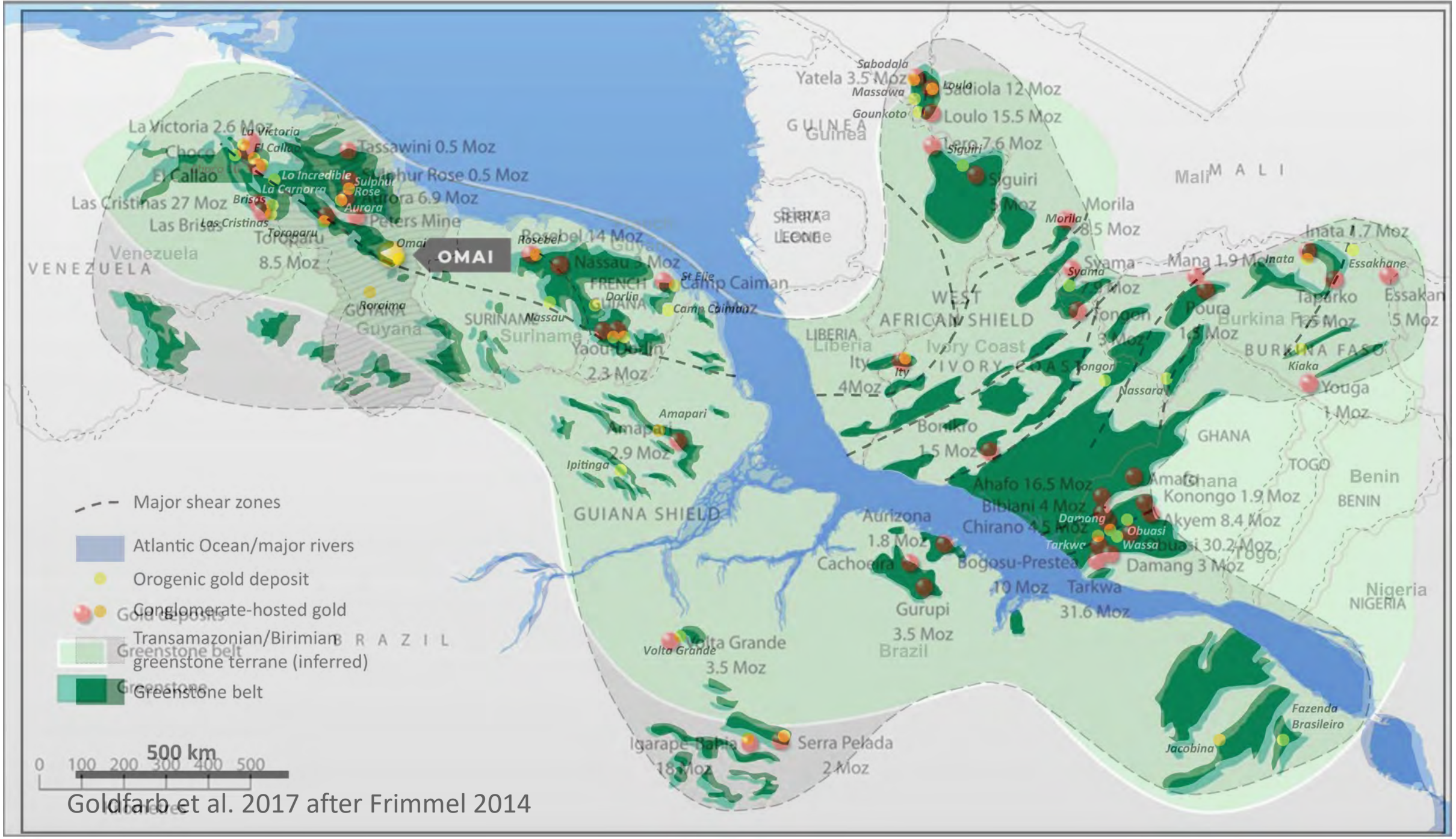




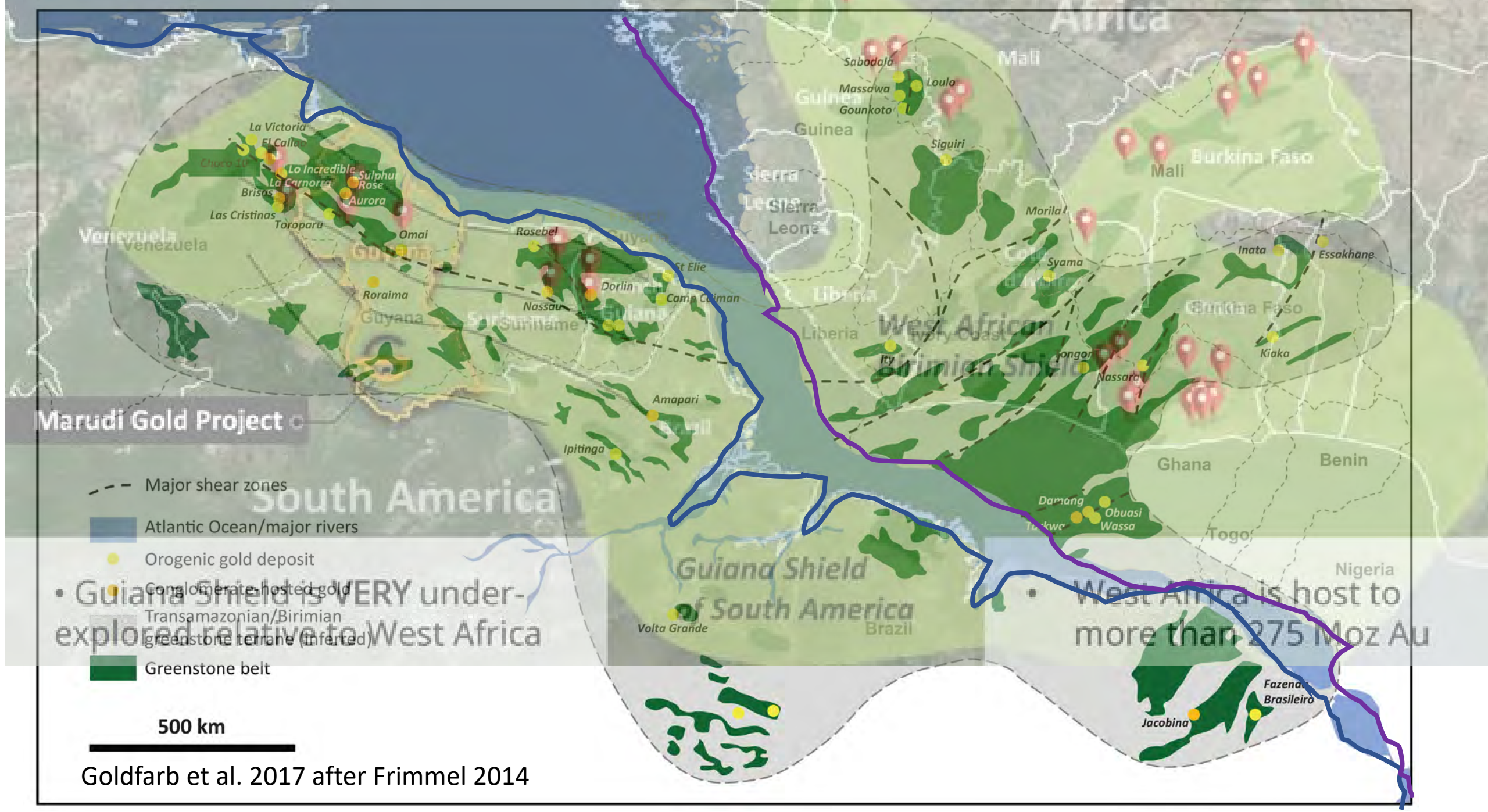

La Victoria
0.4 M oz.
Sulphur Rose
(Guyana Goldfields)
0.5 M oz.
Aurora
(Guyana Goldfields)
6.7 M oz.
Choco 10
7.0 M oz.
Las Cristinas
32.0 M oz.
Teroparu
6.0 M oz.
Camp Caiman
3.0 M oz.
Rosebel
14.0 M oz.
Yaou Dorlin
1.0 M oz.
Nassau
3.0 M oz.
Siguiri
6.6 M oz.
Sadiola
3.7 M oz.
Tongon
4.3 M oz.
Obuasi
46.0 M oz.
Ahafo
23.0 M oz.
Chirano
3.5 M oz.
Tarkwa
17.0 M oz.
Guiana Shield
West African Shield
N
Major shield units
Atlantic Ocean/major rivers
Orogenic gold deposit
Major Gold Deposits
Conglomerate-hosted gold
Greenstone Belt
Transamazonian/Birimian
greenstone terrane (inferred)
Greenstone belt
500 km
500 kilometres
Reconstruction of a
Paleoproterozoic
Supercontinent
Goldfarb et al. 2017 after Zeh et al. 2014



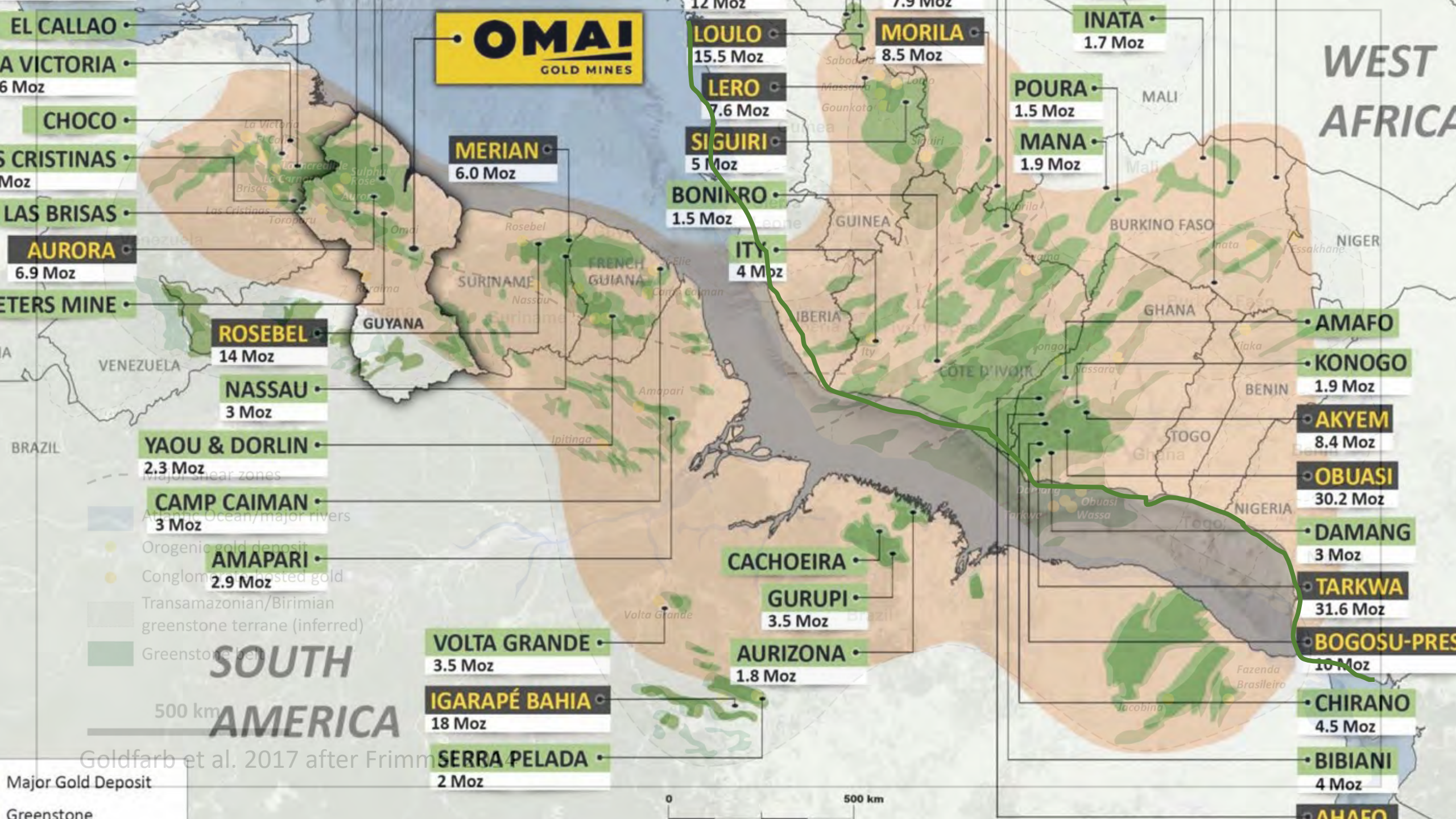
Goldfarb et al. 2017 after Frimmel 2014

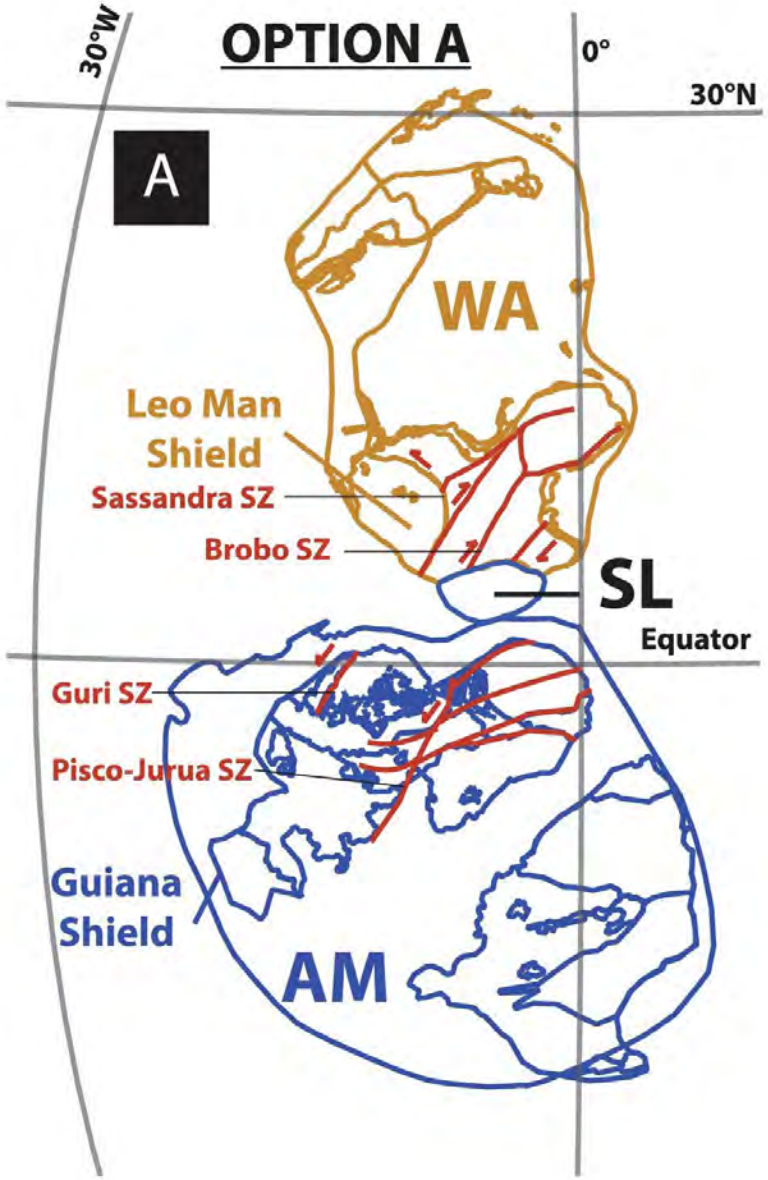


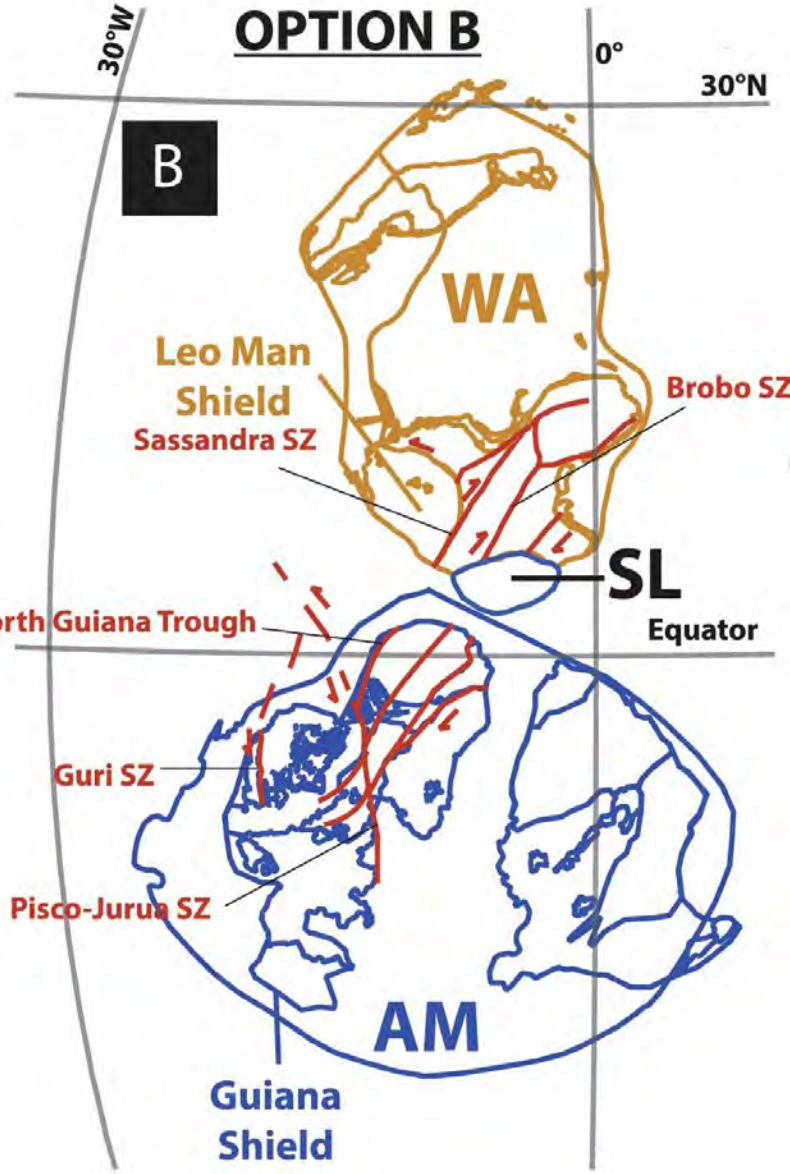
Goldfarb et al. 2017 after Frimmel 2014

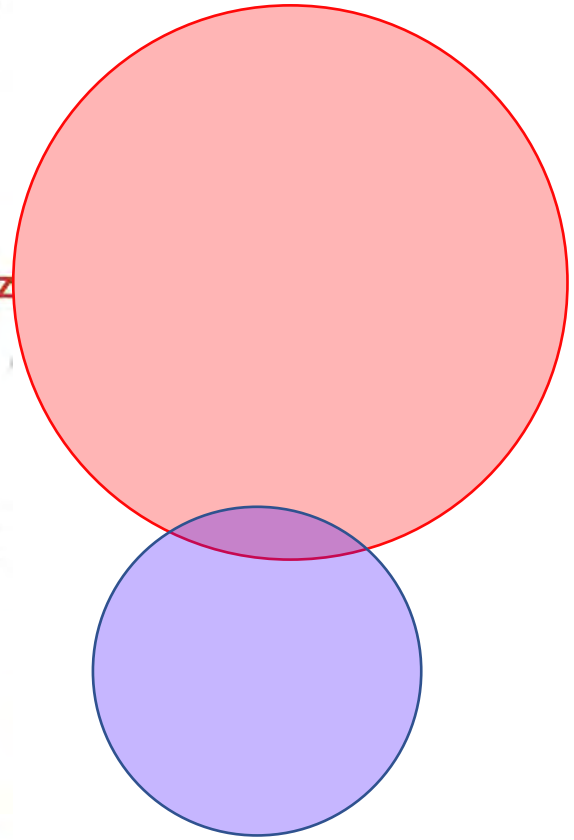


Goldfarb et al. 2017 after Frimmel 2014

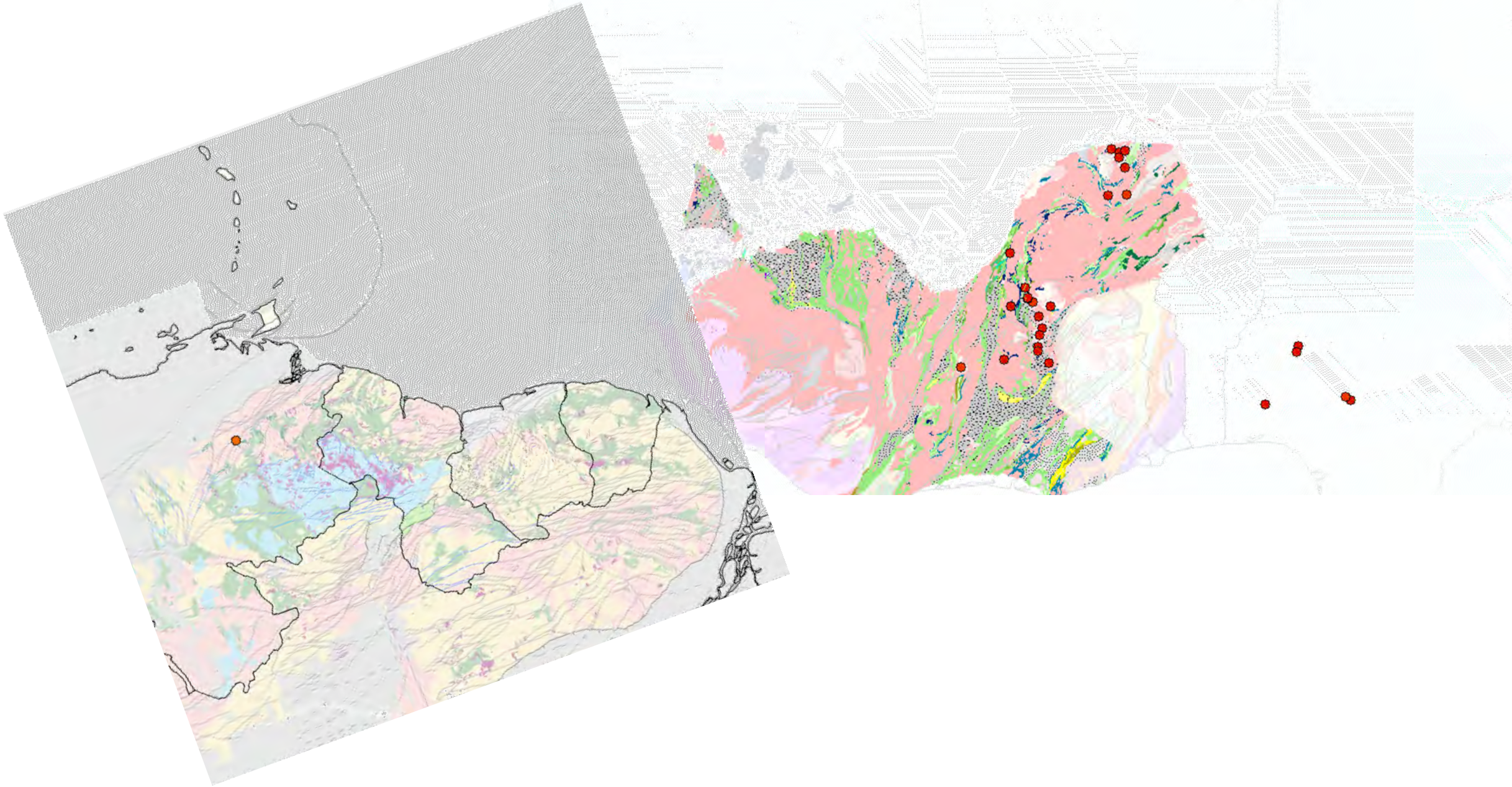

EL CALLAO
A VICTORIA
6 Moz
CHOCO
S CRISTINAS
Moz
LAS BRISAS
AURORA
6.9 Moz
ETERS MINE
OMAI
GOLD MINES
MERIAN
6.0 Moz
ROSEBEL
14 Moz
NASSAU
3 Moz
YAOU & DORLIN
2.3 Moz
CAMP CAIMAN
3 Moz
AMAPARI
2.9 Moz
VOLTA GRANDE
3.5 Moz
IGARAPÉ BAHIA
18 Moz
SERRA PELADA
2 Moz
LOULO
15.5 Moz
LERO
7.6 Moz
SIGUIRI
5 Moz
BONIKRO
1.5 Moz
ITY
4 Moz
MORILA
8.5 Moz
CACHOEIRA
GURUPI
3.5 Moz
AURIZONA
1.8 Moz
INATA
1.7 Moz
POURA
1.5 Moz
MANA
1.9 Moz
AMAFO
KONOGO
1.9 Moz
AKYEM
8.4 Moz
OBUASI
30.2 Moz
DAMANG
3 Moz
TARKWA
31.6 Moz
CHIRANO
4.5 Moz
BIBIANI
4 Moz
GUYANA
SURINAME
FRENCH GUIANA
VENEZUELA
BRAZIL
GUINEA
IBERIA
CÔTE D'IVOIRE
GHANA
BURKINO FASO
MALI
NIGER
BENIN
TOGO
NIGERIA
SOUTH AMERICA
WEST AFRICA
Major shear zones
Atlantic Ocean/major rivers
Orogenic gold deposit
Conglomerate-hosted gold
Transamazonian/Birimian greenstone terrane (inferred)
Greenstone belt
500 km
Goldfarb et al. 2017 after Frimmel
Major Gold Deposit
Greenstone
0
500 km

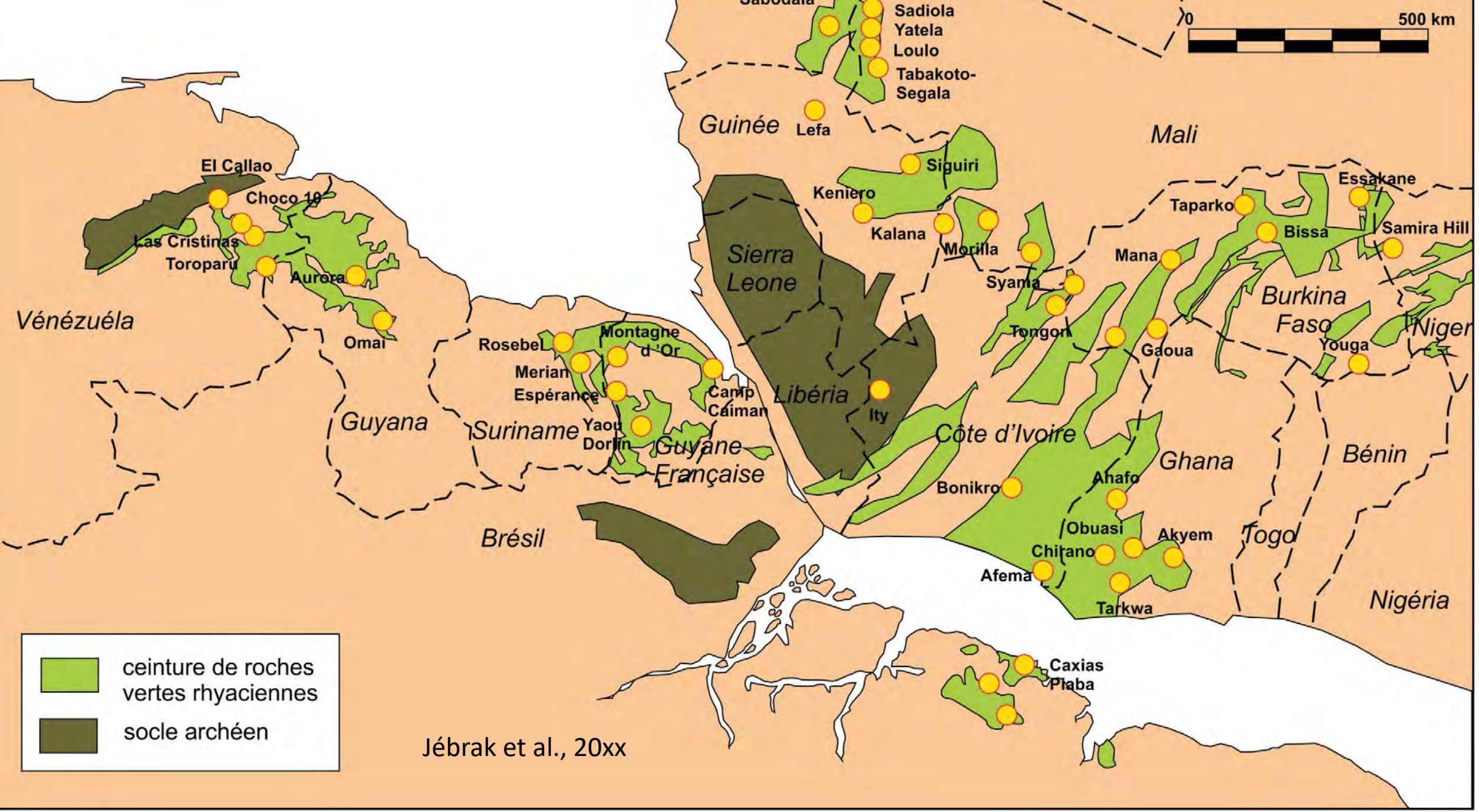




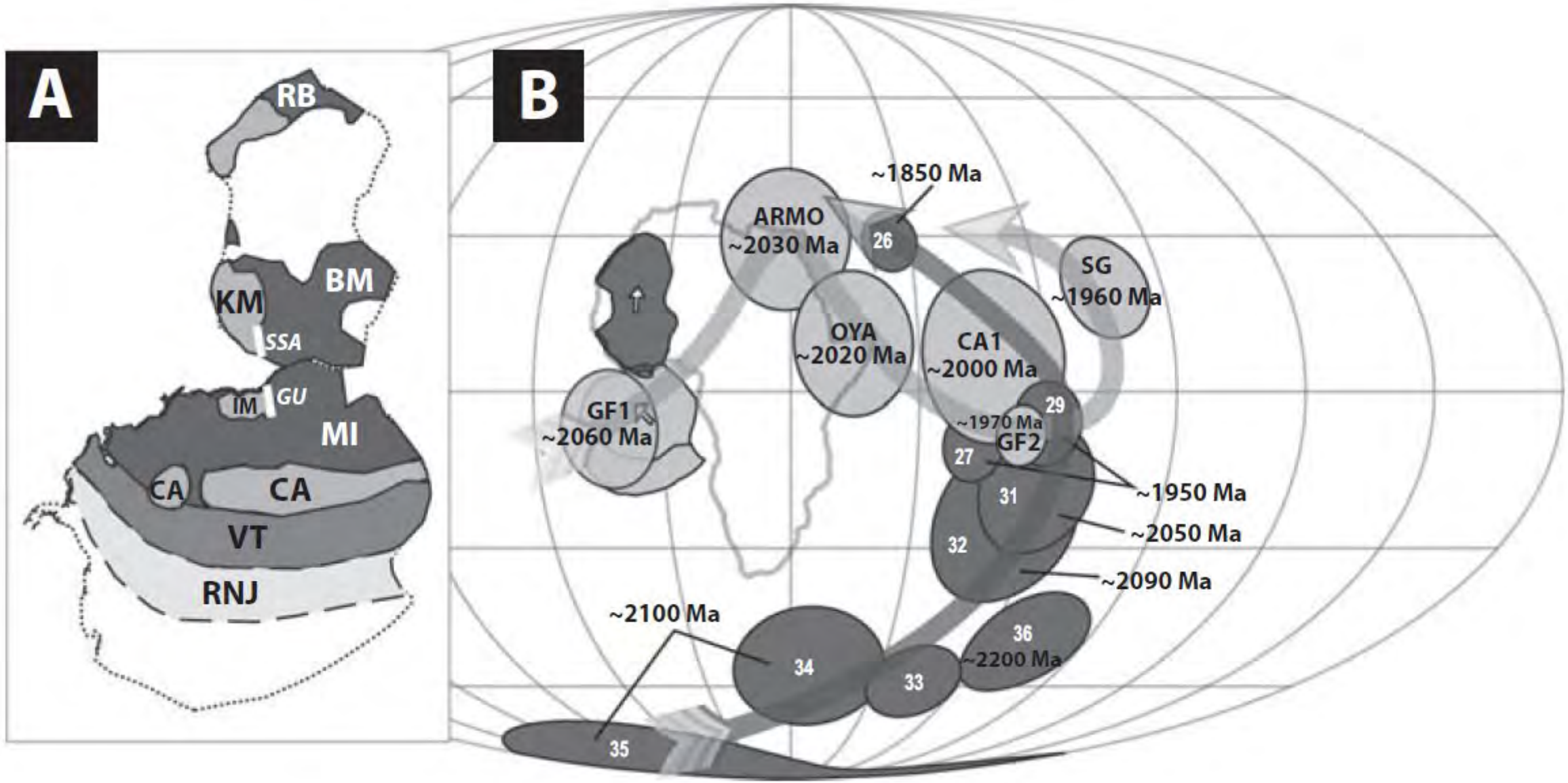


Antonio et al., 2021

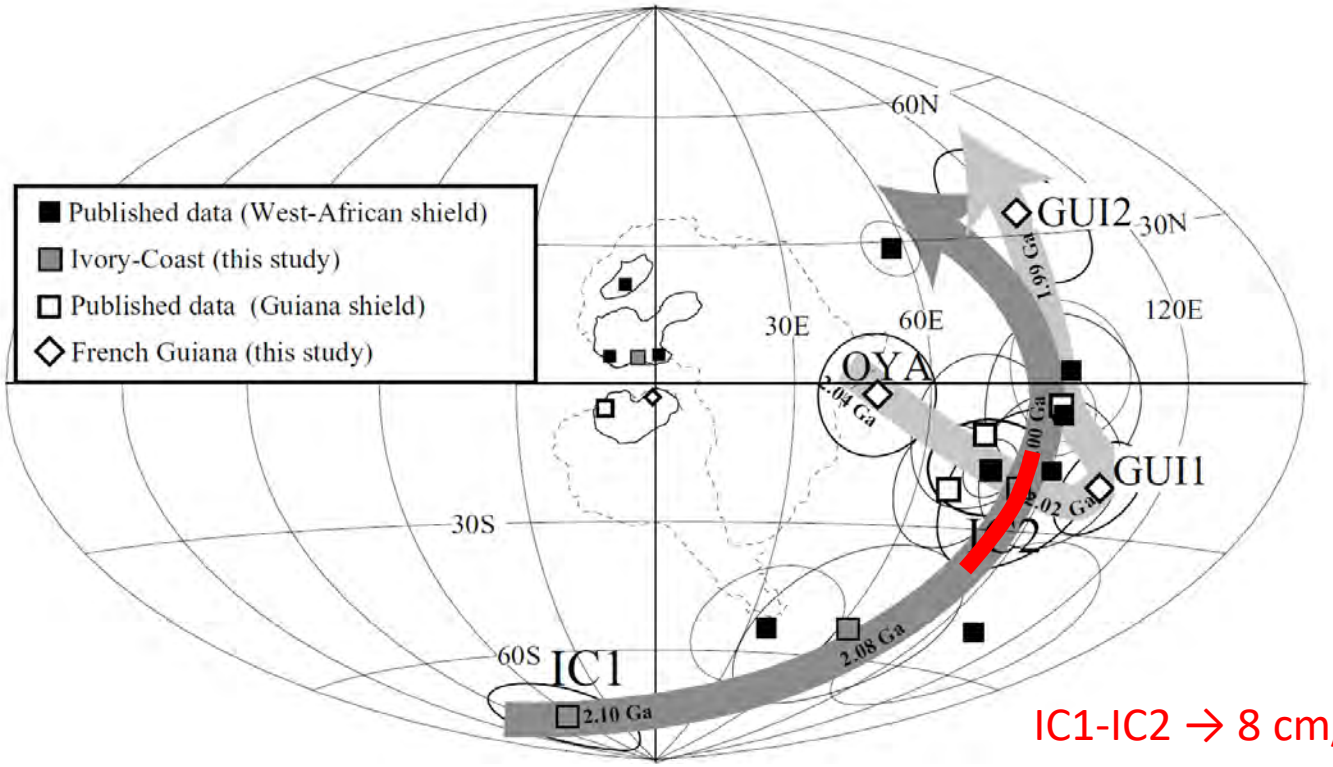




Jébrak et al., 20xx


A
RB
BM
KM
SSA
IM
GU
MI
CA
CA
VT
RNJ
B
~1850 Ma
ARMO
~2030 Ma
26
SG
~1960 Ma
OYA
~2020 Ma
CA1
~2000 Ma
GF1
~2060 Ma
29
~1970 Ma
GF2
27
~1950 Ma
31
~2050 Ma
32
~2090 Ma
~2100 Ma
34
33
36
~2200 Ma
35

Nomade et al. 2003, GJI



IC1-IC2 → 8 cm/yr

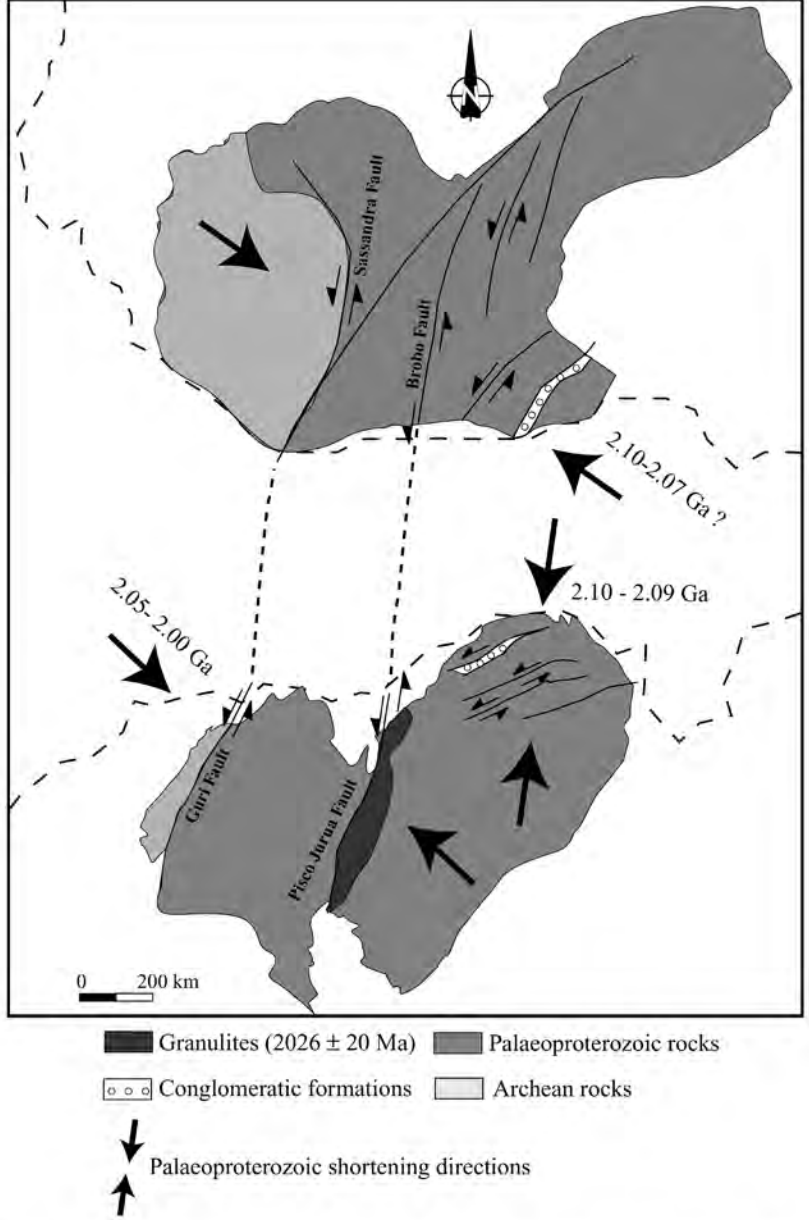
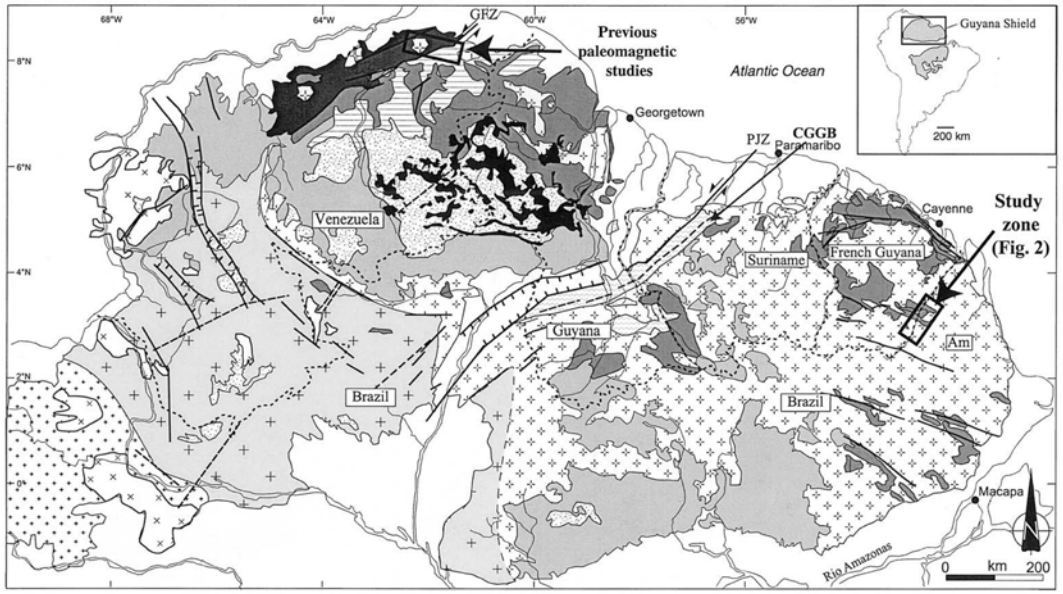


Figure 13. Reposition of Guiana with respect to the West Africa after closing the Atlantic Ocean and alignment of the Guri and Sassandra fault (Onstott & Hargraves 1981). West Africa is in its present position. The arrows show the Palaeoproterozoic regional shortening event and their propose age (Vidal *et al.* 1996; Vanderhaeghe *et al.* 1998).

Guiana Shield
Apparent polar wander



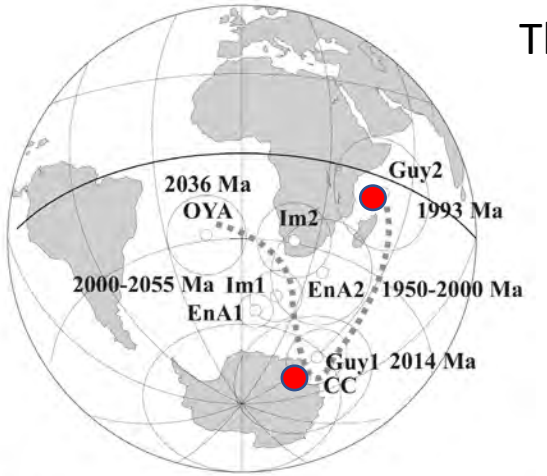


Fig. 2.- Représentation des pôles paléomagnétiques obtenus sur les séries du Paléoprotérozoïque du Bouclier des Guyanes, références dans le texte et le tableau 2. Les âges indiqués sont les âges magnétiques estimés par Nomade *et al.* (soumis).

Theveniaut & Delor 2003

continental velocity of 28±4 to 36±5 cm/y with the zircon dating while the amphibole dating gives 12±3 to 16±4 cm/y.

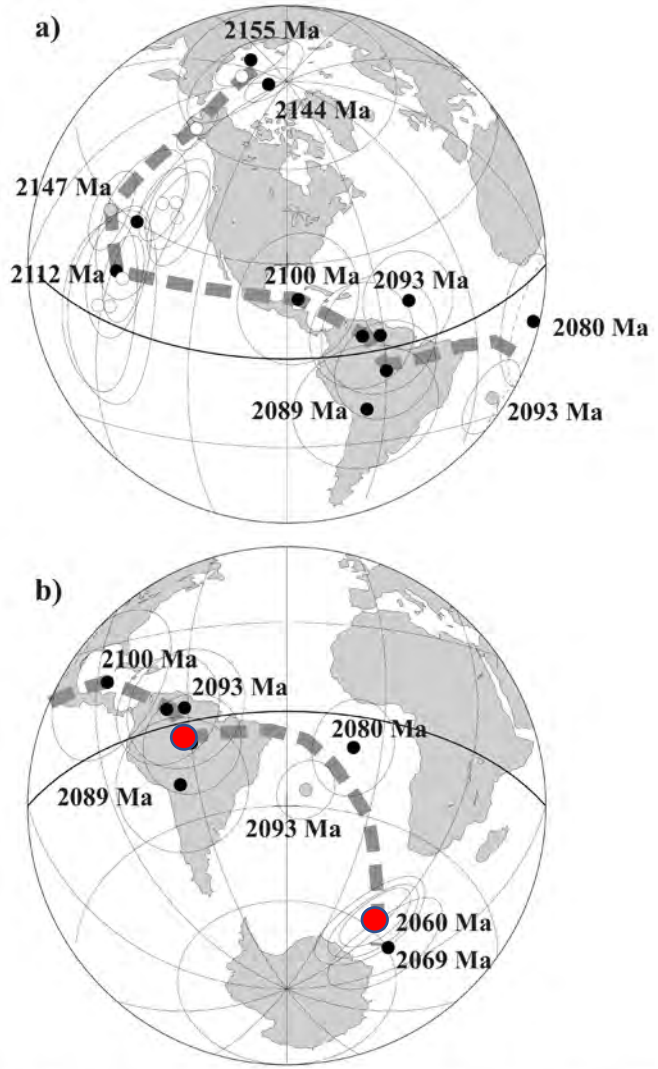
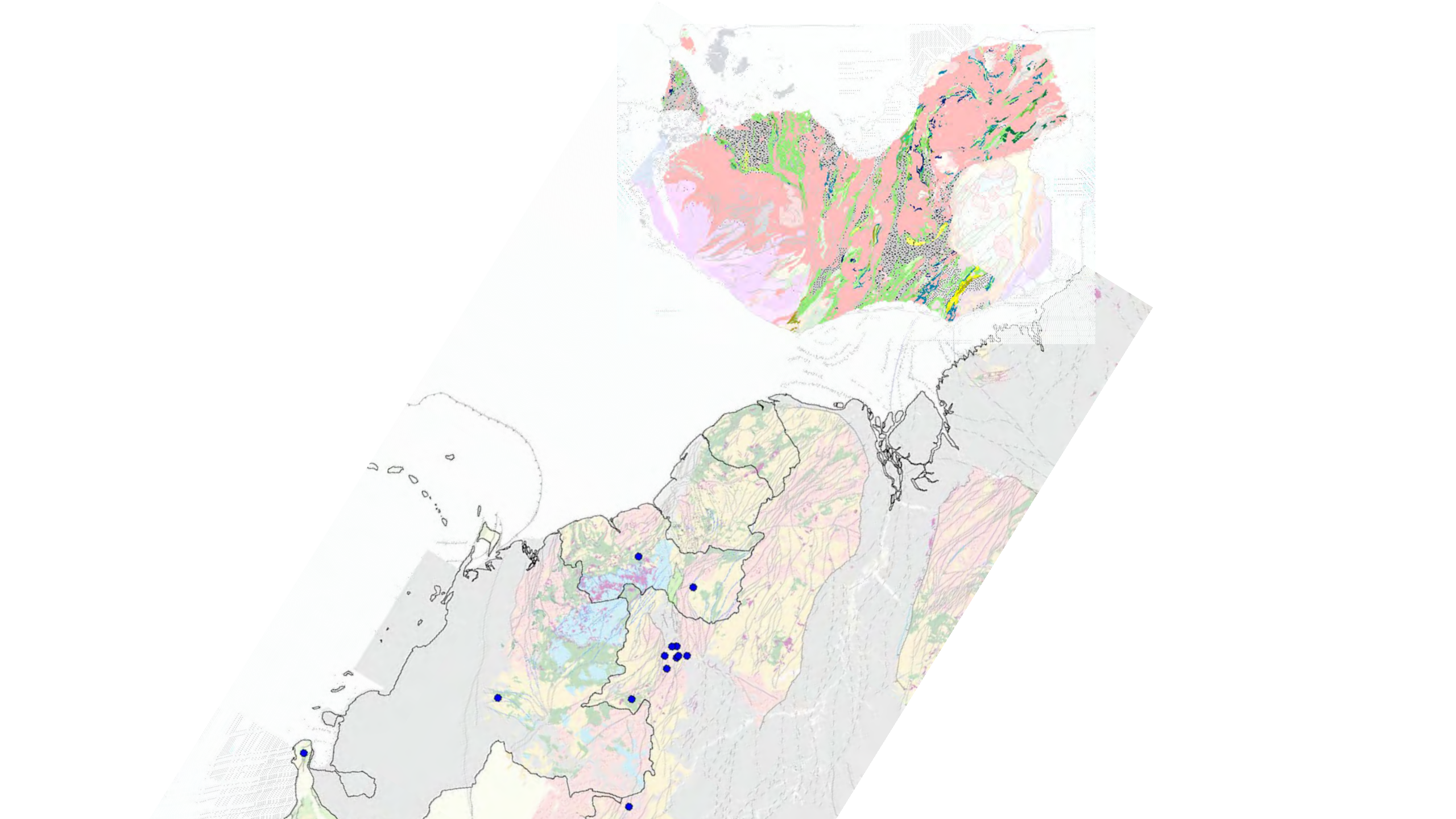
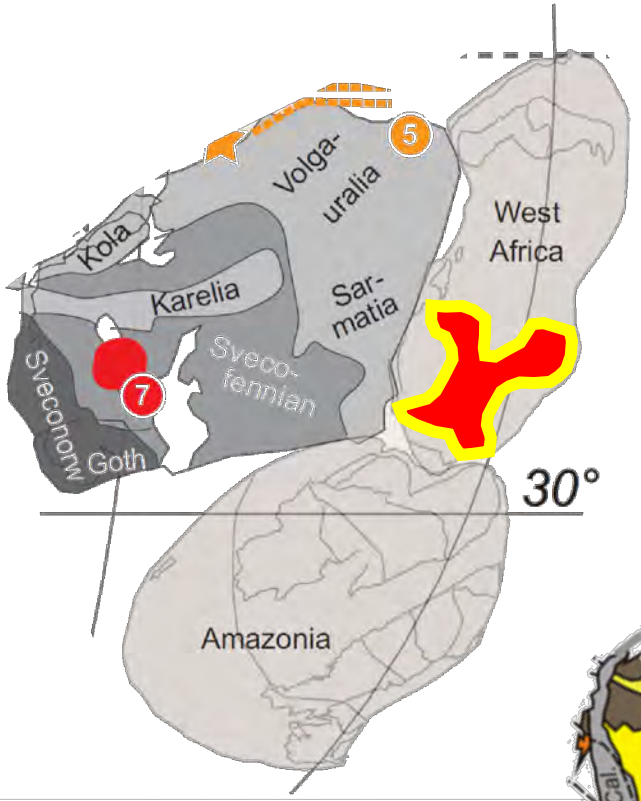


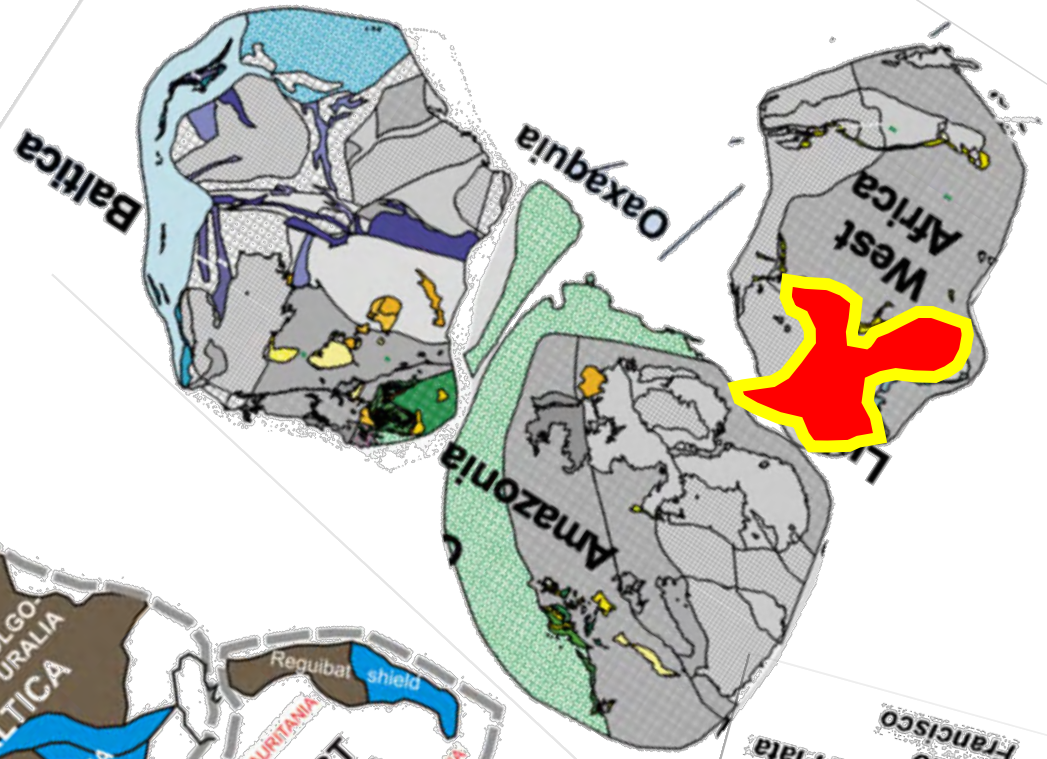
Fig. 3.- Représentation des pôles paléomagnétiques obtenus sur les séries du Paléoprotérozoïque de Guyane Française (Théveniaut *et al.*, in prep.). Les âges indiqués sont les âges des roches (méthode Pb-Pb sur monozircons). 3a) période 2155-2080 Ma ; 3b) période 2100-2060 Ma.

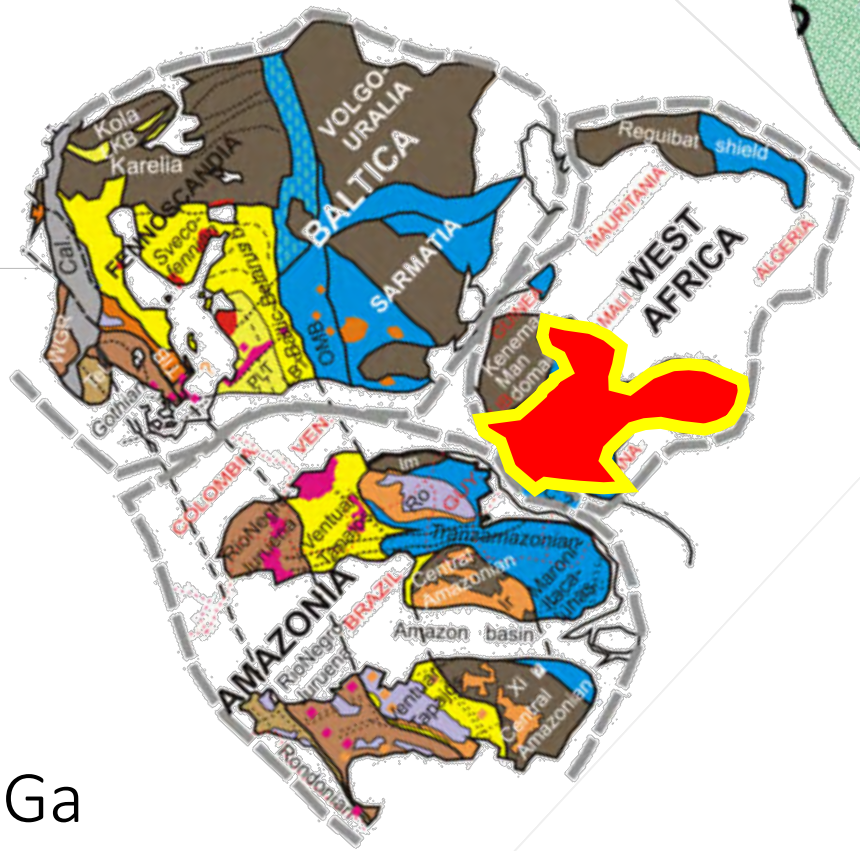
Fig. 3.- Plot of the paleomagnetic poles obtained on the Paleoproterozoic series of the Guiana Shield (Théveniaut et al., *in prep.). The indicated ages are the rock ages (Pb-Pb on single zircons). 3a) 2155-2080 Ma period; 3b) 2100-2060 Ma period.*

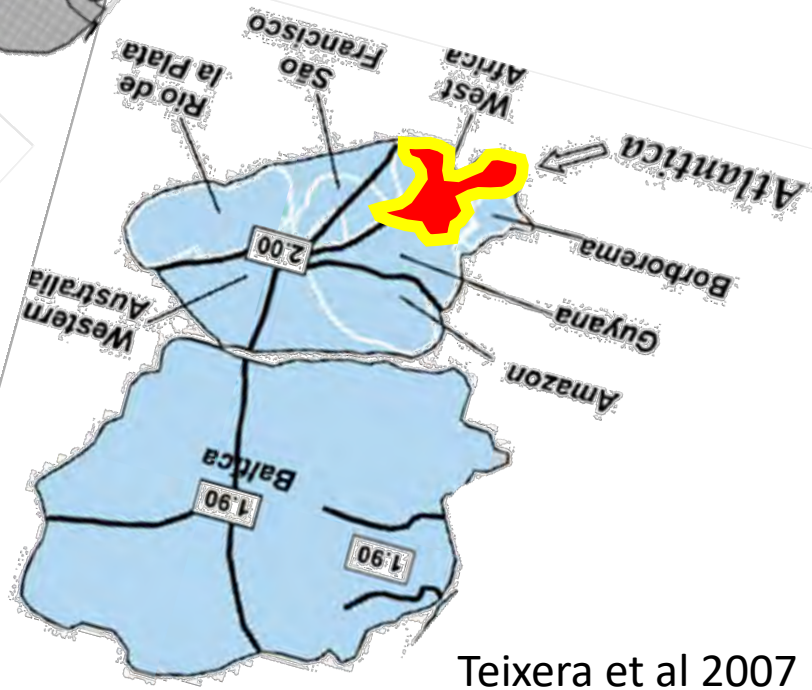
Nomade et al. 2001, PR.











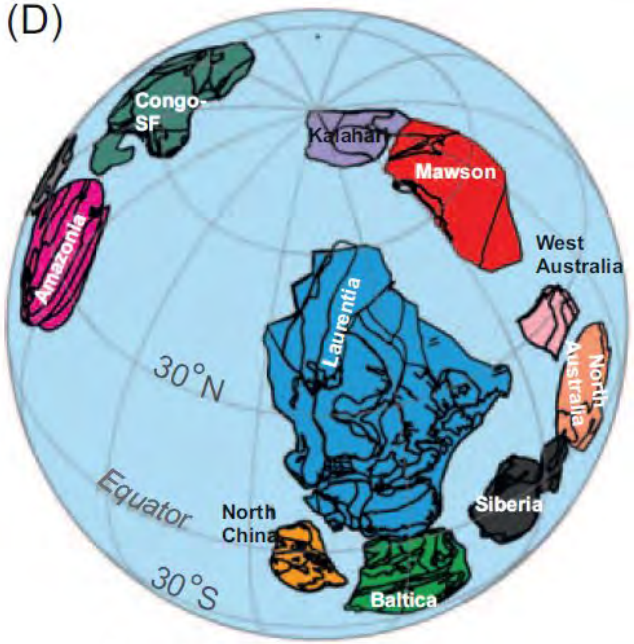
West Africa at ~2.2 Ga

Teixera et al 2007

DIFFERENT NUNA MODELS

NUNA

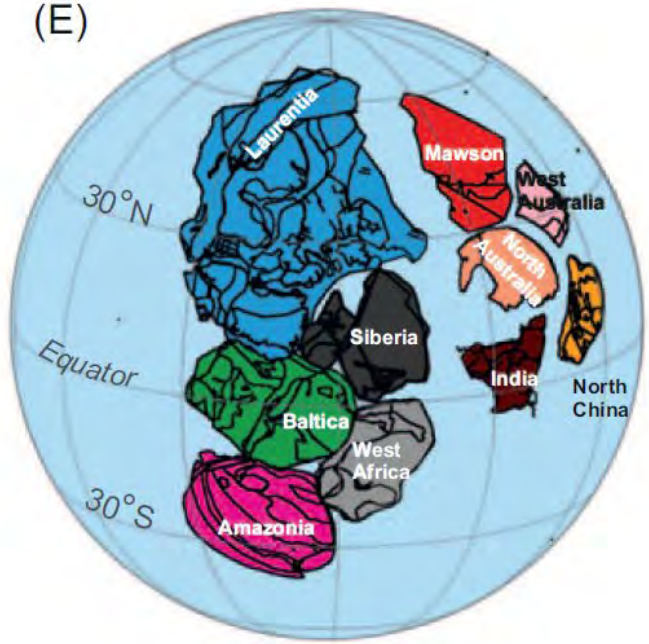
(D)



Rogers 1996,
Rogers and Santosh, 2009

NUNA

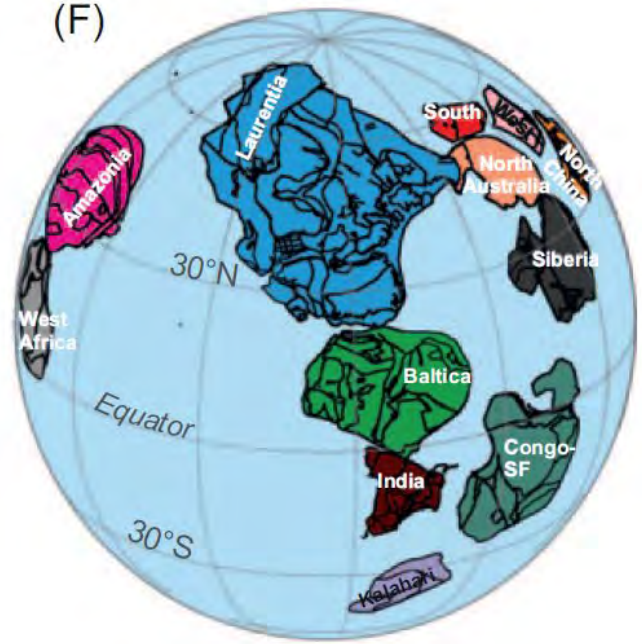
(E)



Zhang et al. 2012

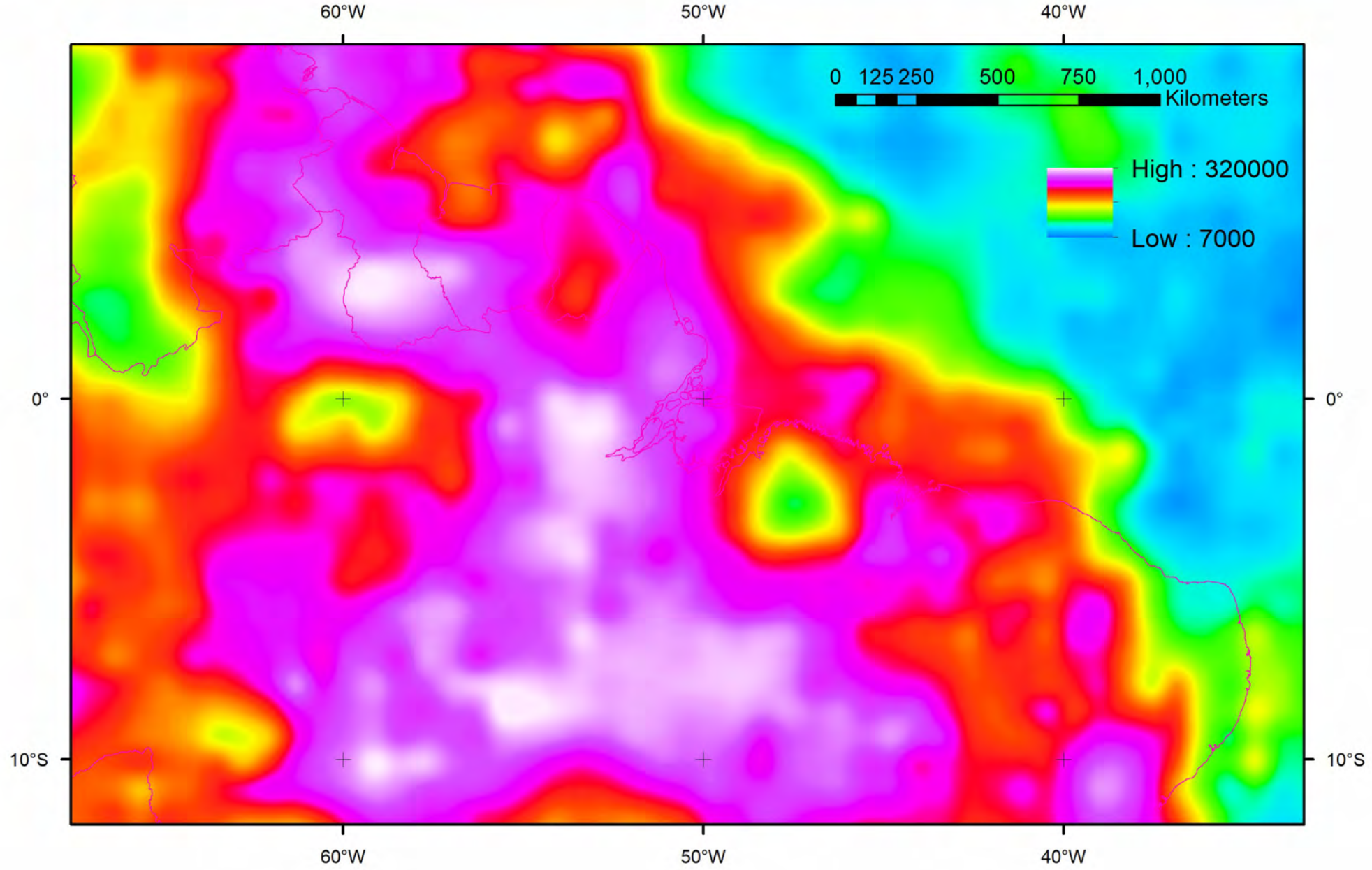
NUNA

(F)



Pisarevsky et al. 2014

Lithosphere
Asthenosphere
Boundary



Pasyanos

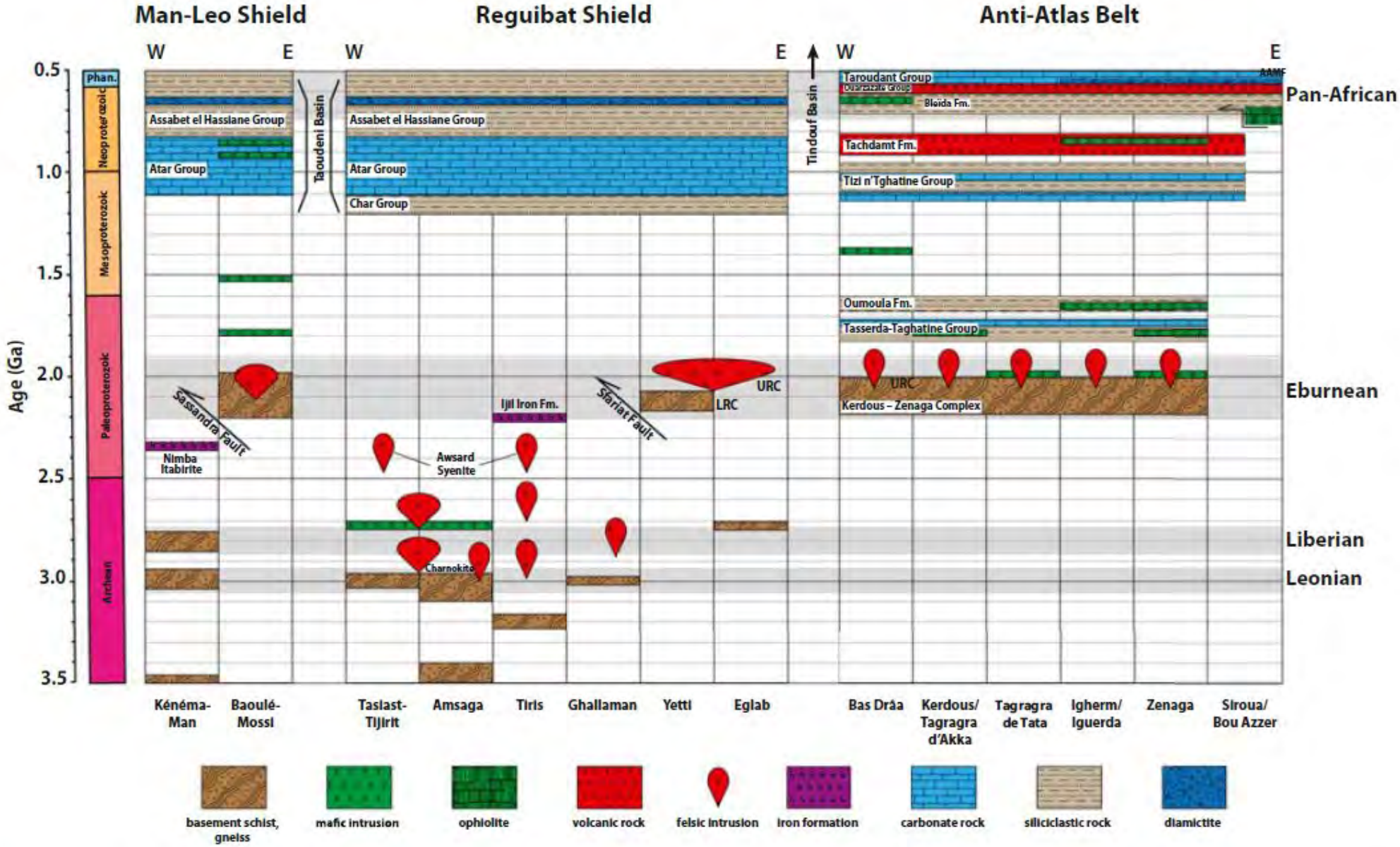
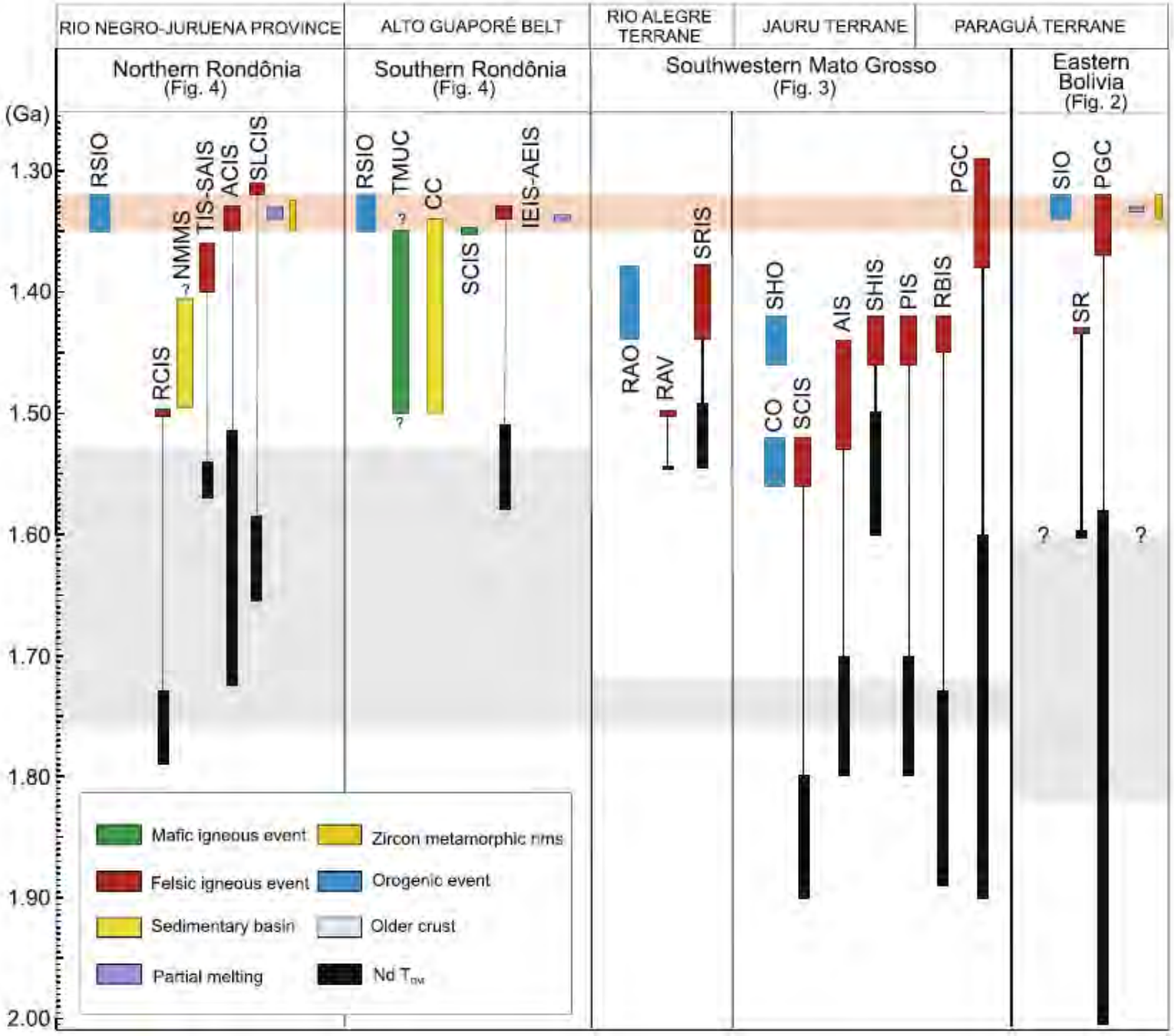
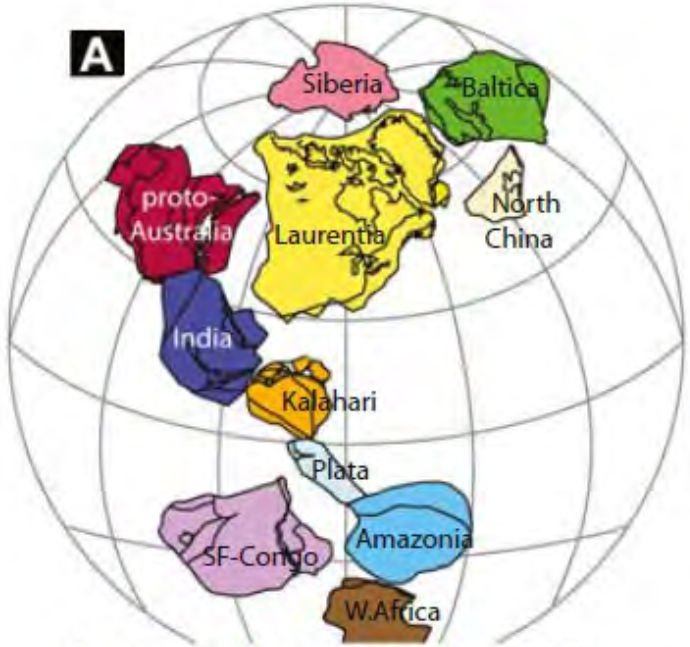


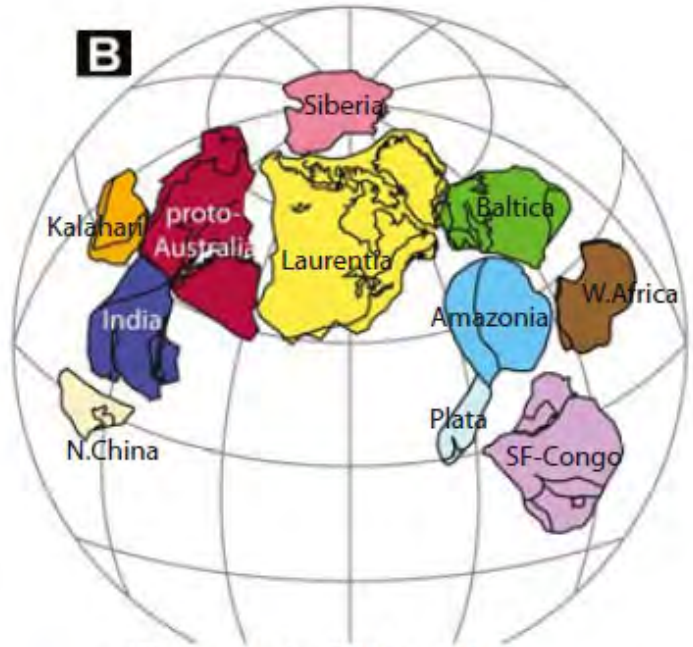
FIGURE 13.2 Time-space diagram demonstrating the spatial and tectonic relationships between the tectonostratigraphic units of West African Craton. LRC, Lower Reguibat Complex; URC, Upper Reguibat Complex; AAMF, Anti-Atlas Major Fault. Neoproterozoic dykes intruded basement rocks in Man-Leo Shield.


RIO NEGRO-JURUENA PROVINCE
ALTO GUAPORÉ BELT
RIO ALEGRE TERRANE
JAURU TERRANE
PARAGUÁ TERRANE
Northern Rondônia (Fig. 4)
Southern Rondônia (Fig. 4)
Southwestern Mato Grosso (Fig. 3)
Eastern Bolivia (Fig. 2)
(Ga)
1.30
1.40
1.50
1.60
1.70
1.80
1.90
2.00
RSIO
NMMS
TIS-SAIS
ACIS
SLCIS
RCIS
TMUC
CC
SCIS
IEIS-AEIS
RAO
RAV
SRIS
SHO
CO
SCIS
AIS
SHIS
PIS
RBIS
PGC
SIO
SR
PGC
Mafic igneous event
Felsic igneous event
Sedimentary basin
Partial melting
Zircon metamorphic rims
Orogenic event
Older crust
Nd T_{DM}

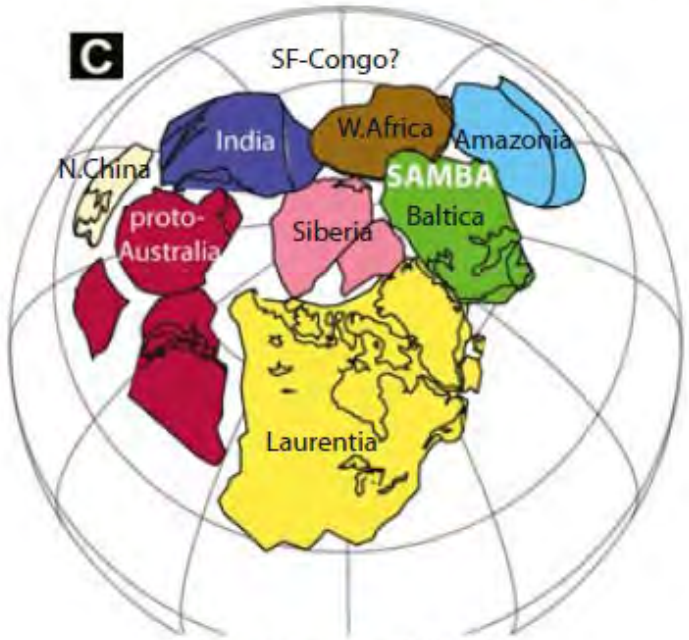
Nuna/ Columbia



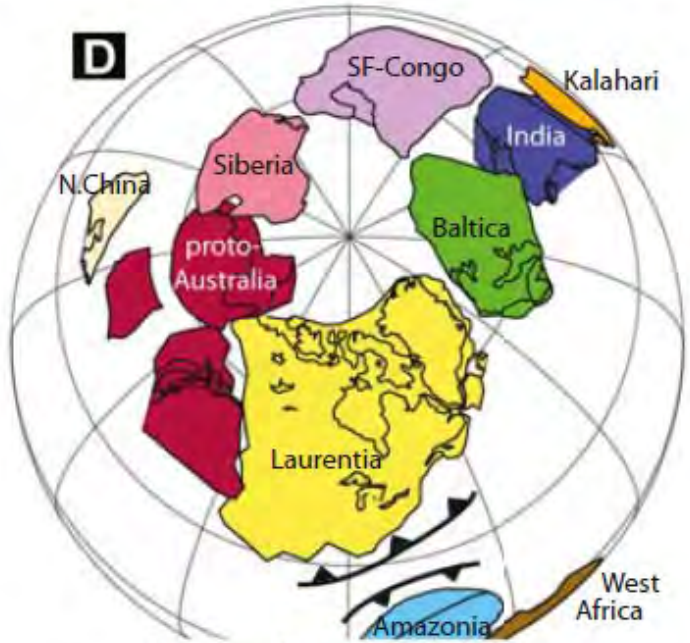
Rogers & Santosh (2002, 2009)



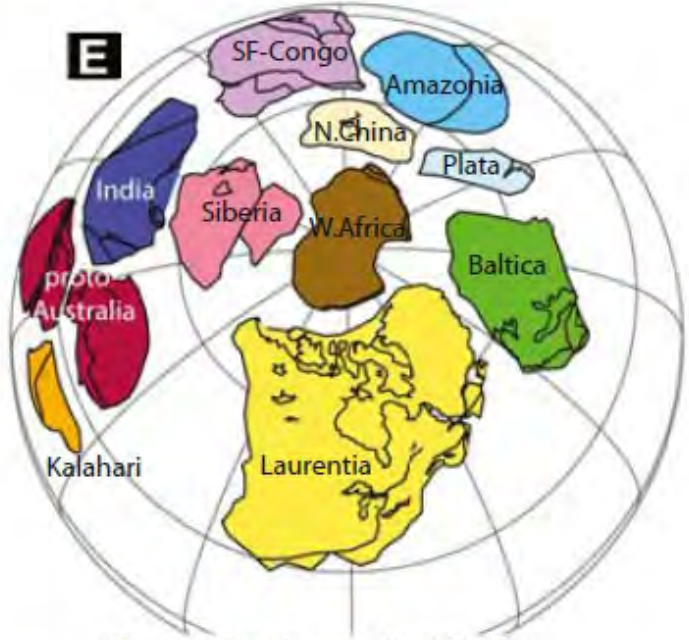
Zhao et al. (2002, 2004)



Zhang et al. (2012)



Pisarevsky et al. (2014)



Chaves & Rezende (2019)